INSTRUCTION MANUAL

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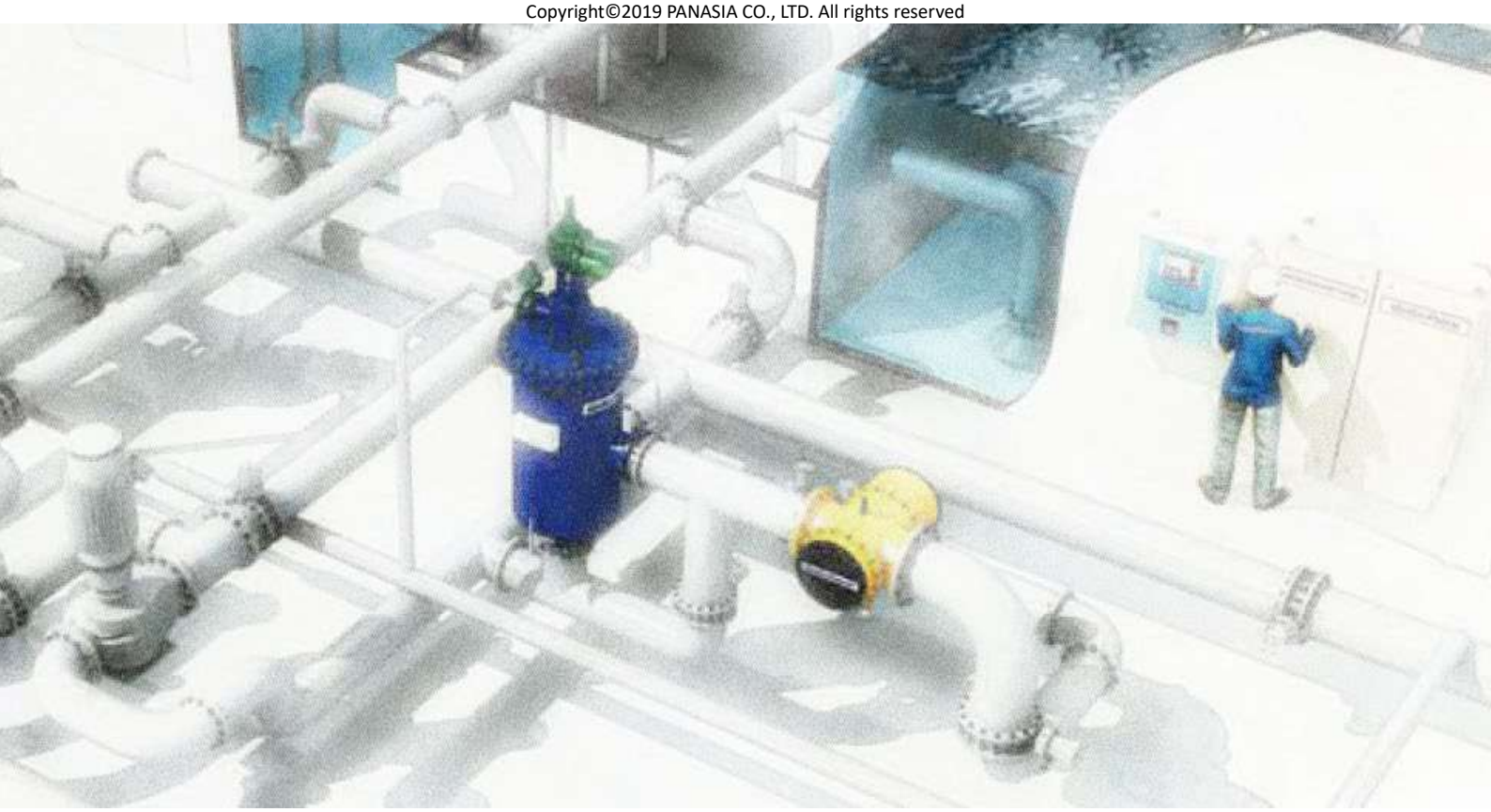

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Table of Contents

I. PRINCIPLES OF BALLAST WATER MANAGEMENT SYSTEM

A. Understanding

PANASIA's Ballast Water Management System is based on a water treatment technology consisting of a filter followed by Ultraviolet (UV) disinfection. Ballast Water Management System operates in four (4) modes:

1. Ballast Mode
2. De-Ballast Mode
3. Eductor (Stripping) Mode
4. Bypass Mode

with the following four (4) major components:

1. Filtration unit: for removal of equal to or larger than 50 micron size organisms and particles (≥ 50µm)
2. UV unit: for disinfection to destroy DNA of organisms and pathogens smaller than 50 micron size (<50µm)
3. Control Panel
4. UV Power Supply Panel

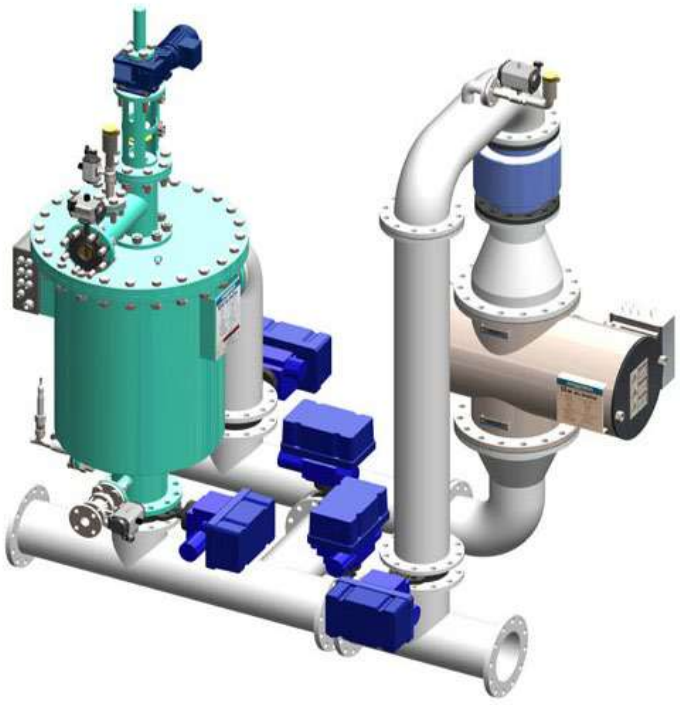


Figure 1.1 configuration of BWMS

The primary treatment takes place during ballasting and a secondary treatment during de-ballasting. During ballasting, organisms and sediment larger than fifty microns (50µm) are separated by the filter and returned to local waters. Smaller organisms passing through the fil ter flow into the UV chamber where the UV disinfection takes place.

During de-ballasting, any surviving organisms during intake are treated again in the UV chamber to ensure compliance of the applicable rules. The filter unit is bypassed during de-ballasting.

- *FILTER UNIT* is located downstream of the ballast pump(s) and removes particles and marine organisms larger than fifty microns (50µm) and returns them to the local waters. When particles and organisms clog the filter screen and the unit senses differential pressure build up, back flushing takes place automatically.

- *UV UNIT (Chamber)* employs high-density, medium-pressure ultraviolet (MPUV) lamps which destroy reproduction cells of living organisms in the water and thereby, prevent organism reproduction and colonization. Each UV lamp is protected in a quartz sleeve with water-tight seals so that water does not come into direct contact with the lamp. Three (3) different levels of power to the UV unit are available and the UV chamber is equipped with UV intensity sensor to ensure required intensity of UV is applied regardless the operating condition.

- *CONTROL PANEL* is a programmable logic controller (PLC) based unit with proportional-integral-derivative (PID) controller and touchscreen operator interface that controls all devices and functions of the BWMS and performs real-time monitoring of operating conditions, data collection and recording.

- *UV POWER SUPPLY PANEL* houses all devices and parts required to provide power to the UV unit. It contains necessary devices to automatically adjust the power level to maintain the required UV intensity level, to protect the UV lamps and to provide safety of the power supply system.

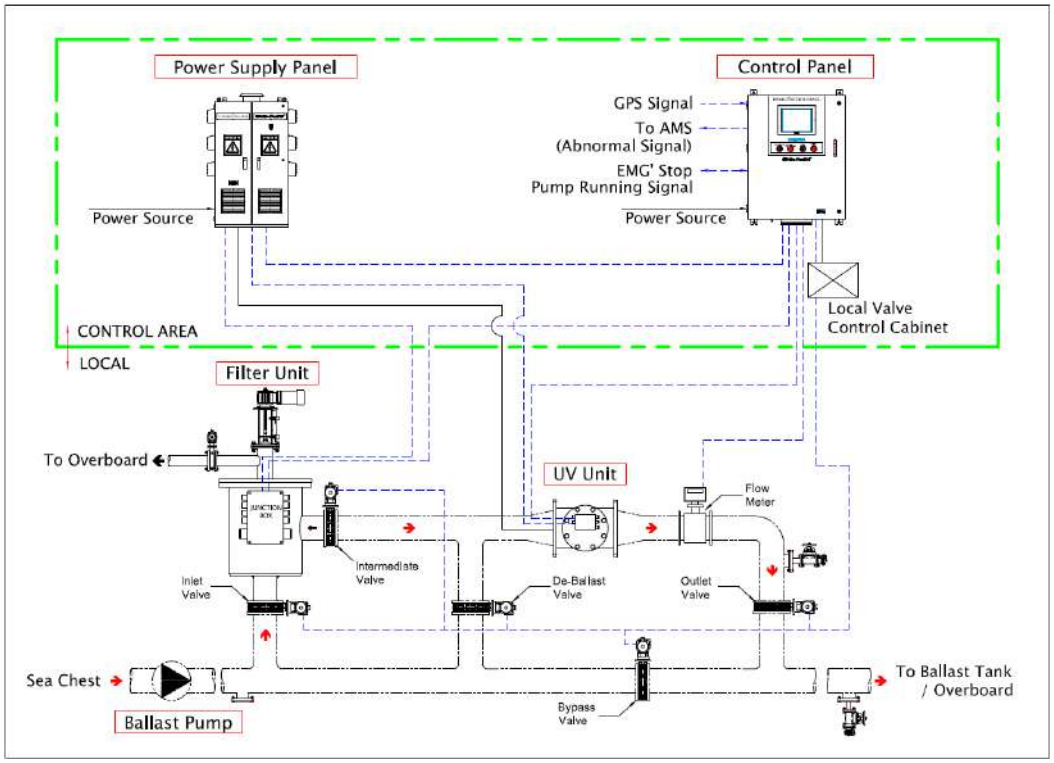


Figure 1.2 Process flow diagram of *BALLAST MODE*

B. The theory of operation

In general, BWMS is composed with 4 major components with 5 main system valves, but it is required to monitor the other valves' position as well (it can be also controlled by VRC - Valve Related Control) for data logging regarding any system bypass of the treatment system.

When the system is ready to operate (Power ON), all main system valves are in closed status as shown in Figure 1.3.

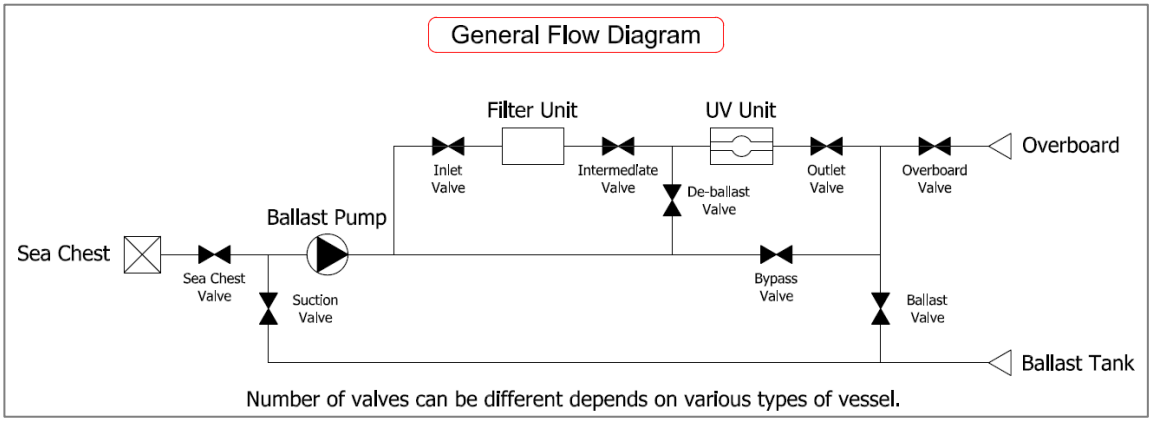


Figure 1.3 Process flow diagram of *BWMS*

Valve Control and Monitoring for log data			
System relevant valves (VRC)		**Main valves (BWMS)**	
Sea Chest Valve	Overboard Valve	Inlet Valve	Outlet Valve
Suction Valve	Ballast Valve	Intermediate Valve	De-ballast Valve
-	-	Bypass valve	-

4 system relevant valves must be operated by VRC(Remote). BWMS should receive these 4 signals from VRC to provide automatic control, but it is not mandatory. If BWMS takes these signals for better operating (automatic), BWMS can send stop signals to the valves for automation. Signal communication with VRC system is connected by MODBUS RTU protocol. Valve status and pump running (status) signals are received from vessel's system such as VRC, and BWMS can control them through the communication protocol as well. Main BWMS valves are automatically operated at all time but system relevant valves are able to be operated manually or automatically and this depends on ship owner's decision.

(1) Ballast Mode

Local water in the sea chest is pumped in and passes through a filter with a fifty micron (50μm) screen. Back-flushing takes place automatically when differential pressure reaches 0.45 bar (kg/cm^2). Suction scanners rotate and move vertically in a spiral manner, to cover the entire screen in approximately 40-45 seconds. Extracted organisms and sediment are discharged overboard into the local waters. Water passed through the filter goes though the UV chamber and then to the ballast tank.

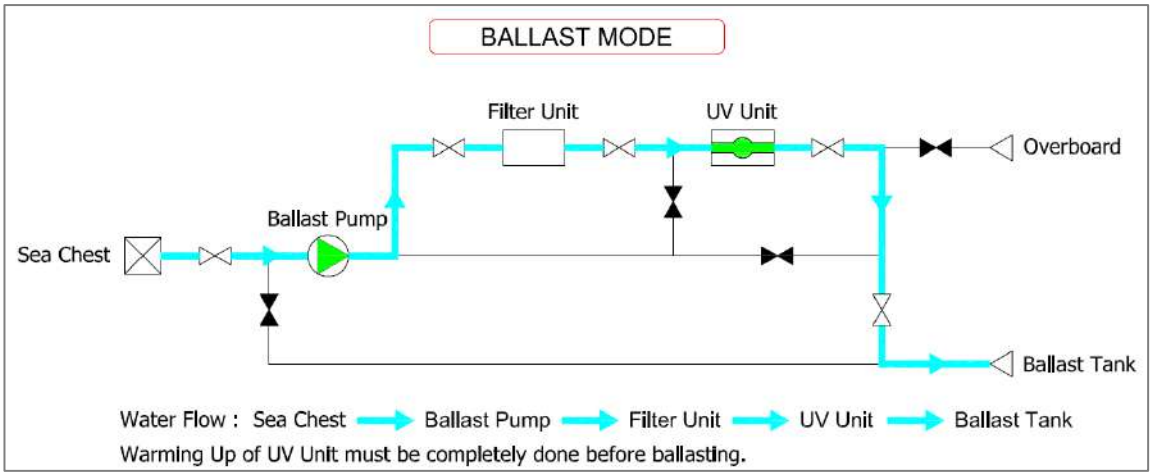


Figure 1.4 Process flow diagram of *BALLAST MODE*

(2) De-Ballast Mode

Treated ballast water is re-treated through the UV unit before being discharged overboard without going through the filter.

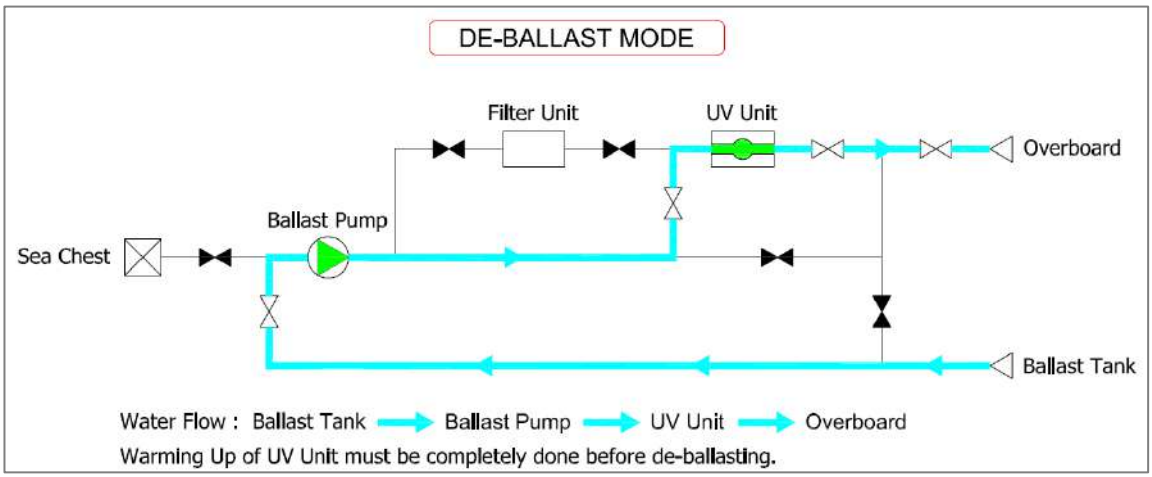


Figure 1.5 Process flow diagram of *DE-BALLAST MODE*

(3) Standby Condition

When the system is in *STANDBY CONDITION*, ballast water with sediment flows from the sea chest and to be discharged overboard. In addition, this process will take place automatically if the valves are arranged as shown in Figure 1.6.

And the main purpose of the process is,

- The preparation of warming up before ballasting or de-ballasting; or
- Cool down of UV unit(s) after operation.

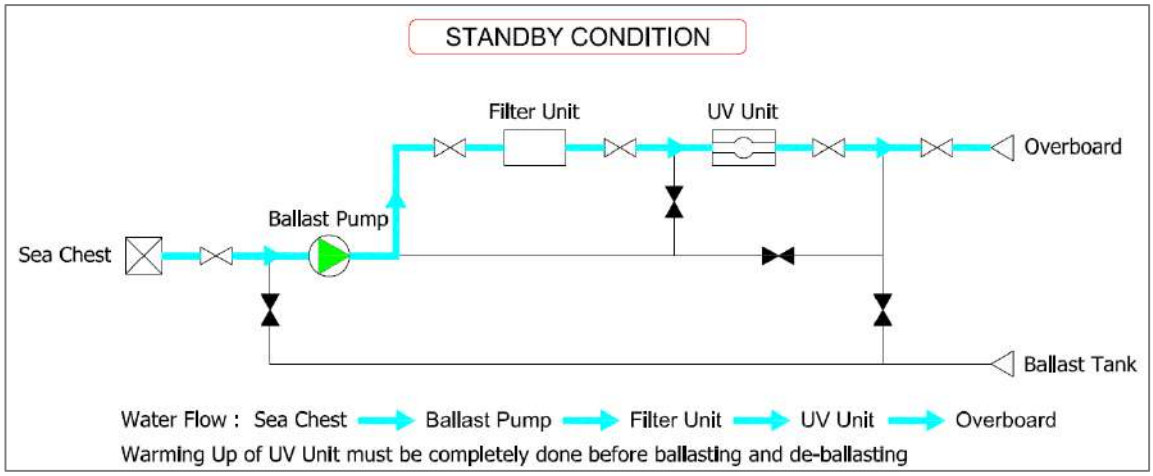


Figure 1.6 Process flow diagram of *STANBY CONDITION*

- Warming up

Before ballasting or de-ballasting, it is mandatory that UV lamps are warmed up (approximately for 5 minutes) while water flows through the UV unit. The water during warm up is discharged overboard and not into the ballast tank.

When *BALLAST MODE* or *DE-BALLAST MODE* is selected on the HMI, three (3) main valves (inlet, intermediate and outlet valve) are opened, but the other two (2) valves (de-ballast and bypass valve) are closed.

Sea chest and overboard valve will be also opened automatically if BWMS can control the system relevant valves. Then it is able to run the ballast pump for warming up or cooling, but it is important that the ballast pump must be operating prior to turn the UV lamp on at all time.

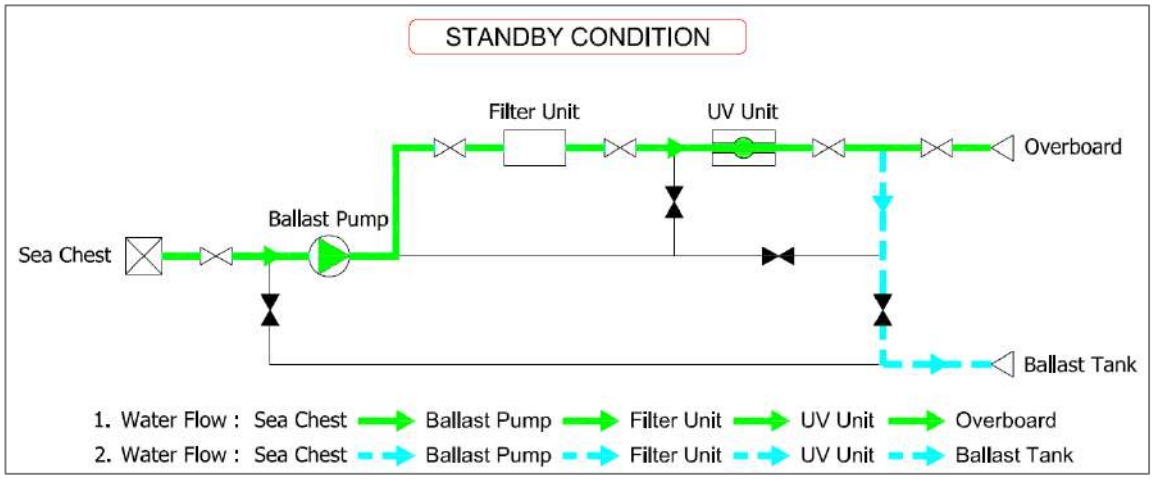


Figure 1.7 Process flow diagram of warming up process before ballasting

When warming up is completed (UV intensity is satisfied), ballasting or de-ballasting will automatically run as Figure 1.7 that shows the example of process changing for ballasting.

NOTE: *If there is no injection/discharge of untreated water during deballasting, the water flow direction of warm-up can be adjusted according to the site conditions. (e.g. tank to tank)*

- Cooling

Otherwise, the system will also change valve configuration automatically after ballasting or de-ballasting in order to cool down the temperature of UV unit as shown in Figure 1.8.

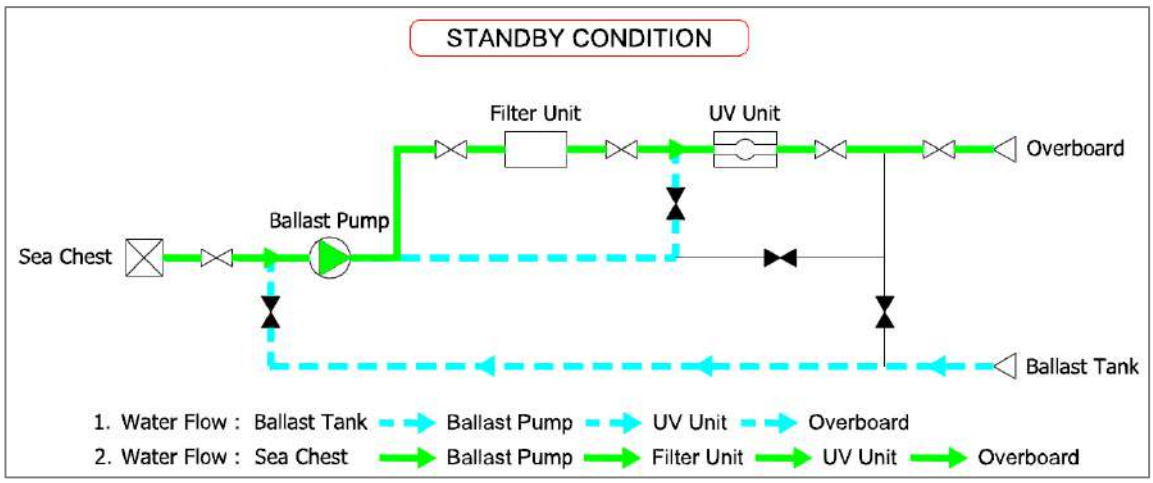


Figure 1.8 Process flow diagram of cooling process after de-ballasting

After cooling down the UV unit, the ballast pump will be stopped then, all system main valves will be closed including the sea chest valve and the overboard valve.

NOTE: *Residual water in the pipe can be treated by circulating it with BWMS. (e.g. circulation treatment)*

(4) Bypass Mode

BYPASS mode is operates at the operator's option in the event of a failure/malfunction outside the system design limitations of the BWMS or under exceptional conditions specified in the IMO(International Maritime Organization) regulations below. Please note that ballast water with high concentrations of turbidity and/or total suspended solids may cause system failure.

Regulations A-3 *Exceptions*

The requirements of regulation B-3, or any measures adopted by a Party pursuant to Article 2.3 and Section C, shall not apply to:

1 the uptake or discharge of Ballast Water and Sediments necessary for the purpose of ensuring the safety of a ship in emergency situations or saving life at sea; or

2 the accidental discharge or ingress of Ballast Water and Sediments resulting from damage to a ship or its equipment:

.1 provided that all reasonable precautions have been taken before and after the occurrence of the damage or discovery of the damage or discharge for the purpose of preventing or minimizing the discharge; and

.2 unless the owner, company or officer in charge willfully or recklessly caused damage; or

3 the uptake and discharge of Ballast Water and Sediments when being used for the purpose of avoiding or minimizing pollution incidents from the ship; or

4 the uptake and subsequent discharge on the high seas of the same Ballast Water and Sediments; or

5 the discharge of Ballast Water and Sediments from a ship at the same location where the whole of that Ballast Water and those Sediments originated and provided that no mixing with unmanaged Ballast Water and Sediments from other areas has occurred. If mixing has occurred, the Ballast Water taken from other areas is subject to Ballast Water Management in accordance with this Annex.

NOTE: *The operator manages the untreated water injected into the BW tank through bypass operation in consideration of BWM Convention Regulations A-3 & A-4 Exceptions and B-4 Ballast Water Exchange.*

- **Bypass Mode**

BYPASS MODE is designed to bypass the system and it must be activated in accordance with exceptions. It is always possible for the safety of vessel and there are three (3) ways to achieve *BYPASS MODE,*

.1 Turned the mode selector switch to *BYPASS* position; or
.2 Push the *EMERGENCY* button on the control panel; or
.3 The *PUMP STOP SIGNAL* not applied during in case of system shutdown

Ballast water is now forced to flow into ballast tank or to be discharged overboard for vessel's safety as shown in Figure 1.9 and 1.10.

All external valve(s) and the ballast pump(s) can be now controlled by an operator and valve status will be recorded (Refer to Figure 3.41 Status log files). This mode allows ballasting or de-ballasting without the system operation while the ballast pump is activating, and it is also able to transfer water between tanks.

Opening the BWMS bypass valve provides a flow path around the filter(s) and UV unit(s) and it closes all main system valves even the system is in operating.

In addition, it triggers an alarm(s) and all events are logged.

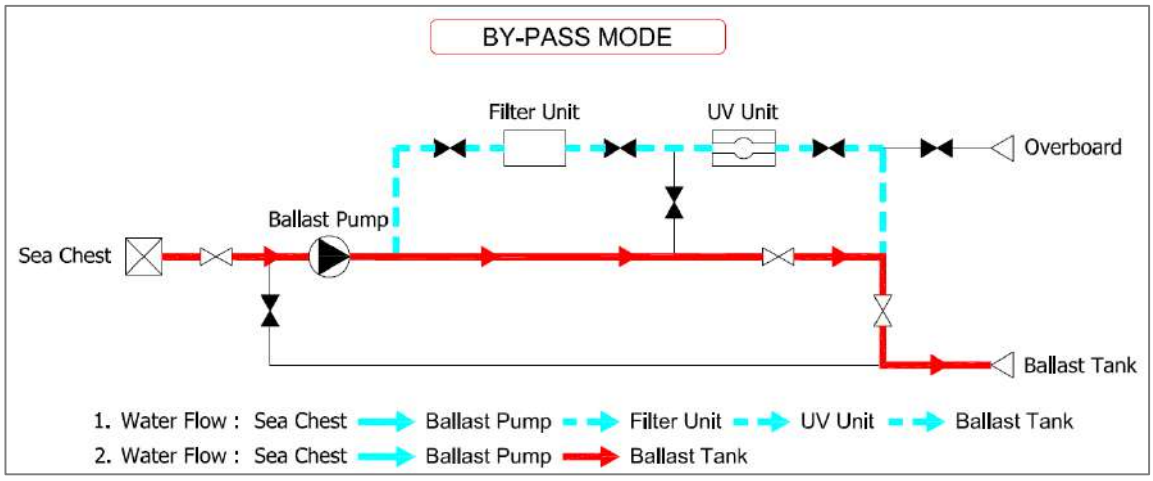


Figure 1.9 Process flow diagram *of BYPASS MODE* during *BALLAST MODE*

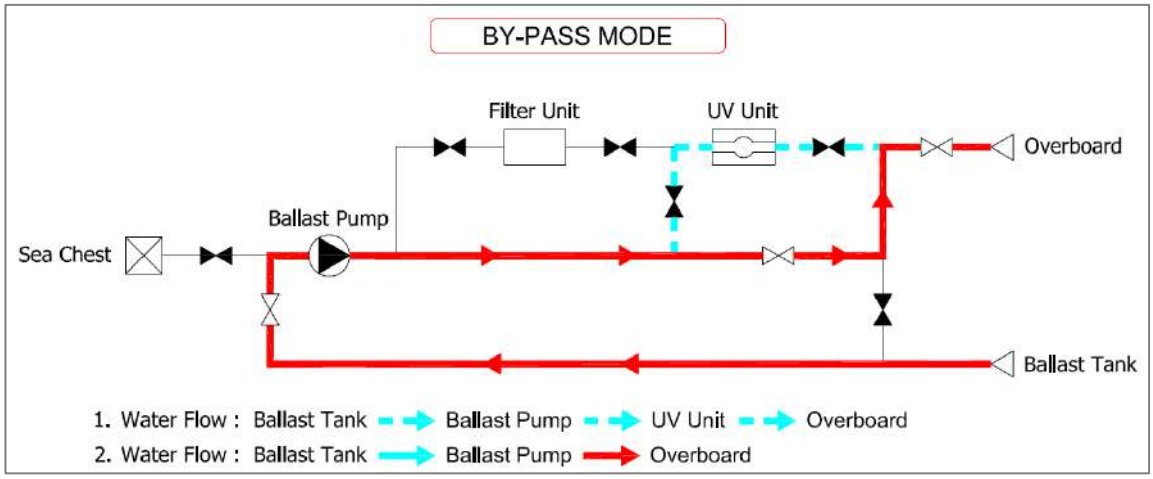


Figure 1.10 Process flow diagram *of BYPASS MODE* during *DE-BALLAST MODE*

(5) Eductor (Stripping) Mode

To remove the remaining water in the tank, a stripping eductor is used. After completing the warm up process, an operator will need to open the eductor suction valve. After *EDUCTOR MODE,* close the eductor suction valve then turn off the UV unit. The unit will have a cooling time period of approximately one (1) minute. Once the cooling time is completed, system will automatically switch to initial state (ballast pump stop and then, all main valves will be closed).

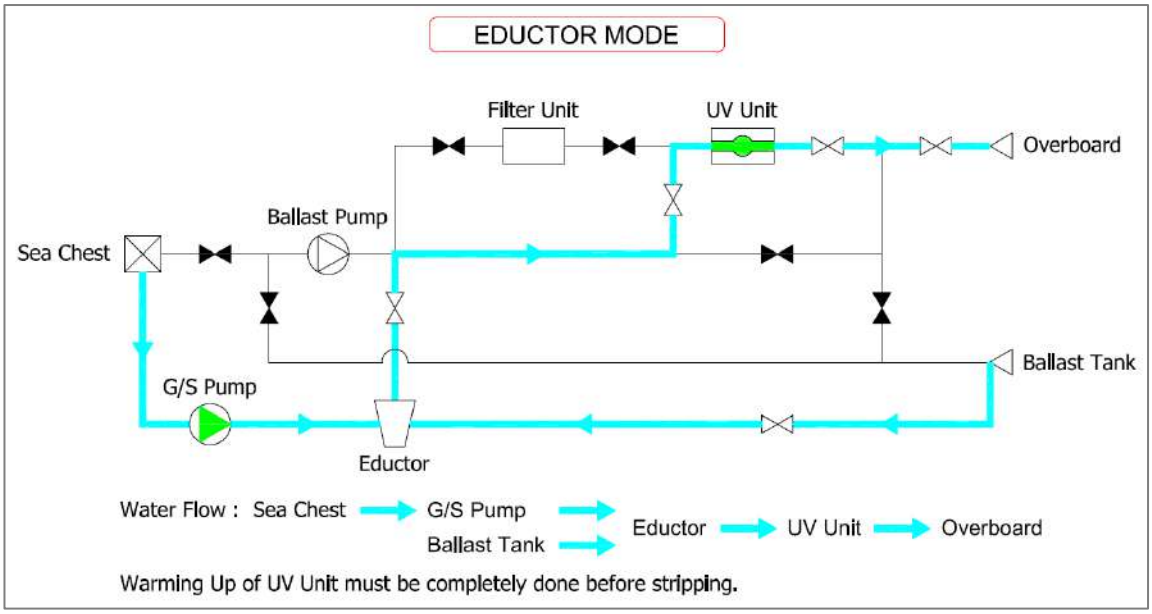


Figure 1.11 Process flow diagram of *EDUCTOR MODE* during *DE-BALLAST MODE*

C. Limitations of system

There will be no limitation or adverse effects to the vessel's ballast water, ballast water tanks and ballast water piping and pumping systems except for the removal of particles and marine organisms larger than 50 microns (50μm) and the destruction of reproduction cells of living organisms in the remaining water.

The system does not use or have a by product of any substances, relevant chemicals, and pesticides generated or stored onboard the vessel.

The following constraints are incorporated in the system design:

<table>
<tr><th colspan="3">Classification of Mode Selection by Model Version</th></tr>
<tr><td>GloEn-Patrol 2.0</td><td colspan="2">USCG HT<2day + USCG HT≥2day + IMO G8</td></tr>
<tr><td>GloEn-Patrol 2.01</td><td colspan="2">USCG HT≥2day + IMO G8</td></tr>
<tr><td>GloEn-Patrol</td><td colspan="2">USCG HT≥2day</td></tr>
<tr><td colspan="3"><u>NOTE:</u>
1. Classification of certificate by operational limitations
   1) USCG
   • USCG HT≥2day : Subject to Coast Guard Approval Number 162.060/14/(x)
   • USCG HT<2day : Subject to Coast Guard Approval Number 162.060/27/(x)
   (x) : Revision number
   2) IMO (BWMS code)
   • Subject to DNV Certificate Number TAP00001VN
2. Please refer to 'Chapter III. A.' for mode selection method.</td></tr>
<tr><th colspan="3">Operational Performance</th></tr>
<tr><td>Minimum UV Transmittance</td><td colspan="2">Table 1.2</td></tr>
<tr><td>UV Intensity (Control Target Value)</td><td colspan="2">Table 1.2</td></tr>
<tr><td rowspan="3">UV intensity alarm
(Refer to table 1.2)</td><td>USCG HT≥2day</td><td>59mW/cm^2</td></tr>
<tr><td>USCG HT<2day</td><td>MW/BW : 59mW/cm^2
FW : 81mW/cm^2</td></tr>
<tr><td>IMO G8 (BWMS Code)</td><td>59mW/cm^2</td></tr>
<tr><td>Maximum UV Lamp Power</td><td colspan="2">4.0 kW</td></tr>
<tr><td>Flow Rate</td><td colspan="2">See Table(s) 1.3, 1.4 and 1.5</td></tr>
<tr><td>Maximum Flow Rate</td><td colspan="2">Table 1.5</td></tr>
<tr><td>Minimum Flow Rate</td><td colspan="2">Table 2.7</td></tr>
<tr><td>Inlet Pressure</td><td colspan="2">1 kg/cm^2</td></tr>
<tr><td>Differential Pressure (Back-flushing)</td><td colspan="2">0.1 kg/cm^2</td></tr>
<tr><td>Maximum Working Pressure</td><td colspan="2">10 kg/cm^2</td></tr>
<tr><th colspan="3">Maritime Environmental Condition</th></tr>
<tr><td>Ambient Temperature</td><td colspan="2">0°C ~ 55°C</td></tr>
<tr><td>Water Temperature</td><td colspan="2">-2°C ~ 40°C</td></tr>
<tr><td>Salinity</td><td colspan="2">0 ~ 37PSU</td></tr>
<tr><td>Holding Time</td><td colspan="2">Table 1.2</td></tr>
<tr><td colspan="3"><u>NOTE:</u></td></tr>
</table>

- *Filtration + UV disinfection system is applicable for any type(salinity) of water.*
- *Outside of these limitations, it is not assessed that the BWMS will meet the performance standard of regulation D-2.*

Table 1.1 System Design Limitation (SDL)

Operational Performance Range (UVI mW/cm^2 / UVT %)					
Salinity condition	Description		USCG HT≥2day	USCG HT<2day	IMO
Marine/Brackish Water	Full flow	UVI	x > 90	x > 90	x > 70
		UVT	x > 70	x > 70	x > 60
	Half flow	UVI	60 ≤ x ≤ 90	60 ≤ x ≤ 90	60 ≤ x ≤ 70
		UVT	55 ≤ x ≤ 70	55 ≤ x ≤ 70	55 ≤ x ≤ 60
Fresh Water (x < 1PSU)	Full flow	UVI	x > 90	x > 110	x > 90
		UVT	x > 70	x > 75	x > 70
	Half flow	UVI	60 ≤ x ≤ 90	82 ≤ x ≤ 110	60 ≤ x ≤ 90
		UVT	55 ≤ x ≤ 70	63 ≤ x ≤ 75	55 ≤ x ≤ 70
Holding time (minimum)			48hrs	24hrs	Not limited
Remark			x : measured value		

UV Set value (mW/cm^2)			
Description	Case 1	Case 2	Case 3
UVI Set	93	113	73
Half Flow Set	90	110	70
Alarm 1 Set	60	82	60
Alarm 2 Set	59	81	59
Trip 1 Set	56	78	56

Classification by case according to mode and salinity condition				
Mode	Salinity condition	Case 1	Case 2	Case 3
USCG HT≥2day	MW / BW	O		
	FW	O		
USCG HT<2day	MW / BW	O		
	FW		O	
IMO	MW / BW			O
	FW	O		

Table 1.2 Detail of performance range and conditions

- Auto Flow Control Function

  When maximum power is provided for UV unit but UV Intensity is lower than the minimum target intensity, Auto Flow Control function in BWMS automatically begins to control flow rate to achieve system performance available under UV transmittance.

- Auto UV Power Control Function

  In case the UVI is increased over the 120mW/cm2, when the BWMS starts up and after warming up, the BWMS is operated to Mid. Power. But, in case UVI is increased over the 120mW/cm2 even at Mid. Power, the power of the BWMS is operated to Min. power. Also, in case the UVI is decreased below 93mW/cm^2 (case1) & 113mW/cm^2 (case2) & 73mW/cm^2 (case3) the current power level will go up one level. If UVI is decreased to the below 90mW/cm^2 (case1) & 110mW/cm^2 (case2) & 70mW/cm^2 (case3) even at the full power, the flow rate is operated to half flow by auto flow control.

- Auto Salinity Control Function (Applies only to GloEn-Patrol 2.0)

  When the salinity level increases by more than 1 PSU through the conductivity sensor, BWMS recognizes it as marine water or brackish water and sets the appropriate UV set value automatically. If the salinity level is less than 1 PSU, BWMS recognizes it as fresh water and sets the appropriate UV set value automatically. (Refer to Table 1.2)

D. Performance ranges and expectations

Two (2) types of UV units are available depending on the area classification:

- PU### model is used in non-hazardous area(s);
- PU###-Ex (explosion-proof) model is IEC-Ex certified and used for hazardous area (Zone 1).

	Model Name	Application	# of Lamps	Maximum Capacity (TRC)
UV Unit	*PU50(2)*	*Standard model*	*2*	*50 m^3/hr*
	PU250(6)		*6*	*150 m^3/hr*
	PU250(8)		*8*	*250 m^3/hr*
	PU250(12)		*12*	*350 m^3/hr*
	PU500(18)		*18*	*500 m^3/hr*
	PU500(24)		*24*	*700 m^3/hr*
	PU1000(22)	*High Capacity model*	*22*	*1,000 m^3/hr*
	PU1250(26)		*26*	*1,250 m^3/hr*
	PU1500(32)		*32*	*1,500 m^3/hr*
NOTE: *For application in hazardous area, all electrical devises are explosion proof type. Explosion proof type (Optional):* *a. IEC-Ex : Ex px IIC T4 Gb (-20°C ≤ Ta ≤ 60°C)* *b. ATEX : II 2 G Ex px IIC T4 (-20°C ≤ Ta ≤ 60°C)*				

Table 1.3 UV unit models

	Model Name	Application	Maximum Capacity (TRC)
Filter Unit	*PF50*	*Standard model*	*50 m^3/hr*
	PF250		*250 m^3/hr*
	PF500		*500 m^3/hr*
	PF750		*750 m^3/hr*
	PF900	*High Capacity model*	*900 m^3/hr*
	PF1200		*1,200 m^3/hr*
	PF1500		*1,500 m^3/hr*
	PF2000		*2,000 m^3/hr*
	PF2500		*2,500 m^3/hr*
	PF3000		*3,000 m^3/hr*
NOTE: *For application in hazardous area, all electrical devises are explosion proof type.*			

Table 1.4 Filter unit models

Standard filter models handle capacity between 50m^3/hr and 750m^3/hr inclusive. High capacity filter models handle capacity between 900 and 3,000 m^3/hr inclusive. Capacity in the range of 750 ~ 6,000 m^3/hr can be handled by combining single or multiple capacity UV unit(s) and filter(s) in parallel (Refer to Table 1.4). Though BWMS is made of several UV units and Filter units, they aren't controlled as a group. Each unit controls its own flow by itself based on TRC.

Model Name	Maximum Capacity	UV Unit (Quantity of Lamps)	Filter Unit
GloEn-P50	*50 m3/hr*	*PU50 (2)*	*PF50*
GloEn-P150 (-Ex)	*150 m3/hr*	*PU250 (6)*	*PF250*
GloEn-P250 (-Ex)	*250 m3/hr*	*PU250 (8)*	
GloEn-P300 (-Ex)	*300 m3/hr*	*PU250 (12)*	*PF500*
GloEn-P350 (-Ex)	*350 m3/hr*		
GloEn-P500 (-Ex)	*500 m3/hr*	*PU500 (18)*	
GloEn-P700 (-Ex)	*700 m3/hr*	*PU500 (24)*	*PF750*
GloEn-P750 (-Ex)	*750 m3/hr*	*PU1000 (22)*	
GloEn-P750-1 (-Ex)		*PU250 (8)+PU500 (18)*	
GloEn-P800 (-Ex)	*800 m3/hr*	*PU1000 (22)*	*PF900*
GloEn-P800-1 (-Ex)		*PU250 (12)+PU500 (18)*	*2 x PF500*
GloEn-P900 (-Ex)	*900 m3/hr*	*PU1000 (22)*	*PF900*
GloEn-P900-1 (-Ex)		*2 x PU500 (18)*	*2 x PF500*
GloEn-P1000 (-Ex)	*1,000 m^3/hr*	*PU1000 (22)*	*PF1200*
GloEn-P1000-1 (-Ex)		*2 x PU500 (18)*	*2 x PF500*
GloEn-P1200 (-Ex)	*1,200 m^3/hr*	*PU1250 (26)*	*PF1200*
GloEn-P1200-1 (-Ex)		*2 x PU500 (24)*	*2 x PF750*
GloEn-P1500 (-Ex)	*1,500 m^3/hr*	*PU1500 (32)*	*PF1500*
GloEn-P1500-1 (-Ex)		*3 x PU500 (18)*	*3 x PF500*
GloEn-P2000 (-Ex)	*2,000 m^3/hr*	*2 x PU1000 (22)*	*PF2000*
GloEn-P2000-1 (-Ex)		*3 x PU500(24)*	*3 x PF750*

GloEn-P2500 (-Ex)	*2,500 m^3/hr*	*2 x PU1250 (26)*	*PF2500*
GloEn-P2500-1(-Ex)		*4 x PU500(24)*	*PF2500*
GloEn-P3000 (-Ex)	*3,000 m^3/hr*	*2 x PU1500 (32)*	*PF3000*
GloEn-P3000-1 (-Ex)		*6xPU500(18)*	*PF3000*
GloEn-P3500 (-Ex)	*3,500 m^3/hr*	*3 x PU1250 (26)*	*3xPF1200*
GloEn-P4000 (-Ex)	*4,000 m^3/hr*	*3 x PU1500 (32)*	*3xPF1500*
GloEn-P4500 (-Ex)	*4,500 m3/hr*	*3 x PU1500 (32)*	*3xPF1500*
GloEn-P5000 (-Ex)	*5,000 m3/hr*	*4 x PU1250 (26)*	*2xPF2500*
GloEn-P6000 (-Ex)	*6,000 m3/hr*	*4 x PU1500 (32)*	*2xPF3000*

Table 1.5 System configurations

NOTE: *Configuration of each system consists of a single line to control the flow rate not exceeding the TRC of each component.*

NOTE: *This table shows general system configuration as recommended by the manufacturer. A BWMS model may be used with a larger filter unit than specified above. The maximum TRC of any configuration is determined by either the maximum capacity of the UV unit or the filter unit, whichever is smaller.*

E. Intended locations and conditions

The system can be skid mounted and located in the engine room, pump room or on deck, depending on available space and ship owner's preference.

The BWMS is supplied with a machine case (enclosed area) which is a part of vessel when it is installed on deck. The BWMS is not installed independently for deck application.

Standard installation position of UV unit is vertical type installation, and horizontal type installation is applied to resolve insufficient space for installation. UV lamps shall be positioned horizontally under any circumstances even though UV unit itself can have horizontal & vertical position consistent with pipe position.

For existing vessels where available space, in general is limited, the four (4) major components of the system (filter unit, UV unit, UV power supply panel and control panel) are supplied and installed separately. If necessary, filter unit and UV unit can be separated. UV Power supply panel and control panel can be located remotely from the filter and UV units. Existing or new ballast pump characteristics need to be considered for flow and pressure requirement of the BWMS.

The system is designed to operate in all conditions of salinity, temperature and UV transmittance with the understanding that a minimum UV intensity and exposure time (flow rate) will be required for optimal effectiveness.

If a vessel with more than two sets of ballast pumps it is recommended to use applicable BWMS for treatment so vessel must have a suitable system depending on the capacity of ballast pump. Figure 1.12 shows general arrangement of BWM system.

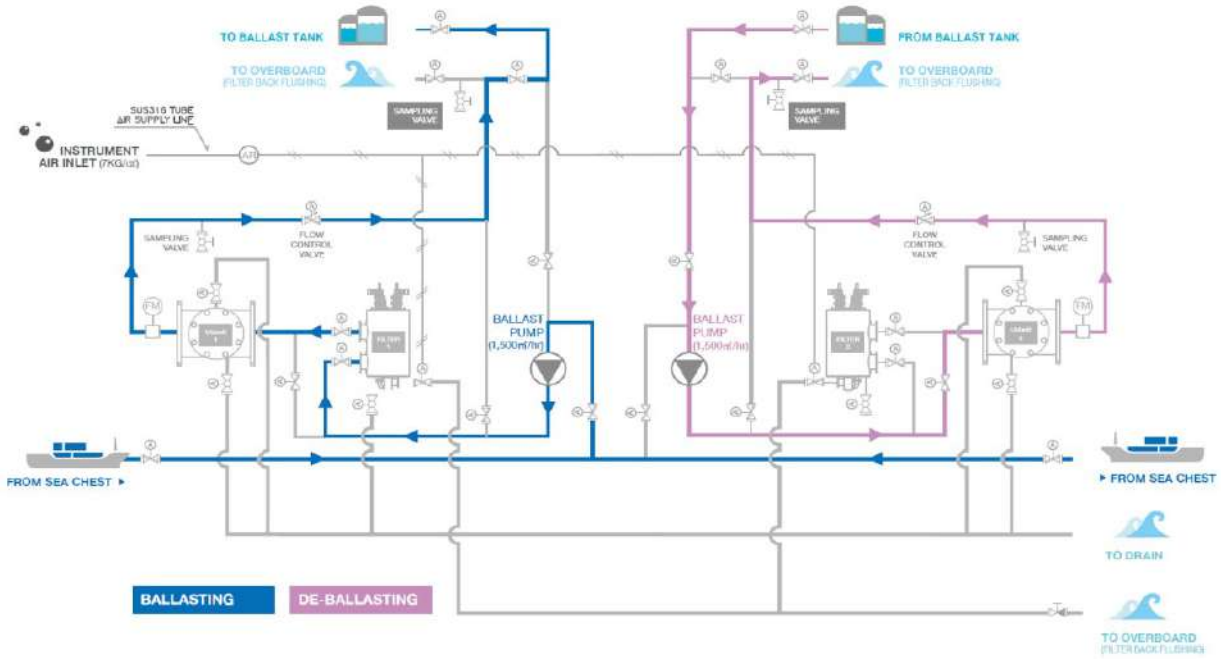


Figure 1.12 Position of multiple BWMS installations

Parallel installation of filter and UV units in the treatment system is designed to ensure an even flow distribution for each UV unit. It is fully controlled with individual flow meter and flow control valve unless even flow is justified due to unusual vessel condition.

NOTE: *If BWMS is intended to be installed on deck of a ship, we recommend inlet piping line shall be vent piping to avoid that the water flows rapidly down when the BWMS is shut down.*

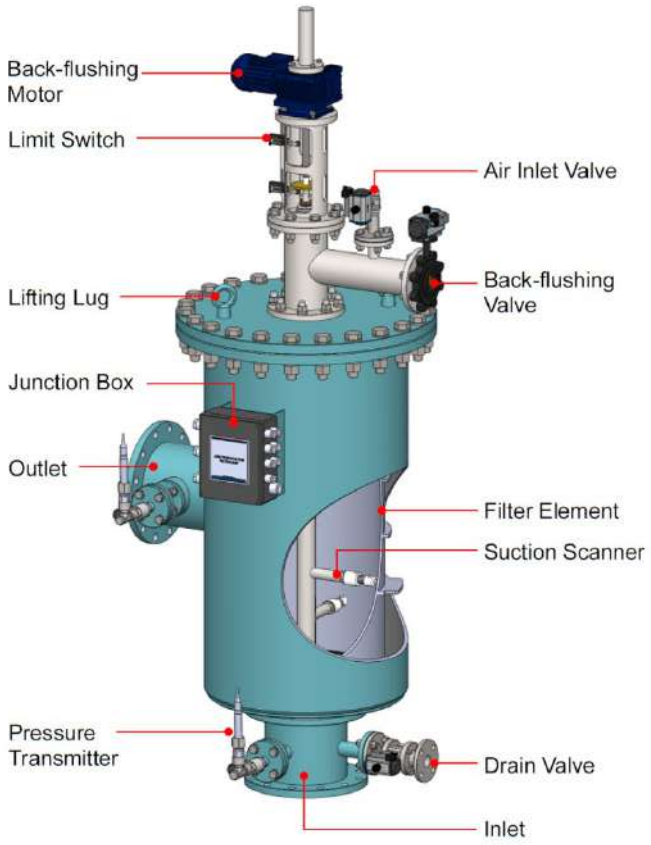
NOTE: *If BWMS is intended to be installed on deck of a ship, we recommend that Vacuum Breaker should be installed in the piping of UV unit since it is easy to generate a vacuum due to the height difference of piping.*

II. MAJOR SYSTEM COMPONENTS

A. General description of the materials used for construction and installation

(1) Filter unit

Filter unit is installed prior to UV unit. It must operate during ballasting, while it is bypassed during de-ballasting. Filter element (screen) is of 50 microns (50μm) size, and clogged organisms and particles equal to or larger than 50 microns are removed and returned to local water by filter cleaning (back-flushing) is automatic. Several cleaning (scanner) heads scan over the filter screen surface with a "corkscrew-like" rotational & vertical motion by an electric motor and suck clogged materials. There are several size filter chambers and each chamber can accommodate a few different size of filter element and also some chambers have multiple numbers of filter elements (Refer to Figure 2.1). The filter unit consists of a filter elements, sensors and back-flushing parts.



Pressure Transmitter

Filter Element

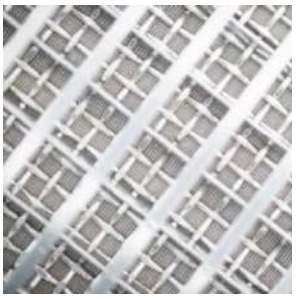


Figure 2.1 Components of the filter unit

- Filter element:

  .1 Installed inside filter chamber 50 microns mesh screen (normally made of Hastelloy) in a stainless steel frame.

  .2 PF 250/ 500/ 750 have one filter element and PF 900/ 1200/ 1500/ 2000/ 2500/ 3000 have several filter elements in one chamber.

- Sensor part:

.3 Pressure Transmitters: Two (2) transmitters, one (1) for inlet and one (1) for outlet pressure of the filter. Differential pressure between two transmitters activates back-flushing.

.4 Limit switches: Switches to limit axial movement of the cleaning head (suction scanner) assembly and located on two different points of the threaded shaft of the cleaning assembly.

- Back-flushing part:

.5 There are several suction scanners inside the filter element. They move axially and rotate over the screen surface. High differential pressure across the screen activates back-flushing automatically and opens the back-flushing valve. When the valve opens, suction takes place and removes and clogged materials. Construction of the filter for high-capacity application is shown in the Figure 2.2.

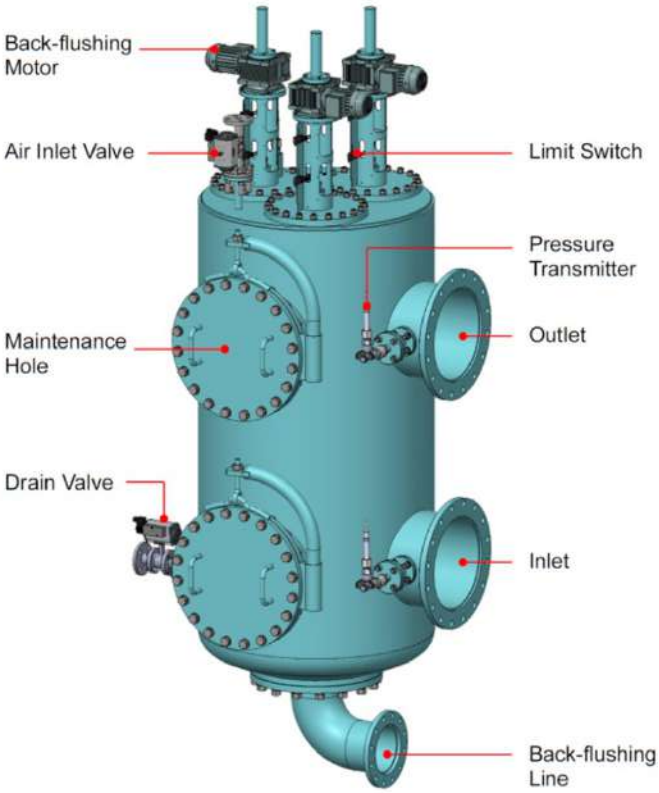


Figure 2.2 Components of the filter unit

- Features:

.6 Rugged construction and reliable mechanism;

.7 Simple and easy maintenance.

.8 Large filtering area takes low pressure drop.

.9 Minimum flow and pressure requirement for self-cleaning.

.10 Ballasting un-interrupted during back-flushing.

Body material	ASTM A516-70
Filter element	316L and HASTELLOY
Cleaning mechanism	316L and plastics
Seals	EPDM

Table 2.1 Construction materials for filter unit

Electric motor	400W, 60Hz, 30 Gear output R.P.M.
Rated operation voltage	AC 380V/440V, 3 Phase, 60Hz
Current consumption	0.8 Amps, with 3 Phase, 380V/440V

Table 2.2 Electrical rating and requirements of (control voltage 220VAC) for filter unit

- Back Flushing Mode

- DP (Differential Pressure) Mode: This mode is the default setting for Back-Flushing and in this mode, Back-Flushing automatically commence when DP reaches setting value (default: 0.1 kg/cm^2)

(2) UV unit (Chamber)

The system uses high intensity UV light to destroy living organisms present in the ballast water being treated so that it prevents to preclude invaders from colonizing.

UV lamps emitting rays perpendicular to the fluid flow are well designed to reach the maximum to destroy the organisms. This design has several unique advantages to manufacture in compact design, including the ability to treat effectively with a very poor transmittance, or extremely high flow rates without bypass. As flow rates increase, chamber size and lamp power output can be increased to the current maximum single chamber capacity. For larger flows, multiple chambers are used. All the necessary monitoring equipment is integral and the separate power/ control modules can be installed either remotely or in proximity to the UV treatment chamber. Reliable disinfection requires that a constant UV intensity is applied to the water.

Fluctuations in the power supply are common in some installations, but BWMS(UV system) is designed to handle such fluctuations and to deliver constant power to the UV unit. Major components and features of the UV unit are as follows (Refer to Figure 2.3 and Figure 2.4).

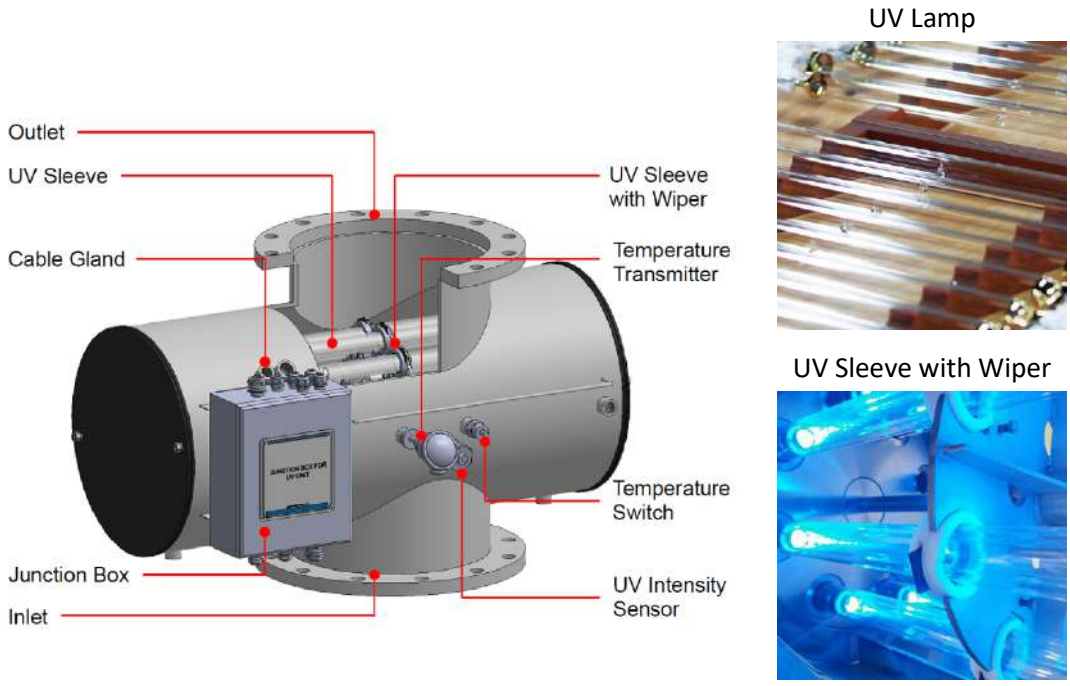


Figure 2.3 Components of the UV unit

- Sensor Part:

  .11 Absolute and failsafe UV intensity sensor.
  .12 Temperature transmitter and temperature switch for over-heating.
  .13 Limit switch for wiper control.

- Lamp & Sleeves:

  .14 Broad-spectrum, high intensity medium pressure UV lamps with the entire germicidal output range.
  .15 Multiple lamp configurations.
  .16 High-purity quartz for maximum transmission.
  .17 Three (3) levels of power supply automatically adjustable to compensate UV

transmittance and flow rate.

.18 Long lamp life (lamp is developed specifically for ship application & patented).

- Chamber:

.19 316L stainless steel construction.
.20 Compact lamp configuration.
.21 Pressure Rating: 10 bar (kg/cm^2) continuous, 15 bar (kg/cm^2) test.
.22 JIS 10K flange connections.

- Features:

.23 Mechanical wiper systems for automatic quartz sleeve cleaning.
.24 Easy to install and maintain.
.25 Low maintenance cost.

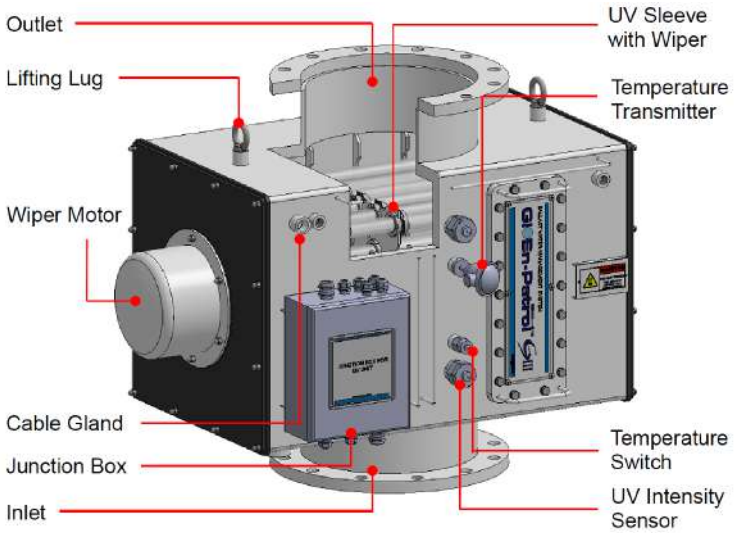


Figure 2.4 Components of the UV chamber

Body Material	316L
Degree of protection	IP54
Type of lamps	MPUV(Medium-Pressure UV) lamp
Temperature Sensor	PT100
UV intensity sensor	Fitted
Drain valve	Fitted (Option)
Air relieve valve	Fitted (Option)

Table 2.3 Construction materials for UV chamber

Electric motor	40W, 60Hz, 30 Gear output R.P.M.
Rated operation voltage	AC 220V, 60Hz
Current consumption	0.18 Amps, with 1 Phase, 220V

Table 2.4 Electrical rating and requirements (control voltage 220VAC) for UV wiper motor

< Non Explosion proof model>

- Temperature Transmitter and Temperature switch

The UV lamps generate large amount of heat during operation. Generated heat causes high temperature and it affects to the UV system. This is the main reason why it requires both warming up and cooling down process for protection. Even it indirectly exposed into the running water, this cooling effect is quite limited and it is not always safe for continuous working with proper flow that must be secured under normal operation. High temperature would become a potential problem in the long term, and it is able to affect to be shut down during ballasting and de-ballasting.

In order to prevent forced termination of BWM system due to high temperature, both temperature transmitter and switch are installed for monitoring the temperature in/outside of the chamber for Non proof model. Mechanically, most heated air transferred out through the vent hole, but these temperature sensors are equipped for secondary safety. The temperature transmitter is installed as the first layer of safety. If the temperature inside of chamber exceeds the normal set point, a warning signal appears and shut down process are given in regular logic sequence. In addition, the temperature switch is installed as the second layer of safety. So if temperature of UV surface exceeds the normal set point, shut down function can be performed by mechanical type which is independent of the PLC or software type which is controlled by PLC control. For protection of human body from touching, surface temperature of the chamber must be maintained by a temperature switch sensor.

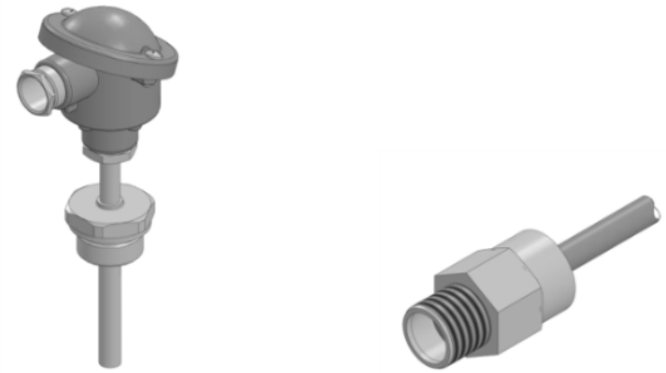


Figure 2.5 Temperature transmitter (left) and temperature switch (right)

< Explosion proof model>

- Temperature Transmitter and Flow switch

In the case of Ex proof models, temperature transmitter and two (2) flow switches are fitted for checking the loss of water flow through BWMS during any stage of ballasting including warming up and cooling down stages. If the temperature inside of the UV chamber could reach high temperature due to potential damage or problem, it would cause serious problem. So In order to prevent this situation, the UV chamber must be filled with water during operation. As the same method with temperature switch, flow switch is second layer of safety. If flow switch become a trip condition, shut down function can be performed by mechanical type which is independent of the PLC or software type which is controlled by PLC control.

Figure 2.6 Flow switch

(3) Control Panel

Control panel is a programmable logic controller (PLC) based unit with proportional-integral-derivative (PID) controller and touchscreen operator interface that controls all devices and functions of the BWMS and performs real-time monitoring of operating conditions, data collection and recording. The electromagnetic ballasts, which are installed in UV power supply panel, are controlled by PLC which controls each lamp with a maximum input power 4 kW. Three (3) stage power levels are available in each system and adjust automatically based on the UV intensity sensor.

Figure 2.7 Control panel (External view)

An operator with the help of a touchscreen takes charge of the operation and commands each task. The control panel also performs real-time monitoring while storing the operating conditions of each unit and the data detected by the main sensor(s) at the same time.

Material	SS400, 3.2T with Painted steel
Color (Standard)	Munsell No. 7.5BG 7/2
Degree of protection	IP23 (Option IP44/56)
Electrical Information	
Voltage	AC 110V/220V, 1 Phase
Frequency	50/60 Hz
Control system	Yes
Controller	SIEMENS PLC
CPU	CPU 315-2DP (Memory: 2MB)
Power Supply	PS 307 5A
Digital Input	16 × DC 24V
Digital Output	16 × Rel. AC 120V/ 230V
Analog Input	8 × 12 bit
Communication (PLC↔GP)	Ethernet Communication

Communication (PC↔GP)	Ethernet Communication

Table 2.5 Construction materials and electrical rating and requirements for control panel

Mode Selector Switch	Turn to embedded mode to access 'CHECK' and 'BY-PASS'
Warming up Indicating Lamp	UV lamp is warming up (Steady on)
	Warming up is completed (Flickering)
Buzzer	Audible alarm device
Emergency Stop Button	Physical button to shut-down the system manually

Table 2.5 Component details of control panel

(4) UV Power Supply Panel

The major function of UV power supply panel is to operate the medium pressure lamps inside the UV chamber. It controls the strength of the UV lamp with the capacitors mounted in the panel. Also it detects whether the UV lamps are functioning properly or not. The temperature sensor is mounted inside to monitor in order to give an alarm to an operator and shut down the system in case of emergency. The UV power supply panel enables the UV lamp to be powered and controlled in a safe manner with the backup of monitoring and safety functions. A control of three (3) stage power levels takes place automatically to maintain the required minimum UV intensity in changing UV transmittance and flow conditions.

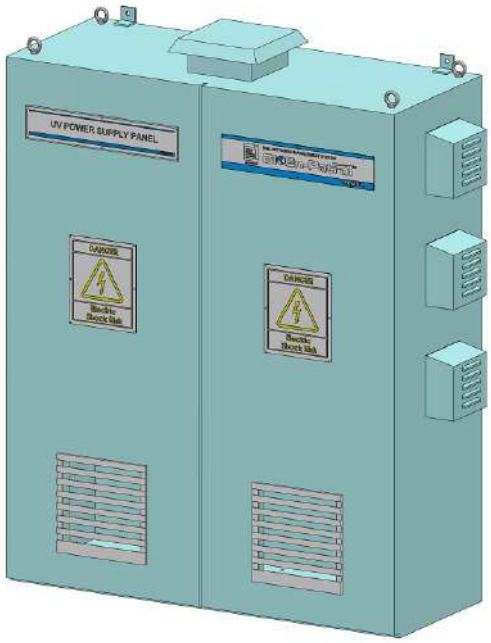


Figure 2.8 UV Power Supply Panel (External View)

Material	SS400, 3.2T with Painted steel
Color (Standard)	Munsell No. 7.5BG 7/2
Degree of protection	IP23 (Option IP44/56)
Electrical Information	
Voltage	AC 220V & 380V/440V, 3 Phase
Frequency	50/60 Hz
Control system	Yes

Table 2.6 Construction materials and electrical rating and requirements for power supply panel

B. General arrangement(s)

The system can be arranged skid mounted or in a dedicated enclosure and located in the engine room, pump room or on deck, depending on available space and ship owner's preference.

FILTER UNIT (Standard and High Capacity Models) can be arranged in a vertical or horizontal arrangement. Those models requiring multiple units can be arranged in a series in vertical or horizontal arrangements. These arrangements are dependent of the available space

UV UNIT (Standard and High Capacity Models) can be arranged in a vertical or horizontal arrangement, but UV lamps must be installed in a horizontal. Those models requiring multiple units can be arranged in a series in vertical or horizontal arrangements.

C. Intended usage

The system can be used with all vessel types, services and locations. While the salinity and temperature of local waters having little or no effect, the system does require a minimum UV intensity to kill or inactivate organisms. (refer to Chapter I.C. Limitation of system) The UV transmittance and radiation angle and distance from the UV source will affect UV intensity. The exposure duration (Flow Rate) is very important for system effectiveness.

D. Maximum and minimum flow and volume capacities

** General application (Both)*

High Flow Rate	*Alarm Point*	*Flow rate higher than the 110% of standard capacity*
	Trip Point	*Flow rate higher than the 115% of standard capacity*

** For Vertical application*

Low Flow Rate	*Alarm Point*	*Flow rate lower than the 30% of standard capacity*
	Trip Point	*Flow rate lower than the 10% of standard capacity*

** For Horizontal application*

Low Flow Rate	*Alarm Point*	*Flow rate lower than the 40% of standard capacity*
	Trip Point	*Flow rate lower than the 30% of standard capacity*

Table 2.7 Maximum and minimum flow volume

NOTE: If the ship's eductor specifications do not satisfy 30% or 40% of standard capacity, the Low Flow Rate Alarm Point can be adjusted by Panasia engineers as follows when performing Eductor (Stripping) Mode. The Low Flow Rate Trip Point remains unchanged.
Please note that the operator should not arbitrarily manipulate the alarm/trip point.

Low Flow Rate Alarm Point	*For Vertical application*	*Flow rate within 15~30% of standard capacity*
	For Horizontal application	*Flow rate within 35~40% of standard capacity*

Table 2.7.1 Low flow rate alarm point (Option)

E. Dimensions, weight and connection of the main components

Unit	Model Name	Application	Connection Flange	Weight (kg)
UV Unit	*PU50*	*Standard model*	*80A*	*120*
	PU250		*350A*	*180*
	PU500		*350A*	*230*
	PU1000	*High Capacity model*	*350A*	*300*
	PU1250		*400A*	*500*
	PU1500		*400A*	*700*

Table 2.8 UV unit Models

Unit	Model Name	Application	Connection Flange	Weight (kg)
Filter Unit	*PF50*	*Standard model*	*80A*	*450*
	PF250		*200A*	*500*
	PF500		*300A*	*750*
	PF750		*350A*	*1,100*
	PF900	*High Capacity model*	*350A*	*2,300*
	PF1200		*350A*	*2,500*
	PF1500		*400A*	*3,000*
	PF2000		*500A*	*3,400*
	PF2500		*500A*	*4,000*
	PF3000		*500A*	*4,400*

NOTE:
Connection Flange could be changed by shipyard piping size.

Table 2.9 Filter unit models

Model Name	Footprint (m^2)	Weight (kg)
GloEn-P50 (-Ex)	*2.5*	*1,430*
GloEn-P150 (-Ex)	*3.0*	*1,528*
GloEn-P250 (-Ex)	*3.0*	*1,658*
GloEn-P350 (-Ex)	*5.0*	*1,933*
GloEn-P500 (-Ex)	*5.0*	*2,283*
GloEn-P700 (-Ex)	*5.0*	*2,383*
GloEn-P750 (-Ex)	*5.0*	*3,820*
GloEn-P800 (-Ex)	*9.0*	*4,349*
GloEn-P900 (-Ex)	*9.0*	*4,349*
GloEn-P1000 (-Ex)	*9.5*	*3,567*
GloEn-P1200 (-Ex)	*9.5*	*5,287*
GloEn-P1500 (-Ex)	*11.0*	*5,487*
GloEn-P2000 (-Ex)	*15.5*	*6,996*

GloEn-P2500 (-Ex)	*17.5*	*9,456*
GloEn-P3000 (-Ex)	*20.5*	*10,366*
GloEn-P3500 (-Ex)	*23.5*	*11,225*
GloEn-P4000 (-Ex)	*24.5*	*13,564*
GloEn-P4500 (-Ex)	*31.0*	*15,204*
GloEn-P5000 (-Ex)	*33.0*	*16,689*
GloEn-P6000 (-Ex)	*38.5*	*19,223*

Table 2.10 Approximated size and weight

F. Design Information for hazardous locations

IEC-Ex is the International Electrotechnical Commission Explosive Scheme and ATEX is a European Union standard. The objective the IEC-Ex or ATEX certified system is to facilitate international trade in equipment and services for use in explosive atmospheres.

IEC-Ex: Ex px IIC T4 Gb (-20°C ≤ Ta ≤ 60°C)
ATEX: II 2 G Ex px IIC T4 (-20°C ≤ Ta ≤ 60°C)

PU###-Ex (explosion-proof) models are certified by DNV-GL for compliance of IEC-Ex and ATEX. The model complies with USCG (United States Coast Guard) and IMO (International Maritime Organization) specifications for hazardous area (Zone 1). Ex models use all explosion proof type components with proper label or certification by UL (Underwriters Laboratories), CE (Conformite Europeene) mark or other globally recognized safety agencies. UV chamber is a purge/pressurization type built and certified.

Previously, Table 1.4 shows the names and maximum capacity of models and specific components can be found on Figure 2.9.

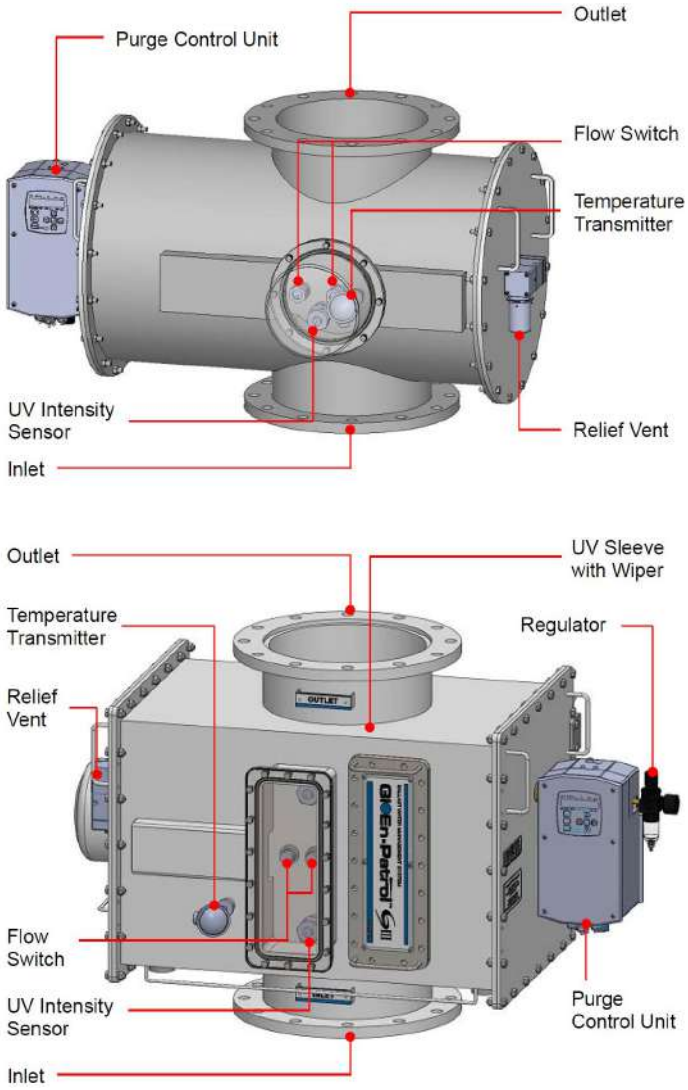


Figure 2.9 Components of the UV Chamber (Explosion proof model)

Figure 2.10 Purge control unit and relief vent for Explosion proof model

General specifications	
Power requirement	20 to 30 VDC / 0.6A
Operating temperature	–20°C ~ 60°C
Protected enclosure contact output × 2	8A @ 240VAC/24VDC
Auxiliary contact output × 2	2A @ 240VAC/24VDC
LED indication	
Safe pressure	BLUE – when safe pressure is achieved
Enclosure power	GREEN - power on / RED - power off
Rapid exchange	BLUE - when purging is running
System bypass	YELLOW - when bypass is activated
Alarm fault	RED (flicking) - any alarm / RED (not flicking) - system fault

Table 2.11 Specifications of the purge system

General parameters	
Pressure requirement	0.3 MPa ~ 0.7 MPa
Degree of protection	IP66
Minimum purging flow rate	141 ℓ /min
Minimum purging duration	10 minutes
Type of protective gas	Air
Minimum over pressure	63 Pa
Maximum over pressure	999 Pa
Minimum flow rate (pressurization)	0.3 ℓ /min
Maximum leakage rate	3.0 ℓ /min
Low Pressure alarm	100 Pa
Electrical rating	UV lamp: 480V, ~ 9A, 60Hz Wiper Motor: 220V ~ 0.36A 60Hz Purge/Pressurization system: 24Vd.c. 0.6A
Type of lamp	Medium pressure UV lamp
Type of protection (IEX-Ex)	*Ex px IIC T4 Gb (-20°C ≤ Ta ≤ 60°C)*
Type of protection (ATEX)	*II 2 G Ex px IIC T4 (-20°C ≤ Ta ≤ 60°C)*

Table 2.12 Common specifications of UV unit

Specific parameters					
Model	**PU250-Ex**	**PU500-Ex**	**PU1000-Ex**	**PU1250-Ex**	**PU1500-Ex**
Enclosure volume	0.05 m^3	0.08 m^3	0.08 m^3	0.11 m^3	0.13 m^3
Water flow rate	~ 350 m^3/hr	~ 750 m^3/hr	~ 1,000 m^3/hr	~ 1,250 m^3/hr	~ 1,500 m^3/hr
Max. of Lamp	12 ea	24 ea	22 ea	26 ea	32 ea
Wiper motor	1 ea	1 ea	1 ea	2 ea	2 ea

Table 2.13 Specific characteristics of UV unit

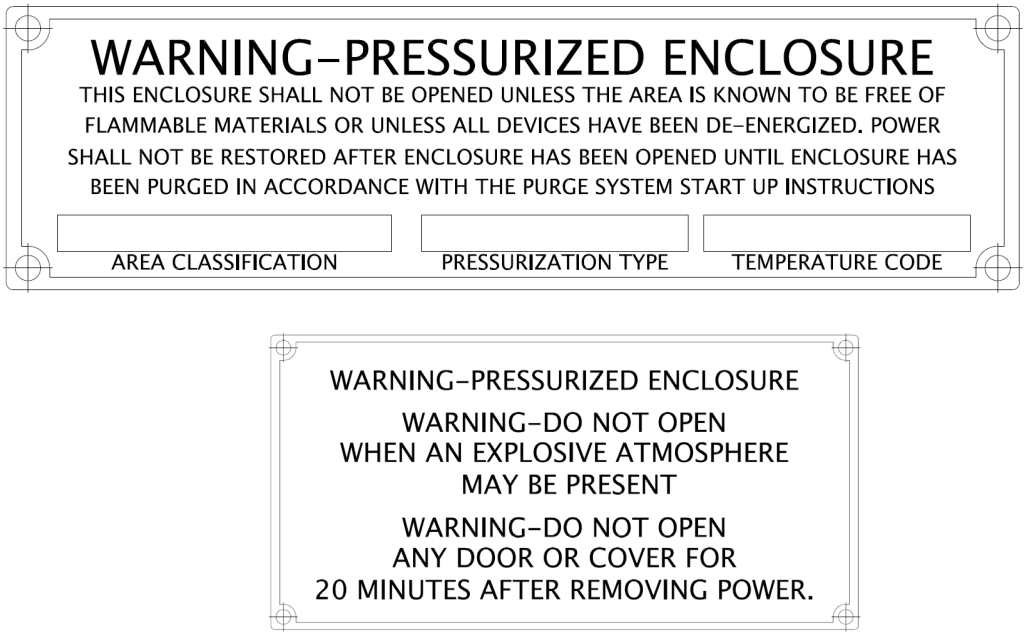


Figure 2.11 Warning labels on UV unit

CAUTION	➢ *UV unit is NEVER installed in Zone 0. UV unit is in Equipment-Group II, Category 2.* ➢ *The cable should be NOT damaged, and the intrinsic safe cable must be connected separately from common cable.* ➢ *The weight of UV unit is approx. 400kg. Do NOT hang the rope on the purge/pressurization unit during lifting.* ➢ *Installation, operation, maintenance and servicing must only be carried out by trained personnel.*

WARNING	➢ *All electrical components MUST be power-off during purging process.* ➢ *Inside of UV unit MUST be completely purged by purge/pressurization unit.* ➢ *After completion of purging, UV unit will operate to run:* *.26 Purging complete* *.27 Minimum flow: over 10% of TRC (Vertical) / 30% of TRC (Horizontal)* *.28 Pressure: above 0.5 bar (kg/cm^2)* *.29 Temperature of UV unit inside: below 45 ℃* *.30 Water flow of UV unit inside: two (2) flow switches must be closed in which means water is filled*

After all conditions meet requirements, then BWMS can be operated as *Chapter III. STANDARD OPERATION PROCEDURE* in this document.

It is especially important to achieve suitable water flow rate for normal operation. The flow switches, temperature transmitter and flow transmitter are safety barriers for explosion proof modes, so If UV unit does not operate properly, check out with trouble shooting.

Figure 2.12 Name plate of UV unit (Ex model only)

ATEX marking								
Ex	II	2	G	Ex	px	IIC	T4	-20°C ≤Ta≤60°C
①	②	③	④	⑤	⑥	⑦	⑧	⑨

IEC-Ex marking					
Ex	px	IIC	T4	-20°C ≤Ta≤60°C	Gb
⑤	⑥	⑦	⑧	⑨	⑩

① Marking of explosion protection

② Equipment group II, Electrical apparatus for places with an explosive gas atmosphere other than mines susceptible to firedamp.

③ Category 2. Equipment in this category is intended for use in areas in which explosive atmospheres caused by gases, vapors, mists or air/dust mixtures are likely to occur.

④ For equipment-group II, the letter “G” (Concerning explosive atmospheres caused by gases, vapors, or mists)

⑤ Marking of explosion protection

⑥ Type of protection. Pressurization, level of protection “px”

⑦ Explosion Group

⑧ Classification of maximum surface temperature. T4 is 135°C.

⑨ Ambient Temperature

⑩ Equipment Protection Levels. Gb is Zone 1

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III. STANDARD OPERATING PROCEDURES

A. Selection method for USCG and IMO mode / ≥2day and <2day mode

The mode selection function for each model is classified as shown in the table below.

Model \ Mode	USCG		IMO
	HT≥2day	HT<2day	(BWMS code)
GloEn-Patrol 2.0	O	O	O
GloEn-Patorl 2.01	O	-	O
GloEn-Patrol	O	-	

Our BWMS can be operated in each modes. Please check the following (1) and (4) select the proper mode to operate the equipment.

(1) Preparation before selection the USCG and IMO mode

a. After completing the unloading at the current port and when the ballasting operation is conducted, please check the mode to be applied at the next port.
b. USCG mode should be set before vessels on a voyage to all US waters; not only to the "Great Lakers, Hudson River north of the George Washington Bridge". But except for this areas, IMO mode should be set. If there is a separate request for the mode setting, it can be set accordingly.
c. Check the currently selected mode on the Home screen and select it appropriately.

(2) How to selection the USCG and IMO mode

a. Please click to button (USCG MODE or IMO MODE) to select the USCG mode or IMO mode in the Home Screen.

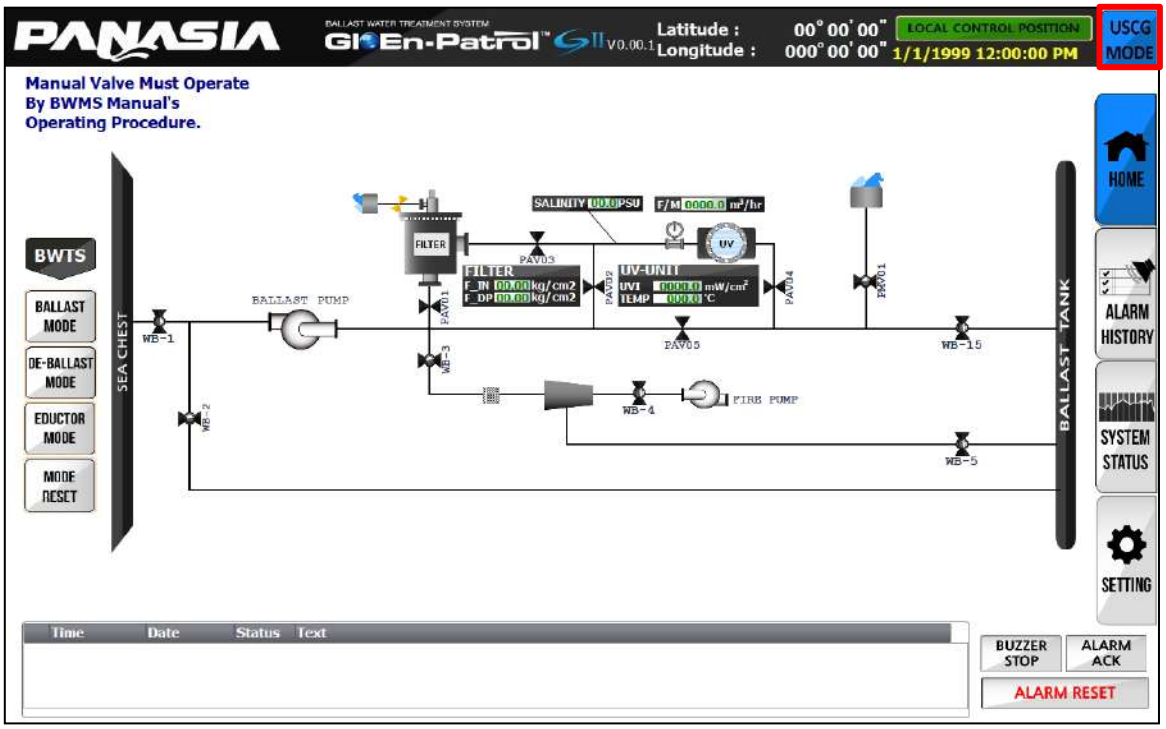


Figure 3.1 Home screen

b. In the HOME screen, the currently selected mode is displayed in the top right in the screen.

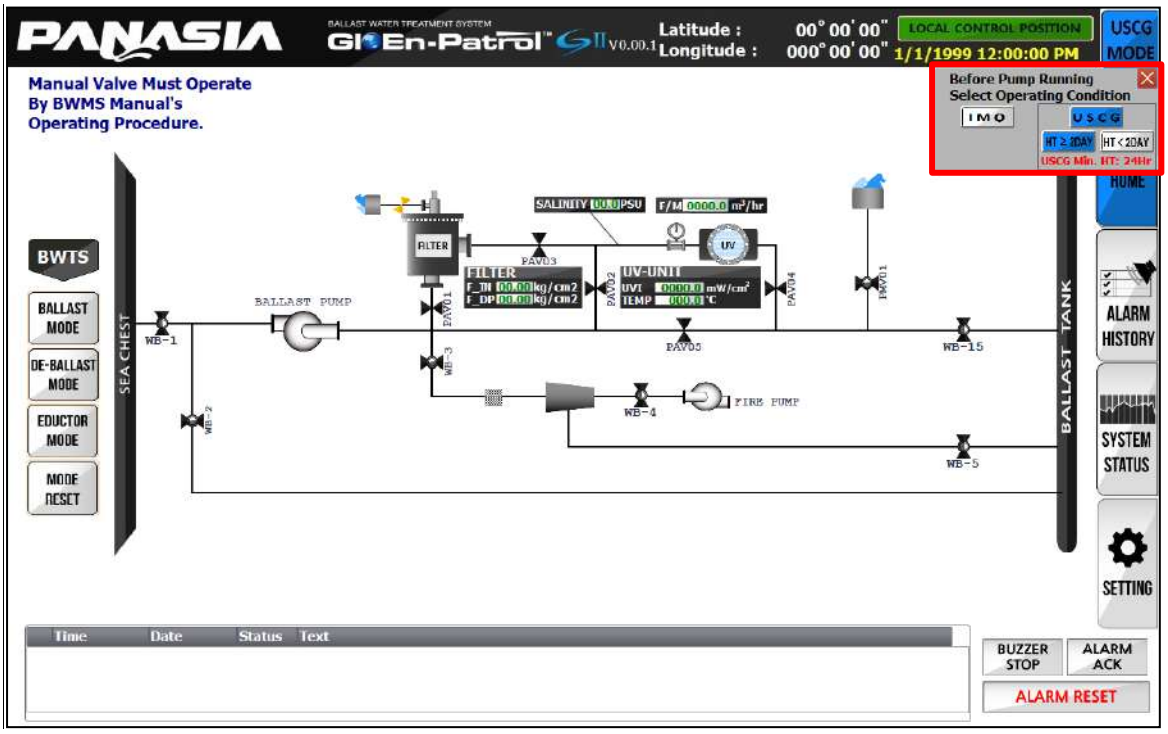


Figure 3.2 Selection Popup window for USCG or IMO mode

- Change of Mode can be available through the selecting at the top right of the Home screen.
- The mode is changed each time the button is pressed once.
- However, the mode can not be changed while the UV lamp & pump running is on (button interlock)

Mode Button		
Mode	Button	Explanation
USCG mode	USCG	When selected, BWMS is operated with USCG mode
IMO mode	IMO	When selected , BWMS is operated with IMO mode

(3) The Screen of each mode

a. USCG mode

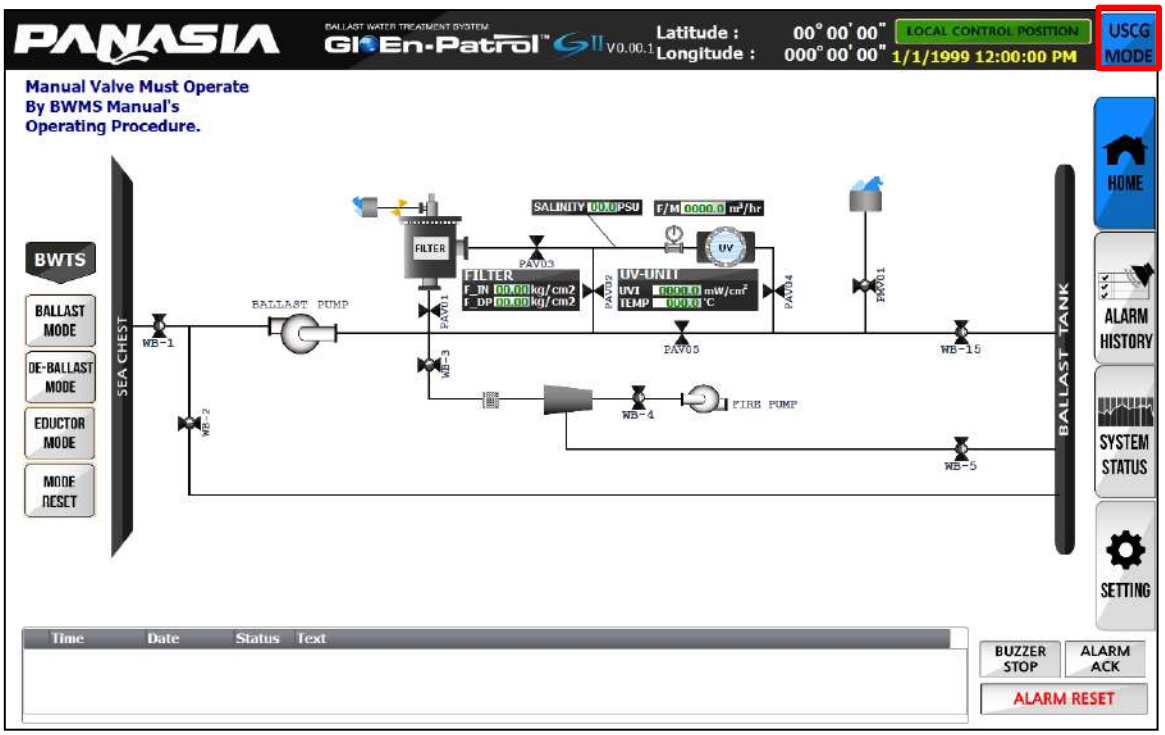


Figure 3.3 Home screen for USCG mode

b. IMO mode

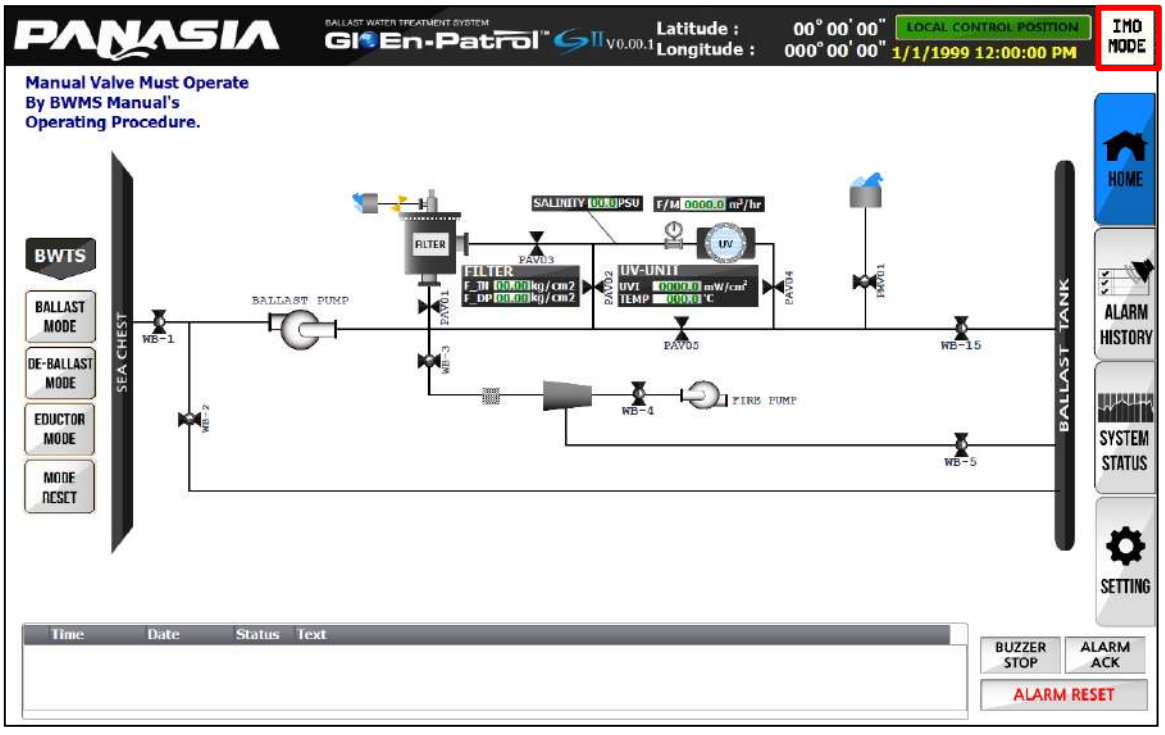


Figure 3.4 Setting screen for IMO mode

(4) Preparation before selection the ≥2day and <2day mode

a. Select the mode to be applied according to the following conditions before ballasting in order to perform loading at the currently docked port.

b. The prerequisite for choosing the Holding time applies only when performed with USCG mode.

(5) How to selection the ≥2day and <2day mode

a. If the estimated time from the currently docked port to the next port is 48 hours or longer, select the " HT ≥ 2DAY " button.

b. If the estimated time from the currently docked port to the next port is more than 24 hours to less than 48 hours, select the " HT < 2DAY " button.

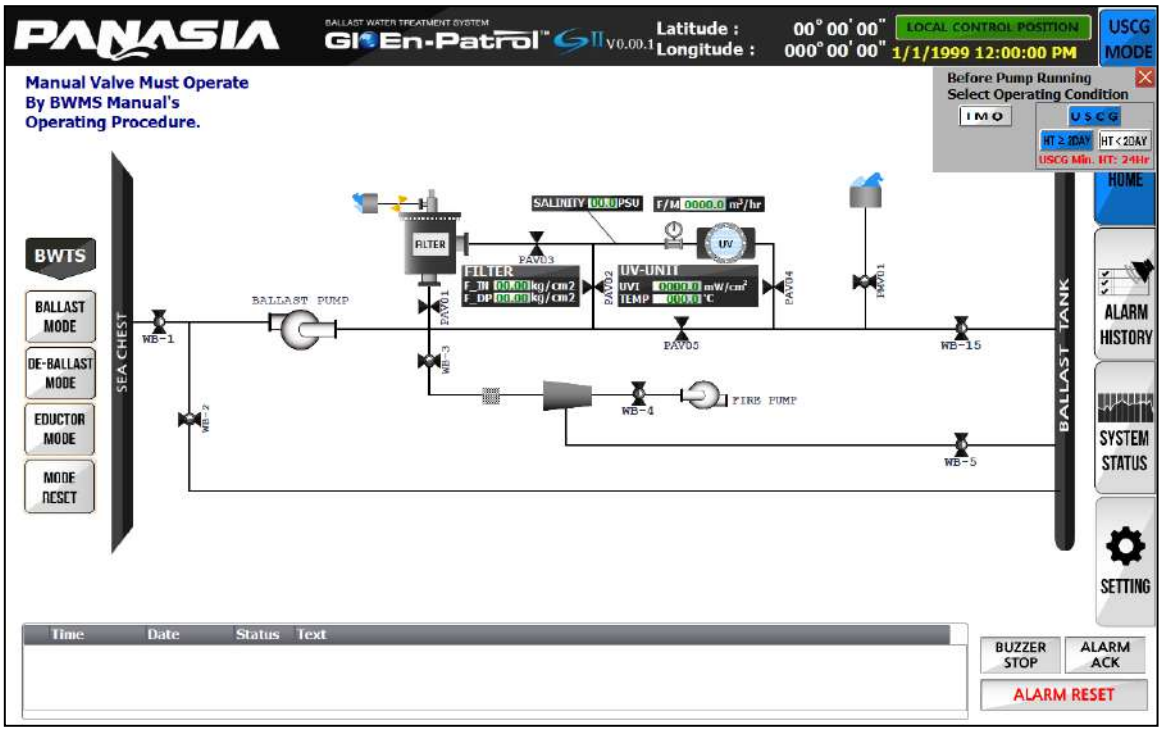


Figure 3.5 Home screen

Holding Time Selection Button		
Mode	Button	Explanation
≥2day mode	HT ≥ 2DAY	When selected, BWMS is operated with ≥2day mode
<2day mode	HT < 2DAY	When selected , BWMS is operated with <2day mode

B. Display information of Control Panel

(1) Home Screen

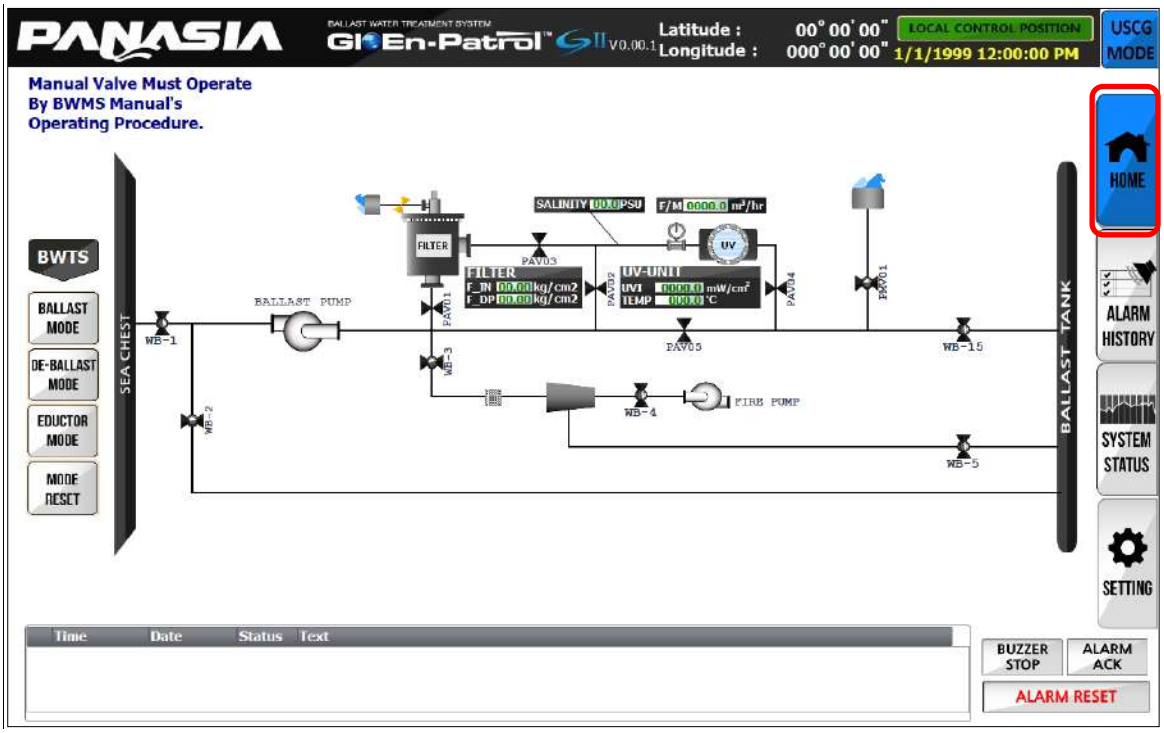


Figure 3.6 Home screen

Figure 3.6 shows the initial *HOME* screen that operator can see when BWMS is on. Operator can check parameters or operation status from this screen. This home screen displays the following:

- Valve working status;
- Filter unit inlet pressure;
- Filter differential pressure;
- UV intensity;
- UV unit inside temperature;
- Flow rate.
- Salinity
- The color status of each unit on the screen:

Valve			**UV unit**		
- Blue		: Opened	Green		: Lamp On
- Black		: Closed	Black		: Lamp Off
- Yellow		: Moving or Abnormal	F R		: Wiper Motor is forward : Wiper Motor is reverse
Pump			**Filter**		
- Blue		: Running	Green		: Back-flushing is working
- White		: Stop	White		: Back-flushing is not working
Pipe line					
- Blue		: Flow			
- Black		: No Flow			

- **Standby Condition**

The warm up and cooling process in *STANDBY CONDITION*, while not a separate mode, is required for the valves to be arranged in order for water to flow through the ballast line and to ensure the sufficient time takes the system to reach full power or temperature decreasing:

Sea chest → Ballast Pump → Filter Unit → UV Unit → Overboard

Normal warming up process when operator selects *BALLAST MODE* or *DE-BALLAST MODE* button(s) can be shown here in Figure 3.7.

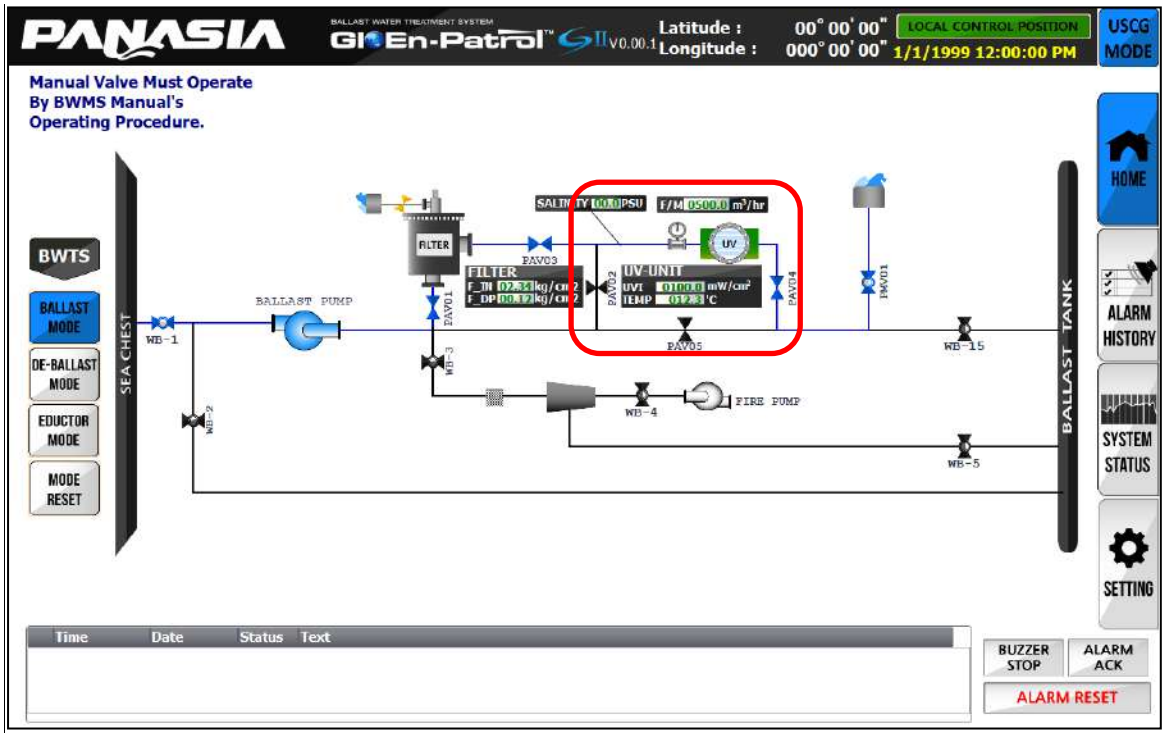


Figure 3.7 Warm Up process

The UV lamps are turned on and the system waits for the lamps to warm up in order to provide sufficient UV intensity. This warm-up time is 5 minutes and when the measured UV intensity reaches the “UVI Set" in the following Table1.2 (refer to Chpter I.C. Limitations of system), the warm-up process is completed automatically and the ballast mode or de-ballast mode is ready.

NOTE: BWTS will be shut down when temperature reaches at trip value even though in warm up procedure by temperature switch and/or transmitter.

- **Ballast Mode**

After warming up completely and when *BALLAST MODE* button (

) is selected, valves will arrange for water to enter ballast tank. Water will flow from the sea chest, through the pipeline and into the ballast tank:

Sea chest → Ballast Pump → Filter Unit → UV Unit → Ballast Tank

Normal ballasting process can be shown here in Figure 3.8.

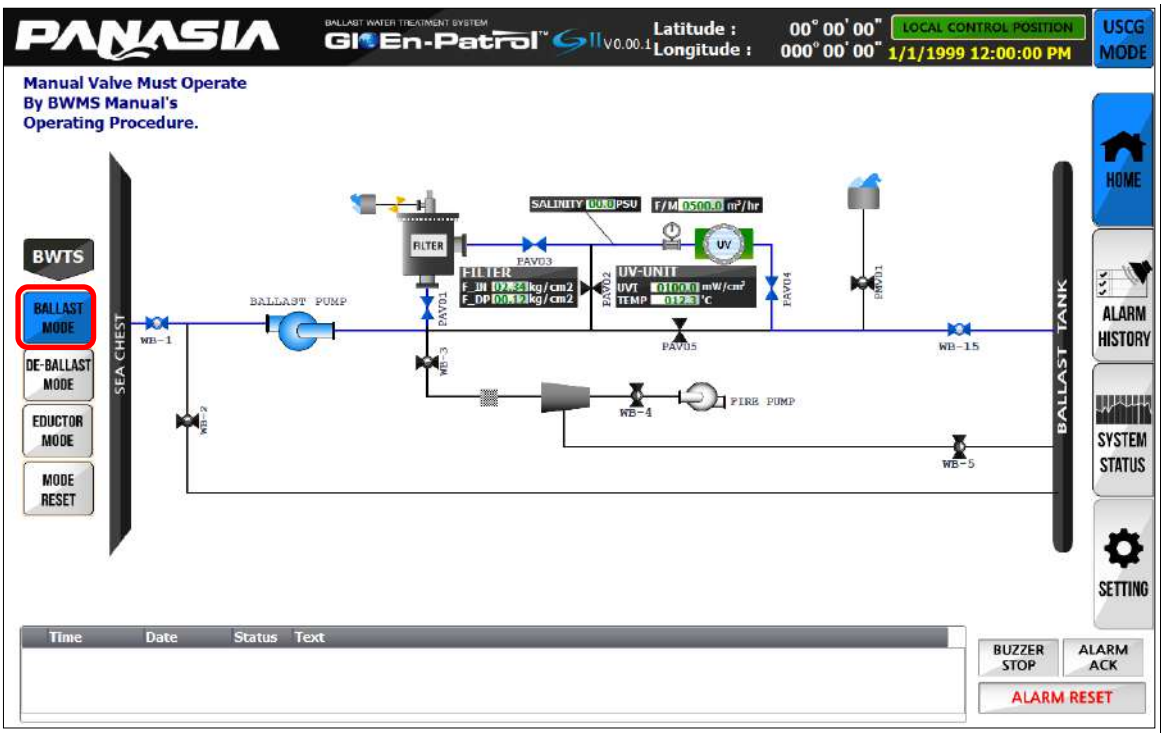


Figure 3.8 Ballast Mode screen

NOTE: In case of the parallel installation of filter units, the filter back-flushing occurs simultaneously for both units. If one filter DP reached the set point, both filters will start back flushing.

- **De-Ballast Mode**

When *DE-BALLAST MODE* (DE BALLAST MODE) button is selected, valves will arrange for discharging water overboard. Ballast water will flow from ballast tank through the pipeline overboard:

Ballast Tank → Ballast Pump → UV Unit → Overboard

Normal de-ballasting process can be shown here in Figure 3.9.

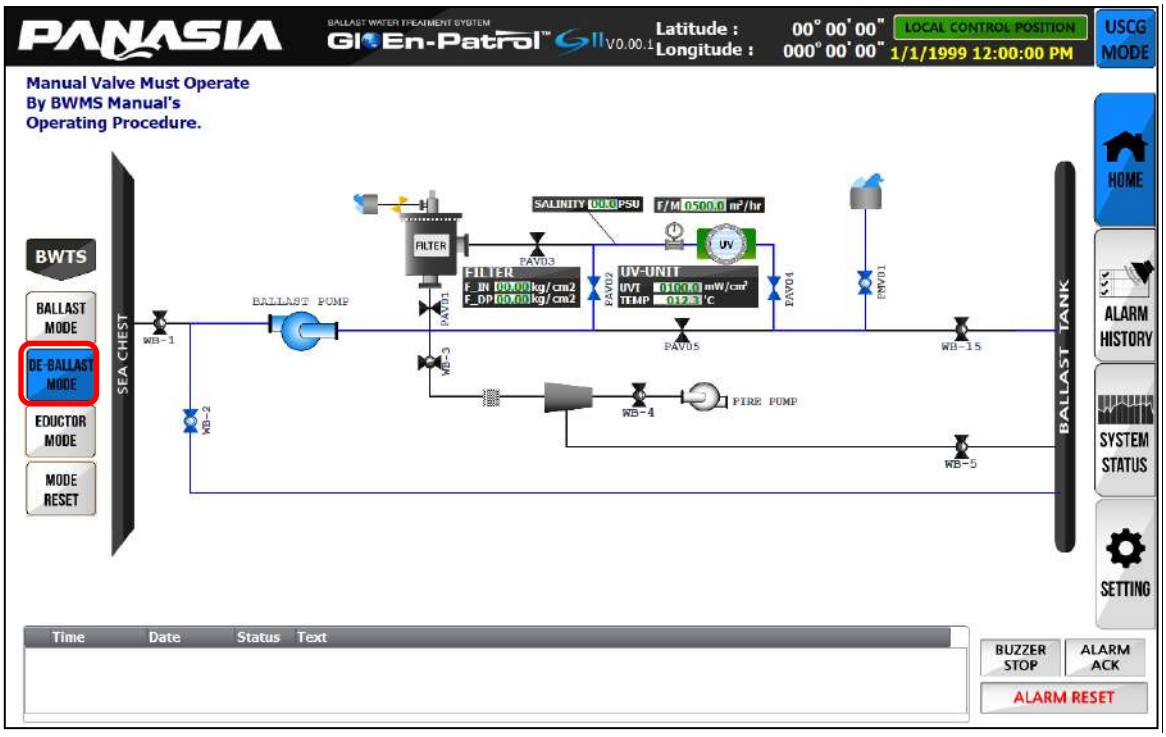


Figure 3.9 De-Ballast Mode screen

- **Eductor (Stripping) Mode**

When *EDUCTOR MODE* (EDUCTOR MODE) button is selected, valves will arrange for discharging water overboard. Ballast water will flow from ballast tank through the pipeline overboard:

Driving (G/S, Fire) Line → Eductor → UV Unit → Overboard

Normal stripping process can be shown here in Figure 3.10, and de-ballast, outlet valves activate automatically in *EDUCTOR (STRIPPING) MODE*.

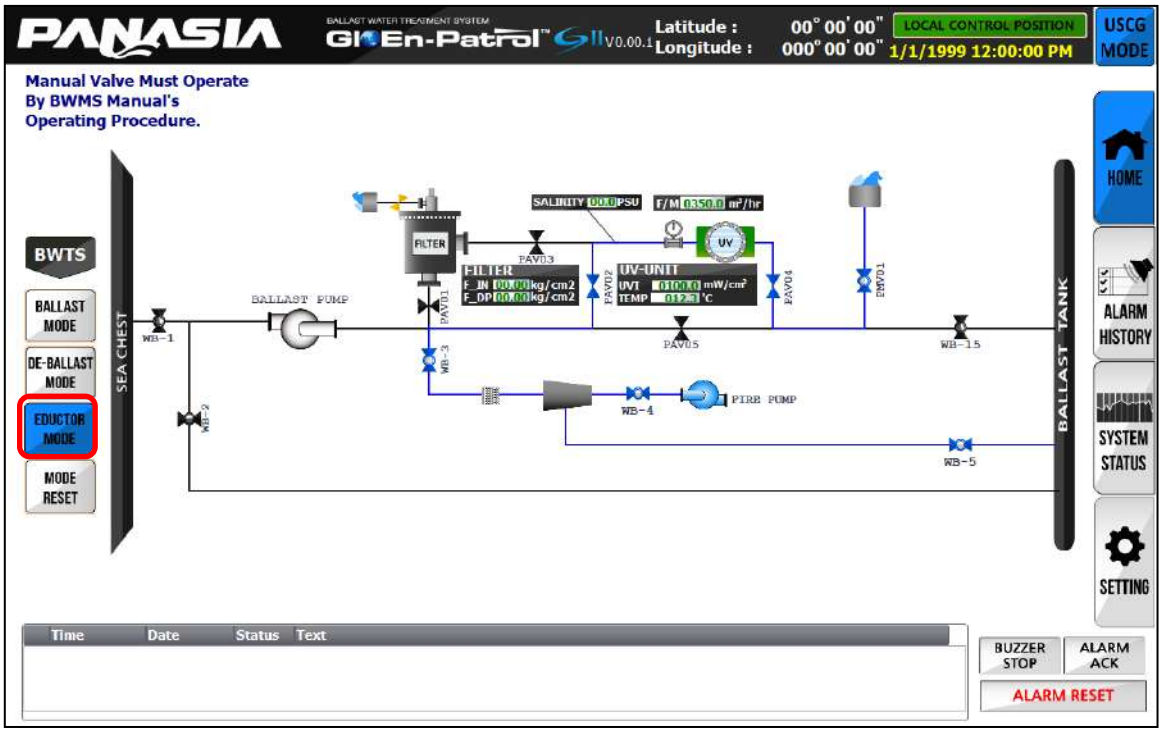


Figure 3.10 Eductor (Stripping) Mode screen

The VRC (Valve Remote Control) system can contribute to organize relevant valves for the warming up process if necessary.

Once it completes, the ballast pump is able to operate.

- **Mode Reset**

If unexpected problem such as valve malfunction occurs before the UV lamp(s) turns on, an operator can simply select *MODE RESET* button in order to reset the operating mode (all valves will be closed after pump shutoff).

When *MODE RESET* (MODE RESET) button is selected, a pop up window will ask whether it is necessary to get back to initial state (ballast pump stop and all valves close). If operating mode is already activated (UV lamp on), *MODE RESET* does not work because each operation mode stop procedure must be followed due to turn the UV lamp off.

Process sequence is that the ballast pump will stop and then, all valves will automatically arrange as initial state.

Normal process can be shown here in Figure 3.11.

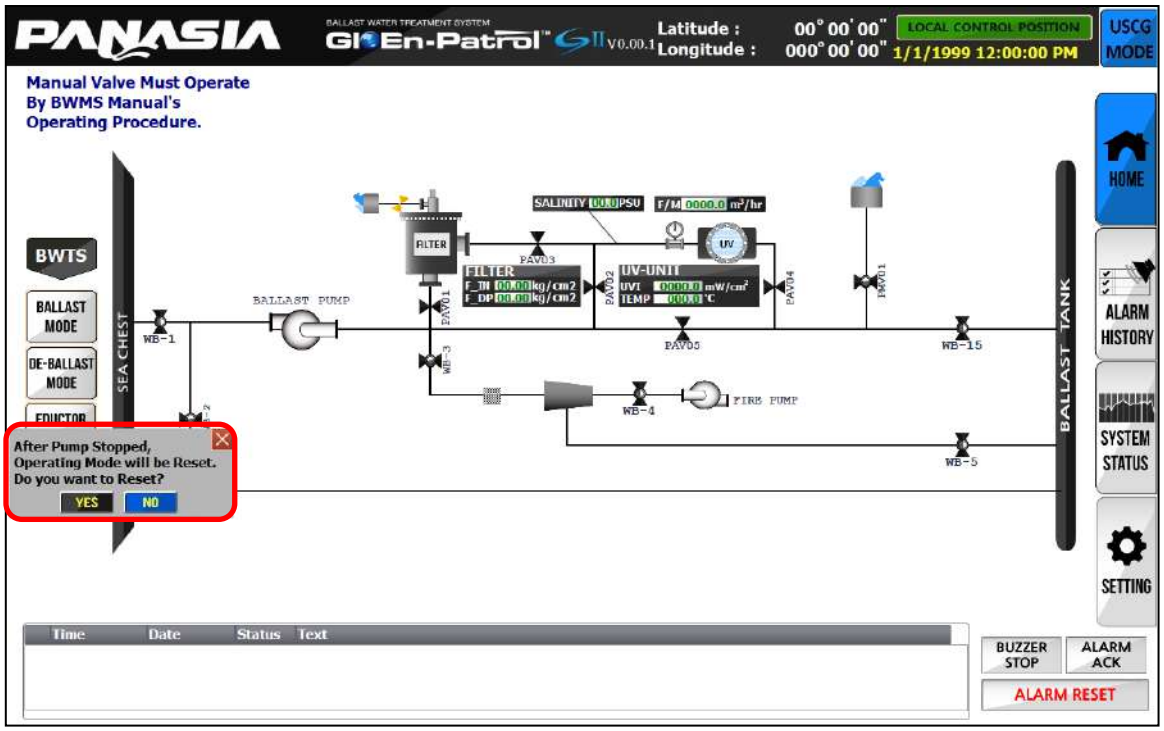


Figure 3.11 Mode Reset screen with pop up window

(2) Alarm History

When an alarm occurs during system operation, the *ALARM HISTORY* button (

) located on the right side of the *HOME* screen will be flickered, and at that time, operator should select the now blue colored button marked *ALARM HISTORY* (

). The flickering (light blue/dark blue) alarm list will stop when the *ACK* button (

) is respectively selected. The ACK button will not stop all flickering alarm lists at one click. When the alarm(s) is acknowledged, the description of *ALARM HISTORY* indicates color dark red as shown on Figure 3.11. If selected alarm is reset, the described alarm(s) will be individually changed to color white.

The audible alarm will stop when the *BUZZER STOP* button (

) is selected.

An operator can scroll up and down to check alarm history by swiping up or down on the screen.

The *ALARM RESET* button (

) will reset the entire system.

➔ When an alarm occurs, following action should be done.

1) *Press the BUZZER STOP* button (

) and then

2) *Press* the ALARM ACK button (

) after checking the alarm history and then

3) *Press the* ALARM RESET button (

)

The *OPERATING LOG* button (

) will advance the screen onto the *OPERATING LOG* page.

The *ALARM HISTORY* screen can be shown here in Figure 3.12.

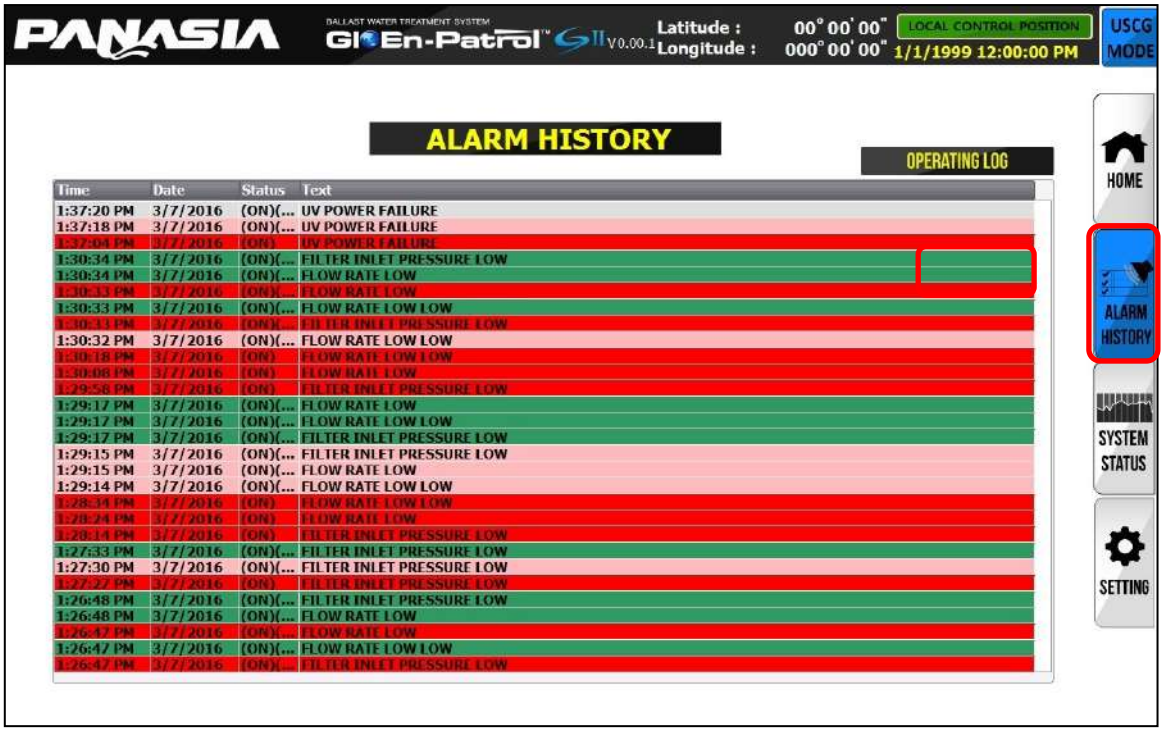


Figure 3.12 Alarm History screen

NOTE: Alarm acknowledgment is available in selected location separately (Local or Remote).

- **Operating Log**

When an operator selects the *OPERATING LOG* button (OPERATING LOG) located on the right upper side of the screen, all the system operational information will appear (as shown below in Figure 3.8). All operational information of the filter unit, UV unit and valves are recording in the system's memory for as long as twenty-four (24) months.

The log and the real-time readings can be sorted by year, month, day and time. In order to set up or change values in the *OPERATING LOG*, you must first login with a created password. To save any records in the *OPERATING LOG*, the password will again be required.

An operator can scroll up and down to check alarm history by swiping up or down on the screen.

The *OPERATING LOG* screen can be shown here in Figure 3.13.

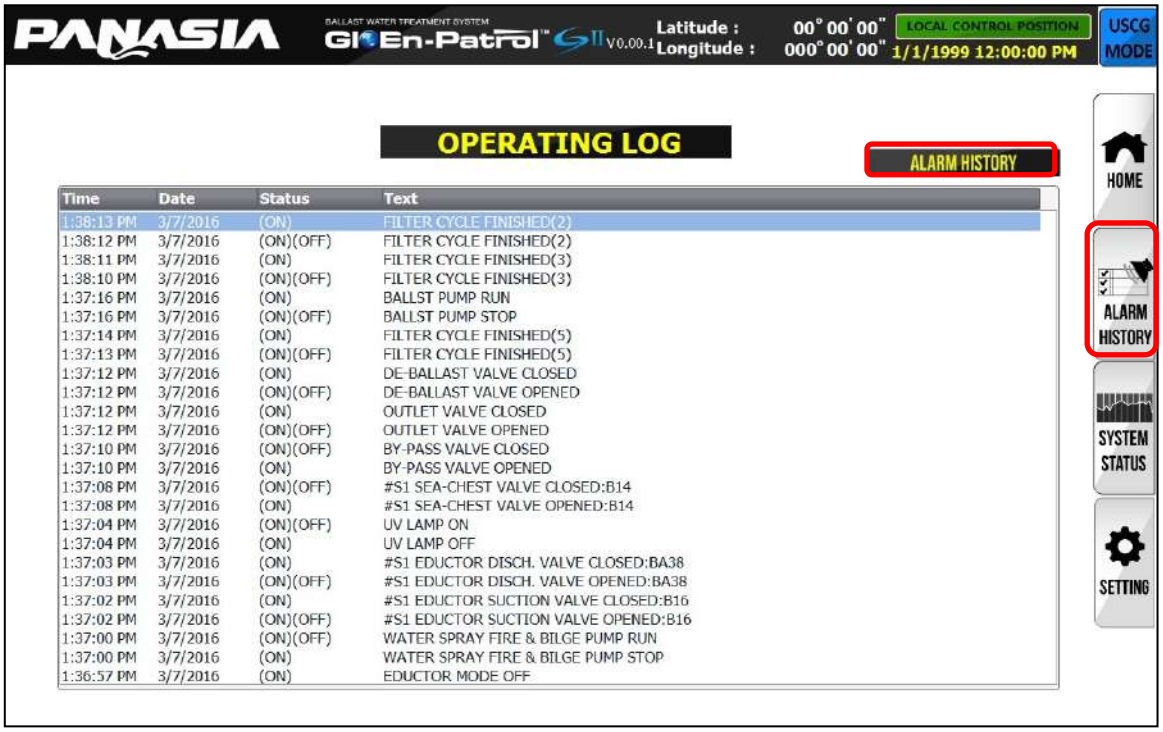


Figure 3.13 Operating Log screen

NOTE: To avoid the loss of data log, after the touch screen recognizes normal connection, number of log and file number stored in the non-volatile memory of the PLC will be transferred to touch screen. And there is no problem in saving the log even when abnormal power on/off .

(3) System Status

When an operator selects the *SYSTEM STATUS* button (

), the status list of all control positions will show on-screen. If an operation is on, the indicator lamp will be green. If an operation is off, the indicator lamp will be gray.

The *SYSTEM STATUS* screen can be shown here in Figure 3.14.

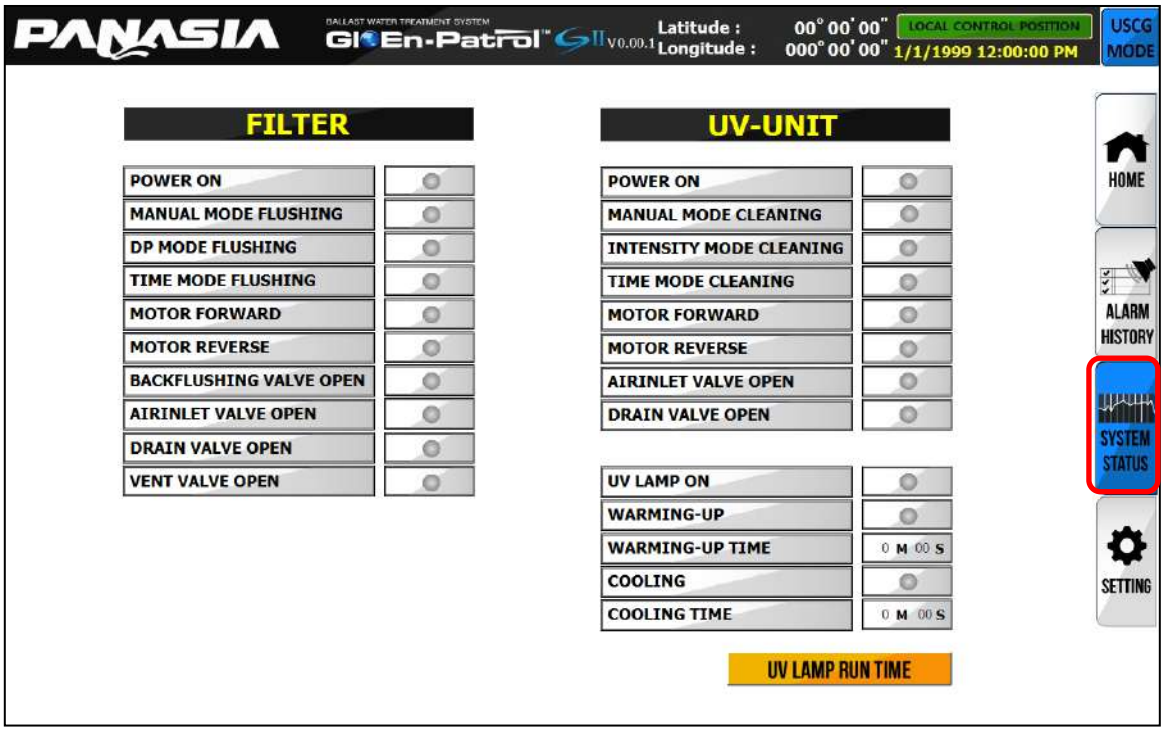


Figure 3.14 System Status screen

- Filter unit (Explanation of each parameter):

Parameter	Explanation
POWER ON	Filter unit is on
MANUAL MODE FLUSHING	Back-flushing is manually operated
DP MODE FLUSHING	Automatically initiates back-flushing (by using differential pressure) when it is higher than set value
MOTOR FORWARD	Back-flushing motor rotates forward
MOTOR REVERSE	Back-flushing motor rotates in reverse
FLUSHING VALVE OPEN	Back-flushing valve is opened
AIR INLET VALVE OPEN	Air inlet valve is opened
DRAIN VALVE OPEN	Drain valve is opened
VENT VALVE OPEN	Vent valve is opened

- UV unit (Explanation of each parameter):

Parameter	Explanation
POWER ON	UV unit is on
MANUAL MODE CLEANING	Wiper is manually operated
INTENSITY MODE CLEANING	Automatically initiates wiper when intensity of UV lamps is less than set value
TIMER MODE CLEANING	Automatically initiates wiper set time
MOTOR FORWARD	Wiper motor rotates forward
MOTOR REVERSE	Wiper motor rotates in reverse
AIR INLET VALVE OPEN	Air inlet valve is opened
DRAIN VALVE OPEN	Drain valve is opened
UV LAMP ON	UV Lamp(s) are activating
WARMING-UP	Required warming up period for UV lamps (approximately 5 minutes) before UV lamps reach necessary intensity level
WARMING-UP TIME	Displays remaining time before completed UV lamp warming-up
COOLING (LAMP)	Required Cooling period for UV lamps (approximately 1 minute) after UV lamps are turned off
COOLING (LAMP) TIME	Displays remaining time before complete Lamp Cooling

When an operator selects the *UV LAMP RUN TIME* button (UV LAMP RUN TIME), bellow information will be pop up to check how long times relevant UV lamps are operated.

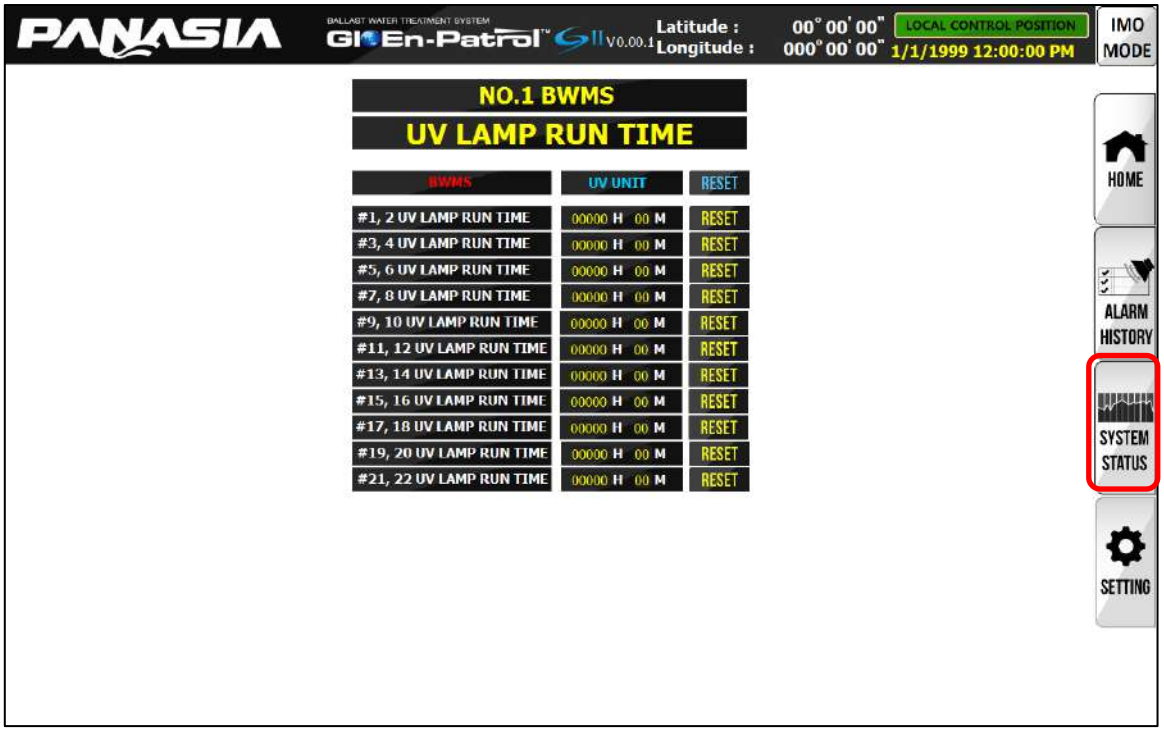


Figure 3.15 Pop up window for the UV lamp run time

(4) Setting

When selecting the *SETTING* button ( ), the operator must enter a user(ID) and security password.

User(ID) : CREW

Password : 1 1 1 1 1 1 1 (7 digits)

The password is required for adjusting system pre-set settings (i.e. emergency situation, trip condition). In case of power loss, the system will automatically restore and resume operation without entering any passwords.

Current set values will be indicated on the display. A keypad will pop up when the indicated value/number on the display is touched. The operator can change the value by entering a new value and saving new value by selecting the enter ENT button ( ). The system will save and update the new set value once the operator selects the ENT button ( ). If the operator selects the CANCEL button ( ), the entered value will be canceled and previous set value will be used.

If the operator enters the value which is not within the system's preset range and selects the ENT button ( ), the entered value will not be set.

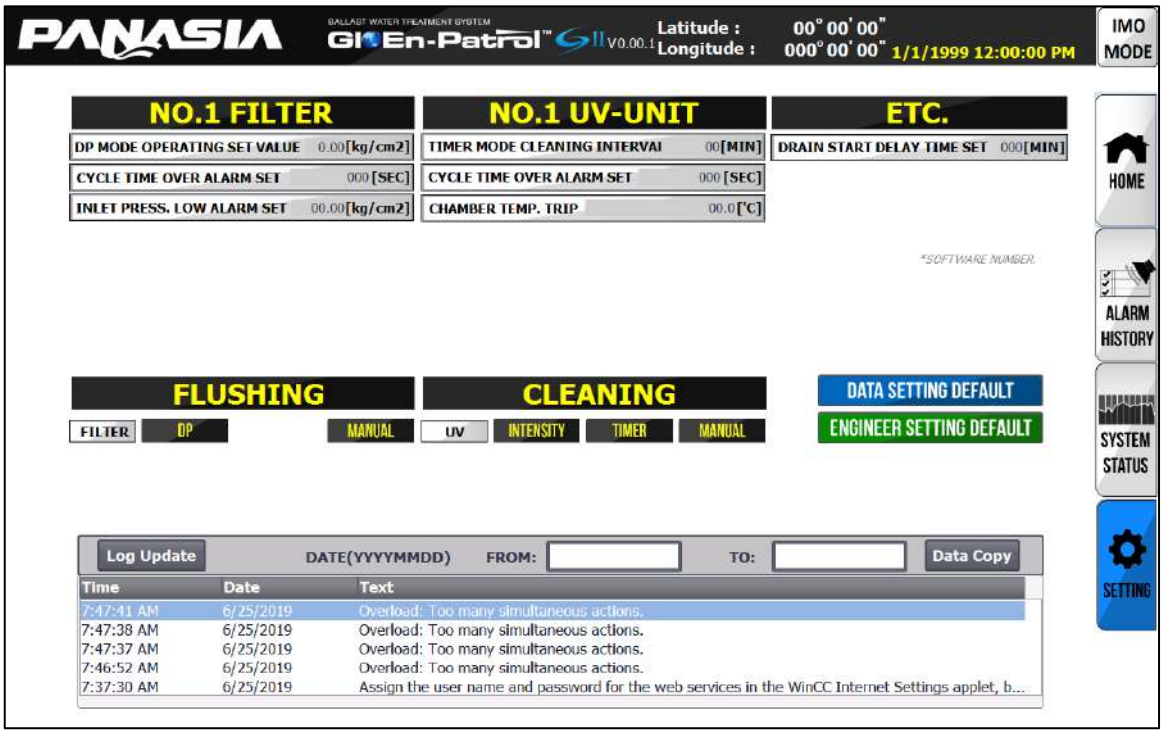


Figure 3.17 Setting screen

The bottom portions of the *SETTING* screen shown in Figure 3.17 are for an operator to set the *WIPER ACTIVATION MODE* in the following options:

Flushing		
Mode	Button	Explanation
DP Mode	DP	When selected, Mode will change to option of Back-flushing will automatically activate when DP is higher than the set value
Manual Mode	MANUAL	When selected, Mode will change to option of Back-flushing will activate and will revert back to the previous mode (DP MODE or TIMER MODE)

Cleaning		
Mode	Button	Explanation
Intensity Mode	INTENSITY	When selected, Mode will change to option of Wiper cleaning will activates when the dose of the UV is lower than the set value
Timer Mode	TIMER	When selected, Mode will change to option of Wiper cleaning will activate and operate at the set time duration
Manual Mode	MANUAL	When selected, Mode will change to option of Wiper will activate and will revert back to the previous mode (*INTENSITY MODE* or *TIMER MODE*)

Setting		
Description	Default	Setting Range
Timer Mode cleaning interval	15 min	0 ~ 60 min
UV cycle time over	60 sec	0 ~ 100 sec
Chamber temperature trip	60 °C	40 ~ 60 °C
Filter cycle time over	53 sec	20 ~ 60 sec
Filter inlet low pressure	1.00 kg/cm^2	0.50 ~ 1.00 kg/cm^2
DP set value	0.1 kg/cm^2	0.00 ~ 0.50 kg/cm^2
Drain start delay time set	120 min	0 ~ 930 min

Table 3.2 Setting range

NOTE: Each modification in setting screen on setting value related to system operation is recorded as log file, and modification under check mode is also recorded.

NOTE: Setting parameter on setting screen.

1) UV Timer Mode Cleaning Interval
2) UV Chamber Temp. Trip
3) UV Cycle Time Over Alarm Set,
4) Filter DP Mode Operating Set Value
5) Filter Cycle Time Over Alarm Set
6) Filter Inlet Press. Low Alarm Set
7) Drain Start Delay Time Set

NOTE: Initially, the password is set and given by PANASIA as shown above, but it can be changed by a PANASIA engineer at onboard as shipowner's request. Neither create nor change current password is not allowable to avoid removal of logging data and any records without permission.

C. Operating, safety, and emergency procedures

(1) Ballast Mode

When *BALLAST MODE* button (

) is selected, valves will arrange for water to enter ballast tank. Water will flow from the sea chest, through the pipeline and into the ballast tank:

NOTE: *Open the appropriate valves are located inline as below sequences by VRC.*

Sea chest → Ballast Pump → Filter Unit → UV Unit → Ballast Tank

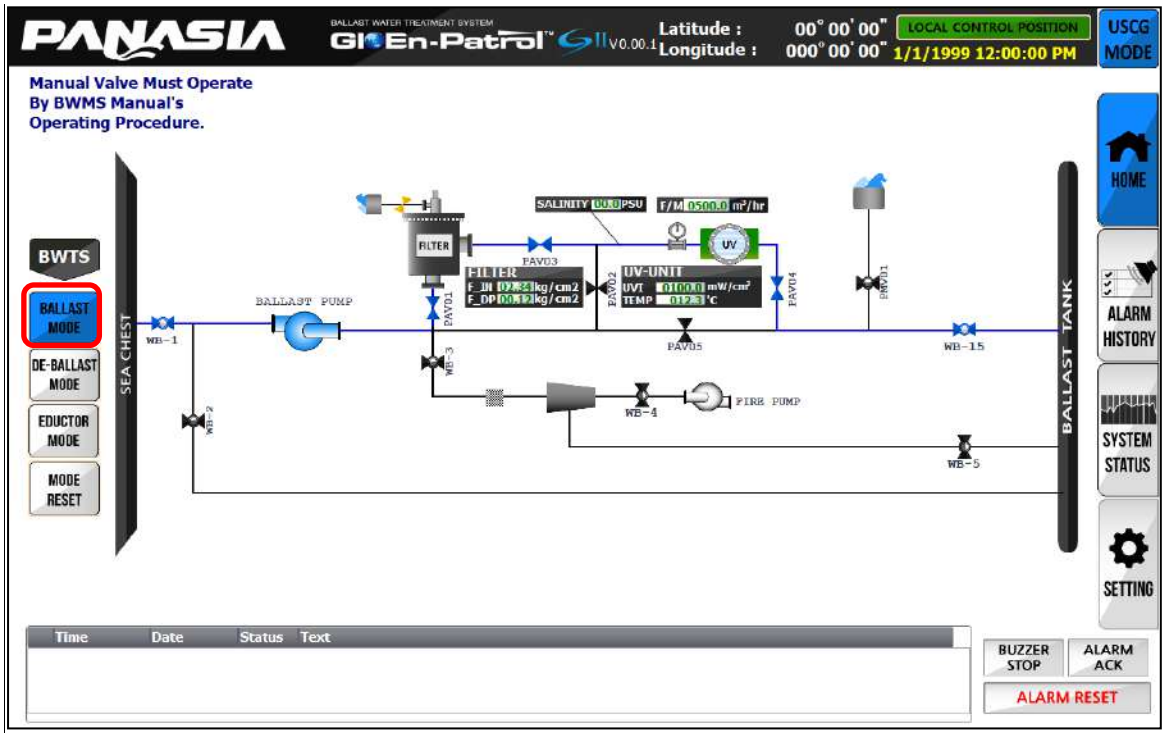


Figure 3.18 Normal ballasting processes

NOTE: *If above step(s) are not done properly, operator can NOT proceed.*

CAUTION	*Number of valves can be different for each vessel.* *Check the head pressure of the ballast pump(s) before operating.*

- **Ballasting Start Procedure**

a. Select the *BALLAST MODE* button () in the *HOME* screen.

b. Automatically, valve arrangement switch to *STANDBY CONDITION* in order.

c. Ballast pump must be run prior to turn the UV lamp on by an operator.

d. Select the *UV UNIT* icon () when flow rate reaches required level.

e. Select the *START* button () in the pop-up window which UV unit will activate.

f. Required warming up period for UV lamps is approximately five (5) minutes before UV lamps reach necessary intensity level. View the display for the remaining time before completed lamp warming up is finished.

g. *WARMING UP* indicating lamp turns on until warming up process is completed then, it will be flicker up.

h. The ballast valve will open and then, the overboard valve will close in order.

i. *WARMING UP* indicating lamp on the control panel will turn off.

j. Ballasting will commence to the relevant tank(s).

- **Ballasting Stop Procedure**

a. Select the *UV UNIT* icon () in the *HOME* screen.

b. Select the *STOP* button () in the pop-up window to stop the process.

c. Open the overboard valve and then, close the ballast valve in order (*STANDBY CONDITION: UV Lamp OFF)*.

d. UV cooling down process will be activated.

* To avoid organic matter remaining on the screen of filter element, Back flushing will be started 30 seconds before the cooling time is completed and the Back Flushing will operated until all valves stands as *STANDBY CONDITION.*

e. When the UV cooling process is completed, all valves will stand as *STANDBY CONDITION* until the ballasting pump will be stopped.

f. The ballast pump will be stopped automatically or manually. If the pump has not been stopped for a period of time, the *Pump Stop* pop-up appears on the home screen.

g. Then, all valves will be automatically closed as initial state.

h. Draining will commence from the filter and UV unit after operating.

i. Water must be drained from the system by opening the drain and inlet valves of the filter and UV unit after operating in order to prevent the unit elements from corrosion.

NOTE: *Two (2) hours (default) after BWMS operation, draining process starts automatically.*

NOTE: *If abnormal shut down occurs, operator must keep the required cooling time (5 minutes) before starting a BWMS.*

- **Drain operating sequences**

  a. BWMS operating completed (Ballast pump-stop and all valves-close).

  b. Filter drain valve will open after set time interval.

  c. Filter air inlet valve will open after 10 seconds.

  d. Filter air inlet and drain valves will close after 9 minutes and 50 seconds.

  e. UV drain valve open after 20 minutes.

  f. UV air inlet valve will open after 10 seconds.

  g. UV air inlet and drain valve will close after 10 minutes.

  ✓ Original 7 bar compressed air is depressurized through regulator installed at air inlet valve 2 bars, and injected into units. Therefore, inner overpressure is prevented from the beginning.

  ✓ If drain set time interval is '0(zero)', drain will start directly after BWMS operation.

  ✓ Drain operation will not commence if BWT system is operating. This means, water will not be automatically drained when BWT system is running.

NOTE: *When filter and UV unit are operated for drain, air inlet valve makes the drain possible smoothly by putting air into them.*

- **Time interval for drain check**

  a. Drain is delayed during set value after ballasting/de-ballasting operation.

  b. After drain delay time, drain automatically starts.

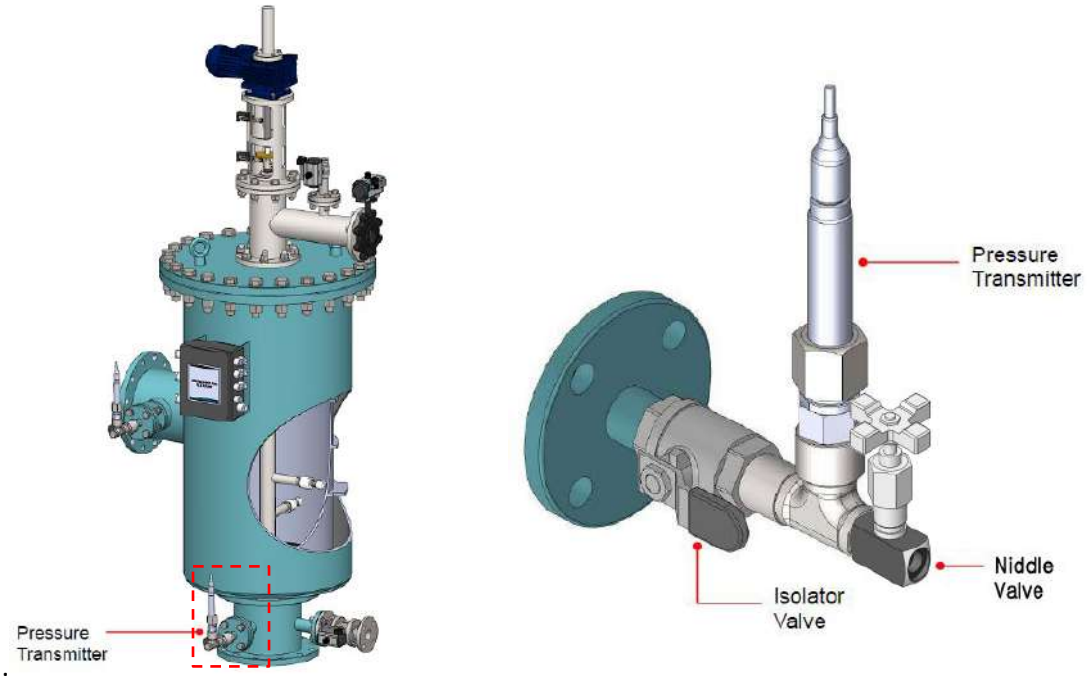
  c. After drain is completed, operator is allowed to do manual drain check.

NOTE: *Please make sure that the manual drain should be carried out after the automatic drain is finished to prevent the corrosion.*

NOTE: *Manual drain operation must be performed and is operated by opening of air inlet valve and drain valve.*

NOTE: *The manual drain is operated in physical way and is worked under the same condition according to drain operating sequences.*

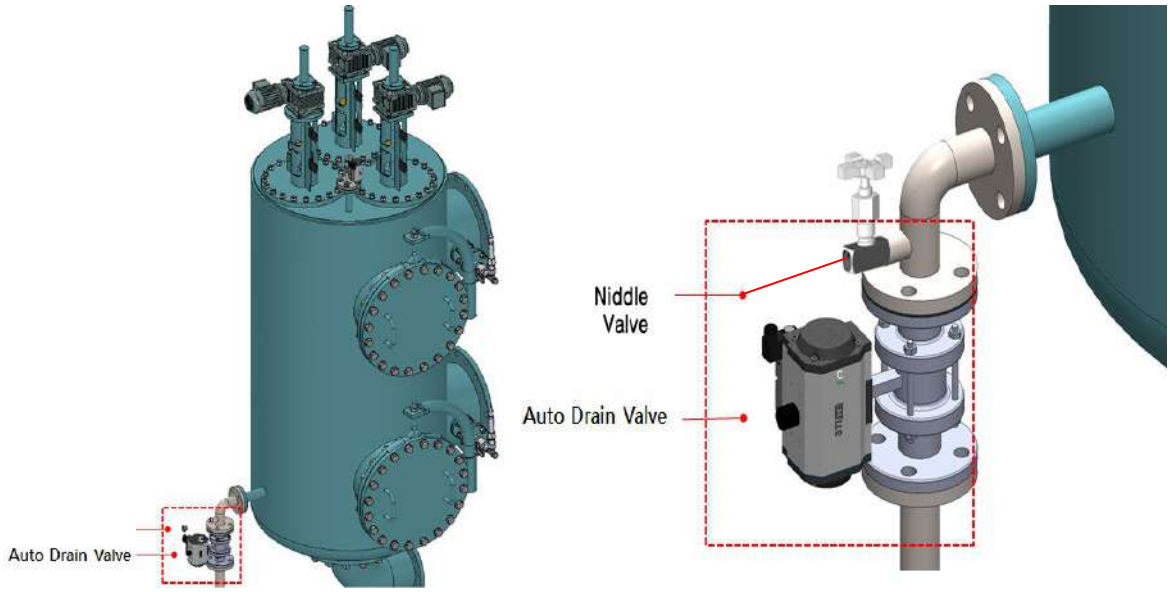
<Standard filter unit>



NOTE: *Manual drain check point of standard filter unit can be found at the end of pressure transmitter as shown above illustrates. NIddle valve can be open then it is available to check.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

<High capacity filter unit>



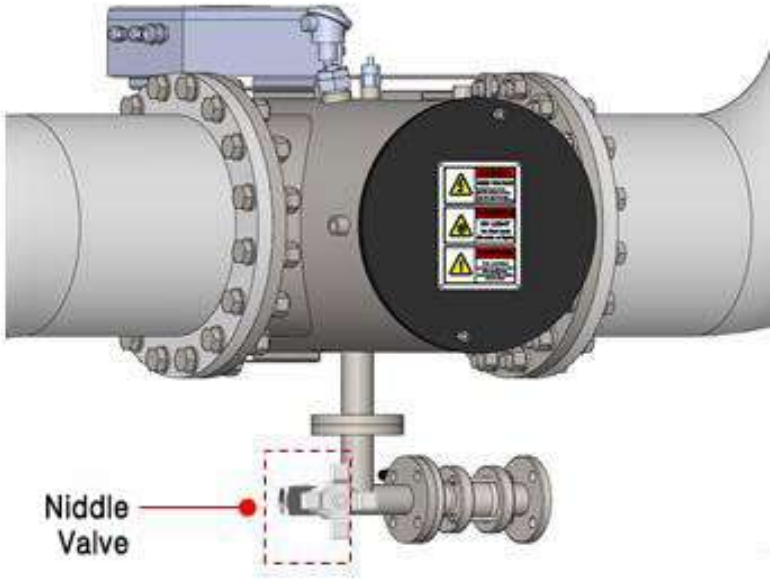
NOTE: *Manual drain check point of high capacity filter unit can be found by opening the Niddle valve that is located on the piping connected with auto drain valve as shown above illustrates.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

In case of UV unit, method of drain confirmation is different depending on the UV unit type.

<Standard UV unit>

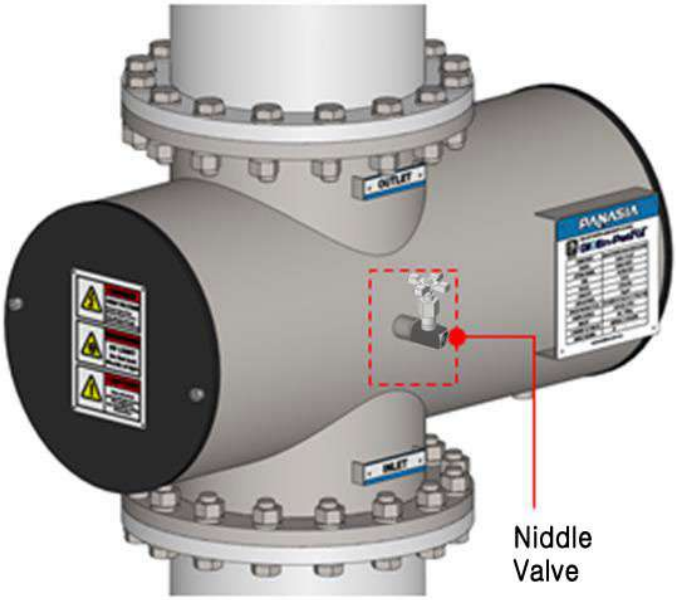
1) Horizontal type



NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of manual valve which is installed at the end of UV unit as shown above illustrates.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

2) Vertical type

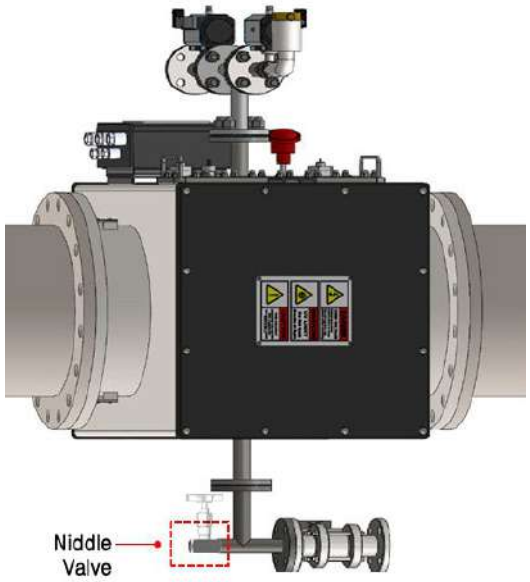


NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

<High capacity UV unit>

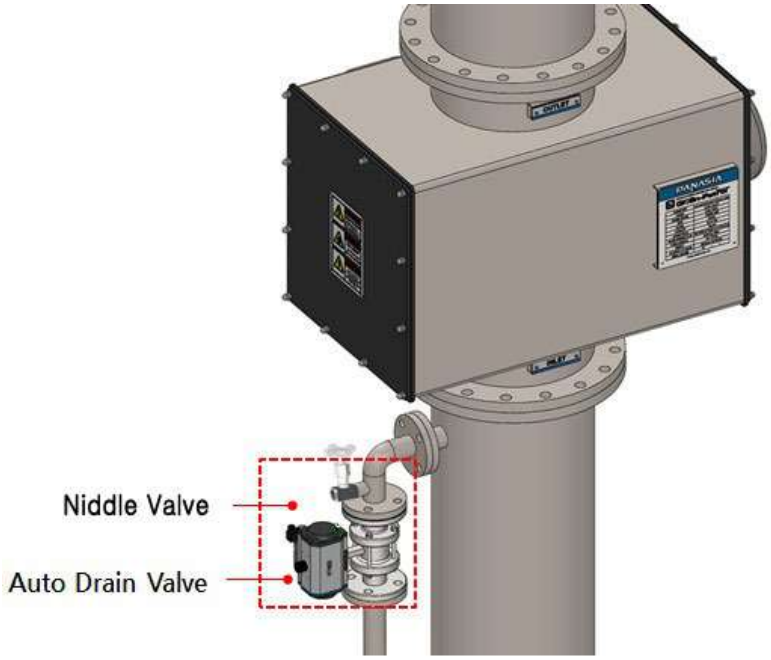
1) Horizontal type



NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of manual valve which is installed at the end of UV unit as shown above illustrates. Plug can be temporally removed then it is available to check.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

2) Vertical type



NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

CAUTION	*BWMS requires for operators to completely drain the system by either confirming open positions of all individual equipment drain valves during the draining stage, by using the manual drain point(s) throughout the system after a predetermined number of ballasting operation, or after a set time interval.*

- **General Safety Measures in failure situations**

  There are three measures to react against system failure.

  1) System shutdown during operation.

  a. The system will shutoff (UV Lamp off);

  b. Ballast pump will be stopped; and then

  c. All valves will be closed; and

  d. No bypass valve opens.

  ✓ *BWMS* receives 'Pump Running Signal' to recognize pump running status, but also BWMS sends 'Ballast Pump Stop Signal' to stop ballast pump.

  2) Switching mode selector to BYPASS position.

  a. The system will shutoff (UV Lamp off);

  b. No ballast pump will be stopped; and then

  c. All Valves will be closed; and

  d. Bypass valve opens.

  3) Physical pushing on EMERGENCY STOP button.

  a. The system will shutoff (UV Lamp off);

  b. Ballast pump will be stopped; and then

  c. All valves will be closed; and

  d. Bypass valve opens.

  4) Loss of power

  a. The system will shutoff (UV Lamp Off)

  b. No ballast pump will be stopped; and then

  c. Inlet valve, Intermediate valve and De-ballast valve will be keep as it stands; and

  d. Outlet valve and Bypass valve will be closed with the local valve control cabinet.

  NOTE: *In case of the bypass valve is opened manually for ballast operation if needed, the open can be possible with using the Hand Pump.*

  NOTE: *In case of the BWMS outlet valve can not be controlled by the ship's system, it can be closed manually by the crew with using the Hand pump.*

NOTE:

- ✓ *When power is out, audible and sound alarms will come when power returns together with 'POWER FAIL' message.*
- ✓ *PLC failures are logged, and indicated through the message 'PLC stopped' without sound alarm in GP screen, and PLC to be rebooted.*
- ✓ *Wire failure is a problem in a part of system, causing alarm or trip if the problem is related to below indicated analogue input.*
- ✓ *Trip : Intensity Sensor, Temp. Sensor*
- ✓ *Alarm : Inlet/Outlet Sensor, Flow meter*

- **In case of the pump stop signal is not applied for independent operation of the pump in failure situations**

1) System shutdown during operation.

a. The system will shutoff (UV Lamp off);

b. No ballast pump will be stopped; and then

c. All Valves will be closed; and 10 seconds later;

d. Bypass mode switched automatically.

CAUTION	*BWMS basically recommends stopping the pump automatically or manually in case of a system failure during operation. And if the pump stops, refer to "Chapter VI. Troubleshooting procedure" to solve the problem before operating the system.* *Nevertheless, the operator should consider the pump operation in bypass mode only if it is determined that the shutdown of the pump will endanger the safety of the ship. And please be aware of the following.* *When the system fault situation during operation, pump operation continues, but treatment does not met D-2 discharge standards and does not comply with type approval certificates. A warnings and audible bypass alarms is issued and recorded in the operating log.* *The operator must take action according to the ballast water plan to comply with the type approval certificate, even if operation continues through by-pass valve or alternative route for need. (Refer to chapter I.B.(4) Bypass Mode)* *Note : The operator manages the untreated water injected into the BW tank through bypass operation in consideration of BWM Convention Regulations A-3 & A-4 Exceptions and B-4 Ballast Water Exchange.* *Therefore, in order to prevent intentionally and unintentionally injecting / discharging untreated ballast water, the operator is required to take appropriate checks and maintenance according to Chapter VI & VII of the manual before operating the equipment and to make efforts to comply with the type approval certificate.*

- **Air Vent Valve Operation**

Air Vent Valve is utilized to discharge heat accumulated inside UV chamber, and this operates in the condition where inner UV chamber temperature reaches to the value of 'Temperature High High(Trip) value – 15℃' regardless of UV lamp power on/off, e.g. If Temp. High High value is 60℃, Air Vent Valve functions at 45℃. This function is only applied for horizontal type UV unit.

- **Auto Flow Control Sequences**

Automatic Flow Control is composed depending on the UV Intensity level.

The sequences begin only when UV Intensity is lower than half flow set value (refer to table 1.2).

a) If UVI is lower than half flow set value (refer to table 1.2) flow rate is reduced 50% in total from TRC (Total Rated Capacity).

b) If UVI reaches to alarm 2 set value (refer to table 1.2) alarm is generated.

c) If UVI reaches to trip 1 set value (refer to table 1.2), BWMS automatically shuts down.

(2) De-Ballast Mode

When *DE-BALLAST MODE* (DE BALLAST MODE) button is selected, valves will arrange for discharging water overboard. Ballast water will flow from ballast tank through the pipeline overboard:

Ballast Tank → Ballast Pump → UV Unit → Overboard

Normal de-ballasting process can be shown here in Figure 3.19.

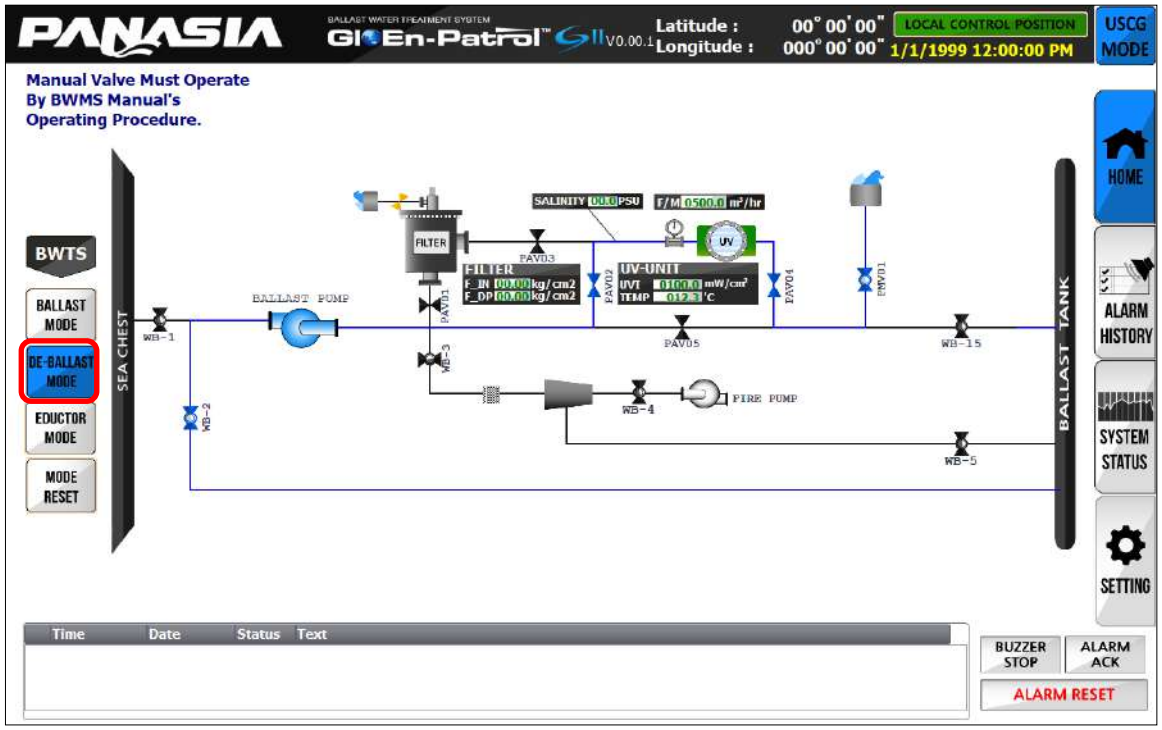


Figure 3.19 Normal de-ballasting processes

NOTE: *If above step(s) are not done properly, operator can NOT proceed.*

CAUTION	*Number of valves can be different for each vessel.* *Check the head pressure of the ballast pump(s) before operating.*

- **De-Ballasting Start Procedure**

a. Select the *DE-BALLAST MODE* button () in the *HOME* screen.

b. Automatically, valve arrangement switch to *STANDBY CONDITION* in order.

c. Ballast pump can be run prior to turn the UV lamp on by an operator.

d. Select the *UV UNIT* icon () when flow rate reaches required level.

e. Select the *START* button () in the pop-up window which UV unit will activate.

f. Required warming up period for UV lamps is approximately five (5) minutes before UV lamps reach necessary intensity level. View the display for the remaining time before completed UV lamp warming up is finished.

g. *WARMING UP* indicating lamp turns on until warming up process is completed then, it will be flicker up.

h. The suction valve will open and then, the sea chest valve will close in order.

i. The de-ballast valve will open then, the inlet and the intermediate valves will close in order.

j. *WARMING UP* indicating lamp on the control panel will turn off.

k. De-ballasting will commence to the overboard.

- **De-Ballasting Stop Procedure**

a. Select the *UV UNIT* icon () in the *HOME* screen.

b. Select the *STOP* button () in the pop-up window to stop the process.

c. Open the sea chest valve and then, close the suction valve in order.

d. Open the inlet and the intermediate valves and then, close the de-ballast valve in order (*STANDBY CONDITION: UV Lamp OFF).*

e. UV cooling down process will be activated.

* To avoid organic matter remaining on the screen of filter element, Back flushing will be started 30 seconds before the cooling time is completed and the Back Flushing will operated until all valves stands as *STANDBY CONDITION.*

f. When the UV cooling process is completed, all valves will stand as *STANDBY CONDITION* until the ballasting pump will be stopped.

g. The ballast pump will be stopped automatically or manually. If the pump has not been stopped for a period of time, the *Pump Stop* pop-up appears on the home screen.

h. Then, all valves will be automatically closed as initial state.

i. Draining will commence from UV unit after operating.

j. Water must be drained from the system by opening the drain and inlet valves of the filter and UV unit after operating in order to prevent the unit elements from corrosion.

NOTE: *Two (2) hours (default) after BWMS operation, draining process starts automatically.*

NOTE: If abnormal shut down occurs, operator must keep the required cooling time (5 minutes) before starting a BWMS.

- **Drain operating sequences**

  a. BWMS operating completed (Ballast pump-stop and all valves-close).

  b. Filter drain valve will open after set time interval.

  c. Filter air inlet valve will open after 10 seconds.

  d. Filter air inlet and drain valves will close after 9 minutes and 50 seconds.

  e. UV drain valve open after 20 minutes.

  f. UV air inlet valve will open after 10 seconds.

  g. UV air inlet and drain valve will close after 10 minutes.

  ✓ Original 7 bar compressed air is depressurized through regulator installed at air inlet valve 2 bars, and injected into units. Therefore, inner overpressure is prevented from the beginning.

  ✓ If drain set time interval is '0(zero)', drain will start directly after BWMS operation.

  ✓ Drain operation will not commence if BWT system is operating. This means, water will not be automatically drained when BWT system is running.

NOTE: *When filter and UV unit are operated for drain, air inlet valve makes the drain possible smoothly by putting air into them.*

- **Time interval for drain check**

  a. Drain is delayed during set value after ballasting/de-ballasting operation.

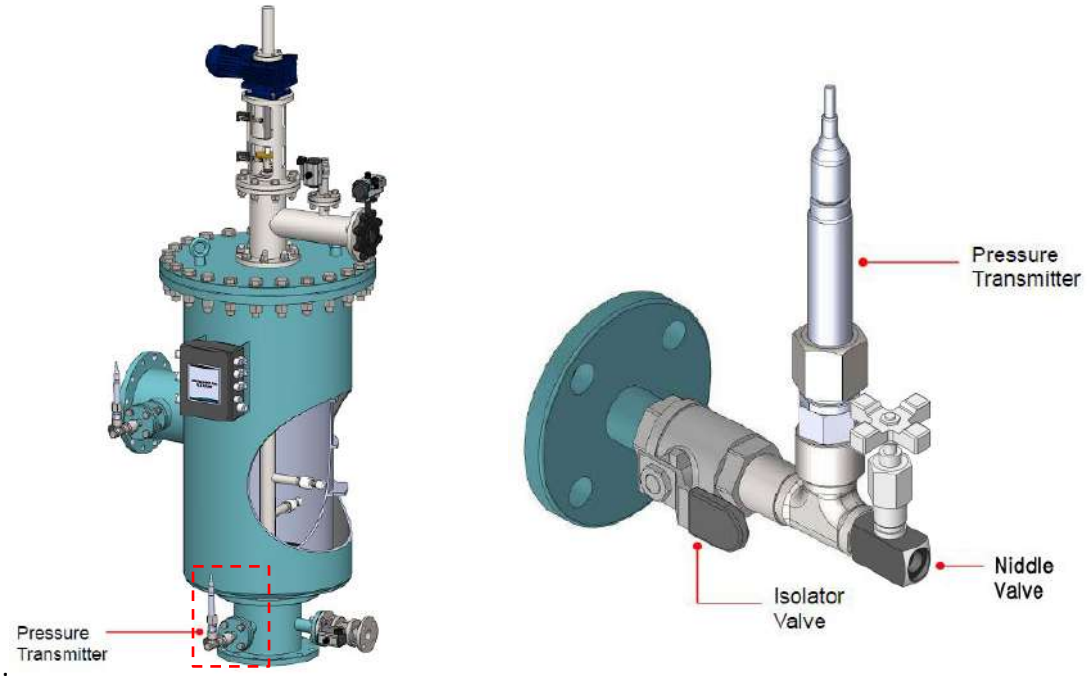
  b. After drain delay time, drain automatically starts.

  c. After drain is completed, operator is allowed to do manual drain check.

NOTE: *Please make sure that the manual drain should be carried out after the automatic drain is finished to prevent the corrosion.*

NOTE: *The manual drain is operated in physical way and is worked under the same condition according to drain operating sequences.*

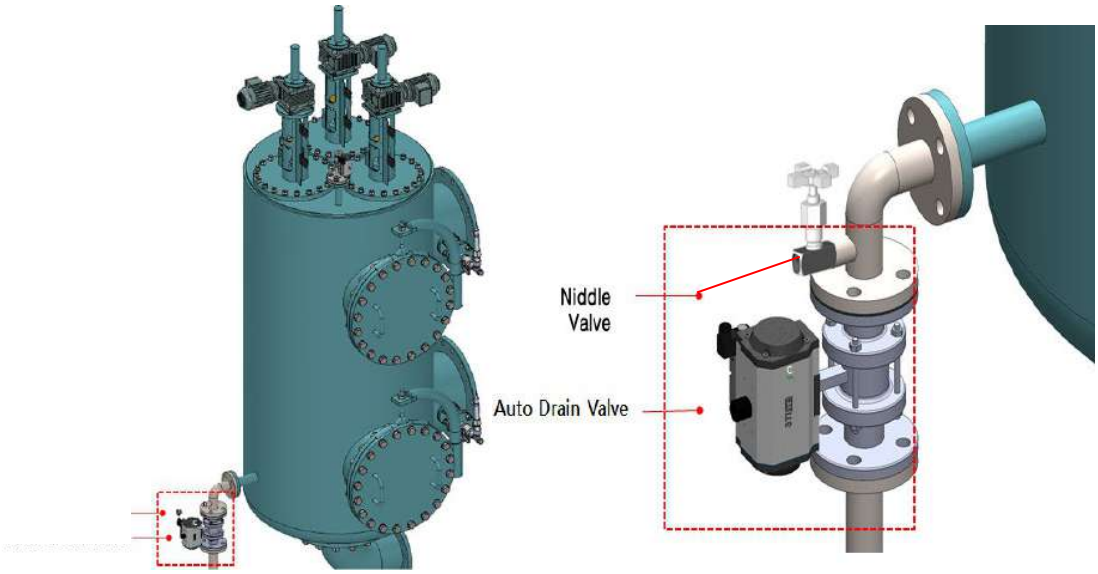
<Standard filter unit>



NOTE: *Manual drain check point of standard filter unit can be found at the end of pressure transmitter as shown above illustrates. Niddle valve can be opened then it is available to check.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

<High capacity filter unit>



NOTE: *Manual drain check point of high capacity filter unit can be found by opening the Niddle valve that is located on the piping connected with auto drain valve as shown above illustrates.*

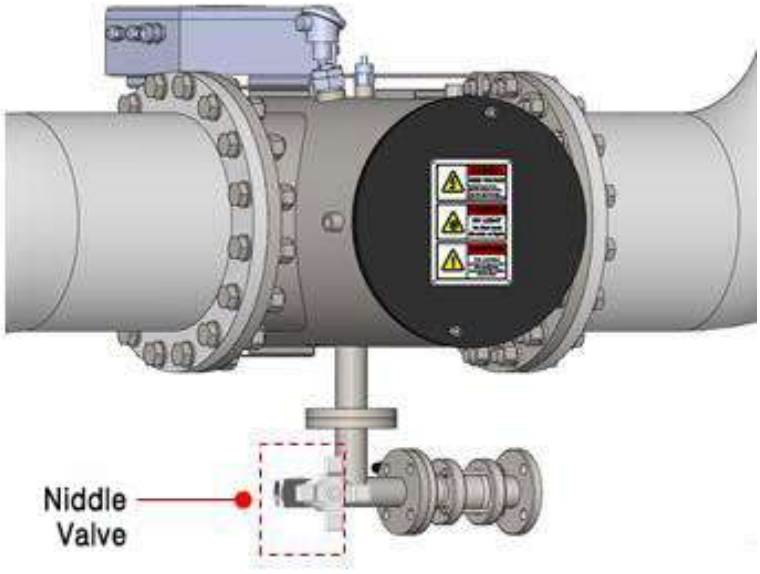
NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle*

valve. If high pressure water comes out, open the valve slowly.

In case of UV unit, method of drain confirmation is different depending on the UV unit type.

<Standard UV unit>

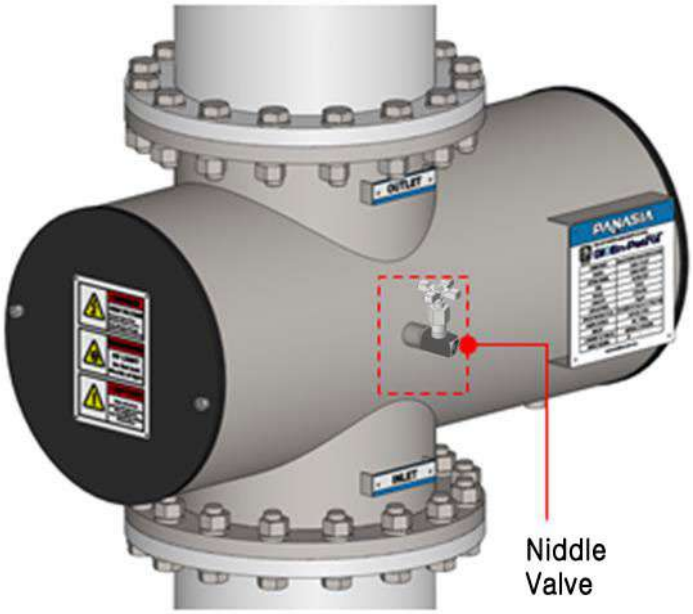
1) Horizontal type



NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of manual valve which is installed at the end of UV unit as shown above illustrates.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

2) Vertical type

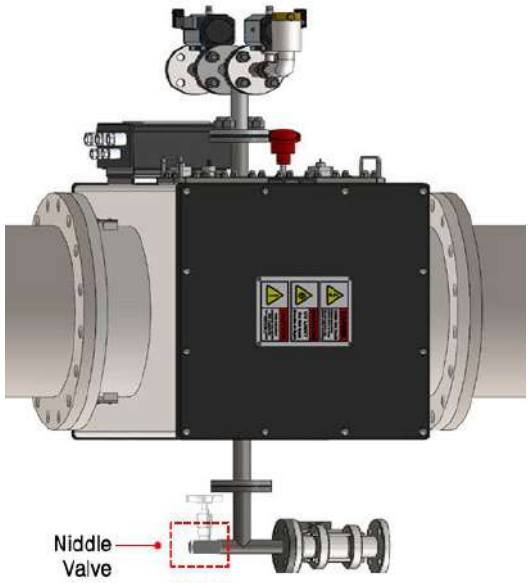


NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

<High capacity UV unit>

1) Horizontal type

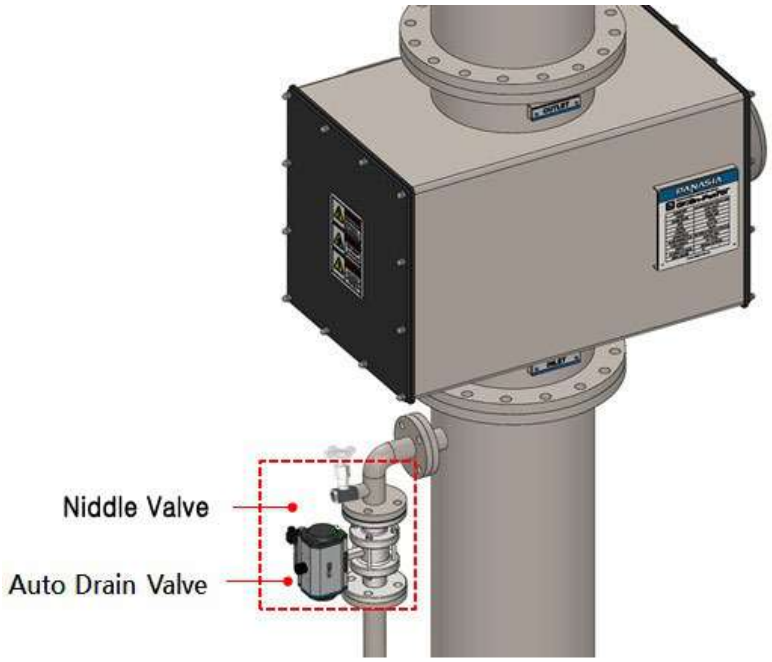


NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of*

manual valve which is installed at the end of UV unit as shown above illustrates.

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

2) Vertical type



NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

CAUTION	*BWMS requires for operators to completely drain the system by either confirming open positions of all individual equipment drain valves during the draining stage, by using the manual drain point(s) throughout the system after a predetermined number of ballasting operation, or after a set time interval.*

- **General Safety Measures in failure situations**

There are three measures to react against system failure.

1) System shutdown during operation.

a. The system will shutoff (UV Lamp off);

b. Ballast pump will be stopped; and then

c. All valves will be closed; and

d. No bypass valve opens.

✓ *BWMS* receives 'Pump Running Signal' to recognize pump running status, but also BWMS sends 'Ballast Pump Stop Signal' to stop ballast pump.

2) Switching Mode Selector to BYPASS position.

a. The system will shutoff (UV Lamp off);

b. No ballast pump will be stopped; and then

c. All Valves will be closed; and

d. Bypass valve opens.

3) Physical pushing on EMERGENCY STOP button.

a. The system will shutoff (UV Lamp off);

b. Ballast pump will be stopped; and then

c. All valves will be closed; and

d. Bypass valve opens.

4) Loss of power

a. The system will shutoff (UV Lamp Off)

b. No ballast pump will be stopped; and then

c. Inlet valve, Intermediate valve and De-ballast valve will be keep as it stands; and

d. Outlet valve and Bypass valve will be closed with the local valve control cabinet.

NOTE: *In case of the bypass valve is opened manually for ballast operation if needed, the open can be possible with using the Hand Pump.*

NOTE: *In case the BWMS outlet valve can not be controlled by the ship's system, it can be closed manually by the crew with using the Hand pump.*

NOTE:

- ✓ *When power is out, audible and sound alarms will come when power returns together with 'POWER FAIL' message.*
- ✓ *PLC failures are logged, and indicated through the message 'PLC stopped' without sound alarm in GP screen, and PLC to be rebooted.*
- ✓ *Wire failure is a problem in a part of system, causing alarm or trip if the problem is related to below indicated analogue input.*
- ✓ *Trip : Intensity Sensor, Temp. Sensor*
- ✓ *Alarm : Inlet/Outlet Sensor, Flow meter*

- **In case of the pump stop signal is not applied for independent operation of the pump in failure situations**

1) System shutdown during operation.

a. The system will shutoff (UV Lamp off);

b. No ballast pump will be stopped; and then

c. All Valves will be closed; and 10 seconds later;

d. Bypass mode switched automatically.

CAUTION	*BWMS basically recommends stopping the pump automatically or manually in case of a system failure during operation. And if the pump stops, refer to "Chapter VI. Troubleshooting procedure" to solve the problem before operating the system.* *Nevertheless, the operator should consider the pump operation in bypass mode only if it is determined that the shutdown of the pump will endanger the safety of the ship. And please be aware of the following.* *When the system fault situation during operation, pump operation continues, but treatment does not met D-2 discharge standards and does not comply with type approval certificates. A warnings and audible bypass alarms is issued and recorded in the operating log.* *The operator must take action according to the ballast water plan to comply with the type approval certificate, even if operation continues through by-pass valve or alternative route for need. (Refer to chapter I.B.(4) Bypass Mode)* *Note : The operator manages the untreated water injected into the BW tank through bypass operation in consideration of BWM Convention Regulations A-3 & A-4 Exceptions and B-4 Ballast Water Exchange.* *Therefore, in order to prevent intentionally and unintentionally injecting / discharging untreated ballast water, the operator is required to take appropriate checks and maintenance according to Chapter VI & VII of the manual before operating the equipment and to make efforts to comply with the type approval certificate.*

- **Air Vent Valve Operation**

Air Vent Valve is utilized to discharge heat accumulated inside UV chamber, and this operates in the condition where inner UV chamber temperature reaches to the value of 'Temperature High High(Trip) value – 15℃' regardless of UV lamp power on/off, e.g. If Temp. High High value is 60℃, Air Vent Valve functions at 45℃. This function is only applied for horizontal type UV unit.

- **Auto Flow Control Sequences**

Automatic Flow Control is composed depending on the UV Intensity level.

The sequences begin only when UV Intensity is lower than half flow set value (refer to table 1.2).

a) If UVI is lower than half flow set value (refer to table 1.2) flow rate is reduced 50% in total from TRC (Total Rated Capacity).

b) If UVI reaches to alarm 2 set value (refer to table 1.2) alarm is generated.

c) If UVI reaches to trip 1 set value (refer to table 1.2), BWMS automatically shuts down.

(3) Eductor (Stripping) Mode

When *EDUCTOR MODE* (EDUCTOR MODE) button is selected, valves will arrange for discharging water overboard. Ballast water will flow from ballast tank through the pipeline overboard:

Driving (G/S, Fire) Line → Eductor → UV Unit → Overboard

Normal stripping process can be shown here in Figure 3.20, and de-ballast, outlet valves activate automatically in *EDUCTOR MODE*.

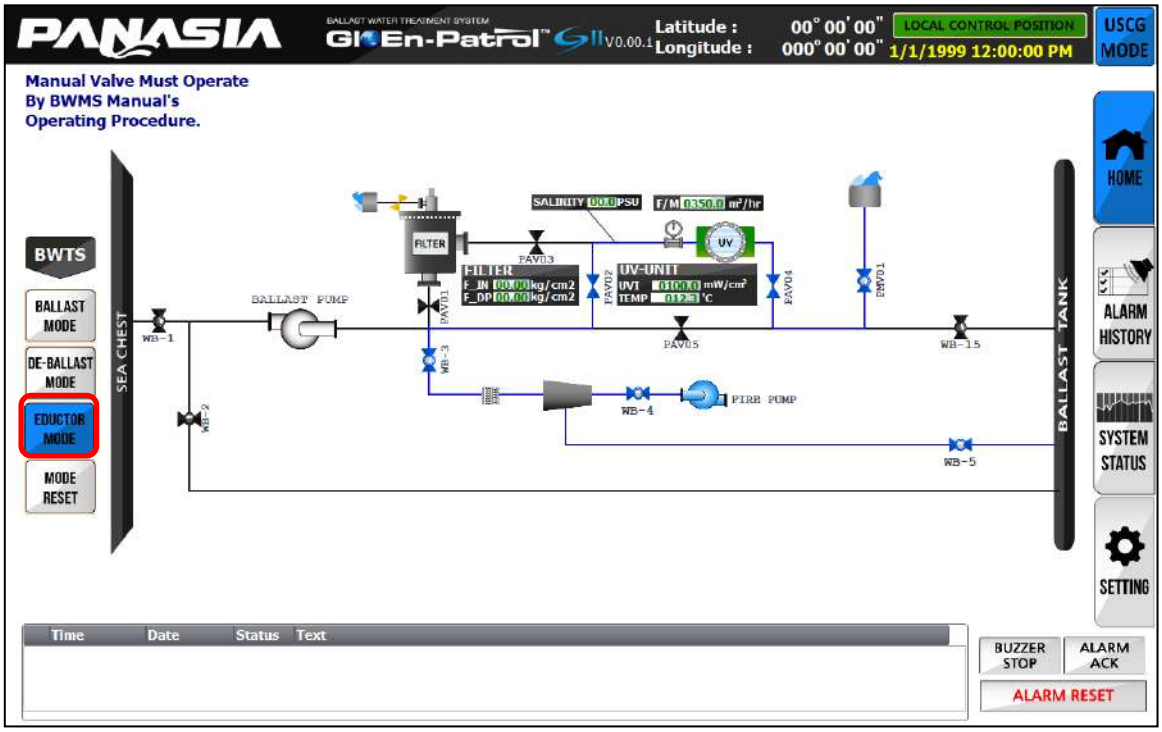


Figure 3.20 Stripping process

From the VRC (Valve Remote Control) system contributes for the warming up process.
Once it completes, the ballast pump is able to operate.

NOTE: *If above step(s) are not done properly, operator can NOT proceed.*

CAUTION	*Number of valves can be different for each vessel.* *Check the head pressure of the ballast pump(s) before operating.*

(1) Stripping Start Procedure

a. Select the *EDUCTOR (STRIPPING) MODE* button (

) in the *HOME* screen.

b. The de-ballast and the outlet valve will open automatically.

c. The overboard valve will open.

d. The driving pump can be run prior to turn the UV lamp on by an operator.

e. Select the *UV UNIT* icon () when flow rate reaches required level.

f. Select the *START* button (

) in the pop-up window which UV unit will activate (warming up with driving water).

g. Required warming up period for UV lamps is approximately five (5) minutes before UV lamps reach necessary intensity level. View the display for the remaining time before completed lamp warming up is finished.

h. *WARMING UP* indicating lamp turns on until warming up process is completed then, it will be flicker up.

i. The eductor suction valve will open.

j. *WARMING UP* indicating lamp on the control panel will turn off.

k. Eductor (Stripping) will commence from the relevant tank(s).

(1) Stripping Stop Procedure

a. Select the *UV UNIT* icon () in the *HOME* screen.

b. Select the *STOP* button (

) in the pop-up window to stop the process.

c. Close the eductor suction valve.

d. UV cooling down process will be activated (cooling down with driving water).

e. When the UV cooling process is completed, all valves will stand as *STANDBY CONDITION* until the eductor pump will be stopped.

f. The eductor pump will be stopped automatically or manually. If the pump has not been stopped for a period of time, the *Pump Stop* pop-up appears on the home screen. And eductor outlet valve must be closed.

g. Draining will commence from UV unit after operating.

h. Water must be drained from the system by opening the drain and inlet valves of the filter and UV unit after operating in order to prevent the unit elements from corrosion.

NOTE: *Two (2) hours (default) after BWMS operation, draining process starts automatically.*

NOTE: *If abnormal shut down occurs, operator must keep the required cooling time (5 minutes) before starting a BWMS.*

- **Drain operating sequences**

  a. BWMS operating completed (Ballast pump-stop and all valves-close).

  b. Filter drain valve will open after set time interval.

  c. Filter air inlet valve will open after 10 seconds.

  d. Filter air inlet and drain valves will close after 9 minutes and 50 seconds.

  e. UV drain valve open after 20 minutes.

  f. UV air inlet valve will open after 10 seconds.

  g. UV air inlet and drain valve will close after 10 minutes.

  ✓ Original 7 bar compressed air is depressurized through regulator installed at air inlet valve 2 bars, and injected into units. Therefore, inner overpressure is prevented from the beginning.

  ✓ If drain set time interval is '0(zero)', drain will start directly after BWMS operation.

  ✓ Drain operation will not commence if BWT system is operating. This means, water will not be automatically drained when BWT system is running.

  NOTE: *When filter and UV unit are operated for drain, air inlet valve makes the drain possible smoothly by putting air into them.*

- **Time interval for drain check**

  a. Drain is delayed during set value after ballasting/de-ballasting operation.

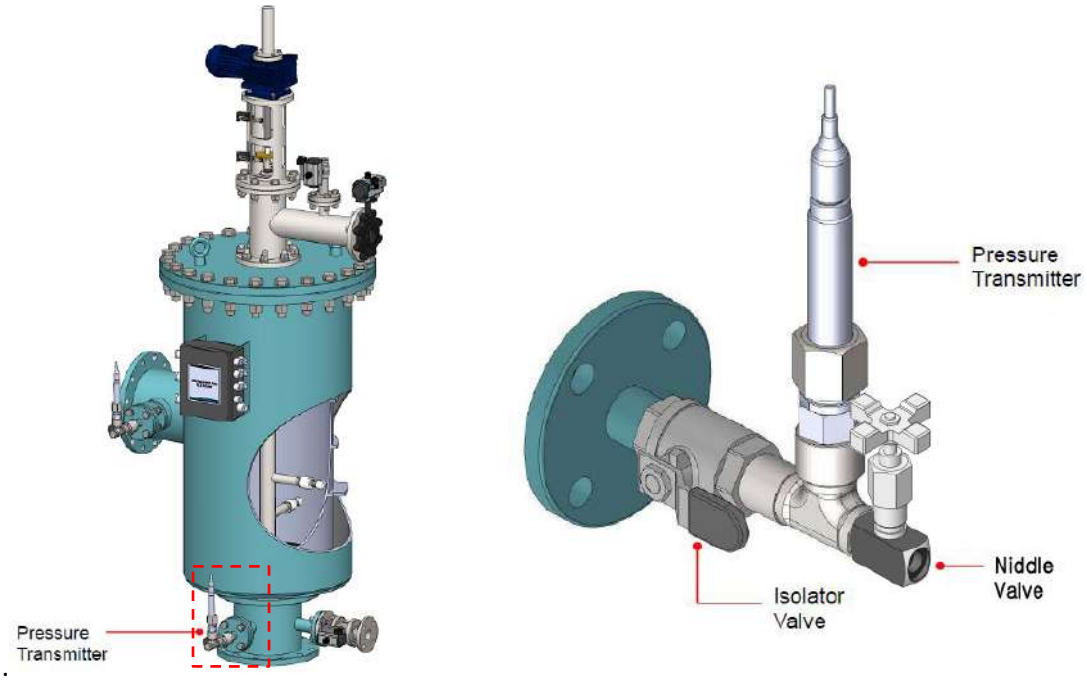
  b. After drain delay time, drain automatically starts.

  c. After drain is completed, operator is allowed to do manual drain check.

  NOTE: *Please make sure that the manual drain should be carried out after the automatic drain is finished to prevent the corrosion.*

  NOTE: *The manual drain is operated in physical way and is worked under the same condition according to drain operating sequences.*

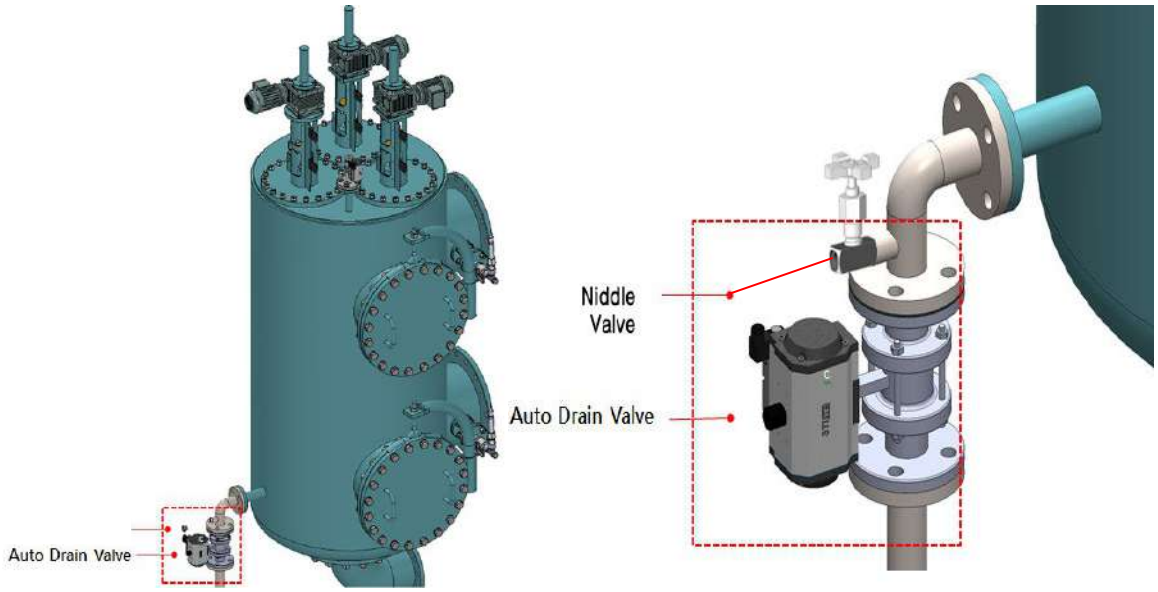
<Standard filter unit>



NOTE: *Manual drain check point of standard filter unit can be found at the end of pressure transmitter as shown above illustrates. Niddle valve can be opened then it is available to check.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

<High capacity filter unit>

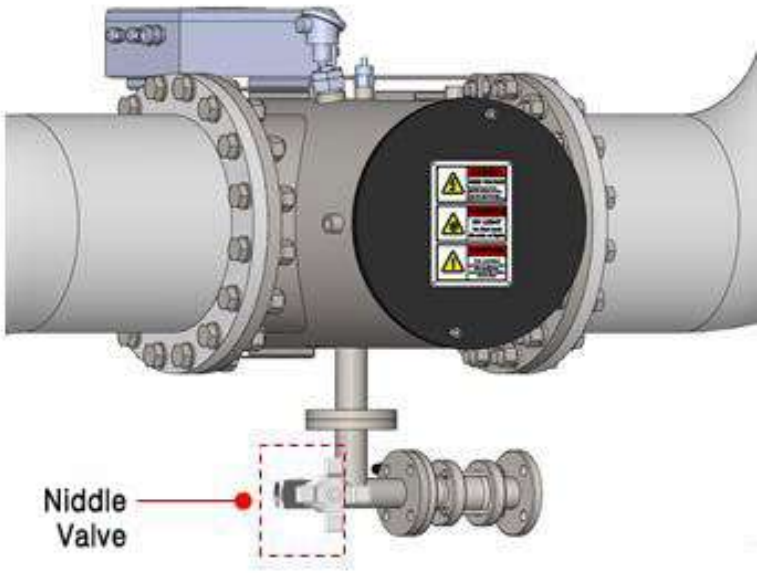


NOTE: *Manual drain check point of high capacity filter unit can be found by opening the Niddle valve that is located on the piping connected with auto drain valve as shown above illustrates.*

In case of UV unit, method of drain confirmation is different depending on the UV unit type.

<Standard UV unit>

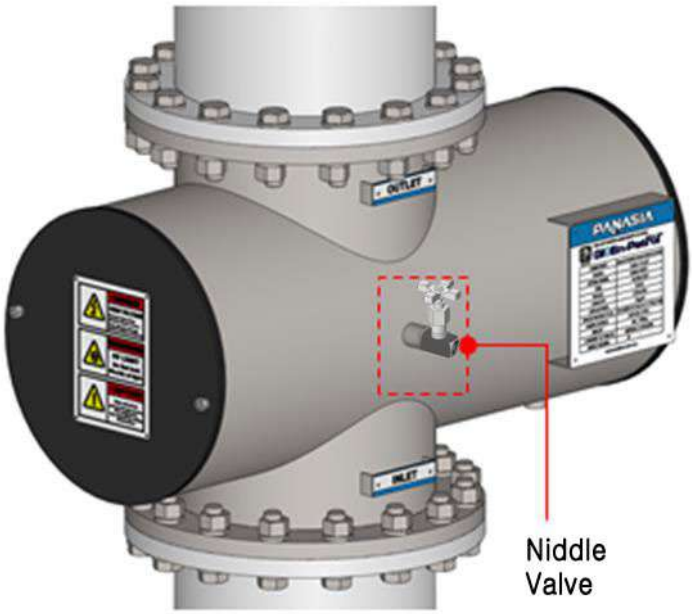
1) Horizontal type



NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of manual valve which is installed at the end of UV unit as shown above illustrates.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

2) Vertical type

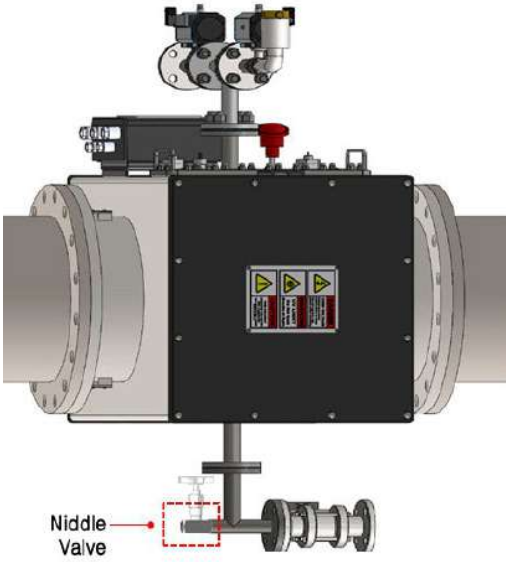


NOTE: *Manual drain check of standard UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

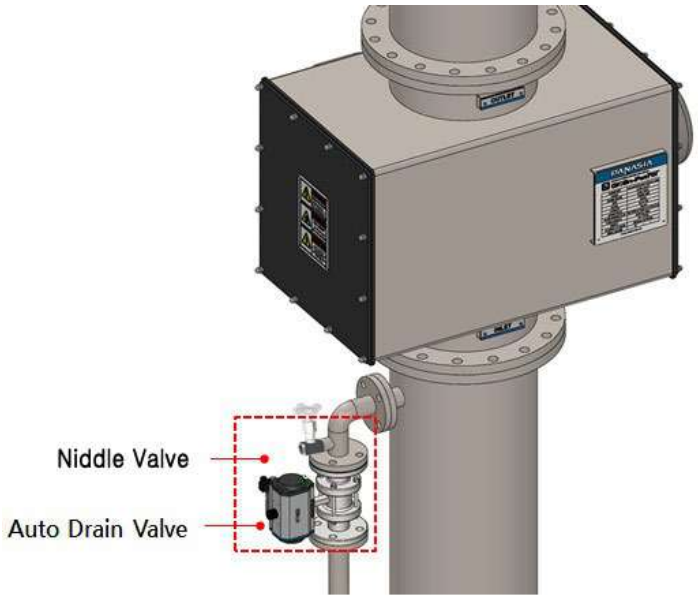
<High capacity UV unit>

1) Horizontal type



NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of manual valve which is installed at the end of UV unit as shown above illustrates.*

2) Vertical type



NOTE: *Manual drain check of high capacity UV unit can be possible by opening the Niddle valve of UV lamp chamber.*

NOTE: *When the valve is opened, please be carefule for the high pressure water through the needle valve. If high pressure water comes out, open the valve slowly.*

 **CAUTION**	*BWMS requires for operators to completely drain the system by either confirming open positions of all individual equipment drain valves during the draining stage, by using the manual drain point(s) throughout the system after a predetermined number of ballasting operation, or after a set time interval.*

- **General Safety Measures in failure situations**

There are three measures to react against system failure.

1) System shutdown during operation.

a. The system will shutoff (UV Lamp off);

b. Ballast pump will be stopped; and then

c. All valves will be closed; and

d. No bypass valve opens.

✓ *BWMS* receives 'Pump Running Signal' to recognize pump running status, but also BWMS sends 'Ballast Pump Stop Signal' to stop ballast pump.

2) Switching Mode Selector to BYPASS position.

a. The system will shutoff (UV Lamp off);

b. No ballast pump will be stopped; and then

c. All Valves will be closed; and

d. Bypass valve opens.

3) Physical pushing on EMERGENCY STOP button.

a. The system will shutoff (UV Lamp off);

b. Ballast pump will be stopped; and then

c. All valves will be closed; and

d. Bypass valve opens.

4) Loss of power

a. The system will shutoff (UV Lamp Off)

b. No ballast pump will be stopped; and then

c. Inlet valve, Intermediate valve and De-ballast valve will be keep as it stands; and

d. Outlet valve and Bypass valve will be closed with the local valve control cabinet.

NOTE: *In case of the bypass valve is opened manually for ballast operation if needed, the open can be possible with using the Hand Pump.*

NOTE: *In case the BWMS outlet valve can not be controlled by the ship's system, it can be closed manually by the crew with using the Hand pump.*

NOTE:

- ✓ *When power is out, audible and sound alarms will come when power returns together with 'POWER FAIL' message.*
- ✓ *PLC failures are logged, and indicated through the message 'PLC stopped' without sound alarm in GP screen, and PLC to be rebooted.*
- ✓ *Wire failure is a problem in a part of system, causing alarm or trip if the problem is related to below indicated analogue input.*
- ✓ *Trip : Intensity Sensor, Temp. Sensor*
- ✓ *Alarm : Inlet/Outlet Sensor, Flow meter*

- **In case of the pump stop signal is not applied for independent operation of the pump in failure situations**

1) System shutdown during operation.

a. The system will shutoff (UV Lamp off);

b. No ballast pump will be stopped; and then

c. All Valves will be closed; and 10 seconds later;

d. Bypass mode switched automatically.

CAUTION	*BWMS basically recommends stopping the pump automatically or manually in case of a system failure during operation. And if the pump stops, refer to "Chapter VI. Troubleshooting procedure" to solve the problem before operating the system.* *Nevertheless, the operator should consider the pump operation in bypass mode only if it is determined that the shutdown of the pump will endanger the safety of the ship. And please be aware of the following.* *When the system fault situation during operation, pump operation continues, but treatment does not met D-2 discharge standards and does not comply with type approval certificates. A warnings and audible bypass alarms is issued and recorded in the operating log.* *The operator must take action according to the ballast water plan to comply with the type approval certificate, even if operation continues through by-pass valve or alternative route for need. (Refer to chapter I.B.(4) Bypass Mode)* *Note : The operator manages the untreated water injected into the BW tank through bypass operation in consideration of BWM Convention Regulations A-3 & A-4 Exceptions and B-4 Ballast Water Exchange.* *Therefore, in order to prevent intentionally and unintentionally injecting / discharging untreated ballast water, the operator is required to take appropriate checks and maintenance according to Chapter VI & VII of the manual before operating the equipment and to make efforts to comply with the type approval certificate.*

- **Air Vent Valve Operation**

Air Vent Valve is utilized to discharge heat accumulated inside UV chamber, and this operates in the condition where inner UV chamber temperature reaches to the value of 'Temperature High High(Trip) value – 15℃' regardless of UV lamp power on/off, e.g. If Temp. High High value is 60℃, Air Vent Valve functions at 45℃. This function is only applied for horizontal type UV unit.

- **Auto Flow Control Sequences**

Automatic Flow Control is composed depending on the UV Intensity level.

The sequences begin only when UV Intensity is lower than half flow set value (refer to table 1.2).

a) If UVI is lower than half flow set value (refer to table 1.2) flow rate is reduced 50% in total from TRC (Total Rated Capacity).

b) If UVI reaches to alarm 2 set value (refer to table 1.2) alarm is generated.

c) If UVI reaches to trip 1 set value (refer to table 1.2), BWMS automatically shuts down.

(4) Emergency operation

In *BYPASS MODE, e*mergency ballasting (into ballast tank) and de-ballasting (from ballast tank) can be operated in the case of the system and/or instrument(s) and/or UV lamp(s) is failed and it is difficult to recover troubles in short period of time or vessel emergency.

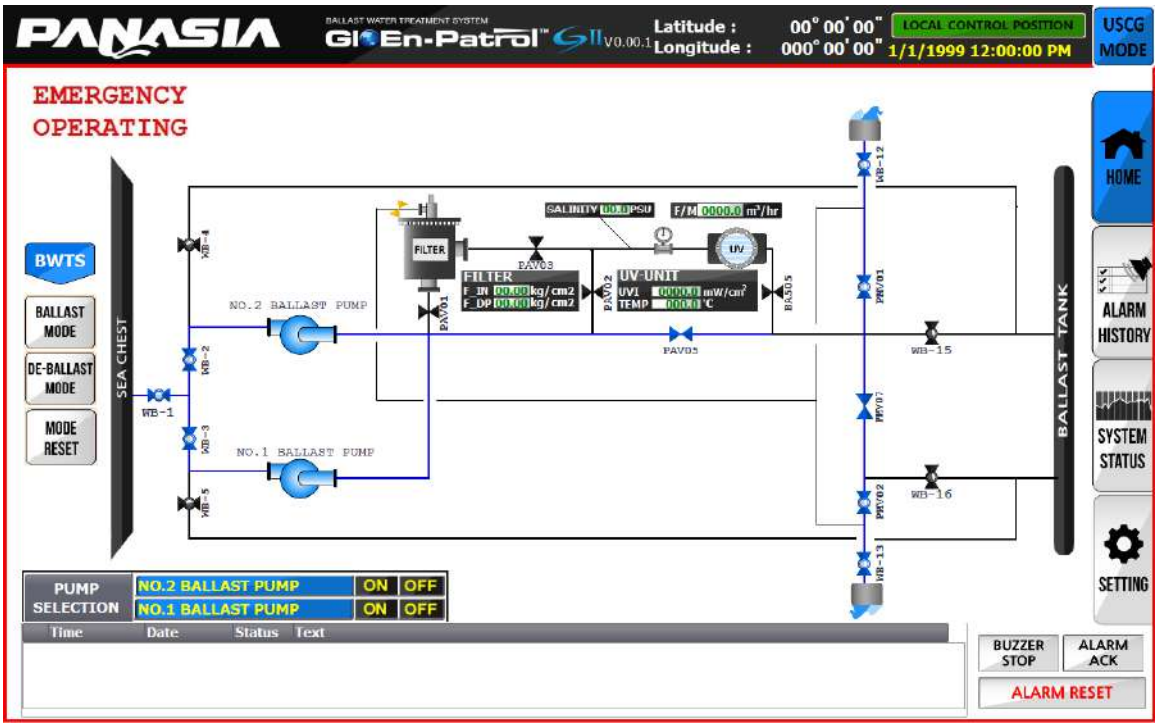


Figure 3.21 Bypass Mode screen

It triggers alarm and all operating events will be logged during emergency operation because untreated water would be stored in the ballast tank or discharged overboard.

In the event of BWMS shut down, the system could be completely disabled by turning the main power switch on the power supply panel to the *OFF* position or any other problems.

1) If power is supplied to the BWMS, the bypass valve will be automatically opened then all system valves will be closed. Emergency ballasting and de-ballasting operation will take place when;

a. Turn the mode selector switch on the control panel to *BYPASS* position.

b. System relevant valves and pump(s) must be operated by VRC system.

c. The bypass valve will be opened then, all system valves will be closed automatically as shown in Figure 3.21.

CAUTION	➢ *BWMS will not send any signals to the VRC system for further operation!*

d. Ballast water can be now forced to flow into ballast tank or to be discharged overboard.

e. It triggers alarm(s) and all events are logged.

2) If power supply is not available due to power failure, Outlet valve and Bypass valve will be closed and the other valves will be stopped as it stands. At this moment, it is difficult to recognize the valve(s) status because it is not able to check through the PLC, but all events will be automatically recorded after power recovery. The system logging will show the latest status of valve(s) position.

a. Ballast pump(s) must be stopped to operate by VRC system.

b. If necessary, opening the bypass valve manually by using provided hand-pump.

c. The rest of the system valves can be manually closed, but it is not mandatory.

d. All system relevant valves must be operated by VRC system.

 **CAUTION**	➢ *BWMS will not send any signals to the VRC system for further operation!*

e. Ballast water is forced to flow into ballast tank or to be discharged overboard.

f. All valves position will be automatically logged after power recovery.

In order for emergency operation with above situation, an operator must consider what operating should be required.

a. Ballasting operation to take water into ballast tank; or

b. De-ballasting operation to discharge overboard.

The ballast pump(s) operation must be executed by an operator for ballasting or de-ballasting in emergency situation.

D. Limitations, precautions, and set points

(1) Alarm list

- Filter Alarm list

NO.	Alarm	Set Point	Delay Time (s)	Remark
1	FILTER DP HIGH	0.6 bar	60	
2	FILTER INLET LOW PRESSURE	≥ 0.9 bar	40	
3	FILTER OPERATING TIME OVER	0.1 bar	600	
4	FILTER CYCLE TIME OVER	-	60	
5	FILTER INLET PRESSURE SENSOR FAIL	-	2	
6	FILTER OUTLET PRESSURE SENSOR FAIL	-	2	

- UV Alarm list

NO.	Alarm	Set Point	Delay Time (s)	Remark
1	UV WIPER MOTOR CB TRIP	-	-	
2-1	UV INTENSITY LOW	59mW/cm^2	50	Refer to "Alarm 2 Set in Table1.2"
2-2	UV INTENSITY LOW	81mW/cm^2	50	
3	UV CHAMBER INSIDE TEMPERATURE HIGH	50°C	5	
4	UV CYCLE TIME OVER	-	60 ~ 100	Depend on TRC
5-1	UV OPERATING TIME OVER	60mW/cm^2	1,200	Refer to "Alarm 1 Set in Table1.2"
5-2	UV OPERATING TIME OVER	82mW/cm^2	1,200	
6	UV POWER SUPPLY PANEL INSIDE TEMP HIGH	60°C	-	

- Other Alarm list

NO.	Alarm		Set Point	Delay Time (s)	Remark
1	FLOW METER FAIL		-	2	
2	FLOW RATE LOW	VERTICAL	30% of UV capacity	50	Refer to Chapter II.D'
		HORIZONTAL	40% of UV capacity	50	
3	VRC COMMUNICATION FAIL		-	-	
4	GRAVITY DEBALLAST		-	IMMEDIATELY	
5	BYPASS OPENED OPERATING		-	IMMEDIATELY	
6	UV LAMP MIS-OPERATING			IMMEDIATELY	
7	EHS VCC* POWER FAIL			IMMEDIATELY	
8	FLOW RATE HIGH		110% of UV capacity	50	
9	LOCAL/REMOTE GP RESPONSE TIME OUT		-	30	

10	GPS COMMUNICATION FAIL	-	60	
11	CHECK MODE SWITCH ON	-	-	
12	CONDUCTIVITY SENSOR FAIL	-	2	Applies only to GloEn-Patrol 2.0

** EHS VCC: Electro-Hydraulic System Valve Control Cabinet (Local Valve Control Cabinet)*

(2) Trip list

- Filter Trip list

NO.	Alarm	Set Point	Delay Time (s)	Remark
1	FILTER DP HIGH HIGH	1.2 bar	20	
2	FILTER FLUSHING MOTOR CB TRIP	-	-	

- UV Trip list

NO.	Alarm	Set Point	Delay Time (s)	Remark
1	UV CIRCUIT BREAKER TRIP	-	-	
2	UV ELCB TRIP	-	-	
3	UV LAMP TROUBLE	-	-	
4-1	UV INTENSITY LOW LOW	56 mW/cm^2	60	Refer to "Trip 1 Set in Table1.2"
4-2	UV INTENSITY LOW LOW	78 mW/cm^2	60	
5	UV CHAMBER INSIDE TEMPERATURE HIGH HIGH	60°C	5	
6	UV CHAMBER SURFACE TEMP HIGH	50°C	-	
7	UV POWER SUPPLY PANEL INSIDE TEMPERATURE HIGH	70°C	-	
8	UV INTENSITY SENSOR FAIL	-	2	
9	UV CHAMBER TEMPERATURE SENSOR FAIL	-	2	
10	UV FLOW SWITCH OFF	-	IMMEDIATELY	

- Other Trip list

NO.	Alarm		Set Point	Delay Time (s)	Remark
1	EMERGENCY STOP		-	-	
2	FLOW RATE LOW LOW	VERTICAL	10% of UV Capacity	60	
		HORIZONTAL	30% of UV Capacity	60	
3	POWER FAILURE		-	IMMEDIATELY	
4	BYPASS MODE SWITCH ON		-	IMMEDIATELY	
5	PUMP FAIL		-	IMMEDIATELY	

6	BWMS MIS-OPERATING	-	IMMEDIATELY	
7	EDUCTOR MIS-OPERATING	-	IMMEDIATELY	
8	EHS* VALVE OPERATING TIME OVER	-	IMMEDIATELY	
9	PLC RESPONSE TIME OUT	-	30	
10	FLOW RATE HIGH HIGH	115% of UV capacity	60	

** EHS: Electro-Hydraulic System*

E. Detailed instructions on check/solution of each monitoring device

(1) Check Mode for malfunction

CHECK MODE is normally used for checking system operation & maintenance.

Figure 3.34 shows that the screen appears if the mode selector switch is turned to *CHECK* position on the control panel.

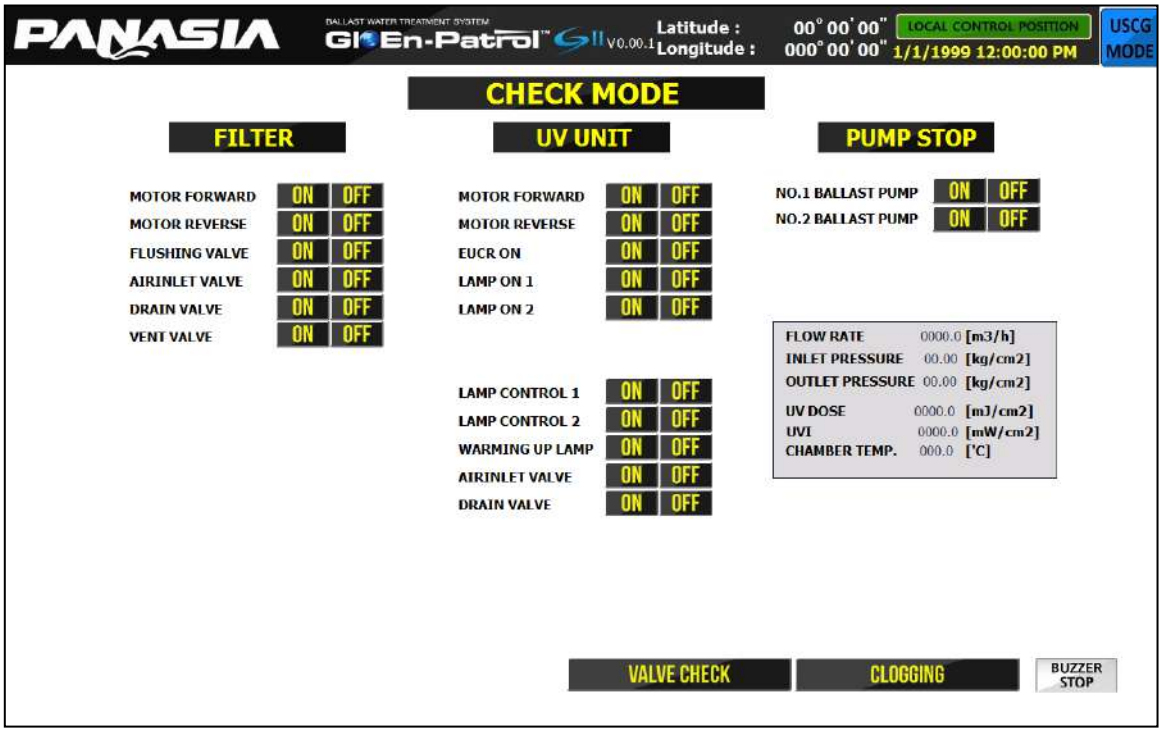


Figure 3.34 Check Mode screen

PLC individual output can be controlled on this screen by selecting either *ON/OFF* icons (ON / OFF). By selecting either *ON/OFF* icon(s) (ON / OFF), each individual item can be checked whether each item (i.e. motors, lamps) is properly operating.

The *CHECK MODE* screen is changed to *VALVE CHECK PAGE* when selecting the *VALVE CHECK* button (VALVE CHECK) at the bottom of the *CHECK MODE* screen.

It is also available to change the screen to *FILTER CLOGGING SOLUTION* when selecting the *CLOGGING* button (CLOGGING) at the bottom of the *CHECK MODE* screen.

NOTE: *Do NOT change the mode selector switch to CHECK while system is operating in either BALLAST / DE-BALLAST MODE. If the operator accidentally changes the mode selector switch to check, system will trip.*

NOTE: *BWTS will be shut down when temperature reaches at trip value even though in check mode by temperature switch and/or transmitter.*

NOTE: *After using the "Check mode", change the Ballast Water Treatment system to "Normal mode". Check the valve condition and alarm condition before operating of Ballast Water Treatment system and then operating Ballast Water Treatment system.*

(2) Valve Check

The *VALVE CHECK* screen appears if the mode selector switch is turned to *CHECK* position on the control panel and selecting the *VALVE CHECK* button (VALVE CHECK) at the bottom of the *CHECK MODE* screen.

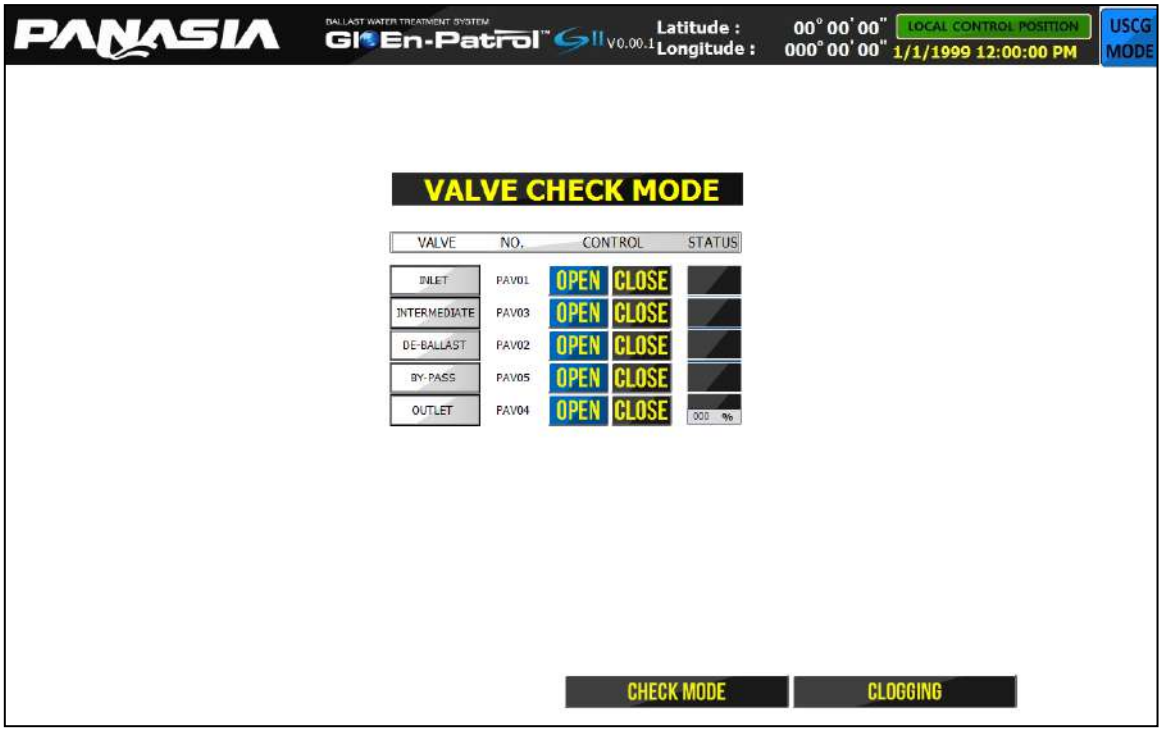


Figure 3.35 Valve Check screen

When selecting the *OPEN* button (OPEN) on any of the valves on-screen, the valve should open.

When selecting the *CLOSE* button (CLOSE), on any of the valves on-screen, the valve should close.

If the valve is opened, yellow 'OPENED' is indicated on *STATUS* window(s) and when valve is closed, blue *'CLOSED'* is indicated on *STATUS*.

If any valves do not work, the system has a problem and must be checked.

(3) Filter Clogging Solution

When system shuts down due to *FILTER DP HIGH HIGH* (Refer to Alarm and trip conditions) situation, the filter clogging problem can be resolved by using this operation.

The *FILTER CLOGGING SOLUTION* screen appears if the mode selector switch is turned to *CHECK* position on the control panel, and then selecting the *CLOGGING* button (CLOGGING) at the bottom of the *CHECK MODE* screen.

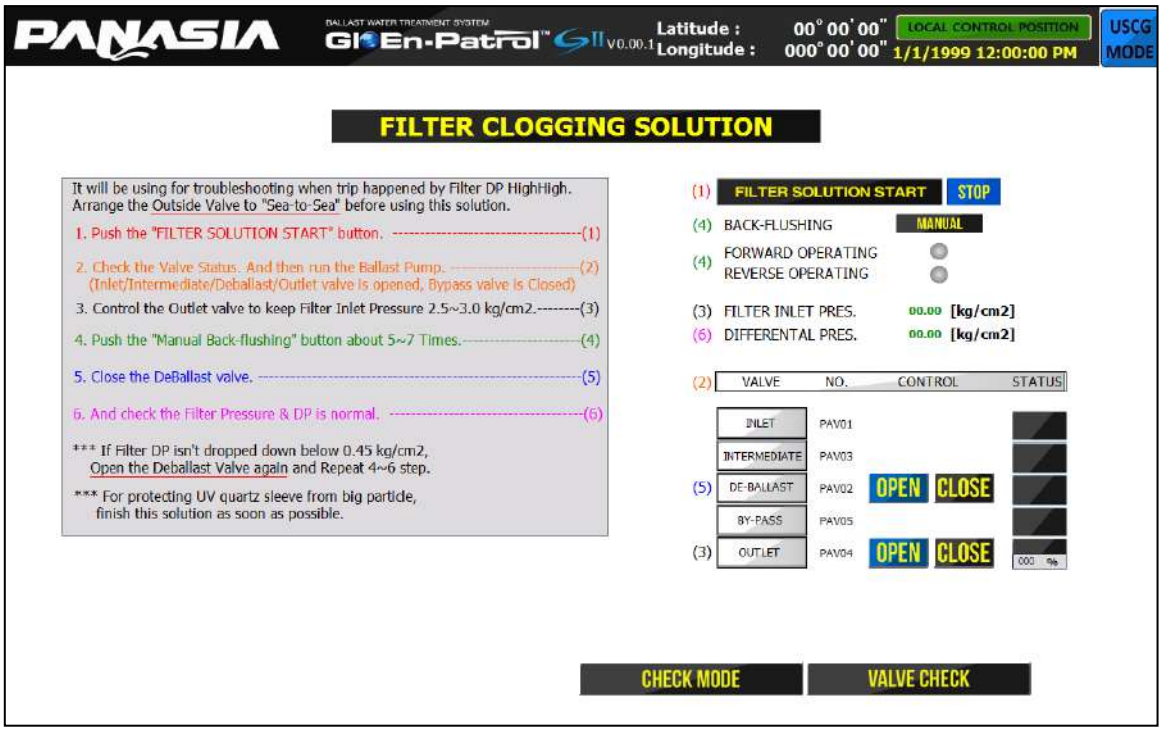


Figure 3.36 Filter Clogging Solution screen

Step-by-step trouble shooting actions will pop-up on left side of screen for operator to review.

After solving the filter clogging problem, select the *STOP* button (STOP) and change the mode selector switch to *NORMAL*.

(4) Flow Reduction

Flow reduction will be used when need to reduce the flow rate according to ship/load condition.

In case of Filter`s Clogging, Flow Reduction can be used that serves to reduce the amount of sea water by reducing the flow rateand reducing the amount of sea water processed by per unit area of the filter element to reduce the difference pressure (DP).

When *FLOW REDUCTION* Button () is selected, the following Pop-up window comes up. The operator can control the flow rate in this Screen . The flow control value may be adjusted in the range of 35% to 100%.

FLOW REDUCTION Button		
Mode	Button	Explanation
Flow Reduction START		When selected, operator can control the flow rate
Flow Reduction STOP		When selected, BWMS automatically control the flow rate.

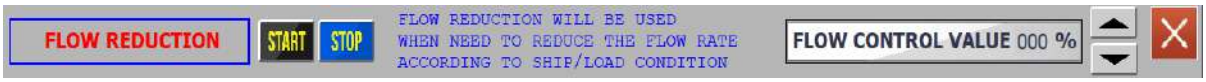


Figure 3.7 Flow Reduction Pop-up Window

NOTE: *FLOW CONTROL VALUE means the percentage of TRC.*

- **Flow reduction procedure**

a. Select the *FLOW* REDUCTION Button () in the *HOME* screen

b. *Select* the *START* button () in the Pop-up window. Then, the FLOW REDUCTION is activated ( -> )

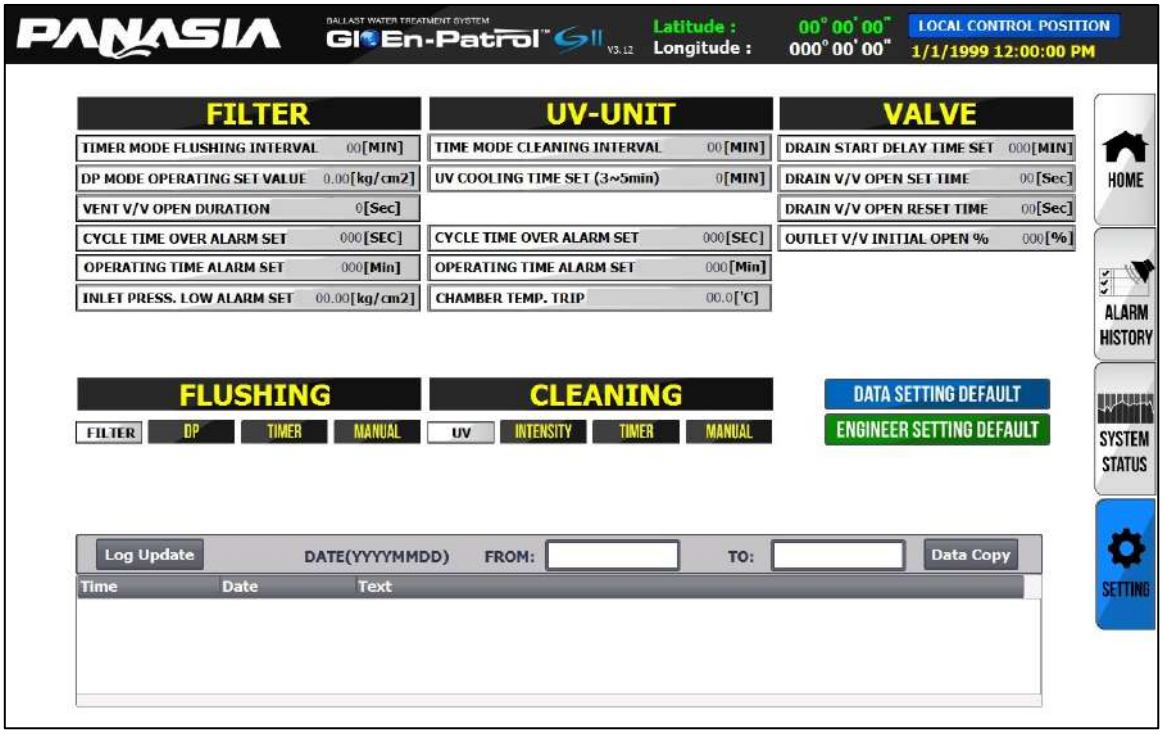
c. Flow *Control* Value automatically changed to 50% and can be changed the setting value by 5% each using the control button ()

d. After finish setting FLOW REDUCTION, press the button() to close the window

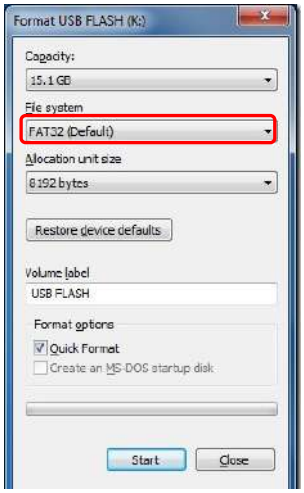
e. If you want to stop the flow reduction. Select the *STOP* button () in the the Pop-up window. Then, the FLOW REDUCTION mode is inactivated ( -> ) and Flow Control Value automatically changed to 100%.

f. Press the button() to close the window.

F. Software setup and data downloading



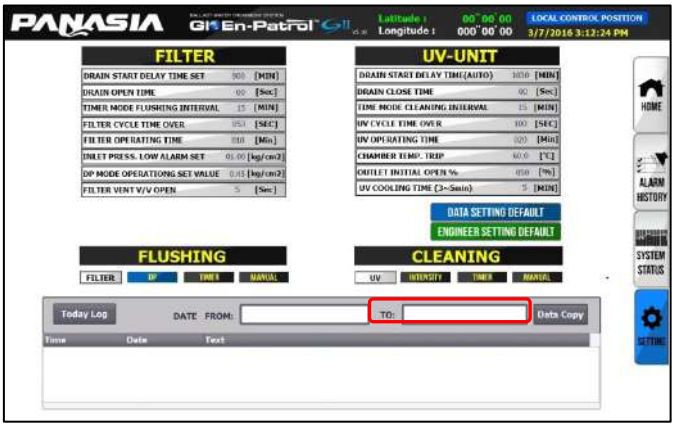
1) Open the control panel and then connect the USB under the touch screen as shown in the picture
   - The file system type of USB must be “FAT32” (If the USB which is another file system type is used, the touch screen does not recognize the data.)



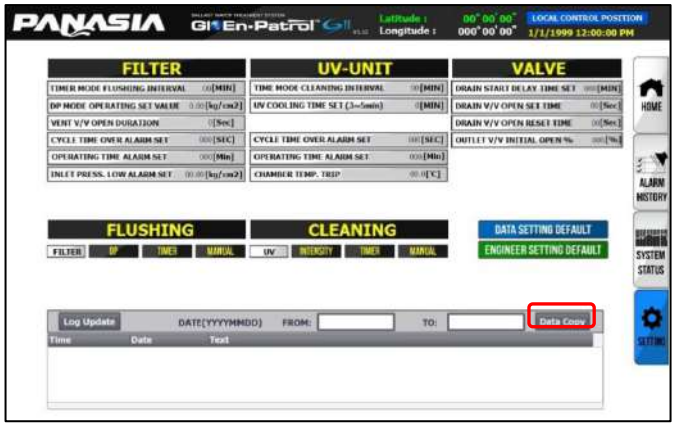
2) Select “Log Update” button on the screen for checking logging file on the day. The logging data which has been recorded until now would be shown. Logging data is created automatically on every 3 hours as excel file.

3) An operator can enter the date for start date in FROM as shown in the picture below. (ex: 20150901)

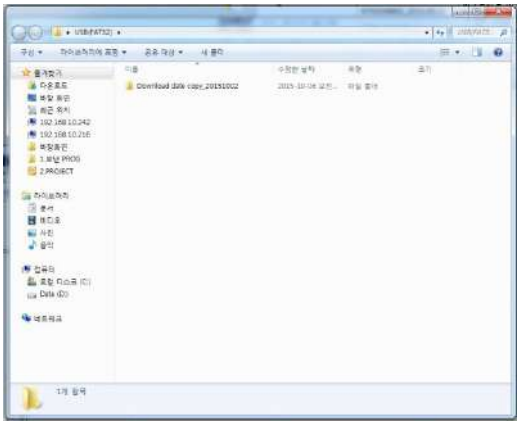
4) An operator can enter the date for end date in TO as shown in the picture below. (ex: 20151030)



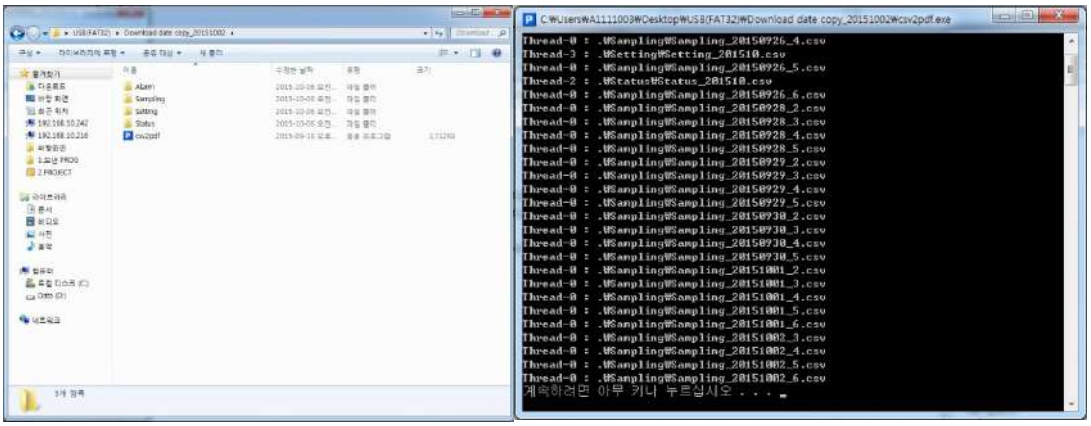
5) When selecting the “Data Copy” button, logging file is copied to USB.



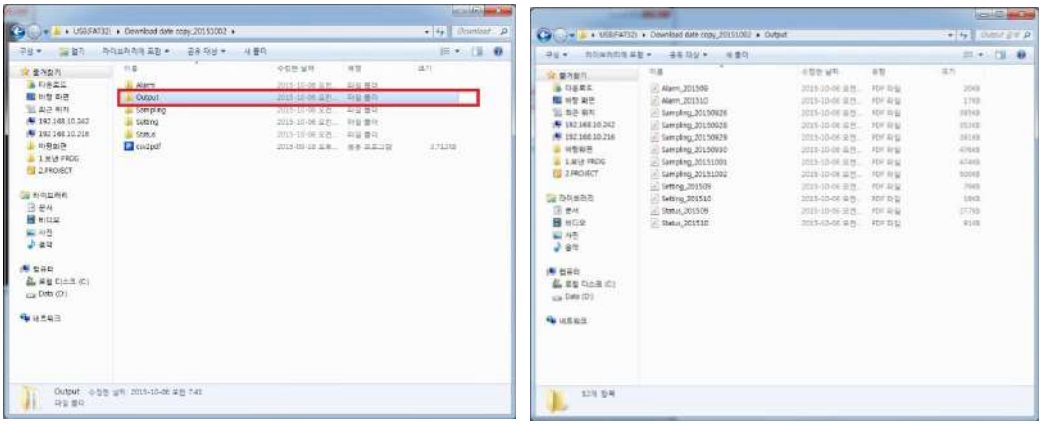
6) The folder on that day is created in the USB.



7) The data is in each folder and it can be converted to PDF file from Excel file when executing the "CSV2pdf"(P).



8) Files converted to PDF are added to output folder.



✓ Sampling, alarm, status and setting data will be saved in the same format as the file below.

✓ Sampling data will be saved daily. Alarm and status data will be saved monthly and setting data will be saved whenever operators turn on the power or change the setting value.

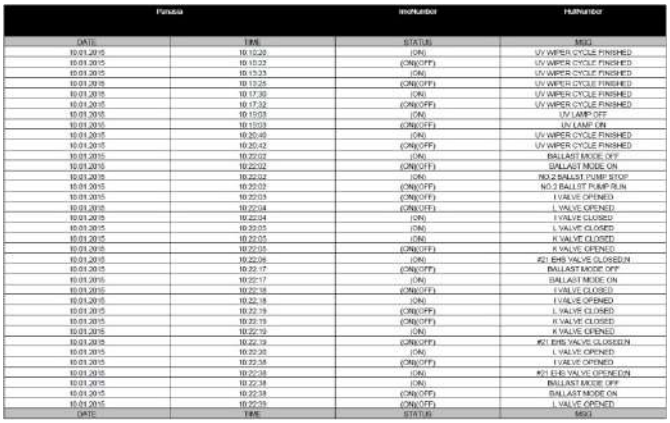
✓ Data Logging is shown below and "MAKER NAME", "IMO NUMBER", "VESSEL NAME" will be displayed on the top.

Panasia															
DATE	TIME	NS	LATITUDE	EW	LONGITUDE	FLOW	F_IN	F_OP	DOSE	TEMP					
10.01.2015	7:59:01	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	7:59:11	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	7:59:21	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	7:59:31	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:04	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:14	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:24	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:34	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:44	N	3506	E	12903.61	0	0.01	0.01	0	23.3					
10.01.2015	8:02:54	N	3506.01	E	12903.6	0	0.01	0	0	20.6					
10.01.2015	8:03:04	N	3506.01	E	12903.6	0	0.01	0	0	20.6					
10.01.2015	8:03:14	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:03:24	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:03:34	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:03:44	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:03:54	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:04:04	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:04:14	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:04:24	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:04:34	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:04:44	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:01	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:13	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:23	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:33	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:43	N	3506.01	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:06:53	N	3506	E	12903.6	0	0.01	0	0	20.6					
10.01.2015	8:07:03	N	3506	E	12903.6	0	0.01	0	0	20.6					
10.01.2015	8:07:13	N	3506	E	12903.6	0	0.01	0	0	20.6					
10.01.2015	8:07:23	N	3506	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:07:33	N	3506	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:07:43	N	3506	E	12903.61	0	0.01	0	0	20.6					
10.01.2015	8:07:53	N	3506	E	12903.61	0	0.01	0	0	20.6					
DATE	TIME	NS	LATITUDE	EW	LONGITUDE	FLOW	F_IN	F_OP	DOSE	TEMP					

Figure 3.23 Sampling Data

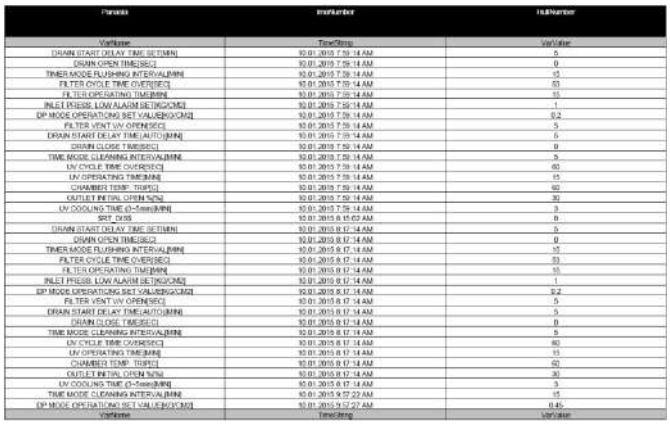
Panasia			
DATE	TIME	STATUS	MSG
10.01.2015	8:03:12	(ON)	BY-PASS VALVE TIME OUT M
10.01.2015	8:03:12	(ON)	UV INLET VALVE TIME OUT L
10.01.2015	8:03:12	(ON)	INTERMEDIATE VALVE TIME OUT K
10.01.2015	8:03:12	(ON)	DE-BALLAT VALVE TIME OUT J
10.01.2015	8:03:12	(ON)	INLET VALVE TIME OUT I
10.01.2015	8:03:12	(ON)	SEA CHEST VALVE TIME OUT S
10.01.2015	8:07:37	(ON)(ACK)	SEA-CHEST VALVE TIME OUT S
10.01.2015	8:07:39	(ON)(OFF)	BY-PASS VALVE TIME OUT M
10.01.2015	8:07:39	(ON)(OFF)	UV INLET VALVE TIME OUT L
10.01.2015	8:07:39	(ON)(OFF)	INTERMEDIATE VALVE TIME OUT K
10.01.2015	8:07:39	(ON)(OFF)	DE-BALLAT VALVE TIME OUT J
10.01.2015	8:07:39	(ON)(OFF)	INLET VALVE TIME OUT I
10.01.2015	8:07:39	(ON)(ACK)(OFF)	SEA-CHEST VALVE TIME OUT S
10.01.2015	8:07:39	(ON)(OFF)	FLOW RATE HIGH
10.01.2015	8:07:59	(ON)(OFF)(ACK)	INLET VALVE TIME OUT I
10.01.2015	8:07:59	(ON)(OFF)(ACK)	DE-BALLAT VALVE TIME OUT J
10.01.2015	8:07:59	(ON)(OFF)	BY-PASS VALVE OPEN ALARM
10.01.2015	8:09:26	(ON)(OFF)(ACK)	INTERMEDIATE VALVE TIME OUT K
10.01.2015	8:09:28	(ON)(OFF)(ACK)	UV INLET VALVE TIME OUT L
10.01.2015	8:09:58	(ON)(OFF)(ACK)	BY-PASS VALVE TIME OUT M
10.01.2015	8:09:31	(ON)(OFF)(ACK)	BY-PASS VALVE OPEN ALARM
10.01.2015	8:09:31	(ON)(OFF)(ACK)	FLOW RATE HIGH
10.01.2015	8:26:52	(ON)	BY-PASS VALVE OPEN ALARM
10.01.2015	8:37:09	(ON)(OFF)	BY-PASS VALVE OPEN ALARM
10.01.2015	8:37:15	(ON)(OFF)(ACK)	BY-PASS VALVE OPEN ALARM
10.01.2015	9:27:12	(ON)	BY-PASS VALVE OPEN ALARM
10.01.2015	9:27:12	(ON)	PLC STOP STATUS ALARM
10.01.2015	9:27:15	(ON)(ACK)	PLC STOP STATUS ALARM
10.01.2015	9:27:17	(ON)(ACK)	BY-PASS VALVE OPEN ALARM
10.01.2015	9:27:19	(ON)(ACK)(OFF)	BY-PASS VALVE OPEN ALARM
10.01.2015	9:27:26	(ON)(ACK)(OFF)	PLC STOP STATUS ALARM
10.01.2015	10:12:54	(ON)	FLOW RATE LOW
10.01.2015	10:13:57	(ON)(ACK)	FLOW RATE LOW
10.01.2015	10:13:59	(ON)(ACK)(OFF)	FLOW RATE LOW
10.01.2015	11:46:14	(ON)	BY-PASS VALVE OPEN ALARM
DATE	TIME	STATUS	MSG

Figure 3.24 Alarm Data



Panasia		InsNumber	HullNumber
DATE	TIME	STATUS	MSG
10.01.2015	10:10:20	(ON)	UV WIPER CYCLE FINISHED
10.01.2015	10:15:22	(ON)(OFF)	UV WIPER CYCLE FINISHED
10.01.2015	10:15:23	(ON)	UV WIPER CYCLE FINISHED
10.01.2015	10:13:25	(ON)(OFF)	UV WIPER CYCLE FINISHED
10.01.2015	10:17:30	(ON)	UV WIPER CYCLE FINISHED
10.01.2015	10:17:32	(ON)(OFF)	UV WIPER CYCLE FINISHED
10.01.2015	10:19:03	(ON)	UV LAMP OFF
10.01.2015	10:19:03	(ON)(OFF)	UV LAMP ON
10.01.2015	10:20:40	(ON)	UV WIPER CYCLE FINISHED
10.01.2015	10:20:42	(ON)(OFF)	UV WIPER CYCLE FINISHED
10.01.2015	10:22:02	(ON)	BALLAST MODE OFF
10.01.2015	10:22:02	(ON)(OFF)	BALLAST MODE ON
10.01.2015	10:22:02	(ON)	NO.2 BALLAST PUMP STOP
10.01.2015	10:22:03	(ON)(OFF)	NO.2 BALLST PUMP RUN
10.01.2015	10:22:03	(ON)(OFF)	I VALVE OPENED
10.01.2015	10:22:04	(ON)(OFF)	L VALVE OPENED
10.01.2015	10:22:04	(ON)	I VALVE CLOSED
10.01.2015	10:22:05	(ON)	L VALVE CLOSED
10.01.2015	10:22:05	(ON)	K VALVE CLOSED
10.01.2015	10:22:05	(ON)(OFF)	K VALVE OPENED
10.01.2015	10:22:06	(ON)	#21 EHS VALVE CLOSED/N
10.01.2015	10:22:17	(ON)(OFF)	BALLAST MODE OFF
10.01.2015	10:22:17	(ON)	BALLAST MODE ON
10.01.2015	10:22:18	(ON)(OFF)	I VALVE CLOSED
10.01.2015	10:22:18	(ON)	I VALVE OPENED
10.01.2015	10:22:19	(ON)(OFF)	L VALVE CLOSED
10.01.2015	10:22:19	(ON)(OFF)	K VALVE CLOSED
10.01.2015	10:22:19	(ON)	K VALVE OPENED
10.01.2015	10:22:19	(ON)(OFF)	#21 EHS VALVE CLOSED/N
10.01.2015	10:22:20	(ON)	L VALVE OPENED
10.01.2015	10:22:38	(ON)(OFF)	I VALVE OPENED
10.01.2015	10:22:38	(ON)	#21 EHS VALVE OPENED/N
10.01.2015	10:22:38	(ON)	BALLAST MODE OFF
10.01.2015	10:22:38	(ON)(OFF)	BALLAST MODE ON
10.01.2015	10:22:39	(ON)(OFF)	L VALVE OPENED
DATE	TIME	STATUS	MSG

Figure 3.25 Status Data



Panasia	InsNumber	HullNumber
VarName	TimeString	VarValue
DRAIN START DELAY TIME SET(MIN)	10.01.2015 7:59:14 AM	5
DRAIN OPEN TIME(SEC)	10.01.2015 7:59:14 AM	0
TIMER MODE FLUSHING INTERVAL(MIN)	10.01.2015 7:59:14 AM	15
FILTER CYCLE TIME OVER(SEC)	10.01.2015 7:59:14 AM	53
FILTER OPERATING TIME(MIN)	10.01.2015 7:59:14 AM	15
INLET PRESS. LOW ALARM SET(KG/CM2)	10.01.2015 7:59:14 AM	1
DP MODE OPERATIONG SET VALUE(KG/CM2)	10.01.2015 7:59:14 AM	0.2
FILTER VENT UV OPEN(SEC)	10.01.2015 7:59:14 AM	5
DRAIN START DELAY TIME:AUTO(MIN)	10.01.2015 7:59:14 AM	5
DRAIN CLOSE TIME(SEC)	10.01.2015 7:59:14 AM	0
TIME MODE CLEANING INTERVAL(MIN)	10.01.2015 7:59:14 AM	5
UV CYCLE TIME OVER(SEC)	10.01.2015 7:59:14 AM	60
UV OPERATING TIME(MIN)	10.01.2015 7:59:14 AM	15
CHAMBER TEMP. TRIP[C]	10.01.2015 7:59:14 AM	60
OUTLET INITIAL OPEN %[%]	10.01.2015 7:59:14 AM	30
UV COOLING TIME (0~5min)(MIN)	10.01.2015 7:59:14 AM	3
SET_DOSE	10.01.2015 8:15:02 AM	0
DRAIN START DELAY TIME SET(MIN)	10.01.2015 8:17:14 AM	5
DRAIN OPEN TIME(SEC)	10.01.2015 8:17:14 AM	0
TIMER MODE FLUSHING INTERVAL(MIN)	10.01.2015 8:17:14 AM	15
FILTER CYCLE TIME OVER(SEC)	10.01.2015 8:17:14 AM	53
FILTER OPERATING TIME(MIN)	10.01.2015 8:17:14 AM	15
INLET PRESS. LOW ALARM SET(KG/CM2)	10.01.2015 8:17:14 AM	1
DP MODE OPERATIONG SET VALUE(KG/CM2)	10.01.2015 8:17:14 AM	0.2
FILTER VENT UV OPEN(SEC)	10.01.2015 8:17:14 AM	5
DRAIN START DELAY TIME:AUTO(MIN)	10.01.2015 8:17:14 AM	5
DRAIN CLOSE TIME(SEC)	10.01.2015 8:17:14 AM	0
TIME MODE CLEANING INTERVAL(MIN)	10.01.2015 8:17:14 AM	5
UV CYCLE TIME OVER(SEC)	10.01.2015 8:17:14 AM	60
UV OPERATING TIME(MIN)	10.01.2015 8:17:14 AM	15
CHAMBER TEMP. TRIP[C]	10.01.2015 8:17:14 AM	60
OUTLET INITIAL OPEN %[%]	10.01.2015 8:17:14 AM	30
UV COOLING TIME (0~5min)(MIN)	10.01.2015 8:17:14 AM	3
TIME MODE CLEANING INTERVAL(MIN)	10.01.2015 9:57:22 AM	15
DP MODE OPERATIONG SET VALUE(KG/CM2)	10.01.2015 9:57:27 AM	0.45
VarName	TimeString	VarValue

Figure 3.26 Setting Data

- ✓ Sampling Data: Record the Sampling Data(GPS / Flow / Filter Inlet / Outlet / UV dose / Temperature)
- ✓ Alarm Data: Record the Alarm Data. ((ON): alarm happen, (ON) (ACK): The alarm is acknowledged, (ON) (OFF): The alarm is stop)
- ✓ Status Data: Record the status Data. (Pump / Each Operating Mode / Valve etc. Others equipment)
- ✓ Setting Data: Record the setting Data. (Each data of setting screen)

NOTE: *The Operator can check the "SETTING" screen of the data logging procedure.*

IV. HEALTH AND SAFETY RISKS TO THE PERSONNEL ASSOCIATED WITH THE INSTALLATION, OPERATION AND MAINTENANCE

A. Instruction for any health and safety certification/training requirements of personnel operating the system

(1) Safety of vessel and operator

The our Ballast Water Management System is designed for simple and easy operation. Although the BWMS will not generate any active substances, the system must be operated by properly trained staff. Please follow all the instructions in this document for personnel safety. In addition, an operator must be familiar with these instructions during operation and maintenance.

Operations and maintenance personnel should read and fully understand prior to working on the system in accordance with applicable safety rules. Following the instructions in this manual will describe for general safety during installation, operation and maintenance of BWMS so that it prevents personnel injury or fatality or damage to equipment.

(2) Safety instruction for filter unit

The filter unit is a mechanical device, causing little to no danger, but the following instruction must be taken for safety.

1) General instruction

- ✓ Prior to installation and/or operation, review the installation and operation instructions thoroughly;
- ✓ While operating the filter, all conventional safety instructions should be observed in order to avoid harm to operators property and others in the vicinity;
- ✓ No alterations or modifications to the equipment are permitted without written approval given by the manufacturer or representative on the manufacturer's behalf.

2) Installation

- ✓ Install the filter unit according to the installation instructions detailed in this manual;
- ✓ Make sure to leave ample clearance for easy and safe access for installation, operation and maintenance;
- ✓ Electrical wiring should be performed by an authorized electrician only, using standardized and approved components;
- ✓ Avoid water contact on the electrical components or on the control panel while installing the filter unit.

3) Operation, control and maintenance

- ✓ Disconnect power supply from the filter unit before maintenance or operation;
- ✓ Removing bolts should be done only after the pressure in the filter has been released;

- ✓ Avoid moisture build-up (i.e. splashing and/or water leaks) minimize slipping or electrical dangers;
- ✓ Use authorized spare parts only for maintenance.

4) Use of lifting equipment

- ✓ Make sure that the lift point of filter components;
- ✓ All parts must be chained securely and properly before lifting;
- ✓ Do NOT leave equipment elevated unnecessarily;
- ✓ Do NOT stand under elevated equipment;
- ✓ Wear proper safety gears while using lifting equipment.

5) Filter Sludge

The BWMS does not discharge nor creates byproducts due to the UV technology.

However, a pre-treatment filter is installed prior to the UV unit to eliminate sludge and sea creatures larger than 50 microns. The filter accumulates large particles and organisms inside of the filter screen. Over time, the large particles must be removed to maintain the filter efficiency. A back-flushing cleaning system has been installed to return large particles to the local water, so BWMS will not pollute to the marine environment at all.

(3) General safety of UV unit

Prior to installation or handling of the UV unit, read the operating and maintenance manual and follow caution signs carefully.

1) Grounding

Ensure that all the equipment, especially the UV chamber, be grounded by using an adequate cross section of the conductor, and it complies with local electrical wiring regulations.

2) Ultraviolet light

While in use, the UV lamps emit high intensity Ultraviolet (UV) radiation, which may damage to the eyes and any exposed skin.

 **CAUTION**	➢ *Do NOT operate the UV lamp without wearing personal protections for test!* ➢ *Do NOT look at the UV light, when the UV lamp is switched on!*

3) High Voltages

Installation and maintenance should be performed by qualified individuals because electrical hazards are present with power supply panel. The electrical isolator must be in the OFF position.

 CAUTION	➢ *Ensure all covers are secured before operating equipment!* ➢ *All installation and maintenance work must be carried out by qualified personnel!* ➢ *Before changing the quartz sleeve(s), hydraulically isolate and drain the chamber first!*

4) High Temperature

The UV lamp temperatures will reach up to 600°C ~ 800°C during normal operation and the ceramic supports of the UV lamps retains heat for a while after they have been powered off.

 WARNING	➢ *Take extreme care when handling hot UV lamp(s) after operation!*

5) Mercury

The UV lamp contains a small amount of Mercury. Great care should be taken to avoid any breakage of the lamp. Dispose of UV lamp(s) safely, complying with local environmental rules and regulations. UV lamp(s) must be stored in their original packing until required for use.

6) Optional Purge/ Pressurization system (Ex proof model only)

The UV unit with purge/ pressurization system is specially installed for operating in hazardous area and is a pressurized enclosure.

The enclosure shall not be opened unless the area is known to be free of flammable materials or unless all devices have been de-energized. Power shall not be restored after enclosure has been opened until enclosure has been purged in accordance with the purge system start up instructions.

 CAUTION	➢ *DO NOT open when an explosive atmosphere may present!* ➢ *DO NOT open any door or cover within 20 minutes after power off!*

Risk	Control and Precaution	Person on duty
High Voltages (Panel and UV lamp)	- Fixed guards to prevent access to live terminals in control panel; - Instruction to wait one minute for voltage to dissipate. - "High voltage" warning signs. - Circuit breakers in OFF position. - Incorporation of earth leakage trip.	Service Engineer Operator Installer
Ultraviolet light (UV lamp)	- Hazard *WARNING* sign at UV lamp removal point. - Instruction to turn off and isolate system prior to replacing UV lamp. - Statement in operating manual referring to exposure to eyes and skin.	Service Engineer Operator Installer
High Temperatures (UV lamp)	- Shut-down device to operate when over-heating results from low or no flow condition. - Instruction in operation manual to allow UV lamp to cool before removal.	Service Engineer Operator Installer
Mercury (UV lamp)	- This is a COSHH listed substance. Handling and disposal instructions are outlined in the operating manual. (Refer to Appendix 1.)	Service Engineer Operator Installer
Water (Pressure)	- Local inlet/outlet valves with isolation *WARNING* tags (operator responsibility)	Service Engineer Operator Installer

Table 4.1 Risk assessment

B. Material safety data sheets for hazardous or relevant chemicals used, stored, or generated by or for the system.

Material Safety Data Sheet
Mercury MSDS

Section 1: Chemical Product and Company Identification

Product Name: Mercury

Catalog Codes: SLM3505, SLM1363

CAS#: 7439-97-6

RTECS: OV4550000

TSCA: TSCA 8(b) inventory: Mercury

CI#: Not applicable.

Synonym: Quick Silver; Colloidal Mercury; Metallic Mercury; Liquid Silver; Hydragyrum

Chemical Name: Mercury

Chemical Formula: Hg

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Mercury	7439-97-6	100

Toxicological Data on Ingredients: Mercury LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (corrosive, permeator). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Hazardous in case of skin contact (permeator). CARCINOGENIC EFFECTS: Classified A5 (Not suspected for human.) by ACGIH. 3 (Not classifiable for human.) by IARC. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to blood, kidneys, liver, brain, peripheral nervous system, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation.

Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
When thrown into mercury vapor, boron phosphodiiodide ignites at once. Flame forms with chlorine jet over mercury surface at 200 deg to 300 deg C. Mercury undergoes hazardous reactions in the presence of heat and sparks or ignition.

Special Remarks on Explosion Hazards:
A violent exothermic reaction or possible explosion occurs when mercury comes in contact with lithium and rubidium. CHLORINE DIOXIDE & LIQUID HG, WHEN MIXED, EXPLODE VIOLENTLY. Mercury and Ammonia can produce an explosive compound. A mixture of the dry carbonyl and oxygen will explode on vigorous shaking with mercury. Methyl azide in the presence of mercury was shown to be potentially explosive.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, metals.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 25°C (77°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.025 from ACGIH (TLV) [United States] SKIN TWA: 0.05 CEIL: 0.1 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 0.025 (mg/m3) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Heavy liquid)

Odor: Odorless.

Taste: Not available.

Molecular Weight: 200.59 g/mole

Color: Silver-white

pH (1% soln/water): Not available.

Boiling Point: 356.73°C (674.1°F)

Melting Point: -38.87°C (-38°F)

Critical Temperature: 1462°C (2663.6°F)

Specific Gravity: 13.55 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 6.93 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility: Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, metals.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Ground mixtures of sodium carbide and mercury, aluminum, lead, or iron can react vigorously. A violent exothermic reaction or possible explosion occurs when mercury comes in contact with lithium and rubidium. Incompatible with boron diiodophosphide; ethylene oxide; metal oxides, metals(aluminum, potassium, lithium, sodium, rubidium); methyl azide; methylsilane, oxygen; oxidants(bromine, peroxyformic acid, chlorine dioxide, nitric acid, tetracarbonynickel, nitromethane, silver perchlorate, chlorates, sulfuric acid, nitrates,); tetracarbonylnickel, oxygen, acetylinic compounds, ammonia, ethylene oxide, methylsiliane, calcium,

Special Remarks on Corrosivity:
The high mobility and tendency to dispersion exhibited by mercury, and the ease with which it forms alloys (amalga) with many laboratory and electrical contact metals, can cause severe corrosion problems in laboratories. Special precautions: Mercury can attack copper and copper alloy materials.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A5 (Not suspected for human.) by ACGIH. 3 (Not classifiable for human.) by IARC. May cause damage to the following organs: blood, kidneys, liver, brain, peripheral nervous system, central nervous system (CNS).

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (corrosive, permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May affect genetic material. May cause cancer based on animal data. Passes through the placental barrier in animal. May cause adverse reproductive effects(paternal effects- spermatogenesis; effects on fertility - fetotoxicity, post-implantation mortality), and birth defects.

Special Remarks on other Toxic Effects on Humans:

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Mercury UNNA: 2809 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Mercury California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Mercury Connecticut hazardous material survey.: Mercury Illinois toxic substances disclosure to employee act: Mercury Illinois chemical safety act: Mercury New York acutely hazardous substances: Mercury Rhode Island RTK hazardous substances: Mercury Pennsylvania RTK: Mercury Minnesota: Mercury Massachusetts RTK: Mercury New Jersey: Mercury New Jersey spill list: Mercury Louisiana spill reporting: Mercury California Director's List of Hazardous Substances.: Mercury TSCA 8(b) inventory: Mercury SARA 313 toxic chemical notification and release reporting: Mercury CERCLA: Hazardous substances.: Mercury: 1 lbs. (0.4536 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):
R23- Toxic by inhalation. R33- Danger of cumulative effects. R38- Irritating to skin. R41- Risk of serious damage to eyes. R50/53- Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. S2- Keep out of the reach of children. S7- Keep container tightly closed. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S39- Wear eye/face protection. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). S46- If swallowed, seek medical advice immediately and show this container or label. S60- This material and its container must be disposed of as hazardous waste. S61- Avoid release to the environment. Refer to special instructions/Safety data sheets.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:22 PM

Last Updated: 11/01/2010 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab.com be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.

V. INSTALLATION REQUIREMENT

A. General safety

The BWMS is designed and built for easy, simple and efficient operation.

Operators nevertheless, must take proper steps to assuring the personal and vessel's safety by reading and thoroughly understanding this manual and subsequent training. In addition to this instruction manual, general applicable safety rules and regulations must be observed at all times.

The following points should always be taken into account:

- Keep your work area clean and tidy; make sure it is properly illuminated.
- Keep the control panel closed during normal use.
- Carry out proper maintenance on a regular basis.

 **WARNING**	➢ *This equipment generates high-voltage electricity, Do NOT open the UV Power Supply Panel door during operation. There is a high risk of electric shock.* ➢ *This equipment generates high heat if operated under abnormal conditions. Therefore, before making any contact with the UV unit, check to see if the system is working properly. When the unit is over-heated, there is a risk of injury when making contact.* ➢ *Do NOT move, connect, or run system checks while there is a flow of electricity. Always turn the power OFF before proceeding with any work.* ➢ *Do NOT come in contact with any instruments when they are wet. There is a high risk of electric shock.* ➢ *Do NOT look directly into the UV lamps while it is turned ON without putting on protective goggles. This could cause major eye damage.* ➢ *Do NOT come in contact with the lamp after operation until it completely cools down. Sufficient cool down takes approximately 5 minutes to complete. There is a high risk of skin burn when making contact.* ➢ *In case the UV lamp(s) is/are damaged/ broken due to carelessness during transporting and/or handling, Do NOT touch the Mercury inside the lamp or leave the lamp exposed to the air for a long period of time. Collect lamp(s) immediately and seal inside provided container. This is placed in the BWTS spare box and dispose of separately. Also, refrain from breathing in Mercury while collecting damaged/broken pieces. Collection containers can be selected in accordance with the local laws.* ➢ *When the manual drain is operated, please be carueful for the high water pressure through the needle valve. If high pressure water comes out, please open the valve slowly.*

CAUTION	➢ *For installation, check the power voltage of the instrument.* ➢ *To replace UV lamp(s), switch the power OFF. This must ALWAYS be done (see Table 7.3 of this instruction manual for detailed procedures)* ➢ *Please ground the UV unit to avoid risk of an electrical accident.* ➢ *To replace or check UV lamp, please always wear clean gloves.* ➢ *Mercury is contained inside the UV lamp glass tubes. Disposing of these tubes must be done safely and properly.* ➢ *Please use only authentic PANASIA CO., LTD. provided UV lamps.* ➢ *Do NOT use products by other companies and/or different models.*

B. A description of parts to have during installation

(1) Filter unit Installation

1) Design recommendations

For multi-filter applications, if flow increases and pressure drops drastically, it is recommended that a pressure-sustaining valve be installed upstream of the filters in order to ensure a controlled fill-up to the line flow and pressure stability.

2) Installation instructions

- ✓ Install the filter in a way which will allow sufficient space to dismantle and separate the Filter for maintenance purposes;
- ✓ Confirm the flow direction according to the inlet and outlet marked on the filter housing;
- ✓ Connect pipe to the back-flushing valve. The back-flushing pipe should be designed so that it creates minimal resistance to flow;
- ✓ Operator should arrange for suitable lighting in the area of the filter to enable good visibility and safe maintenance;
- ✓ Operator should arrange for suitable platforms and safety barriers to enable easy and safe access to the filter.
- ✓ For the Eductor(Stripping) Mode, the strainer that size has 4mm is required.

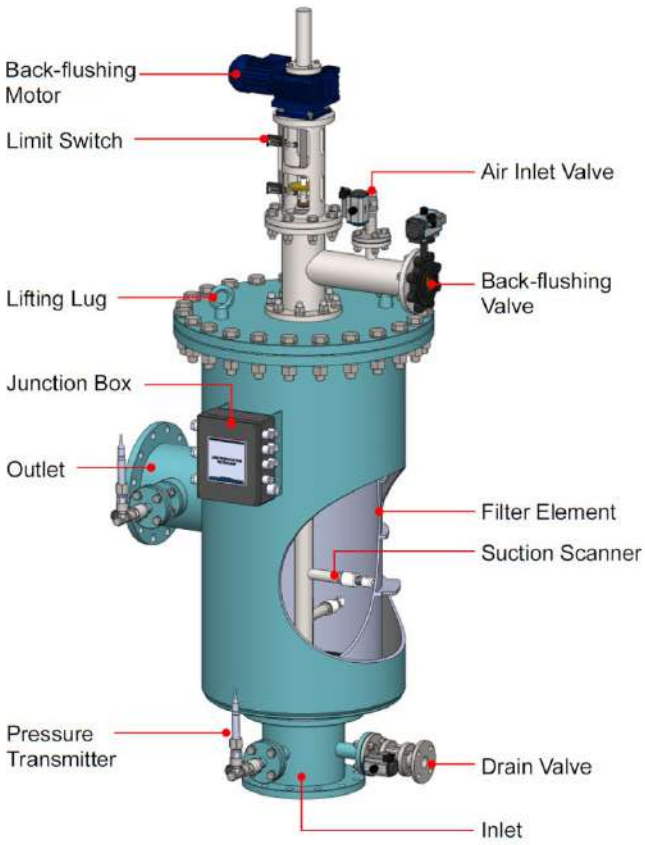


Figure 5.1 Components of the filter unit

Filter body must be supported by the lugs to floor. Maintenance space ("A") is needed above the filter to lift the unit by device hooks as below Figure 5.2 and Figure 5.3: If needed, install an access floor for maintenance to replace the filter element.

NOTE: *When the pressure for back flushing is not enough, a Booster Pump is required. Supply Scope of the Booster Pump is yard or shipowner. However, when the Booster pump is used, please consult with PANASIA for the operation procedure.*

In addition, if Booster Pump is installed in the explosion proof zone, booster pump for the explosion-proof type should be installed.

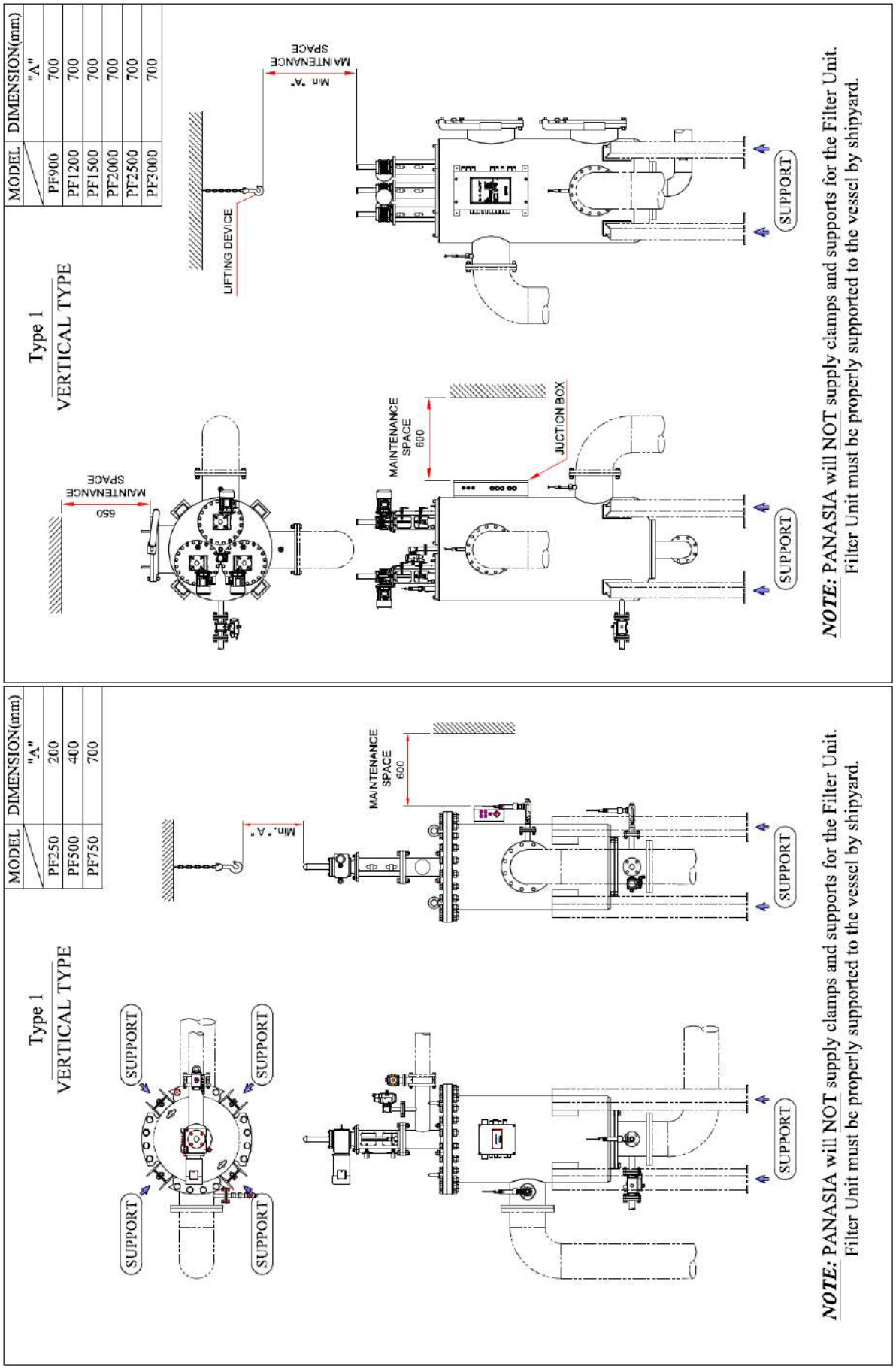


Figure 5.2 Installation support for the filter unit (Vertical Type)

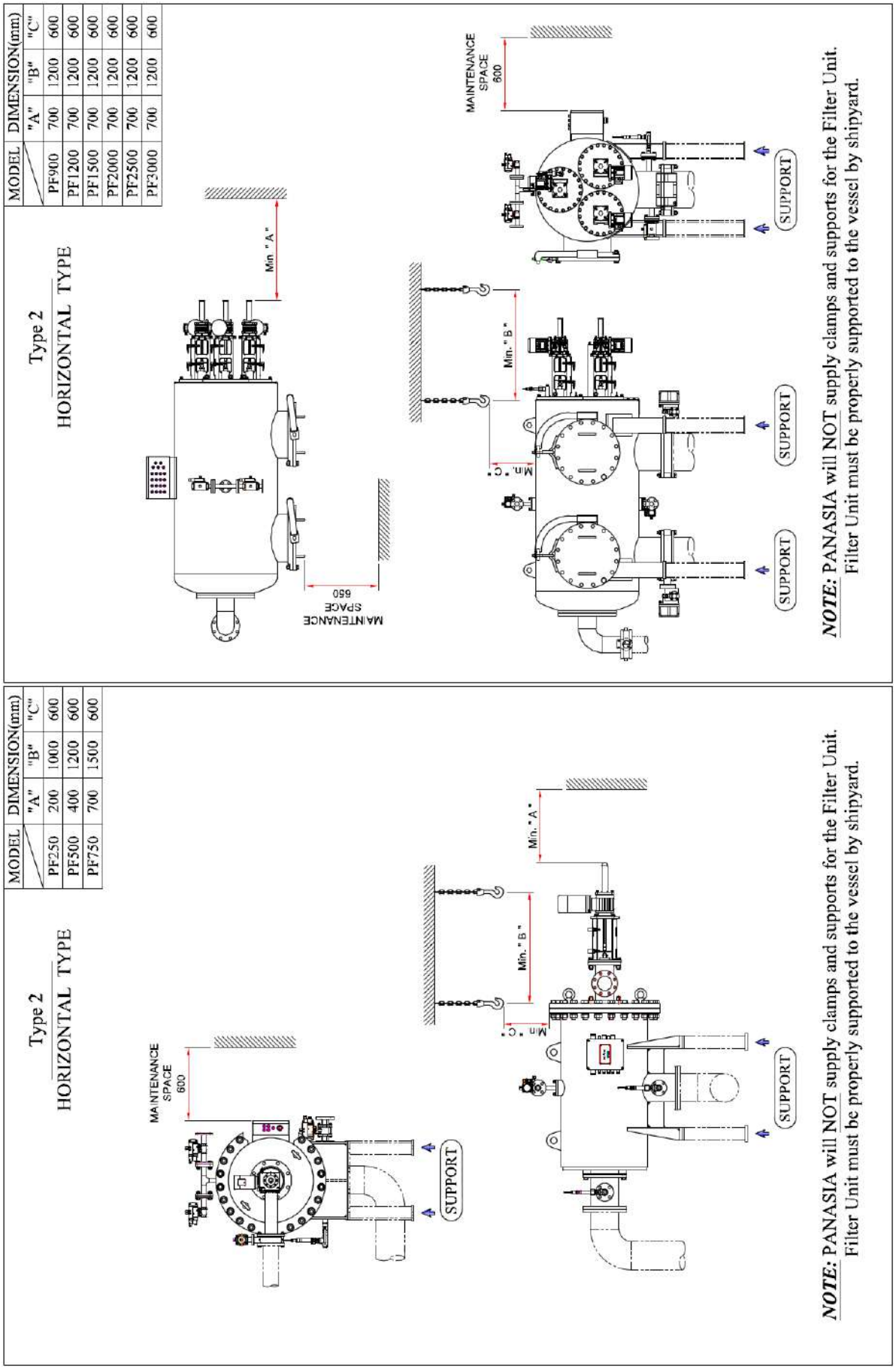


Figure 5.3 Installation support for the filter unit (Horizontal Type)

(2) UV unit Installation

1) Installation recommendations

- ✓ Install equipment in a dry area;
- ✓ Ambient temperature in installation area between 0°C ~ 55°C;
- ✓ Relative humidity < 90%;
- ✓ Install chamber horizontally with water exit on top;
- ✓ Allow sufficient maintenance space around the unit;
- ✓ UV unit's outlet pipe must be supported from outlet pipe to the floor;
- ✓ Allow sufficient maintenance space (about 600 mm) on the left and right sides of UV unit.

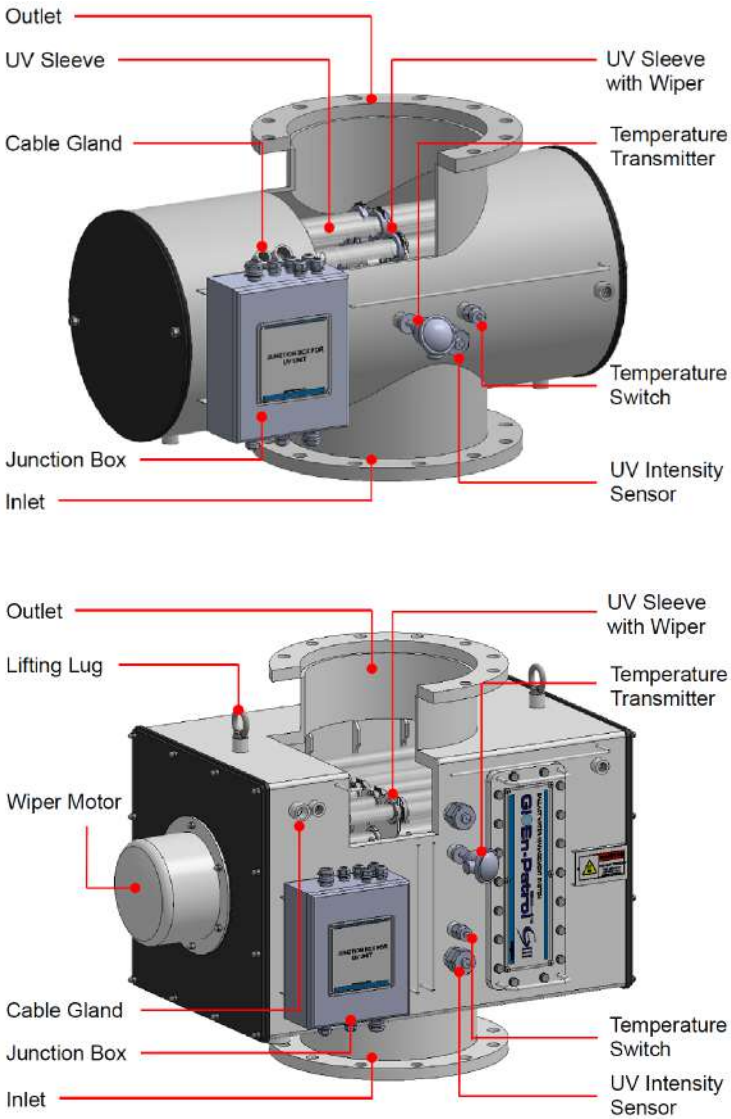


Figure 5.4 Components of the UV unit

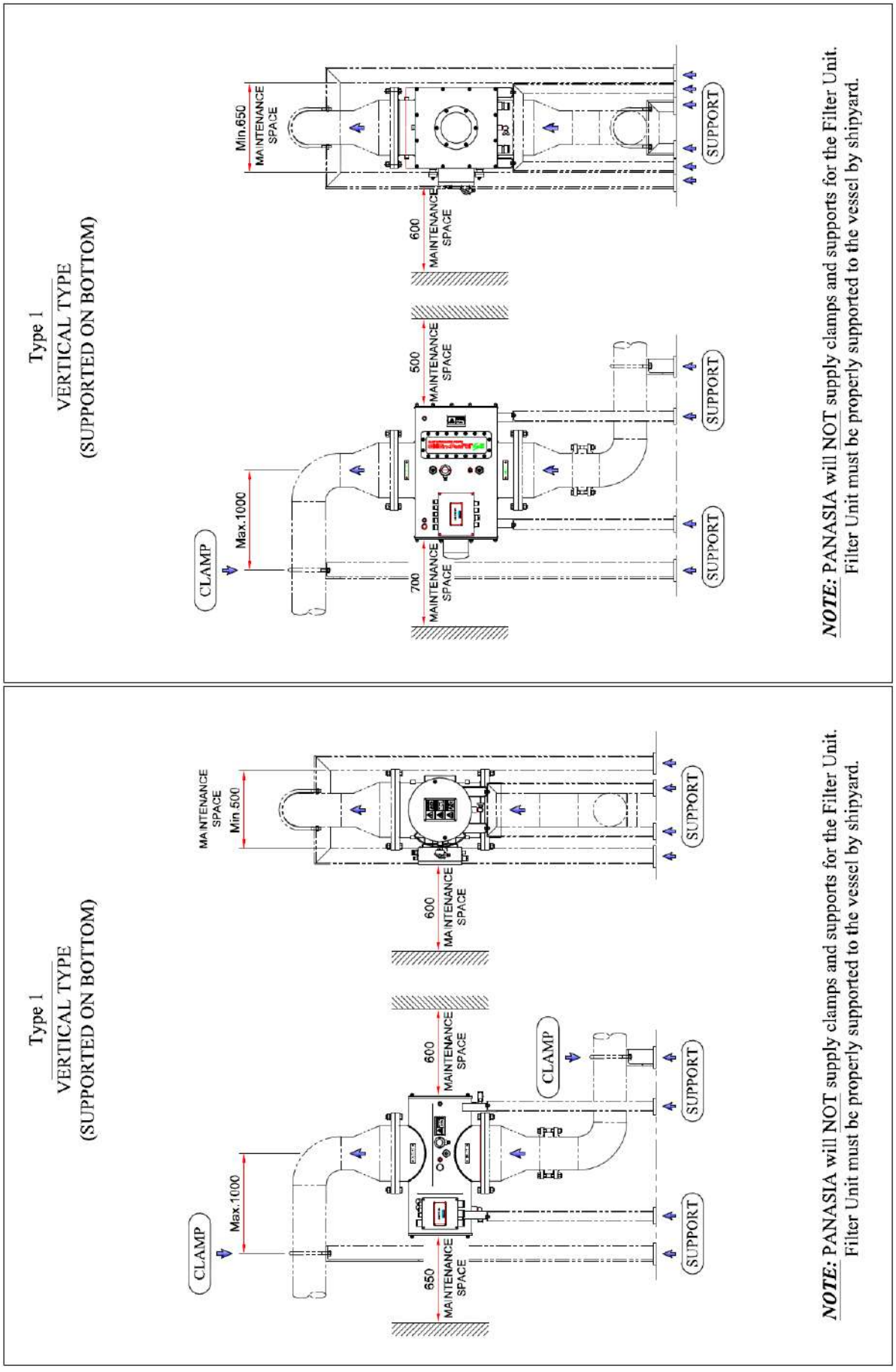


Figure 5.5 Installation support for the UV unit (Vertical Type: Bottom support)

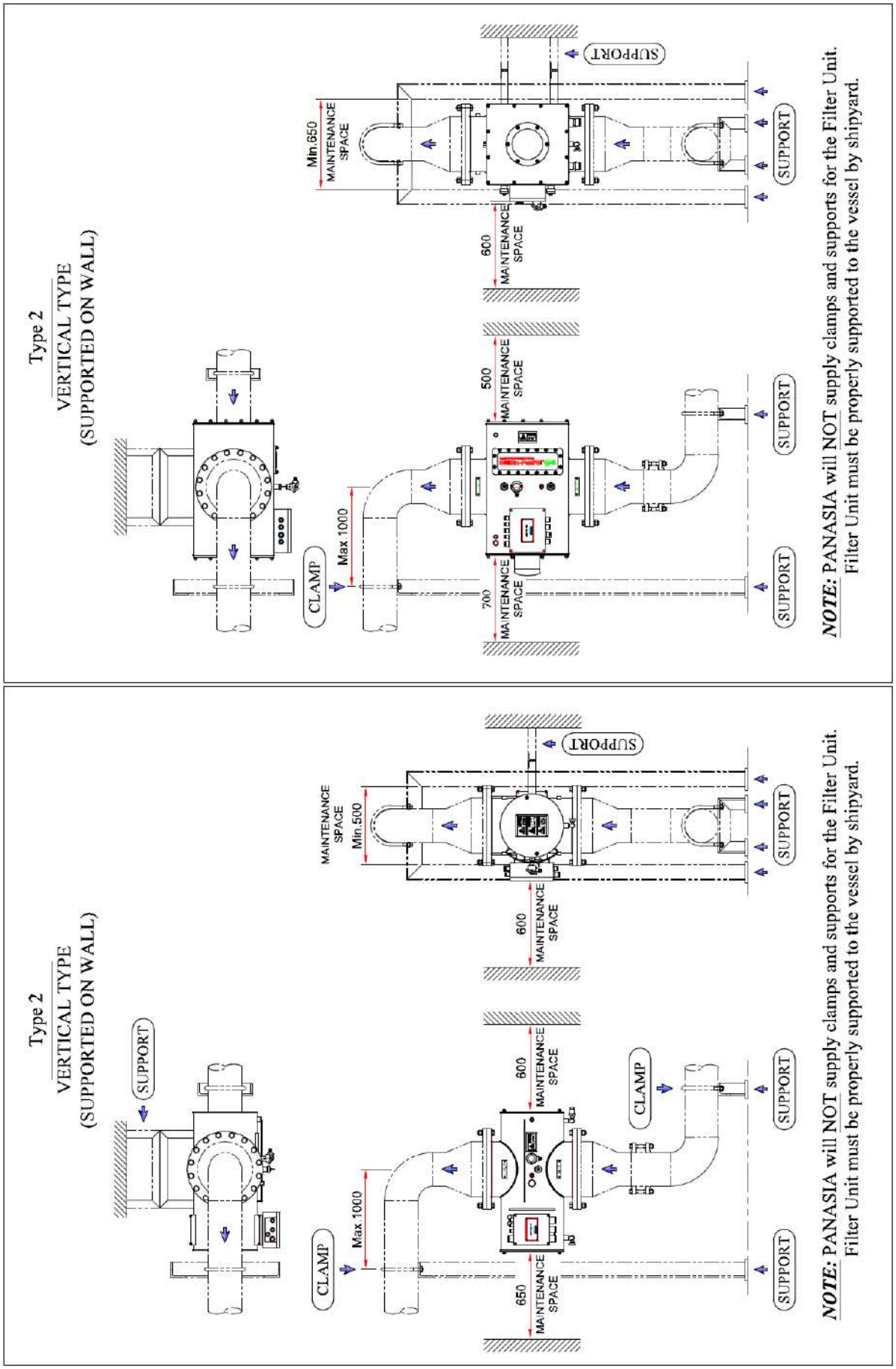
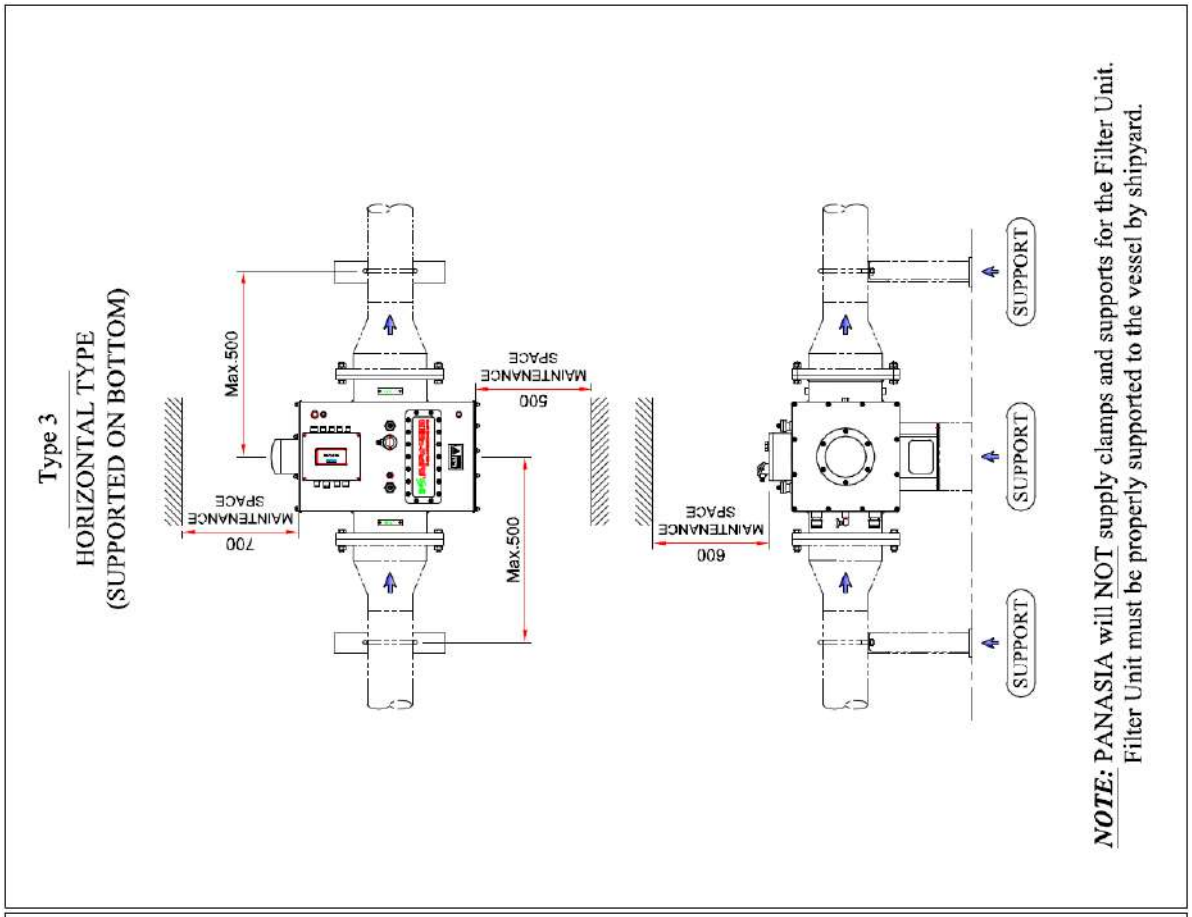


Figure 5.6 Installation support for the UV unit (Vertical Type: Wall mount)



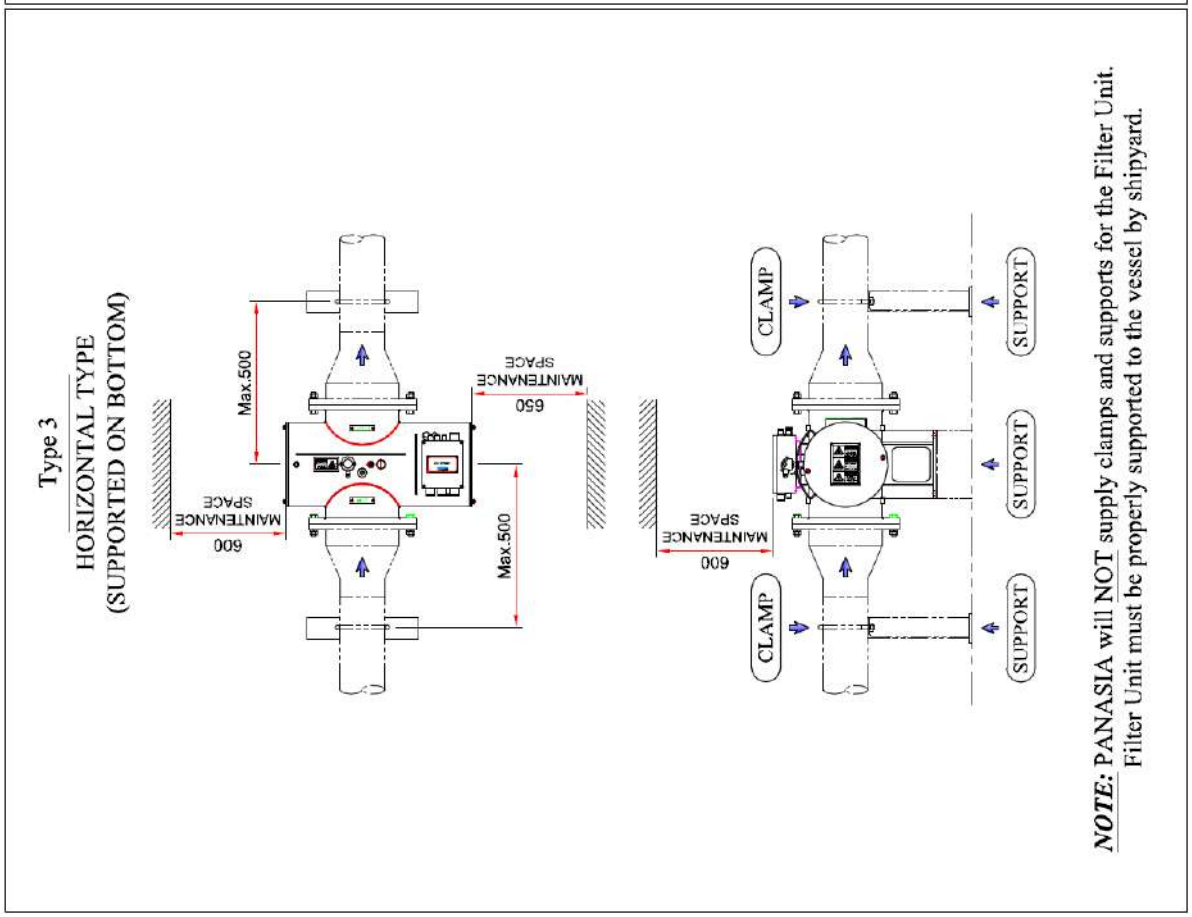


Figure 5.7 Installation support for the UV unit (Horizontal Type: Bottom support)

2) UV Lamp(s) Installation and replacement

CAUTION	➢ *All installation work must only be carried out by qualified personnel.* ➢ *Read the safety instruction manual before commencing installation.* ➢ *UV lamp(s) to be mounted horizontally.*

To remove any accidental finger marks on the UV lamps, use isopropyl alcohol and a cloth.

CAUTION	➢ *Never touch a UV lamp with bare fingers. Use a tissue or cotton gloves when handling UV lamp(s).*

NOTE: *When UV lamps are cold, Mercury may condense in patches on the inner surfaces and appear as finger marks. This is normal and will NOT affect lamp efficiency.*

3) Quartz sleeve(s) fitting and replacement.

The quartz sleeve forms a water-tight barrier between UV lamps and the treated water. It is essential that the sleeves are kept clean, or possible reduction of UV intensity will reduce the effectiveness of treatment.

❖ UV lamp(s) and Quartz sleeve(s) fitting and replacement

→ See detailed instructions in Table 7.3 and 7.5

a. Cleaning the quartz sleeve(s)

The quartz sleeves should be handled with care. Iron and/or carbonate deposits from hard water may develop. If so, clean sleeves with a 5% citric acid, wash off with water and dry carefully. Replacement of sleeves will be necessary if the deposits cannot be removed.

b. Cleaning the UV intensity sensor

The UV intensity sensor should be cleaned periodically with isopropyl alcohol, ideally whenever the quartz sleeves are also being cleaned.

c. UV intensity Sensor Adjustments

If the system is set in dose control, no adjustment is necessary. As the wiper passes the monitor, UV intensity will drop for a few seconds, which is normal occurrence.

(3) Electric wiring

The UV unit is controlled by the PLC, enclosed in the control panel, but UV lamps and wiper motor are connected to UV power supply panel. Temperature transmitter, UV intensity transmitter, two level switches and two reed switches and purge/pressurization system (for Ex proof model) are also connected to control panel.

Refer to each drawing for detail connection. The technical section (schematic diagram of the monitoring system, electrical wiring diagrams enabling faultfinding and other additional drawings) is to be kept in a maintenance record, separately supplied to ship owner and shipyard.

Description	Drawing No.	Connected PLC module
Temperature transmitter	GP**E104	AI module
UV Intensity transmitter	GP**E104	AI module
Level switch	GP**E102	DI module
Reed switch	GP**E102	DI module
Wiper motor	GP**E103, GP**E201	DO module
UV lamp	GP**E103*, GP**E202	DO module
Purge/Pressurization system	EXGP**E001, GP**E101	-

Table 5.1 Drawing number for connection information

- *The drawings for the above descriptions can be found in Wiring Diagram that provided by manufacturer.*

1) PLC safety components

Description	Model No.	Quantity	Manufacturer
PLC CPU	6ES7315-6FF01-0AB0	1	SIEMENS
PLC Power supply	6ES7307-1EA00-0AA0	1	SIEMENS
PLC memory	6ES7953-8LL20-0AA0	1	SIEMENS
PLC DI module	6ES7326-1BK02-0AA0	2	SIEMENS
PLC DO module	6ES7326-2BF01-0AA0	3	SIEMENS
PLC AI module	6ES7336-4GE00-0AB0	1	SIEMENS
PLC AO module	6ES7332-5HD01-0AB0	1	SIEMENS
NOTE: *Quantity can be changed by type of model.*			

Table 5.2 Drawing number for connection information

2) Caution of electric wiring for explosion proof model

 **CAUTION**	➢ *Intrinsically safe cable must be applied to the line between the Purge Control Unit and Relief Vent, and between the Temperature Transmitter and the Control Panel through the safety barrier.* ➢ *Intrinsically safe cable must be separated away at least 50mm from the common cable(s).* ➢ *For replacement of safety barrier, see the following electric data of the temperature transmitter.* *- Signal output / supply, terminal 1 to 2:* *- Ui: 30 VDC, Ii: 120 mADC, Pi: 0.84 W, Li: 10 µH, Ci: 1.0 nF.*

(4) Sampling Valve

Installation of a sampling valve in the BWMS complies with USCG ETV and IMO G2 regulation. A sampling valve is installed at the nearest practical discharge point. Furthermore, sampling valves can be installed at the inlet and/or outlet points per the shipowner's request keeping the following considerations:

- ✓ Sampling valve must be installed along a straight pipe;
- ✓ Sampling valve must be compatible with a two inch valve exclude ball, gate or butterfly valve.

(5) Control panel and UV power supply panel Installation

The install location must be accessible by operator(s) and door clear to mount the control panel and UV power supply panel(s). Except specific purpose of using, it should be installed dry area against water ingress.

(6) Flow Meter Installation

- ✓ Flow meter can be installed horizontally or vertically;
- ✓ In case of vertical installation, flow preferably from below to above;
- ✓ Entrapped air or gas bubble formation in the measuring tube can result in an increase in measuring errors.

AVOID the following pipe installation locations (Refer to Figure 5.8):

- ✓ The highest point or in the draining-off side of a pipeline which could increase the risk of air accumulating;
- ✓ Directly upstream from a free pipe outlet in a vertical pipeline.

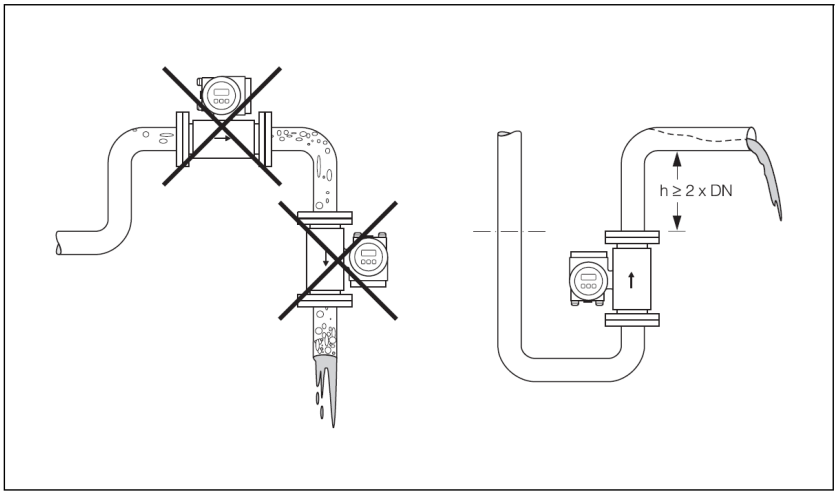


Figure 5.8 INCORRECT installation locations of a Flow meter

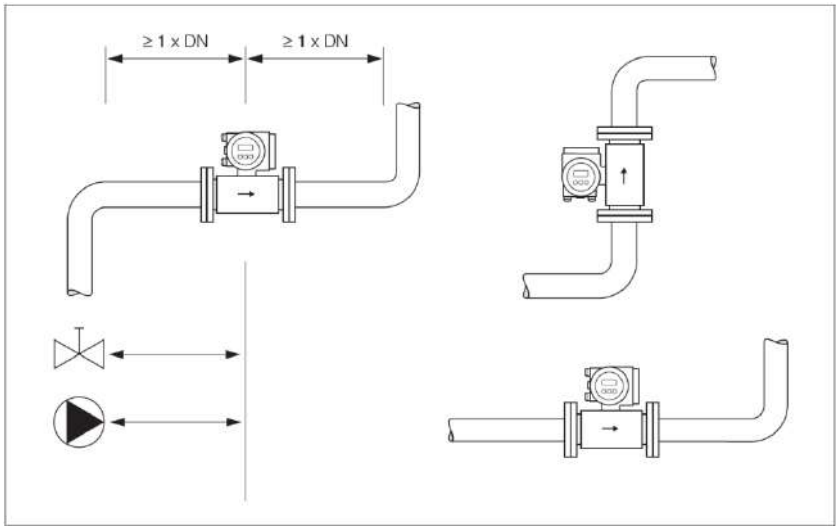


Figure 5.9 CORRECT installation locations of a flow meter

If possible, install the sensor well clear of assemblies such as valves, manifolds, fittings etc. in front of the meter tube. Note the following inlet and outlet runs to comply with measuring accuracy specifications;

Straight Inlet Section	Straight Outlet Section
≥ 1 × DN	≥ 1 × DN

VI. TROUBLESHOOTING PROCEDURE

The following list of troubleshooting situations will identify the cause and action(s) needed to be taken onboard during operation. It must be executed by authorized and/or certified persons who have been trained properly to operate the BWMS. Troubleshooting situations are designated by Alarm and Trip conditions.

A. Alarm and trip conditions for filter unit

FILTER DIFFERENTIAL PRESSURE HIGH (ALARM)	
Alarm indicates that differential pressure is over 0.6 bar (kg/cm^2) for longer than 60 seconds.	
Cause	**Troubleshooting / Action**
Pressure transmitter calibration	Test each pressure transmitter output (4-20mA)
Loss of power (Pressure transmitter/ Motor/ Solenoid)	Verify all wires are properly terminated
	Check current with an ammeter
Failure of solenoid valve (back-flushing)	Visually inspect air supply lines and regulator

FILTER INLET LOW PRESSURE (ALARM)	
Alarm indicates that inlet pressure is lower than set value (Default = 1 bar).	
Cause	**Troubleshooting / Action**
Filter inlet valve failure	Verify all relevant valves work properly
Pressure transmitter calibration	Test each pressure transmitter output (4-20mA)
Ballast pump failure	Verify proper opera tion of the pump

FILTER OPERATING TIME OVER (ALARM)	
Alarm indicates that differential pressure is still between 0.45 - 0.6 bar (kg/cm^2) after 10 minutes of back-flushing.	
Cause	**Troubleshooting / Action**
Pressure transmitter calibration	Test each pressure transmitter output (4-20mA)
Loss of power	Verify all wires are properly terminated
	Check current with an ammeter
Solenoid failure	Visually inspect air supply lines and regulator

FILTER CYCLE TIME OVER (ALARM)	
Alarm indicates that the back-flushing motor has exceeded maximum set point.	
Cause	**Troubleshooting / Action**
Limit switch failure	Check the limit switch works properly
	Verify all wires are properly terminated
Motor failure	Check the movement of limit plate by using motor fan in manual
Power controller (Power Supply Panel)	Verify the circuit break failure
	Verify power controller is undamaged and check wiring connections

FILTER INLET PRESSURE SENSOR FAIL (ALARM)	
Alarm indicates that inlet pressure transmitter is out of working range and/or has loss of output signal (4-20mA).	
Cause	**Troubleshooting / Action**
Pressure transmitter calibration	Test pressure transmitter output (4-20mA)
Loss of output signal	Verify that the pressure transmitter is installed in correct position
	Verify that the pressure transmitter is working by checking connections
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated in accordance with system circuit diagram

FILTER OUTLET PRESSURE SENSOR FAIL (ALARM)	
Alarm indicates that the outlet pressure transmitter is out of working range and/or has loss of output signal (4-20mA).	
Cause	**Troubleshooting / Action**
Pressure transmitter calibration	Test pressure transmitter output (4-20mA)
Loss of output signal	Verify that the pressure transmitter is installed in correct position
	Verify that the pressure transmitter is working by checking connections
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated in accordance with system circuit diagram

FILTER DIFFERENTIAL PRESSURE HIGH HIGH (TRIP)	
Trip indicates that differential pressure is over 1.2 bar (kg/cm^2) for longer than 20 seconds and therefore, automatically bypass mode activates	
Cause	**Troubleshooting / Action**
Clogged filter	Check single operation via control panel *(Operate "Filter Clogging Solution")*
	Verify that the filter is not clogged *(Use de-scaling liquid to cleaning inside filter)*

FILTER FLUSHING MOTOR CIRCUIT BREAKER TRIP (TRIP)	
Trip indicates that filter back flushing motor does not work properly	
Cause	**Troubleshooting / Action**
Over current	Verify the circuit breakers work
	Repair/ replace the circuit breaker
Motor failure	Verify all wiring connections are tight, not grounded and motor is undamaged
	Identify and correct the cause of any loss of power
	Check the movement of limit plate by using motor fan manually
	Repair/ replace the motor
Mechanical drive screw failure	Identify and correct the cause of a coupling failure
	Identify and correct the cause of a worm reducer gear box binding up
Motor controller	Verify motor controller undamaged and check wiring connections

B. Alarm and trip conditions for UV unit

UV WIPER MOTOR CIRCUIT BREAKER TRIP (ALARM)	
Alarm indicates that the wiper motor has experienced a mechanical overload.	
Cause	**Troubleshooting / Action**
Overload	Identify and correct the cause of the wiper plate and motor drive jam
Wiper motor failure	Repair/ replace the motor
Circuit breaker failure	Check / replace the circuit breaker
Poor or no wire connection	Verify all wires are properly terminated in accordance with system circuit diagram

UV INTENSITY LOW (ALARM)	
Alarm indicates that the UV intensity is below than 59mW/cm^2 (Case1&3) or 81mW/cm^2 (Case2) for longer than 50 seconds. (Refer to Alarm 2 Set in Table 1.2)	
Cause	**Troubleshooting / Action**
Intensity transmitter calibration	Test intensity sensor output (4-20mA)
Intensity sensor fouling	Cleaning the sensor and fittings with alcohol
Quartz sleeve fouling	Cleaning the quartz sleeve(s) with alcohol
	Replace the quartz sleeve(s)
Wiper ring worn	Replace wiper rings if necessary
Lamp end of life	Check lamp hours and replace as necessary

UV CHAMBER INSIDE TEMPERATURE HIGH / HIGH HIGH (ALARM / TRIP)	
Alarm indicates that the water temperature inside UV chamber has exceeded alarm set value. (Default = 50°C) Trip indicates that the water temperature inside UV chamber has exceeded trip set value. (Default = 60°C)	
Cause	**Troubleshooting / Action**
Temperature transmitter calibration	Test the transmitter output (4-20mA)
Temperature transmitter failure	Repair/ replace transmitter if necessary
Insufficient flow rate	Check the flow rate via flowmeter whether it is within specification
Poor or no wire connection	Verify all wires are properly terminated in accordance with system circuit diagram

UV CYCLE TIME OVER (ALARM)	
Alarm indicates that wiper motor has a current trip or has not completed 1 cleaning cycle within preset time limit (60 to 90 seconds).	
Cause	**Troubleshooting / Action**
Reed switch failure	Verify all wiring connections are tight, not grounded, undamaged and/or binding
Motor failure	Verify all wiring connections are tight, not grounded and motor is undamaged
Motor controller	Verify motor controller is undamaged and check wiring connections
Mechanical faults	Identify and correct the cause of coupling and screw binding up
Circuit breaker failure	Check the circuit breaker(s) status

UV OPERATE TIME OVER (ALARM)	
Alarm indicates that UV intensity is below 60mW/cm^2 (Case1&3) or 82mW/cm^2 (Case2) in spite of cleaning the quartz sleeves for longer than 20 minutes. (Refer to Alarm 1 Set in Table 1.2)	
Cause	**Troubleshooting / Action**
Low transmittance	Check the water transmittance
Wiper system failure	Verify proper operation of the wiper system

UV POWER SUPPLY PANEL TEMPERATURE HIGH / HIGH HIGH (ALARM / TRIP)	
Alarm indicates that the temperature inside the power supply panel has exceeded 60°C. Trip indicates that the temperature inside the power supply panel has exceeded 70°C.	
Cause	**Troubleshooting / Action**
Cooling fan fault	Check the electric ballast fans work
	Verify that all cooling fans work properly
	Check the actual temperature with a thermometer
	Clean the fan filter if necessary
Thermostat sensor failure	Check the sensor status and verify all wiring is free from damage

UV CIRCUIT BREAKER TRIP (TRIP)	
Trip indicates that overcurrent occurs in a circuit.	
Cause	**Troubleshooting / Action**
Overcurrent	Check that the circuit breaker is work properly
UV power cable insulation	Verify all wiring connections are tight, not grounded , and check wires with an ammeter

UV EARTH LEAKAGE CIRCUIT BREAKER TRIP (TRIP)	
Trip indicates that a problem(s) occurs between electric ballast and ELCB, between electric ballast and UV lamp(s), or relevant connection line(s).	
Cause	**Trouble shooting / Action**
UV power cable insulation	Verify all wiring connections are tight, not grounded , and check wires with an ammeter
Water leakage of UV unit	Verify all sleeves and O-rings are correctly placed and secured tightly
Physical damage of sleeve(s)	Replace the sleeve(s) and if necessary UV lamp(s)

UV LAMP TROUBLE (TRIP)	
Trip indicates that lamps in the UV chamber have trouble or have problem(s) with the connection lines	
Cause	**Troubleshooting / Action**
Breaker to power supply panel failed	Check if circuit breaker(s) and transformer(s) are functioning
	Verify the NTC terminal block of ballast transformer is undamaged
	Check the NTC terminal block of ballast transformer with an ammeter
Feed breaker failure	Check if circuit breaker(s) and transformer(s) are functioning
Physical damage of UV lamp(s)	Check the damage of UV lamp(s)
	Replace the UV lamp(s) if necessary

UV INTENSITY LOW LOW (TRIP)	
Trip indicates that the UV intensity is lower than 56mW/cm^2 (Case 1&3) or 78mW/cm^2 (Case 2) for longer than 60 seconds. (Refer to Trip 1 Set in Table 1.2)	
Cause	**Troubleshooting / Action**
Intensity sensor failure	Test intensity sensor output (4-20mA)
Voltage levels	Identify and correct the cause of any broken and/or damaged wires

UV CHAMBER SURFACE TEMPERATURE HIGH (TRIP)	
Trip indicates that the surface temperature of UV chamber is over 50°C.	
Cause	**Troubleshooting / Action**
Poor or no wire connection	Verify all wires are properly terminated between UV junction box to control panel
Temperature switch failure	Check the sensor with an ammeter
	Replace the sensor

UV INTENSITY SENSOR FAIL (TRIP)	
Trip indicates that the UV intensity sensor output is out of range.	
Cause	**Troubleshooting / Action**
Intensity transmitter calibration	Test intensity sensor output (4-20mA)
Intensity sensor fouling	Clean the sensor and fittings with alcohol
Intensity sensor failure	Replace the sensor
Poor or no wire connection	Verify all wires are properly terminated between UV junction box to control panel

UV CHAMBER TEMPERATURE SENSOR FAIL (TRIP)	
Trip indicates that the UV temperature sensor output is out of range.	
Cause	**Troubleshooting / Action**
Temperature sensor calibration	Test temperature sensor output (4-20mA)
Temperature sensor failure	Replace the sensor
Poor or no wire connection	Verify all wires are properly terminated between UV junction box to control panel

UV FLOW SWITCH OFF (TRIP)	
Trip indicates that no fluid in the UV chamber*.	
Cause	**Troubleshooting / Action**
Flow switch failure	Check the flow switch works properly Verify all wires are properly terminated
Accumulation of Foreign substance	Remove the foreign substance in the sensing plate

** The location of flow switch in the UV chamber is descried on the "Components of the UV Chamber (Explosion proof model) " on the chapter II.A.(2).*

C. Alarm and trip conditions for other components

FLOW METER FAIL ALARM (ALARM)	
Alarm indicates that the flow meter does not work properly	
Cause	**Troubleshooting / Action**
Loss of output signal	Verify that the flow meter is installed in correct position
	Verify that the flow meter is working by checking connections
Transmitter failure	Test the flow meter signal output (4-20mA)
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated including power line and fuse
Ballast pump failure	Verify the pump is working properly and check the flow rate

FLOW RATE LOW / LOW LOW (ALARM / TRIP)	
FOR VERTICAL INSTALLATION	
Alarm indicates that flow is below 30% of UV unit capacity for longer than 50 seconds. Trip indicates that flow is below 10% of UV unit capacity for longer than 60 seconds.	
Cause	**Troubleshooting / Action**
Flow meter calibration	Test flow meter signal output (4-20mA)
	Verify that the flow meter is installed correctly
Relevant valves status	Check the valves' position
Ballast pump failure	Verify the pump is working properly and check the flow rate
Poor or no wire connection	Verify all wires are properly terminated for flow meter

FLOW RATE LOW / LOW LOW (ALARM / TRIP)	
FOR HORIZONTAL INSTALLATION	
Alarm indicates that flow is below 40% of UV unit capacity for longer than 50 seconds. Trip indicates that flow is below 30% of UV unit capacity for longer than 60 seconds.	
Cause	**Troubleshooting / Action**
Flow meter calibration	Test flow meter signal output (4-20mA)
	Verify that the flow meter is installed correctly
Relevant valves status	Check the valves' position
Ballast pump failure	Verify the pump is working properly and check the flow rate
Poor or no wire connection	Verify all wires are properly terminated for flow meter

VRC COMMUNICATION FAIL (ALARM)	
Alarm indicates that BWMS would not be linked with VRC.	
Cause	**Troubleshooting / Action**
Loss of signal	Verify that the VRC is turned on
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated in accordance with wiring diagram

GRAVITY DEBALLAST (ALARM)	
Alarm indicates that both sea chest and suction valves are opened at the same time if the ballast pump does not work.	
Cause	**Troubleshooting / Action**
Valve signal error	Check each valve status and output signal of VRC
Sea chest valve malfunction	Verify that the sea chest valve is closed (One of the two valves must be closed) (Check the valve failed to open/close in order)

BYPASS OPENED OPERATING (ALARM)	
Alarm indicates that ballast valve and/or suction valve are opened during by-pass operation.	
Cause	**Troubleshooting / Action**
Ballast valve is opened	Verify that the ballast valve is closed (Check the valve failed to open/close in order)
Suction valve is opened	Verify that the suction valve is closed (Check the valve failed to open/close in order)

UV LAMP MISOPERATING (ALARM)	
Alarm indicates that operator intended to turn UV lamp on while it is not available.	
Cause	**Troubleshooting / Action**
Misoperating	Check the BWMS operation procedure
Alarm recovery failure	Verify that all alarms are recovered
Ballast pump failure	Verify the pump is working properly and check the flow rate

EHS VCC* POWER FAIL (ALARM)	
Alarm indicates that BWMS would not be linked with EHS.	
Cause	**Troubleshooting / Action**
Loss of signal	Verify that the EHS is turned on
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated in accordance with wiring diagram

** EHS VCC – Electro-Hydraulic System Valve Control Cabinet (Local Valve Control Cabinet)*

FLOW RATE HIGH / HIGH HIGH (ALARM / TRIP)	
Alarm indicates that flow is higher 110% of UV unit capacity for longer than 50 seconds. Trip indicates that flow is higher 115% of UV unit capacity for longer than 60 seconds.	
Cause	**Troubleshooting / Action**
Flow meter calibration	Test flow meter signal output (4-20mA)
	Verify that the flow meter is installed correctly
Relevant valves status	Check the valves' position
Poor or no wire connection	Verify all wires are properly terminated for flow meter

CONDUCTIVITY SENSOR FAIL ALARM (ALARM) (Applies only to GloEn-Patrol 2.0)	
Alarm indicates that the conductivity sensor does not work properly	
Cause	**Troubleshooting / Action**
Loss of output signal	Verify that the conductivity sensor is installed in correct position
	Verify that the conductivity sensor is working by checking connections
Conductivity sensor failure	Test the conductivity sensor signal output (4-20mA)
Analog card or channel failure	Verify that the cards are working by checking connections
Poor or no wire connection	Verify all wires are properly terminated including power line and fuse
Ballast pump failure	Verify the pump is working properly

LOCAL/ REMOTE GP RESPONSE TIME OUT (ALARM)	
Alarm indicates that the graphic panel does not work	
Cause	**Troubleshooting / Action**
Loss of signal	Verify that the GP monitor (Local/ Remote) is turned on
Alarm recovery failure	Verify that all alarms are recovered
Poor or no wire connection	Verify all wires are properly terminated in accordance with wiring diagram

GPS COMMUNICATION FAIL (ALARM)	
Alarm indicates that there is a loss of communication between PLC to GPS module.	
Cause	**Troubleshooting / Action**
GPS failure	Verify that the GPS is working properly (Check the color of green LED lamp) - Flicker: Normality - On-state: Cable wiring problem - Off-state: GPS does not send signal
Poor or no wire connection	Verify all wires are properly terminated in accordance with wiring diagram

CHECK MODE SWITCH ON (ALARM)	
Alarm indicates that starting the BWMS under the situation that the mode selector switch was turned to 'CHECK' position on the control panel.	
Cause	**Troubleshooting / Action**
Mode selector switch position	Verify that the mode selector switch indicates 'NORMAL' position
Mode selector switch failure	Check/ replace the mode selector switch

EMERGENCY STOP (TRIP)	
Trip indicates that the 'Emergency' button was pushed.	
Cause	**Troubleshooting / Action**
Emergency situation	Verify that there are no problems at all
Emergency signal activated	Release the emergency button

POWER FAILURE (TRIP)	
Trip indicates that main power is not supplied and/or circuit breaker(s) is damaged.	
Cause	**Troubleshooting / Action**
Power source	Check the power supplement
Circuit breaker failure	Check the circuit breaker(s) status

BYPASS MODE SWITCH ON (TRIP)	
Trip indicates that starting the BWMS under the situation that the mode selector switch was turned to 'BYPASS' position on the control panel.	
Cause	**Troubleshooting / Action**
Mode selector switch position	Verify that the mode selector switch indicates 'NORMAL' position
Mode selector switch failure	Check/ replace the mode selector switch

PUMP FAIL (TRIP)	
Trip indicates that the ballast pump is shut down while UV lamp is operating.	
Cause	**Troubleshooting / Action**
Misoperating	Verify that the ballast pump is working properly (Do not stop operating the ballast pump during the BWMS is running)
Ballast pump failure	Verify the pump is working properly and check the flow rate

BWMS MISOPERATING (TRIP)	
Trip indicates that ballast valve and/or suction valve are opened before warming up of UV lamp completed.	
Cause	**Troubleshooting / Action**
Ballast valve is opened	Verify that the ballast valve is closed (Check the valve failed to open/close in order)
Suction valve is opened	Verify that the suction valve is closed (Check the valve failed to open/close in order)

EDUCTOR MISOPERATING (TRIP)	
Trip indicates that suction valve is opened before warming up of UV lamp completed.	
Cause	**Troubleshooting / Action**
Suction valve is opened	Verify that the suction valve is closed (Check the valve failed to open/close in order)

EHS* VALVE OPERATING TIME OUT (TRIP)	
Trip indicates that suction valve is opened before warming up of UV lamp completed.	
Cause	**Troubleshooting / Action**
Suction valve is opened	Verify that the suction valve is closed (Check the valve failed to open/close in order)
Circuit breaker failure	Check / replace the circuit breaker
Poor or no wire connection	Verify all wires are properly terminated in accordance with wiring diagram

** EHS: Electro-Hydraulic System*

PLC RESPONSE TIME OUT (TRIP)	
Trip indicates that PLC does not work	
Cause	**Troubleshooting / Action**
Power shut off	Correct the cause of loss of power
Control panel CPU failure	Check the CPU status

VII. MAINTENANCE REQUIREMENT

A. Use of tools and test equipment in accordance with the maintenance procedures

(1) Filter unit maintenance

1) Weekly maintenance

Check that the filter is operating properly with weekly inspection.

Check that sufficient grease is applied on the drive shaft and drive bushing. If necessary add additional grease.

Take care of any leaks from the scanner shaft. If necessary, tighten the gland packing or replace the sealing materials.

If the BWMS will not operate for more than a month, complete the following steps;

- ✓ Manual back-flushing of the filter for cleaning (if possible, cleaning with fresh water).
- ✓ Disconnect the power of the control panel and UV power supply panel.
- ✓ Drain the inside of the filter.
- ✓ Grease the drive shaft and drive bushing.

Preparation prior to re-operation;

- ✓ Power supply to the control panel and power supply panel.
- ✓ Grease on the drive shaft and drive bushing.
- ✓ Operate back-flushing manually and simultaneously then check all movements.
- ✓ If necessary, replace the gland packing and/or internal O-ring.

CAUTION	➢ *All installation work must only be carried out by qualified personnel.* ➢ *Read the safety instruction manual before commencing installation.* ➢ *UV lamp(s) to be mounted horizontally.*

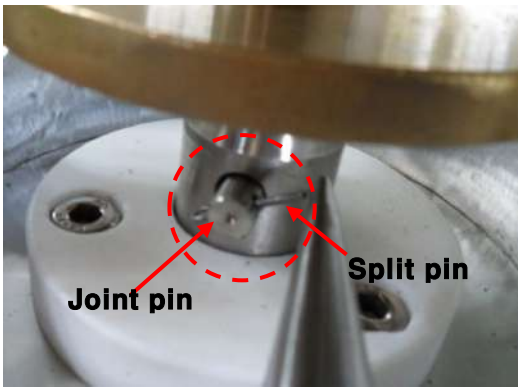
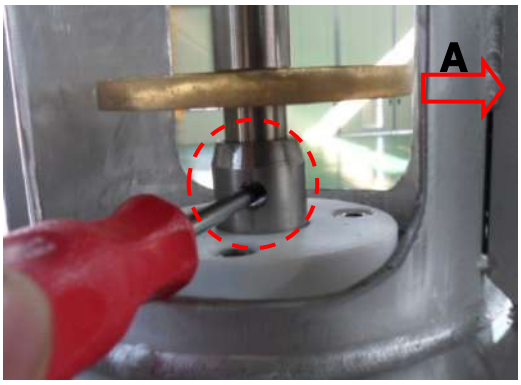
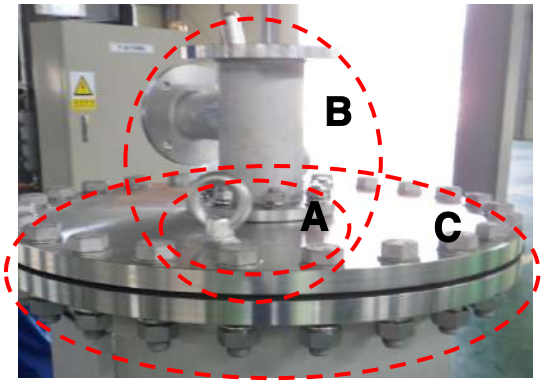
2) Disassembly of the filter screen

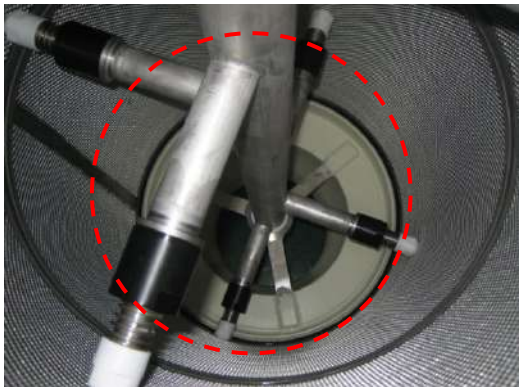
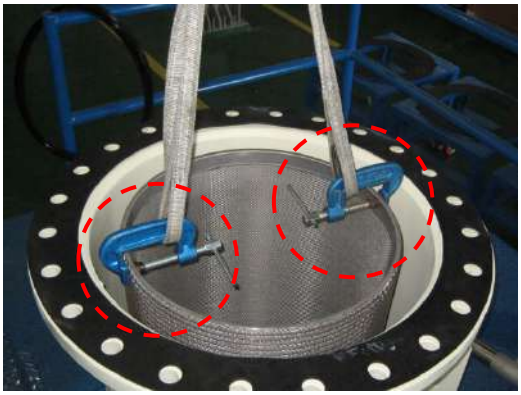
Prior to dismantling the filter elements, it is recommended that manual back-flushing operation should be completed prior to disassembly.

- ✓ Close the Filter inlet and outlet valves and release the pressure;
- ✓ Press the *MANUAL BACK-FLUSHING* button on the control panel;
- ✓ Disconnect the power when the scanner is in the middle of its track.

NOTE: *If the BWMS will not operate for two months, it is recommended that disassembly of the filter screen is conducted.*

Table 7.1 Disassembly of the filter elements

Step	Description	Figure
1.	Remove the S/B housing after unscrewing bolts.	
2.	Remove the split pin from the inside of B/F Drum.	
3.	Remove the joint pin from the inside of B/F Drum (A).	
4.	Remove the B/F Drum (B) after unscrewing bolts (A). Unscrew the bolts from the flange of filter body (C).	

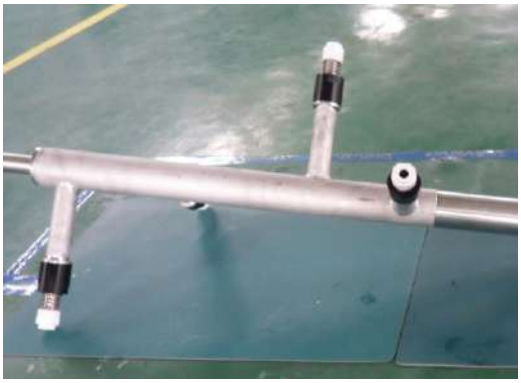
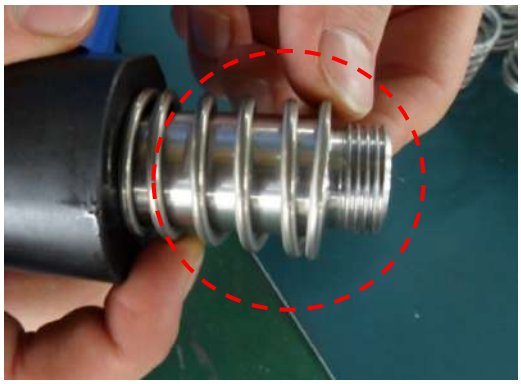
5.	Take the flange from upper end side using lifting equipment and included eye bolts.	
6.	Take suction scanner out of the filter element.	
7.	Install the clamps to the filter element. Take the flange from upper side using lifting equipment with clamps.	
*	In case of the high capacity models, If the filter (PF900 ~ PF3000) is installed horizontally, uninstall the PRESSURE TRANSMITTER in the upward direction (checking the COVER BOLT direction) before taking the flange for filter element (ref.: The quantities are different depending on the capacity.)	

✓ Assemble the filter unit in reverse order of disassembly procedure.

3) Suction scanner

When the differential pressure inside the filter reaches the set value, filter cleaning (back-flushing) is automatically activated and ballasting is uninterrupted during cleaning. Several cleaning (scanner) heads scan over the filter screen surface with a “corkscrew-like” rotational and an up & down, vertical motion by an electric motor and un-clog trapped materials. Back-flushing pump (optional) runs simultaneously with the scanner to discharge the flushing water from the filter overboard so that differential pressure will be decreased.

Table 7.2 Dismantling the suction scanner.

Step	Description	Figure
1.	Place the S/S drum on clean plate.	
2.	Use the spanner to unscrew the suction scanner from S/S drum.	
3.	Replace the spring before screwing on the suction scanner. Use the spanner to screw the suction scanner to S/S drum.	

NOTE: *This drawing is an example for the shape of filter unit. Please refer to each project's final drawing for each code/part No. and size.*

(1) Standard model Unit : EA

COMPONENT	PF50	PF250	PF500	PF750
Helical & Worm Reducer (with motor)	1	2	1	1
Limits Switch	2	2	2	2
Element of Filter	1	1	1	1

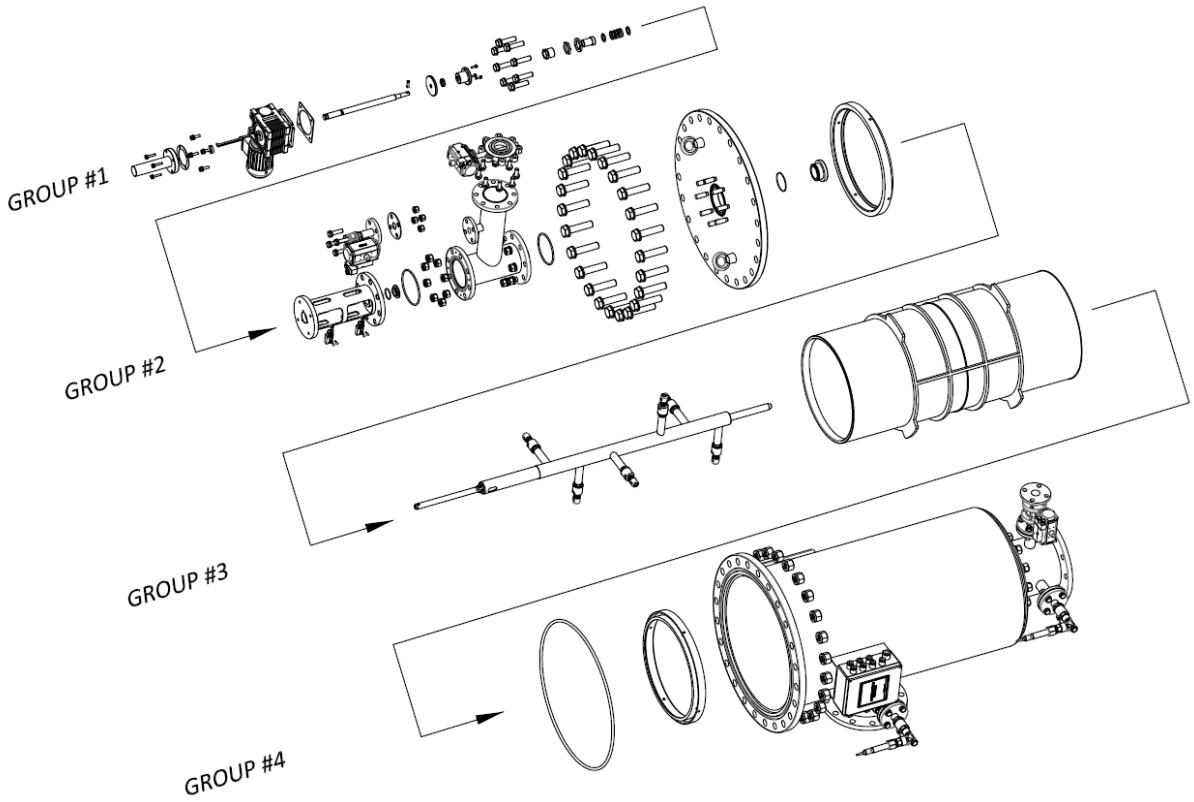
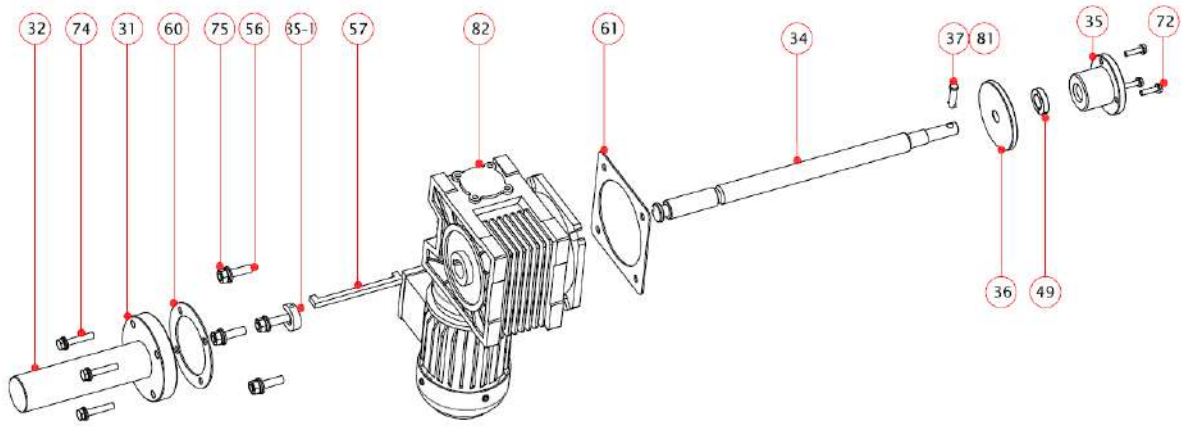
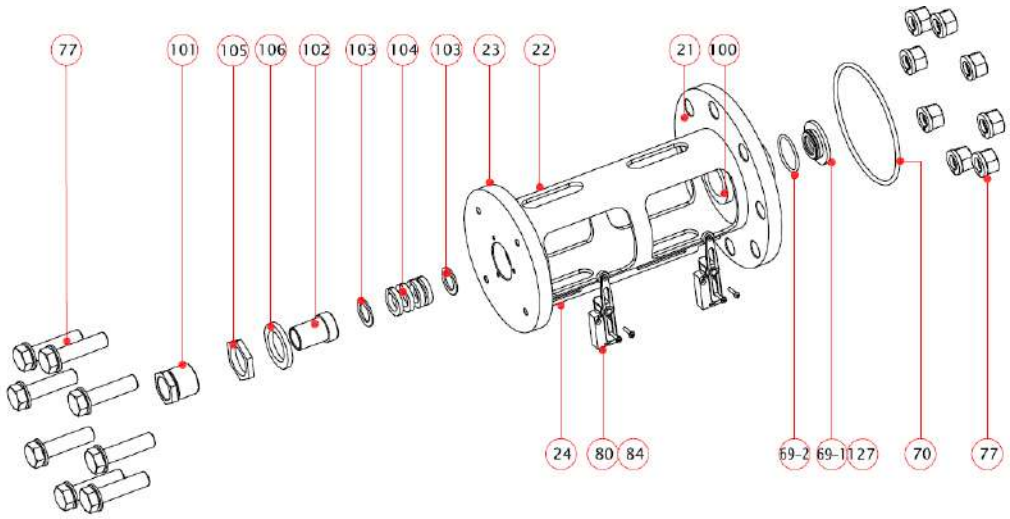


Figure 7.1 Overhaul of the Filter Unit



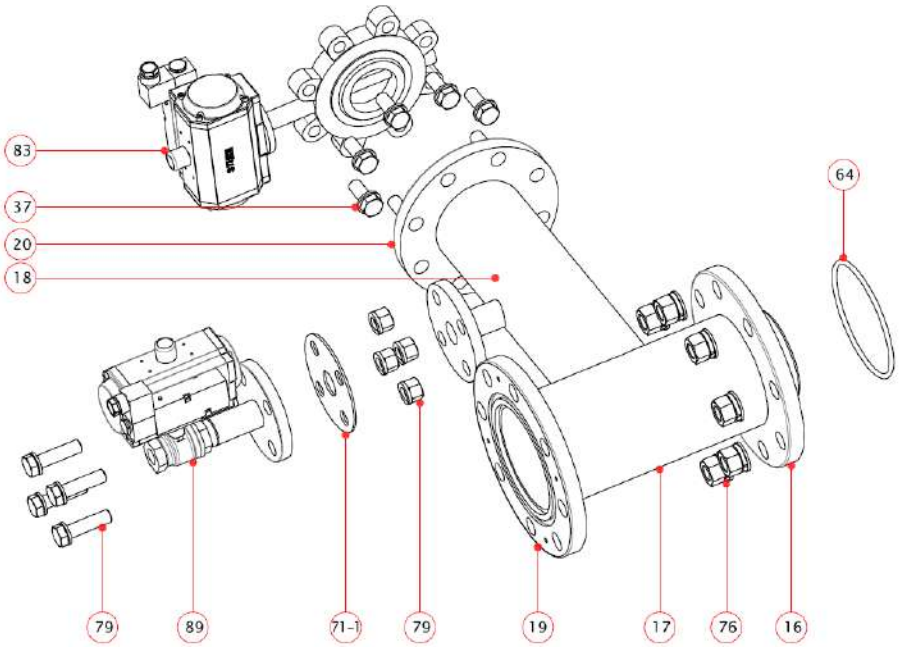
31	Cap Flange	57	Key
32	Cap Body	60	Cap Gasket
34	Rev. Screw	61	Motor Gasket
35	Rev. Nut	72	Hex. Bolt (P/W, S/W)
35-1	Stopper of Rev. Screw	74	Hex. Bolt (P/W, S/W)
36	Limit Plate	75	Nut (P/W, S/W)
37	Joint Pin	81	Split Pin
49	Set Colar Slit	82	Helical & Worm Reducer
56	Stud Bolt		

Figure 7.2 Overhaul of the Filter (Group #1)



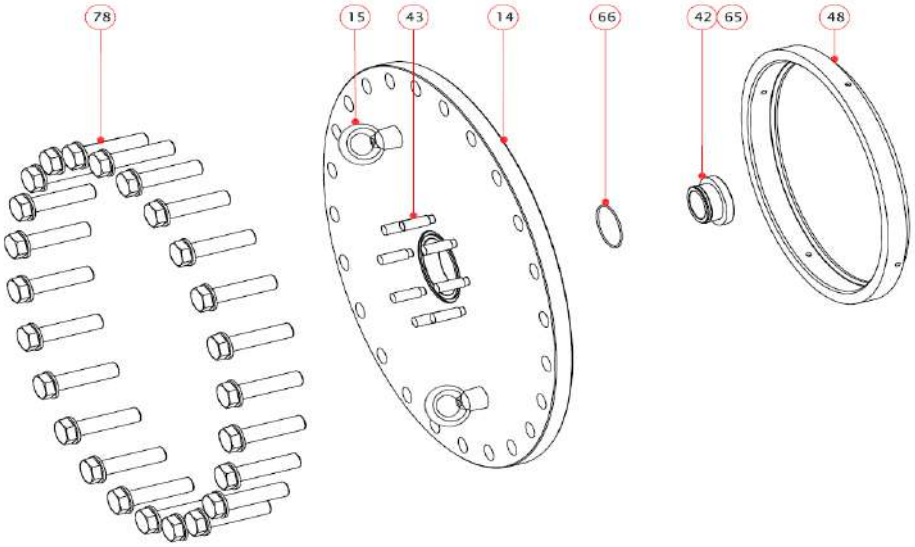
21	S/B Bottom Flange	84	Limit Switch
22	S/B Housing	100	Drum Seal Housing
23	S/B Stop Flange	101	Drum Seal Plug
24	Limit Switch Bracket	102	Drum Seal Bush
69-1	O-ring (G25)	103	Washer
69-2	O-ring (P46)	104	Grand Packing
70	O-ring (G160)	105	Clamp Nut
77	Hex. Bolt & Nut (P/W, S/W)	106	Nord Lock Washer
80	Round Head Bolt & Nut	127	Body Seal Bush

Figure 7.3 Overhaul of the Filter (Group #2)



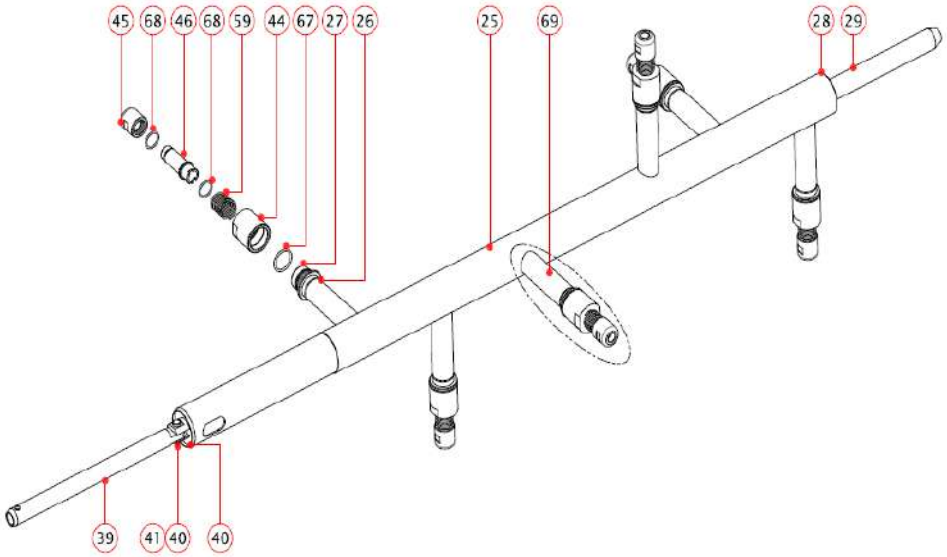
16	B/F Bottom Flange	71-1	Gasket
17	B/F Drum	73	Hex. Head Bolt
18	B/F Nozzle	76	Nut (P/W, S/W)
19	B/F Top Flange	79	Hex. Bolt (P/W, S/W)
20	B/F Fitting Flange	83	Back-flushing Valve
64	O-ring (P140)	89	Air Inlet Valve

Figure 7.4 Overhaul of the Filter (Group #2)



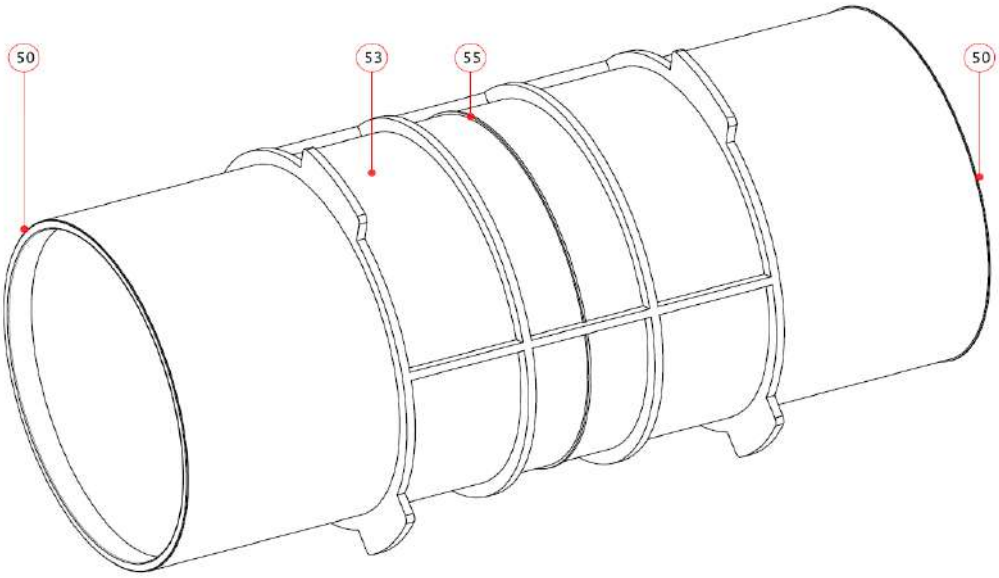
14	Cover Flange	65	O-ring (P58)
15	Lifting Eye Nut	66	O-ring (G85)
42	Body Seal Bush	78	Hex. Bolt (P/W, S/W)
43	W.S. Joint Bolt		
48	Element Packing		

Figure 7.5 Overhaul of the Filter (Group #2)



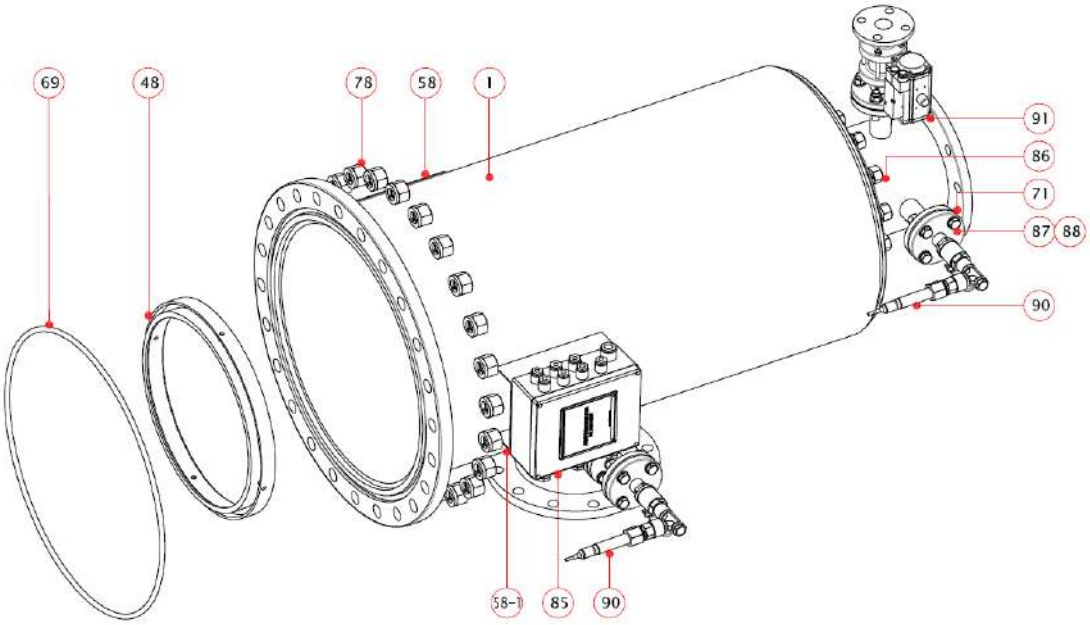
25	Suction Scanner Drum	41	Joint Nut
26	Suction Scanner Branch Nozzle	44	Suction Scanner Body
27	Suction Scanner Branch Boss	45	Suction Scanner Cover
28	Suction Scanner Bottom Boss	46	Suction Scanner Boss
29	Suction Scanner Rev. Bar	59	Spring
30	Suction Scanner Top Boss	67	O-ring (G30)
39	Joint Bar	68	O-ring (P22)
40	Joint Pin	69	Nozzle Assembly

Figure 7.6 Overhaul of the Suction Scanner (Group #3)



50	End Ring	55	Middle Ring
53	Filter Element		

Figure 7.7 Overhaul of the Filter Element (Group #3)



1	Filter Body	85	Junction Box
58	Name Plate Bracket	86	Stud Bolt & Nut (P/W, S/W)
58-1	Junction Box Bracket	87	Stud Bolt & Nut (P/W, S/W)
69	O-ring	88	Stud Bolt & Nut (P/W, S/W)
71	Gasket	90	Pressure Transmitter
78	Hex. Bolt & Nut (P/W, S/W)	91	Drain Valve

Figure 7.8 Overhaul of the Filter (Group #4)

(2) High capacity model Unit : EA

COMPONENT	PF900	PF1200	PF1500	PF2000	PF2500	PF3000
Helical & Worm Reducer (with motor)	3	4	5	7	9	11
Limits Switch	6	8	10	14	18	22
Element of Filter	3	4	5	7	9	11

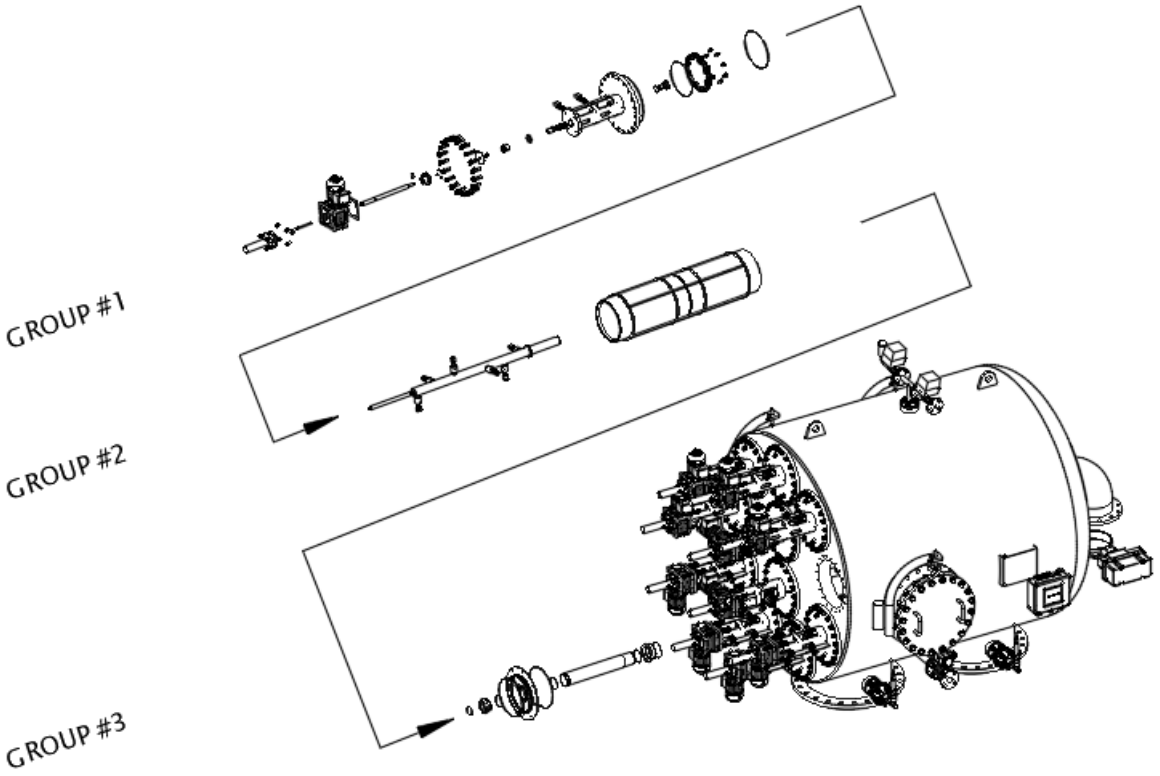
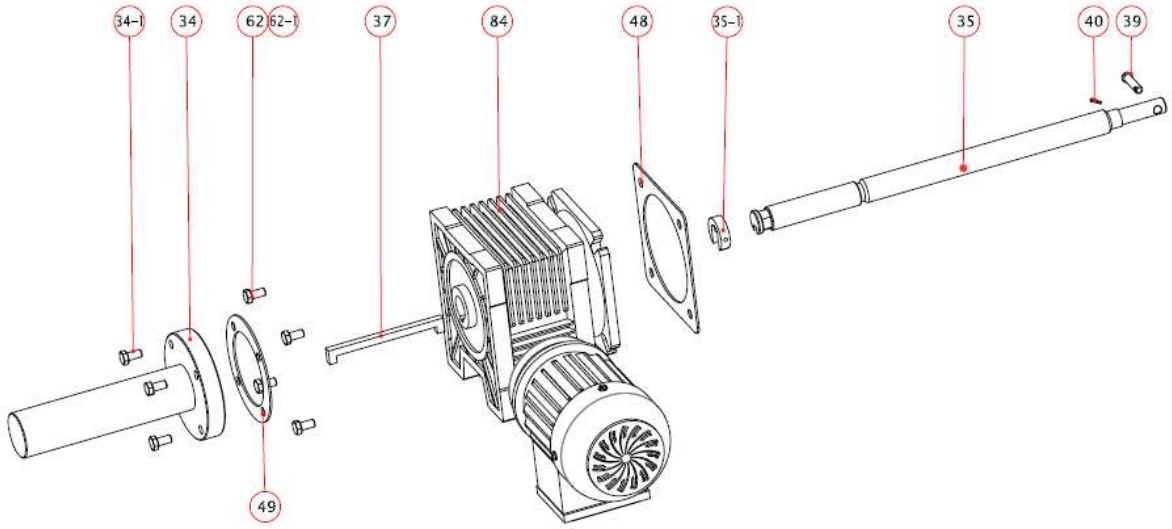
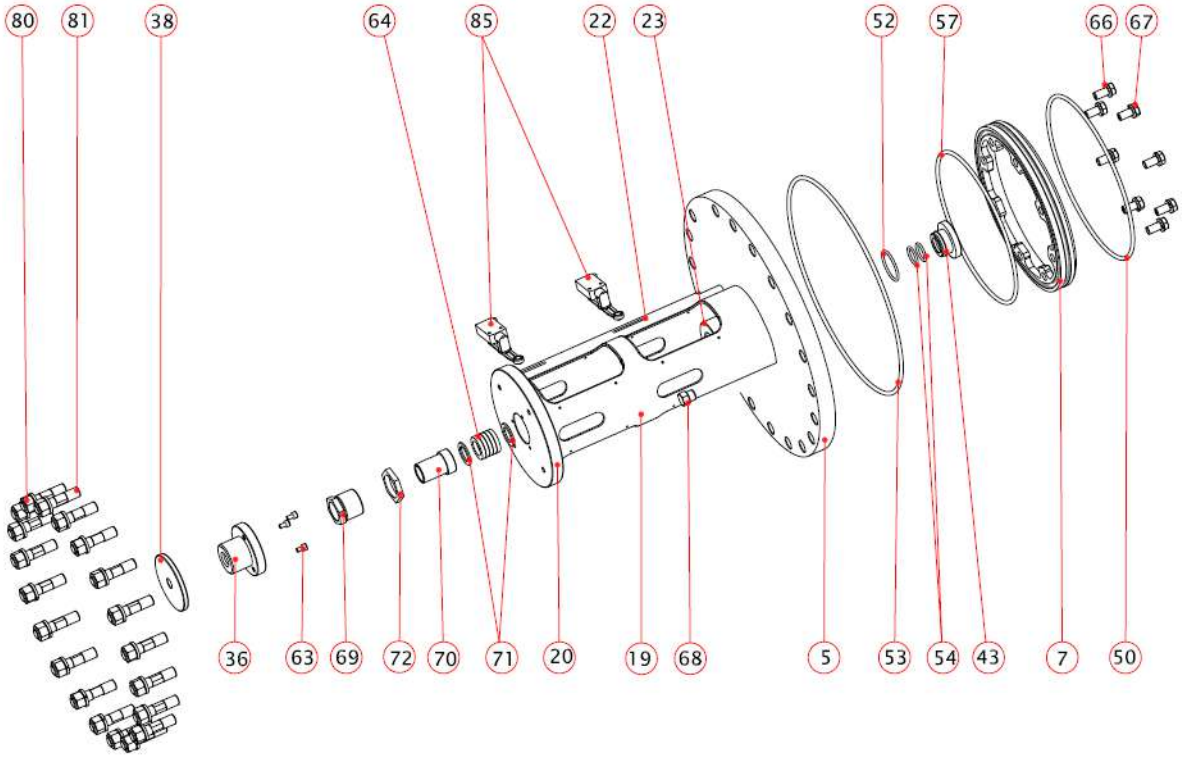


Figure 7.9 General Assembly of the Filter



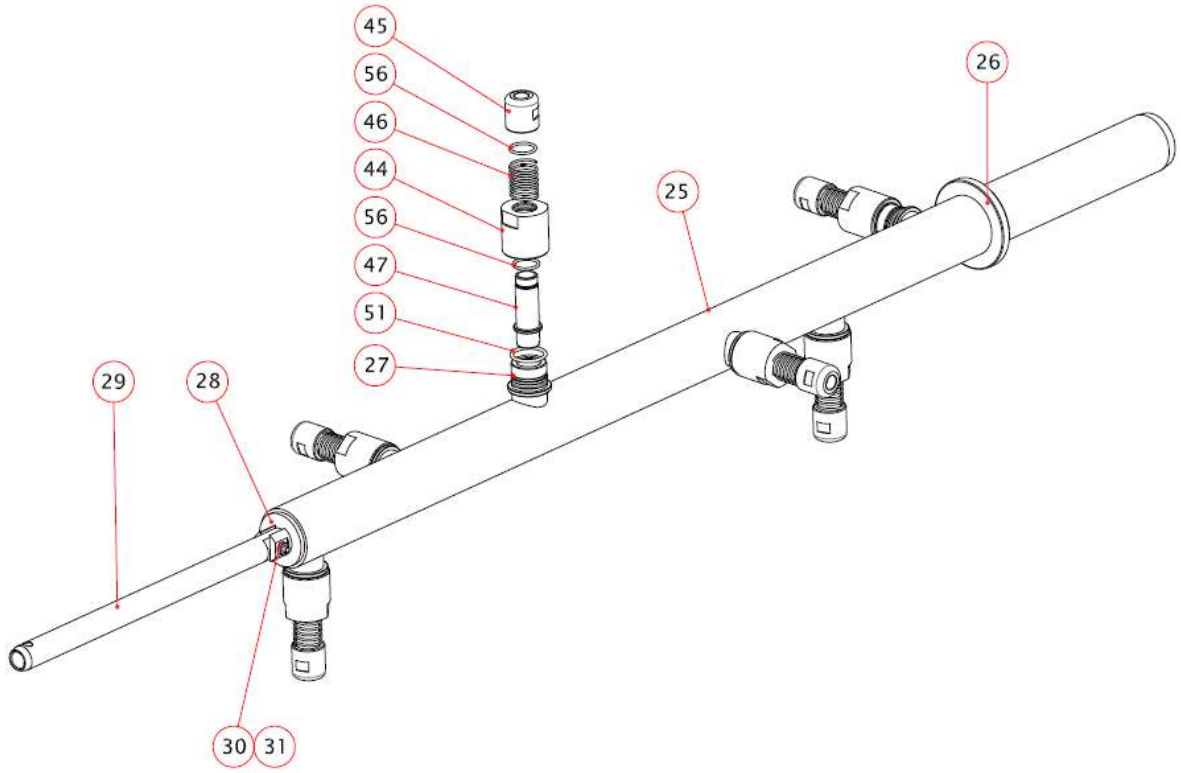
34	CAP FLANGE	39	JOINT NUT
34-1	H/BOLT(S/W)	40	SPLIT PIN
35	REV. SCREW	62	NUT/W/SW
35-1	STOPPER OF REV. SCREW	62-1	STUD BOLT
37	KEY	84	HELICAL & WORM REDUCER

Figure 7.10 Disassembly of the Filter Element (Group #1)



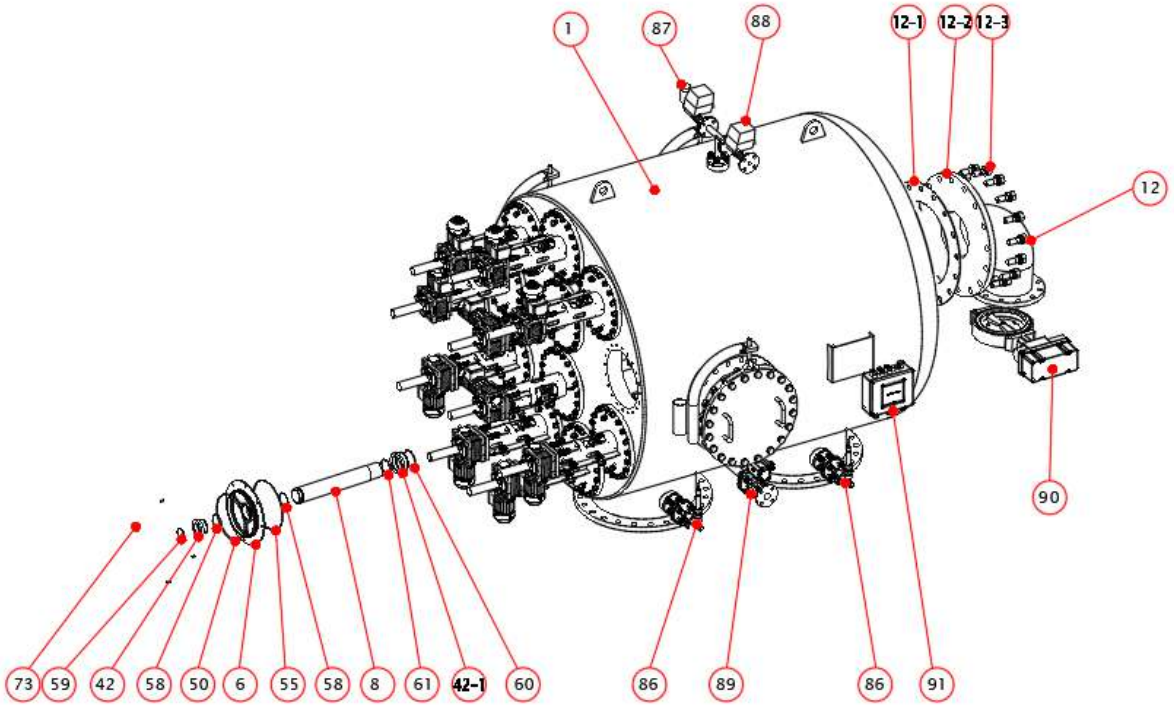
5	COVER FLANGE	57	O-RING (G250)
7	TOP E/T STOP RING	63	WRENCH BOLT
19	S/B HOUSING	64	GLAND PACKING
20	S/B STOP FLANGE	66	W/SW
22	LIMIT SWITCH BRACKET	67	HEX BOLT
23	DRUM SEAL HOUSING	68	PLUG
36	REV. NUT	69	DRUM SEAL PLUG
38	LIMIT PLATE	70	DRUM SEAL BUSH
43	BODY SEAL BUSH	71	WASHER
50	O-RING (G270)	72	CLAMP NUT
52	O-RING (P46)	80	NUT/W/SW
53	O-RING (G360)	81	STUD BOLT
54	O-RING (P25)	85	LIMIT SWITCH

Figure 7.11 Disassembly of the Filter Element (Group #1)



25	S/S DRUM	44	SUC. SCANNER BODY
26	BOTTOM STOPPER	45	SUC. SCANNER COVER
27	S/S BRANCH BOSS	46	SPRING
28	S/S TOP BOSS	47	SUC.SCANNER BOSS
29	JOINT BAR	51	O-RING (G30)
30	JOINT PIN	56	O-RING (P22)
31	JIONT WASHER		

Figure 7.12 Disassembly of the Filter Element (Group #2)



1	FILTER BODY	58	O-RING (G85)
6	BOTTOM E/T STOP RING	59	O-RING (P58)
8	LOWER DRUM	60	O-RING (G110)
12	BACK FLUSHING PIPE	61	O-RING (P85)
12-1	BACK FLUSHING PIPE GASKET	73	STRAIGHT DOWEL PIN
12-2	STUD BOLT	86	PRESSURE TRANSMITTER
12-3	NUT(N,W,S/W)	87	AIR INLET VALVE
42	BODY SEAL BUSH	88	VENT VALVE
42-1	BACK F' SEAL BUSH	89	DRAIN VALVE
50	O-RING (G270)	90	BACK FLUSHING VALVE
55	O-RING (G290)	91	JUNCTION BOX

Figure 7.13 Disassembly of the Filter Element (Group #3)

(2) UV unit maintenance

1) Cleaning the quartz sleeve

The quartz sleeve(s) must be cleaned regularly. The frequency of cleaning will depend on water quality. When the measured UV intensity is below than set value (93mW/cm^2), automatic wiper-cleaning will activate. Although quartz sleeve(s) has an automatic cleaning function, if it is determined that contamination for the quartz sleeve(s) has occurred, the following chemical cleaning method should be performed manually by manufacturer's engineer according to the OMSManual. The frequency of inspection for contamination is recommended at least once a year or in case that BWMS has been suspended for 2months.

NOTE: *By removing the intensity sensor hosing in UV unit,* contamination *for the quartz sleeve(s) can be checked visually.*

 WARNING	➢ *Turn OFF the main switch and the circuit breakers in the control panel before removing the intensity sensor housing.* ➢ *Make Sure that UV lamp power turns off.* ➢ *Drain the remaining water inside of the UV chamber*

2) Chemical cleaning method

If the quartz sleeves are still not cleaned by auto-wiping, it should be manually cleaned with alcohol. Cleaning must be accomplished as follows:

- ✓ Thurn off the main switch of the BWMS;
- ✓ Disconnect the power of control panel and UV power supply panel;
- ✓ Drain the remaining water inside of the UV chamber;
- ✓ Disassemble the UV end cover, and then take off the quartz sleeve(s);
- ✓ Rinse the quartz sleeve(S) with a solution of alcohol.

3) Cleaning the UV intensity sensor and quarts window

The UV intensity sensor measures the efficiency of the UV lamps in combination with the level of UV transmittance of the water. A quartz window on the inside of the disinfection chamber covers the measuring surface of the sensor.

Build up may occur on this window and has a negative effect on the UV measurement. If the system does not have a built-in cleaning mechanism the quartz window should be cleaned chemically as described below.

 WARNING	➢ *Turn OFF the main switch and the circuit breakers in the control panel.* ➢ *Turn OFF the flow and drain the liquid in the disinfection chamber.* ➢ *Remember that the lamps can be HOT.*

4) Replacing lamps and quartz sleeves

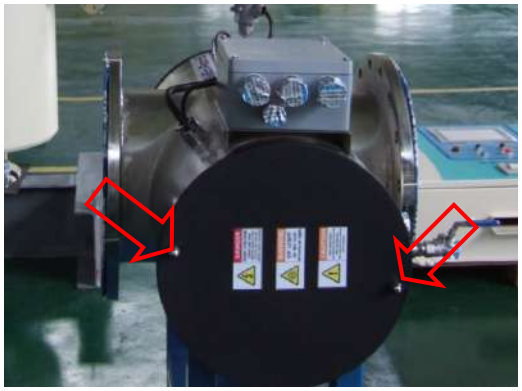
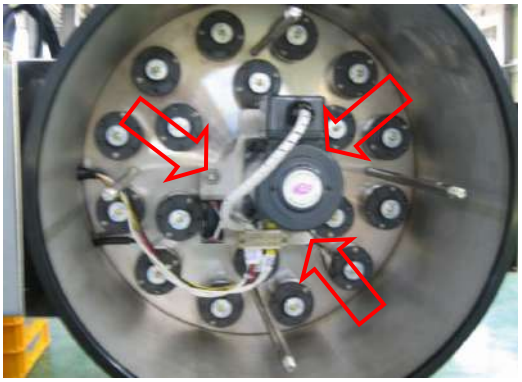
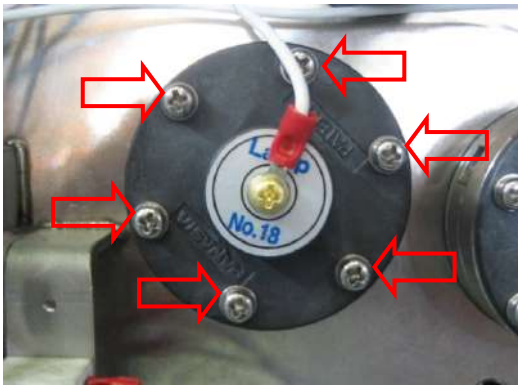
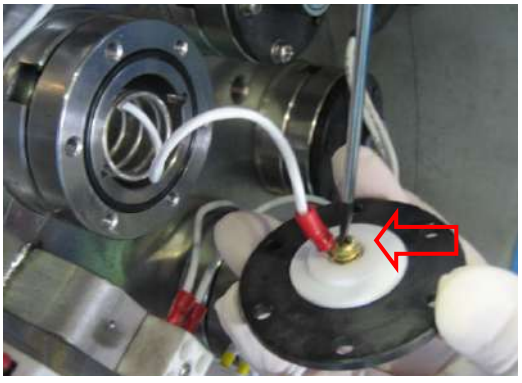
Procedure describes the actions required to replace lamp(s) and to clean and/or replace quartz sleeves.

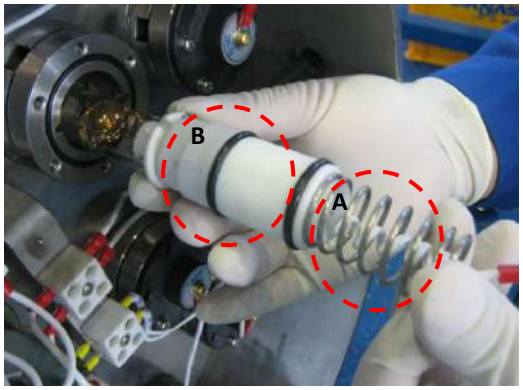
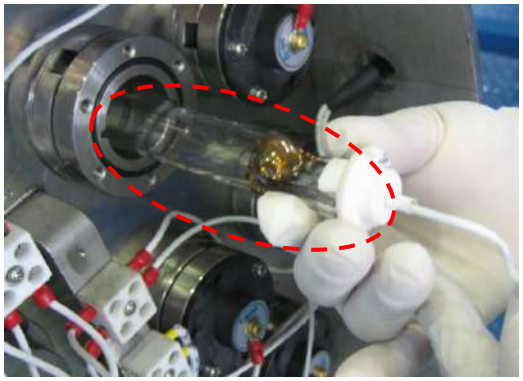
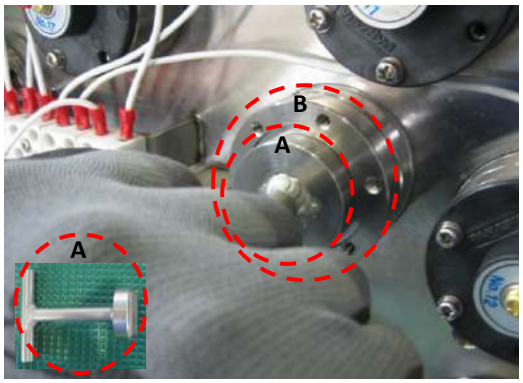
 **WARNING**	➢ *Turn OFF the main switch and the circuit breakers in the control panel.* ➢ *Turn OFF the flow and drain the liquid in the disinfection chamber.* ➢ *Remember that the lamps can be HOT.*

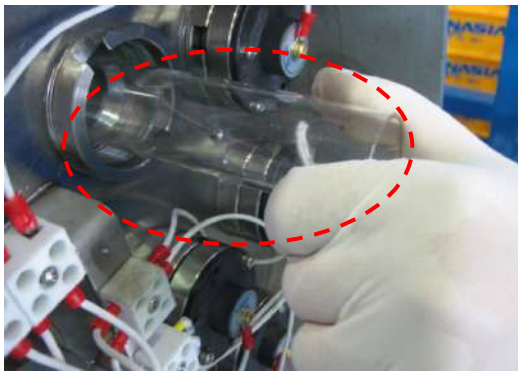
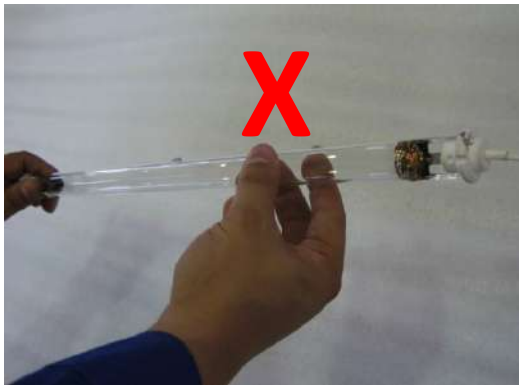
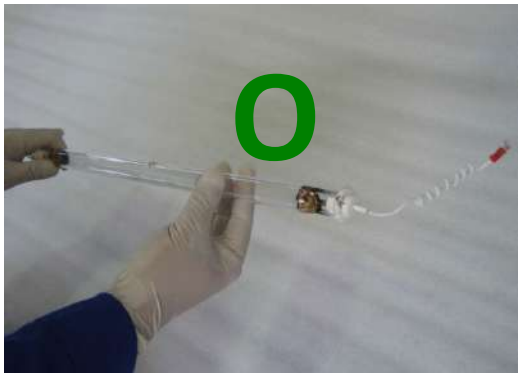
 **CAUTION**	➢ *Wear clean gloves free of talcum powder and grease to avoid damaging the lamp(s).* ➢ *Regarding the handling Mercury (Hg) vapor within the lamps must be cared in accordance with Material Safety Data Sheet (MSDS) in this document.*

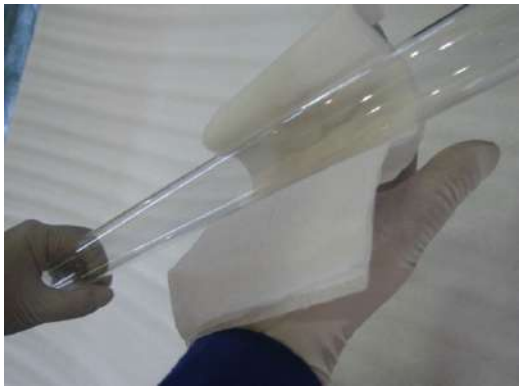
 **CAUTION**	➢ *When lamps are replaced, the lamp tube should be not directly in front of the sensor diffusing light.*

Table 7.3 Replacing lamps and quartz sleeves

Step	Description	Figure
1.	Remove the end cover from both sides.	
2.	Unscrew the three (3) screws from the wiper motor mounting plate.	
3.	Unscrew the lamp holder plate (6 × M4) screws from both ends.	
4.	Unscrew the lamp wire on the connector block (from both ends).	

5.	Take the spring (A) and anti-vibration stopper (B) out of the quartz sleeve.	
6.	Take the old lamp out of the quartz sleeve.	
7.	On both ends use tool (A) to unscrew the isolating T/B body (B) from the chamber end plate.	
8.	Repeat moving both sides of the quartz sleeve appoximately10 millimeters; Remove backup-ring and O-ring.	

9.	Remove a quartz sleeve.	
10.	New UV lamps are supplied individually in its own packaging.	
11.	Never touch the lamp glass with bare hands.	
12.	Wear clean gloves and hold the lamp at the ends.	

13.	If necessary, clean the lamp with a cotton cloth applied with a few drops of alcohol.	
14.	If necessary, clean the quartz sleeve with a cotton cloth applied with a few drops of alcohol.	

CAUTION	➢ *Used lamp(s) MUST BE returned to PANASIA CO., LTD.* ➢ *Do <u>NOT</u> dispose old lamp(s) as unsorted municipal waste.* ➢ *Waste must be disposed of in accordance with federal, state and local environmental control regulation.*

5) UV Lamp Test Kit

It is difficult to check the faulty UV lamp(s) if the UV lamp(s) have been already installed in the UV chamber. In order to reduce inconveniences, a UV lamp test kit comes with the BWM system. As this test kit is applicable to check the UV lamp(s) on a vessel without dismantling many parts, it contributes to decrease maintenance costs and working hours.

Material	ABS
Input Voltage	AC 110/220 V
Weight	0.6kg

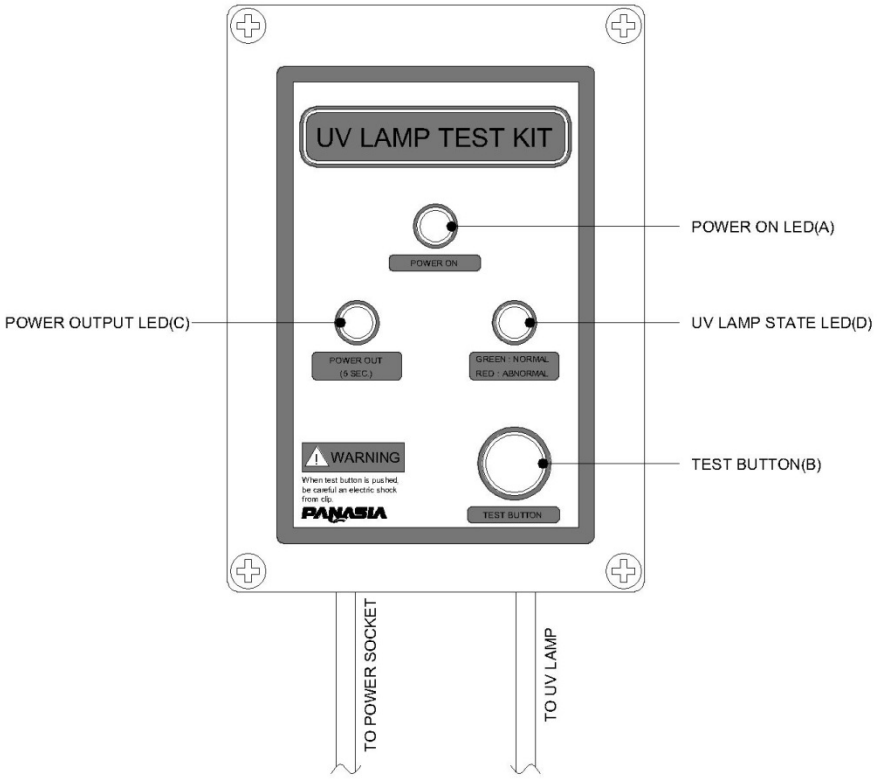
Figure 7.14 UV Lamp Test Kit

CAUTION	➢ *Do NOT test during BWMS operation (it MUST be power off before using the test kit).* ➢ *Do NOT touch the clamps while the POWER OUTPUT LED lamp turns on due to a high risk of electric shock.* ➢ *Do NOT supply exceeding 220VAC for the TEST KIT.* ➢ *NEVER touch a UV Lamp with bare fingers. Use a tissue or cotton gloves when handling UV Lamp(s)* ➢ *UV Lamp contains a small amount of Mercury. UV Lamp(s) must be stored in the original packing until required for use.* ➢ *Used UV Lamp(s) must be returned to PANASIA CO., LTD.* ➢ *Do NOT dispose old UV Lamp(s) as unsorted municipal waste.* ➢ *Waste must be disposed of in accordance with federal, state and local environmental control regulation.*

It is designed to use as free voltage so it includes common plug for 110VAC. The one set of test kit is shown on Figure 7.15.

UV Lamp Test Kit	1 EA
110VAC Plug	1 EA
Spare Fuse	5 EA

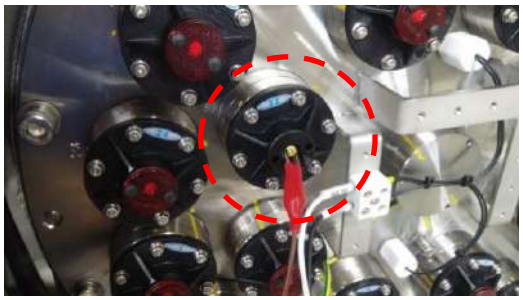
Figure 7.15 Components of Test Kit



POWER ON LED(A)	*POWER ON LED* will show that the test kit is activated
TEST BUTTON(B)	*TEST BUTTON* is the manual button to test the UV lamp.
POWER OUTPUT LED(C)	*POWER OUTPUT LED* will show that high voltage is generated.
UV LAMP STATE LED(D)	The *GREEN LED* will show that the UV lamp is normal to use. The *RED LED* will show that the UV lamp is abnormal to use.

Figure 7.16 Part description

Table 7.4 Test procedure

Step	Description	Figure	
1.	Put the clamps on each bolt head located in the center of the UV Lamp.		
1-1.	Or put the clamps on each O-type terminal of the UV Lamp.		
2.	Put the plug into the power socket (110V OR 220VAC), and the *POWER ON LED (D)* turns on.		
3.	Click the *TEST BUTTON(B)* and check both *POWER OUTPUT LED(C)* and *UV LAMP STATE LED(D)* turn on. (Lighting will turn off automatically after 5 seconds) If the UV Lamp is normal, the *UV LAMP STATE LED(D)* shows color *GREEN* and if the UV Lamp is faulty the *UV LAMP STATE LED(D)* shows color RED.	 GREEN LED (NORMAL)	 RED LED (ABNORMAL)

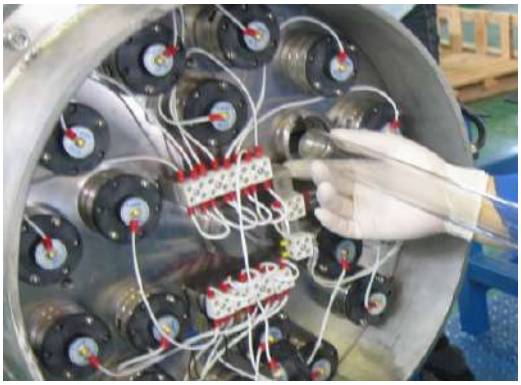
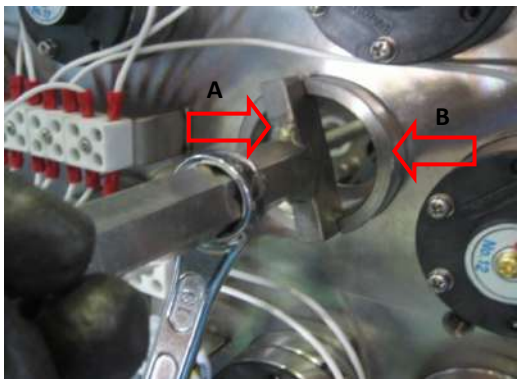
6) Maintenance of the wiper system

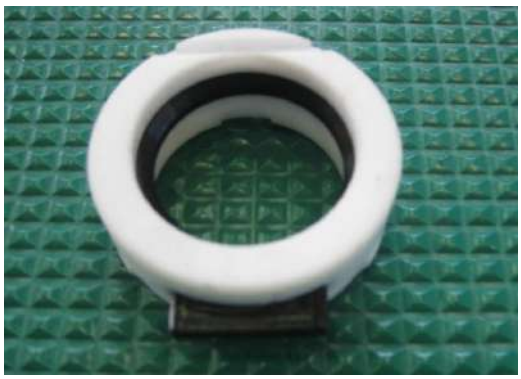
See below the detailed table of maintenance of the automatic cleaning mechanism.

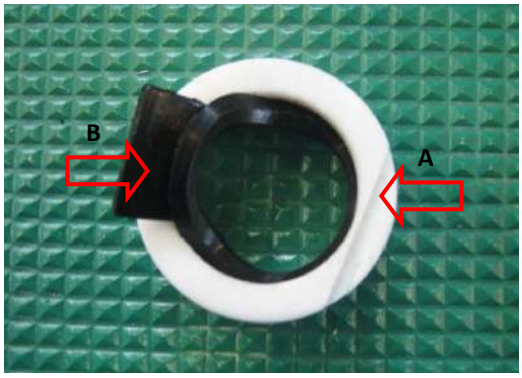
WARNING	➢ *Turn OFF the main switch and the circuit breakers in the control panel.* ➢ *Turn OFF the flow and drain the liquid in the disinfection chamber.* ➢ *Remember that the lamps can be HOT.*

CAUTION	➢ *Wear clean gloves free of talcum powder and/or grease to avoid damaging UV lamp.*

Table 7.5 Maintenance of the automatic cleaning mechanism

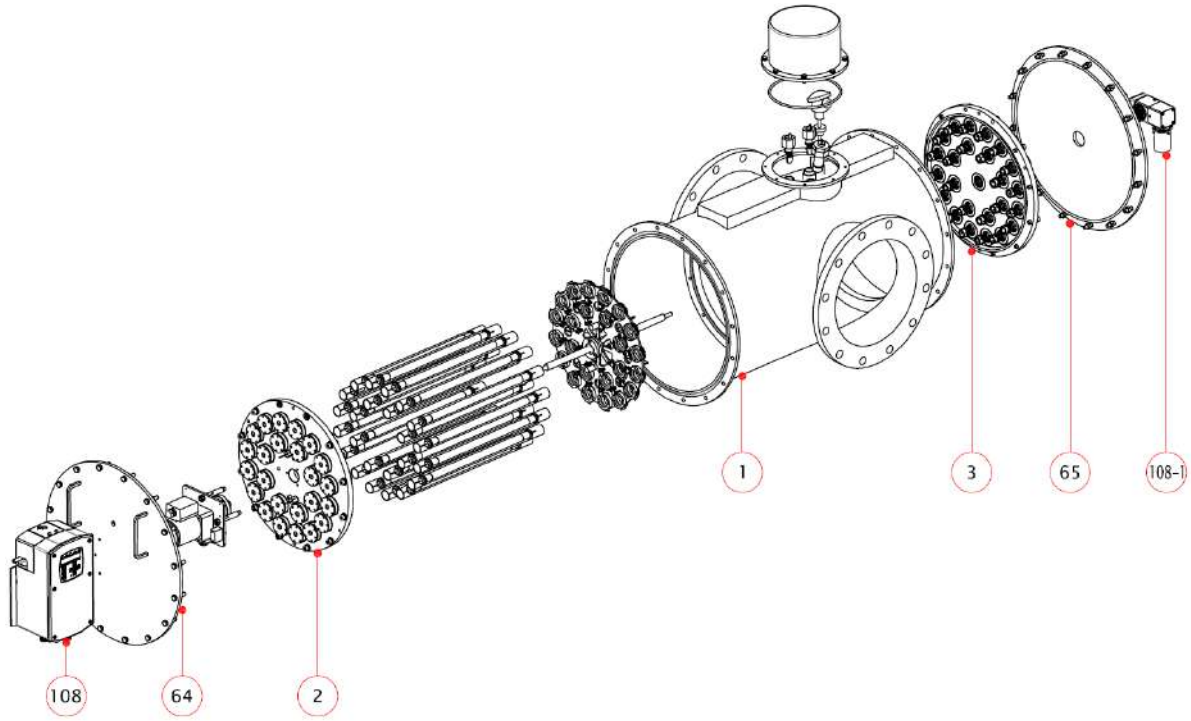
Step	Description	Figure
1.	Remove always in the following order: • Wiper motor • UV lamps • Quartz sleeves	
2.	On wiper motor side use flat spanner (A) to unscrew the screw plug adopter (B) from the chamber end plate.	

3.	Unscrew the fixed bracket bolt from wiper holder.	
4.	By hand, take the wiper holder out with a turn from wiper housing.	
5.	Take the wiper holder out of the chamber side cover.	
6.	Place the wiper holder on a clean plate.	

7.	Take wiper (B) out of the wiper holder (A).	
8.	If necessary, replace the wiper with a new one.	

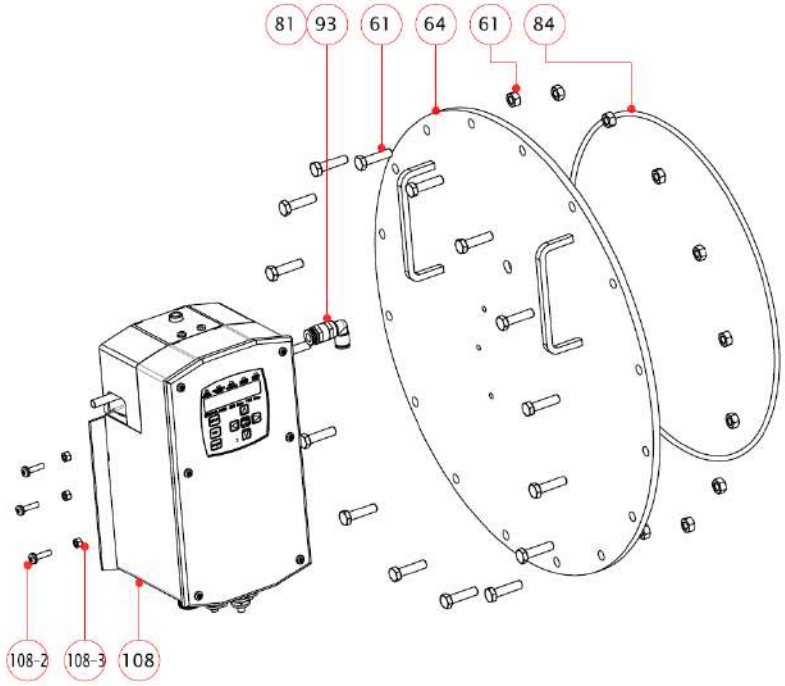
(1) Standard model Unit : EA

COMPONENT	PU50	PU250 (-Ex)			PU500 (-Ex)	
UV Lamp	2	6	8	12	18	24
Wiper Motor	1	1	1	1	1	1



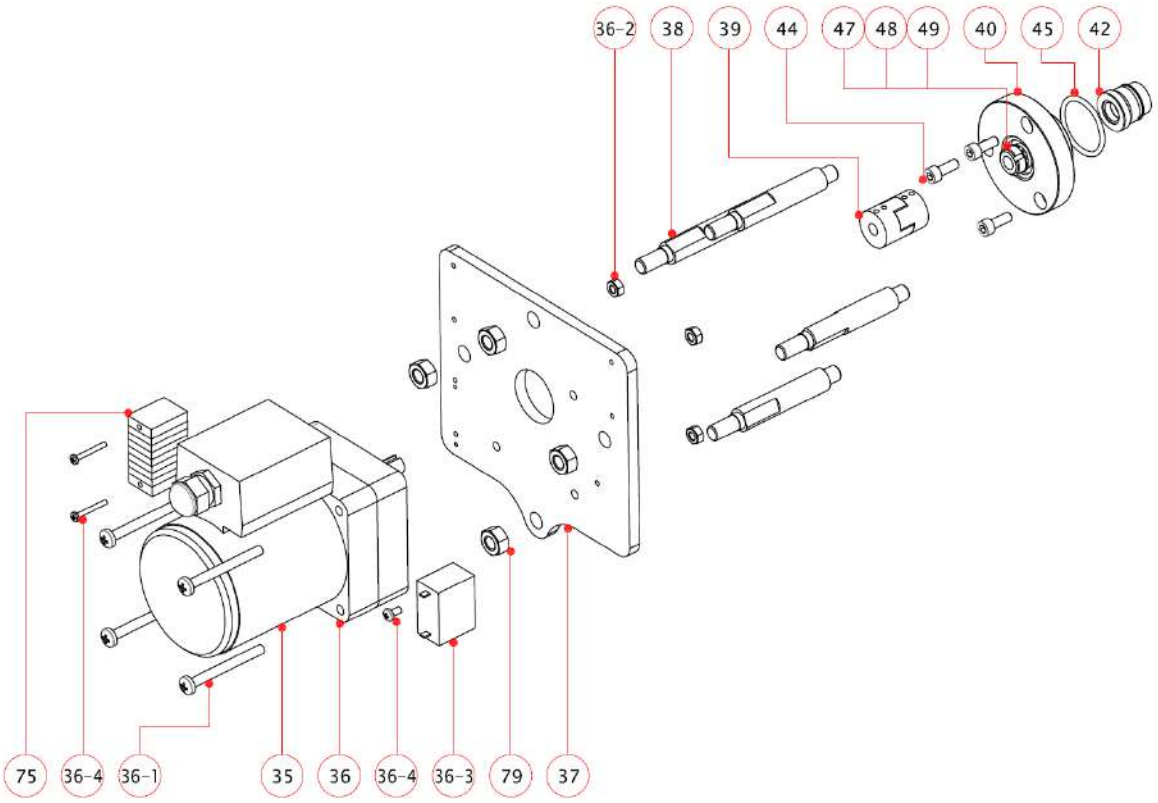
1	UV Chamber Body	65	Side Cover (Right)
2	Chamber End Plate Right	108	Purge/ Pressurization System
3	Chamber End Plate Left	108-1	Purge Vent Unit
64	Side Cover (Left)		

Figure 7.17 General Assembly of the UV Unit (Explosion proof type)



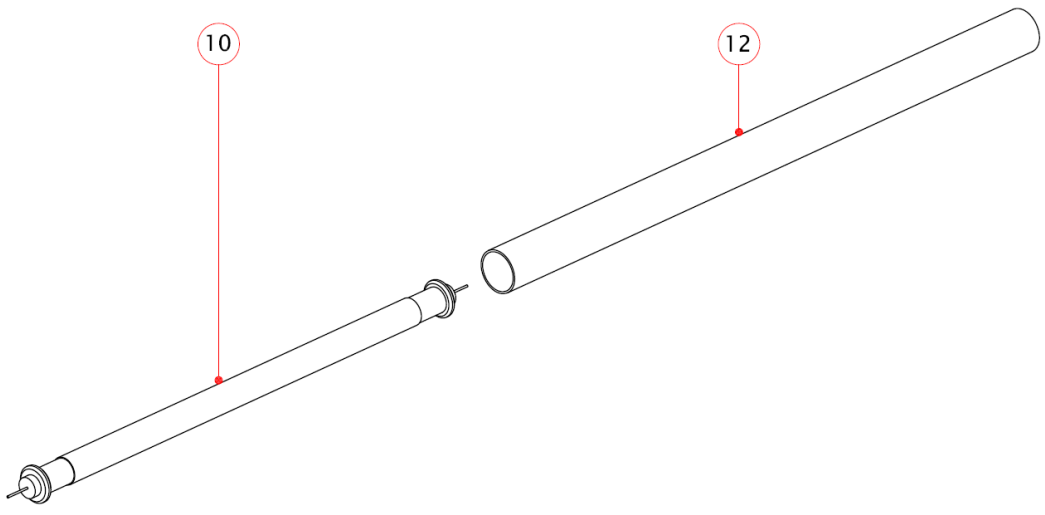
61	Hex. Bolt and Nut (S/W, P/W)	93	Bulkhead Female Connector
64	Side Cover (Left)	108	Purge/ Pressurization System
81	BLM Connector	108-2	R/Bolt (S/W)
84	O-ring (AS568#469)	108-3	Hex. Nut

Figure 7.18 Disassembly of UV Unit Element (Left Side Cover)



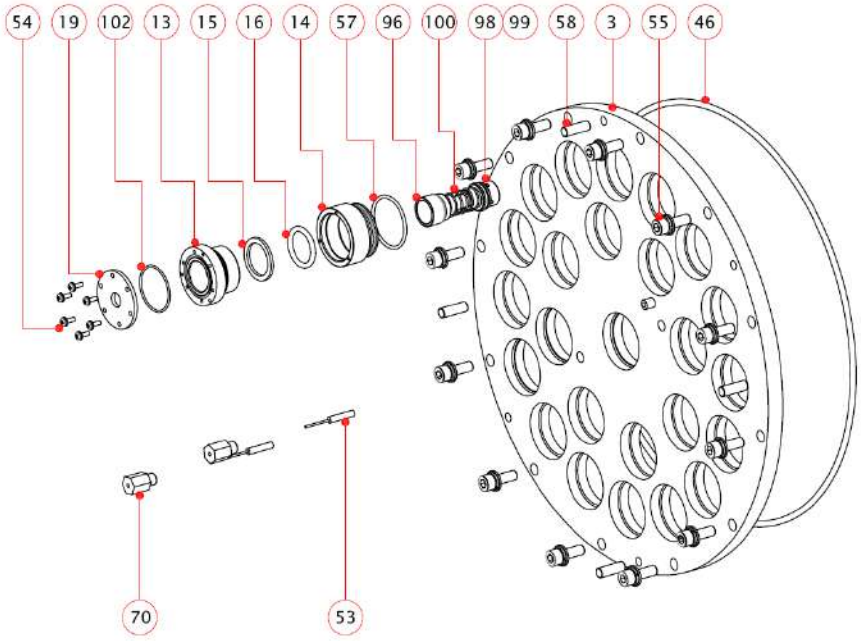
35	Wiper Motor	40	Screw Plug adjuster
36	Reduction Gear	42	Mechanical Seal
36-1	Round Bolt	44	W/ Bolt (B)
36-2	Hex. Nut (S/W)	45	O-ring (G35)
36-3	Condenser	47	Ball Bearing
36-4	Round Bolt	48	Snap Ring (Hole)
37	Motor Support	49	Bearing Nut/ Washer
38	Support Bar	75	Terminal Block
39	Coupling	79	Hex. Nut (S/W)

Figure 7.19 Disassembly of UV Unit Element (Reducer Motor)



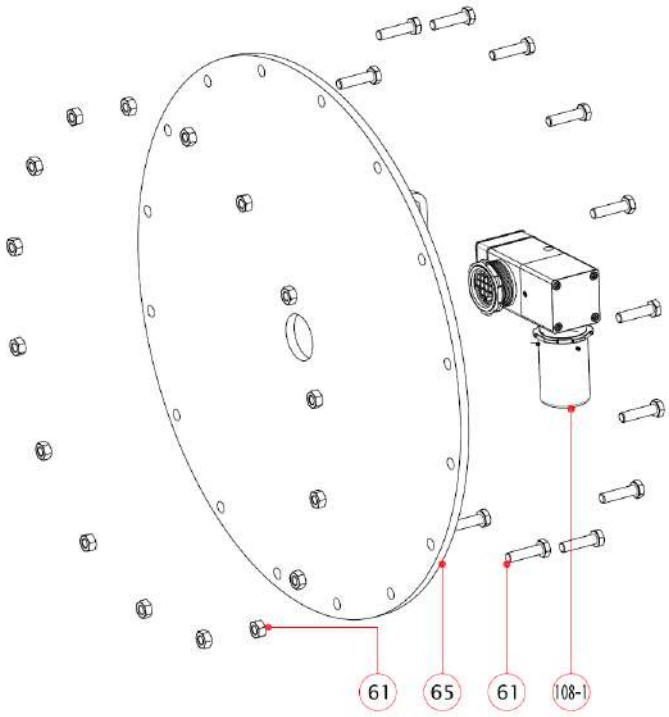
10	UV Lamp (3.5kW)	12	Lamp Sleeve

Figure 7.20 Disassembly of UV Unit Element



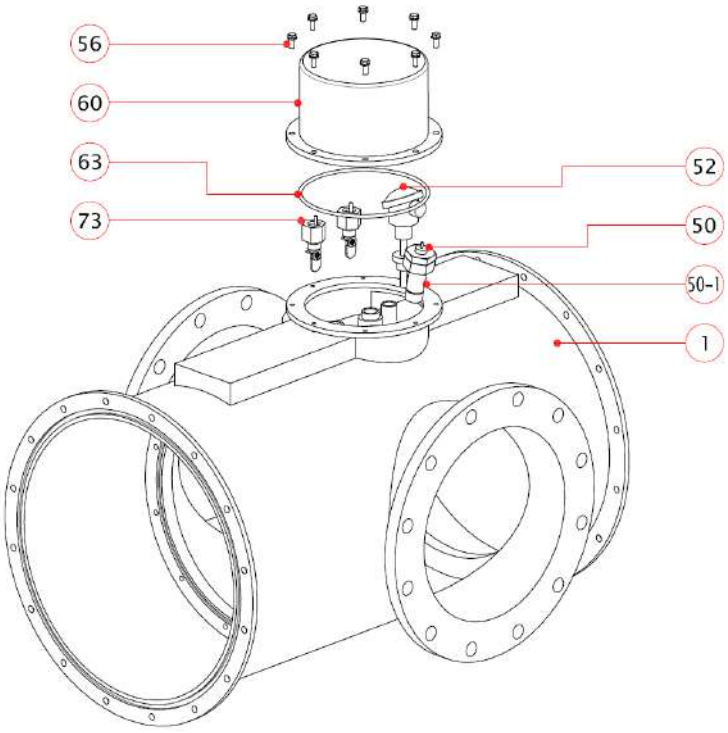
3	Chamber End Plate (Right)	55	W/ Bolt (B, P/W, S/W)
13	Screw Plug	57	O-ring (G50)
14	Screw Plug Adapter	58	Dowel Pin
15	Backup Ring	70	Reed Switch Housing
16	O-ring	96	Anti-V Cushion
19	Isolating Bracket	98	Anti-V Stopper
46	O-ring (V430)	99	Anti-V O-ring
53	Reed Switch	100	Anti-V Spring
54	Round Bolt (B, S/W-Integral)	102	O-ring (S46)

Figure 7.21 Disassembly of UV Unit Element (Chamber End Plate)



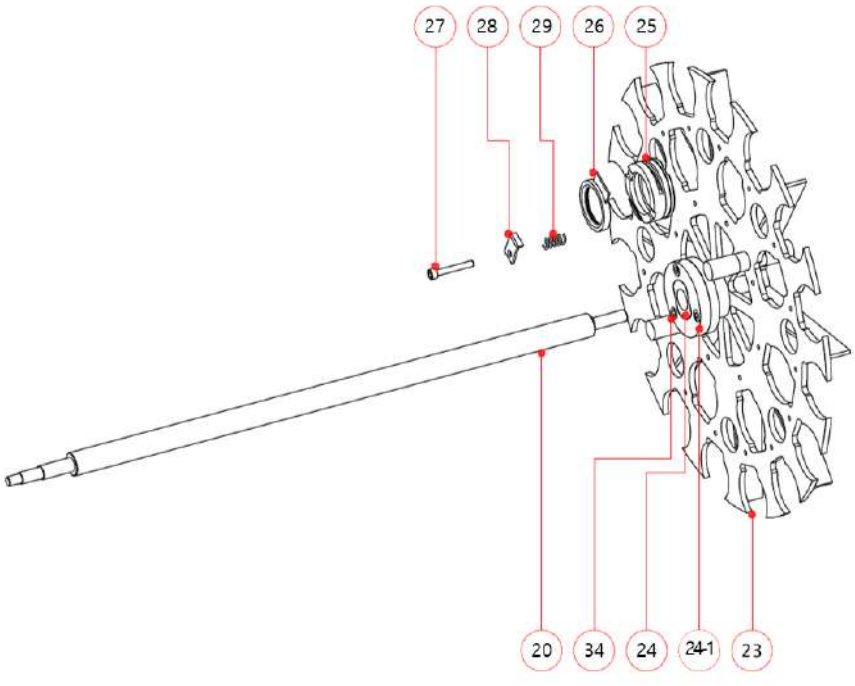
61	Hex. Bolt and Nut (S/W, P/W)	108-1	Purge/ Pressurization System
64	Side Cover (Left)		

Figure 7.22 Disassembly of UV Unit Element (Right Side Cover)



1	UV Chamber Body	56	Hex. Bolt (B, S/W)
50	UV Intensity Transmitter	60	Sensor Cover
50-1	UV Transmitter Housing	63	O-ring (G210)
52	Temperature Transmitter	73	Flow Switch

Figure 7.23 Disassembly of UV Unit Element (Chamber)



20	Lead Screw	26	Wiper
23	Wiper Housing	27	Pin
24	Screw Female	28	Fixed Bracket
24-1	Screw Female Cover	29	Torsion Spring
25	Wiper Holder	34	W/ Bolt (B)

Figure 7.24 Disassembly of UV Unit Element (Wiper System)

- High capacity model Unit : EA

COMPONENT	PU1000 (-Ex)	PU1250 (-Ex)	PU1500 (-Ex)
UV Lamp	22	26	32
Wiper Motor	1	2	2

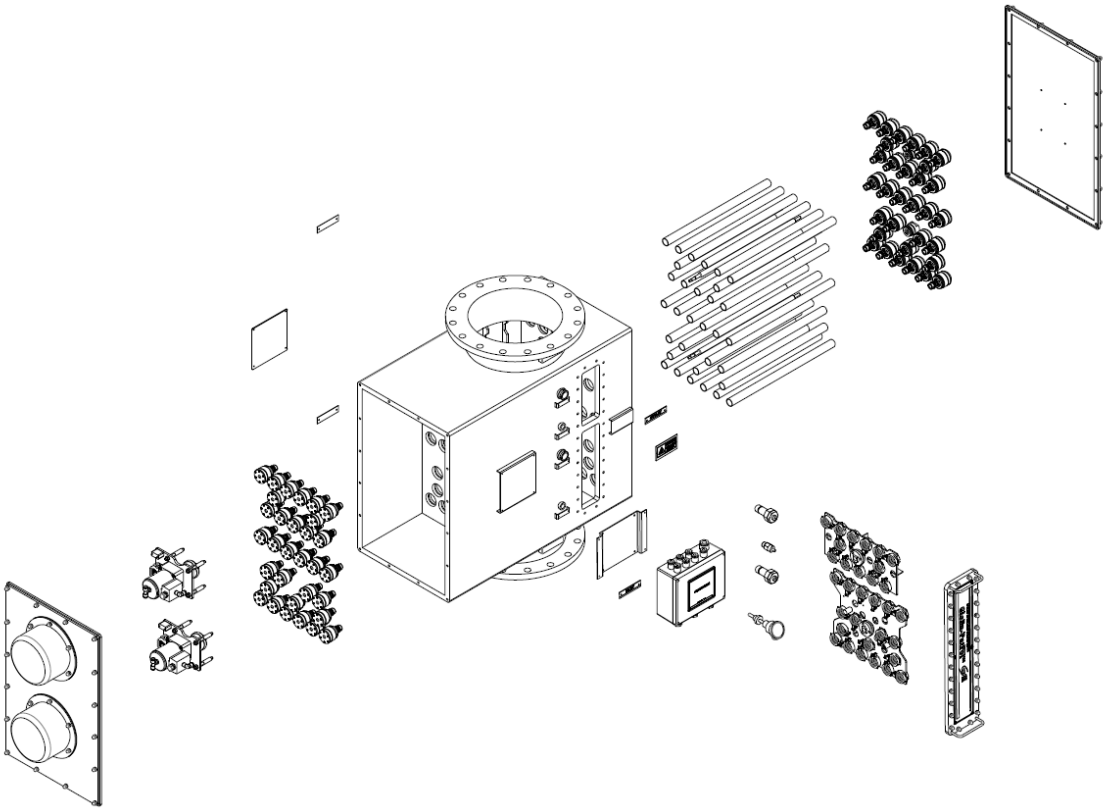
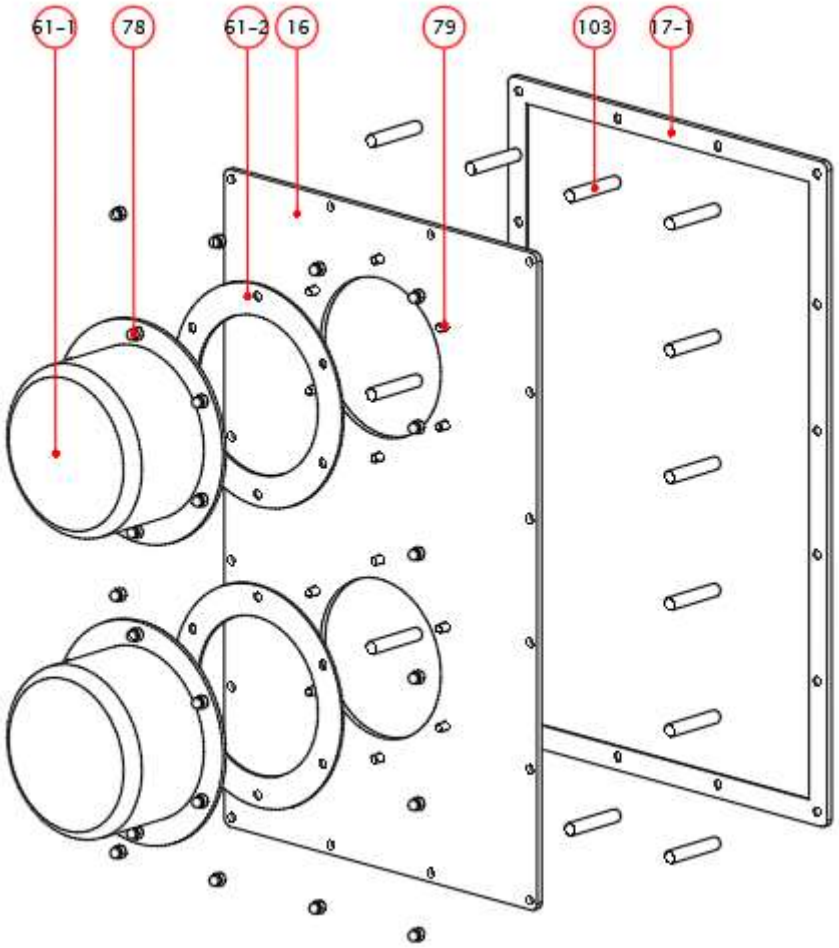
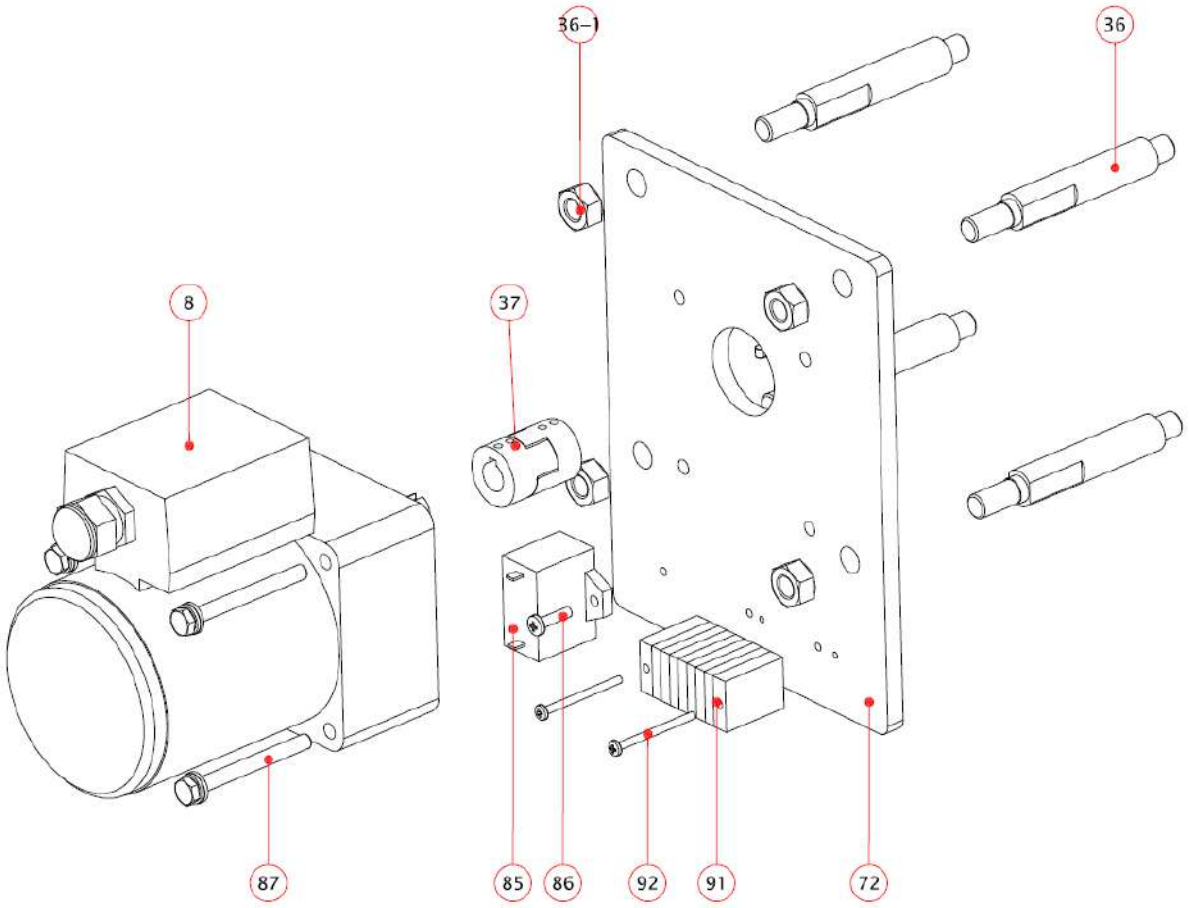


Figure 7.25 General Assembly of the UV Unit (Explosion proof type)



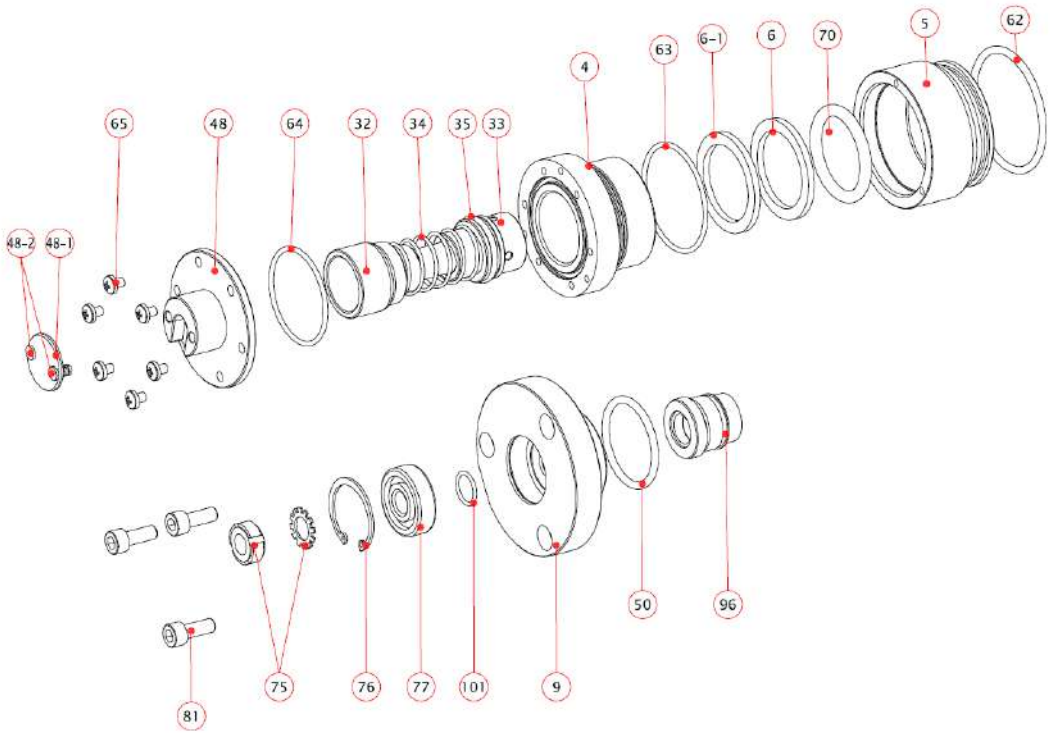
16	SIDE COVER-LEFT	78	HEX. CAP NUT
17-1	PACKING OF SIDE COVER	79	H/BOLT(B,S/W)
61-1	MOTOR COVER	103	STUD BOLT
61-2	PACKING OF MOTOR COVER		

Figure 7.26 Disassembly of UV Unit Element (Left Side Cover)



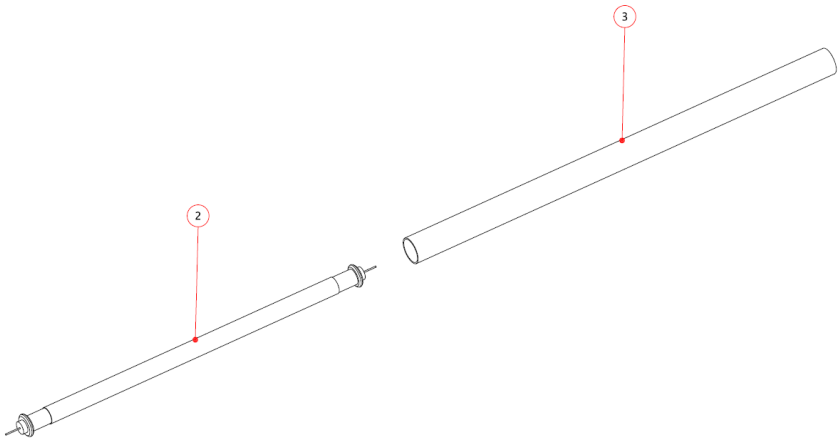
8	MOTOR	85	CONDENSOR:2UF
36	SUPPORT BAR	86	R/BOLT
36-1	MOTOR SUPPORT BAR NUT	87	H/BOLT(N, P/W, S/W)
37	COUPLING	91	TERMINAL BLOCK
72	MOTOR SUPPORT	92	R/BOLT(B,S/W)

Figure 7.27 Disassembly of UV Unit Element (Reducer Motor)



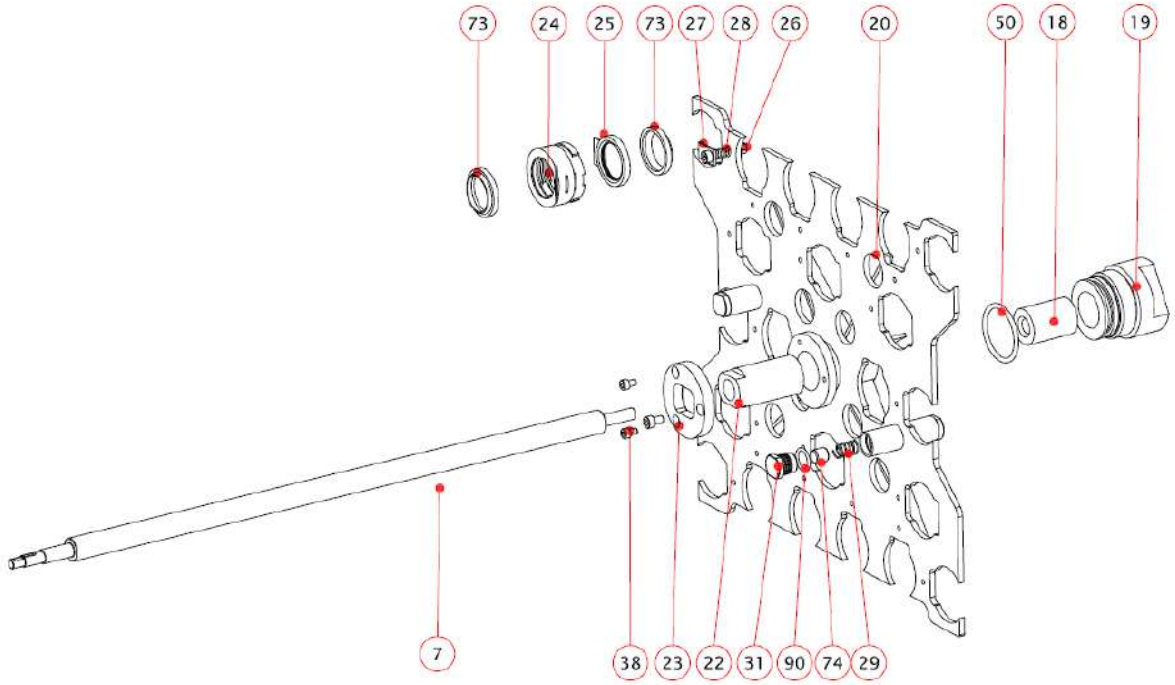
4	ISOLATING T/B BODY	50	O-RING (G35)
5	SCREW PLUG ADAPTER	62	O-RING (G50)
9	SCREW PLUG ADJUSTER	64	O-RING (S40)
32	ANTI-V CUSION	75	BEARING NUT & WASHER
33	ANTI-V STOPPER	76	SNAP RING(HOLE)
34	ANTI-V SPRING	77	BALL BEARING
35	ANTI-V O-RING	81	W/BOLT(B)
48	ISOLATING T/B ASS'Y	96	MECHANICAL SEAL
48-1	TERMINAL COVER	101	O-RING (S12.5)
48-2	FIXING PIN		

Figure 7.28 Disassembly of UV Unit Element



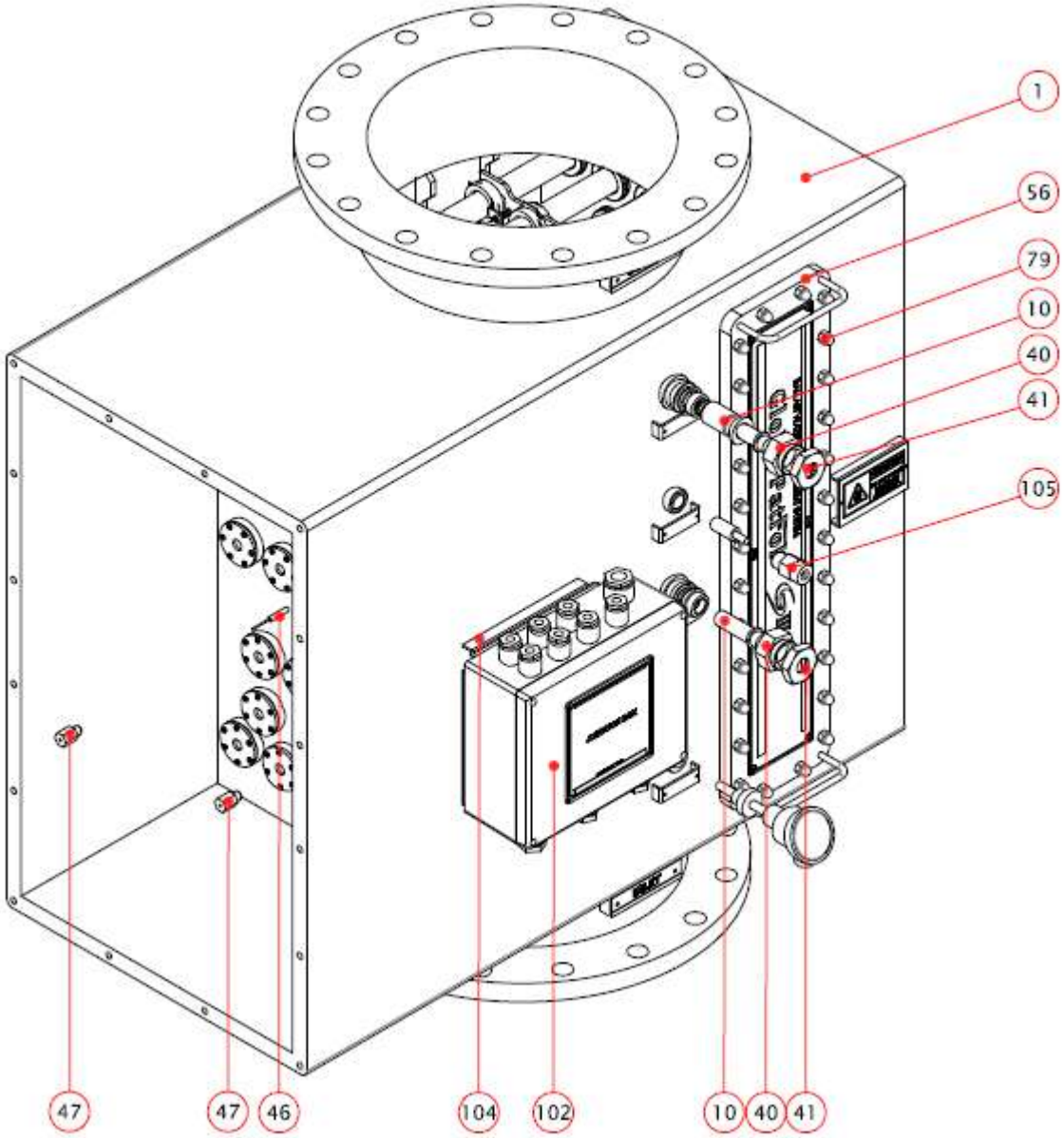
2	UV LAMP_3.5KW	3	LAMP SLEEVE

Figure 7.29 Disassembly of UV Unit Element (Chamber End Plate)



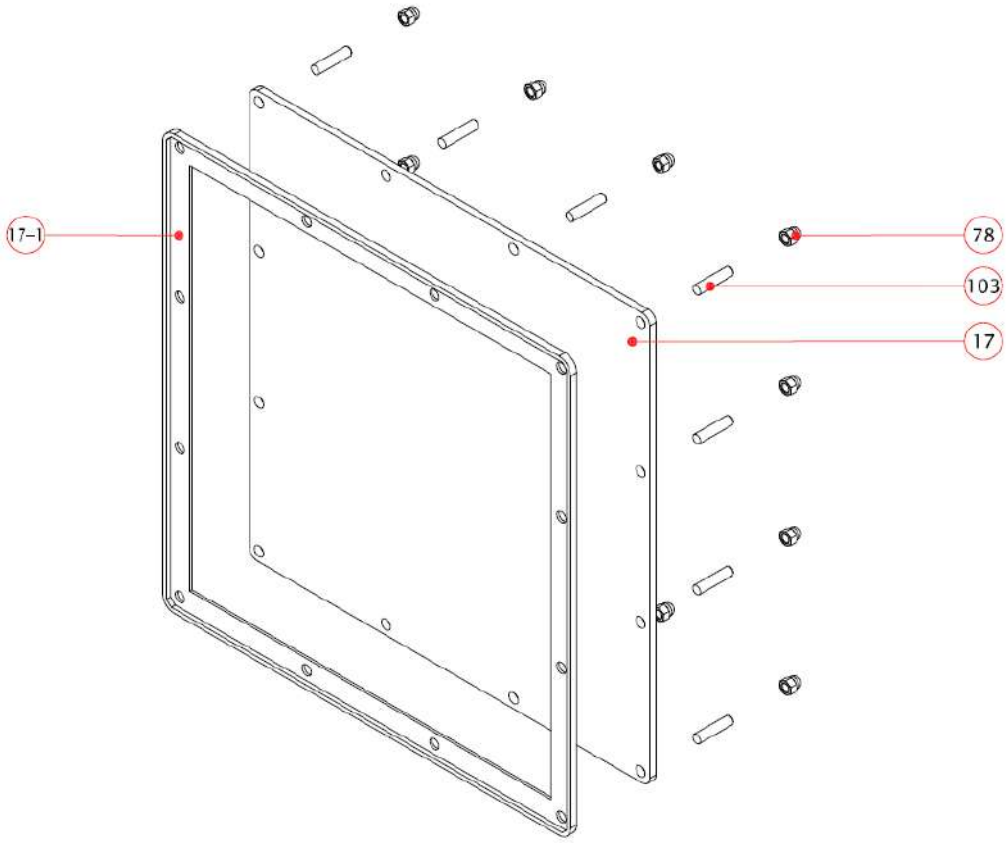
7	Lead Screw	28	TENSION SPRING
18	BUSH BEARING	29	SUPPORT SPRING
19	SCREW PLUG	31	BASE
20	WIPER HOUSING	38	W/BOLT(B,S/W)
22	SCREW FEMALE	50	O-RING
23	SCREW FEMALE COVER	73	SCRAPER
24	WIPER HOLDER	74	MAGNET
25	WIPER	90	O-RING (P16)
26	PIN		

Figure 7.30 Disassembly of UV Unit Element (Wiper System)



1	MEGA UV CHAMBER BODY	47	REED SWITCH HOUSING
10	UV TRANSMITTER	56	MAIN COVER
12	TEMP TRANSMITTER(4-20mA)	79	H/BOLT(B,S/W)
40	UV TRANSMITTER NUT #1	102	JUNCTION BOX
41	UV TRANSMITTER NUT #2	104	JUNCTION BOX BRACKET
46	REED SWITCH	105	THERMOSTAT

Figure 7.31 Disassembly of UV Unit Element (Chamber)



17	SIDE COVER-RIGHT	78	HEX. CAP NUT
17-1	PACKING OF SIDE COVER	103	STUD BOLT

Figure 7.32 Disassembly of UV Unit Element (Right Side Cover)

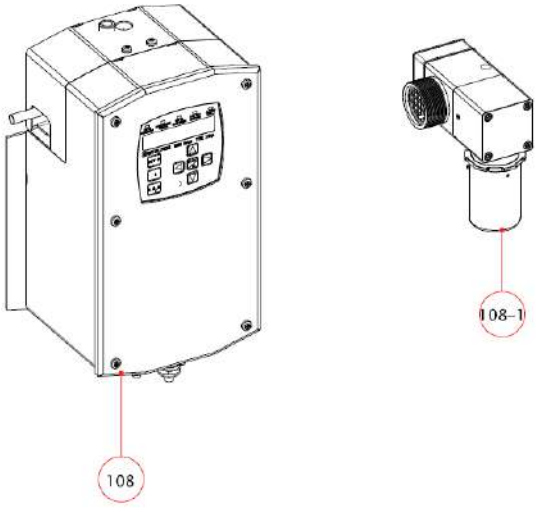


Figure 7.33 Purge/Pressurization system & Purge Vent Unit (Explosion proof type)

108	Purge/Pressurization System	108-1	Purge Vent Unit

NOTE: *In case of the Explosion proof type, Purge/Pressurization system is supplied.*

(3) Control panel and power supply panel maintenance

1) Air fan of the control panel

Regularly check and, if necessary replace air fan.

2) Earth Leakage Circuit Breaker (ELCB) check

Check the Earth Leakage Circuit Breaker (ELCB) monthly by pressing the test button to make sure it is working properly. The system will shut-down immediately.

3) Control panel part names and functions

Figure 7.34 Components of the control panel

1) *CBN001*: Main circuit breaker for the entire BWMS monitoring system.

2) *CBN002*: Circuit breaker for the relay and flowmeter.

3) *CBN003*: Circuit breaker for the cooling fan system.

4) *CBN004*: Circuit breaker for the PLC I/O card.

5) *CBN005*: Circuit breaker for control circuit (i.e. PLC, etc.).

6) *SMPS1*: 24VDC power supply for printer.

7) *SMPS2*: 24VDC power supply for PLC I/O card.

8) *TX1*: Transformer used to isolate secondary circuit from primary circuit.

9) *NF1*: Noise filters to stabilize power which is supplied to the power supply of PLC.

10) *PLC*: Controller for the entire monitoring system, from left to right: Power Supply, CPU, Digital Input (DI), Digital Output (DO), Analog Input (AI) and Analog Output (AO) modules.

11) *HUB*: Device for connecting multiple Ethernet devices together.

12) *AUX1~9*: Electronic relays to control filter and UV unit.

13) *TB*: Common terminal block for power line of PLC system.

14) *PO*: 220VAC power supply outlet for auxiliary equipment (i.e. laptop).

15) *TBN01~06*: Input/output terminal blocks.

16) *MONITORING UNIT*: Graphic panel with touch screen functions for control and monitoring.

17) *YPL*: Lamp for warming up.

18) *S/S1*: Mode selector switch (*CHECK MODE* or *BYPASS MODE*).

19) *BZ*: Alarm device when there is any abnormality in the monitoring system.

20) *EMG*: Emergency button to shut-down the system manually.

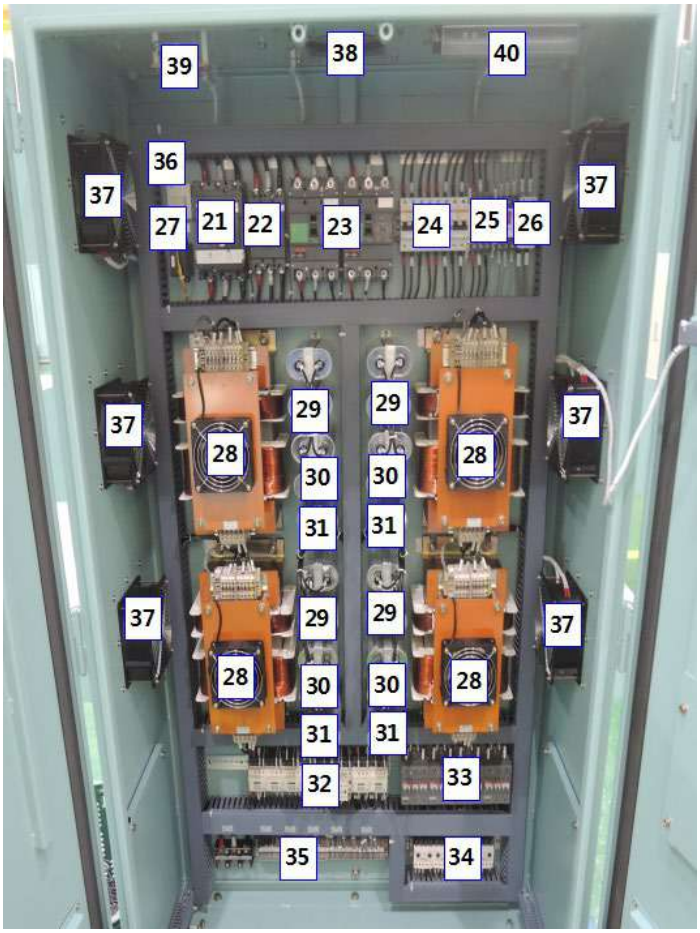


Figure 7.35 Components of the UV power supply panel

21) *CBS110*: Main circuit breaker for the UV unit.

22) *CBS120*: Circuit breaker for the UV lamps (ELCB S101~S102).

23) *ELCB S101~S102*: Device to stop the UV system under any abnormal condition by detecting a leakage current, which could be generated in operating an UV lamp, and each ELCB connected to two (2) electromagnetic ballast.

24) *CBS121~125*: Circuit breaker for the UV lamps, and installed two (2) breakers depending on number of electromagnetic ballast installed.

25) *CBS101, CBS141*: Circuit breaker for the back flushing motor and wiper motor.

26) *CBS100*: Circuit breaker for control circuit (i.e. cooling fan, etc.).

27) *CPS11*: Surge protector, protecting control and driving circuits from switching surges, generated at times of controlling the main circuit breaker.

28) *EBS101~S104*: Electromagnetic ballasts for discharging lamps to operate UV lamps. Each controls two (2) UV Lamps

29) *SC101~128*: UV lamps capacitors connected to the secondary of electromagnetic ballast. Each electromagnetic ballast has three (3) capacitors independently.

30) *SC151~154*: Capacitors for power control of UV Lamps (Step 1; 88% of maximum power)

31) *SC171~174*: Capacitors for power control of UV Lamps (Step 2; 72% of maximum power)

32) *MCS1FF*: Forward-turn electronic switch of three-phase motor used for filter flushing.

MCS1FR: Reverse-turn electronic switch of three-phase motor used for filter flushing.

MCS1UF: Forward-turn electronic switch of a single-phase motor used in UV lamp cleaning.

MCS1UR: Reverse-turn electronic switch of a single-phase motor used in UV lamp cleaning.

MCS101~105: Electronic switches for UV lamps operation control. Each controls two (2) UV lamps.

33) *MCS110~114*: Electronic switches for power control of UV lamps.

34) *EUCRS101~104*: Device to stop the UV System under any abnormal conditions by detecting an undercurrent, generated by operating an UV lamp. Each controls two (2) UV lamps.

35) *TBS12~15*: Input/output terminal blocks.

36) *SWS11*: Switch to turn on the fluorescent lamp at the panel.

37) *FAN S101~106*: Cooling fans (side) that discharge the internal air outside the panel.

38) *FAN S107*: Cooling fans that (top) discharge the internal air outside the panel.

39) *THTS101~102*: Sensor for detecting internal temperature of the panel.

40) *WL*: Fluorescent lamp for the panel.

B. Calibration of instrument

(1) Pressure transmitter (Level-3000)

1) Test before calibration

Test pressure transmitter output (4-20mA) signals whether the range of pressure indicates between 0 ~ 14 bar.g by using a milliampere meter.

2) Calibration procedure

If current pressure transmitter seems to be failure, it requires calibration as following.

a. Set the calibrator to pressure mode.

b. Connect the pressure calibrator with setting plug and kit to the transmitter connector in the junction box as shown on Figure 7.23.

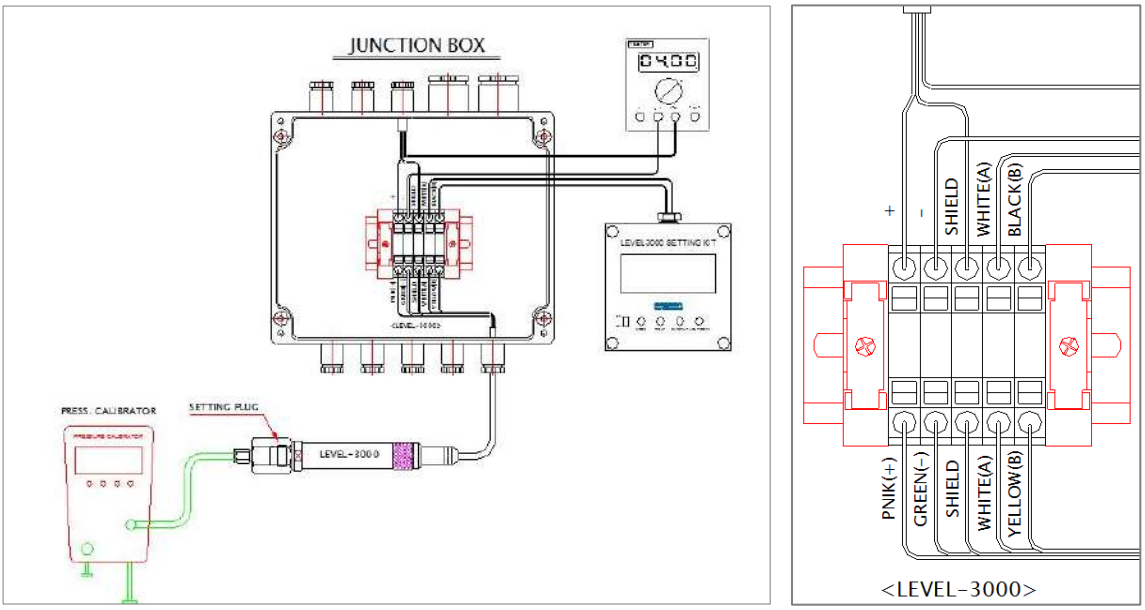


Figure 7.36 Wiring connection for calibration

c. Check the range of milliampere meter

d. Output signal should be adjusted to 4.00mA at atmospheric pressure (0 bar) (Press the *ENTER/UP* button at *Zero Setting Mode* of setting kit).

e. Increase the pressure to maximum (14 bar) and the output signal to be adjusted to 20.00mA (Press the *ENTER/UP* button at *Span Setting Mode* of setting kit).

Current : 00.000 mA
<ZERO SETTING MODE>
→SET TO ZERO
COMP. INC DEC

<Zero Setting Mode>

Current : 00.000 mA
<SPAN SETTING MODE>
→SET TO SPAN
COMP. INC DEC

<Span Setting Mode>

f. Remove the pressure calibrator and check the zero point at atmospheric pressure.

g. Check the linearity at 0% - 25% (3.5 bar) – 50% (7.0bar) – 75% (10.5 bar) and 100% (14 bar).

h. If necessary, repeat the steps 'd' to 'g'.

NOTE: *Allowable accuracy is 0.05%FS or better, as well as 4 $^{1}/_{2}$ digit milliampere meter.*

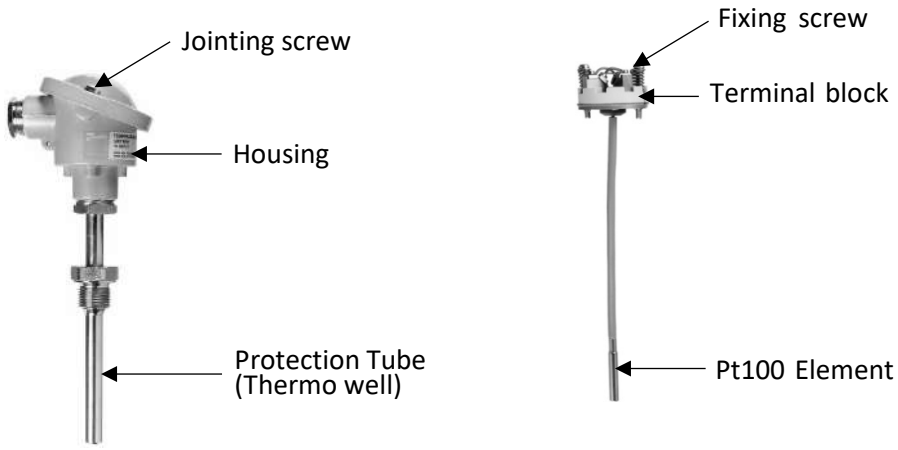
(2) Temperature transmitter (MBT 5252-9110)

1) General

The MBT 5252 is a heavy-duty temperature sensor that can be used for controlling cooling water, lubrication oil, hydraulic oil and refrigeration plants within general industry and marine applications.

This temperature sensor is based on a standardized Pt100 element, which gives a reliable and accurate measurement. If needed, a transmitter (MBT 9110) can be ordered as an integrated part of the sensor. All parts in contact with the media are made of stainless steel AISI 316 Ti.

Temperature transmitter figure is as below.



<Outside View> <Sensor Element>

This type of temperature sensor element can be separated from protection pocket (Tube) without pocket removing. Like a picture as below, maintenance is possible with sensor installation.

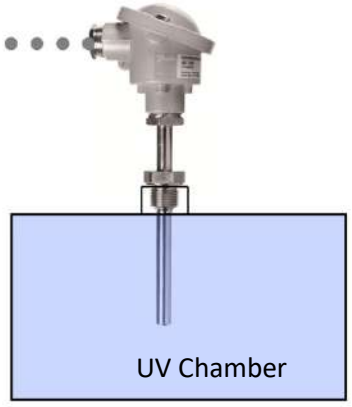
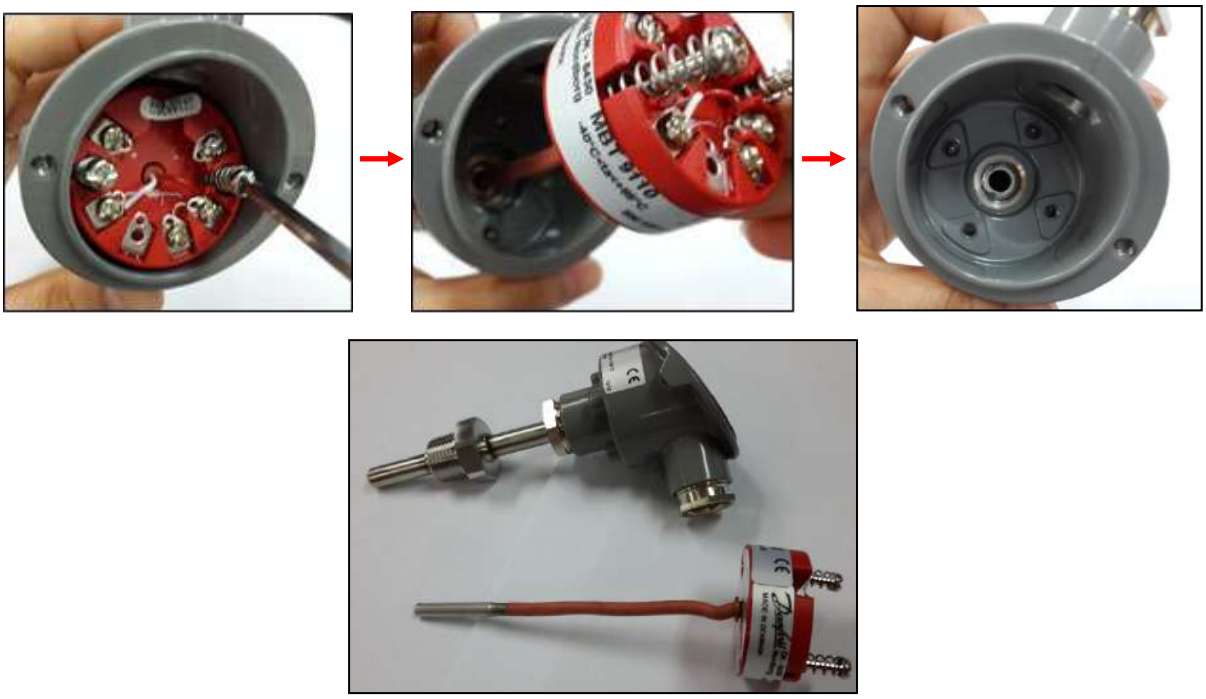


Figure 7.37 Installation method

2) Calibration procedure

a. Open the housing cover with driver as below figure.

You can see terminal block inside. Remove two fixing screws with driver, sensor element can be separated from pocket (thermo well) as like below picture.



b. Please connect temperature sensor as below with multimeter and DC 24V power supply.

Refer to 3wire type PT 100Ω wire connection is as below

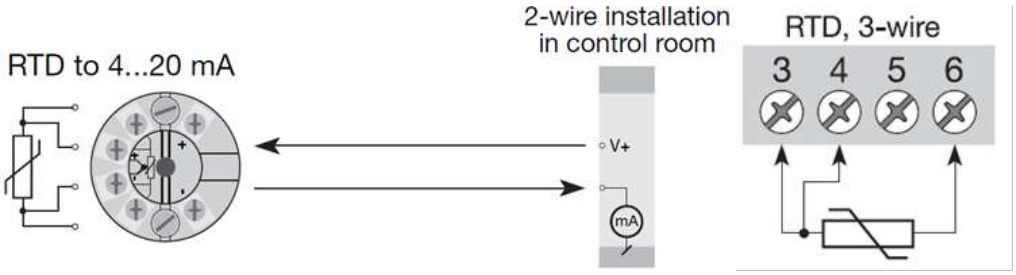


Figure 7.38 Wiring connection for calibration

c. Put the sensor into temperature bath or ice water (0℃) and check milliampere. In this case normal milliampere is 3.68 to 4.32 milliampere.

d. Put the sensor into temperature bath or boiling water (100℃) and check milliampere. In this

case normal milliampere is 19.68 to 20.32 milliampere.

e. If checked milliampere value is below or over to normal milliamper, please replace the terminal block and check again upper method after replace the sensor element.

If checked milliampere value is below or over to normal milliamper again, then replace the terminal block.

f. After checking sensor element you will assemble element as reverse course of disjoint.

(3) UV intensity sensor (SUV 20.2 Y2C)

1) Check before calibration

It requires recording the current UV intensity value just after warming up through the *CHECK MODE* (Figure 3.15, p54) to compare with target value.

a. Then, UV sensor should be removed from the UV chamber.

b. Install the UV reference radiometer (MUV 2.4 WR) and recording the value shown on the display.

Figure 7.39 UV intensity housing (Left) and UV reference radiometer (Right)

c. If measured value is out of value ±5%, compared with recording data of installed UV intensity sensor, it requires replace to brand new sensor.

d. Check the UV intensity value of replaced sensor with the measured value of MUV 2.4 WR whether those values are comparable (±5%).

NOTE: *Pressure transmitter, Temperature transmitter and UV intensity sensor should be calibrated annually and calibration should be carried out by ship's crew or manufacturer's engineer or test facility engineer according to the OMSManual. When the calibration is carried out, the result of calibration should be recorded in the BWTS calibration sheet.*

Technology	Measurement	Monitoring Sensor or Equipment	Data Recording	Calibration	Service on-board	Time interval	Option
Filtration	Flow rate	Flow meter	"Flow rate" on graphic panel	Required	Not available	1 year	Third parties
	Pressure differential	Pressure transmitter	"Inlet and differential pressure" on graphic panel	Required	Available	1 year	Pressure calibrator
	Back-flushing frequency	Motor and limit switch	Operating Log message: #OO Filter cycle finished	N/A	-	–	-
UV unit	Power consumption, voltage and	A tester (multi meter) and clamp meter (not included)	UV power monitoring method	N/A	-	–	-
	Lamp status and age	N/A	"UV lamp on time" on system status screen of graphic	N/A	-	–	-
	UV Intensity	UV intensity sensor	Manual logging (Calculation Required)	Required	Available	1 year	Intensity calibrator
	Transmittance	Potable meter (UV Transmittance)	Manual logging	N/A	Available		Potable UV transmittance meter
	Flow rate	Flow meter	"Flow rate" on graphic panel	Required	Not available	1 year	Third parties
	Temperature	Temperature transmitter	N/A	Required	Available	1 year	Temperature calibrator

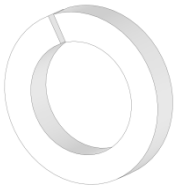
Table 7.6 Monitoring, recording and calibration

NOTE: *According to the VGP 2013 regulations, calibration should be conducted once a year. So if compliance with VGP 2013 regulations is not required, there is no need to do calibration once a year.*

C. Illustrated list of spare parts

SPARE PART LIST
(for Filter Unit)

No.	Name	Illustration	Spec. (Mat'l)	Weight (kg)	Q'ty	Model	Remark
1	Spare Box		SS400	10	1	N/A	-
2	Pressure Transmitter		SUS316L	0.5	1	LEVEL 3000	Cable: 2m
3	Scanner Tip		Teflon	0.03	2	N/A	For Suction scanner
4	O-ring		EPDM	0.01	4	P22	For Suction scanner body
5	O-ring		EPDM	0.01	1	P58	For Body seal bush

6	O-ring		EDPM	0.01	1	P25	For Body seal bush
7	O-ring		EDPM	0.01	2	P30	For Suction scanner branch boss
8	Gland Packing		PTFE FIBER	0.03	6	N/A	For Filter (ø25x ø38x 6.5t)
9	Special Jig		SUS304	1	N/A	N/A	-

SPARE PART LIST
(for UV Unit)

No.	Name	Illustration	Spec. (Mat'l)	Weight (kg)	Q'ty	Model	Remark
1	UV Lamp		Quartz	0.2	1	PUL 3.5_1	-
2	Lamp Sleeve		Quartz	0.4	1	PUS 3.5_1	-
3	UV Intensity Transmitter		SUS316	0.2	1	SUV 20.2	-
4	Wiper		EPDM	0.01	1	N/A	For Wiper Unit
5	O-ring		EPDM	0.01	1	N/A	For Quartz Sleeve (ø32.8x Ø42.8x5t)
6	Mechanical Seal		VITON & SUS304	0.01	1	N/A	For Lead Screw

7	Reed Switch		Teflon	0.02	2	N/A	For Reed Switch Housing
8	Special Tool		SUS304	0.8	1	N/A	For Removal of Screw Plug

Point(s) of contact for technical assistance

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