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# System 12

Underwater Magnetic Particle  
Inspection (MPI) System

Instruction Manual

V7.3



This manual applies to TVC ASAMS System 12 units supplied from January 2016.

Units supplied prior to this date are NOT covered under this manual! Please see System 12 Manual V6.1 for earlier units.



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## 1.0 Introduction

The System 12 Underwater Magnetic Particle Inspection (MPI) System was developed by ASAMS Ltd and is now manufactured and maintained under an exclusive license by The Validation Centre (TVC) Limited. Designed for shallow water and splash zone use, it provides a self-contained, flexible and compact alternative to other systems.

Safety considerations were prioritised during its design and the system safety specifications are in excess of recommendations. Additionally, emphasis was placed on keeping weight and size to a minimum whilst achieving high performance and flexibility.

The system provides all the facilities necessary to undertake magnetic particle inspection utilising the electromagnetic yoke to magnetise the work piece. No surface umbilical is required by the unit and all operational controls are available to the diver / inspector.

### 1.1 Dimensions, weights and depth specifications

Dimensions	
<i>Subsea Unit</i>	190mm x 130mm x 270mm
<i>Ultraviolet Lamp</i>	110mm (.dia); 185mm (L)
<i>Ink Dispensing Unit</i>	200mm (.dia); 270mm (H); 3.5L capacity

Weights	<i>In Air</i>	<i>In Sea Water (approx.)</i>
<i>Subsea Unit</i>	7Kg	2.6Kg
<i>Ultraviolet Lamp</i>	4Kg	2.3Kg
<i>Ink Dispensing Unit</i>	4Kg	Neutral

Depth ratings	
<i>Subsea Unit</i>	200M in sea water; individually tested
<i>Ultraviolet Lamp</i>	200M in sea water; individually tested and certified
<i>Ink Dispensing Unit</i>	100M in sea water; individually tested



**For depths greater than 150M, manual hand-held trigger dispensing is recommended.**

## 2.0 Technical description

### *Electrical supply*

- 12V DC supplied from a 12Ah rechargeable battery
- Protection offered by a 5-amp re-settable poly-switch fuse

### *Subsea unit*

- Houses the rechargeable battery and the electronic circuits for controlling the UV lamp
- Underwater mate-able connections for the electromagnetic yoke and the UV lamp
- UV lamp on / off switch
- Vent and purge connections for use during battery charging operations

### *Ultraviolet lamp*

- 4 x LED UV Lamp (12V, 20W) with Wood's filter for consistent 365 nm UV output
- UV intensity in excess of 2000 $\mu$ W/Cm<sup>2</sup> at 400mm distance
- Fluorescent ink dispensing trigger and nozzle built into lamp handle

### *Ink dispenser*

- 3.5L capacity reservoir
- Fitted with two x quick-release connections for ink dispensing and air supply
- Pressure relief valve set at **5 psi**

## **3.0 Warnings and precautions**

The following warnings and precautions **MUST** be read before using the System 12:

# **WARNINGS**

**1. The fluid dispensing system pressure should NEVER be set above 5 psi prior to diving!!**

**2. There are NO field serviceable electrical or electronic parts in this unit excluding changing the UV lamp LED's or the 12V battery in the Subsea unit.**

**Any attempt to carry out field repairs to the electrical and / or electronic control circuits will invalidate any manufacturer's warranty!!**

**3. Always ensure the vent plug is fitted and tightened BEFORE submerging unit. Damage will result if the Subsea unit is immersed without the venting plug fitted. Damage of this nature will NOT be covered under the equipment warranty.**

**4. The lamp housing MUST be completely dry before attempting to change the UV lamp LED's! Water MUST NOT be allowed to enter the lamp housing!**

**The use of suitable UV eye protection is recommended when carrying out UV LAMP LED replacement!**

**5. The Subsea unit MUST be completely dry before attempting to change the battery! Water MUST NOT be allowed to enter the Subsea unit!!**

## **4.0 Operating Instructions**

### **4.1 Method of magnetisation**

The only magnetisation method available is by electromagnetic yoke. The electromagnetic yoke, as supplied, is complete with articulating legs to ensure satisfactory contact with the test surface. The 12V DC yoke operation develops in excess of 18Kg pull.

### **4.2 Fluid dispensing system**

A pre-mixed solution is contained in a pressurised external reservoir. Pressure is maintained in the reservoir by connecting to the diver's pneumo. The fluid is delivered to the hand-held UV lamp by a small diameter hose to a **MAXIMUM OF 5 PSI** above ambient water pressure. Capacity of the reservoir is equivalent to approximately 3.5L of ready-to-use mix.

The external reservoir is easily replaced underwater. Before using, however, **ALWAYS** check the pressure relief valve is free and **ALWAYS** ensure the reservoir is flushed with fresh water after use.

If the flow from the ink nozzle on the lamp becomes restricted, ensure that the lamp is not blocked by ink particles.

 **MAXIMUM OF 5 PSI!**  
**Do not increase the pressure to the ink reservoir as this will cause damage to the unit!**

### 4.3 Equipment preparation

Ensure battery is fully charged using supplied charger. Disconnect the charger from the mains power and Subsea unit. Fit the vent plug and tighten. Ensure the UV lamp switch is in the 'off' position then plug the lamp and electromagnetic yoke into the unit.

 **Always ensure the vent plug is fitted and tightened before submerging unit. Failure to do so will result in water ingress causing damage to the Subsea unit; damage of this nature will not be covered under the equipment warranty!**

Switch on the lamp to check it is working as anticipated.

 **Do not leave lamp on for more than one minute! Allow to cool before submerging!**

Check the electromagnetic yoke by placing legs on steel surface and pressing the trigger. If required, use an 18Kg test weight to validate the yoke capability.

Fill the ink dispenser unit with approximately 3.5L of pre-mixed fluorescent ink, mixed in accordance with manufacturer's instructions or as stated in the inspection procedure, connect dispenser to lamp, apply air pressure to unit - **MAXIMUM PRESSURE OF 5 PSI** - and check ink flow.

### 4.4 Subsea MPI

#### 4.4.1

On reaching the inspection site, the diver should connect pneumo hose to the input quick-release socket on top of the ink dispensing unit and bleed in air until the pressure relief valve opens. Shake the unit to ensure fully mixed ink and attach the unit to the subsea housing frame, ensuring that it always remains upright. The ink reservoir should be shaken periodically during inspection to keep the ink fluid evenly mixed.

#### 4.4.2

Adjust the articulated legs on electromagnetic yoke to suit the configuration to be inspected to give maximum contact. Pole-piece legs **MUST** be at right angles to material surface.

Depress the trigger switch to energise the electromagnetic yoke - the magnetising force occurs directly between the poles of the yoke.

Switch the UV lamp on. **Full output from the LED lamp is almost instantaneous - no warm up time is required.**

Whilst the electromagnet yoke is in the correct position and the magnetising current is on, apply the fluorescent ink to the work piece.

# NOTES

1. The interpretation **MUST** only be made between the poles. Any defects found transverse to this field will be preferentially located.
2. Ink reservoir is changed out easily.

The 20W UV lamp contains four 5W LED's. The LED's run relatively cool, however, it is not recommended that the lamp is placed in cold water after extended running on the surface.

### **ALLOW THE GLASS FILTER TO COOL COMPLETELY BEFORE IMMERSION!**

4. To conserve battery power, only switch on the UV lamp and electromagnetic yoke when required for immediate inspection purposes. On completion of inspection, recover the MPI system and disconnect the ink reservoir unit. Flush out the reservoir and hoses with clean water. Switch off all power and clean and spray all electrical connectors with silicone spray. Wash with clean water then silicone spray the articulated legs on the Electromagnetic Yoke.

## 5.0 Magnetic Particle Inspection: Basics

 **This method detects surface breaking and minor sub-surface defects in ferromagnetic materials only!!**

### 5.1 *Cleaning*

Prior to any form of magnetic particle inspection, the material must be cleaned to bare metal. For the best finish, use a grit injection system. Hydro jets or wire brushes are acceptable if an injection system is unavailable.

For weld inspection, and as specified in the procedure being used, an area at least 100mm (approx. 4") on either side of any weld should also be cleaned. If required, perform a visual inspection of the area using a white light source, again, in accordance with the inspection procedure.

### 5.2 *Ink type selection*

The ink reservoir holds 3.5L of ready-mixed solution - all mixes should be prepared according to manufacturer's instructions, or, according to certifying authorities' procedure.

For the most critical form of MPI, a fine particle fluorescent magnetic ink should be used. It may also be necessary to change the ink for better results with photography.

 **Use fluorescent ink suitable for water dilution only!!**

### 5.3 **Method of Magnetisation**

The magnetisation method required will normally be specified by operational or certification company specifications.

 **The System 12 is only capable of magnetisation by use of electromagnetic yoke!!**

#### 5.4 Use of flux indicators

There are a few magnetic flux indicators available, the most widely used are the Burmah Castrol type. Their results should be used an indication of magnetising force only. They were developed for surface use so their use underwater should be as a guide only. Strict adherence to the manufacturer's instructions is necessary.

### 6.0 Spare / replacement components

#### 6.1 Complete system

12V100	Subsea battery / control unit
12V200	Subsea ultraviolet lamp
12V300	Electromagnetic yoke
12V400	Ink reservoir ( <i>air powered</i> )
12V500	Battery charger
BOX/0003	Transit / storage case

#### 6.2 Subsea unit

12V408	Ink reservoir ( <i>hand pump</i> )
12V101	Battery ( <i>6.5Ah</i> )
12V102	Battery ( <i>12Ah</i> )
12V103	Bulkhead connector ( <i>lamp</i> )
12V104	Bulkhead connector ( <i>yoke</i> )
12V105	Vent plug
12V107	Switch
12V114	'O' ring
12V109	Carrying strap
12V115	Safety rail
12V113	Switch penetrator shaft

### 6.3 Ultraviolet LED lamp

12V203	Lamp lead
12V204	Wood's filter
12V205	Filter retainer
12V206	Ink dispensing nozzle ( <i>incl. fitting</i> )
12V207	Pressure valve
12V208	Ink hose
12V209	'O' ring kit
12V210	LED UV module
12V211	Replacement UV LED
12V212	DC-DC board

### 6.4 Electromagnetic yoke

12V301	Articulated legs ( <i>pair</i> )
12V302	Switch
12V303	Switch diaphragm
12V304	Switch 'boot'
12V305	Switch actuation plunger
12V306	Connector
12V307	Switch repair kit

### 6.5 Ink reservoir / dispenser

12V401	Dispense check valve
12V402	Air input check valve
12V403	Pressure relief valve
12V404	Container
12V405	Strap
12V406	Probe
12V407	Lid ( <i>pre-drilled and tapped</i> )
12V409	Air input hose fitting

## 7.0 Three-stage battery charger



**CHARGING LEAD AC-D BATTERIES CAN CAUSE HYDROGEN BUILD UP WITHIN THE HOUSING!**

The below instructions **MUST** be followed!

The battery charger utilises the latest technology designed to give the greater charging control of lead-acid batteries with increased product reliability.

The subsea housing **MUST** only be charged with the **UNIT IN THE UPRIGHT POSITION** with the **GRAB RING** and **VENT PLUS AT THE TOP!**

Do **NOT** attempt to charge the subsea unit battery with the unit horizontal or inverted!

### 7.1 Operational procedure

#### 7.1.1

Ensure the charger is disconnected from the mains supply.

#### 7.1.2

Remove the vent plug from the subsea unit.

#### 7.1.3

Connect the battery charger to the electromagnetic yoke / charger socket.

#### 7.1.4

Connect the charger to the mains supply and switch on.

#### 7.1.5.

During start up the charger will determine the battery status and, depending on the result, will display:

	<b>Red indicator</b>	Bulk charge mode
	<b>Amber indicator</b>	Timed charge mode
	<b>Green indicator</b>	Float charge mode



**When the charger enters float charge mode the battery is 100% fully charged. If no indicators illuminate, unplug the charger, check the fuse in the plug and replace if necessary.**

#### 7.1.6

When charging is complete, disconnect the mains supply to the charger. Allow the unit to stand for a minimum 60 minutes before replacing the vent plug. This allows any residual charging gases to vent from the Subsea unit.

### 7.1.7

Finally, re-fit the vent plug.



**Failure to fit the vent plug prior to submerging the Subsea unit will cause and the unit to flood!! Damage of this nature will invalidate the warranty!!**

## 8.0 Replacing an LED and replacing a battery

### 8.1 Replacing an LED

In the event of failure, a single LED can be replaced, it is not necessary to replace the entire module.

**The use of suitable UV eye protection is recommended when carrying out UV LED replacement!!**



**The lamp housing must be completely dry before attempting to change the UV LED(s). WATER MUST NOT BE ALLOWED TO ENTER THE LAMP HOUSING!!**

#### 8.1.1

Disconnect the lamp from the Subsea unit. Ensure the lamp housing is clean and dry.

#### 8.1.2

Remove the six cap-head screws from the filter retainer. Remove the filter retainer, 'O' ring, Wood's filter and the Wood's filter 'O' ring. Carefully inspect the 'O' ring seals. Discard and replace if worn or damaged.

#### 8.1.3

Connect the lamp to the Subsea unit, switch on and mark the LED(s) which require replacement.



**DO NOT STARE DIRECTLY INTO LED LIGHTS!!**

Switch the lamp off and disconnect from the Subsea unit. Mark the filter retaining ring and lamp body with a suitable marker; this will ensure the filter retaining ring is re-fitted in the same orientation.

#### 8.1.4

Remove the LED module from the lamp housing and remove the power supply lead from the LED module. Slacken all four nylon contact insulators to release the spring pressure on the filter support plate; approx. 10mm of nylon thread showing on each unit should be sufficient.

Slacken the contact spigots by 0.5 to 1.0 full turn.

#### 8.1.5

Unscrew and remove the two screws holding the filter support plate onto the LED module. Remove the support plate. Access is now available to the individual LED(s). Remove the faulty LED(s) and replace.



**DO NOT TRAP THE CENTRE CONTACT / WIRE!!**

Refit the filter support plate and tighten the two screws. Tighten the contact spigots against the filter support plate and screw in the nylon insulators fully. **Do not over-tighten!!**



**DO NOT STARE DIRECTLY INTO LED LIGHTS!!**

### 8.1.6

Check the internal housing is completely dry. Reconnect the power supply lead and re-fit the LED module into the lamp housing, routing the wires carefully to avoid trapping. Connect the UV lamp to the Subsea unit and switch on to test.

### 8.1.7

Inspect the lamp filter support 'O' ring and replace if necessary. Apply silicone grease to the 'O' ring. Thoroughly clean the Wood's filter and re-fit into the lamp housing. Inspect the filter retainer 'O' ring and replace if required. Apply silicone grease to the 'O' ring. Fit the filter retaining ring, lining up the orientation mark made in Step 3, above, to ensure correct positioning. Loosely fit the six cap-head screws and tighten.



**TORQUE THE SIX CAP-HEAD SCREWS IN A DIAGONAL PATTERN TO 8Nm (5.9 ft lb)**

Connect the lamp to the Subsea unit and switch on to test.

## 8.2 Replacing the battery



**The Subsea unit must be completely dry before attempting to change the battery. WATER MUST NOT BE ALLOWED TO ENTER THE SUBSEA UNIT!!**

### 8.2.1

Mark the edge of the Subsea unit body and front plate using a suitable marker. This mark will ensure the front plate is re-fitted in the same orientation. Remove the eight cap-head screws to release the safety rail and subsea front plate.

### 8.2.2

Carefully lift off the front plate and place on a clean, dry surface so the internal components are easily accessible. Remove the two wires, red and black, from the battery terminals. Insulate the battery terminals with tape to prevent shorting during removal. Pull out the old battery using the tape handle.



**Retain the packing foam from around the battery!!**

Using a strong tape, e.g. duct tape, or similar, create a 'handle' for the new battery. This will make fitting and removal much easier.

### 8.2.3

Remove any debris from the Subsea unit and check it is clean and dry. Fit the new battery into the housing and pack securely using the foam packing retained from Step 8.2.2, above.

Connect the wires onto the new battery, observing correct polarity, and secure with silicone mastic or tape to prevent accidental disconnection.

### 8.2.4

Inspect the front plate 'O' ring and replace if required. Apply silicone grease to the front plate 'O' ring and re-fit the to the subsea unit, ensuring the 'O' ring is fully situated into its groove. Line up the orientation mark made in Step 1, above, to ensure correct positioning. Fit the eight cap-head screws loosely, gradually tightening the screws in a diagonal pattern until secure.



**TORQUE THE SIX CAP-HEAD SCREWS IN A DIAGONAL PATTERN TO 8Nm (5.9 ft lb)**