



System 12

UNDERWATER MAGNETIC PARTICLE INSPECTION (MPI) SYSTEM
INSTRUCTION MANUAL

V7.2



THIS MANUAL APPLIES TO ASAMS SYSTEM 12 UNITS SUPPLIED PRIOR TO JANUARY 2016. UNITS SUPPLIED AFTER THIS DATE ARE NOT COVERED UNDER THIS MANUAL; PLEASE SEE SYSTEM 12 MANUAL V 7.1 FOR LATER 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 Reservoir</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

Subsea unit

- Houses the rechargeable battery and the electronic circuits for controlling the UV lamp
- Underwater mateable 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 μ W/Cm² at 400mm distance
- Fluorescent ink dispensing trigger and nozzle built into lamp handle

Electromagnetic yoke

- 12V DC operation with fully articulated legs
- Power >18Kg pull

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:

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

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!!



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. If the unit is to be used as a lamp only, the electromagnetic yoke / charger port blanking-plug **MUST** be fitted **PRIOR** to immersion in water.

Damage will result if the Subsea unit is immersed without the blanking plug fitted. **Damage of this nature will NOT be covered under the equipment warranty.**

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!

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, always check the pressure relief valve is free and always ensure that 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 - **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. **During charging, the vent plug is to be open and a low-pressure, compressed air stream passed through the unit via purge connection.**

When charging is complete, switch off and disconnect the battery charger. Allow a further ten minutes purging before closing the vent and disconnecting the purge connections. Ensure the UV lamp on / off switch is in the 'off' position and plug the lamp and electromagnetic yoke into the unit.

Check the UV lamp by switching it on - do not leave lamp on for more than 1 minute! - then allowing to cool before submerging.

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.

NB: 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.

If the unit is to be used as a lamp only, the electromagnetic yoke and charger blanking plug must be fitted prior to immersion in water. Damage to the unit will result if the Subsea unit is immersed without the blanking plug fitted; 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

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.

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.

Apply the fluorescent ink to the work piece while the electromagnet yoke is in the correct position and that the magnetising current is on.

Note 1 The interpretation must only be made between the poles and defects found transverse to this field will be preferentially located.

Note 2 Ink reservoir may be changed out easily.

Note 3 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!

Note 4 To conserve battery power, only switch the UV Lamp and Electromagnetic Yoke on when required for 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

NB: 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 some a of grit injection system, although hydro jets or wire brushes are acceptable if an injection system is unavailable.

For weld inspection, an area at least 100mm (approx. 4”) on either side of any weld should also be cleaned, as specified in the procedure being used. 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 be necessary to change the ink for better results with photography.

NB: 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.

NB: 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
12V408	Ink reservoir (<i>hand pump</i>)
BOX/0003	Transit / storage case

6.2 Subsea unit

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
12V106	Purge plug
12V107	Switch
12V108	'O' ring
12V109	Carrying strap
12V110	Safety rail
12V112	Purge plug cap
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

The latest battery charger technology has been utilised to create a three-stage battery charger. The charger combines the greater charging control of lead-acid batteries with increased product reliability.

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, remove the cap from the purge valve, connect the purge pump hose to the purge valve, connect the pump to the mains supply and switch on. Purge air will flow through 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 switch to:

Red indicator	Bulk charge mode
Amber indicator	Timed charge mode
Green indicator	Float charge mode

NB: 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 purge pump to run for a further ten minutes.

7.1.8

Disconnect the mains supply to the purge pump and disconnect the purge hose from the valve. Refit the purge valve cap and vent plug. If a new 'O' ring is required, fit to vent plug prior to re-fitting the cap and plug.

NB: Failure to fit the vent plug prior to submerging the subsea unit will cause the unit to flood!! Damage of this nature will invalidate the warranty.

8.0 Fitting the UV lamp LED module and replacing an LED

8.1 Fitting the UV lamp LED module

NB: These instructions are intended for fitting a UV lamp LED module into a Subsea lamp, i.e., replacing the pre-2016, old-style gas discharge lamp modules.

Parts required	Tools required
LED module	Wire cutters and strippers
Subsea unit 'O' ring	Terminal screwdriver
Lamp filter retainer 'O' ring	Allen keys
Lamp filter 'O' ring	
Silicone grease	

8.1.1

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

8.1.2

Mark the position of the filter retaining ring and lamp body using a suitable marker. This mark will ensure the filter retaining ring is refitted correctly aligned.

8.1.3

Remove the screw securing the ink dispensing nozzle to the filter retaining ring. Remove the six cap-head screws from the filter retaining ring

8.1.4

Remove the ring, the 'O' ring, the Wood's filter and the filter 'O' ring. Carefully inspect the 'O' ring seals; discard and replace if worn or damaged.

8.1.5

Remove the filter support, reflector and light bulb. Disconnect the two wires and remove the bulb holder and igniter unit. These components are now redundant and can be disposed of.

NB: The LED module is fitted with a connector with two fly leads coloured white and black respectively.

These wires need to be connected to the two existing wires of the same colour from the lamp housing penetrator. Correct polarity is critical:



White -ve (Negative)
Black +ve (Positive)

Incorrect connection of these wires will result in permanent damage to the LED module drive circuit!

Damage of this nature will not be covered under warranty!

8.1.6

TVC recommend the two supply wires in the lamp be soldered to the appropriate flying leads from the LED module and insulated using heat shrink sleeving. **A terminal block may be used but is not recommended.** Both wires must be insulated from each other and to prevent contact with the lamp housing.

8.1.7

Once connected, the wires can be carefully fed into the lamp housing and the LED module inserted into the housing. The LED module has an integral filter support plate; position the module so that it sits firmly against the housing support lip and the front of the filter support plate is located flat. Care must be taken to prevent trapping wires which may cause the LED module to extrude front face edge of the lamp. Place the lamp in a clean and dry area.

DO NOT CONNECT THE LAMP TO THE SUBSEA UNIT TO TEST AT THIS STAGE!

8.1.8

Mark the edge of the Subsea unit body and front plate using a suitable marker; this will ensure the front plate is refitted in the correct position. Remove the ten cap-head screws to release the subsea front plate. Carefully lift 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.

8.1.9

The lamp ballast unit (circular component) needs to be removed from the front plate. Disconnect the two blue wires from the terminal strip of the ballast units and disconnect the ballast supply wires - red and black - from the switch. Remove the ballast unit and clamp; these components are now redundant and can be discarded.

8.1.10

Refit wire N° 3 from the yoke connector and wire N° 3 and N° 4 from the lamp connector to the front panel chassis. Connect the lamp connector wires N° 1 and N° 2 to the switch in substitution of the ballast supply wires which were removed and discarded (*see above*).



Wire N° 1 is positive (+ve) and wire N° 2 is negative (-ve) !!

Insulate the wire connections on the switch!

Care must be taken to ensure correct polarity!!

Incorrect connection will result in permanent damage to the LED module!

8.1.11

Reconnect the battery, observing correct polarity!

Do not connect the lamp to the Subsea unit!

Turn the lamp switch on and, using a multimeter, check for 12V DC on Pin N° 1 and Pin N° 2 of the lamp connector. Confirm Pin N° 1 is **positive** and Pin N° 2 is **negative** and turn the switch off.

8.1.12

Connect the lamp to the Subsea unit and switch on; all four LED's should now be illuminated.

DO NOT STARE DIRECTLY INTO LED LIGHTS!!

8.1.13

Switch the lamp off and disconnect from the Subsea unit. Inspect the front plate 'O' ring and replace if damaged.

Apply silicone grease to the front plate 'O' ring and refit the Subsea unit front plate, ensuring the 'O' ring is fully situated in its groove. Line up the mark made to ensure correct positioning and fit the ten cap-head screws loosely. Gradually tighten the screws in a diagonal pattern until secured.

8.1.14

Inspect the lamp filter support 'O ring' and replace if required. 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 mark made to ensure correct positioning. Loosely fit the six cap-head screws and gradually tighten in a diagonal pattern until secured.

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

8.2 Replacing an LED

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

8.2.1

Disconnect the lamp from the Subsea Unit and ensure the lamp housing is clean and dry.

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

Connect the lamp to the Subsea unit, switch on and mark the LED(s) requiring replacement. Switch the lamp off and disconnect from the Subsea unit.



Failure to disconnect the lamp prior to removal of the internal components could result in permanent damage to the system.

Damage caused will not be covered by any warranty.

8.2.2

Remove the LED module from the lamp housing. Remove the power supply lead from the LED module.

Slacken the four retaining grub screws securing the contact spigots. Slacken all four nylon contact insulators to release the spring pressure on the filter support plate - approx. 10mm of nylon thread showing on each should be sufficient. Slacken the contact spigots by 0.5 to 1.0 full turn.

Remove the two screws holding the filter support plate onto the LED module. Remove the plate.

8.2.3

Access is now available to the individual LED's. Remove the faulty LED and replace with a new LED. **Do not trap the centre contact / wire.** Re-fit 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.** The filter support plate must fit flush with the LED mounting plate. Adjust the contact spigots of the replaced LED's to ensure they do not protrude from the mounting plate before tightening the filter support.

Reconnect the power supply lead and refit the module into the lamp housing.

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

DO NOT STARE DIRECTLY INTO LED LIGHTS!!

Inspect the lamp filter support 'O' ring and replace if required. 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 mark made to ensure correct orientation. Loosely fit the six cap-head screws and tighten in a diagonal pattern until secured.

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

9.0 Replacing the Subsea unit battery

9.1 Replacing the battery

9.1.1

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 into the correct position. Remove the ten cap-head screws to release the Subsea unit front plate. Carefully lift the front plate and place on a clean, dry surface so the internal components are easily accessible.

9.1.2

Remove the two wires - **red and black** - from the battery terminals. Pull out the old battery using the tape handle. **Retain the packing foam from around the battery.**

9.1.3

Using a strong tape (duct tape or similar) create a 'handle' to the new battery. This will make fitting and removal far easier.

9.1.4

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

9.1.5

Inspect the front plate 'O' ring and replace if damaged. Apply silicone grease to the front plate 'O' ring and refit the Subsea unit front plate ensuring the 'O' ring is fully situated into its groove.

9.1.6

Line up the mark made to ensure correct positioning and fit the ten cap head screws loosely. Gradually tighten the screws in a diagonal pattern until secured.