

The Company reserves the right to make such changes to the design or specification of the equipment as it shall see fit. The information contained in this manual is issued for the guidance of users and does not form part of any contract. It is strongly recommended that all users and supervisors familiarise themselves with the contents...

PRIOR TO COMMENCING USE OF THE SYSTEM

...and in particular, the section on safety precautions which should be used as a guide to safe operation in accordance with the requirements of the relevant Health and Safety at Work legislation.

AIR PLASMA LIMITED

3 LIMEHURST AVE
LOUGHBOROUGH
LEICESTERSHIRE
LE11 1PE
ENGLAND

Tel No. +44 (0)1509 237369
Fax No. +44 (0)1509 234942
Email. goodwinplasma@aol.com

Contents

1.	SAFETY	4
1.1	General	4
1.2	Safety Features	5
1.3	Warning Signs	5
1.4	Packaging Handling and Transport	5
2.	INTRODUCTION TO THE PLASMA PROCESS	6
3.	INSTALLATION	7
3.1	Power Supply	7
3.2	Earth Requirements	7
3.3	Phase Determination	8
4.	PLASMA AND TORCH CONNECTIONS	9
4.1	Connecting the Torch and Plasma Earth Lead to the Power Unit	9
4.2	Control of the Torch	10
5.	OPERATION	11
5.1	Machine Controls	11
5.1.1	WARNING INDICATORS	13
5.2	Power Up Procedure	14
5.3	Cutting Procedure	15
5.3.1.	STARTING AND FINISHING A CUT.	15
5.3.2.	CUTTING WITH STAND OFF.	15
5.3.3.	CUTTING SPEED.	16
5.3.4.	PIERCING THICKER MATERIALS WITH A HAND TORCH	17
5.5.	Consumable Life.	18
5.5.1.	INTRINSIC LIFE.	18
5.5.2.	ALIGNMENT.	18
5.5.3.	TRANSIENT DAMAGE.	18
5.4	Troubleshooting	18
5.5.4.	OPERATIONAL DAMAGE.	19
5.5.5.	ELECTRODE “NON-STARTING”.	19
5.6	Changing Consumables	20
6.	TECHNICAL DATA	23
6.1	Power Unit	23
6.1.1.	ELECTRICAL INPUT	23
6.1.2.	Electrical Output	23
6.2	Torch and Hose Set	23
6.2.1	HAND TORCH	23
7.	SERVICE INFORMATION	24
7.1	The Power Unit	24
7.1.1.	CIRCUIT DIAGRAM	25
7.1.2.	MACHINE LAYOUT	26
7.1.2.	DIAGNOSTIC INDICATORS.	28
7.2	The Torch and Hose Set Repair	29
7.3	Maintenance	30

1. SAFETY

1.1 General

Before any cutting operations are started, the user must ensure that the installation and proposed working methods comply with all relevant safety regulations, environmental and electricity standards.

The plasma arc produced at the torch head is a jet of high energy and is potentially dangerous. Users unfamiliar with a plasma arc should seek basic training. Goodwin Air Plasma can offer comprehensive training courses.

In addition, the following points are particularly important:

- a) The mains connection must be properly grounded and the supply lines fitted with fuses or circuit breakers of the specified rating. The mains cable must be properly secured and protected from possible damage.
- b) High voltage exists at the torch when power is applied and the pilot arc is struck (up to 350V), and when the main arc is cutting (150-200V). Under no circumstances should anyone touch the nozzle with power applied to the torch. All adjustments and replacement of parts should be done with the power unit supply isolated. The standard torch should not be used in excessively wet conditions or if the torch or hose set are damaged in any way.
Note that the PTU torch, its umbilical and associated extensions and connectors are designed to be used underwater. The current specification is to a maximum of 30m, although it has been tested to a simulated 70m..
The electrical connectors are underwater mateable (to ocean depth) but in practice it is not advisable to disconnect the coolant and air lines underwater, so this would normally be done on the surface.
- c) The mains supply should be isolated from the unit AT THE SUPPLY before removing any panels from the unit. Only authorised service personnel should remove panels.
- d) Keep the work area clear of all inflammable materials. Ensure that any material ejected from the cut is not a hazard to the operator or to others.
- e) Protection is necessary against ultraviolet radiation emitted from the arc. A helmet or shield with shade glass is recommended. Note, however, that the plasma arc does not usually need to be observed closely, if at all. It is more often necessary to be able to see the material surrounding the cut, so a lighter shade than that used for welding will probably be required. Furthermore, when cutting underwater, the UV is absorbed by the water to a considerable degree. Wear gloves and adequate protective clothing where appropriate. Adequate screening should be arranged to protect others in the vicinity or passing by in a similar manner to that required for arc welding operations.
- f) Adequate ventilation or fume extraction to remove the cutting fume and dust is required at all times around any plasma cutting operation.
- g) The wheels on the unit are meant for ease of movement around the work place and should not be used over rough surfaces nor at excessive speeds.
- h) The plasma power unit should be positioned on stable level ground and if necessary secured against any unwanted movement.
- i) The operation of this equipment and the plasma cutting process can result in noise levels that could be harmful. When cutting underwater the noise level from the arc is substantially reduced and does not represent a risk to the diver. The employer should undertake a noise assessment to monitor compliance with relevant legislation.
- j) Material to be cut should be supported in such a way that any material cut from the work piece will not be a hazard and fall onto the user, the equipment, or others in the vicinity.
- k) Care should be taken when manoeuvring the hose set with either a hand held torch or one connected to a robotic device, that it does not snag on objects or other equipment which may result in damage to the hose set, or topple the objects or equipment. Hose sets that are subject to excessive mechanical tension may result in damage to the hose set connections at the machine, the torch, or the hose set components themselves.

1.2 Safety Features

The plasma unit includes the following features for the safety of the operator:

- * The body of the plasma torch is earthed.
- * The continuity of the torch earth and the voltage on the body is monitored.
- * Cutting current flowing in the supply earth is monitored.
- * The voltage on the torch nozzle is monitored.
- * In the event of a faulty condition of the above, the machine will switch off power to the torch.

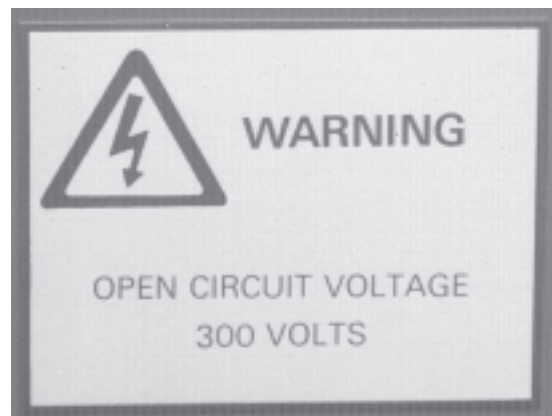
The emergency stop procedure is to hit the red emergency stop button located on the lower front control panel.

A tool (10mm spanner) is required to remove the canopy for access to the internal components. Under no circumstances should the canopy be removed whilst the mains supply is still connected. Only suitably trained and authorised personnel should remove the canopy.

1.3 Warning Signs

The location of the warning signs fitted to the plasma unit are:

- a) At the front of the machine -
Warning Open Circuit Voltage 300 volts.



- b) At each rear lower corner of the canopy -
Warning Disconnect the Mains Supply.....



These should be maintained in a legible condition.

1.4 Packaging Handling and Transport

Should the plasma unit need to be shipped, we recommend re-use of the original packing crate. Also:-

- a) That the hose set be disconnected to prevent any damage to the hose set / plasma connections.
- b) That the control panel is adequately protected against potential damage.
- c) Any lifting should be done using the eyebolt located in the top of the canopy together with certified lifting equipment (not supplied). Precautions should be taken to prevent rotation about the eyebolt.
- d) The plasma unit should be shipped and stored in the upright position to avoid any heavy internal components breaking free from their mountings.
- e) Storage should be undercover, preferably in a clean dry environment.

2. INTRODUCTION TO THE PLASMA PROCESS

The plasma process is created by passing a stream of clean air, provided by an oil free compressor, through a NOZZLE in the torch. The air stream is ionised by a PILOT ARC, initiated by a HIGH FREQUENCY unit (HF Unit) which passes from the ELECTRODE to the nozzle when the torch is activated. When the PILOT ARC is brought close to the work piece, MAIN ARC is TRANSFERRED to the work piece as a jet of high energy which rapidly melts any metal with which it makes contact, providing fast cutting, low residual heat input, and low material distortion.

The electrode and nozzle are cooled by the air and a recirculating water cooling system, and as the air is passed through the nozzle it is caused to swirl around the arc by a SWIRL BUSH to aid stability of the arc.

The HF unit operates automatically to establish an arc when power is applied to the torch and it ceases to operate when the pilot or main arc is established.

3. INSTALLATION

May be carried out by a competent electrician. No specialist tools are required.

3.1 Power Supply

The power unit is provided with a length of flexible cable which must be connected to a 3-phase and earth electrical supply. The supply should be fitted with fuses or circuit breakers of appropriate rating and a means of isolating the power unit from the supply should be provided. A plug should be fitted if appropriate. The machine is phase/rotation sensitive.

The power unit has power factor correction capacitors fitted as standard. It must be noted that when the unit derives its power from a generator, the power factor correction may disturb the generators' automatic voltage control. If recommended by Goodwin Air Plasma, the power factor correction circuit can be disconnected however this will increase the input current demand. The P30U has automatic switching of the power factor correction so that it only operates whilst cutting, so it is unlikely to cause this problem. This may be fitted as an option to other variants.

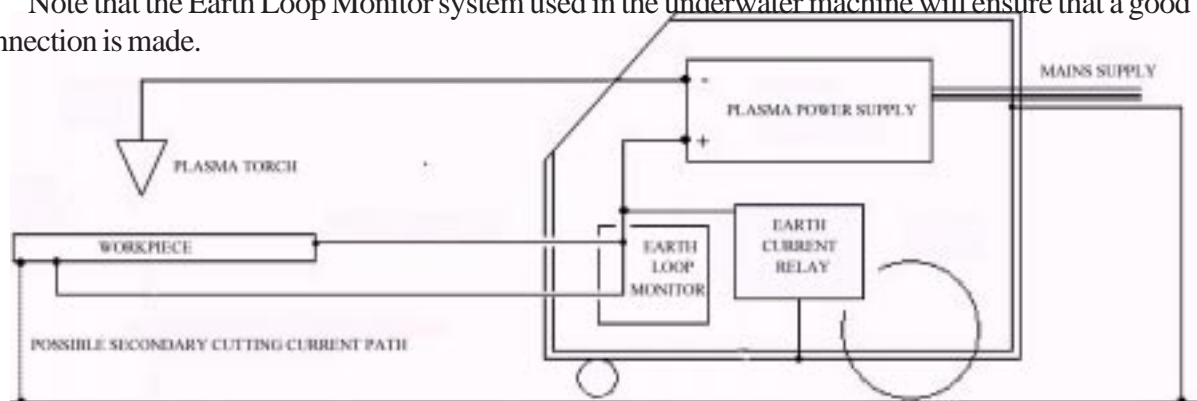
Refer to the rating plate on the machine and Technical Data section 6.1.1. for the correct voltage and current requirements.

3.2 Earth Requirements

The installation should ideally be arranged such that the only path to earth (or ground) from the work piece is by way of the plasma earth lead connected to the front of the machine.

Where the material to be cut forms part of the structure which is earthed or grounded to the mains electrical supply system, then the cutting current could flow through that route rather than the plasma earth lead to the machine. Always ensure that there is a good connection between the work piece and the machine via the plasma earth lead as a poor connection will cause excessive current in the mains supply earth which will create a current trip fault condition (see section 7.4 fault finding).

Note that the Earth Loop Monitor system used in the underwater machine will ensure that a good connection is made.



In installations where it is not possible to avoid earth current trips, even though a good cutting current earth path has been ensured, it will be necessary to check that the alternative mains earth paths are substantial enough to carry higher currents than the current trip setting of 30amps (*) without causing damage, as where the cutting earth is not connected to the work piece at all, this would be the full cutting current. If the earth paths are not substantial they must be uprated or re-routed to avoid the possibility of damage. Once the necessary checks and precautions have been taken, the earth current trip circuit may be disabled by means of the switch on the Earth Current Relay (ECR) located inside the power unit.

*Since the workpiece will often be substantially connected to the supply earth in underwater work, and significant currents must be allowed to flow in seawater to the torch and umbilical earth, a less sensitive earth current relay is used. The standard machine sensitivity is 10A. This should avoid most cases of nuisance tripping, and the need to disable the ECR.

3.3 Phase Determination

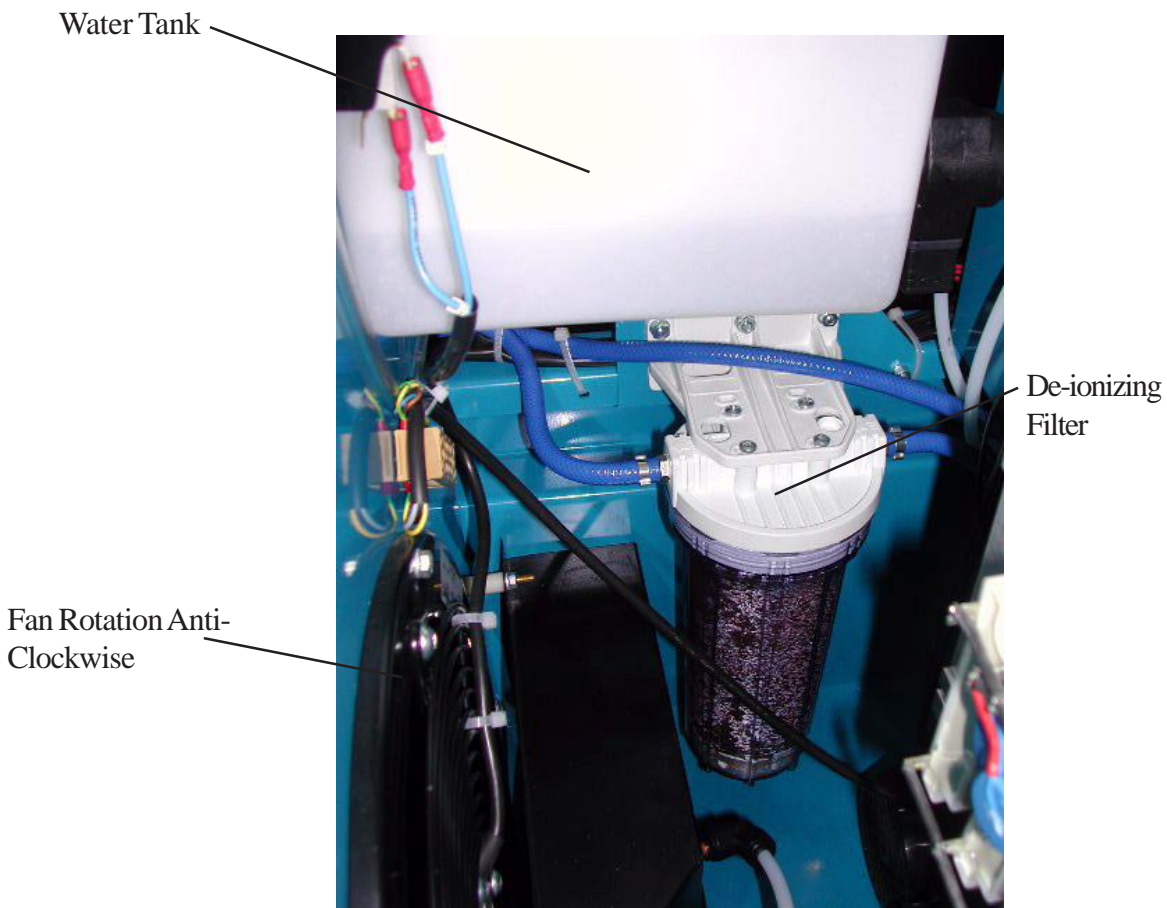
Connect the torch to the machine (see section 4).

Fill the water system with distilled water.

***Note.** To avoid damaging the water pump the machine should not be run without water in the system. Also, the machine should not be run for more than a few seconds without a torch connected to the machine. It may be necessary to eliminate air from the system, and vent the de-ionizing filter, to establish a proper flow.*

Switch on the machine by rotating the main isolator and pressing the on/off button ensuring the emergency stop switch is unlatched.

Correct phase connection is determined by checking that the cooling air flowing through the power unit is from the front panel to the rear of machine. If this condition is not correct, change two of the three phase connections at the power supply and check again. The fan rotation, when viewed from the front of the machine, is anti-clockwise.



If there is any doubt regarding installation, consult your distributor or Goodwin Air Plasma.

4. PLASMA AND TORCH CONNECTIONS

4.1 Connecting the Torch and Plasma Earth Lead to the Power Unit

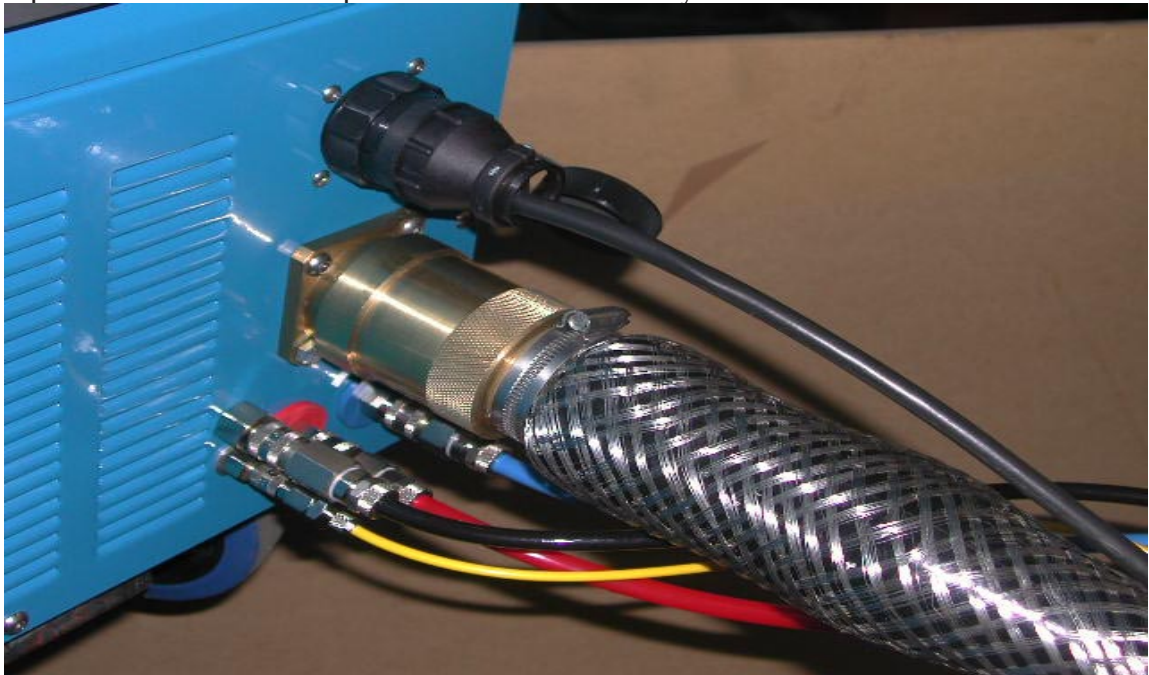
Note. Do not run the power unit without the torch connected.
The connections to the power unit are located at the front of the unit.

The PTU torch and umbilical extensions use a specially designed electrical connector for the power, safety earth, pilot arc, and all other electrical connections. There is a central pin that carries the power, a pin for the pilot arc connection and 5 smaller pins for safety monitoring and the diver's control switch. The safety earth is made through the locking sleeve. There are four hose connectors, filled with quick acting connectors.

*the blue hose is the cooling water to the torch;
the red hose is the cooling water return from the torch
the black hose carries the plasma air
the yellow hose is a "pneumo" connection to allow the plasma air pressure to automatically track the working depth*

The water connections are not polarised but it is advisable to follow the colour coding. These connectors are found on the machine front panel and replicated at the socket end of the extension umbilicals.

The supervisor's remote control panel connects to a multiway socket above the torch connectors.



The two earth connectors (insert and twist clockwise to lock) are located on the left hand side of the front panel. An indicator lamp indicates when an earth loop has been successfully made.

(Note that this is an "analogue" lamp, therefore it may be illuminated but not at full brightness, and the indicator (which is "digital") on the front panel and the supervisors panel still fail to light because of a poor connection).

When first switching on, allow enough time for the water to circulate through the system. Top up the header tank as required. Use only distilled or de-ionised water. (See section 7.1 regarding use of methanol in freezing conditions).

4.2 Control of the Torch

Note that the torch has a switch for use by the diver, but that this is used in conjunction with the supervisors panel and a communications procedure to energise the torch. The torch will de-energise if the diver's switch is released at any time.

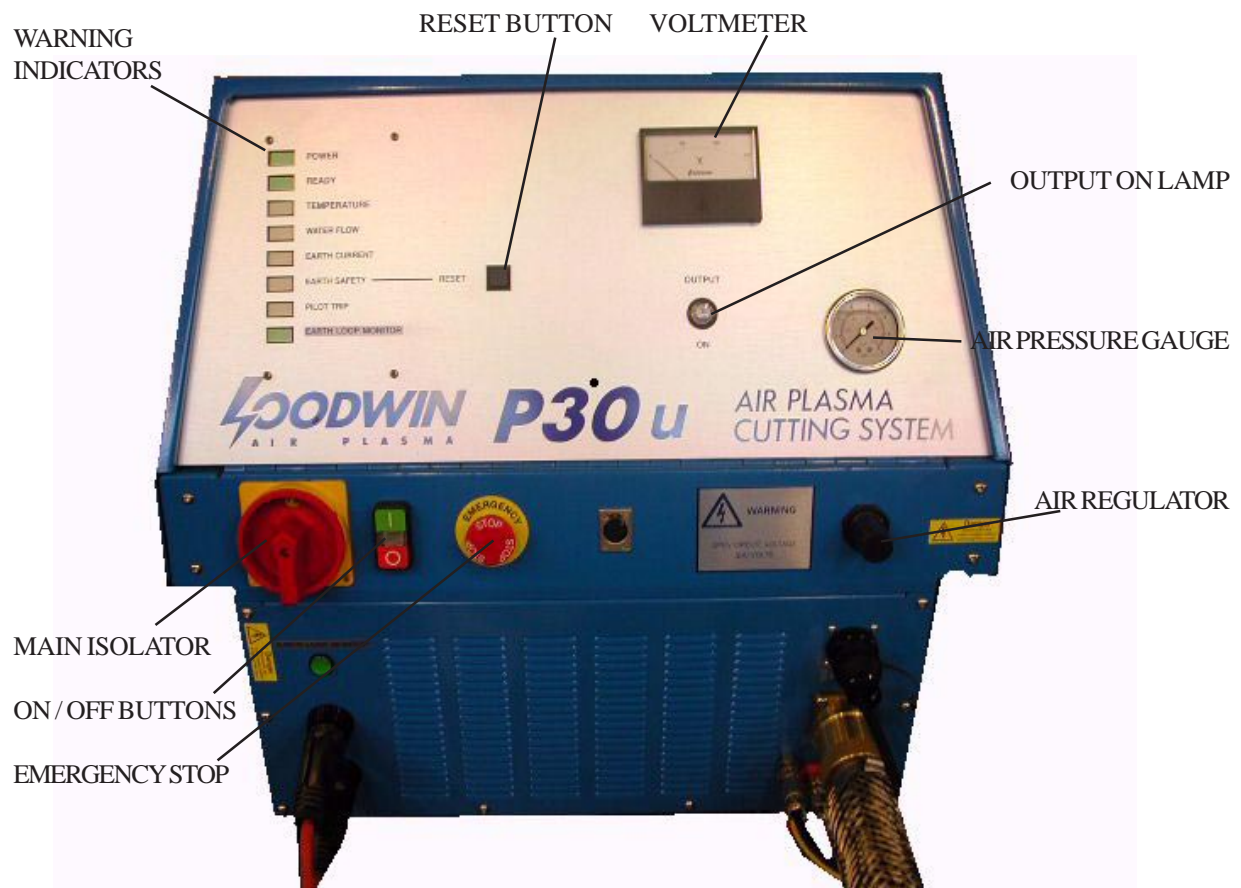
Note that it is good practice to leave the power unit running at all times when the torch is underwater to prevent the torch and air hose filling with water.

Cooling air will flow through the torch at all times when the machine is switched on.

5 OPERATION

5.1 Machine Controls

The front panel of the machine provides a range of displays and control gear to ensure correct operation



ON / OFF BUTTONS

Switches auxiliary circuits on and off. ie Compressor, water pump, cooling fan and control circuits

MAIN ISOLATOR

Isolates machine from mains supply. It may be padlocked in the off position.

EMERGENCY STOP

Switches machine off. The switch latches mechanically and must be rotated to release.

Hose Connections

See section 4. Connecting the torch to the power unit.

Voltmeter

Indicates the arc voltage.

Typical values would be: Power applied to torch but no arc 300v (actually off-scale: up to 350V)

For Pilot Arc 250 to 300 volts

For Main Arc 150 to 200 volts

(Voltage is affected by supply voltage, cutting depth, cutting speed and material thickness)

Output ON LAMP

Indicates that power is applied to the torch.

Reset Button

Resets earth current, earth safety, and water warning circuits.

Air Pressure Gauge

Displays the back pressure in the system during the pilot arc and cutting modes

Typical values would be: For Pilot Arc 0.7 to 2.2 bar (10 to 30 psi)

For Main Arc 2.4 to 3.4 bar (35 to 50 psi)

Note that the air regulator tracks the working depth, therefore the pressure gauge shows this operating pressure plus the working depth (1 bar = 10m = 32 ft)

Tracking Air Regulator

Sets the air flow through the torch to give a stable pilot arc and adjusts to allow for the working depth.

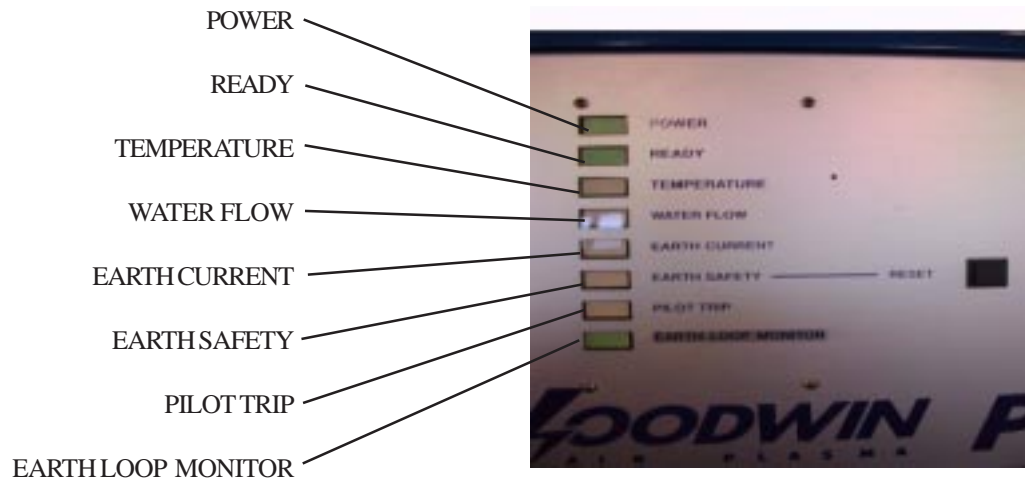
Note that essential indicators on the front panel, and the reset button, are replicated on the supervisor's panel, and it is normally only necessary to switch the machine on or off at the power unit.

Note that the supervisor's panel and the dual earth system must be used before it is possible to energise the torch.

It is possible to use the machine in a conventional mode for dry cutting in the workshop (ie single earth and control by torch switch) by use of a special bypass plug fitted to the supervisor's remote control socket. If supplied this should not normally be kept with the machine to prevent use in inappropriate circumstances. It should never be used when operating underwater

5.1.1 WARNING INDICATORS

See section 7.1.2 Displays and Controls for more details.



POWER INDICATOR -

Indicates that power is available to the system control circuit.

READY INDICATOR -

Indicates system interlocks are operational and the machine is ready to cut

TEMPERATURE INDICATOR -

Indicates that the rectifier or transformer temperature is too high.

WATER INDICATOR -

Indicates insufficient water flow in the torch.

EARTH CURRENT INDICATOR -

Indicates excessive currents in the supply earth (see section 3.2).

EARTH SAFETY INDICATOR -

Indicates a break in the earth connection to the torch or a voltage in excess of 10 volts to the torch body.

PILOT TRIP INDICATOR -

Indicates the pilot arc has excessive current, due to consumable condition or insufficient air flow.

EARTH LOOP ENABLED -

This shows that the dual earths are properly connected to the workpiece which will enable the diver's switch

5.2 Power Up Procedure

Having completed the mains and cutting earth wiring, connected the torch and checked the fan rotation, and connected the supervisors panel, the machine is ready for use.

Switch the machine on and after allowing time for the water to circulate through the torch, press the reset button on the front panel or supervisors panel. The red indicators should go out and the ready light will illuminate. Note that the supervisors panel will always need to be reset, even if the machine has been reset on the front panel.

To ascertain the absence of air leaks, the air regulator should be wound fully clockwise and the pressure gauge should indicate a back pressure in excess of 3 bar.

It is now necessary to adjust the air pressure to give the highest possible reading consistent with good arc starting and a stable pilot arc, this should be at least 0.7 bar. Switch on the torch with the nozzle well clear of any workpiece, person or equipment, and re-adjust the air pressure until it is at maximum or the pilot arc becomes unstable (very noisy, misfire, and the voltmeter showing 300 volts). At this point reduce the pressure to restore stability (arc less noisy, stable arc, and the volt meter showing 250/300 volts).

Always maintain as high an air pressure as possible for pilot arc as this gives the best consumable life.

The output neon is “on” and the voltmeter reads between 250 vdc and 300 vdc at this stage.

The machine is now setup and is now ready to be used. Before starting a cut please see section 1 for safety information and then section 5.3 for cutting procedure. The correct procedure for cutting underwater is considered more fully in the Supervisors Panel Instructions

NOTE.

As this plasma power unit does not have a voltage stabilised power supply, a fluctuation in the input voltage will directly affect the output current. This may not be noticeable if the input voltage rises slightly above the norm as it will provide more power for cutting. If the rise is excessive, consumable life may suffer. However, when the input voltage falls, the output power also falls, affecting both the pilot arc and main arc. In these circumstances it will be necessary to adjust the air pressure regulator to reduce the airflow to obtain a stable pilot arc, and readjust it when the mains voltage returns to normal.

5.3 Cutting Procedure

5.3.1. Starting and Finishing a Cut.

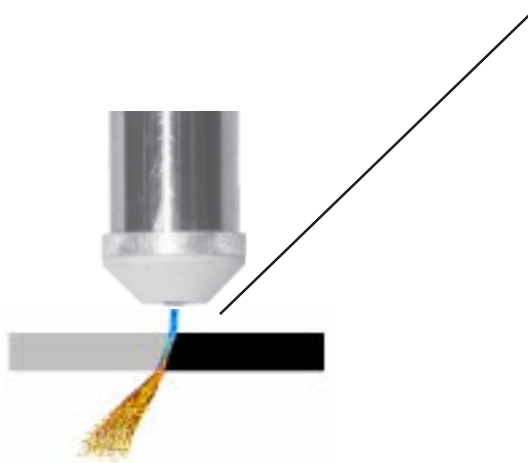
Where possible it is better to start a cut at a plate edge or hole because the piercing process reduces consumable life.

Cuts can be started by either initiating the pilot arc and moving the torch into the proximity of the work piece, or by positioning the torch over the edge of the work piece and starting the pilot arc. Underwater, and especially at depth, it may be necessary to always start very close to the workpiece.

Materials with a capacity to absorb heat energy, especially thicker sections, require more care and technique when starting a cut. In these cases the cut will appear slow to start and pierce through the material. Once a cut is established then cutting speeds may be increased.

Cutting can be stopped either by releasing the torch switch, or at the supervisors panel, or in an emergency by switching off the power unit. It will stop cutting if moved away from the workpiece, but will then re-establish a pilot arc. This is not recommended practice for underwater cutting.

5.3.2. Cutting With Stand Off.



Under normal cutting conditions the torch is designed to operate with a STAND OFF of about 6 mm. This is the distance between the end of the nozzle and the work piece. Underwater this will probably be reduced to 2-3mm, say, by modifying the Guide Ring, if used.

Where the work piece is rusty, scaly, or with thick sections of steel or aluminium etc., a build up of dross on the top of the work piece may occur which will cause damage to the nozzle. In these conditions, the stand off distance should be increased slightly.

A guide ring is available to assist the operator in maintaining the desired stand off height. This can also be used against a straight edge to maintain a straight cut.

IMPORTANT

If the arc should “flare”, be coloured green, or emit any unusual noise, it is essential that the torch be immediately switched off and the condition of the consumables checked. This usually indicates that the consumables are damaged or reached the end of their useful life. Continuing to try and cut under these conditions may result in damage extending beyond the consumables to other parts of the torch.

5.3.3. Cutting Speed.

Best results are usually obtained by cutting at the optimum cutting speed.



OPTIMUM CUTTING SPEED

Correct cutting speed is judged by experience from observing the angle at which the cut material leaves the lower edge of the plate, either by observing the ejected material or by studying the surface of a cut after completing a test cut. The drag back of the arc is approximately 30 degrees.



CUTTING TOO SLOW

Arc appears to blow straight through the material. Excessive dross may accumulate on the underside of the material.



CUTTING TOO FAST

Arc fails to pierce the material. Blow back of dross will damage the nozzle.

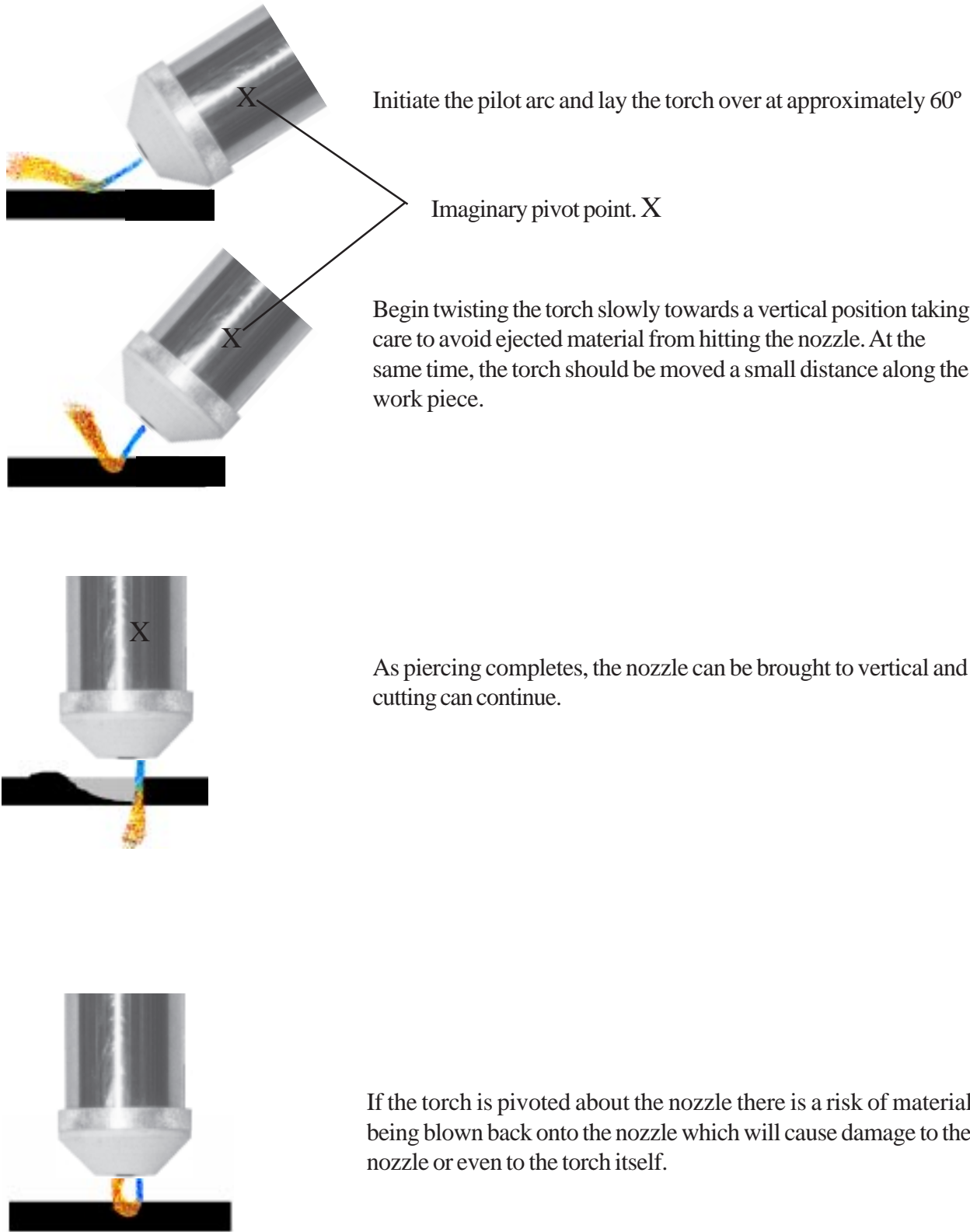


MAXIMUM CUTTING SPEED

Drag back of the arc is around 45°, but cut quality will deteriorate.

5.3.4. Piercing Thicker Materials with a Hand Torch

Piercing will cause cut material to be ejected upwards which can be dangerous, and has a risk of damaging the torch nozzle. This problem is worsened as material thickness increases because it takes longer to pierce. If it is necessary to pierce, then it is best done by angling the torch and gradually bringing it upright as piercing is completed.



5.4

Troubleshooting

Excessive dross on lower edge of cut.	Cutting speed too slow. Torch consumables worn or damaged. Insufficient air flow.
Double arcing.	Damaged torch consumables. Nozzle blocked by dross or too close to work piece. Insufficient air flow.
Main arc not square to work piece.	Nozzle orifice damaged. Electrode eroded "off centre". Consumables wrongly fitted.
Excessive bevel or rounded cut surface.	Speed too high. Stand off too high. Arc not straight - consumables damaged or misaligned.

Bevel is more noticeable on thinner sections and is more pronounced on the left hand side of a cut. It is due to the clockwise swirling of the air induced by the swirl bush in the electrode assembly. Bevel edges can be desirable as an aid to weld preparation, however it can be virtually eliminated by reducing the cutting speed but at the expense of accumulated dross. For minimum bevel cut clockwise around a component and anticlockwise in a hole.

5.5. Consumable Life.

A good consumable life is the single most important factor in achieving optimum cutting economics of any plasma cutting unit. This life is dependent on the intrinsic life of the consumables, correct alignment and the incidence of transient and operational damage.

5.5.1. Intrinsic Life.

The intrinsic life of the consumables is determined by the rate at which they are eroded by the arc process. This erosion rate is however low, and in practice, the life is limited by other factors. The insert in the centre will be eroded slightly each time the arc is struck eventually creating a visible crater. The crater can be more than 2mm deep before the electrode is considered to be expired.

5.5.2. Alignment.

The alignment and construction of the Goodwin Air Plasma Torch is such that problems of grinding and adjusting electrodes do not occur. With reasonable care taken in fitting the consumables, alignment problems should not arise.

5.5.3. Transient Damage.

On starting directly onto main arc, it is occasionally possible to erode some of the copper from the electrode before the arc settles onto the insert material. This generates a crater in the electrode and the insert burns back to become flush. Consumable life is thus reduced if there is a high number of starts relative to the total cutting time.

5.5.4. Operational Damage.

This is the most likely cause of limited consumable life. Since the arc is quite capable of cutting copper, anything which causes the arc to deviate from the centre of the nozzle will result in damage to the orifice. In extreme cases the arc passes not through the orifice but from the electrode to the nozzle and from the nozzle to the work piece - DOUBLE ARCING, causing the rapid erosion of copper from both electrode and nozzle.

The most common cause of these problems is from ejected cut material entering the orifice particularly when piercing or obstructing the nozzle with the work piece.

It is best to operate within the maximum speed capabilities of the machine and avoid unnecessary piercing or stop-start cutting whenever possible.

5.5.5. Electrode “non-starting”.

Occasionally, it may happen that it is difficult to start the pilot arc. This happens when the oxidized material from the electrode insert is deposited over the surface of the copper electrode and inside the nozzle. Starting can be improved by cleaning or scratching the surface of the electrode with a wire brush or sharp implement. Always switch off the power unit before removing the nozzle for this purpose. Once a “non-starting” electrode has been used a few times, starting usually improves.

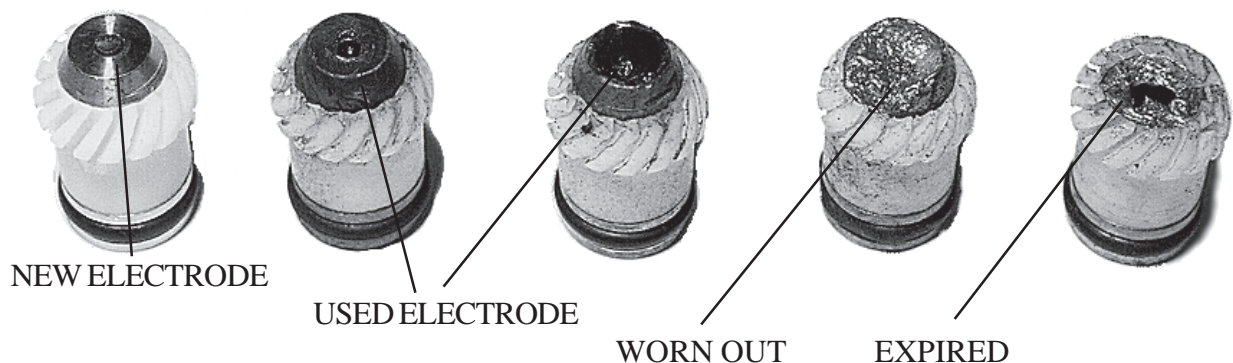
It is not good practice to fire the pilot arc continually in mid-air without striking the cutting arc as this oxidizes the surface of the electrode and leads to “non-starting” problems.

Since cutting usually improves a non-starting electrode, it may be desirable to use a piece of scrap material and start the main arc immediately by positioning the torch close to the material before switching on. Once started, continue to cut for as long as possible before trying to re-initiate the pilot arc.

We have found that on some occasions when cutting under water, the electrode is rapidly covered in a heavy black deposit that causes problems identical to “electrode non-starting”. We are not yet sure why this should happen, although it has been suggested that atmospheric humidity, and consequently excessive water in the compressed air, could be responsible. The air supply is fitted with a drying system:

The practical “cure” is the same – to scratch the copper surface of the electrode, and to this end a special tool is supplied in the tool kit to enable this to be done by the diver underwater, without removing the nozzle. **Note that careful communication procedures should be used when this is done, to ensure the supervisor does not “make it hot” if the diver should inadvertently touch the torch switch.**

ILLUSTRATION TO SHOW ELECTRODE DAMAGE



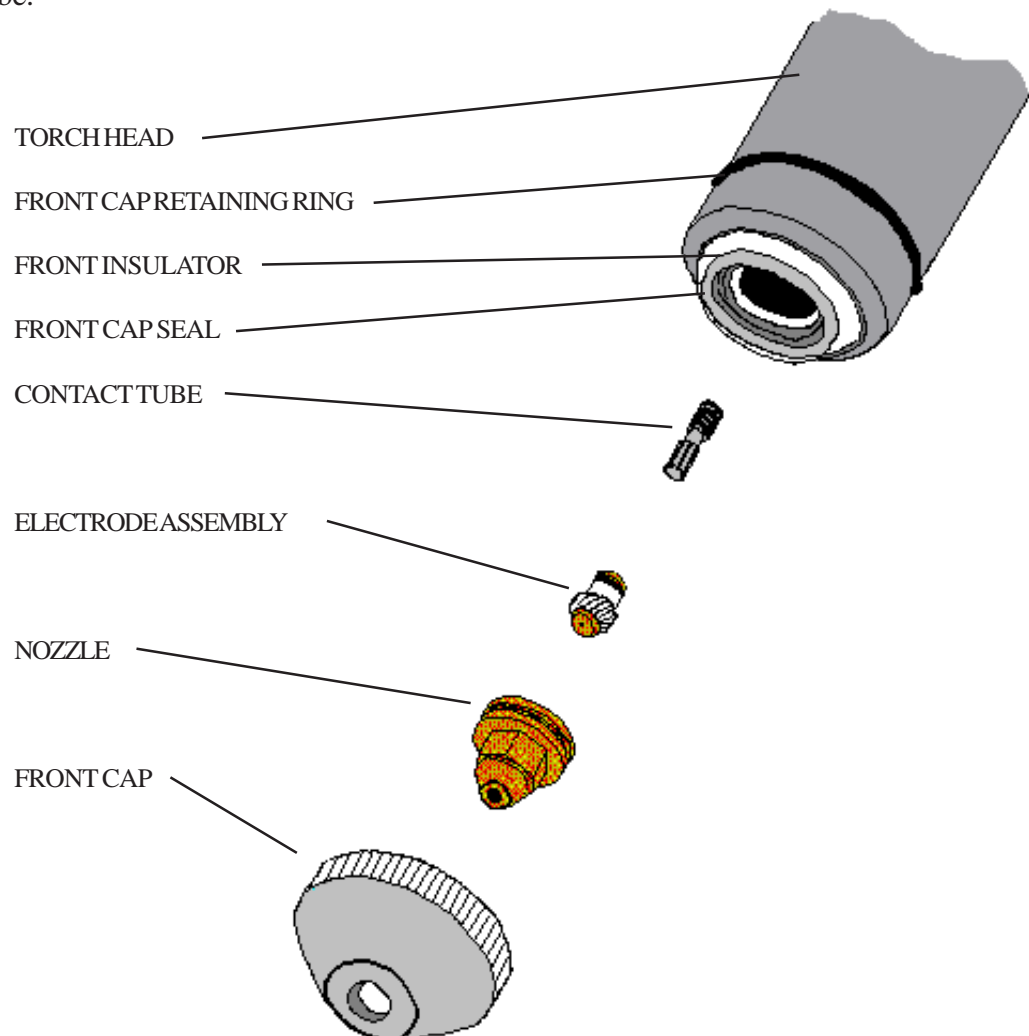
5.6 Changing Consumables

The Goodwin Underwater PTU torch carries a number of elements known as the CONSUMABLES which are eroded during the cutting process. They consist of:

- a) Nozzle.
- b) Electrode Assembly comprising:
 - Electrode
 - Swirl Bush
 - O ring

Other parts that may be damaged and replaced by the user are:

Front Cap
Front Cap Retaining and Sealing Rings
Front Insulator
Contact Tube.



Note that changing consumables should always be done by recovering the torch to the surface, and switching the power unit off.

The electrode and nozzle are the same as the standard torch, although two different sizes of nozzle may be used depending on the nature of the work and the depth.

As well as a retaining ring for the front cap there is a sealing ring fitted in the front insulator that engages with the underwater front cap.

(For dry cutting the standard front cap may be used)

Silicone compound should be applied liberally around the nozzle and this seal, but not fill the space between the seal and the front cap retaining ring as it may be caught between the two seals and prevent fitting of the front cap.

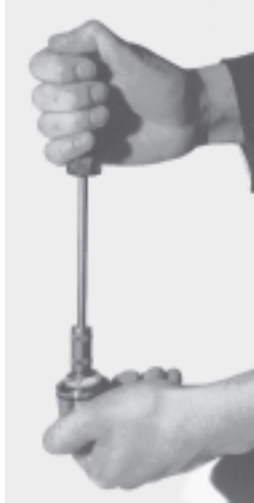
The front insulator may be replaced if damaged using the special tool provided. This is an operation that requires considerable care, as it is necessary to engage a fine thread in the plastic component. The front insulator carries a second (identical) O-ring that should be lightly coated with silicone compound prior to fitting. It is then necessary to engage the fine thread on the outside of the front insulator with that on the inside of the nozzle holder. Once sure that it is properly engaged, the special tool engages with two small slots to screw the insulator fully home. ***Do not use undue force!***

Removal of a damaged insulator may require use of pliers or similar, if the slots have been damaged.

The contact tube can also be replaced if necessary, as on the standard torch, with the 1/8" Allen Key

To renew the consumables, the following procedure should be adopted, remembering that care and cleanliness are of the utmost importance.

1. Recover the torch to the surface.
2. Switch the machine off at the mains supply or Main Isolator.
2. Remove the Front Cap. The cap is a push fit over the O ring seated in a groove in the outer diameter of the Torch Body and engages with a sealing ring on the Front Insulator.



3. Unscrew the Nozzle with the special tool supplied. (See illustration left).

4. Check the condition of the Electrode Assembly. If it is to be removed, grip the Electrode Assembly with the special Electrode Pliers provided, and pull firmly out from the torch body. (See illustration right).



5. Press a new Electrode Assembly carefully but firmly over the contact tube until it is fully home and central. Use the handle of the Nozzle Tool which has been prepared for this purpose. **THIS IS VERY IMPORTANT !** If the Electrode is not pressed fully home onto the Contact Tube, the Swirl Bush may be partly crushed by the Nozzle, and will interfere with the airflow.
6. Carefully screw the Nozzle into the Torch Head using the special tool until fully home. **DO NOT OVER TIGHTEN.**
7. Apply a liberal quantity of Silicone Grease around the front of the torch, especially to fill the space between the nozzle, front cap and sealing ring.
8. Refit the push fit Front Cap. Apply additional grease over the outside of the front cap. The grease will provide a first line of defence against material blown back from the cutting process.

Remember that cleanliness and care must be taken when fitting consumables. Do not allow dirt to obstruct the threaded parts of the torch. Take care when engaging threaded parts not to damage the thread.

CONTACT TUBE REPLACEMENT.

Should the Contact Tube need changing, it is removed by inserting the 1/8" allen key supplied into the centre and unscrewing. Replacement is the reverse of removal but **it is important not to over tighten** as this may cause subsequent electrode fitment to be off centre, producing bevel cuts.

6. TECHNICAL DATA

6.1 Power Unit

6.1.1. Electrical Input

Input is via 3 core and earth flexible: 4 x 16mm² 3 metre length standard.

Machines are available for the following 3 phase supplies:

Note. When the power unit is connected to a generator it may be necessary to disconnect the power factor correction capacitors in the power unit if they disturb the generator's automatic voltage control. This does however increase the demand at full power.

Input Voltage		With PF Correction	Without PF Correction
380v	50Hz	75 amp	106 amp
415v	50Hz	70 amp	98 amp
460v	60Hz	70 amp	98 amp
Other voltages and frequencies available to order			

6.1.2. Electrical Output

Open circuit voltage	330-345V dc
Typical arc voltage	150-200V dc
Main arc power	36kW
Pilot arc current	15 - 20 amps nominal
Duty cycle	100%

6.1.3 Miscellaneous

Compressor type	Oil free twin cylinder.
Water pump type	Regenerative type.
Water capacity	10 litre (aprox. dependant on hose length) distilled or deionised water

6.1.4. Dimensions

Length	1200mm	(48") inc wheels and handle.
Width	800mm	(32") "
Height	800mm	(32") "
Weight	290 kg	(640 lb)

6.2 Torch and Hose Set

6.2.1 Hand Torch

Torch body diameter	40mm
Torch head weight	1.0 kg
Effective weight (inc. hose set)	1.5 kg
Hose set lengths available	10m, 15m, 20m, 30m, longer with 30m Extensions.
Hose set water capacity	0.6 litres per 10m length

7. SERVICE INFORMATION

7.1 The Power Unit

The power is carried to the torch electrode by a cable within the umbilical.

Pilot arc connection to the nozzle is made via a current limiting resistor and switching circuit in the rear of the machine and a coaxial cable in the umbilical. The pilot arc connection to the nozzle is disconnected on main arc transfer. The HF arc ignition is fully automatic in operation, being powered from the torch power lines.

The compressor and cooling fan are the only “phase sensitive” components and it is essential to ensure that their direction of rotation is correct according to the installation instructions (see section 3).

These components and the water pump are protected by thermal / magnetic overload switches. If an overload should operate, after establishing the reason for the trip (e.g. missing supply phase). It can be reset by first removing the machine cover then pressing the manual reset button on the overload unit situated behind the instrument panel.

The transformer, air and water radiators, and the pilot arc resistor, are cooled by an electric fan. A temperature sensing interlock inside the transformer windings protects the system against thermal overload should the cooling fail or be obstructed hence it is essential to ensure adequate air circulation around the machine at all times. The rectifier is cooled by a small fan, and has thermal overload and varistor diode protection.

The air compressor is of the oil free, maintenance free, twin piston type fitted with two cleanable/replaceable inlet filters contained in black screw-in housings. The air from the compressor is first passed through a cooling radiator and then a coalescing filter to dry it. This has an automatic drain.

The high pressure water pump supplies cooling water to the torch through quick release, self sealing couplings so that the torch can be disconnected without the loss of water from the system. There is an interlocked flow sensor on the return line which shuts down the arc if the water flow should be restricted. The water cooling circuit is fitted with a de-ionising canister. This is principally in case of contamination of the coolant (de-ionised water) by seawater or similar, for instance should the pipes become disconnected underwater. Should the coolant become excessively conductive it will be necessary to change the de-ionising cartridge. When the cooling system has been empty it may be necessary to vent the canister of air. This is done either with a vent valve on the top of the unit, when fitted, or by unscrewing the cartridge housing slightly, until the water level rises to the top.

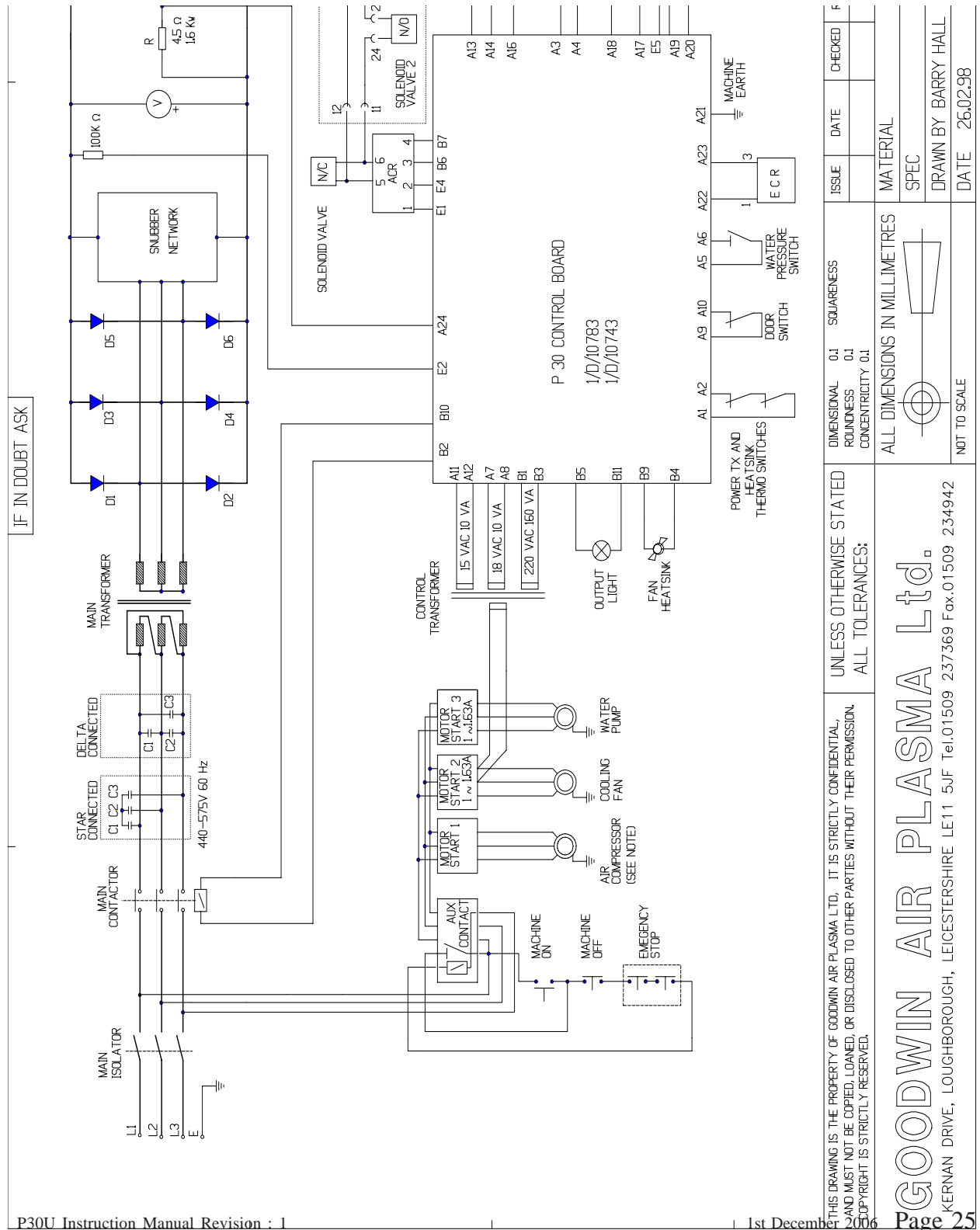
The header tank must be kept full of distilled water at all times. If site conditions dictate that antifreeze should be used, then up to 33% METHANOL may be added.

NOTE. Ethylene glycol or automotive type antifreeze fluids **MUST NOT BE USED**, as they will cause rapid corrosion of the torch.

There is an Earth Loop Monitor device which passes an alternating current around the loop formed by the dual earth connections. This is also fitted with an ammeter shunt to allow the Supervisors Panel to display cutting current. An additional loom connects between this and other additional features, and the standard machine loom and the 24way socket to the Supervisors Panel.

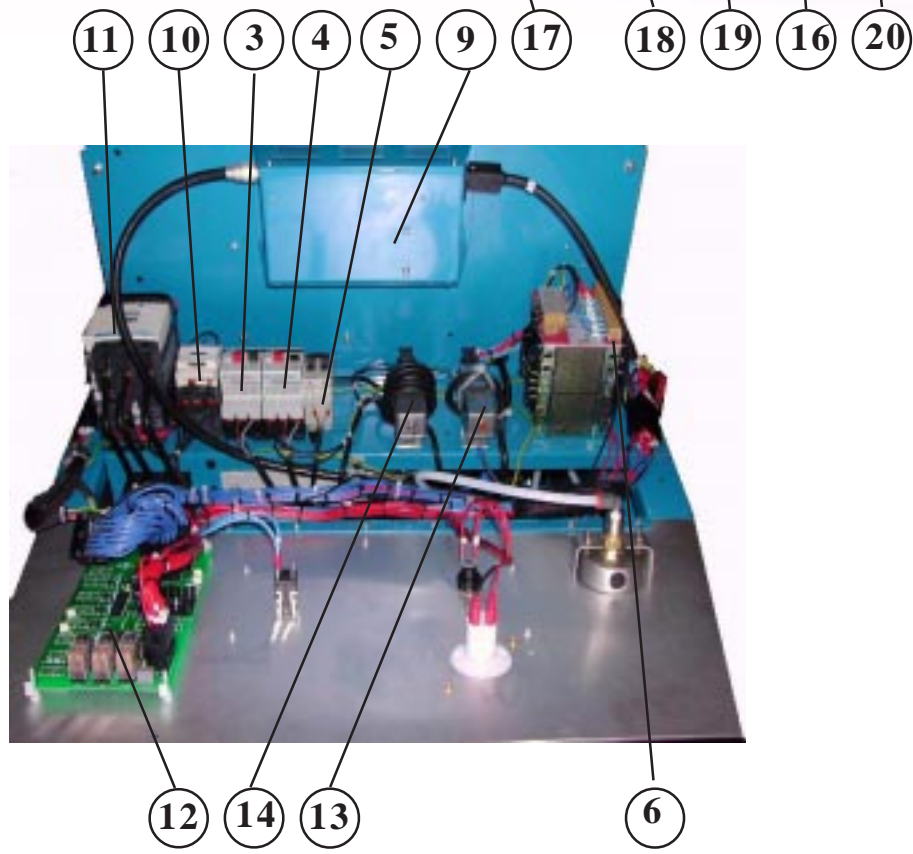
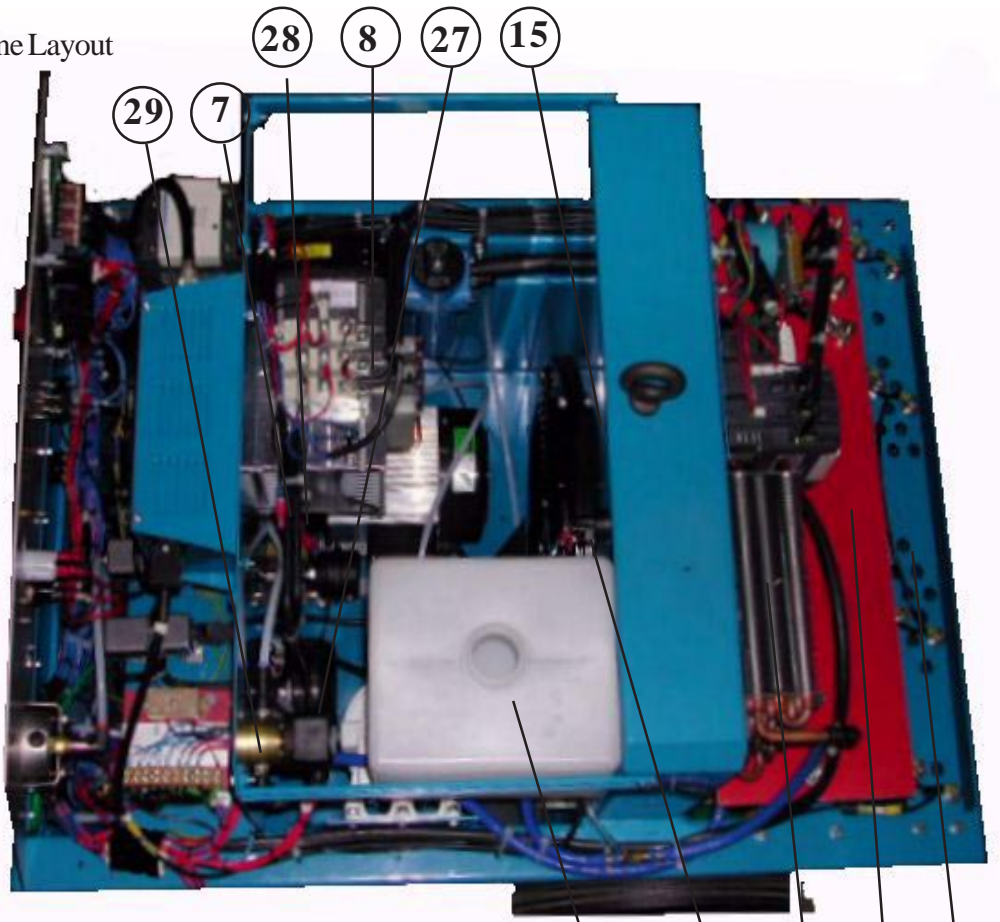
Whenever any of the interlocks come into operation the appropriate warning light on the front panel will indicate to assist in the diagnosis of the problem.

7.1.1. Circuit Diagram



<p>UNLESS OTHERWISE STATED ALL TOLERANCES:</p>		<p>DIMENSIONAL ROUNDNESS CONCENTRICITY 0.1</p>	<p>0.1 0.1 0.1</p>	<p>SQUARENESS</p>	<p>ISSUE</p>	<p>DATE</p>	<p>CHECKED</p>	<p>F</p>
<p>THIS DRAWING IS THE PROPERTY OF GOODWIN AIR PLASMA LTD. IT IS STRICTLY CONFIDENTIAL, AND MUST NOT BE COPIED, LOANED, OR DISCLOSED TO OTHER PARTIES WITHOUT THEIR PERMISSION. COPYRIGHT IS STRICTLY RESERVED.</p>		<p>ALL DIMENSIONS IN MILLIMETRES</p>			<p>MATERIAL</p>		<p>SPEC</p>	
<p>GOODWIN AIR PLASMA Ltd.</p>		<p>NOT TO SCALE</p>			<p>DRAWN BY BARRY HALL</p>		<p>DATE 25.02.98</p>	
<p>KERNAN DRIVE, LOUGHBOROUGH, LEICESTERSHIRE LE11 5JF Tel:01509 237369 Fax:01509 234942</p>								

7.1.2. Machine Layout



PARTS LIST

PART NUMBERS

1	Volt Meter	PX52MV300S
2	Main Isolator	PX50IS99F
3	Motor Starter Compressor	PX50CM025
4	Motor Starter Fan	PX50CM010
5	Motor Starter Water Pump	PX50CM016
6	Control Transformer	PX56A200
7.....	Compressor Filters	PX57CXT01
8	Diodes	PX54S0029
9	H F Box	PX68MFI0870
10	Aux Contactor	PX50CA09
11.....	Main Contactor	PX50CA80
12	Control P C Board	PX55C10782A
13	Arc Current Relay	PX68MF10323
14	Earth Current Relay	PX68MF10565
15	Fan	PX57FA300
16	Main Transformer	PX56M30+VOLTAGE
17	Water Tank / Cap	PX63T10833/PX63M004
18	Water Pressure Switch	PX50SA01
19	Radiator Assembly	TO ORDER
20	Pilot Arc Resistor	PX54R0067
21	Air Pressure gauge	PX28100G
22	Output Neon	PX52BN240A12
23	Air Pressure Regulator	PX29R08
24.....	Stop/Start Switch	PX50SP00Z
25.....	Emergency Stop Switch	PX50SP001
26.....	Reset Switch	PX50SP01
27.....	Water Pump	PX57W500
28	Compressor	PX57C400
29	Solonoid Valve	PX29VS99
(Not Shown).....	Dix Connector	PX4201RD300S
(Not Shown). Power Factor Correction Capacitor		PX54C0038
(NS) ..(Water fitting, Return) Mini Check Unit Long		PX29V01
(NS)(Water fitting, Feed) Mini Check Unit Short		PX29V10829



7.1.2. Diagnostic Indicators.

OUTPUT ON LAMP

Indicates that power is applied to the torch.

POWER INDICATOR

Indicates that 12V power is available to the system control circuit.

READY INDICATOR

Indicates that all system interlocks including the access door are operational and that the machine is ready to operate.

TEMPERATURE INDICATOR

Indicates that the rectifier heatsink and / or main transformer temperature is too high. Cutting operations will immediately stop. Leave the machine running to allow the fan to cool the transformer. Systems will automatically reset when the temperature drops.

WATER INDICATOR

Indicates no water in the system, a water leak, torch blockage, low pump supply pressure or incorrect motor/fan rotation. When water flow is restored, the system will reset automatically.

EARTH CURRENT INDICATOR

Indicates the main arc cutting current is flowing in a secondary path. System will stop until it is reset when the torch switch is released. (See section 3.2 for cutting earth requirements).

EARTH SAFETY INDICATOR

Indicates a break in the earth connection to the torch or a voltage in excess of 10 volts to the torch body. This indicator will also illuminate as a self test when the machine is switched, on Depressing the RESET button will reset the system provided the fault is rectified. This can also be reset on the Supervisors Panel, which must be separately reset in any case.

PILOT TRIP INDICATOR

Indicates the pilot arc has excessive current. The circuit will reset automatically when the torch switch is released. Check air flow adjustment, air leaks, restricted air flow, or consumable condition.

EARTH LOOP MONITOR INDICATOR

Indicates that a satisfactory dual earth connection has been made to the workpiece, which will enable the Diver's Switch.

7.2 The Torch and Hose Set Repair

The torch is a precise assembly of electrically conductive parts and P.T.F.E. insulators housed in a stainless steel body. It is supplied with compressed air, water and electrical power at high voltage which must not be allowed to escape from their designed confines.

Rebuilding torches requires special training and instruction and is not within the scope of this manual. Users who wish to repair damaged torches themselves should consult their supplier or Goodwin Air Plasma for detailed advice. A separate manual is available for suitably trained personnel.

Torches should be removed from the power unit complete with umbilical. Once removed, the torch head may be serviced or repaired.

If a spare torch and umbilical is available, the machine may be put back in service whilst repairs are carried out.

TORCH BLOCKAGE.

The water flow in the torch can occasionally become blocked, usually with scale because deionised / distilled water has not been used or has become contaminated. Also, copper deposits can accure as a result of expiry of an electrode. If this cannot be cleared by "back-flushing" the torch it will be necessary to dismantle the torch (see above).

EXTENSION UMBILICALS

The Extension Umbilicals are fitted with special underwater electrical connectors that are overmoulded after termination. The hose assembly is spiral wound within a stainless steel overbraid. Both of these features render the Extensions essentially un-serviceable, therefore great care should be taken to avoid damaging them. The hose connectors can be replaced if damaged or leaking.

7.3 Maintenance

<p>Daily</p>	<p>Check condition of the consumables regularly. Top up water reservoir with distilled / demineralised water if required.</p>
<p>Monthly (depending on usage)</p>	<p>Check for water and air leaks. If used in a dusty environment, clean the air compressor intake filters. Remove excessive dust from inside the machine taking care not to damage any mechanical or electrical component and avoid exposure to this dust which may represent a health hazard. Use personal protection as necessary.</p>
<p>Annually more frequently in poor conditions or with high usage</p>	<p>Clean or replace the compressor air intake filter. Check tightness of all electrical and mechanical connections. Check the correct operation of all controls and indicators. If possible check the conductivity of the cooling water. If necessary replace the water and the de-ionising cartridge. This may also be required following a known contamination of the cooling circuit, for instance if the hose connectors become detached underwater.</p>

Goodwin Air Plasma Cutting Systems are designed so that only a minimum amount of maintenance is required. By following a regular and careful maintenance procedure, the equipment will give a long productive life.