Plasma*Blast*®

Mobile

PB7000-M-24

208-240VAC

User Manual
Rev 3.0R

September 2022

Model PB7000-M-24

Model PB7000-M-24CE

CE   This mark is the confirmation that the unit with model number PB7000-M-24CE conforms to the applicable EU directives and has been tested according to the Electromagnetic Compatibility Directive 2014/30/EU, and to the Low Voltage Directive 2014/35/EU.

RoHS   This mark indicates conformity RoHS 2011/65/EU Directive and the 2015/863 amendment

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September 2022

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Summary of Technical Data

<u>Models: PlasmaBlast® PB7000-M-24 and -24CE</u>

Mechanical Specifications:

Dimensions:	12" x 14" x 22"	31 cm x 36 cm x 56 cm
Weight:	34 lbs	15.4 kg
Plasma Cable length:	20 ft	6.1 meters

Electrical Specifications:

Input Power	208-240 VAC, 50-60Hz, single phase
Input Current	18 Amps, CE-14.5 Amps
Default Plug Type	NEMA L6-30
Optional Plug Types	NEMA L6-20, NEMA L14-20, NEMA L14-30, NEMA L15-30 3ph
Device EMC Status	Class A Group 2
Applicable Standards	EN/IEC 61326-1:2013 IEN/IEC 60974-10 IEC/EN 60974-1
Degree of Protection	IP 52

Operating Parameters:

Operating Temperatures	14°F - 110°F	-10°C - 43°C
Operating Humidity	<95%, non-condensing	
Elevation	<9843 ft	<3000 meters
Operating Sound Level	~90 dBa	
Input Compressed Air Pressure	80-100 psi	550kPa-690kPa, 5 -7 bar
Burst Pressure	120 psi	827 kPa, 8 bar
Optimal Input Compressed Air Flow	3.5 CFM	99 SLM

CE Rating Plate Information Guide
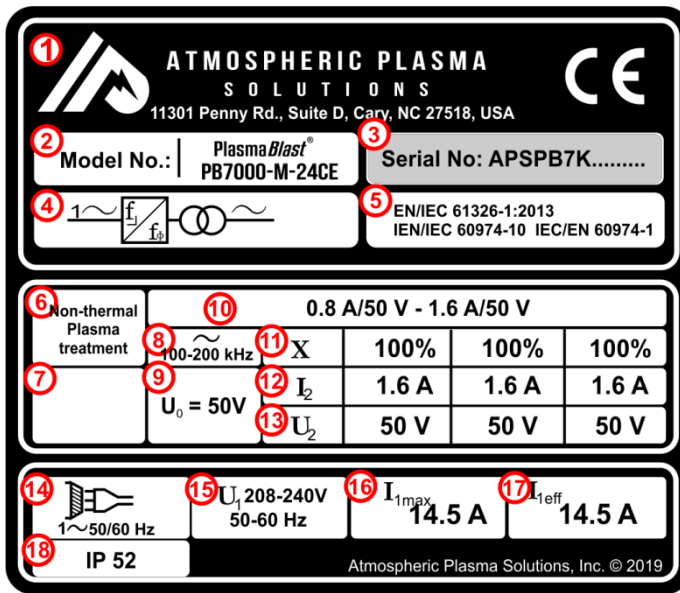
Box 1 – Manufacturer Identification
Box 2 – Model Number
Box 3 – Serial number of the device
Box 4 – Inverter power source with AC output
Box 5 – Applicable standards
Box 6 – Process description
Box 7 – N/A
Box 8 – Current symbol/rated frequency
Box 9 – Rated no-load voltage
Box 10 – Range of output, min./max. current, and their corresponding load value
Box 11-a,b,c – Duty cycle at ambient temp. 40^0C
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Box 14 – Energy input symbol
Box 15 – Rated supply voltage
Box 16 – Rated max. supply current
Box 17 – Max. effective supply current
Box 18 – Degree of protection

1.   Introduction

1.1.   Plasma*Blast* ® System - Principle of Operation

The PlasmaBlast® coating removal system uses a low pressure compressed air source and electricity to produce atmospheric pressure air plasma which can be used to selectively remove polymeric paints and coatings from a wide range of substrate materials. The atmospheric air plasma generated by this system produces chemically active species from the air (atomic oxygen and nitrogen) and oxidizes the polymeric component in paints and other coating systems into gases which essentially removes the coating with minimal residue. The PlasmaBlast® chemical oxidation process converts a large percentage of the removed polymeric coating into gases such as water vapor and carbon dioxide and leaves behind less solid mass than was present in the original coating. The remaining solids are mainly pigments and fillers and can be safely vacuumed away with a suitable HEPA vacuum.

1.2.   Overview of PlasmaBlast® PB7000 Series

Generally, the PlasmaBlast® coating removal system is comprised of a high voltage (HV) plasma controller, a plasma cable, a plasma pen or applicator, and a grounding cable. Inputs to the system are compressed air and electricity, and the system is grounded through its power cord and a ground cable. There are several different models and sub-models of the PlasmaBlast® coating removal system. Each model/sub-model is specialized for and operating voltage, as outlined in Table 1 below.
This manual describes safety, installation, operation, maintenance, and troubleshooting procedures for the PlasmaBlast® Mobile system with 208-240VAC single-phase operating voltage.

Model	Use	Operating Voltage
PB7000-B-24	**Benchtop Operation**: the model can be operated inside buildings/hangars in a semi-stationery setting (on a cart, or a bench)	208-240VAC, Single phase
PB7000-B-48		440-480VAC, Three phase
PB7000-M-24 and -24CE	**Mobile Operation:** the model can be operated in the field/yard	**208-240VAC, Single phase**
PB7000-M-48		440-480VAC, Three phase
PB7000-R-24	**Robotics-compatible:** the model can be integrated with robotic systems	208-240VAC, Single phase
PB7000-R-48		440-480VAC, Three phase

Table 1: Models of PlasmaBlast® system.

The manual is divided into the following chapters:

Chapter	Description
1	Introduction: Provides an introduction to the PlasmaBlast system
2	Safety & Legal: Precautionary measures for safely operating the system and legal statements.
3	System Setup: Describes system connections and facility requirements.
4	System Components and Controls: Describes operational details of the system.
5	System Operation: Describes how to power up and operate the system.
6	Maintenance: Describes maintenance procedures.
7	Troubleshooting: Describes common problems that may occur and methods of their rectification.
8	Support: Provides information on how to obtain technical support

2. Safety and Legal

2.1. Safety Alerts

It is extremely important that you follow the instructions and heed the DANGER and WARNING safety alerts in this Manual. Your safety and the safety of others are very important.

We have provided important safety messages in this Manual and on the PB7000-M.

This is the safety alert symbol. This symbol alerts you to potential hazards that can cause death or injury to you or others.

All safety messages will follow the safety alert symbol and either the word "DANGER" or "WARNING". These words mean:

⚠️**DANGER**	Death or serious injury may occur if you do not follow the instructions in this manual
⚠️**WARNING**	Death or serious injury may occur if you do not follow the instructions in this manual
⚡**DANGER SHOCK HAZARDS**	Death or serious injury may occur if you do not follow the instructions in this manual

2.2. The PB7000-M System and Diagram

See Section 3.1 for the diagram of the PB7000 and the names of the PB7000 system components used in the safety instructions below and throughout this Manual.

Operation of the PB7000 plasma system may require three pieces of additional equipment: (1) an air compressor; (2) an electric generator, and (3) a dust collection system.

⚠️WARNING   *The safety instructions in this manual pertain only to the PB7000. Safe operation of the PB7000 depends on safe operation of the auxiliary equipment. The operator of the PB7000 must be informed about, and comply with, the safety instructions for any auxiliary equipment, such as an air compressor or power generator. Consult the manufacturers' equipment manuals pertaining to this equipment.*

2.3. Safety Instructions

⚠️WARNING SAFETY ALERTS AND INSTRUCTIONS

The PB7000 produces an atmospheric plasma beam capable of removing organic coatings and altering surfaces. A high voltage, high frequency waveform and compressed air are used to internally generate the plasma. Depending on the coating or substrate that the plasma is used on the plasma may interact with coatings and surfaces that may result in the release of toxic and other hazardous materials. This portion of the manual provides instructions on how to use the PB7000 in a safe manner.

Read all safety alerts and all instructions. Failure to follow alerts and safety instructions may result in serious injury or death.

It is important to follow all safety procedures defined in this manual to avoid personal injury to yourself and others.

General
- PlasmaBlast ® system is an electronic device. Drops > 1 meter may cause irreparable damages. Prevent dropping the unit by always placing it on stable, surfaces during operation and storage and securing the unit to reliable structures while in use.
- Follow all local laws, rules, ordinances, statutes and orders.
- Setup and operate the PB7000 as specified in this Manual.
- Have everything you need to setup and operate the PB7000.
- Make sure the equipment not supplied by APS (electrical generator, air compressor, dust collection system, compressed air line, electrical cord) is in proper and safe operating condition.
- Only certified users as designated in the APS certified user logs should use this equipment.

Work Area Safety
- Use proper lighting, sufficient to see the details of the workspace well. Keep work area free of obstacles and as clean as possible – the risk of accidents increases when the operator is not able to see and is hindered by obstacles and clutter.
- Ensure the unit is safely secured to avoid drops or falls.
- Keep the hose out of walkways and vehicle /equipment paths.
- Do not allow access to bystanders to an operational system.
- Wear long sleeved shirt, long pants, closed-toe rubber-sole shoes.
- Remove all loose jewelry, secure long hair.

⚠️ RISK OF EXPLOSION AND FIRE

The plasma nozzle of the PB-7000 system will reach temperatures that may exceed 350°F/ 175°C. If the nozzle comes in contact with flammable materials for extended periods of time there is a possibility of fire. Do not operate the PB7000 in enclosed areas where solvents or other explosive gases are present in the air or where rags and other materials that may have residual solvents exposed to open air. The temperature of the replaceable nozzle of the plasma pen may reach temperatures in excess of 350°F/ 175°C and could ignite these materials; plasma may cause chemical reactions that result in heat; and hot particles ejected from the plasma removal process may create sparks.
Do not operate the PB7000 in the presence of explosive or flammable liquids, gases.

Electrical Safety

⚡ DANGER SHOCK HAZARDS

- **Proper AC Earth Ground required**

AC line voltages are present in the power cord, and the power supply. The plasma cable contains high voltage and high frequency waveform. Do not operate the plasma controller unless it is securely grounded with a low impedance earth ground connection through the supplied AC power cable.
The plug from the electrical cord to the PB7000 must match the receptacle. Always use the electrical cord included with the system. Never modify an electrical plug or an electrical receptacle. Always use a plug that includes and earthed (grounded) plug. Do not use any adapters which would defeat or disconnect the connection to earth (ground).
Serious injury or death may occur if the proper safety procedures are not followed or the plasma system is used by untrained users.

- **Never operate with damaged cables**

Make sure that the cord from the electrical source is in good condition. Keep the cord away from heat, oil, water, sharp edges, and moving parts. Do not otherwise compromise the electrical cord. The electrical cord carries electricity at 240VAC or 480VAC depending on the model. If it is compromised severe injury from electrical shock or a fire hazard may result.

- Wear dry, hole-free, OSHA-approved leather gloves to electrically and thermally protect the hands.

- There are no user serviceable parts inside the plasma system. Do not open any covers on the plasma system. Never operate the plasma controller with the cover panels removed or with the interlock bypassed.
- Only use input voltages between the voltage for which the unit is rated and as indicated on the unit (I.e. 208 – 240V or 440-480 V)
- Always assume that the HV output of the plasma controller is active and at high voltage unless the plasma controller has been turned off and unplugged for several minutes.
- The plasma pen can be used in light precipitation conditions, but make sure that the power supply is kept dry at all times.
- Make sure the plasma cable connector that connects to the power controller is seated and the safety lever is locked in place.
- Never use power cable, ground cable, or pen cable as a lift point.
- Make sure that the plasma cable is in good condition prior to use. Do not pull the cable against sharp objects or permit it to be cut or abraded by foreign objects. Do not permit the plasma cable to become knotted or kinked. Keep the plasma cable away from heat, oil, water, sharp edges, and moving parts. Do not otherwise compromise the plasma cable. It has multiple layers of material protecting the operator but a damaged cable can create the risk of shock, extreme care must be given to the cable and its connection to the plasma controller.
- Do not expose the plasma controller to water, liquids or conductive dusts or powders.
- Do not submerge the plasma system in water or any other liquids.
- Never allow any liquid, such as oil or water, to enter the air lines. Introduction of liquids into the air lines may cause a failure of the plasma system.

Do not open the plasma controller box. *A person who opens the box may be exposed to risk of injury or death from electrocution.*

Operational Safety

⚠️ WARNING OPERATIONAL HAZARDS

Operation of the PB7000 presents hearing, eye and other risks to the operator. Follow all safety instructions to avoid property damage, serious injury or death.

Vision Protection Required
Plasma emits a low output of UV light. Additionally, the interaction of the plasma beam with the surface of a material can produce high velocity airborne particles that may cause permanent eye injury. Protect your eyes with impact resistant clear plastic safety glasses that conform to the current ANSI Z87.1-2015 safety standards.

Hearing Protection Required
The PB-7000 operates at noise levels of approximately 85 dB within 5 feet from the plasma pen. Prolonged exposure to the operating noise of the PB-7000 without hearing protection may cause hearing loss. Protect your hearing with OSHA approved earplugs or earmuffs with a minimum of 28 dB noise reduction rating (NRR).

Heat Hazard

During prolonged PB7000 operation certain parts of the system will become hot.
- Pen tip - >350°F/ 175°C
- Pen grip 95°F -165°F / 35°C - 75°C
- Rear heat sink - >175°F / 80°C

Wear dry, hole-free, OSHA-approved leather thermally insulating gloves to protect the hands. Welder's leather gloves are recommended.

WARNING: Compressed Air

A high velocity compressed air stream is emitted from the plasma pen during operation (approximately 80-100 psi / 5.4-7 bar and 3.5 CFM / 100 SLM air flow). Compressed air can penetrate skin and result in air bubbles in the blood stream that can cause heart attack, brain injury, and other serious injury or death. Do not allow the compressed air exiting the pen nozzle to pass in front of bare skin.

- Do not use any gas other than air. Only use clean, dry air.
- Do not change or modify factory air fittings. The use of adaptors is permitted.
- Do not block the air flow from the pen.
- Do not point the plasma pen at any part of the body of the operator or anyone else.
- Do not attempt to replace, tighten, or adjust the replaceable nozzle when air is flowing through the plasma pen or when the plasma pen is connected to compressed air or to electricity.
- Make sure the replaceable nozzle on the plasma pen is securely fastened prior to starting the plasma controller (see Section 6. Maintenance on replacement of the nozzle). If *the replaceable nozzle is not securely fastened it could fly off at a high velocity when operating the PB7000 and cause property damage or serious injury.*

WARNING: Hazardous Debris & Toxic Coatings

The plasma coating removal process can result in flying debris or release of other material that may be toxic and cause personal injury or property damage. The debris may include sand, grit, rust, pigments, paint particles, gases, liquids and solids resulting from interaction of the plasma with the surface.

- The plasma removal process does not change or mitigate any pre-existing risk in a paint, sealant or other surface coating. If you remove old paint or coatings you may release lead or other hazardous dusts.
- Ensure proper air ventilation. The plasma may generate toxic and other hazardous byproducts, including gases and particulates, depending on the coating chemistry. *For example, removal of lead paint will produce lead paint dust and proper PPE and dust collection equipment should be use to contain the lead dust produced.*
- Do not operate the PB7000 in settings where other people may be injured by toxic and other hazardous debris ejected from the surface being treated. *The plasma plume will dislodge particles in the surface being treated. The debris ejected may strike the operator, other people or physical objects and cause property damage and physical injury.*
- Prior to beginning any removal the user must be aware of the potential health risks associated with the coatings being removed. Obtain and review the Safety Data Sheet of any coating being removed. As needed discuss risks with your company's Environmental Health and Safety staff.

- Always wear protective gear, a dust mask or a respirator. If the exact coating composition is unknown assume that it may be dangerous and take full precautions.
- Always wear protective eye wear and other protective gear as needed for the surface and coating being treated.
-

⚠️ WARNING: Gas Buildup

- Small concentrations of Ozone and NO_X are produced as a natural biproduct of the air-plasma generation process.
- In enclosed spaces with limited ventilation, these gasses can buildup to nuisance or hazardous levels.
- Always use sufficient ventilation. A full-face mask with supplied air ventilator can be used instead. A full-face mask with appropriate multi-gas filter can be used only if ventilation can't be brought into the space and an SA ventilator is not available.
- Symptoms of Ozone and NOx exposure include: irritated eyes, nose, chest, or throat; difficulty breathing; coughing; headaches; dizziness; and light-headedness.

⚠️ WARNING: RISK OF INJURY FROM PLASMA BEAM

Plasma, in direct contact with the body, can damage skin and injure other body parts. Improper use of the plasma beam on toxic coatings, such as lead paint, can cause release of toxic materials. Application of the plasma beam to a glass surface may result in glass breakage or shattering. The plasma beam may etch and otherwise damage physical surfaces.

- Do not point the plasma pen at any part of the body of the operator or anyone else.
- Do not allow the plasma beam to come in contact with bare skin, wear protective gloves and clothing
- Never use the plasma pen on silicate glass; the glass may shatter producing sharps shards.

⚠️ WARNING: RISK OF PROPERTY DAMAGE

Do not point the plasma beam at materials or surfaces that are not intended to be altered. *The plasma may cause damage to unintended materials. For example, the plasma can etch wood and shatter glass.* Do not overexpose surfaces that are intended to be altered. *As is the case with other power tools if a surface is overexposed to the plasma it will be altered in an unintended way and may result in property damage.*

2.4. Maintenance

ATTENTION: THERE ARE NO USER-SERVICEABLE PARTS INSIDE. ANY ATTEMPT TO OPEN THE PLASMA CONTROL MODULE COULD EXPOSE THE USER TO HIGH VOLTAGES AND MAY PERMANENTLY DAMAGE THE EQUIPMENT. OPENING OF THE CONTROLLER BY THE USER WILL VOID WARRANTY.

There are no user-serviceable parts in the PB-7000 system except for the replaceable plasma pen nozzles and electrodes (see Section 6." Maintenance" on replacement of the nozzle or electrode). Do not disassemble any part of the system. Tamper evident seals have been used to detect unauthorized access. Evidence of tampering with or otherwise attempting to open the controller will result in a voided warranty, and for rental systems will void any lease agreement and will require purchase of this non-warrantied system. All repairs and/or modifications should be conducted by qualified APS service personnel.

2.5. Grounding

When using portable generators, follow all grounding instructions included in the operating manual. For facility power, ensure that the power outlet conforms to all local and national electrical codes.
All facility provided outlets must provide a safety ground.
The plasma pen is grounded through the grounding port located on the pen cable about 6 ft from pen body. When working on metal and other conductive substrates, clamp the supplied grounding cable to the substrate. Do not operate the PlasmaBlast system if the grounding cable is damaged or missing.
Do not operate the PlasmaBlast system if the grounding cable is damaged or missing.

2.6. Trained Operator Responsibility

Only operators trained by certified APS trainers should operate the plasma system. The operator of the equipment is responsible for safe operating procedures and proper use of the equipment. APS assumes no responsibility for the operation of the equipment or the safety practices of the end user.
To prevent a possible electrical shock hazard, only replace the nozzles with APS nozzles. Other nozzles may fit the plasma pen but they will not meet the specifications required for safe operation of the plasma pen. There are no third party nozzles suitable for safe operation of the plasma pen
Do not drop, spill liquids on, damage, or otherwise mishandle the PB-7000-B. The system contains breakable parts and parts that will not function when damaged. Do not operate a damaged PB-7000-B.

2.7. Personal Protective Equipment (PPE)

- Always wear impact-resistant, clear plastic safety glasses that conform to the current ANSI Z87.1-2015 safety standards to protect your eyes from dust and flying particles.

- Always wear OSHA-approved hearing protection - foam ear plugs or other approved hearing protection with a minimum 28 dB noise reduction rating (NRR) when operating the plasma pen system.

- Wear OSHA-approved dust mask (N95 or similar)
- If removing a coating with toxic components wear a respirator and any other safety equipment required for the specific toxin encountered.
- If the coating composition is unknown, wear a respirator as a precaution.

- Wear dry, hole-free, OSHA-approved leather gloves to electrically and thermally protect the hands.

3.   System Components and Controls

The PlasmaBlast® PB7000-M system (Figure 1) is comprised of a Plasma Controller ① mounted onto Protective Frame ② equipped with high-density rubber bumpers. Cargo Bag ③ is attached to the front of the Controller.

⚠️ **WARNING: The PlasmaBlast ® System is an electronic device. Drops >3ft (1 meter) may cause irreparable damages. Prevent dropping of the device by placing it on stable surfaces for operation and storage and securing the unit by fastening it to reliable structures.**

The Cargo Bag contains all other system components and consumable parts (Figure 2), such as Plasma Pen ①, Power cable ②, Ground cable ③, Pressure regulator with filter ④, and a set of Replacement Nozzles with anti-seize lubricant ⑤

Figure 1: PB7000-M System

Figure 2: System Components

3.1. PlasmaBlast® Plasma Controller

The PlasmaBlast® system converts electrical energy (from a mains outlet or a portable generator) and compressed air into atmospheric plasma. The function of the Plasma Controller is to filter, rectify, and invert the incoming electrical energy to output a special high-frequency waveform into a custom-designed transformer. The high-voltage output of this transformer is then fed through an umbilical to the plasma pen. Simultaneously, compressed air is fed into an air handling subsystem, which regulates the airflow being fed into the plasma pen.

Figure 3: PlasmaBlast® Controller, front and back

Plasma Controller Module①contains power conditioning and plasma generation electronics. Applicable warning labels and model/serial stickers are located on the back panel of the Plasma Controller.

> ⚠ **WARNING**: *DO NOT ATTEMPT TO DISSASEMBLE THE PLASMA CONTROLLER. THERE ARE NO USER-SERVICEABLE PARTS INSIDE. ANY ATTEMPT TO OPEN THE PLASMA CONTROL MODULE COULD EXPOSE THE USER TO HIGH VOLTAGES AND MAY PERMANENTLY DAMAGE THE EQUIPMENT.*

Heatsinks②on each side and the bottom of the system help dissipate the heat produced by plasma electronics.

Protective Frame③surrounding the plasma controller module features a **built-in handle**④that allows for the system to be easily carried from location to location by a single and a built-in **hexagonal socket tool**⑤used in pen maintenance procedures (see Section 6. Maintenance)

ON/OFF switch ⑥, located on the top of plasma Controller, turns plasma controller on or off. The ON/OFF switch may be used as an emergency stop to turn the plasma off while there is plasma output. *After plasma output has been stopped wait at least 5 seconds before plugging back in or using the front panel ON/OFF button to turn the system back ON.*

Status Display under a protective cover ⑦, also located on the top of the Controller, is protecting the LCD screen that provides the user with information on the status of the system and its operating parameters, as well as displays fault codes which are used in diagnostics in the case of equipment malfunction. Please refer to Section 5.4: Status Display for detailed information on the Status Display operation and fault codes.

Connector Block ⑧ inside the Cargo Bag mounted in the front of the Controller serves as manifold for all system connections (details below).

Pressure Regulator Bracket ⑨ is located on the right side of the Frame and serves as an attachment fixture for mounting the pressure regulator during system operation (see section 3.5 for more details on mounting Pressure Regulator).

Connector Block

All system inputs, outputs and controls are located on the Connector Block inside the Utility Bag of the Controller *(*Figure 4).
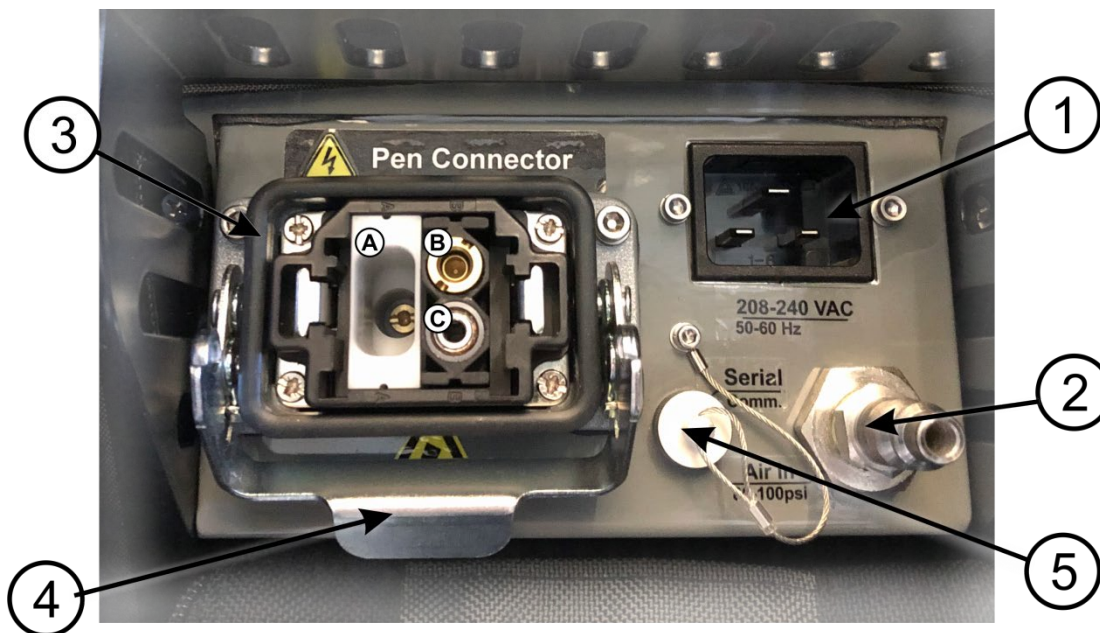

Figure 4: Connector Block Connections

① **Power Input**: The system power cable is connected to this connector. This connector accepts a line cord with an IEC C19 outlet connector. The plasma controller should only be operated with power cord supplied with the system.

② **Air Input:** ¼" standard industrial style air fitting. Air line is not included with the system. It is the responsibility of the user to provide all necessary air lines, connectors, and adapters. Never change or modify factory fittings, use adapters instead.

③ **Pen Connector Receptacle** provides High Voltage, Compressed air, and Communication output to Plasma Pen.

Ⓐ High voltage output power from the plasma controller to the plasma pen.

Ⓑ Compressed air output to the plasma pen

Ⓒ Plasma pen communication connector

This connector is equipped with **latching handle** ④ for secure connection to the plug of the Plasma Pen cable.

⑤ **Data Communication connector**: No user access, for diagnostics only, to be used by a <u>trained service technician only.</u>

3.2. Plasma Pen with Cable

The PlasmaBlast® plasma controller provides electrical power and low pressure, compressed air to the plasma pen through a single umbilical cord assembly *(Figure 5)*.

Figure 5: Plasma Pen with umbilical cable assembly

① **Plasma Pen (**see Section 5.4 "Plasma Pen Operation" for details)

② **Umbilical Pen Cable** is 20-ft long and consists of high voltage cable, air line and a signal cable bundled together inside a flame-retardant protective sleeve.

- Take great care when routing the umbilical cable.
- Route the high voltage cable to avoid the possibility of it being caught or snagged in moving parts of automated equipment.
- Take appropriate precautions to prevent the high voltage cable from becoming kinked, crushed, abraded, or damaged in any way.
- Never use the umbilical cable as a lift point.

DO NOT OPERATE WITH DAMAGED CABLES
- Always check pen cable for damage.
- Immediately contact APS if any damage is discovered

③ **High Voltage Connector Plug** on the other side of the cable connects to the Pen Connector Receptacle on the Plasma Controller.

In the course of routine operation, transportation and storage of PlasmaBlast® system the
Pen Cable should be connected to Plasma Controller via Pen Connector.
DO NOT DISCONNECT THE PLASMA CABLE FROM PLASMA CONTROLLER UNLESS NECESSARY FOR SERVICE OR REPLACEMENT. INCORRECT INSTALLATION MAY CAUSE SEVERE DAMAGE TO EQUIPMENT

④ **Ground Post**, located on the pen cable approximately 6ft from the pen body, serves as the attachment point for Ground Cable during system operation (see Section 5.3 "PlasmaBlast ® PB7000 System Setup" for details).

3.3.   Electrical Power Cord

Included with the PB-7000-M-48 systems is a 15ft long power cable, rated appropriately for 440-480VAC operating voltage.
On the Controller side this cable has an appropriately rated plug that connects to the latching receptacle on the Connector Block of the plasma controller.

The other end of the cable is equipped, by default, with the NEMA L16-30 plug.

Upon request, the system can be equipped with several other plug types. Please see APPENDIX A for list of acceptable receptacle options.

Wiring of Unterminated Power Cable

Wire the provided unterminated power cable (shown in Figure 6) as follows:

G (Earth) = Green
X (Hot) = Black
Y (Hot) = White

Figure 6: PB7000-R unterminated power cable wires

3.4. Grounding Cable with Clamp

To ensure proper grounding the PlasmaBlast ® PB7000-M system is equipped with a **Grounding cable** ①
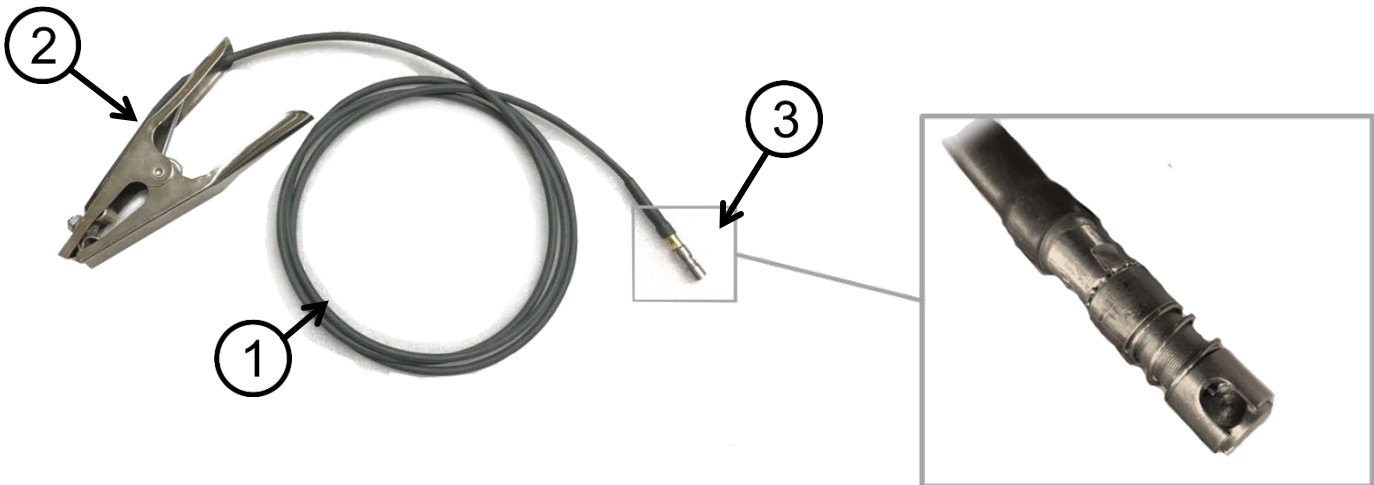with **Ground clamp** ② on one end and a **Ground connector** ③ on the other end (Figure 7).

Figure 7: Grounding cable with clamp and connector.

Ground clamp must be reliably connected during operation to the substrate, surface, or item that will
be plasma cleaned in order to ensure proper equipment operation and personnel safety.

ATTENTION:
*Always place system ground clamp on the substrate subject to coating removal,
near removal area. **If substrate is not grounded properly electric shock to the
user may occur.***

The Ground Connector must be connected to the Ground Post located on the pen cable approximately 6ft from the pen body. Ground Connector is equipped with spring-loaded sleeve which allows for quick connection to the ground post and enables 360^0 rotation of the connector with respect to the post.

Emergency Ground

Located inside the controller bag is an Emergency Ground attachment point. The Emergency Ground attachment point is provided in case the supplied ground cable connector is damaged and not functional. It will be necessary to either provide a similar welding clamp as the APS supplied ground connector or the damaged APS supplied ground cable connector may be cut off and removed and a suitable size ring terminal must be crimped onto the ground cable.   Please notify APS immediately if a ground cable is damaged so a new ground cable can be sent as quickly as possible.
The user may only use the Emergency Ground on a temporary basis until a new ground cable is received.
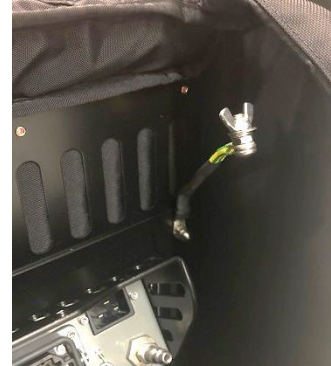
3.5. Pressure Regulator and Air Filter

Pressure regulator is included with the system to ensure an appropriate input pressure for proper operation of the system. The devise is equipped with air filter/dryer designed to capture most of the water, oil and dust particles entering the system.
The pressure regulator assembly (Figure 8) consists of:

Figure 8: Pressure regulator with filter
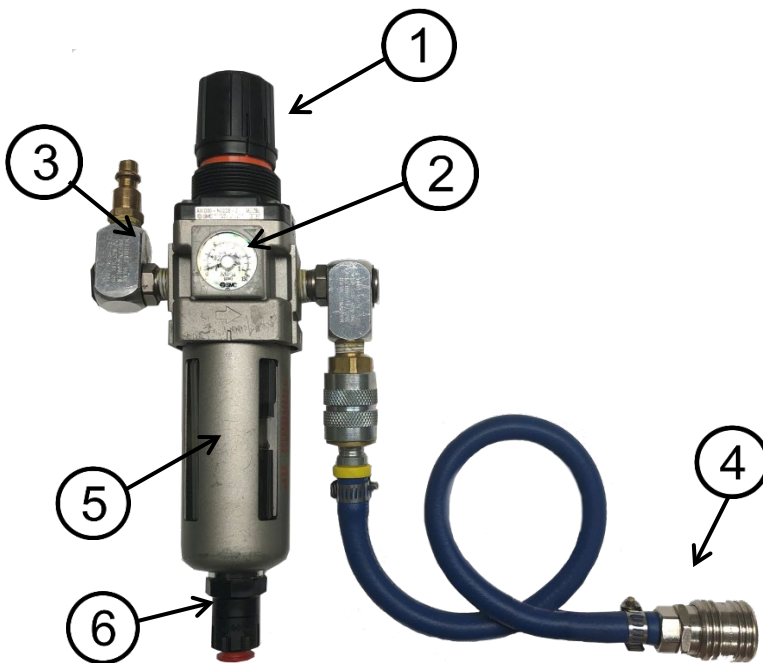
① **Pressure Regulator Knob**: used to adjust the pressure during system setup (see Section 5.3 "Plasma*Blast*® PB7000-M System Setup" for details).

② **Pressure Regulator Dial**: Displays pressure setting value during setup and operation of the system.

③ **Inlet Fitting:** compressed air from facility or portable compressor is connected to this fitting.

④ **Output to Plasma Controller:** connects to "Air In" fitting on Connector Block of the Plasma Controller.

⑤ **Air Filter**: minimizes water, dust, oil and other particles entering internal air line.

⑥ **Water Trap Drain**: the water captured from the air line is collected at the bottom of the filter and must be drained from time to time using the water trap drain.

⚠️ THE PRESSURE REGULATOR MUST BE KEPT IN UPRIGHT POSITION TO ALLOW FOR OF THE WATER TRAP PURGING.

Be alert to any automatic purging of water/other contaminants from the auto-purge valve (Water trap drain) at the base of the filter bowl. Collection of significant amount of water/debris and automatic purging is an indication that there is an excess moisture/contaminant in the air flowing through the system.

⚠️ DO NOT OPERATE THE SYSTEM IN THIS CONDITION. INSTALL SUPPLEMENTAL AIR DRYER AND/OR FILTRATION SYSTEM AT YOUR COMPRESSED AIR SOURCE.

To facilitate proper positioning of the pressure regulator, it must be installed onto the frame using Pressure regulator bracket located on the right side of the frame. The 3 locator pins on the Pressure Regulator Bracket allow for installation of the Pressure Regulator in two different orientations, depending on the position the PB7000-M is used in. Use the orientation that will allow to keep the Regulator upright for proper water drainage.
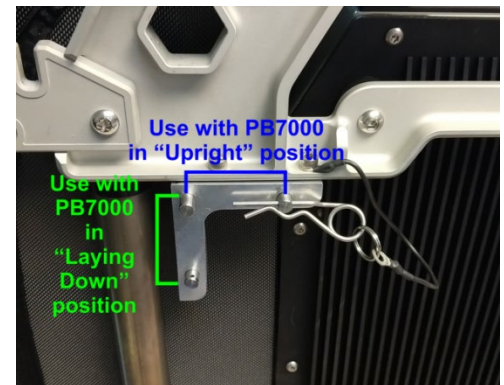
3.6. Consumable Pen Parts

Nozzles

Over time, plasma wears down the nozzle, opening the aperture, and usually slowing removal rates. Nozzles should be replaced after ~8 hours of plasma-on time (See section 6."Maintenance".)
Use only nozzles supplied by APS. A replacement Nozzle Kit containing 5 nozzles and anti-seize lubricant in a squeeze bottle is normally included with the system. Additional kits are available for purchase at APS.

Electrodes

Plasma electrode is located inside the pen body and should be replaced every 100 hours of plasma-on time. Spare electrodes are not supplied with the system, so it is recommended to order spare electrodes from APS ahead of time.

3.7. Toolset

To facilitate nozzle or electrode replacement, the system includes a set of tools:

- 1" Hex tool: used in both nozzle and electrode replacement procedures. It precisely fits the hex feature in the front of the pen and is used to hold the hex feature in place to prevent the rotation of the internal part while loosening the nozzle nut or to loosen/tighten the internal threads during electrode replacement.
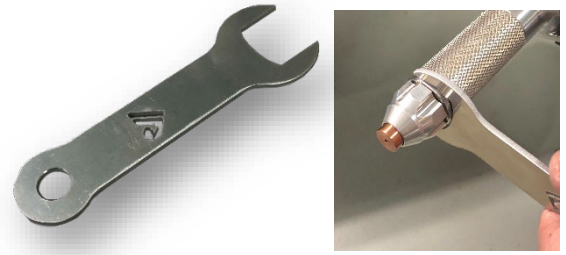
- Deep well ½" 6-point socket with handle: used in electrode replacement procedure to remove and replace the electrode inside the pen body.

- A small (#1) Philips style screwdriver for use in electrode replacement.

4.   Operating Requirements

4.1.   Required Connections

The plasma controller and plasma pen requires connections to facility electrical power, and facility source of compressed air in order to operate. Safe operation also requires the plasma controller to be grounded. System interconnections are presented in the System Interconnections Diagram in Figure 9 below.
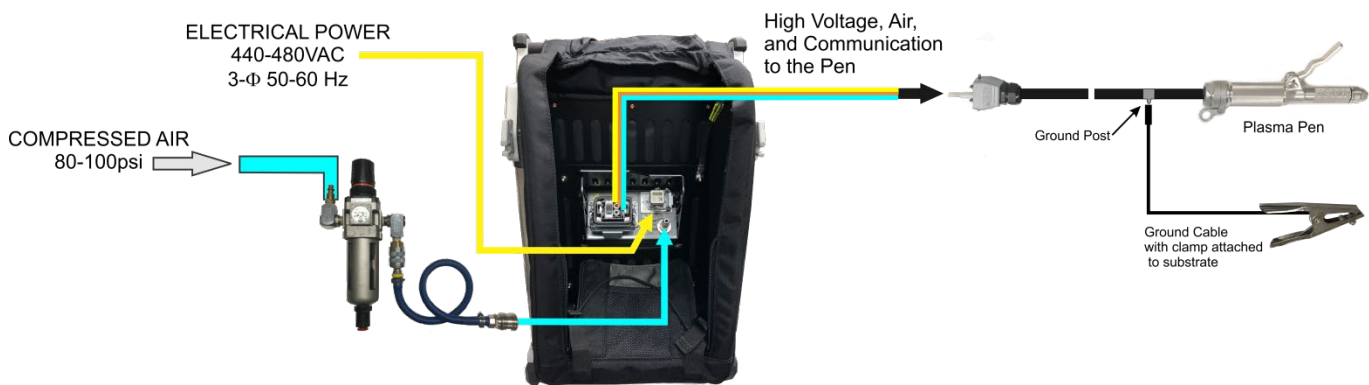
Figure 9: PlasmaBlast® system interconnections.

4.2.   Required System Inputs

Electrical Power

The PB7000-M-24 system requires single phase electrical service breaker of 15-20A at 208-240VAC, 50-60Hz. A portable generator can be used if facility power is unavailable.
By default the power cords included with the system are equipped with NEMA L6-30 plug.

If the User's facility is not equipped with respective receptacles, upon request, the system can be equipped with several other plug types. Please see APPENDIX A for list of acceptable options.

> ⚠ *Always use the power cord supplied with the system. The system components should be grounded as described in Section 2.5 of this Manual.*

Air Supply

The system requires an air supply capable of delivering up to 3.5 CFM / 100 SLM of filtered dry air at 80-100 psi / 5.4-7 bar for proper operation. If using a portable compressor as a compressed air source, the compressor must be rated >3.5 CFM (100 SLM) flow capacity at 90 psi/ 6 bar. Failure to provide dry, oil-free, particulate free air may cause irreparable damage to the plasma system.

The air source should pass through an air dryer producing air with a pressure dew point of 40°F / 4.5°C or less. The pressure regulator with filter, included with the system, must be used in line between the source of compressed air and air input of the plasma controller.

The compressed air input is located on the Connector Block of the system. The default connector is a standard industrial 1/4" air fitting (Figure 10). An air line is not provided with the system. It is responsibility of the user to provide necessary air lines and connectors.

Figure 10: Default PlasmaBlast Air fittings: 1/4" standard industrial style

Ventilation and/or Dust Collection

It is up to the end user to provide sufficient ventilation and dust collection that may be required wherever the plasma system is being used. APS recommends the use of, at minimum, the following:
For enclosed space:
- Requires fume extractor or a ventilated exhaust hood
- Consult with your EHS Team for site-specific requirements

Outside:
- A high velocity pedestal fan ~12"- 24" diam. is recommended
- Place fan so that it blows away from operator
- If strong wind – fan may not be necessary
- Consult with your EHS Team for site-specific requirements

5. System Operation

5.1. Safety Check

ENSURE PROPER GROUNDING OF ALL COMPONENTS!

WEAR THERMALLY AND ELECTRICALLY INSULATING GLOVES WHILE OPERATING THE PLASMA SYSTEM!

- *Wear safety glasses, and hearing protection at all times when operating.*
- *Ensure adequate exhaust of gases, dust, and particulate debris emanating from the plasma pen at all times.*
- *Only properly trained personnel may operate the plasma system.*
- *Please read, understand and follow all of the safety instructions in the complete manual!*

5.2. Recommended Operating Conditions

*The PlasmaBlast® plasma controller is designed specifically to create a stable plasma discharge using dry compressed air when used as directed. **Operation outside of the recommended parameters may cause damage to the system**. Please contact APS for information regarding the use of alternative configurations such as alternate gas mixtures or plasma controller settings.*

Keep the power supply dry at all times. Failure to keep power supply dry may result in electrocution.

The typical input air pressure range of operation for the plasma pen is 85-105 psi / 5.4-7 bar. Optimal pressure is 99 psi (6 bar) with 3.5 CFM / 100 SLM of available flow.
The PlasmaBlast® system is rated for a maximum input pressure of 105 psi / 7 bar and maximum 120 psi/8 bar burst pressure.
Air pressure should be controlled by using the pressure regulator included with the system.

Auxiliary Equipment

<u>Portable Air Compressor</u>
If the system is intended to be operated with a portable compressor it must be verified that the compressor is rated for, and is, in fact, continuously supplying <u>at least 100psi of pressure with 3.5-4 CFM of flow</u> before operating the system. Use the test procedure described in section <u>5.3 PlasmaBlast System Setup – Testing Portable Air compressor</u> to test your portable compressor if using for the first time with PlasmaBlast®.
<u>Portable Electric Generator</u>
To operate PlasmaBlast® a portable electric generator must be rated for at least 4800W peak (or surge) wattage and for 3600W continuous rated wattage.

5.3. PlasmaBlast® PB7000-M System Setup

Setting up the system

1. Position PlasmaBlast® PB-7000-M system on a stable horizontal surface. Secure the system in place to avoid falls or drops.

2. Open the cargo bag and remove power cable, ground cable, pressure regulator, and plasma pen. The Pen Connector should be already plugged in. **Do not unplug unless necessary.** (See step 3-4 if not plugged in).

   Remove transportation strap from plasma pen (if present).

3. _Applies only if Pen Connector is unplugged_:
   Plug in the connector, make sure it is fully seated

Not latched
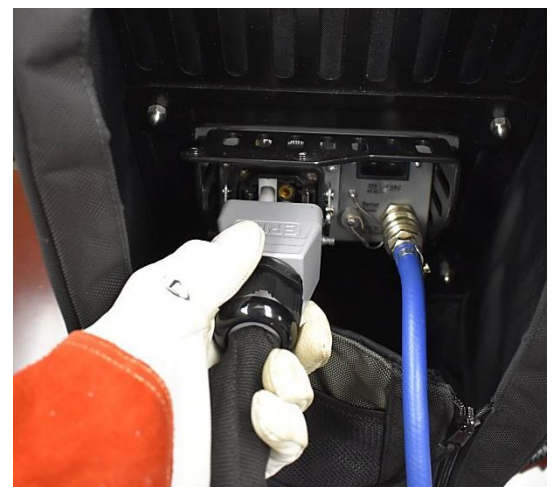
Fully latched

4. **_Applies only if Pen Connector is unplugged:_** Engage the connector base latch with the pins on the plug but pressing up on it firmly until fully latched with a click.

5. Connect the Pressure regulator output hose to 1/4" industrial style air fitting marked "Air In" on the Connector Block of the Controller.

6. Connect air supply hose to filter/regulator

7. Install Pressure Regulator onto the Frame using two out of the three locator pins on the Pressure Regulator Bracket.
The Regulator can be installed in 2 different orientations, depending on the position the PB7000-M is used in. <u>Use the orientation that will allow to keep the Regulator upright for proper water drainage</u>.
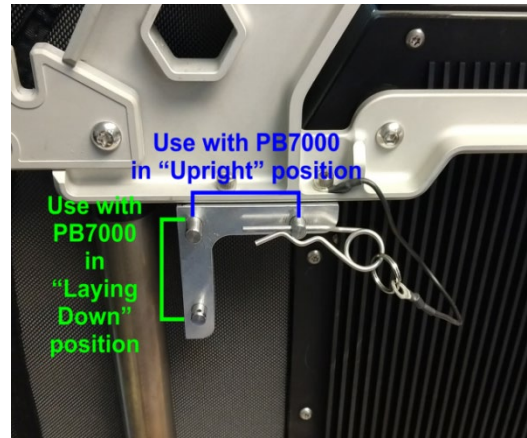
8. Make sure the locator pins are fully inserted into mounting slots of the Pressure Regulator and then insert the retainer pin into a hole in the locator pin.

9. Locate the Ground Port with the ground post which is located approximately 6 feet from the pen body on the pen cable

10. Locate the connector with a spring-loaded sleeve on the ground cable and pull the spring-loaded sleeve back.

11. Place the opening over the ground post. Then let go of the spring. The ground cable will be able to rotate 360 degrees with respect to the post.
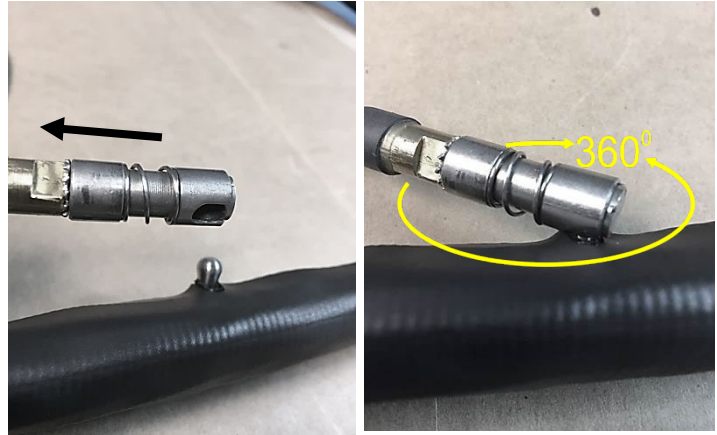
12. **Ground the Substrate**: Attach the clamp to the workpiece where coating removal will occur. Ensure that the clamp is attached to an area that is in direct electrical connection with the metal that is undergoing coating removal.

Failure to ground the substrate may result in electric shock to the operator

⚠️ **Before proceeding with this step make sure that the power cable is UNPLUGGED from the power source**

13. Connect the AC power cable to Power Input on the Connector Block

14. Make sure he On/Off switch is in "OFF" position
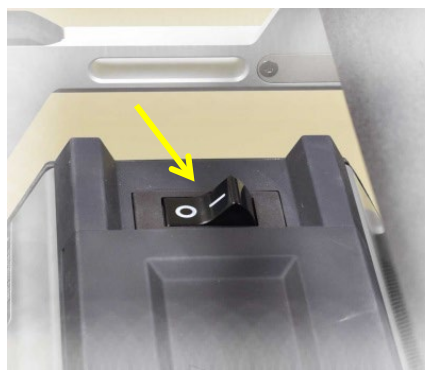
15. Plug the power cable into the facility power outlet or generator power outlet. The plug may vary from the one pictured in this manual.

16. **Ensure that you are wearing appropriate PPE at this point (Gloves, safety glasses, dust mask, hearing protection).**
With the pen nozzle <u>facing away from you and other people,</u> and the pen lever in the off position, turn on the AC power switch on the PB-7000-M.

⚠️ *WARNING: The system will briefly purge air through the plasma nozzle while starting up.*

Setting Operating Air Pressure

⚠️ *This procedure is required to be completed every time the system is plugged into a compresses air source.*

17. Open Status Display cover to access Status Display screen (also see section 5.4 Status Display Module)

18. With the pen nozzle facing away from you and other people, push the safety lever down and quickly depress and release the lever twice Double click, but do not hold down. If this is done properly, there should be a steady flow of air only out of the nozzle with the lever released.
The screen of the Status Display will show "AIR FLOW ON" message.
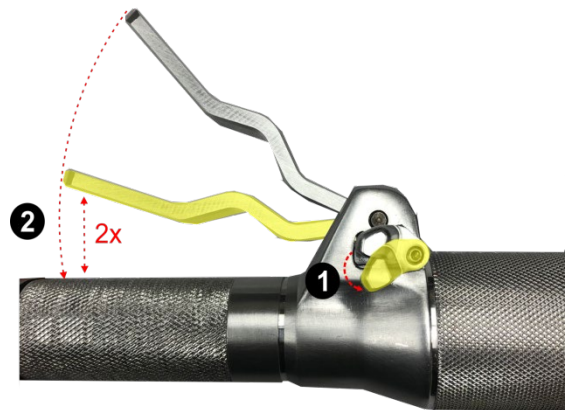
19. Navigate to the "Air Pressure" screen using Menu Navigation Buttons (Section 5.4.- Menu Navigation buttons):
Default screen ◎ User Menus - > ◎ System Info ◎ - > Air Pressure

AIR PRESSURE
105 PSI - OK
FLOW AIR WHILE
MEASURING PRESSUR
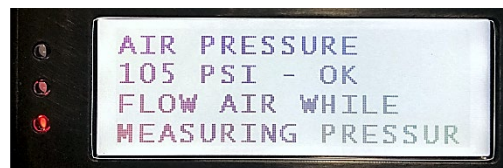
20. While in the air purging state and, adjust the air pressure displayed on the AIR PRESSURE screen by rotating the regulator knob until the pressure displayed is around **99 psi.**
*The acceptable range of air pressure is 85 to 105 psi with **99 psi** being optimal operating air pressure.*
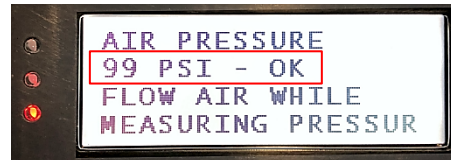
21. Stop air flow by pushing the safety lever down and push the trigger lever forward once then pull back to safe locked position (see Section 5.5 "Plasma Pen Operation").

Testing Portable Air Compressor

Continue to this step if using a portable compressor for the first time with PlasmaBlast®.

22. Purge air through the pen as described in step 18 .

23. Navigate to AIR PRESSURE menu -> AIR PRESSURE screen as described in step 19. Take a note of the pressure displayed on the screen
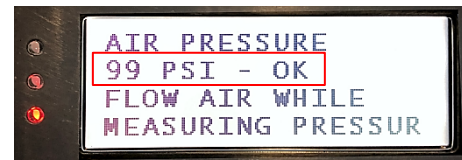
24. Continue to purge air through the pen for 10-15 minutes while watching the AIR PRESSURE screen. Take a note of pressure displayed every minute.

⚠️ 25. Pay special attention to note if the pressure displayed at any point is below **80 PSI.** **If the pressure is at any point below 80 PSI this compressor is not safe to operate with Plasma*Blast*®.**

26. Stop air flow by pushing the safety lever down and push the trigger lever forward once then pull back to safe locked position (see Section 5.5 "Plasma Pen Operation").

System setup is now complete, and you are ready to remove coatings.

5.4.   Status Display Module

Status Display Module is located on the top of the Plasma Controller under the protective cover①. To open the cover use the tab② on the right side of the cover and pull forward to release the latch. Pull the door down to view the display. Under the cover there is **Status Display module** comprised of **Graphic Display**③, **Menu Navigation Buttons**④, and **LED indicators**⑤ .

5.4.1 System Status Display (PLASMA STATUS)

The main System Status screen is loaded by default upon the system power-up, after the splash-screen with the APS logo and then the current software version.

The System Status screen has 4 lines. Displayed values on some lines change based on the system state.

Line 1: Plasma Status: Indicates current plasma status, as follows:
IDLE - Ready
FLOW WAIT - A status during plasma ignition
BUTTON WAIT - Switch press detected, analysis for plasma ignition is underway
AIR FLOW ON - Air is on to cool the pen
PLASMA ON - Plasma is on
PLASMA OFF WAIT- Status while plasma is being extinguished
FAULT WAIT- A fault has occurred
TEMPERATURE- Unit has overheated.

Line 2: Air Line Status: Displays in-line air pressure and the status of it:

OK – The input airline pressure is in an acceptable range.
LOW or HIGH – the input airline pressure is outside of acceptable pressure range.
UNABLE TO READ - have air pressure below ~12 PSI or if the system air pressure sensor has failed.

Line 3: Displays Nozzle life remaining until the replacement is necessary.

Line 4: Displays Electrode life remaining until the replacement is necessary.

5.4.1 Menu Navigation Buttons

Menu Navigation buttons to the right of the display allow the User to move between system menu screens and scroll through menu lines, as well as to make menu selections.

Center Button has "Enter/Select" function and is used to make menu selections and set desired operating parameters.

Left and Right Buttons enable the User to move through menu screens. Right Button is used to advance to the next screen, Left Button is to return to the previous screen.

Up/Down Buttons are used to scroll through menu screen lines.

5.4.2 LED Indicators

The three LED indicators located to the left from the display serve as an additional visual source of system status information which compliments system status information displayed on the screen. Different colors and lighting patterns aid in providing the User with information on system status, plasma status and faults without the necessity to look at the screen.

5.4.3 Navigating Through User Menus:

To access "User Menu" from default System Status screen, push the ⊚ Enter/Select button. The ***USER MENU***screen will be displayed.
Two menus are available under User Menu:
- ➢ **System Info**
- ➢ **Manage System**

- Using ⬦ Up/Down Scroll buttons move the active menu indicator (">") to select a menu.
- Push Enter/Select Button ⊚ to enter the desired menu.

SYSTEM INFO Menu
The System Info menu consists of several sub-menus that contain important information about the system status and operation. The User may be required to access this information and provide it in communications with APS personnel for diagnostics and remote troubleshooting in the case of a system malfunction or a failure.
The Table below summarizes the content of System Info Menu:

System Info Sub-Menus	Information Displayed	Sub-Menu Description
> Plasma Time	PLASMA TIME Current HH:MM:SS System HH:MM:SS	Displays plasma-on time since latest system reboot (Current) and total system plasma-on time (System). This information may be necessary for system performance analysis or in troubleshooting.
> Air Pressure	AIR PRESSURE OK 99 PSI FLOW AIR WHILE MEASURING PRESSURE AIR PRESSURE -UNABLE TO READ- ADJUST PRESSURE TO 80-100 PSI	Displays current input air pressure. This is one of the critical system operating parameters and is monitored by a sensor inside the system. This screen is used to set operating pressure during system setup. If the air pressure is outside of the normal range the screen will display "**LOW**" or "**HIGH**" instead of "**OK**". If the pressure is below 12 psi, or air line has no pressure/not plugged in, the screen will display "**UNABLE TO READ**" message, which may also indicate air sensor failure. **Please note: Plasma will still operate if there is a sensor failure. Use the regulator gauge to adjust air pressure in this case.**
> Software Vers	SOFTWARE VERSION VX.X.X	Displays software version currently installed on the system.
> Bus Voltage	BUS VOLTAGE XXX.XX V	Displays current bus voltage. Bus voltage is an internal system parameter related to, but not equal to, line voltage. It is used for diagnostics of line power issues and is to be used by the user in communication with APS in the case of a system malfunction or failure. **If the Bus Voltage value is 0** – the unit sustained severe damage and must be sent to APS for repair. Please contact APS immediately.
> Temperature	TEMPERATURE XX C	Displays current internal temperature. The normal temperature range is below 80°C. If the temperature exceeds this threshold, the system will shut down and a Temperature Fault will be displayed on the default screen.

> Latest Faults	LAST KNOWN FAULT Scroll > for help Latest ERR: XX Previous ERR: XX	Displays latest known and a previous fault directly preceding the last. This provides valuable information for diagnostics and troubleshooting. Pressing Enter/Select button ◎ will advance to Fault Help screen.
> Fault Help	FAULT XX <FAULT DESCRIPTION> < RECOMMENDED ACTION >	Displays information about the system faults. If the system currently is in a Fault state, the System Status screen will change to Fault Help screen displaying information about the fault the system is experiencing, and troubleshooting assistance related to this fault. See *Fault Codes* in Troubleshooting section for more information.
> Plasma History	YYMMDD HH:MM 1/2 PT HH:MM/HH:MM XXXXXHz, XXXXW XX.XXAp, X/XXAr	Contains various system information used in diagnostics, troubleshooting and system performance evaluation by APS personnel. The User may be asked to provide information from this screen in communications with APS personnel in the case of system malfunction or failure.

MANAGE SYSTEM Menu

Manage System Menu consists of Maintenance sub-menus. It provides information about the timing of necessary maintenance procedures including remaining life of replaceable components (nozzles and electrodes) and allows the user to perform tasks related to maintenance procedures, such as silence audible maintenance alarms and reset the life of the component after replacing it. See **Section 6. Maintenance** for detailed information about maintenance procedures.

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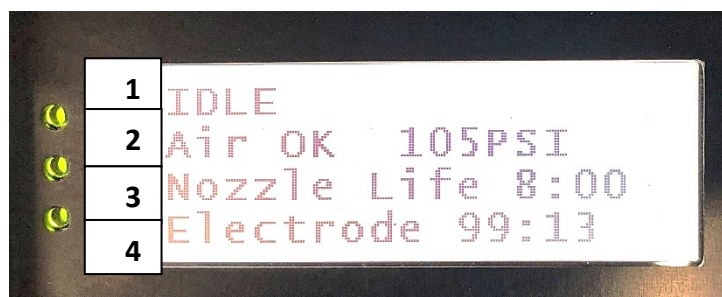**BUTTON WAIT** - Switch press detected, analysis for plasma ignition is underway
AIR FLOW ON - Air is on to cool the pen
PLASMA ON - Plasma is on
PLASMA OFF WAIT- Status while plasma is being extinguished
FAULT WAIT- A fault has occurred
TEMPERATURE- Unit has overheated.

Line 2: Air Line Status: Displays in-line air pressure and the status of it:

OK – The input airline pressure is in an acceptable range.
LOW or HIGH – the input airline pressure is outside of acceptable pressure range.
UNABLE TO READ - have air pressure below ~12 PSI or if the system air pressure sensor has failed.

Line 3: Displays Nozzle life remaining until the replacement is necessary.

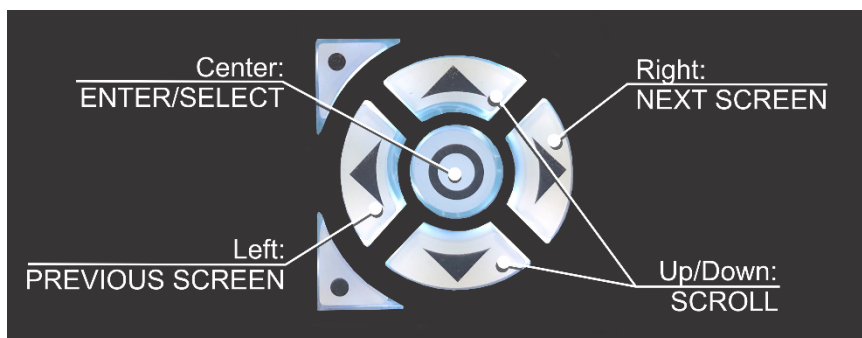**Line 4:** Displays Electrode life remaining until the replacement is necessary.

5.4.1 Menu Navigation Buttons

Menu Navigation buttons to the right of the display allow the User to move between system menu screens and scroll through menu lines, as well as to make menu selections.

Center Button has "Enter/Select" function and is used to make menu selections and set desired operating parameters.
Left and Right Buttons enable the User to move through menu screens. Right Button is used to advance to the next screen, Left Button is to return to the previous screen.
Up/Down Buttons are used to scroll through menu screen lines.

Center:
ENTER/SELECT

Right:
NEXT SCREEN

Left:
PREVIOUS SCREEN

Up/Down:
SCROLL

5.4.2 LED Indicators

The three LED indicators located to the left from the display serve as an additional visual source of system status information which compliments system status information displayed on the screen. Different colors and lighting patterns aid in providing the User with information on system status, plasma status and faults without the necessity to look at the screen.

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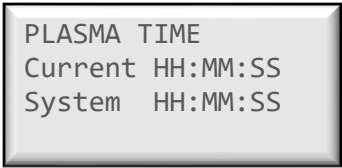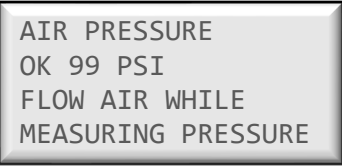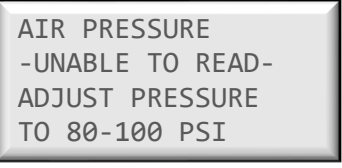- Push Enter/Select Button ⊚ to enter the desired menu.
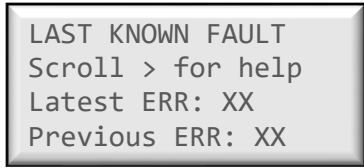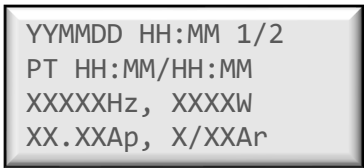
SYSTEM INFO Menu
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The Table below summarizes the content of System Info Menu:

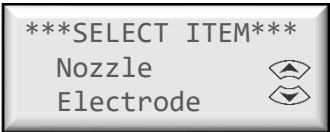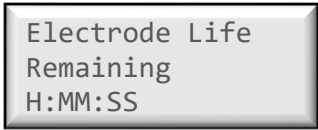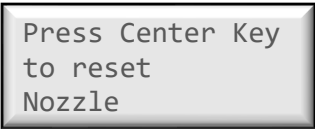| System Info Sub-Menus	Information Displayed	Sub-Menu Description
> Plasma Time	PLASMA TIME Current HH:MM:SS System HH:MM:SS	Displays plasma-on time since latest system reboot (Current) and total system plasma-on time (System). This information may be necessary for system performance analysis or in troubleshooting.
> Air Pressure	AIR PRESSURE OK 99 PSI FLOW AIR WHILE MEASURING PRESSURE AIR PRESSURE -UNABLE TO READ- ADJUST PRESSURE TO 80-100 PSI	Displays current input air pressure. This is one of the critical system operating parameters and is monitored by a sensor inside the system. This screen is used to set operating pressure during system setup. If the air pressure is outside of the normal range the screen will display "**LOW**" or "**HIGH**" instead of "**OK**". If the pressure is below 12 psi, or air line has no pressure/not plugged in, the screen will display "**UNABLE TO READ**" message, which may also indicate air sensor failure. **Please note: Plasma will still operate if there is a sensor failure. Use the regulator gauge to adjust air pressure in this case.**
> Software Vers	SOFTWARE VERSION VX.X.X	Displays software version currently installed on the system.
> Bus Voltage	BUS VOLTAGE XXX.XX V	Displays current bus voltage. Bus voltage is an internal system parameter related to, but not equal to, line voltage. It is used for diagnostics of line power issues and is to be used by the user in communication with APS in the case of a system malfunction or failure. **If the Bus Voltage value is 0** – the unit sustained severe damage and must be sent to APS for repair. Please contact APS immediately.

> Temperature	TEMPERATURE XX C	Displays current internal temperature. The normal temperature range is below 80°C. If the temperature exceeds this threshold, the system will shut down and a Temperature Fault will be displayed on the default screen.
> Latest Faults	LAST KNOWN FAULT Scroll > for help Latest ERR: XX Previous ERR: XX	Displays latest known and a previous fault directly preceding the last. This provides valuable information for diagnostics and troubleshooting. Pressing Enter/Select button ◎ will advance to Fault Help screen.
> Fault Help	FAULT XX <FAULT DESCRIPTION> < RECOMMENDED ACTION >	Displays information about the system faults. If the system currently is in a Fault state, the System Status screen will change to Fault Help screen displaying information about the fault the system is experiencing, and troubleshooting assistance related to this fault. See *Fault Codes* in Troubleshooting section for more information.
> Plasma History	YYMMDD HH:MM 1/2 PT HH:MM/HH:MM XXXXXHz, XXXXW XX.XXAp, X/XXAr	Contains various system information used in diagnostics, troubleshooting and system performance evaluation by APS personnel. The User may be asked to provide information from this screen in communications with APS personnel in the case of system malfunction or failure.

MANAGE SYSTEM Menu

Manage System Menu consists of Maintenance sub-menus. It provides information about the timing of necessary maintenance procedures including remaining life of replaceable components (nozzles and electrodes) and allows the user to perform tasks related to maintenance procedures, such as silence audible maintenance alarms and reset the life of the component after replacing it. See **Section 6. Maintenance** for detailed information about maintenance procedures.

The Table below summarizes the content of Manage System Menu:

Manage System Sub-Menu	Information Displayed	
> Silence Alarm	Pressing Enter/Select button ◎ will silence audio alarm at Level 3 Maintenance alarm. (See Section 6.2 Maintenance of Plasma Pen.)	
| > Time Remaining | ```
***SELECT ITEM***
  Nozzle
  Electrode
``` | ```
Nozzle Life
Remaining
H:MM:SS
``` Displays remaining life of the nozzle. |
| | | ```
Electrode Life
Remaining
H:MM:SS
``` Displays remaining life of the electrode. |
| > Reset Time | ```
***SELECT ITEM***
  Nozzle
  Electrode
``` | ```
Press Center Key
to reset
Nozzle
``` Pressing Enter/Select button ◎ will reset the life of the nozzle to 8 plasma-on hours. |
| | | ```
Press Center Key
to reset
Electrode
``` Pressing Enter/Select button ◎ will reset the life of the electrode to 100 plasma-on hours. |

5.5. Plasma Pen Operation

Parts of Plasma Pen
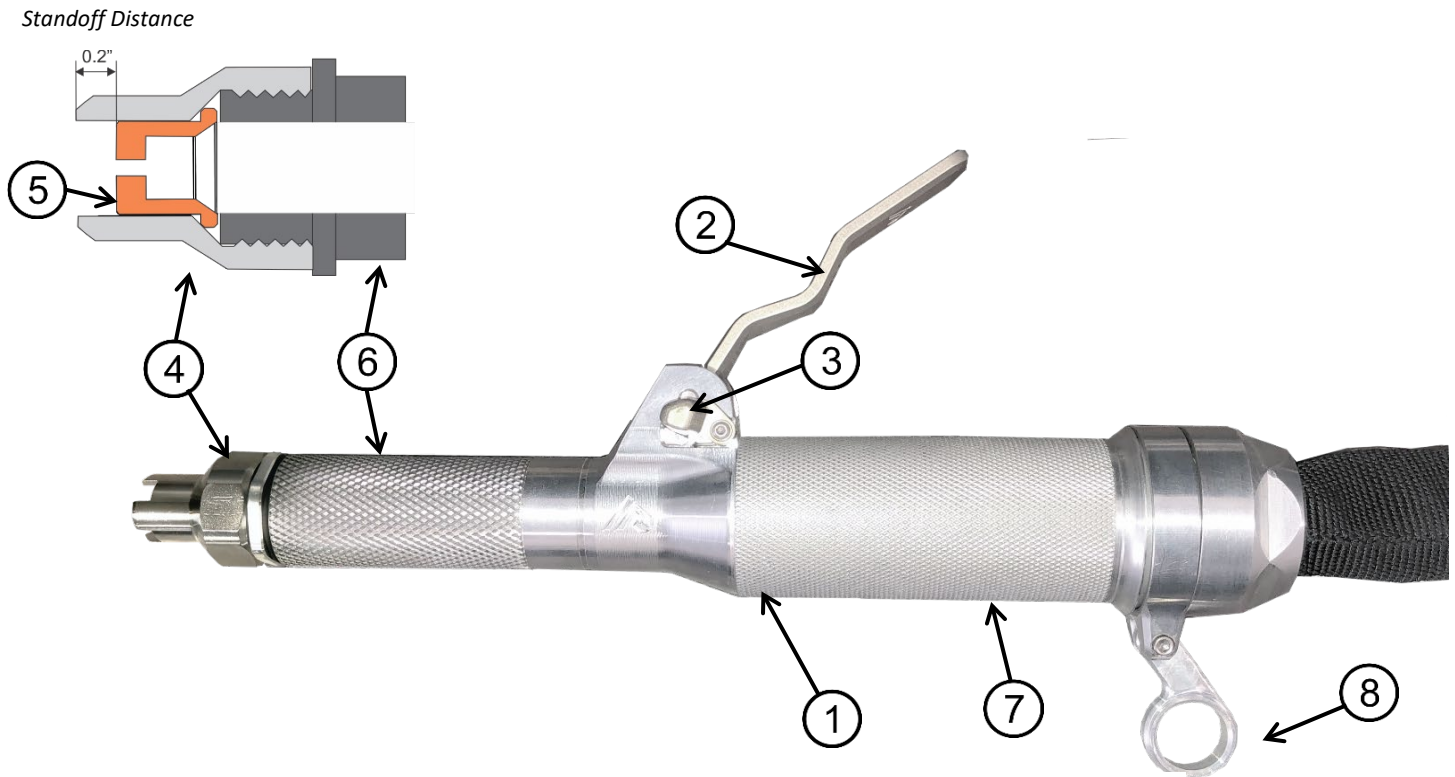
Standoff Distance

Figure 11: Parts of Plasma Pen

①	-Pen Body	⑤	-Nozzle (inside Nozzle Nut)
②	-Plasma Trigger Lever	⑥	-Front Grip
③	-Safety Lever (both sides)	⑦	-Rear Grip
④	-Nozzle Nut with Standoff Attachment	⑧	-Attachment Loop

⚠ WARNING: DO NOT ATTEMPT TO DISSASEMBLE THE PEN BODY. THERE ARE NO USER-SERVICEABLE PARTS INSIDE. ANY ATTEMPT TO OPEN THE PEN BODY COULD EXPOSE THE USER TO HIGH VOLTAGES AND MAY PERMANENTLY DAMAGE THE PEN AND/OR THE POWER SUPPLY.

Plasma Pen Operating Principles

Plasma Pen Grip Positions

The Plasma Trigger Lever can be used in two grip positions: flipped forward and flipped backward.

Flipped Forward

Flipped Backward

Plasma On

Plasma Off

Plasma On

Plasma Off

Plasma Trigger Lever Operational Positions

The Plasma Pen is equipped with a Plasma Trigger Lever that has to be depressed before plasma is delivered to the pen nozzle. There are three operational positions the Plasma Trigger lever can be used in three different positions (Figure 12):
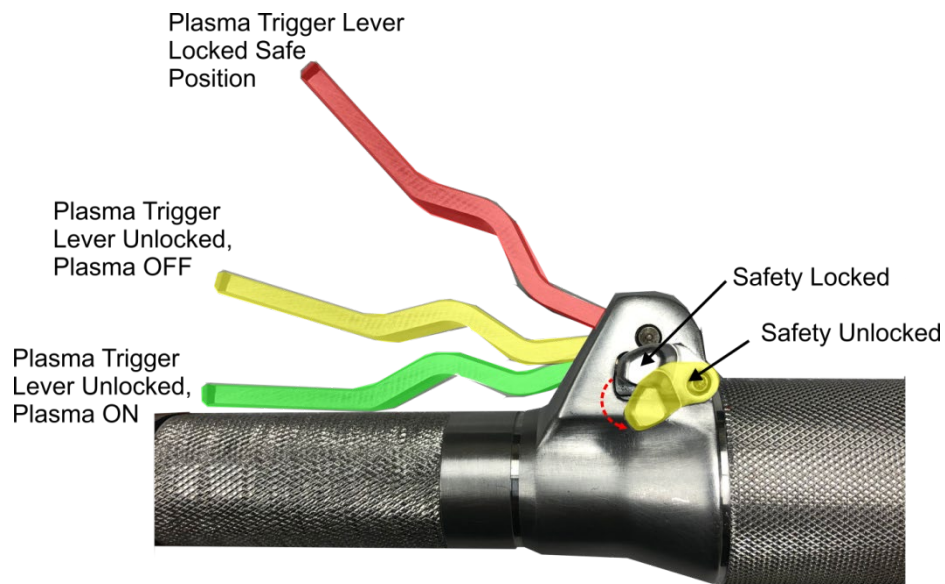

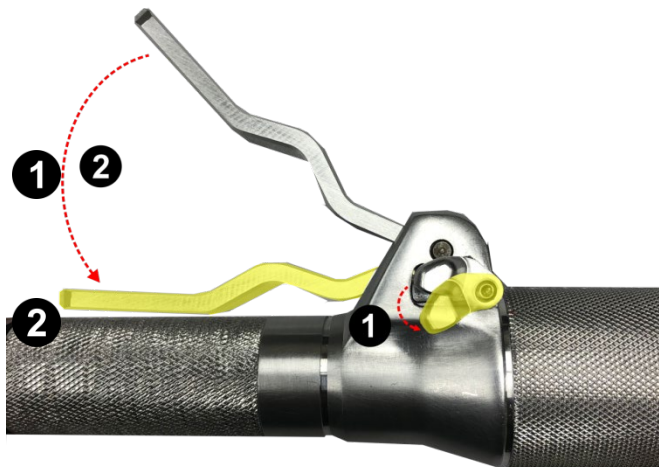*Figure 12: Plasma Trigger Lever operational positions*

1. Locked Safe Position: Plasma Trigger Lever cannot be depressed; Safety Lever is in Locked position.

2. Unlocked, Plasma OFF: the Lever is released from safety and partially depressed; it is being held down lightly; when released it will snap back into safety mechanism.

3. Plasma ON: the lever is fully depressed and being held down while Plasma Pen is generating plasma.

Release of Plasma Trigger from Safety Mechanism

If not in operation, the Plasma Trigger Lever is locked by the Safety Mechanism in a safe position to prevent it from being depressed accidentally. In order to generate plasma the trigger lever must be released from safety.
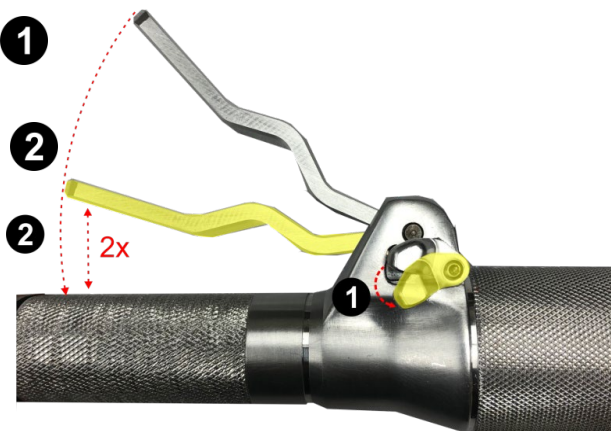

Depress safety lever on either side of the pen and hold down.

Depress plasma trigger lever to the front or to the back, then release the safety lever

Purging Air through the Pen

As a part of Operating procedure (such as setting up the appropriate pressure on the Pressure Regulator), or under various other circumstances (e.g. to cool the Plasma Pen down), an operator may need to be able to purge air through the Plasma Pen, without generating plasma. To accomplish this perform the following steps:

With the pen nozzle <u>facing away from you and other people</u>, push the safety lever down

Quickly depress and release the lever twice (Double click), but do not hold down. The release of the lever into Plasma OFF position should result in a steady flow of air only out of the nozzle.
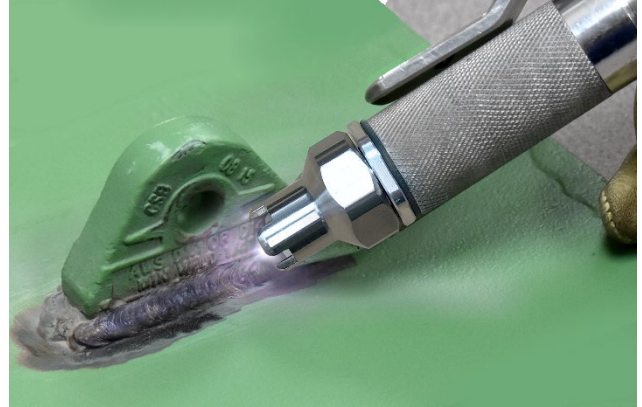
To stop air flow push the safety lever down and push the trigger lever forward once then pull back to safe locked position.

5.6.   Plasma Coating Removal

While handheld plasma coating removal requires some skill that is best developed through practice, there are a few basic principles of plasma coating removal

- Hold the Pen facing the surface to be treated, normally at an angle, with the tip of the nozzle at approximately 1/8" from the surface.
- Move the tip in continuous side-to-side or circular (**small circles)** motion over the removal area.
- Never dwell the plasma beam over one spot, this may cause overtreatment and potential damage to the substrate.
- Minimize touching the bare substrate with nozzle tip, as this may result in arcing.
- Use the angle of the pen and its distance from the surface to control power of removal.

5.7.   Two-Minute Continuous Plasma-On Limit

 Continuous plasma-on operation is limited to 2 minutes at a time as a safety feature preventing the Used from accidentally running the plasma unattended for prolonged periods of time.

Plasma will shut off after 2 minutes of continuous operation. To restart the plasma, release the plasma lever and depress is again.

6.   Maintenance

> **WARNING: Disconnect power and allow time for the plasma pen to cool down, if applicable, before any maintenance operation.**

6.1.   Maintenance of PlasmaBlast® Plasma controller

General Cleaning (as needed)

The outside surface of the plasma controller may require periodic cleaning if operated in a dusty or dirty environment. If necessary the outside of the plasma controller can be wiped with clean, dry static free cloth. Aqueous cleaners or solvents are not recommended to clean the plasma controller.

Do not attempt to open the enclosure; there are no user-serviceable parts inside the Controller. Evidence of tampering with or otherwise attempting to open the controller will result in a voided warranty, and for rental systems requires purchase of this non-warrantied system.

6.2.   Maintenance of Plasma Pen

Plasma Pen contains consumable parts – nozzles and plasma electrodes – that wear off with use and require regular maintenance. This includes regular nozzle cleaning and inspection to determine the level of wear, and regular replacement of nozzles and electrodes.
The time between replacements is defined as "life" of a consumable part and is expressed in hours of "plasma-on" time.
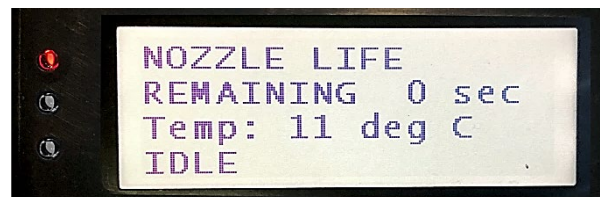The recommended replacement schedule is:

Nozzle – replace every **8 hours** of plasma-on time.
Electrode – replace every **100 hours** of plasma-on time.

Nozzle and Electrode Maintenance Alarms ("MAINTENANCE MINDERS").

To assist the user in keeping up with the maintenance schedule, the PB7000-M system keeps track of plasma-on time and the "life" of currently installed nozzle and electrode remaining after the last replacement. The time remaining for the life of each item can be accessed from Maintenance Menu (see Section 5.4 - System Menus – Manage System Menu)

When a nozzle or an electrode approaches the end of its life (75% of life is reached) Maintenance Alarm screen ("Maintenance Minder") will appear on the display, indicating time remaining on the life of the part.
The middle LED will be lit to indicate active maintenance alarms until it reaches Level 3. The colors of these LEDs

indicate the alarm level. When the replacement becomes overdue, an audio alarm will also be sounded while the alarm screen is being displayed.

There are 3 levels of Maintenance Alarms:

Alarm Level	% Life reached	Item	LED position & color	Audio Alarm	Action
1	reached 75% of life	Either or both Nozzle / Electrode	Middle LED Yellow	No	Prepare for replacement, refer to Life remaining screen to identify component for replacement
2	reached 100% of life	Either or both Nozzle / Electrode	Middle LED Red	No	Replace now, refer to Life remaining screen to identify component for replacement
3	reached 125% of life	Nozzle	Top alternate Red & Yellow	Yes	Replacement is overdue, replace immediately
		Electrode	Bottom alternate Red & Yellow		

The screens will rotate between displaying the Plasma Status screen and one or both Maintenance Minder screen(s). If only one of the maintenance items is under a maintenance alarm, only that maintenance screen is displayed. If both nozzle and electrode are alarmed, there are 2 different screens displayed – one for each item.

The MAINTENANCE MINDER screen(s) will not be displayed, and the audio alarm is silenced while plasma is firing to avoid distractions to the operator.

The audio alarm can be silenced by navigating to User Menus -> Manage System - > Maintenance - > Silence Alarm screen and pressing Enter/Select button" (see Section 5.4 - System Menus – Manage System Menu). The audio alarm will resume after the PlasmaBlast unit is rebooted.

Maintenance alarms do not prevent Plasma*Blast*® unit from operating and generating plasma. However, operating the unit with nozzles or electrodes that have exceeded their life can cause damage to both the Plasma*Blast*® unit and the substrate being treated.

⚠️	**WARNING: APS is not responsible for any damage caused by operating the system with consumable parts that are exceeded their life.**

Once a maintenance item is replaced, the tracked life of the part needs to be RESET by navigating to User Menus -> Manage System - > Maintenance - > Reset Time - > Select Item (Nozzle or Electrode) and pressing Enter/Select button to reset time (see Section 5.4 - System Menus – Manage System Menu).

Plasma Pen Nozzle Inspection

Inspect the plasma pen nozzle daily or as needed if any irregularities, such as assymetric shape of the plasma plume is noticed. To inspect the nozzle:

1. Unscrew the nozzle nut:

- *First try to unscrew it using only fingers.*

- *If you experience difficulty doing this, loosen the nozzle nut first:*

Holding onto the hex feature behind the nozzle nut with included 1" hex tool, turn the tool counterclockwise. <u>Do not use pen body to hold onto while turning,</u> this may cause internal threaded connections to come loos

<u>Do not use conventional tools</u>.

Once loosened, finish unsrewing the nozzle nut with your fingers.

2. Remove the nozzle nut and the nozzle for inspection and cleaninng.

3. Note all damage and wear to the nozzle and nozzle opening, such as:
   • Irregular shape of the nozzle opening.
   • Debris or pieces of material on the outside and the inside surfaces of the nozzle.
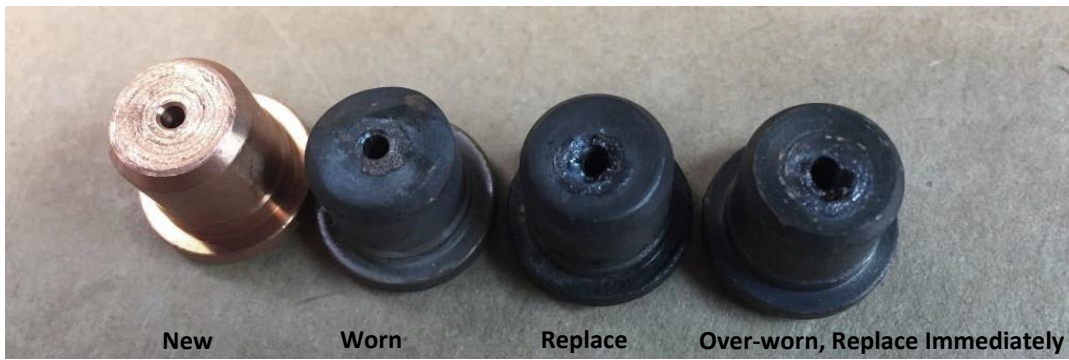   • Debris inside of the nozzle opening.

Plasma Pen Nozzle Cleaning

• If debris is found during the inspection, clean the nozzle by blowing compressed air through the nozzle or using a toothpick, if necessary.

• Make sure the tip of the nozzle is relatively clean of paint or coating residue. Periodic cleaning of the outside surface of the nozzle with a green 3M Scotch-Brite™ pad or similar mild abrasive pad is recommended.

• After cleaning, replace nozzle nut using procedure described in <u>Nozzle Replacement</u> section below.

Plasma Pen Nozzle Replacement

Generally, a plasma nozzle should be replaced approximately every 8 hours of plasma-on time. The wear consistent with this level of use can be identified through visual inspection.

New   Worn   Replace   Over-worn, Replace Immediately

Figure 13: Levels of nozzle wear.

If excessive wear (highly irregular shape of the nozzle opening, pitting around the opening, or material buildup that cannot be removed) is detected on the nozzle during daily inspection, replace the nozzle:

1. Remove nozzle nut as described in Plasma Nozzle Inspection procedure, using a built –in tool in the frame.
2. Remove worn nozzle.

3. Wipe the old grease off the threads with clean cotton cloth, then finish cleaning with a small bronze wire brush to completely remove grease residue from previous nozzle replacement.

 FAILURE TO FOLLOW THIS STEP REGULARLY MAY CAUSE GREASE RESIDUE BUILDUP AND MAY RESILT IN ELECTRIC SHOCK TO THE OPERATOR

4. Insert a new nozzle into the front of the pen as shown.

5. Add copper-based anti-seize compound provided with nozzle kit (Henkel LB 8008/C5-A anti-seize) to the threads and re-attach the nozzle nut. DO NOT SUBSTITUTE THE SPECIFIED ANTI-SEIZE WITHOUT AUTHORIZATION FROM APS.

6. Thread the nozzle nut on, then un-thread to spread out the anti-seize compound.

7. Tighten the nozzle nut by hand, using only 2 fingers. It must not be over tightened.

  DO NOT USE BUILT-IN NOZZLE NUT REMOVAL TOOL OR 1" Hex Tool FOR TIGHTENING!

8. Once the nozzle is replaced, the tracked life of the nozzle needs to be RESET by navigating to User Menus -> Manage System - > Maintenance - > Reset Time - > Select Item > Nozzle and pressing Enter/Select button to reset time.

Plasma Electrode Replacement

The internal Plasma Electrode should be replaced about every 6 months of typical use of the system.

  Before replacing Plasma Electrode disconnect the PB7000-M from AC power. Failure to do so may result in serious injury or death.

If the pen was operated immediately before the electrode replacement, make sure that it sufficiently cooled down before starting the procedure .

• This procedure must be performed in a clean and dry area.
• You will need the following tools:
    • Deep well 1/2" 6 -point socket with handle (provided)
    • 1" hex tool (provided)
    • 3/8" drive ratchet (not provided)
    • 3/8" drive torque wrench (10 -50 inch-pound range), not provided
    • Anti-Seize compound included with consumable nozzles kit

To replace Plasma Electrode:

1. Remove the nozzle nut and nozzle following procedure described in Nozzle Inspection section.

2. Remove the small panhead screw on located on the underside of the pen using a small #1 phillips screwdriver (provided). Turn counter-clockwise to remove.

3. Remove the front of the pen body using the 1" hex feature in the front of the pen. Use a 1" hex tool if necessary.

4. Identify the electrode inside the pen body.

5. Use a 1/2" deep well, 12-point socket to loosen the electrode. Once loose, you can turn it by hand.

6. Remove the electrode from the socket. You may need to push it out with a small screwdriver through the drive opening of the socket.

Worn Electrode

7. Insert a new electrode into the 1/2" deep well, 12-point socket. Turn clock-wise to thread in. Thread in carefully by hand. There should be very little resistance.

⚠ Use the 3/8" drive torque wrench to tighten to a maximum torque of 30 inch-pounds or 3.95 Newton/meters. Do not over tighten as this will strip the threads.

New Electrode

8. Replace the front pen assembly into the pen body.
Make sure the O-ring and threads are clean, do not have debris attached. There is a small amount of anti-seize in this location. If there is some that is visible, then it will not be necessary to apply more.

9. Turn front body assembly clock-wise by hand.
Make sure, as you thread it on, that the notch in the grip goes into the feature on the pen body.
Tighten by hand, then use a 1" hex tool on the hex to tighten further.

10. Re-install the panhead screw.

⚠️ **It is important to tighten the front pen assembly to the point where the threaded hole for the panhead Phillips screw in the front pen assembly aligns with the hole in the locking feature the as shown. Otherwise it will be difficult to install the screw or possible to cross-thread.**

Re-install the Phillips screw and tighten.

11. Re-attach the nozzle nut with the nozzle using the procedure described in Nozzle Inspection section. Use new nozzle if necessary.

12. Once the electrode is replaced, the tracked life of the electrode needs to be RESET by navigating to User Menus -> Manage System - > Maintenance - > Reset Time - > Select Item > Electrode and pressing Enter/Select button to reset time.

Plasma Pen Cable Maintenance

Check Pen Cable for kinks or knots; straighten kinks and remove knots as soon as they are noticed. Check for damage on the cable sleeving. Contact APS immediately if any damage is found.

Pressure Regulator Maintenance

- Check the filter bowl for the presence of water, oil, or other contaminants at least two times a day during normal operation, by visual inspection.
- Be alert to any automatic purging of water/other contaminants from the auto-purge valve at the base of the filter bowl. Collection of significant amount of water/debris and automatic purging is an indication that there is an excess moisture/contaminant in the air flowing through the system. Do not operate the system in this condition. Install supplemental air dryer and/or filtration system at your compressed air source.
- If water/debris are observed in the filter bowl, clean the regulator filter following the below procedure:

  1. Disconnect compressed air source line from the regulator input.

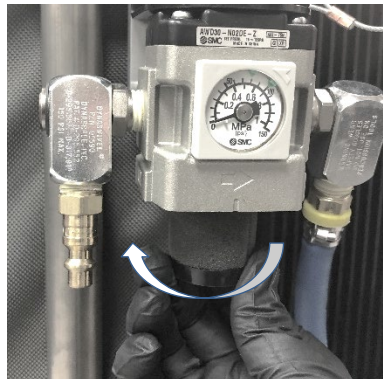2. Slide the black filter bowl locking mechanism downward to unlock the filter bowl.

3. While maintaining pressure on the locking mechanism, rotate the filter bowl in a counter-clockwise direction (as shown).

4. Remove the filter bowl by pulling it down.

5. Unscrew the filter (as shown) and remove it from the regulator.

6. Use clean water to rinse the filter. If oil contamination is present, use mild detergent.
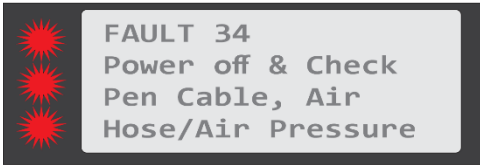
7. Re-install the filter and the filter bowl.

If the foam on the filter appears heavily contaminated or damaged, please contact APS to purchase a replacement filter.

7. Troubleshooting

7.1. PlasmaBlast® Coating Removal System Troubleshooting

PlasmaBlast® is equipped with a digital device safety system that is programmed to detect various abnormalities in system operation and communicate this information to the user through fault codes. In certain instances, the safety system will shut the device down to prevent damage to the system electronics; in some other instances, it will display the fault code as a warning, but will continue operation.

If the system encounters an active fault event, the **fault code** associated with this type of event will be displayed on the main Plasma System Status screen. (e.g FAULT 34) along with required troubleshooting steps. It will be also indicated by all LED indicators lit red.

```
FAULT 34
Power off & Check
Pen Cable, Air
Hose/Air Pressure
```

Once the fault screen is cleared by pressing any button or navigating away from this screen, the troubleshooting information for this fault or any other fault can still be accessed through **Fault Help** Menu.

To access this menu:

- Access **User Menu** from default System Status screen by pushing the ◎ Enter/Select button.
- Move ">" menu selection indicator to select menu using ⬍ Up/Down scroll buttons.
- Press the Enter/Select button ◎ to enter the **System Info** menu.
- Scroll ">" menu selection indicator down to Fault Help menu using ⬍ Up/Down scroll buttons.
- Press ◎ Enter/select button to enter **Fault Help** Menu.
- Scroll to the fault number using ⬍ Up/Down buttons.
- View the troubleshooting tips and take the recommended action.

Fault Codes

Each fault code is associated with a certain type of abnormal system operation. The System Status Display allows the user to view the definitions of the fault codes and the troubleshooting tips for each fault code.
The table below presents the fault codes used by the PlasmaBlast® system, as well as extended descriptions/recommendations for each of the faults.

Fault Code	Probable Cause	Solutions
0	No faults, normal operation	
7	Interlock open 1. Pen cable interlock not fastened.	1. Remove and then re-connect pen cable to unit. May try this several times as oxidation on the connectors may be the problem.

34	Plasma Waveform Fault 1. Low or high air pressure. 2. No air pressure. 3. Very hot pen. 4. Shorted cable.	1. Increase or decrease air pressure to within recommended range. (80-105 psi) 2. Connect air. 3. Perform nozzle maintenance. Let pen cool. 4. Inspect and replace cable if necessary.
35	Switching Current Too High While Plasma is Operating. 1. Internal overheating. 2. Failure in Power Control Loop.	1. Let unit cool. Could be caused by unit being in the direct sunlight. In this case, run external fan directed toward unit. 2. Hardware problem in power control loop. Must be returned for service.
36	Switching Current Too High During Ignition State. 1. Internal overheating. 2. Cable capacitance is too high. 3. Electrode damaged.	1. Let unit cool. Could be caused by unit being in the direct sunlight. 2. Inspect Cable for open or other damage. 3. Inspect nozzle. Replace if necessary.
37	No Cable 1. Cable is missing or not connected. 2. Cable interlock is not fastened.	1. Connect cable securely to unit. 2. Remove then re-connect pen cable to unit. May try this several times as oxidation on the connectors may be the problem.
38	CPU Temperature Too High 1. Unit is too hot.	1. Let unit cool. Could be caused by unit being in the direct sunlight. 2. Run external fan directed toward unit.
39	Line Voltage Out of Range 1. Generator or Line Voltage is too low or too high.	1. Check line voltage. 2. Check generator voltage.
41	High Ripple Power. 1. Mains line frequency too low or too high. 2. Noisy power line. 3. Lost a fuse in a 3-phase system. 4. Lost a filter capacitor.	1. Check generator frequency. (50/60 Hz) 2. Try a different outlet or correct power Line noise. 3. Must be returned for service. 4. Must be returned for service.
42*	Check Air Pressure. 1. Air pressure is too high or too low. 2. Air is not connected.	1. Set air pressure to 85-105 PSI 2. Verify that air is connected to unit.

*If you operate PlasmaBlast® with a <u>portable air compressor</u> and receive a Fault 42 that persists and/or wouldn't clear - test the compressor for air pressure/flow stability using test procedure described in Section <u>5.3 PlasmaBlast System Setup – Testing Portable Air compressor.</u>

8.   Support

For technical support, please call APS at 919-341-8325

<u>Support Hours</u>
Regular hours: 9am – 5pm Monday-Friday, Eastern Time
Emergency hours: 24/7 via email with APS on-call personnel (service@apsplasma.com)

9. Appendix A

Acceptable Receptacle Options (both operating voltages):

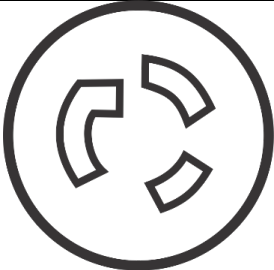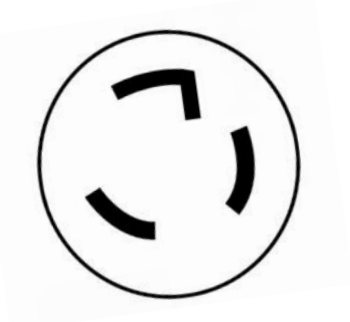**PlasmaBlast® PB7000-M-24 :** 208 to 240 Volt: Single or 3-phase
- o NEMA L6-20
- o NEMA L6-<u>30</u>
- o NEMA L14-20
- o NEMA L14-<u>30</u>
- o NEMA L15-30, 3 phase

PlasmaBlast® PB7000M-48: 440 to 480 Volt: Single or 3-phase
- o NEMA L16-20
- o NEMA L16-<u>30</u>

Table 2: Default and optional receptacles acceptable for PlasmaBlast®

PlasmaBlast-208 to 240 Volt System Receptacles

Receptacle Type	Receptacle	Receptacle Diagram	System sub-model
NEMA L6-20			PlasmaBlast-208 to 240 Volt System
NEMA L6-30 (DEFAULT)			PlasmaBlast-208 to 240 Volt System

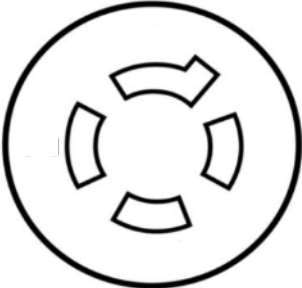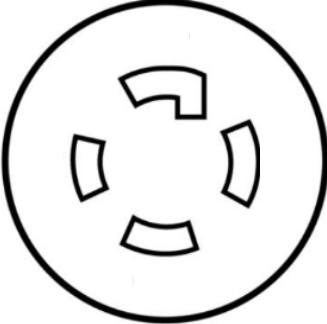|		
NEMA L14-20		PlasmaBlast-208 to 240 Volt System
NEMA L14-30		PlasmaBlast-208 to 240 Volt System
NEMA L15-30 3 phase		PlasmaBlast-208 to 240 Volt System
NEMA L21-20 3 phase		PlasmaBlast-208 to 240 Volt System
NEMA L21-30 3 phase		PlasmaBlast-208 to 240 Volt System

NEMA L6-20   NEMA L6-30   NEMA L14-20   NEMA L14-30

Figure 14: Most commonly used plugs for PlasmaBlast 240V

PlasmaBlast-440 to 480 Volt System Receptacles

Receptacle Type	Receptacle	Receptacle Diagram	System sub-model
NEMA L-16-20			PlasmaBlast-440 to 480 Volt System
NEMA L-16-30			PlasmaBlast-440 to 480 Volt System