PB-7000-M
Mobile Plasma Coating Removal System
Advanced User Training

Rev. 8.3

Atmospheric Plasma Solutions, Inc.

ATMOSPHERIC PLASMA SOLUTIONS

Today's Goals

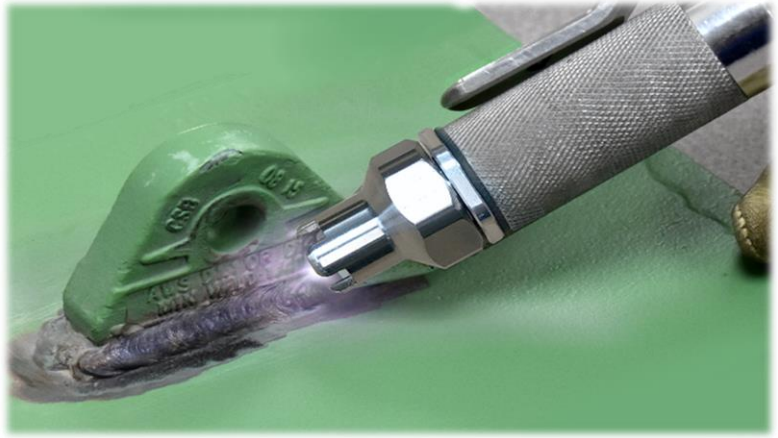
1. Learn the basic concepts and science behind air atmospheric plasma coating removal (air APCR).
2. Learn about the components of the Plasma*Blast*® PB-7000-M
3. Understand the Facility and Environmental Requirement for PB-7000-M operation.
4. Learn and respect the safety requirements and best practices for PB-7000-M use.
5. Learn how to effectively remove coatings with the PB-7000-M.
6. Demonstrate your mastery of the training, so that you can train others.

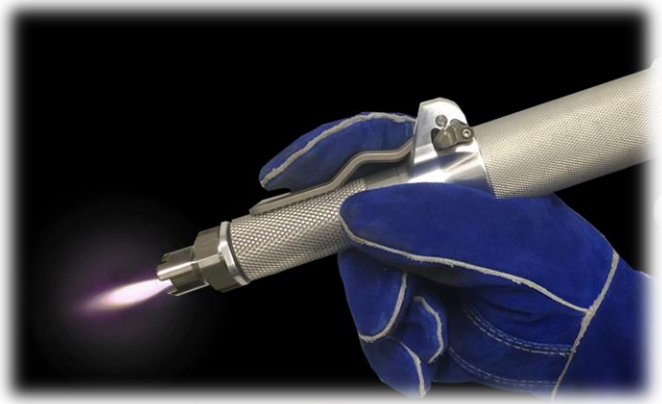
Today's Agenda

1 - Classroom Instruction - ~ 1.5 hours
Break (10 min.)
2 - Multi. Choice Test & Review - ~ 45 minutes
3 - System Demo & Practical Training – ~ 30 minutes
Lunch (60 min.)
4 - Demo of Maintenance & Displays - ~ 15 minutes
5 - Hands-on Training and Practice - ~ 1.5 - 2 hours

INTRO

PlasmaBlast 7000-M





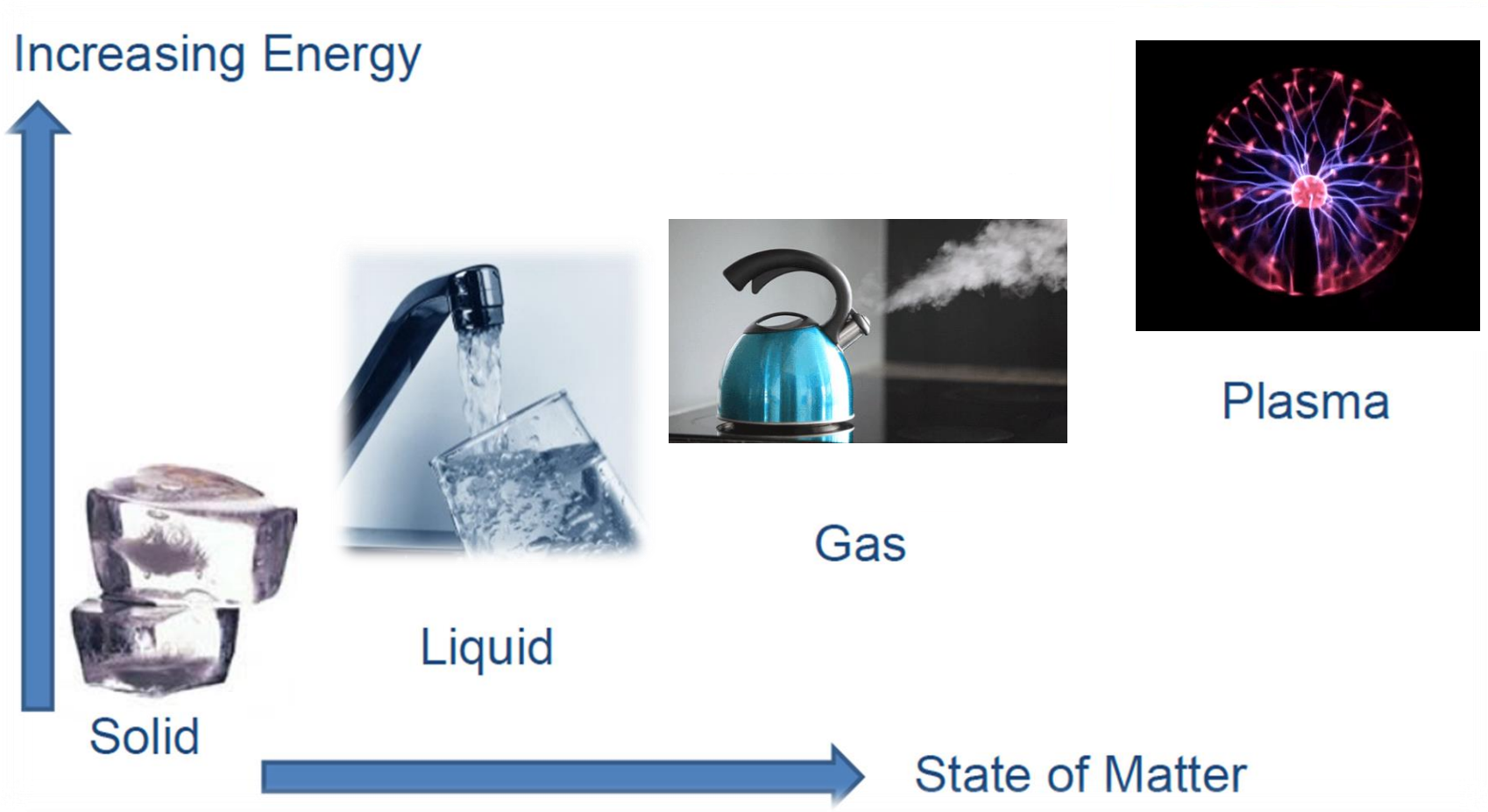
- Videos:

https://www.apsplasma.com/Vk4ZMVH2V95UTpX5k/

https://apsplasma.wistia.com/projects/xk9z2heabi

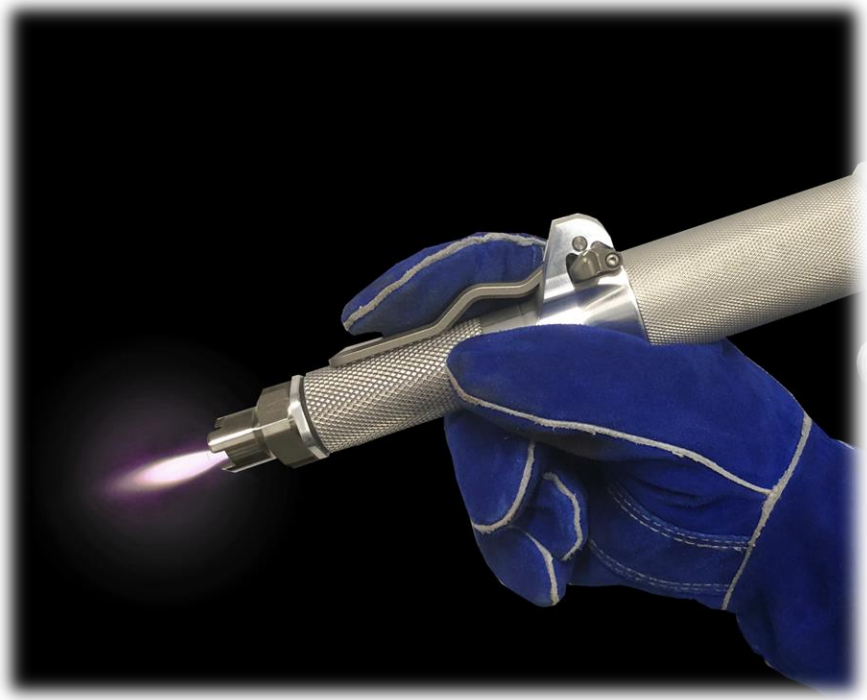
SCIENCE

Plasma: Fourth State of Matter



What is Atmospheric Plasma?

- Atmospheric plasma is a plasma produced and sustained at atmospheric pressure—in other words the same pressure as the atmosphere we live in every day.
- Compressed air is introduced into a region of intense electric field between the internal electrodes of the plasma pen.
- The electric field excites the compressed air and generates:
  - Ions (molecules or atoms with missing electrons)
  - Free electrons (electrons not bound to a nucleus)
  - Dissociated molecules (atomic oxygen from O_2)



Single-Beam Plasma Pen

Thermal vs. Non-Thermal Plasma

THERMAL

- Thermal plasma is characterized as having both its free electron and heavy ion components at high temperatures and in thermal equilibrium with each other.
    - Examples of thermal plasma include: stars & the sun, lightning, plasma cutters, fusion reactors
      ~ 500°C – 10 million°C +

HOT

NON THERMAL

- Non-thermal plasma- the free electron and ion components are not in thermal equilibrium. Typically, the ion components are at a significantly lower temperature than the electrons.
    - Examples of non-thermal plasma include: fluorescent light bulbs, novelty plasma globes, the northern lights.
      ~ 20°C – 300°C

COLD

PlasmaBlast® creates non-thermal plasma

Non-Thermal versus Thermal Plasmas

Fluorescent Lightbulb

Plasma Medicine

APCR

COLD – "Non-Thermal"

µAmps

mAmps

Welding

Plasma Cutter

Lightning

HOT – "Thermal"

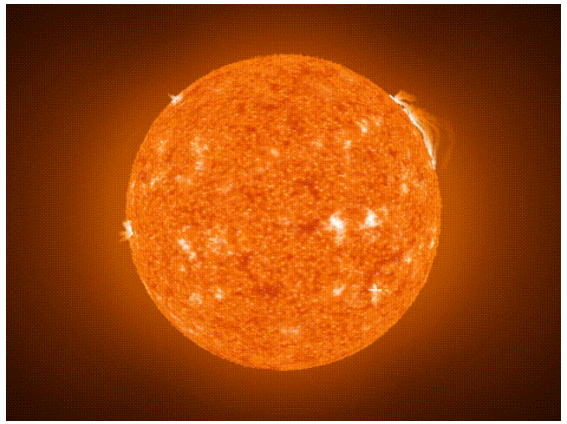
Amps

APCR – uses milliAmps of current : energy is used to make *chemistry* instead of heat

Familiar Plasmas

THERMAL

Lightning



Sun

Arc Welder

HOT

NON THERMAL

Neon Sign

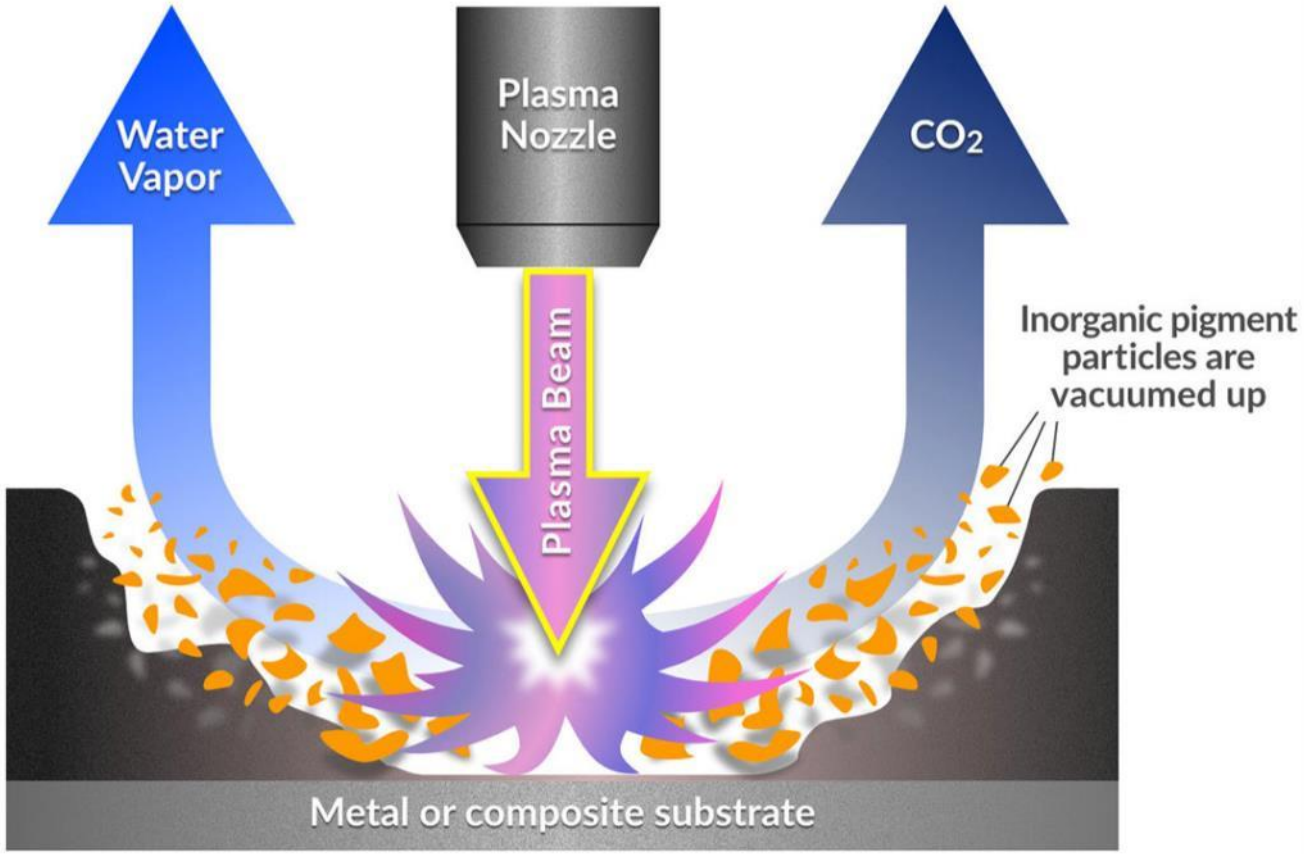
Aurora Borealis (Northern Lights)

Fluorescent Lights

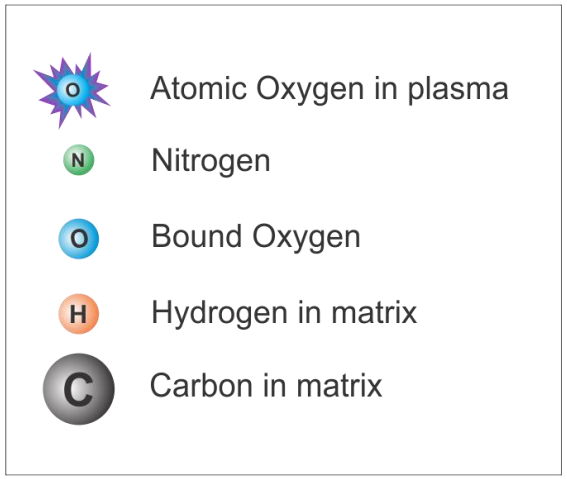
COLD

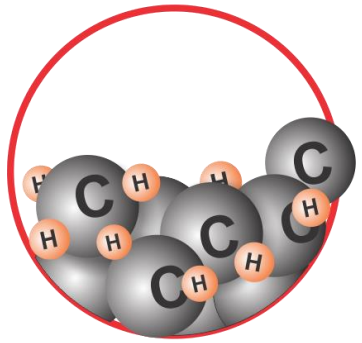
How APCR Works

1. Atmospheric Plasma Coating Removal **(APCR)** uses a low pressure compressed air source and electricity to produce a nonthermal, atmospheric pressure, air plasma
2. Atmospheric air plasma is chemically activated and oxidizes any organic components in paints and other coating materials
3. APCR process converts a significant portion of the removed organic coating into water vapor and carbon dioxide, leaving behind less solid mass than was present in the original coating
4. Remaining solids are mostly inorganic pigments and fillers that can be safely collected with a suitable HEPA vacuum
5. **Removal is top-down, allowing for removal of any thickness of organic coating**, given enough time.



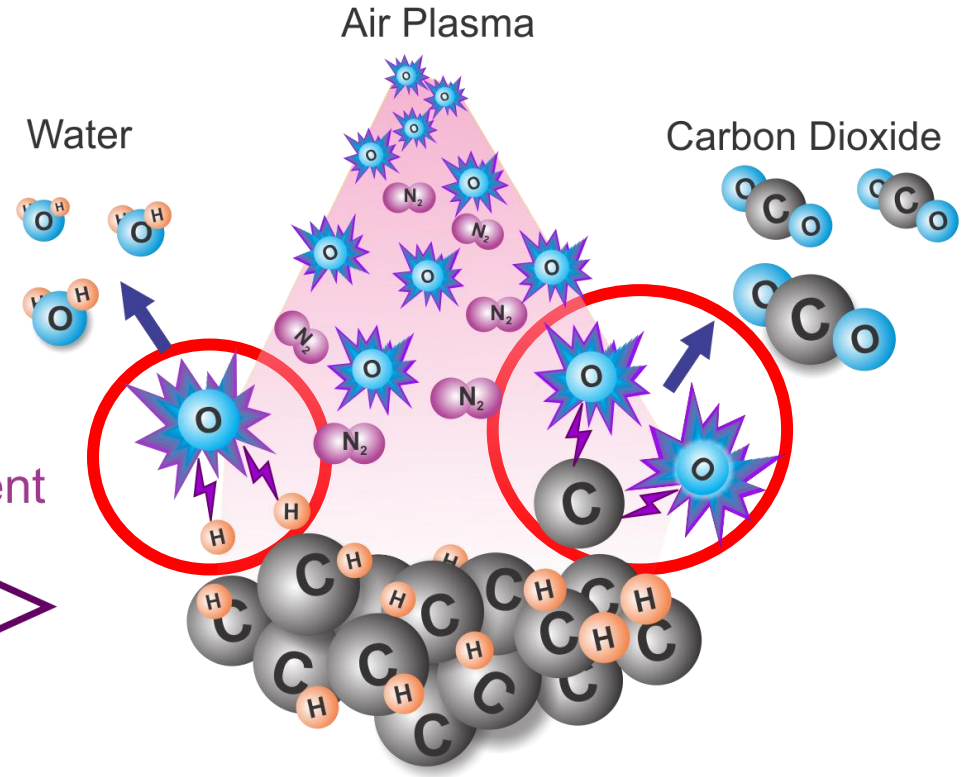
APCR at Molecular Level





Molecular level view of a coating, consisting mainly of carbon and hydrogen

Air Plasma Bombardment

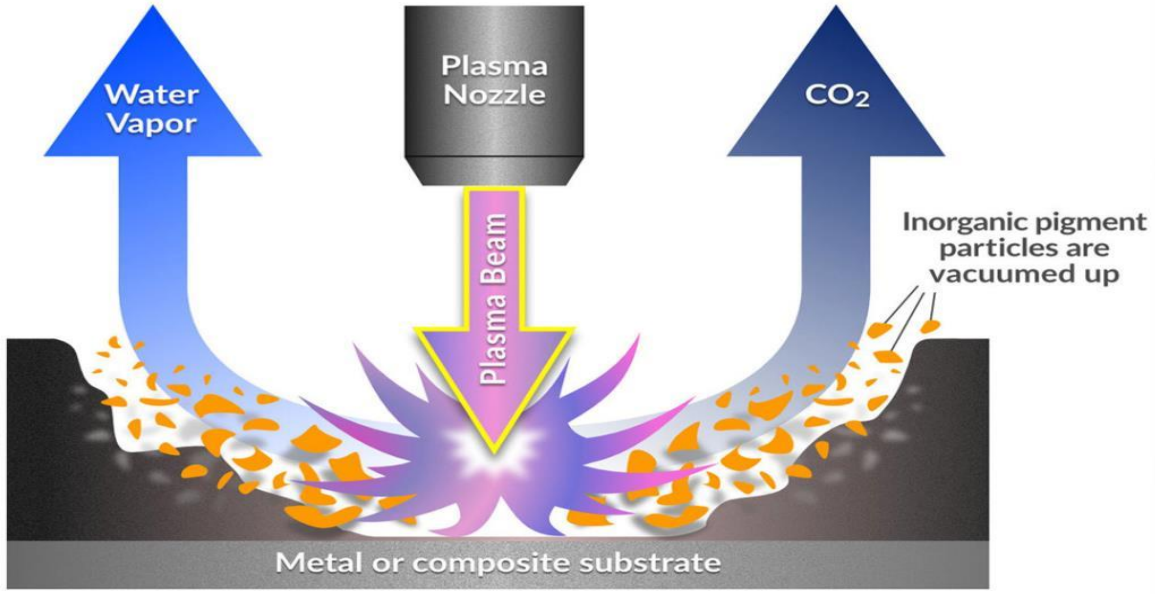


Atomic oxygen binds with hydrogen and carbon, breaking apart existing bonds, and forming water and carbon dioxide molecules

APCR is **not** Laser Ablation

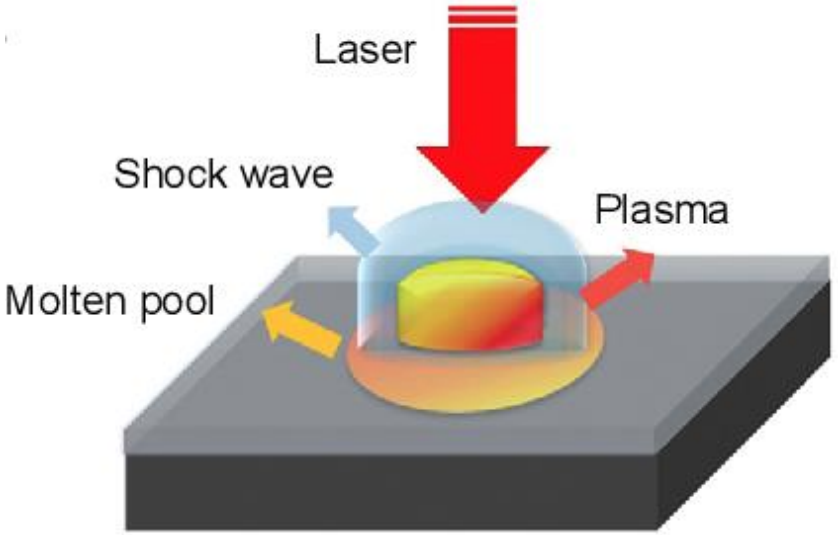
Atmospheric Plasma Coating Removal

- Non-thermal plasma
- Chemical etch
- Non-profiling / unaltered surface
- No dangerous light emissions



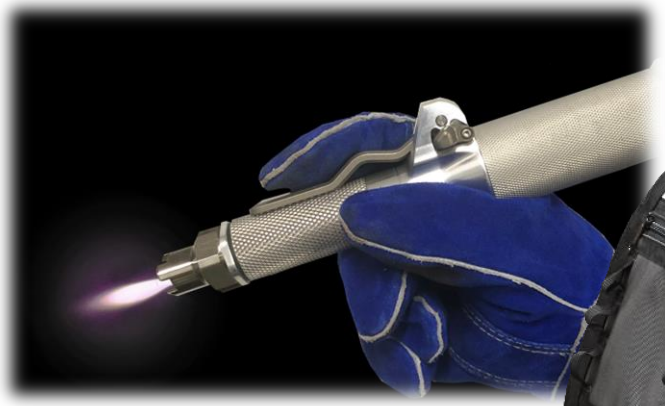
Laser Coating Ablation

- Thermal plasma
- Heat vaporizes coating & surface metal
- Melted / altered surface
- Dangerous light emission/Class IV laser



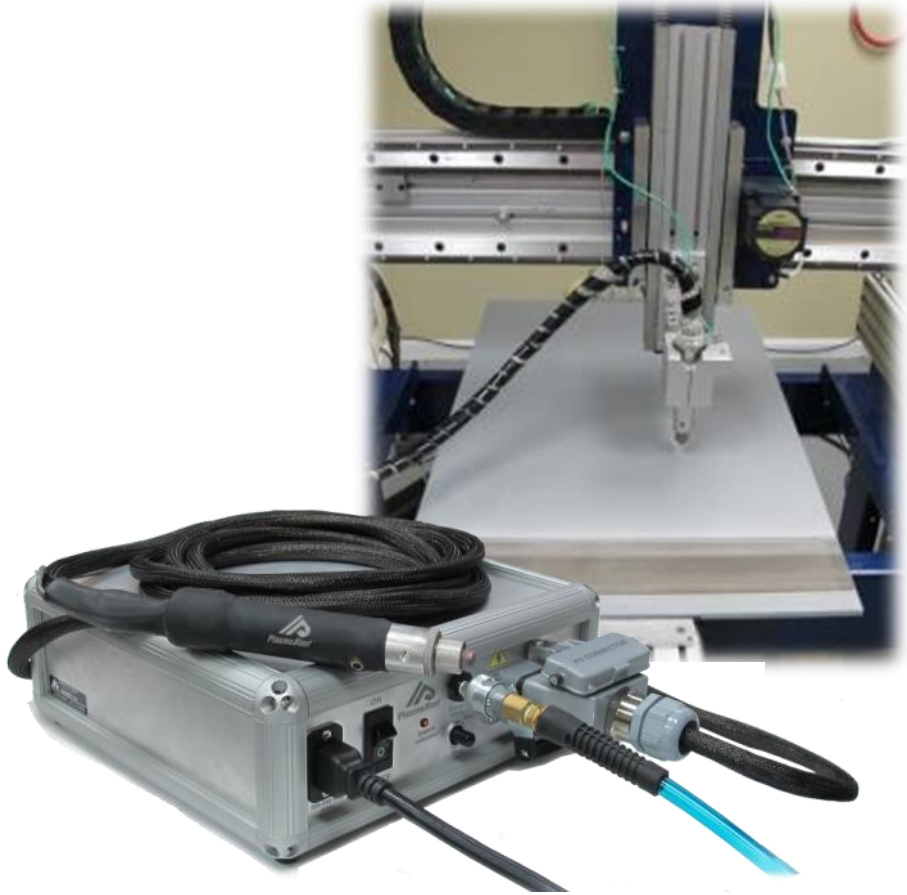
Plasma*Blast*® 7000 System Platforms

Handheld plasma pen



Mobile PB-7000 APCR system

Robot-mounted Plasma pen



Robotic-Compatible APCR system

Applications & Tool Use

COATINGS

- Acrylics
- Alkyds
- Latex
- Epoxies
- Polyurethanes
- Polyesters
- Powder Coats
- Silicone / Polysiloxanes
- Polyurea
- Coal-Tar Epoxy
- Ultra High Solid

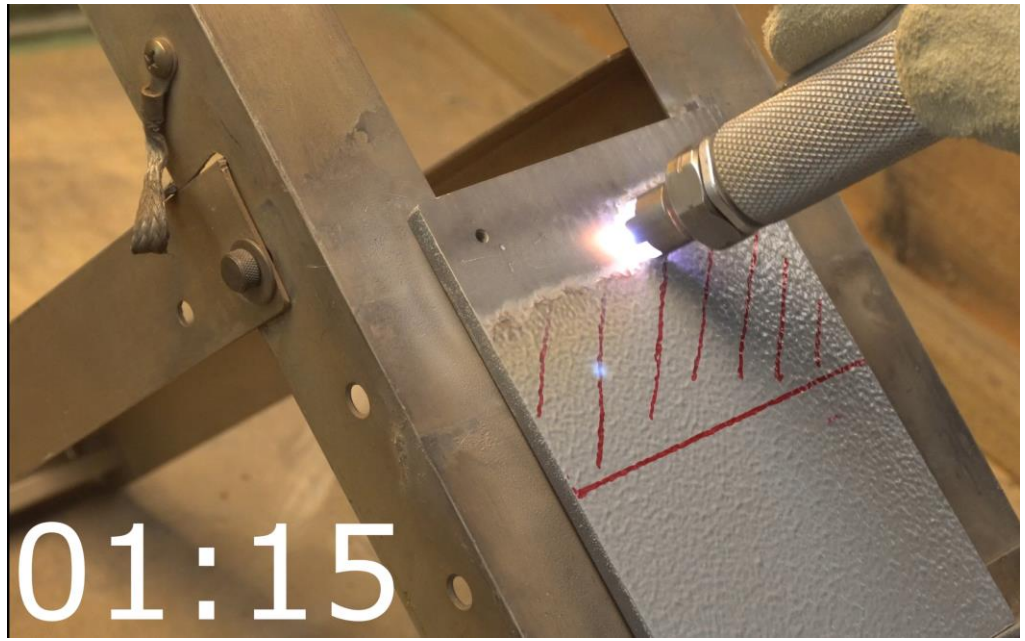
Benefits:

- Reduced wear & fatigue on users
  - Zero vibrational impact to users
- Reduced waste stream
  - No added media
  - Up to 90% of solids are converted to harmless gases depending on coating chemistry
- Non-profiling
  - No damage to substrate or removal of anchor profile

Ideal Applications: Precision removal for complex geometries
weld beads, fasteners, small-angle spaces

Tool Use:

- Remove coating by holding the pen tip ~0.2” from surface and keep pen continually moving in a raster or circular pattern
- Production rate goal of ~ 1.2 ft^2/hr
- Visual inspection of surface cleanliness
- Removal speed will slightly depend on coating chemistry
- When removing a new coating, test speed & height.



SAFETY

PPE

- ✓ Always wear impact-resistant safety glasses to protect your eyes from dust and flying particles.

- ✓ Always wear OSHA-approved hearing protection - foam ear plugs or other hearing protection when operating the plasma pen system.

- ✓ Consult with your EHS team for location specific requirements
- ✓ If the coating composition is unknown consult EHS for requirements
- ✓ If removing a coating with toxic components, follow local EHS requirements
- ✓ At a minimum, wear OSHA-approved dust mask (N95 or similar)

- ✓ Wear dry, hole-free, full-leather, OSHA-approved gloves to electrically and thermally protect the hands.
- ✓ Wear a long-sleeved shirt, long pants, and closed-toed shoes.

General Safety

- Follow all local laws, rules, ordinances, statutes and orders.
- Setup and operate the PB-7000 as specified in the Manual.
- Have everything you need to setup and operate the PB-7000.
- Make sure the equipment not supplied by APS (electrical generator, air compressor, dust collection system, compressed air line) is in proper and safe operating condition.
- **Only trained operators, trained by certified APS trainers, should use this equipment.**

- **There are no user-serviceable parts in the PB-7000 system except for the replaceable plasma pen nozzles and electrodes. Do not disassemble any part of the system. All repairs and/or modifications should be conducted by qualified APS service personnel.**

Work Area Safety

- Keep work area well lit, and as 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.

Equipment Safety

- **Keep Controller and Pen dry**

  Can be used in damp conditions but keep controller dry.

  Never submerge in water.

- **DO NOT operate with damaged cables**

  Always check AC cord and pen cable for damage.

  Immediately contact APS if any damage is discovered

Electrical Safety

Electric Shock Hazard : 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.

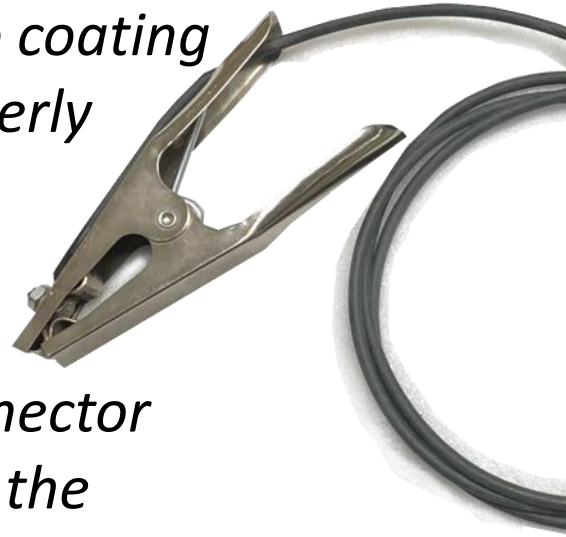
Do not operate the plasma controller unless it is securely grounded with a low impedance earth ground connection through the supplied AC power cable

Serious injury or death may occur if the proper safety procedures are not followed or the plasma system is used by untrained users.

Electrical Safety (Cont'd)

Substrate Grounding

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.



Pen Connector

In the course of normal system operation/storage HV Pen connector should be plugged in and latched. In case it is unplugged keep the connector clean and dry.

DO NOT OPEN 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.

Operational Hazards

Compressed Air

A focused compressed air-stream is emitted from the plasma pen during operation at approximately 80-100 psi and 3.5 CFM 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** 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. 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.*
- Compressed air can blow around any loose material or dust in the work area which may affect nearby personnel.

Operational Hazards

Heat

During prolonged PB7000 operation certain parts of the system may become hot.

- Pen tip/nozzle: 350°F / 175°C (Temp reached within 30 seconds of use)
- Pen grip : 95°F-165°F / 35°C-74°C (Temp reached in 10-60 min of use)
- Rear heat sink : 95°F-175°F/ 35°C-80°C (Temp reached in 1-4 hours of use)
- Remove all flammable materials from the work area prior to performing APCR.
- Wear dry, hole-free, OSHA-approved thermally insulating leather gloves to protect the hands. Welder's leather gloves are recommended for longer coating removal sessions.
- Let plasma pen cool for **at least 5 minutes** before packing it away.

Operational Hazards

Risk of Injury from the Plasma Beam

Plasma, in direct contact with the body, can damage skin and injure other body parts. 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; shattering of the glass—producing sharp shards of glass—may result.
- Plasma is generated using a **High Voltage** signal with a frequency range of **100kHz-150kHz**.
- Direct skin exposure to active plasma may result in burns, electric shock, muscle spasms, or cardiac arrhythmia.
- If you notice smoke, check to make sure your gloves and clothes haven't been damaged by the plasma. Investigate source of smoke and determine whether coating removal can proceed safely.
- If working in a confined space, dust and gasses can be blown around simple safety glasses and irritate the eyes. Consider using safety glasses that seal around the eyes or a full-face mask.

Operational Hazards

Vision and Hearing

Vision: Plasma emits low output of UV light. Additionally, the interaction of the plasma 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.

Hearing: The PB-7000 operates at noise levels of approximately 90 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 industrial rated hearing protection.

Operational Hazards

Gas Buildup

- Small concentrations of Ozone and NO_x are produced as a natural byproduct of the air-plasma generation process. Some coating chemistries can create other toxic or irritant gases. Consult EHS for best practices for the coatings you remove.
- In enclosed spaces with limited ventilation, these gases can buildup to nuisance or hazardous levels.
- Always use sufficient ventilation. A full-face mask with supplied air ventilator may be used if ventilation is insufficient. A full-face mask with appropriate multi-gas filter may be used if ventilation is brought into the space.
- Always obey local EHS guidelines over recommendations in this training
- Symptoms of Ozone and NO_x exposure include: irritated eyes, nose, chest, or throat; difficulty breathing; coughing; headaches; dizziness; and light-headedness.

Operational Hazards

Coating Removal

Prior to beginning any removal, the user must be aware of the potential health risks associated with the coatings being removed.

- **CAUTION:** APCR can be destructive to nonmetallic surfaces. Wood, rubber, insulation, electric installations, instrumentation, etc. must be protected from direct and indirect exposure of plasma if it is to be kept undamaged or unchanged.

- Extensive metallurgical testing was completed that indicated proper use of plasma coating removal on ferrous metal (steel) substrates does not negatively affect the properties of the steel. Plasma coating removal on substrates other than steel (i.e. aluminum, bronze) will require specific approvals by the cognizant local authority until which time a blanket approval is issued

- 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.

Operational Hazards

Hazardous Debris & Toxic Coatings

The plasma coating removal process can result in flying debris or release of toxic components of the coatings.

- **The plasma removal process does not change or mitigate any pre-existing risk** in a paint, sealant or other surface coating.
- Do not operate the PB-7000 in settings where other people may be injured by toxic and other hazardous debris ejected from the surface being treated.
- Ensure proper air ventilation. The plasma may generate toxic and other hazardous byproducts, including gases and particulates, depending on the coating chemistry (e.g. lead paint).
- Always wear protective gear, a dust mask or a respirator. Use a full-face respirator during removal of coatings with toxic components. If the exact coating composition is unknown, assume that it may be dangerous and take full precautions.

PPE

- ✓ Always wear impact-resistant safety glasses to protect your eyes from dust and flying particles.

- ✓ Always wear OSHA-approved hearing protection - foam ear plugs or other hearing protection when operating the plasma pen system.

- ✓ Consult with your EHS team for location specific requirements
- ✓ If the coating composition is unknown consult EHS for requirements
- ✓ If removing a coating with toxic components, follow local EHS requirements
- ✓ At a minimum, wear OSHA-approved dust mask (N95 or similar)

- ✓ Wear dry, hole-free, full leather, OSHA-approved gloves to electrically and thermally protect the hands.
- ✓ Wear a long-sleeved shirt, long pants, and closed-toed shoes.

FACILITY REQUIREMENTS

What you need to operate a PB-7000-M

Compressed Air

- Facility compressed air or portable compressor *(not supplied by APS)*
- Compressor must be rated **>3.5 CFM (100 SLM)** flow capacity at **>90 psi / 6 bar** pressure
- Default Input: 1/4” standard industrial air fitting
- Dry and **oil–free** air required
- Acceptable input pressure range: **80-105** psi
- Optimal pressure/flow: **99 psi / >3.5 CFM**

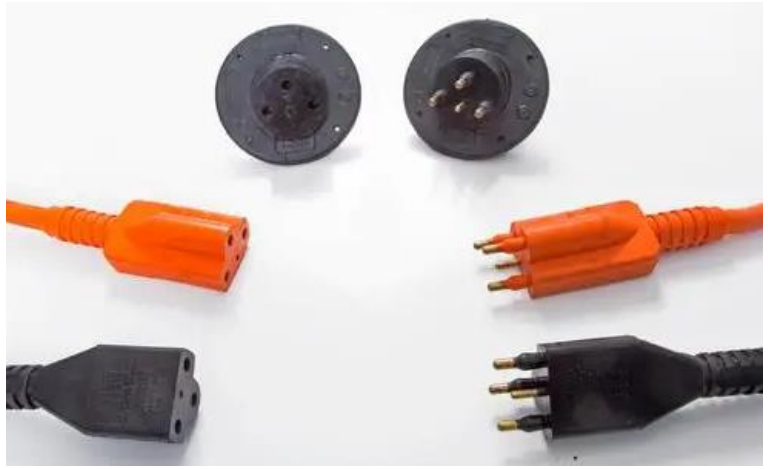
The system will not operate if the input pressure is outside of acceptable range.

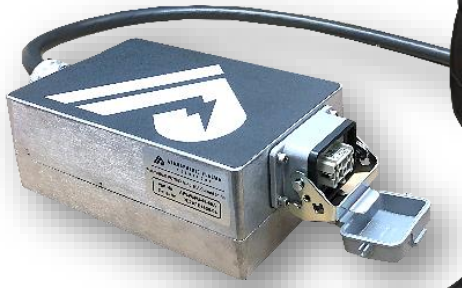
Electric Power

Requires facility power or portable generator *(not supplied by APS)*

440-480 VAC System

- 440-480V, 3-phase, 50-60 Hz, 6-8 Amps
- 10 Amp circuit breaker min
- Default: 4M20 Plug **or** NEMA L16-20





Electric Power

Requires facility power or portable generator *(not supplied by APS)*

208-240 VAC System

- 208 - 240V, Single phase, 50-60 Hz, 14.5 Amps
- 20-30 Amp circuit breaker
- Default receptacle/plug – **NEMA L6-30**

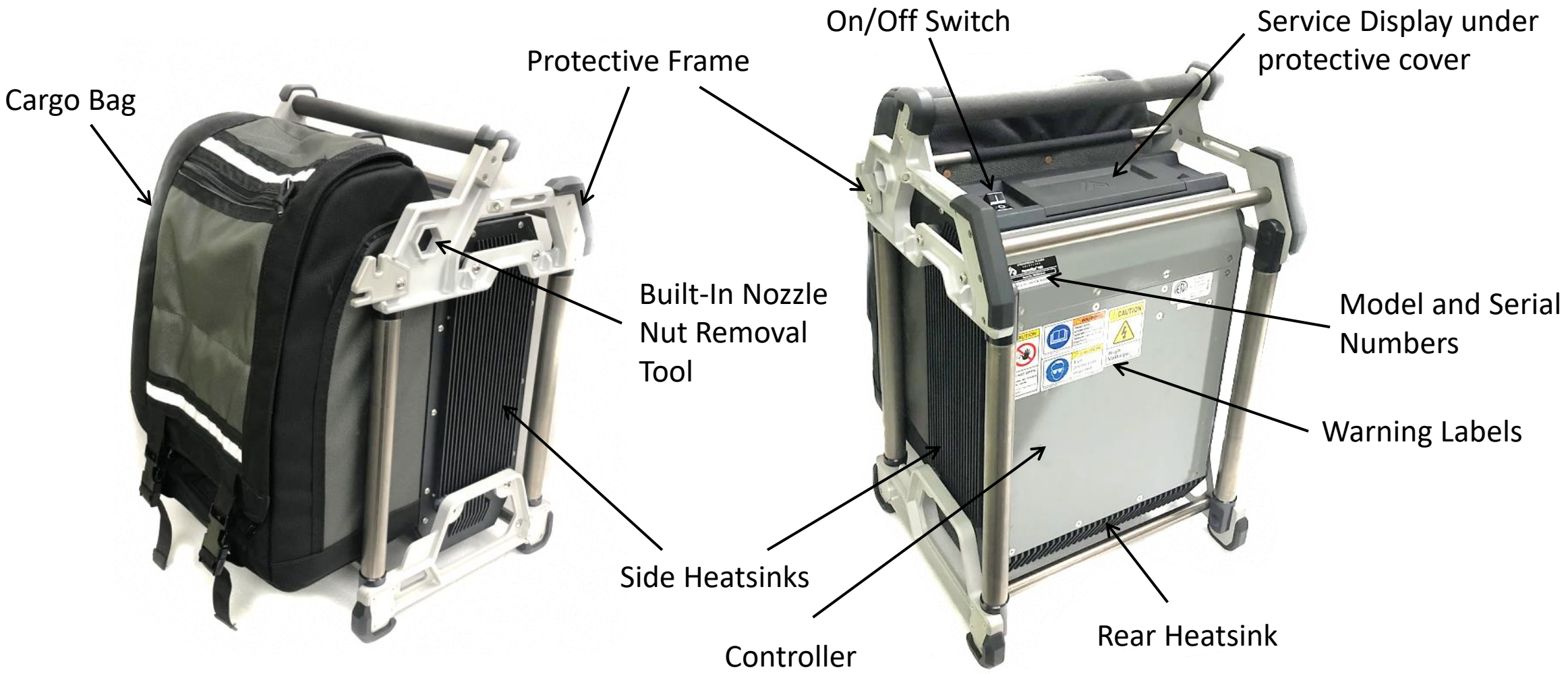
Ventilation/Dust Collection

- **Enclosed space:**
  - Requires fume extractor or a ventilated exhaust hood
  - Consult with your EHS Team for site-specific requirements

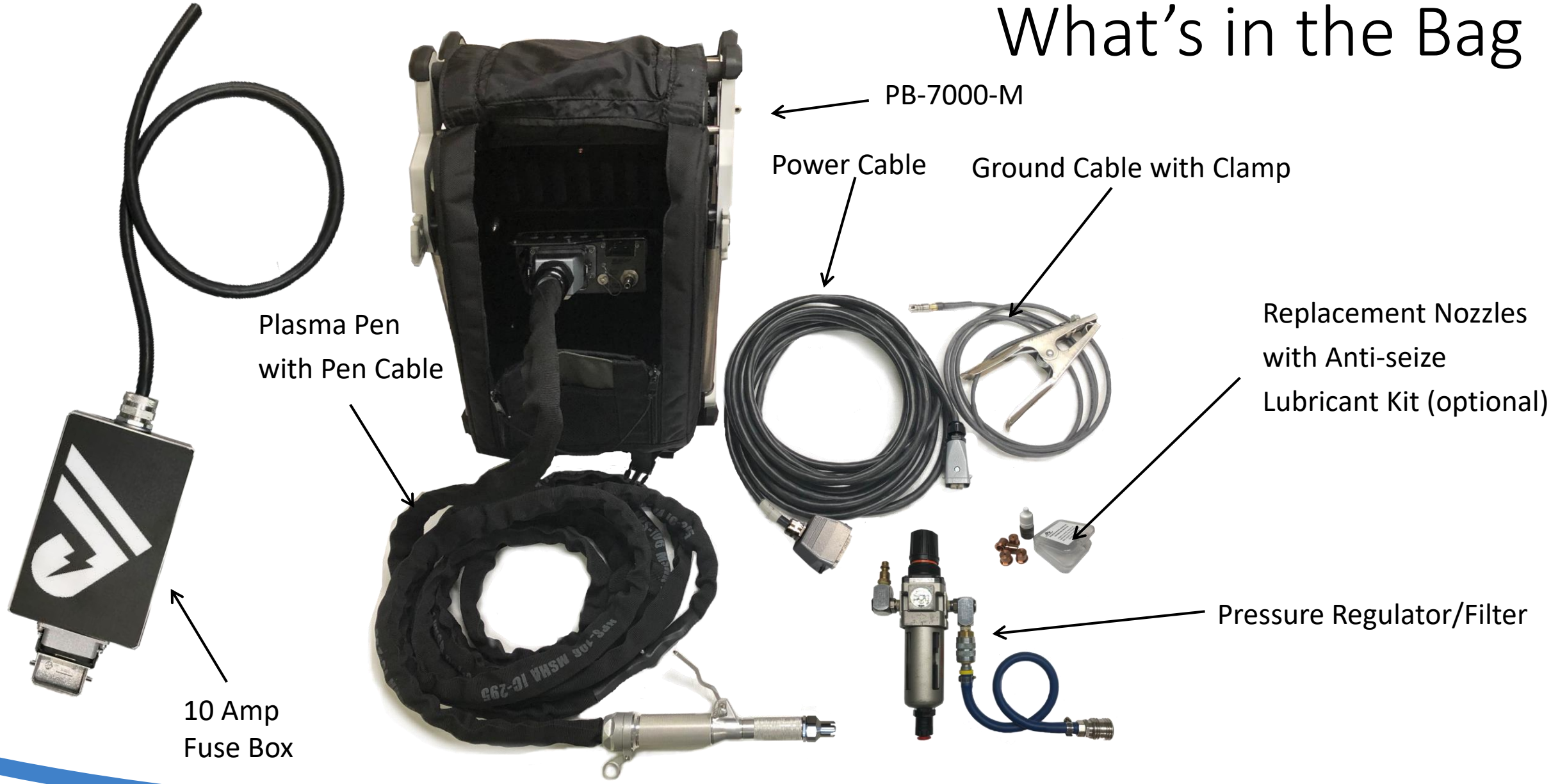
- **Outside:**
  - Consult with your EHS Team for site-specific requirements
  - A pedestal fan ~ 12”- 24” diam. is recommended
  - Place fan so that it blows away from operators

PB-7000-M System and Components Overview

Overview of the PB-7000-M System



What's in the Bag



Plasma Controller and System Connections

208-240 VAC System

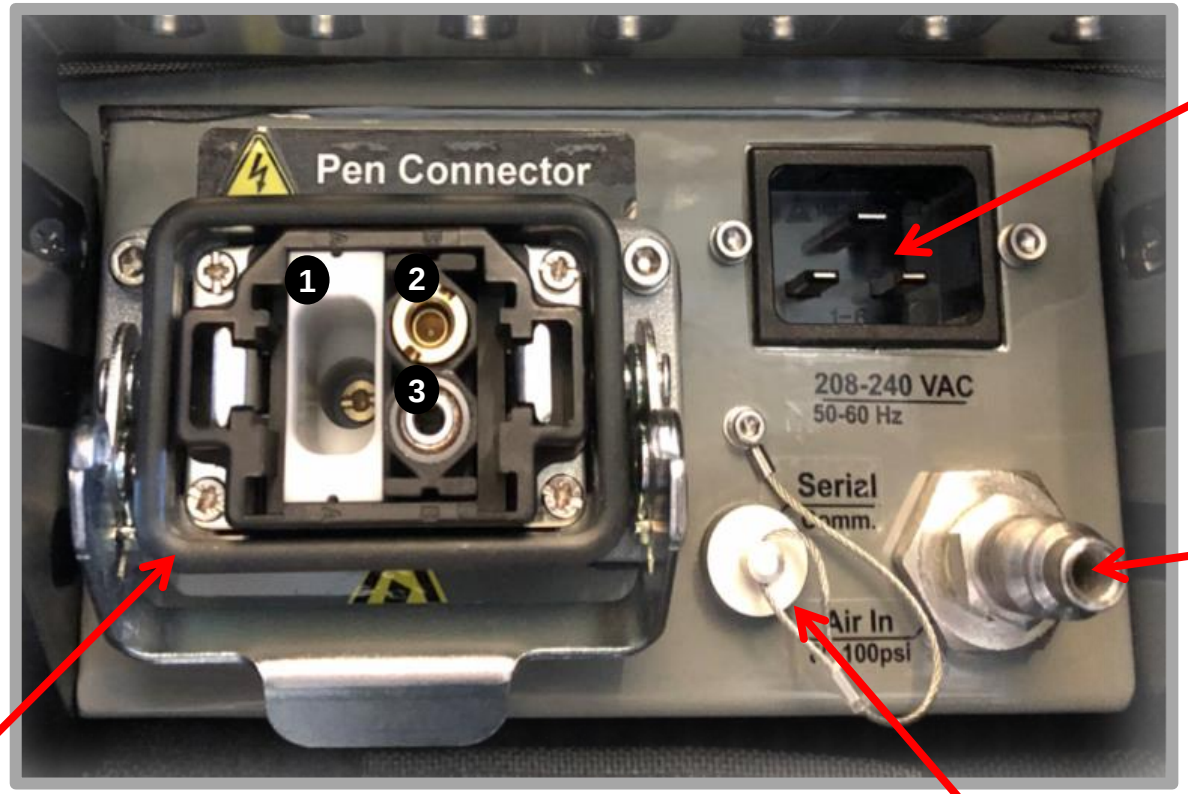
Pen Connector

❶ HV Receptacle

❷ Air connection

❸ Signal connection

Connector Block



Power Input:

- **208-240 VAC**, 50-60 Hz
- C19 Receptacle

Compressed Air Input:

- Connects to facility air or portable compressor through pressure regulator
- 80-100psi

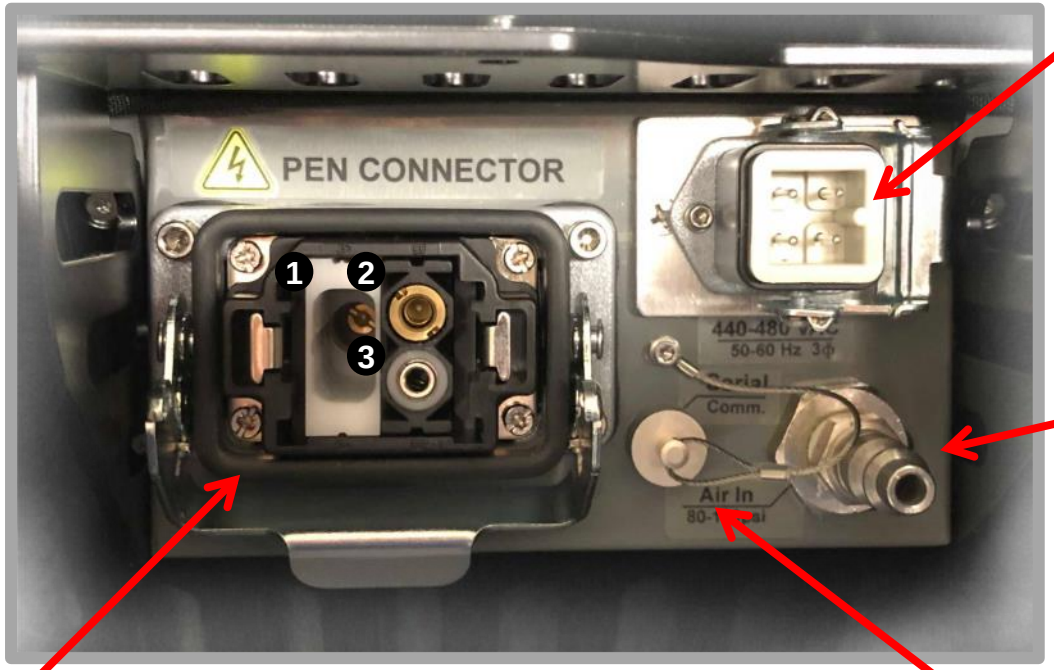
Communication Port:

Service Technician use or User use when directed by APS only

Plasma Controller and System Connections

440-480VAC System

Connector Block



Power Input:

- 440-480 VAC, 3-phase, 50-60 Hz
- Latching connector receptacle

Compressed Air Input:

- Connects to facility air or portable compressor through pressure regulator
- 80-100psi

Pen Connector

❶ HV Receptacle

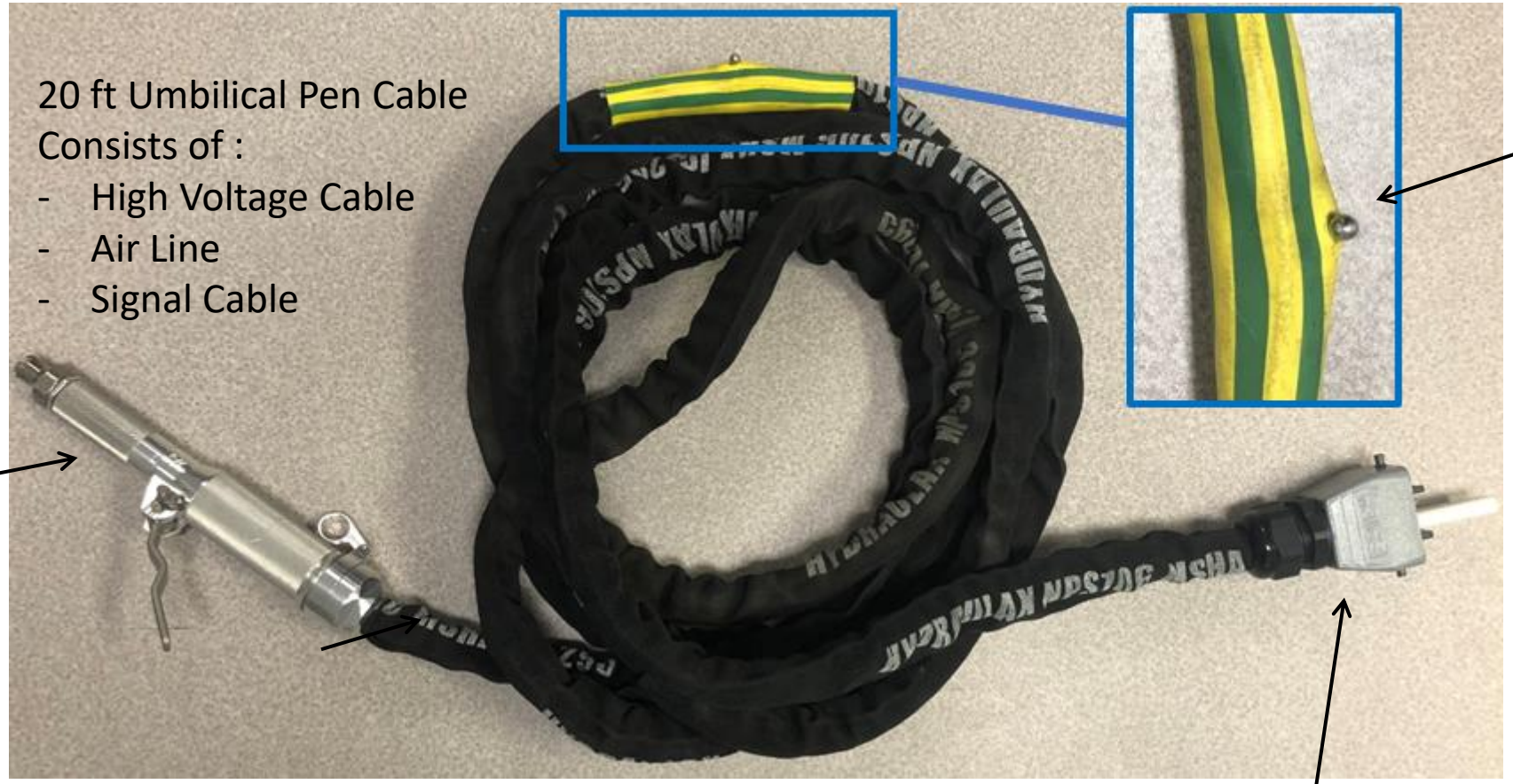
❷ Air connection

❸ Signal connection

Communication Port:

Service Technician use or User use when directed by APS only

Plasma Pen with Cable Assembly



20 ft Umbilical Pen Cable
Consists of :
- High Voltage Cable
- Air Line
- Signal Cable

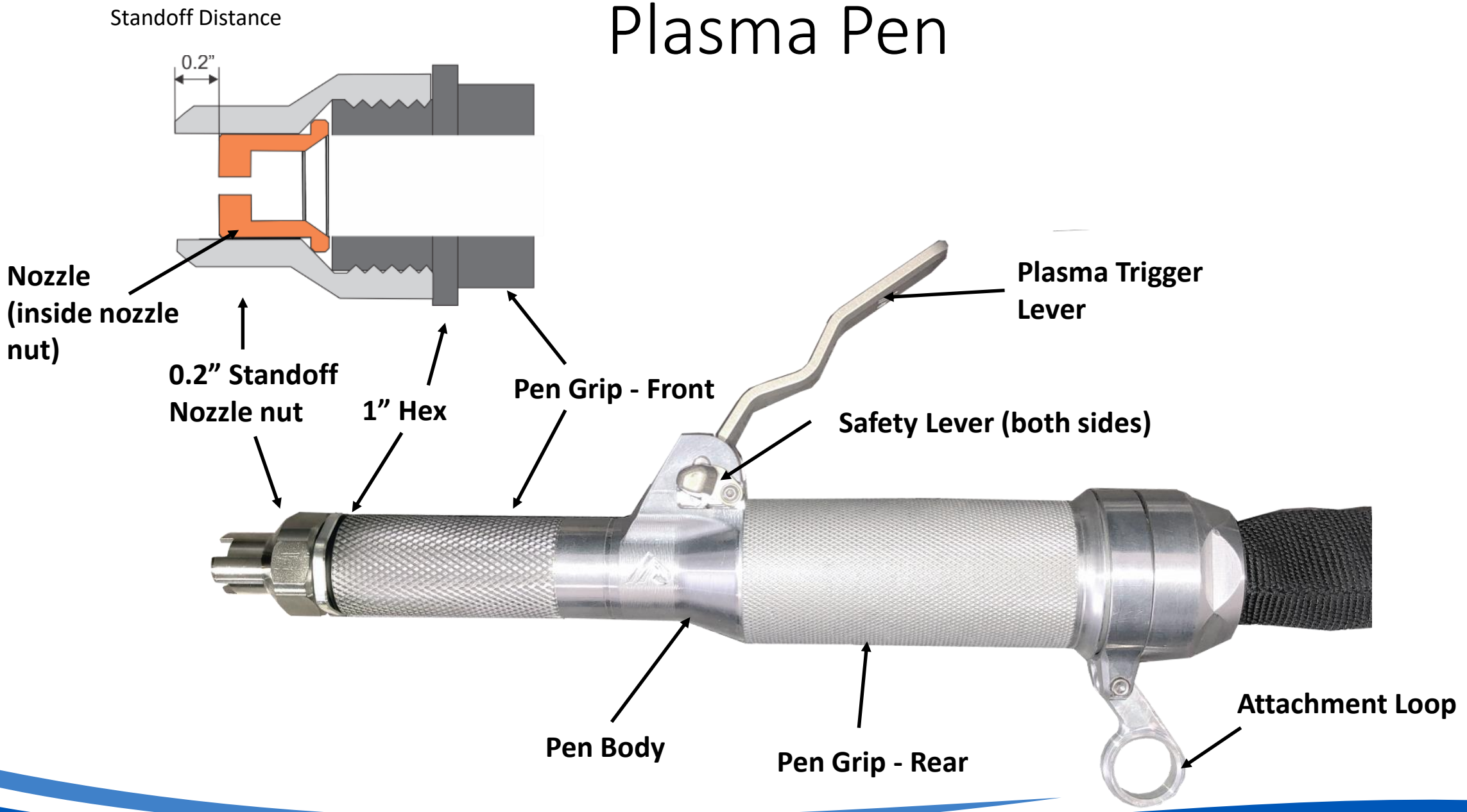
Ground Post
(~ 6 ft from Pen Body)

Plasma Pen

to HV Pen Connector Receptacle on Plasma Controller

High Voltage Connector Plug

Plasma Pen


Standoff Distance
0.2”
Nozzle (inside nozzle nut)
0.2” Standoff Nozzle nut
1” Hex
Pen Grip - Front
Plasma Trigger Lever
Safety Lever (both sides)
Pen Body
Pen Grip - Rear
Attachment Loop

Grounding Cable with Clamp

Grounding Clamp

Ground Cable

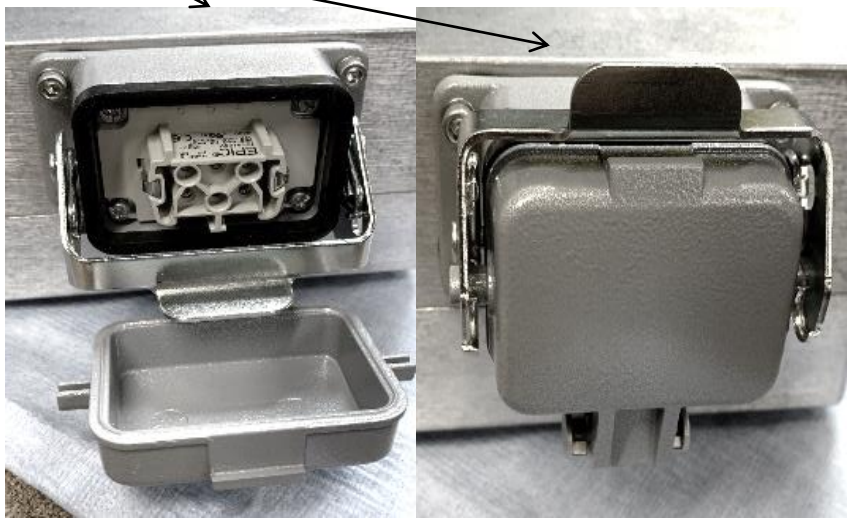
Ground Connector with spring-loaded sleeve: attaches to Ground Post on Pen Cable (~6 ft from pen Body)

Fuse Box & Power Cable

2 8 AWG power wire;
Rated for 1000 VAC & 69 Amps at 86 °F

1 Water-tight aluminum enclosure

3 Latching 6-pin power connector



440-480 VAC System

20ft long

- System side: Latching 4-pin connector
- Default plug: NEMA L16-20

Power Cable

208-240 VAC System

15ft long

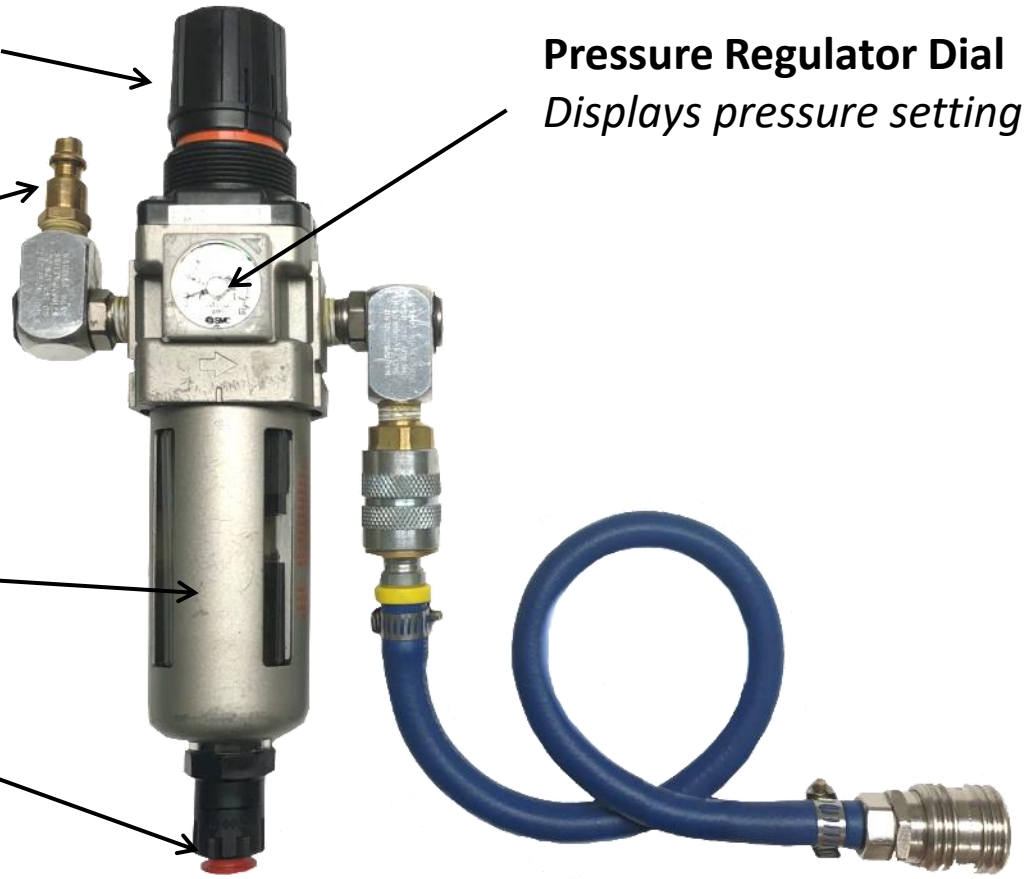
- System side: C18 connector
- Default plug: NEMA L6-30

Pressure Regulator and Filter

Pressure Regulator Knob
Use to adjust the pressure during system setup

Pressure Regulator Dial
Displays pressure setting value

Inlet Fitting
Compressed Air In from facility or portable compressor



Air Filter

Water Trap Drain

Output to Plasma Controller
Connects to "Air In" on Connector Block

IMPORTANT: MUST BE IN UPRIGHT POSITION IN ORDER TO FUNCTION PROPERLY

Consumable Pen Parts

Nozzles (copper tip on the pen)

- Over time, plasma wears down the nozzle, opening the aperture, and usually slowing removal rates.
- Should be **replaced after ~8 hours** of plasma-on time.
- Replacement Nozzle Kits
  - 5 nozzles
  - 1 anti-seize lubricant bottle.
- *NOTICE: Apply lubricant every time the nozzle nut is removed*

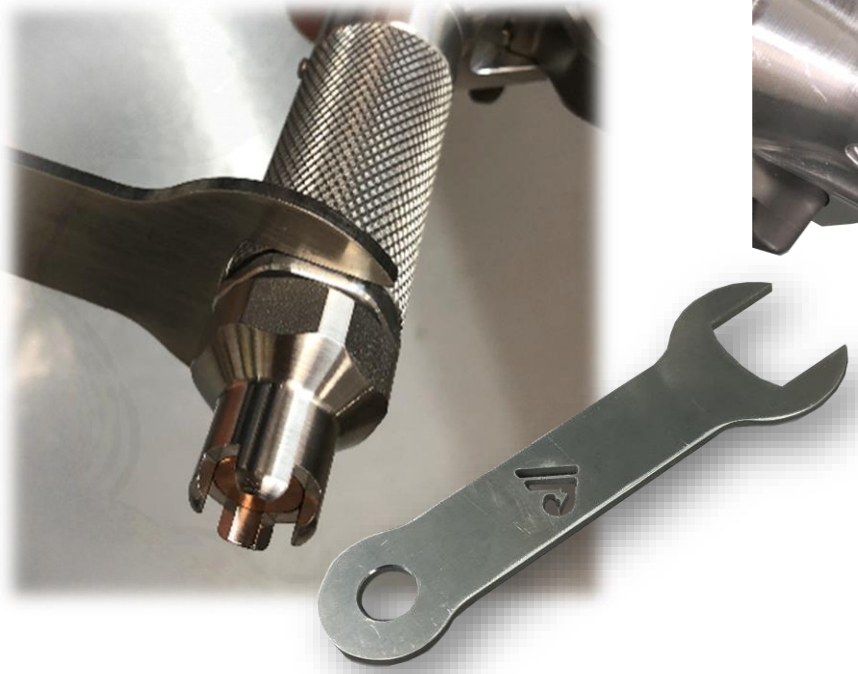
Electrodes

- Replace every 100 plasma-hours.

Toolset Provided with the System

1” Hex Tool

- Fits the hex feature in front of the pen.
- Used in nozzle and electrode replacement procedures.



#1 Phillips Screwdriver

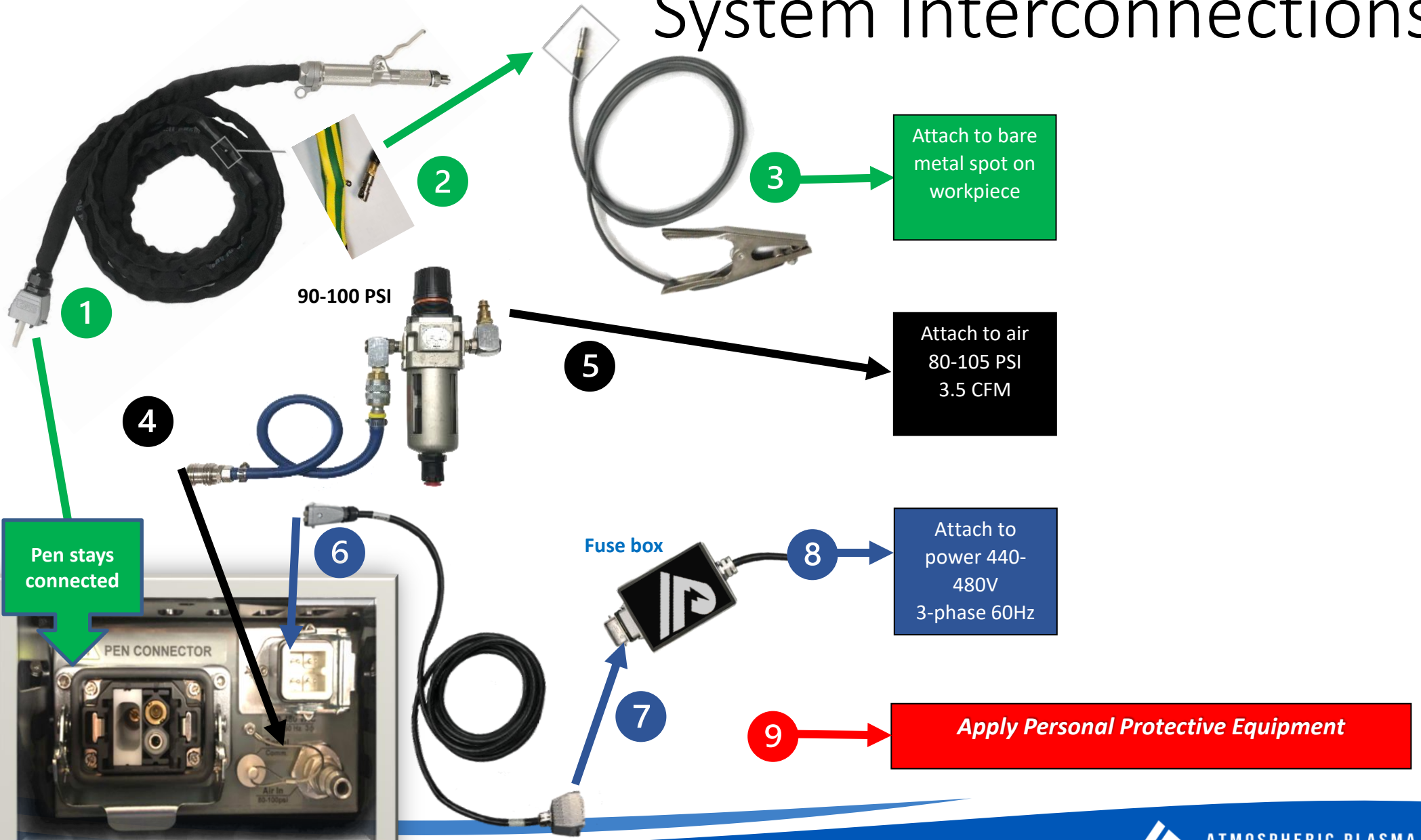
- Used in electrode replacement procedures.

Deep well 1/2” 6-point socket with handle

- Used in electrode replacement procedure

System Setup and Operation

System Interconnections



System Setup

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 5-6 if not plugged in).

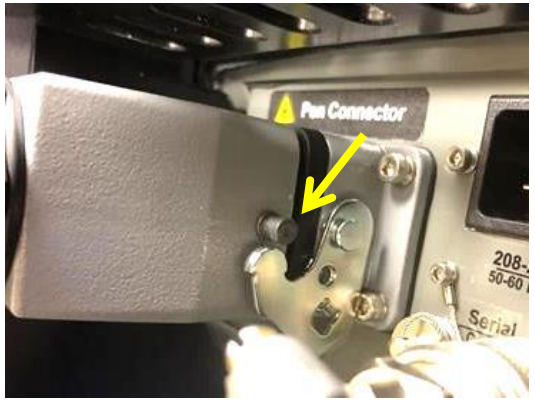
Remove transportation strap from plasma pen (if present)

System Setup (Cont'd)

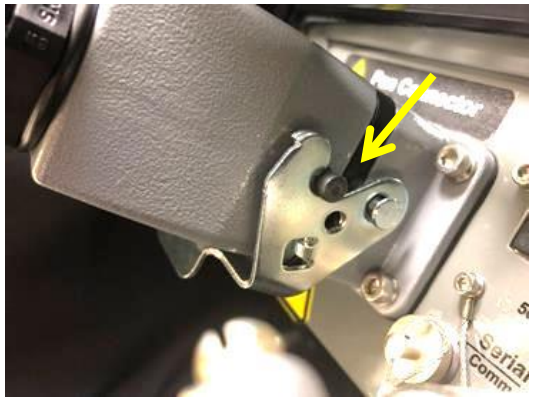
Applies only if Pen Connector is unplugged

3. Plug in the connector, make sure it is fully seated

4. Engage the connector base latch with the pins on the plug but pressing up on it firmly until fully latched with a click.



Not latched

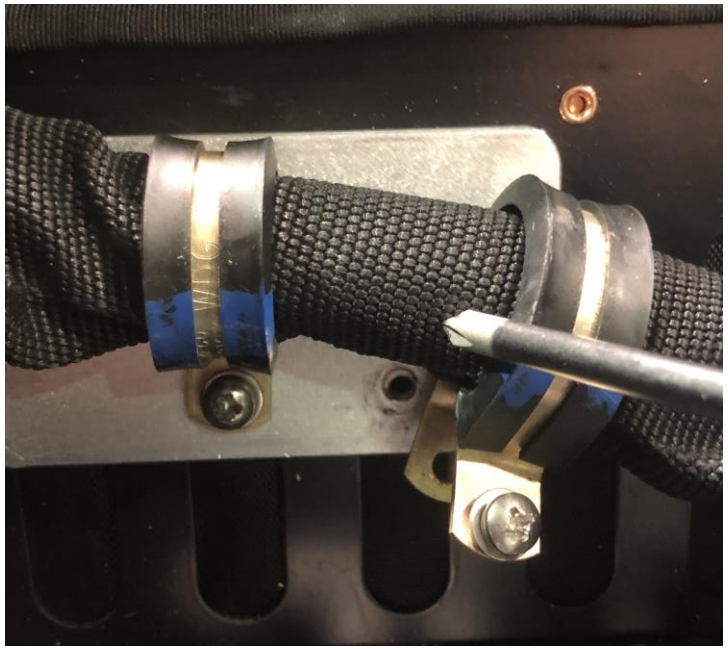


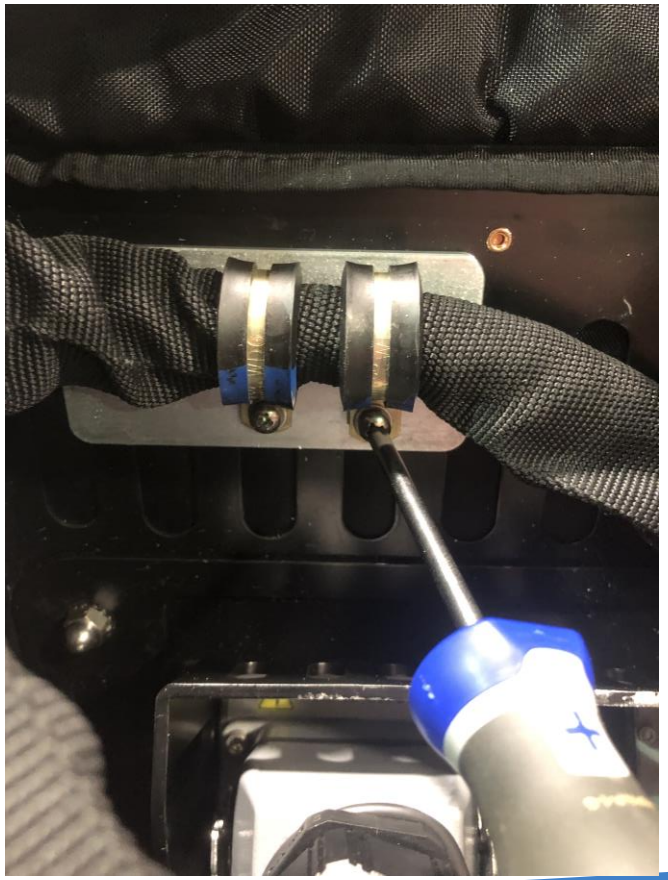
Fully latched

System Setup (Cont'd)

Applies only if Pen Strain Relief is Disconnected

5. Screw in the strain relief connectors, ensuring enough pen cable length in between relief connection and pen input connector (~1 ft).





System Setup (Cont'd)

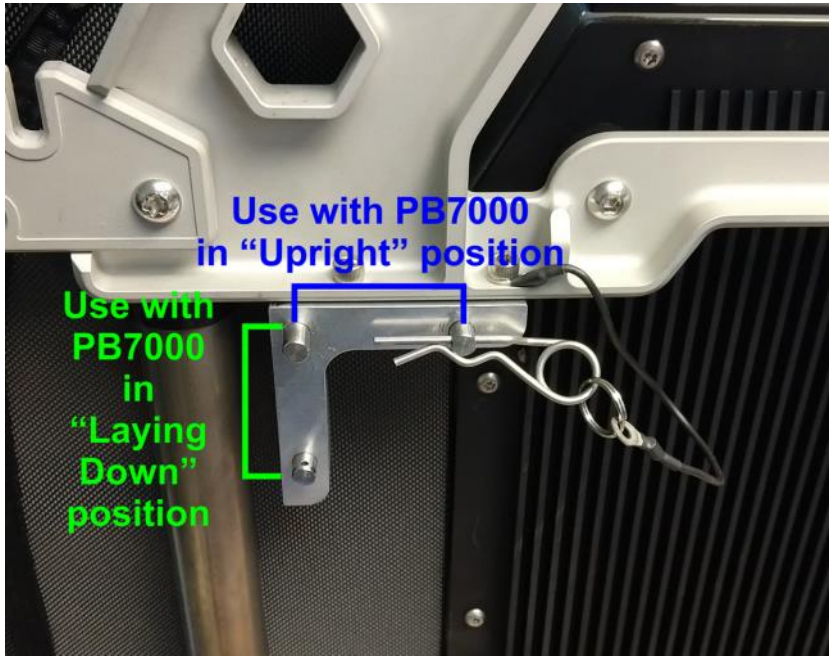
6. Connect the Pressure regulator output hose to 1/4" industrial style air fitting marked "Air In" on the Connector Block of the Controller.

7. Connect air supply hose to filter/regulator

System Setup (Cont'd)

Pressure Regulator must be in upright position to function properly

8. Install Pressure Regulator onto the Frame using two out of the three locator pins on the Pressure Regulator Bracket.
The 3 locator pins allow to install the Regulator in 2 different orientations, depending on the position the PB7000-M is used in. Use the orientation that will allow the system to keep the Regulator upright for proper water drainage.

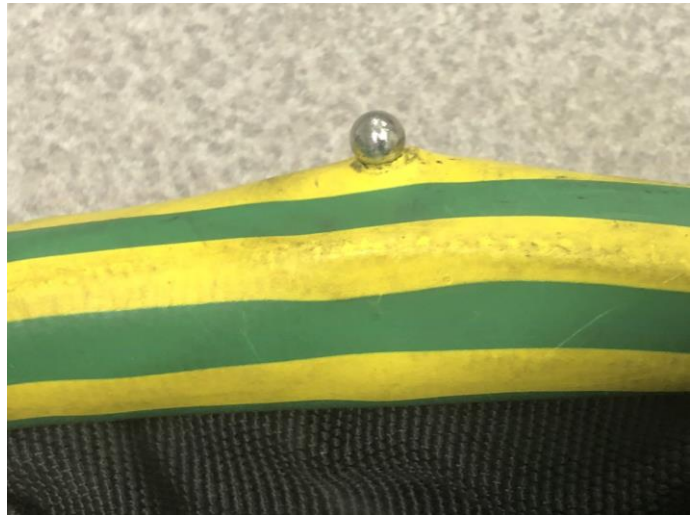


9. Make sure the locator pins are fully inserted into mounting slots of the Pressure Regulator and then insert the retainer pin into a hole in the locator pin.

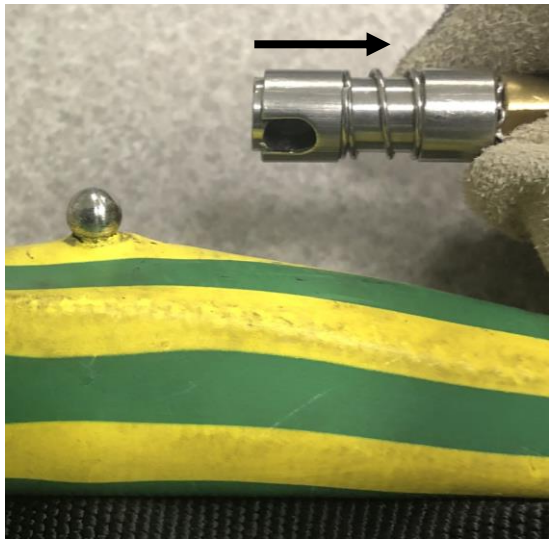
System Setup (Cont'd)

Attaching Ground Cable to Pen cable

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



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



12. Place the opening over the ground post. Then let go of the spring.

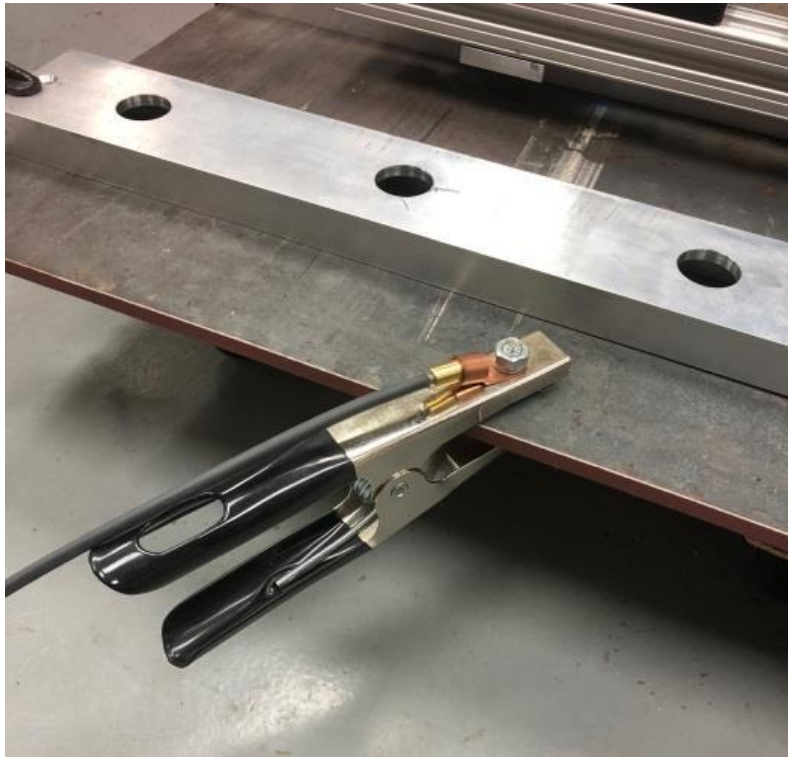
The ground cable will be able to rotate 360 degrees.

System Setup (Cont'd)

Attaching Ground Cable to Pen cable

13. **Ground the Substrate:** Attach the clamp to the substrate, near the area being treated.

Failure to ground the substrate may result in charge build-up which may cause a shock hazard to the user and potential damage to the substrate.

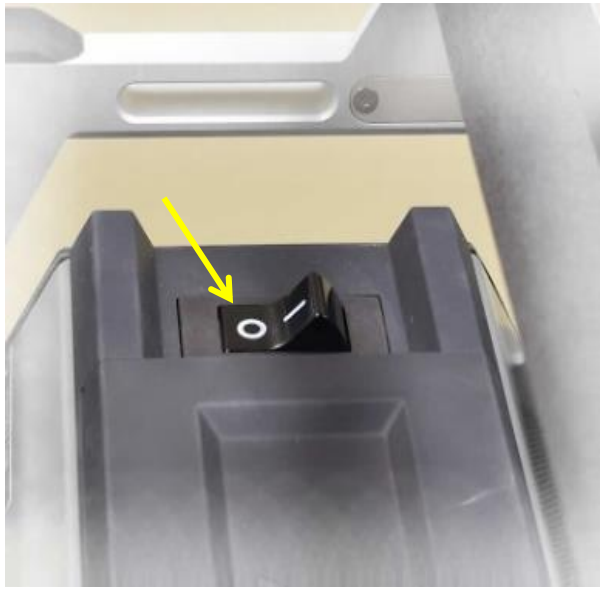


System Setup (Cont'd) / *240V system*

14**. Make sure that the AC power cable is UNPLUGGED from the power source,** then Connect the AC power cable to Power Input on the Connector Block

15. Double check that all connections are properly attached and secured

16. Make sure that the On/Off switch is in "**OFF"** position

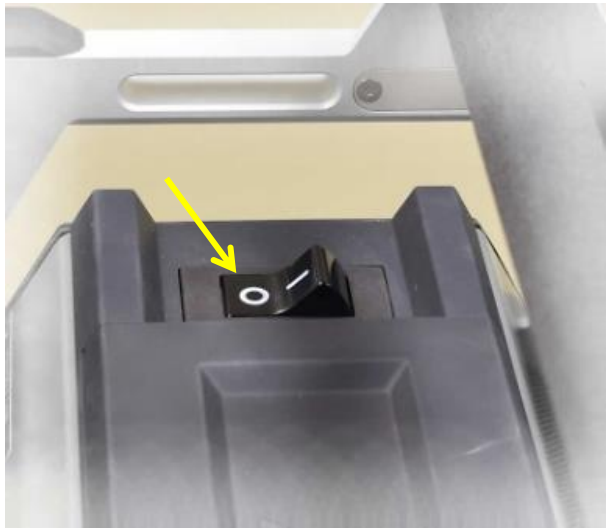


17. Plug the other end of the power cable into the facility power receptacle.

System Setup (Cont'd) *480V system*

14**. Make sure that the AC power cable is UNPLUGGED from the power source,** then Connect the AC power cable to Power Input on the Connector Block

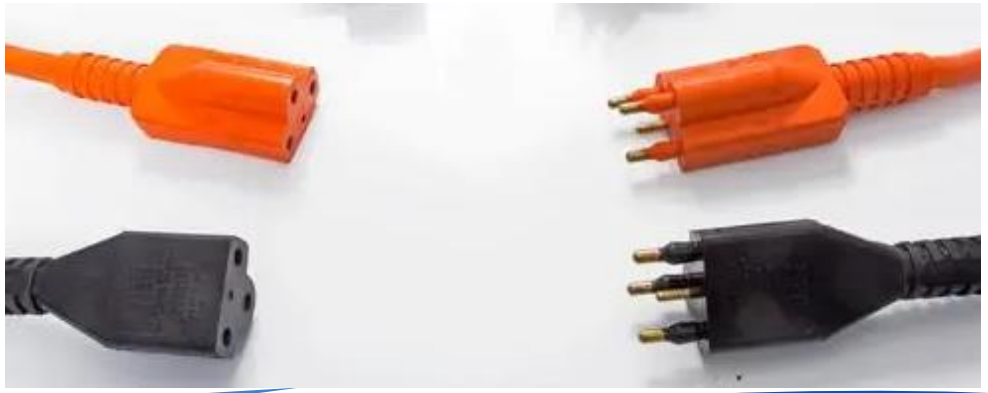
15. Make sure that the connector is latched securely and that the On/Off switch is in the **OFF** position



System Setup (Cont'd) *480V system*

16. Connect the other end of the system power cord (6-pin connector) to the Fuse box 6-pin receptacle.

17. Plug the other end of the power cable into the facility power receptacle.



System Setup (Cont'd)

Powering up the PB-7000-M System

Ensure that you are wearing appropriate PPE at this point (Gloves, safety glasses, dust mask, hearing protection).

18. With the pen nozzle facing away from you and other people, and the pen lever in the off position, turn on the AC power switch on the PB-7000-M. The system will briefly purge air while starting up.

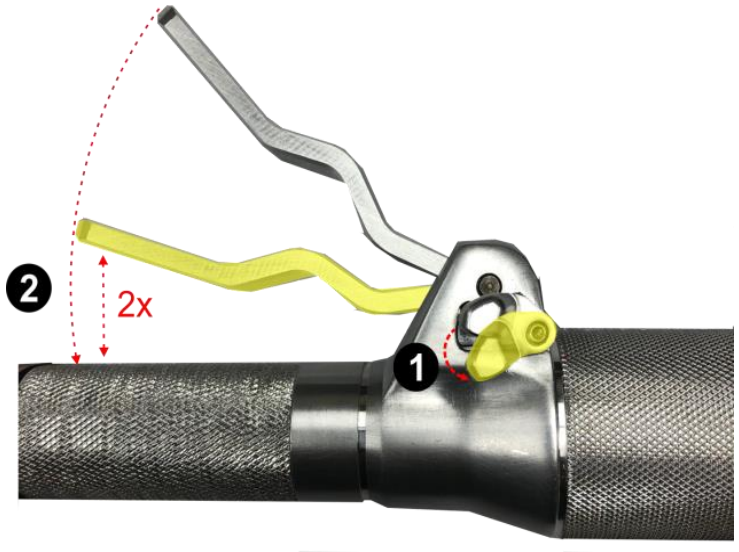
System Setup (Cont'd)

Setting Operating Air Pressure

19. Open Status Display cover to access Status Display screen (see Status Display Module)

20. 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.

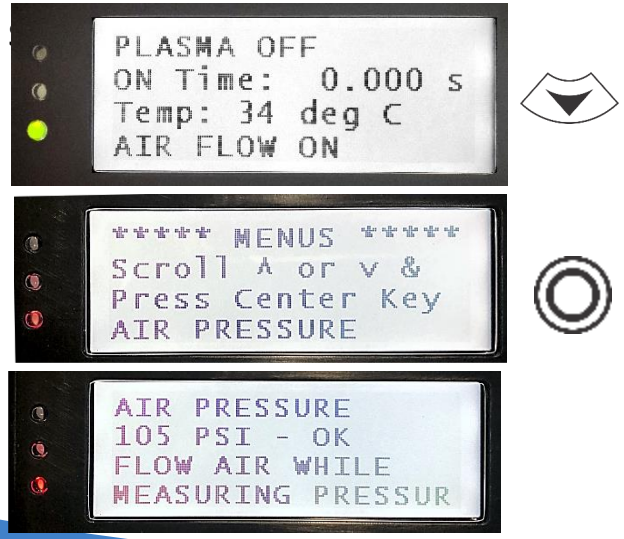
The screen of the Status Display will show "**AIR FLOW ON**" message.



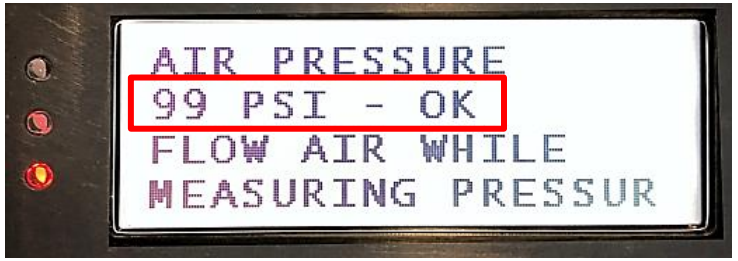
System Setup (Cont'd)

Setting Operating Air Pressure

21. Navigate to "Air Pressure" screen using Manu Navigation Buttons. From the current screen press "Down" button until the "AIR PRESSURE" Menu screen is displayed, then press the Enter/Select button to enter AIR PRESSURE



22. With the air flowing thorough the pen adjust the air pressure displayed on the AIR PRESSURE screen by rotating the regulator knob until the pressure displayed on the screen (NOT on the regulator read-out) is around **99 psi.**



*The acceptable range of air pressure is 85 to 105 psi with **99 psi** being optimal operating air pressure.*

23. Stop air flow by pushing the safety lever down and push the trigger lever forward once then pull back to safe locked position.

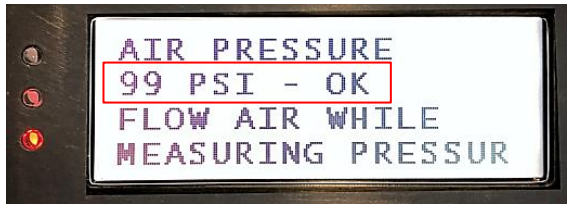
System Setup (Cont'd)

Testing Portable Air Compressor

(if using PlasmaBlast with portable compressor for the first time)

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

25. Navigate to AIR PRESSURE menu -> AIR PRESSURE screen as described in step 19. Take a note of the pressure displayed on the screen



26. Continue to purge air through the pen for 10-15 minutes while watching the AIR PRESSURE screen. Take a note of pressure displayed <u>every minute.</u>

27. 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 may cause damage to equipment if used with the PB-7000-M

The system will not operate if the input pressure is outside of acceptable range.

28. Stop air flow by pushing the safety lever down and push the trigger lever forward once then pull back to safe locked position

REVIEW OF THE SETUP PROCESS

- ✓ Position and secure the system
- ✓ Remove power cable, ground cable, pressure regulator, and plasma pen from the bag
- ✓ Remove transportation strap from the pen
- ✓ Check that the Pen Connector is plugged in tightly and latched
- ✓ Connect the pressure regulator output hose to controller
- ✓ Connect air supply hose to filter/regulator
- ✓ Attach the ground cable to pen cable
- ✓ Secure the ground clamp to the substrate
- ✓ Connect the AC power cable to Power Input on the System's Connector Block
- ✓ Connect 6-pin end of power cable into receptacle of Fuse Box
- ✓ Connect fuse box plug into power source receptacle
- ✓ Ensure all PPE is in place prior to powering up the system
- ✓ Power up the PB-7000-M System
- ✓ Set the correct operating pressure on the Pressure Regulator

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

Note on System Re-Packing

Unplug the system in reverse of the setup steps:

- Disconnect the system power connection from the AC wall receptacle, then the fuse box connector, and finally the small system plug on the PB7000M.
- Disconnect the source air connection, then the system air connection, and remove the regulator from the side-frame bracket.
- **Keep the pen cable connected to the system** but remove and collect the ground cable from the work site.

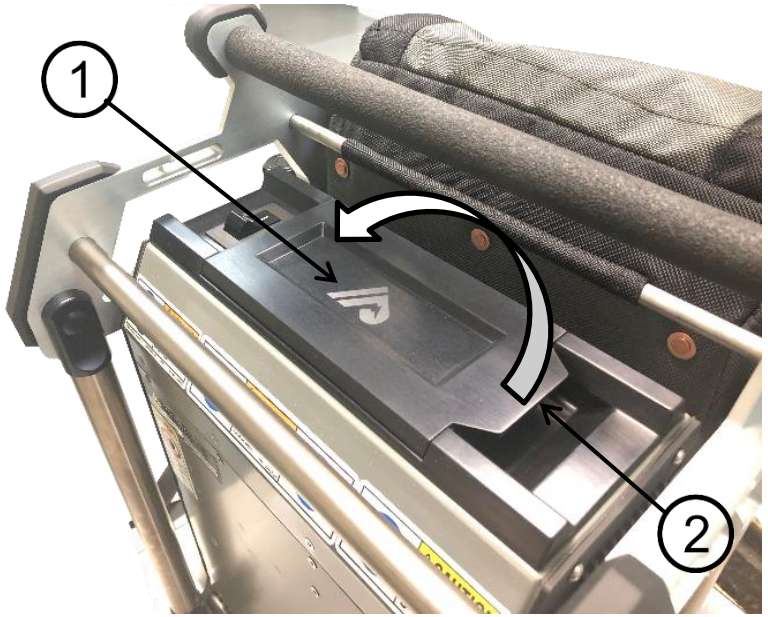
When re-packing the system bag:

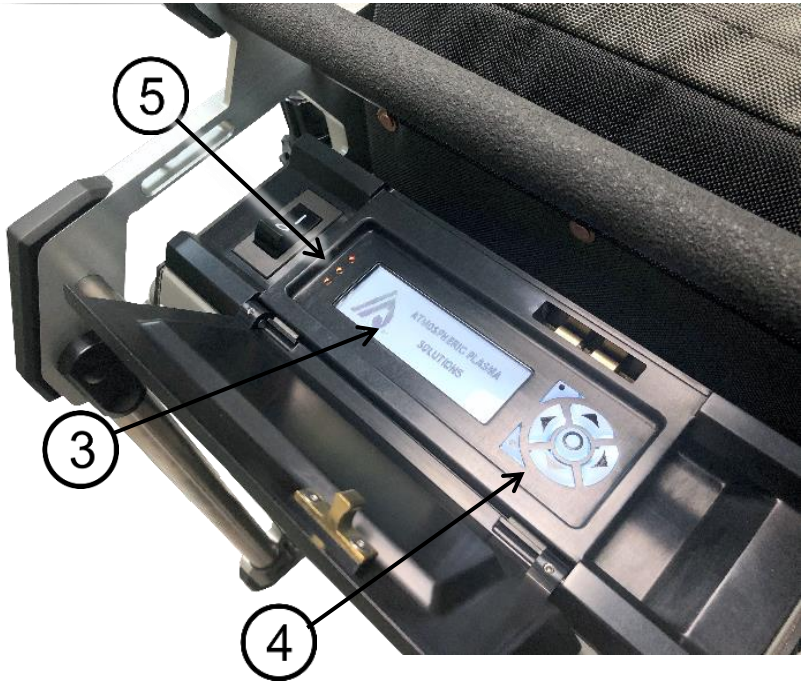
- Start with the pen cable first and use the entire height and width of the system bag to coil the pen cable and pen, allowing for a large curve radius of the plasma pen cable to minimize cable strain.
- Once the pen cable and plasma pen have been placed in the bag, begin adding the other items in the center of the plasma pen cable coil.

Status Display Module

Status Display Module

Status Display Module is located on the top of the Plasma Controller under the protective cover ①.
Use the tab ② to open the tab to open the cover to view the display.
③ **Graphic Display** ④ **Menu Navigation Buttons** ⑤ **LED indicators.**





System Status Display (PLASMA STATUS)

- **The main System Status screen is loaded by default upon the system power-up**
- **Displays real-time information about system state and plasma status**

Line 1: Plasma Status: Indicates current plasma status, as follows:

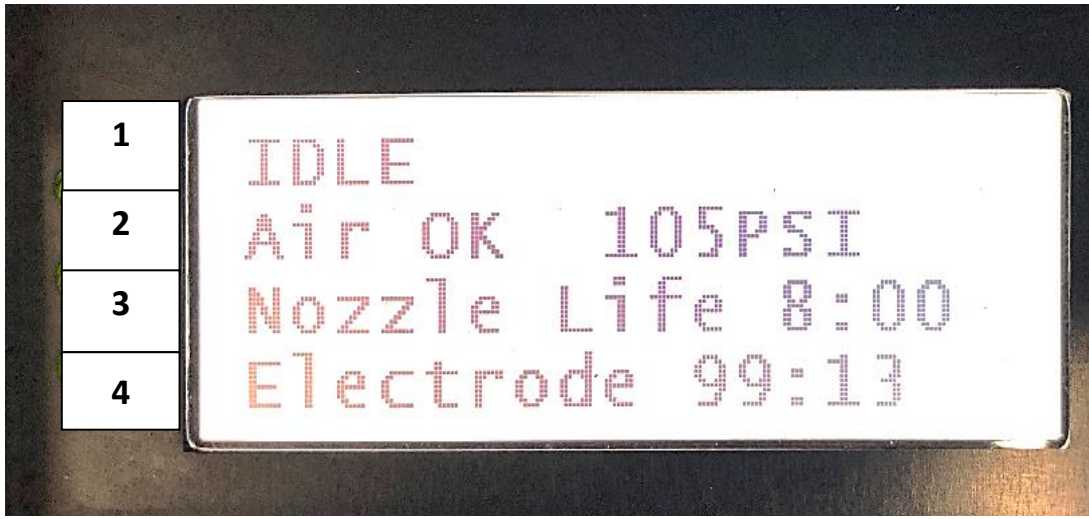
IDLE - Ready
FLOW WAIT - A status during plasma ignition
BUTTON WAIT - Switch press detected, analysis for plasma ignition is underway
AIR FLOW ON - Air is on to cool the pen
PLASMA ON - Plasma is on
PLASMA OFF WAIT- Status while plasma is being extinguished
FAULT WAIT- A fault has occurred
TEMPERATURE- 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. 100% lifetime = 8 hours

Line 4: Displays Electrode life remaining until the replacement is necessary. 100% lifetime = 100 hours



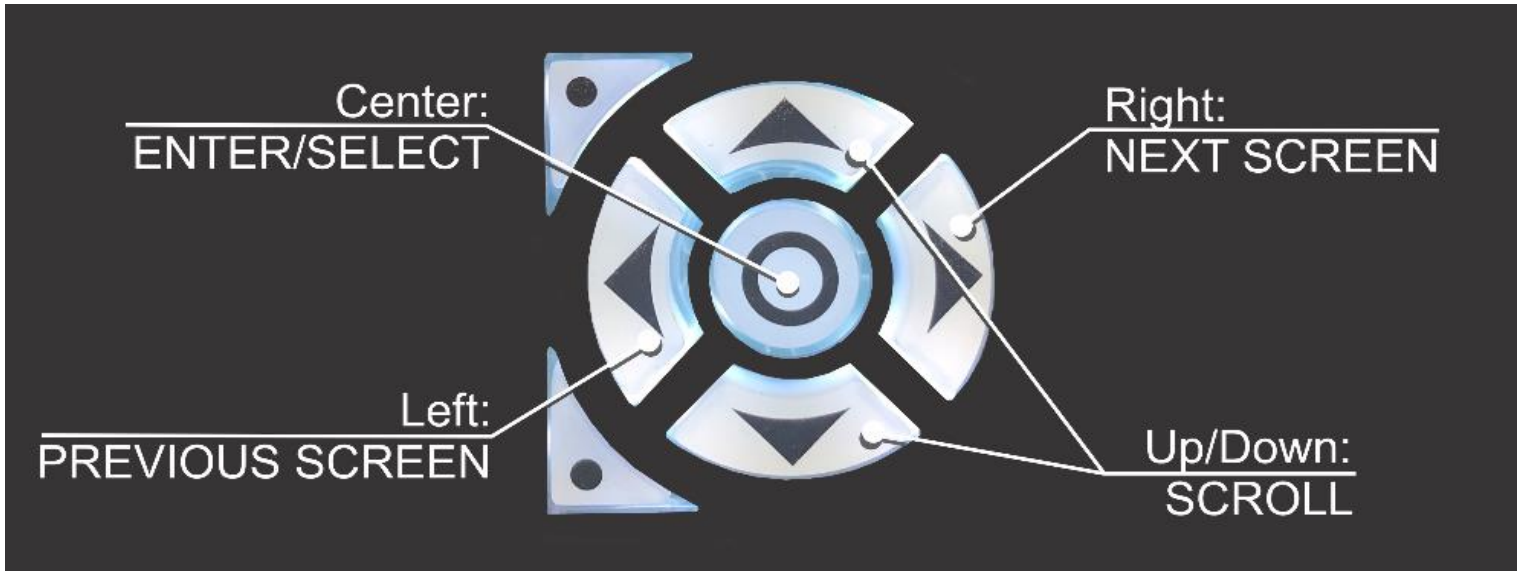
Menu Navigation Buttons

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** =“Enter/Select”
- Used to make menu selections and set desired operating parameters.

- **Left and Right Buttons** move through menu screens.
- Right Button -advance to the next screen
- Left Button return to the previous screen.

- **Up/Down Buttons** scroll through menu screen lines



System Menus

- To access the “User Menu” page push the Enter/Select button.

- The *User Menu* screen will be displayed.

  - Scroll using Up/Down buttons
  - Advance through the system menus. Pressing Up or Down button will rotate through available menus:

  - Initial Options:
    - System Info
    - Manage System

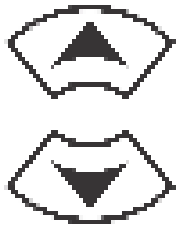
Note: Plasma Status (System status) screen is loaded on power-up.

- Push the Enter/Select button to enter the desired menu.

Submenu 2: Manage System

- Scroll using Up/Down buttons
- advance through the system menus. Pressing Up or Down button will rotate through available menus:

- Maintenance:
  - Silence Alarm
  - Time Remaining
  - Reset Time

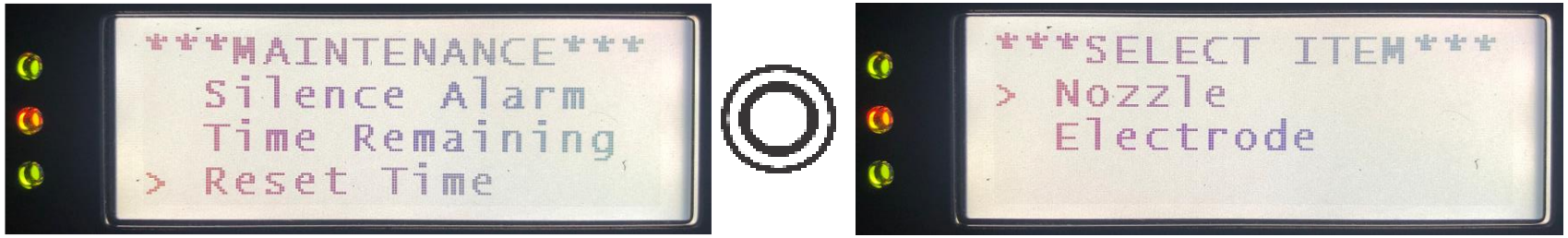


- Push the Enter/Select button to enter the desired menu.

Note: Plasma Status (System status) screen is loaded on power-up.

System Menus: Maintenance Menu

The “Maintenance” menu 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 alarms. This menu consists of NOZZLE and ELECTRODE sub-menus. The “Time Remaining” submenu follows the same format.

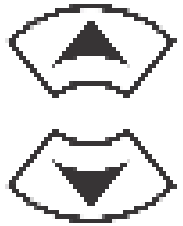


Access this menu by scrolling down through the Menus using Up/Down arrow buttons, then press Enter/Select button; this will open NOZZLE sub-menu. Press Up/Down button to access ELECTRODE sub-menu

More information on Maintenance menu in Maintenance Section of this training.

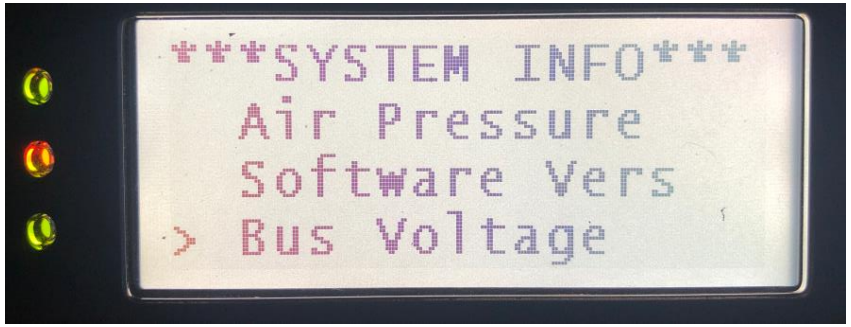
System Info 1: System Info

- Scroll using Up/Down Scroll buttons
- advance through the system menus. Pressing Up or Down button will rotate through available menus:
  - Plasma Time
  - Air Pressure
  - Software Version
  - Bus Voltage
  - Temperature
  - Latest Faults
  - Fault Help
  - Plasma History



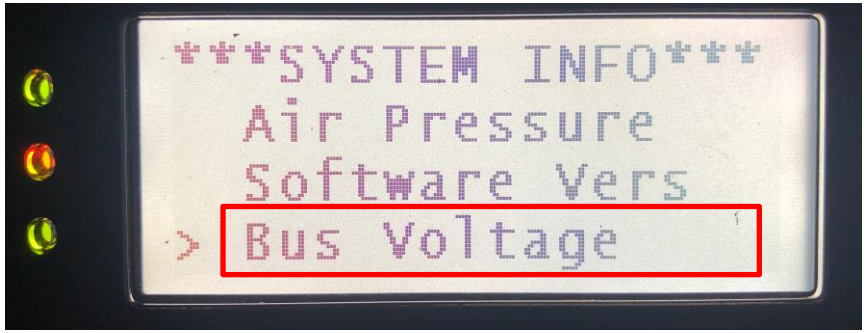
Note: Plasma Status (System status) screen is loaded on power-up.

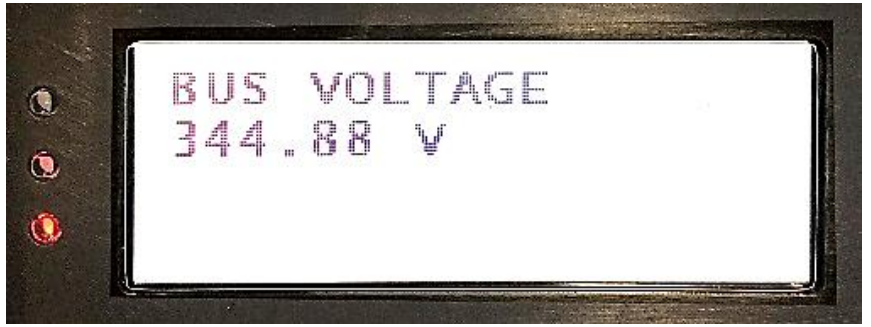
- Push the Enter/Select button  to enter the desired menu.



System Menus: Bus Voltage Menu – 208-240V

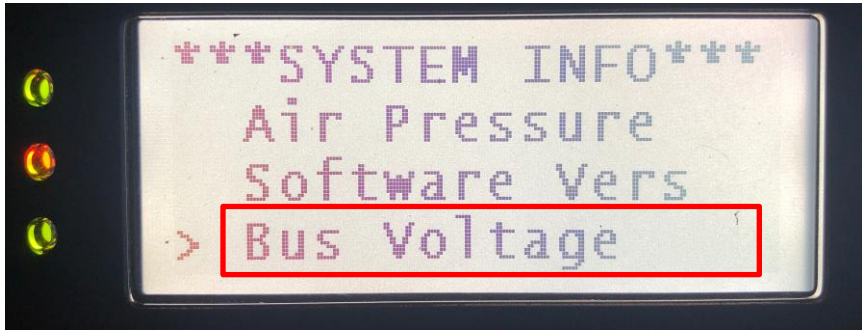
This menu provides information about the current bus voltage. This screen is for information only and to be used by the user in communication with APS when troubleshooting, in the case of a system malfunction or a failure.
Bus voltage is an internal system parameter related to, but not equal to, line voltage. For proper system operation Bus Voltage reading must be within 351V to 430V (208V-240V systems)

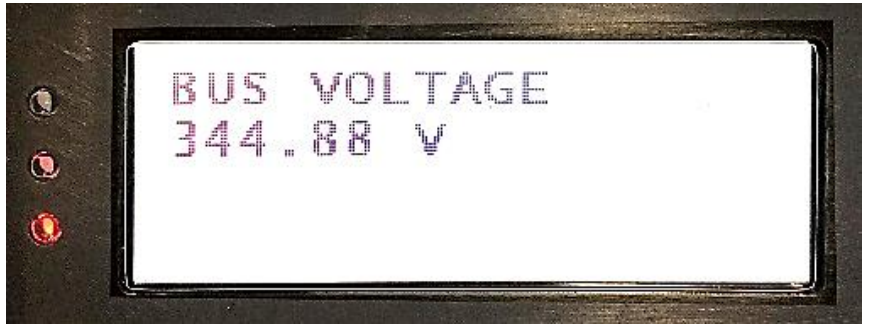




System Menus: Bus Voltage Menu – 440-480 V

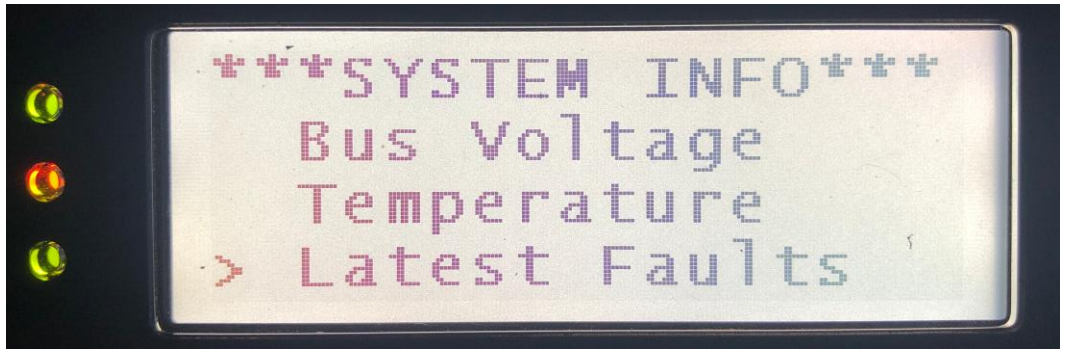
This menu provides information about the current bus voltage. This screen is for information only and to be used by the user in communication with APS when troubleshooting, in the case of a system malfunction or a failure.
Bus voltage is an internal system parameter related to, but not equal to, line voltage. For proper system operation Bus Voltage reading must be within 570 VDC to 713 VDC (440V-480V systems)

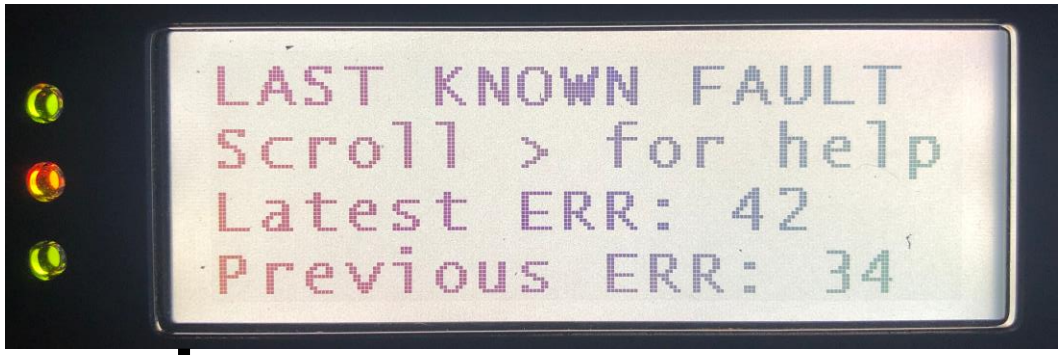




System Menus: Latest Fault Menu

- Provides valuable information about the latest fault that the system encountered that can be used in diagnostics.
- Additionally, this screen displays information for the fault the system experienced immediately before the last one.
- This information should be used by the User in communication with APS in the case of a system malfunction or a failure





Able to press to move to Fault Help steps

System Menus: Fault Help Menu

- Fault Help Menu is a list of system fault codes and their description/troubleshooting tips.
- If the system encounters a 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.
- Once the fault screen is cleared, by pressing any button or navigating away from this screen, the troubleshooting information for this fault can still be accessed through the Latest Fault and Fault Help menus.

1. Navigate to Fault Help Menu and press center button.
2. Scroll to the fault number that was displayed on the Plasma Status screen (e.g FAULT 34) using Up/Down buttons.
3. View the troubleshooting tips and take the recommended action.

Fault Codes

- If a system fault occurs, the System status display will indicate the fault code (e.g FAULT 42) and a brief description of the recommended troubleshooting steps. It will be also indicated by the bottom LED indicator lit yellow.
- Follow recommended actions displayed on Fault screen
- Refer to Fault Help Menu for instant tips/recommended action.
- Refer to User Manual for extended fault listing, fault descriptions, causes , and recommended solutions.

Fault Codes (Cont'd)

Fault Code	Probable Cause	Solutions
0	No Faults, normal operation	
7	Interlock open 1. Pen cable interlock not fastened.	1. Remove 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 or torch. 4. Shorted cable.	1. Increase or decrease air pressure to within recommended range. (80-100 psi) 2. Connect air. 3. Perform nozzle maintenance. Let pen cool. 4. Inspect and replace cable if necessary.
35	Switching current is 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 is too high during ignition state. 1. Internal overheating. 2. Cable Capacitance is too high. 3. Electrodes 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 is out of Range 1. Generator or Line Voltage is too low or too high.	Check line voltage, must be within 208-240VAC or 440-480VAC depending on the model. 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 too high or too low. 2. Air not connected.	1. Set air pressure 85-105 PSI 2. Verify air is connected to unit.

Pen Operation

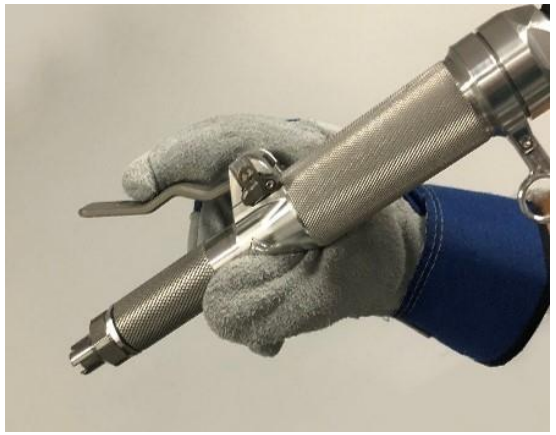
Pen Grip Positions

Plasma Pen Grip Positions

The Plasma Pen can be used in two grip positions – front and back, in which Plasma Trigger Lever is flipped forward and backward respectively.

Lever Flipped Forward

Plasma On



Plasma Off

Lever Flipped Backward

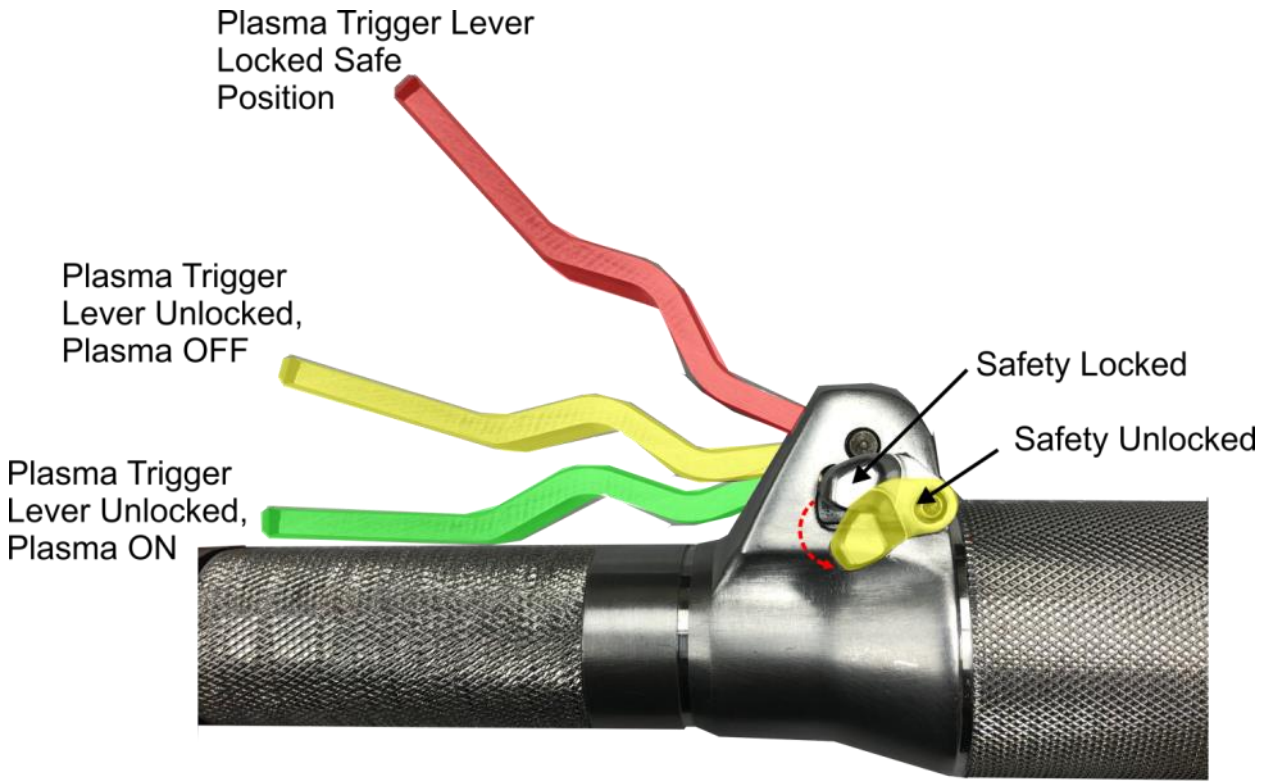
Plasma On

Plasma Off

Plasma Trigger Lever Operation

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 is three operational positions the Plasma Trigger lever can be used in:



Locked Safe Position: Plasma Trigger Lever can not be depressed, Safety Lever is in Locked position.

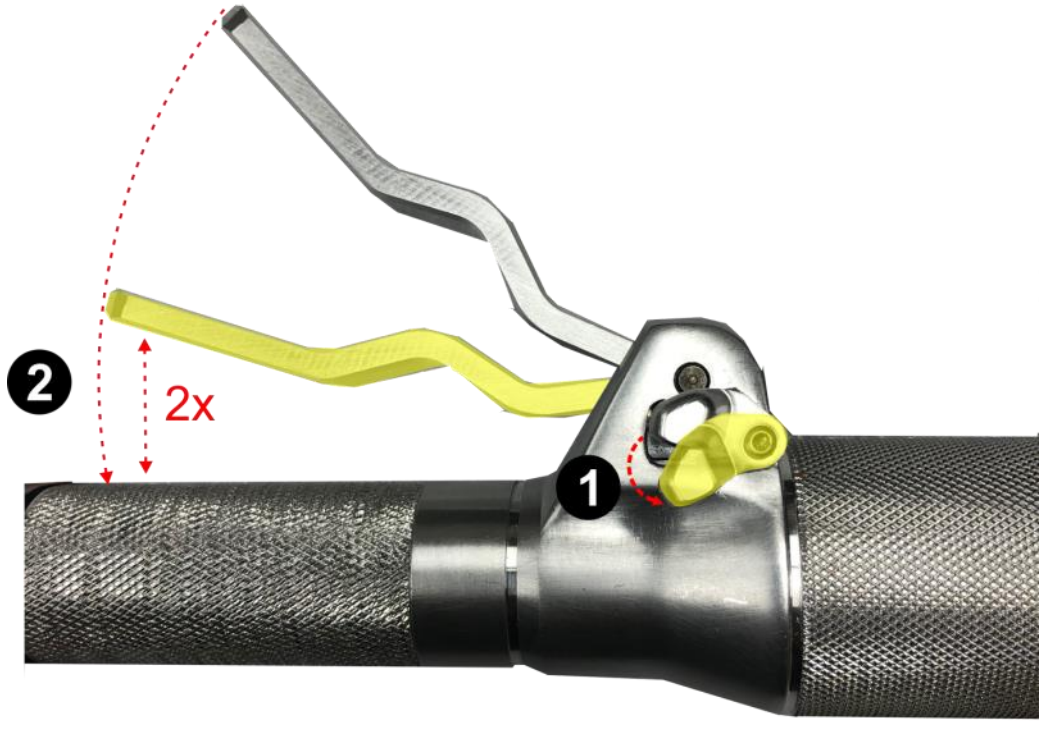
Unlocked, Plasma OFF: the lever is released from safety and partially depressed; it is being held down lightly; when released it will snap back into safety mechanism.

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

Pen Purging Air

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:



1. With the pen nozzle facing away from you and other people, push the safety lever down

2. 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.

Tool Application

1. Plasma Coating Removal

While handheld plasma coating removal requires some skill that is best developed through practice, there are a few basic principles you need to know before moving on to hands-on training.

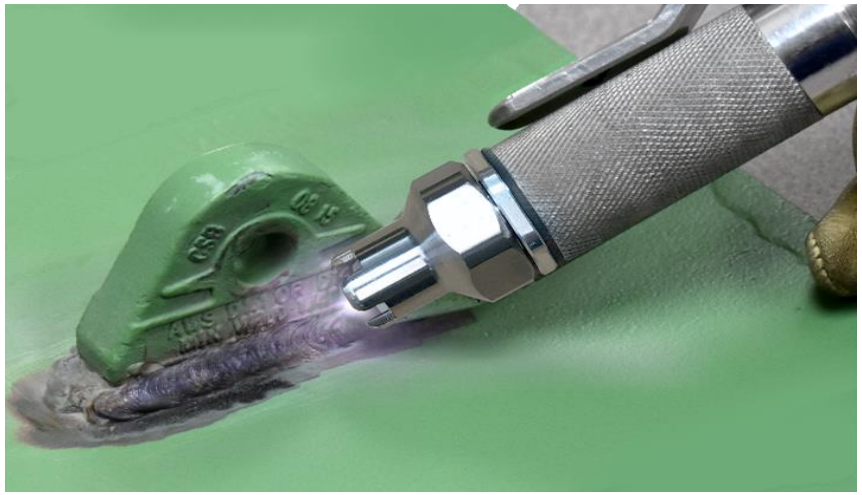
- Hold the Pen facing the surface to be treated, normally at a slight angle, with the tip of the nozzle at approximately 0.2” from the surface. A built-in stand-off on the nozzle nut maintains the 0.2” distance

- Move the tip in continuous side-to-side or circular (**small circles)** motion over the removal area. About the speed you move your toothbrush when brushing your teeth

- Never dwell the plasma beam over one spot, this may cause overtreatment and potential damage to the substrate

- **Heat added to substrate is minimized during active coating removal** with proper technique

- For additional safety: 2-minute timer for plasma run time. After 2-minutes trigger must be let go and re-engaged

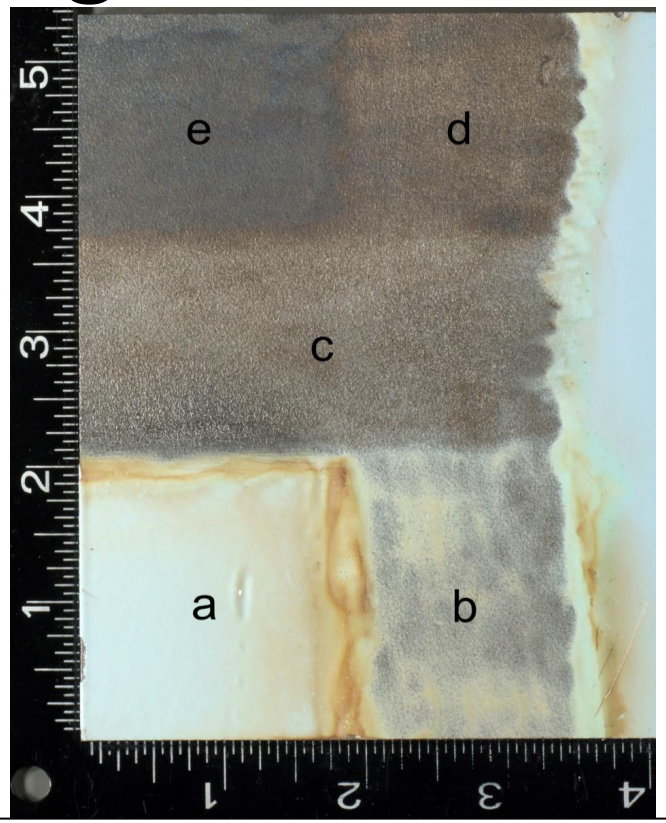


Extensive metallurgical testing was completed that indicated **proper use of plasma coating removal on ferrous metal (steel) substrates does not negatively affect the properties of the steel.** Plasma coating removal on substrates other than steel (i.e. aluminum, bronze) will require specific approvals by the cognizant local authority until which time a blanket approval is issued

APCR Technique for Effective Coating Removal -1

Visual inspection of surface cleanliness

- Removal speed will slightly depend on coating type/chemistry
- Find a speed that fully removes to desired surface cleanliness in one pass
- When removing a new coating, test <u>speed & height</u> for:
  - undertreated, optimally treated, overtreated



Handheld removal of Fast Clad ER on Steel:
a = un-treated coating
b = under-treated surface
c = optimally-treated surface
d = slightly over-treated surface
e = over-treated surface

APCR Technique for Effective Coating Removal -2

Under-treated: coating/contamination still remaining after 1st pass

To Solve: 1) Ensure height of pen is 0.2”-0.4” from coating

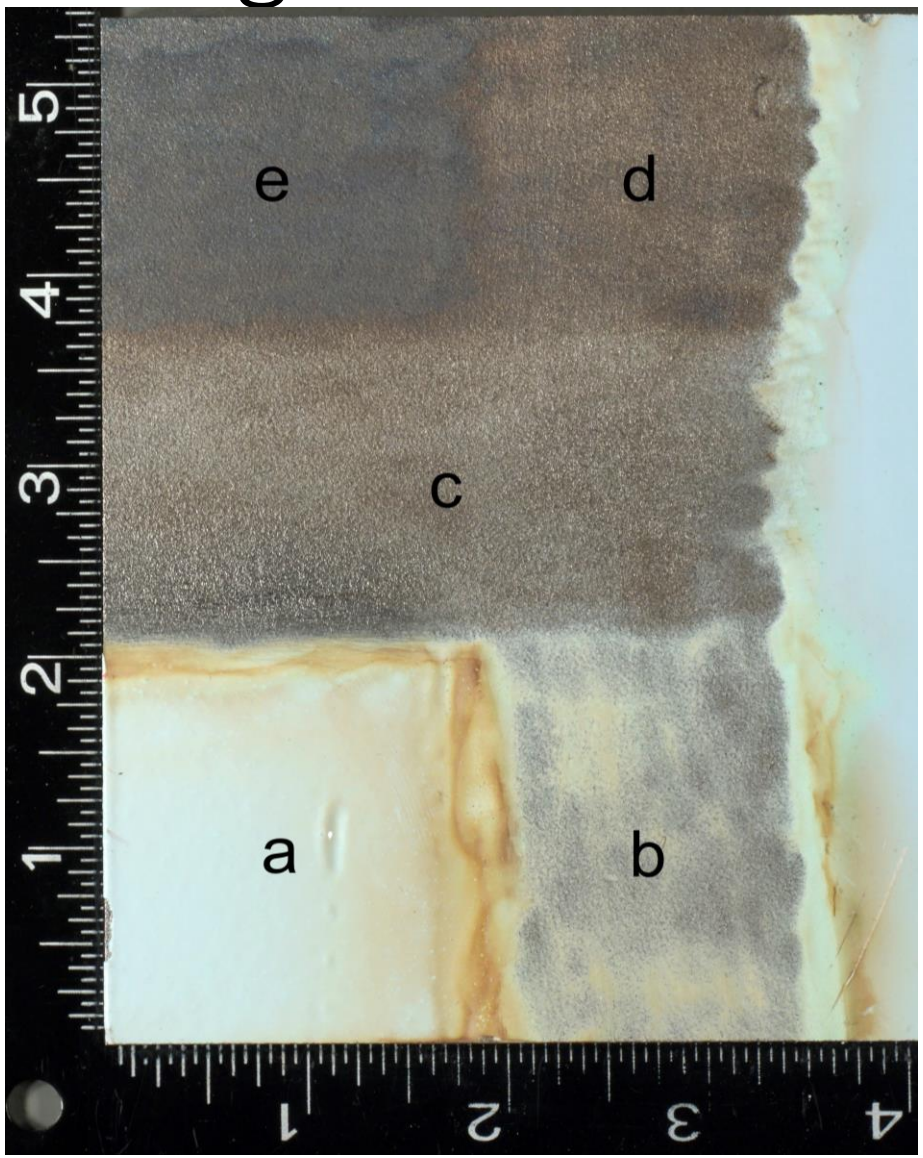
2) slow down movement pattern until full removal is seen

Optimally Treated: fully removed coating with minimal greying/darkening of uncovered substrate

Overtreated: Fully removed coating, but significant greying/darkening of substrate

To Solve: 1) Speed up movement pattern until greying/darkening of substrate is minimized while still fully removing coating

Handheld removal of Fast Clad ER on Steel:
a = un-treated coating
b = under-treated surface
c = optimally-treated surface
d = slightly over-treated surface
e = over-treated surface



APCR Technique for Effective Coating Removal - 3

Production rate goal:

~ 1.2 ft²/hour

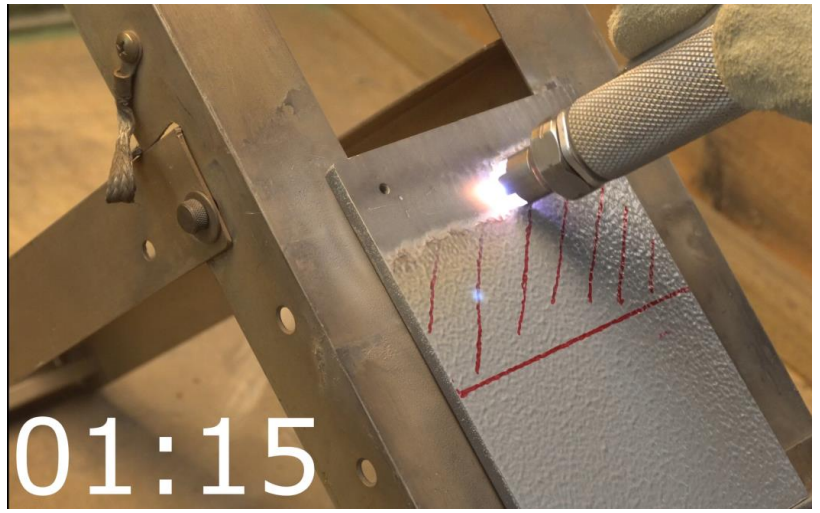
Demonstrated by:

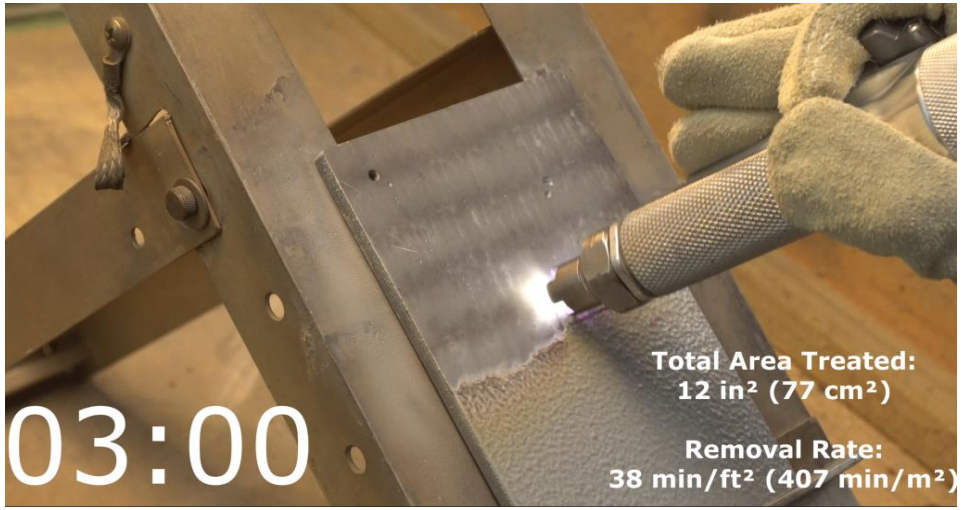
4” x 3” removal of 30 mil thick FastClad in < 4 minutes

Handheld demo:

https://apsplasma.com/Vk4ZMVH2V95UTpX5k/

https://apsplasma.wistia.com/projects/xk9z2heabi

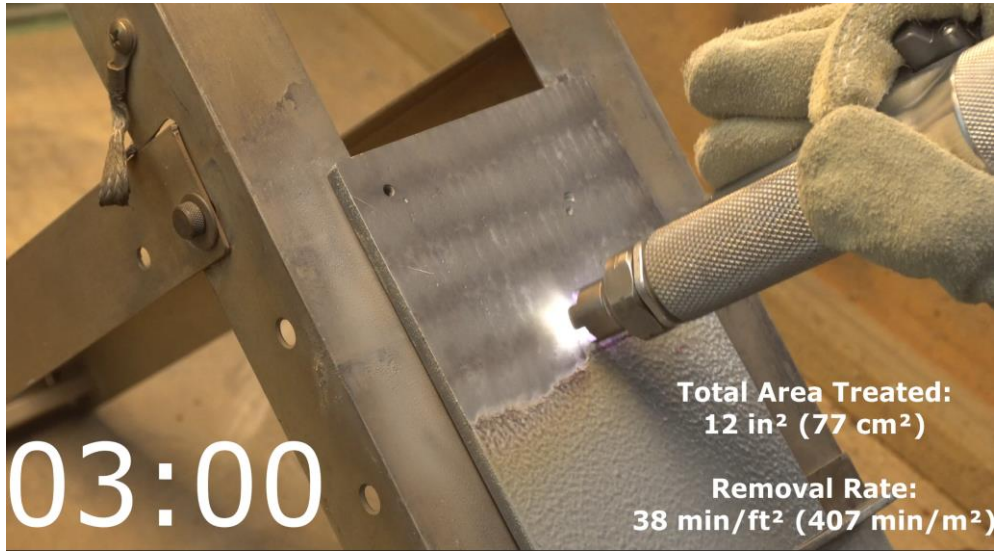


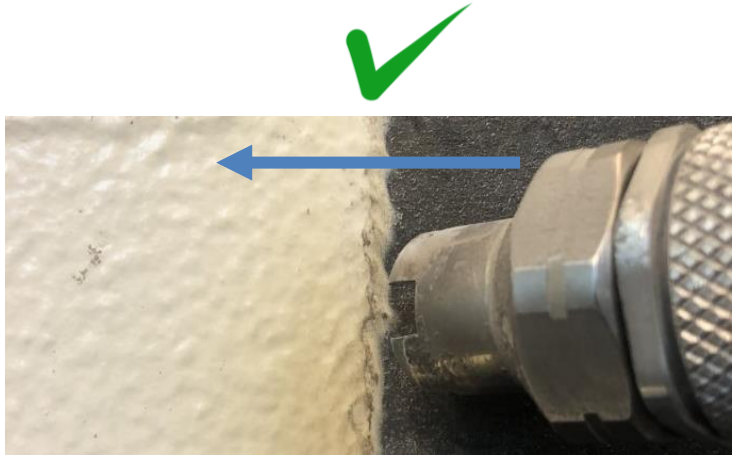


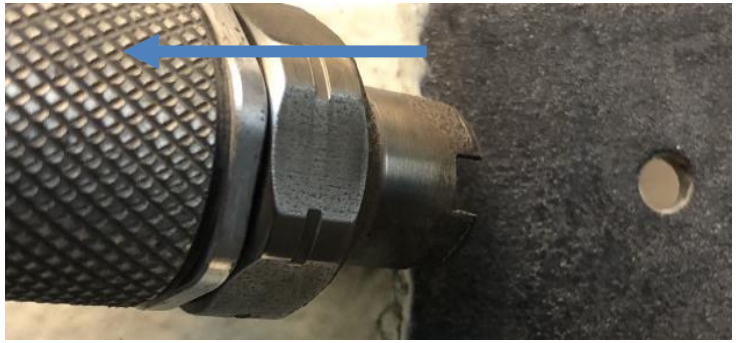
APCR Technique for Effective Coating Removal - 4

- Plasma is directional
- Point pen towards the local ventilation to direct dust and debris into the vent

- To minimize dust left on the surface, angle the plasma pen towards the coated area to be removed, instead of towards the bare metal area. Shown in the left image below.





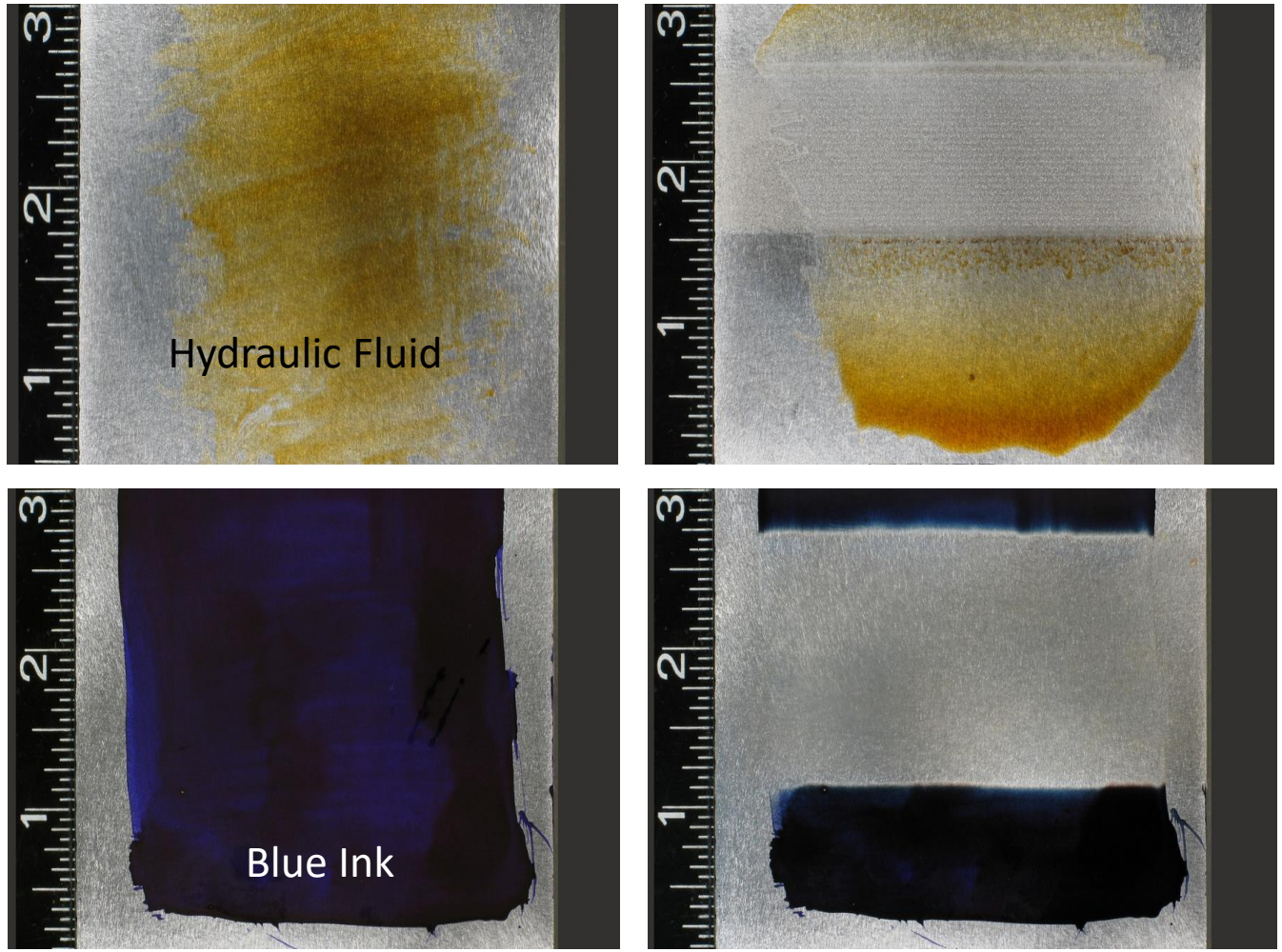


2. Light Surface Cleaning

- Reactive plasma species cleans surfaces by removing carbonaceous materials.
- Treatment can vaporize many commonly used oils, greases, waxes.
- Often removal can be performed faster & with the plasma pen further away from substrate compared to full coating removal.
- Less intense plasma exposure, so less heat into the substrate. Can be used for more delicate applications.

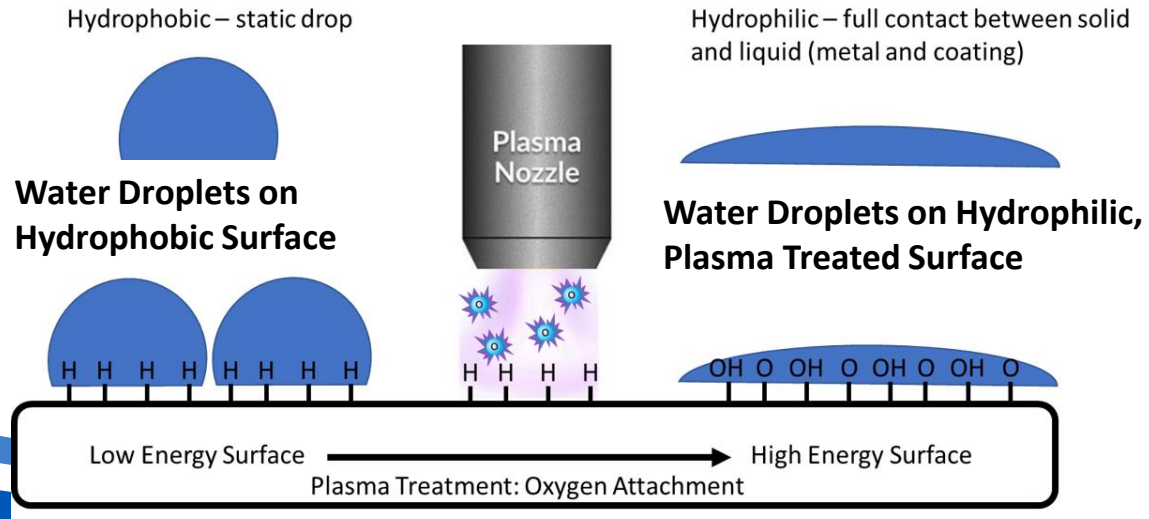
Before Plasma

After Plasma



3. Adhesion Promotion

- Chemical activation of substrate (organic or inorganic).
- Increases surface energy, allowing for further wet out and stronger chemical bonding of applied paint/adhesion.
- **Can be done after coating removal but before recoat to increase new coating adhesion**
- Adhesion Promotion is quicker than coating removal:
  - Roughly 10x speed @ 1” height, and 0.5” raster width
- Effect lasts ~ 2 hours before diminishing gradually
  - Worsened by poor environmental conditions



Salt Fog Testing – Rust Creep

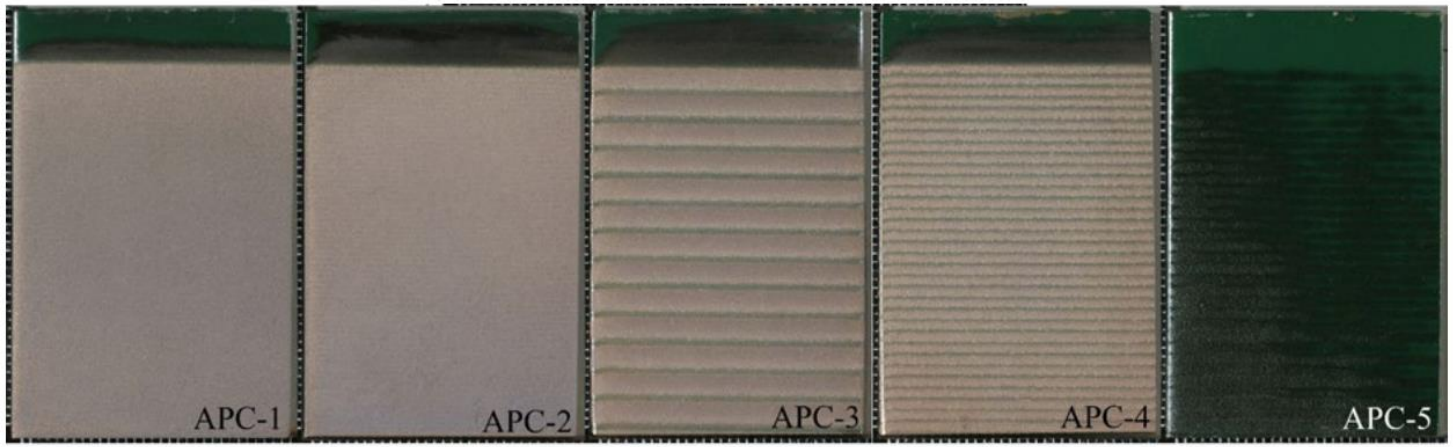
	Polished 1500 hours	**Grit Blasted** 1500 hours
Untreated		
Plasma Treated		

AMPP Standard for Surface Cleanliness - SP21523

Society for Protective Coatings (SSPC)
+ National Association of Corrosion Engineers (NACE)
= Association for Materials Protection and Performance (AMPP)

SP21523 – Non-thermal Plasma Surface Preparation of Metals
Released November 2022
5 levels of cleanliness

Degree of Cleanliness	Staining Allowed	Tightly Adhered	Similar to:
APC-1	0%	0%	SSPC-SP5/WJ1
APC-2	5%	0%	SSPC-SP10
APC-3	10%		SSPC-SP14
APC-4	33%		SSPC-WJ3
APC-5	100%		SSPC-SP7/WJ4



Maintenance

WARNING : Disconnect power before any maintenance operation.

Maintenance of PlasmaBlast® Plasma Controller

General Cleaning (as needed)

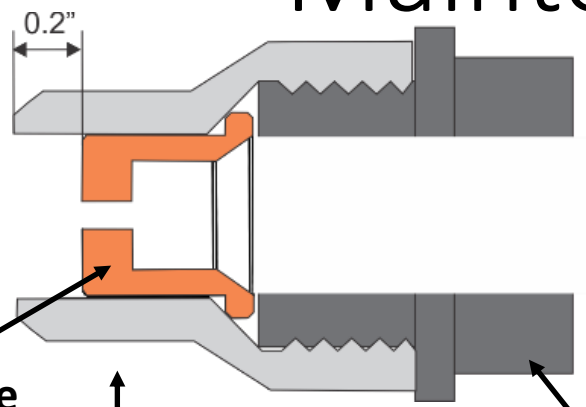
The outside surface of the plasma controller may require periodic cleaning if operated in a dusty or dirty environment. If necessary the outside of the plasma controller can be wiped with clean, dry static free cloth. Aqueous cleaners or solvents are not recommended to clean the plasma controller.

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.

Maintenance of Plasma Pen

Pen Parts Identification

Standoff Distance



Nozzle (inside nozzle nut)

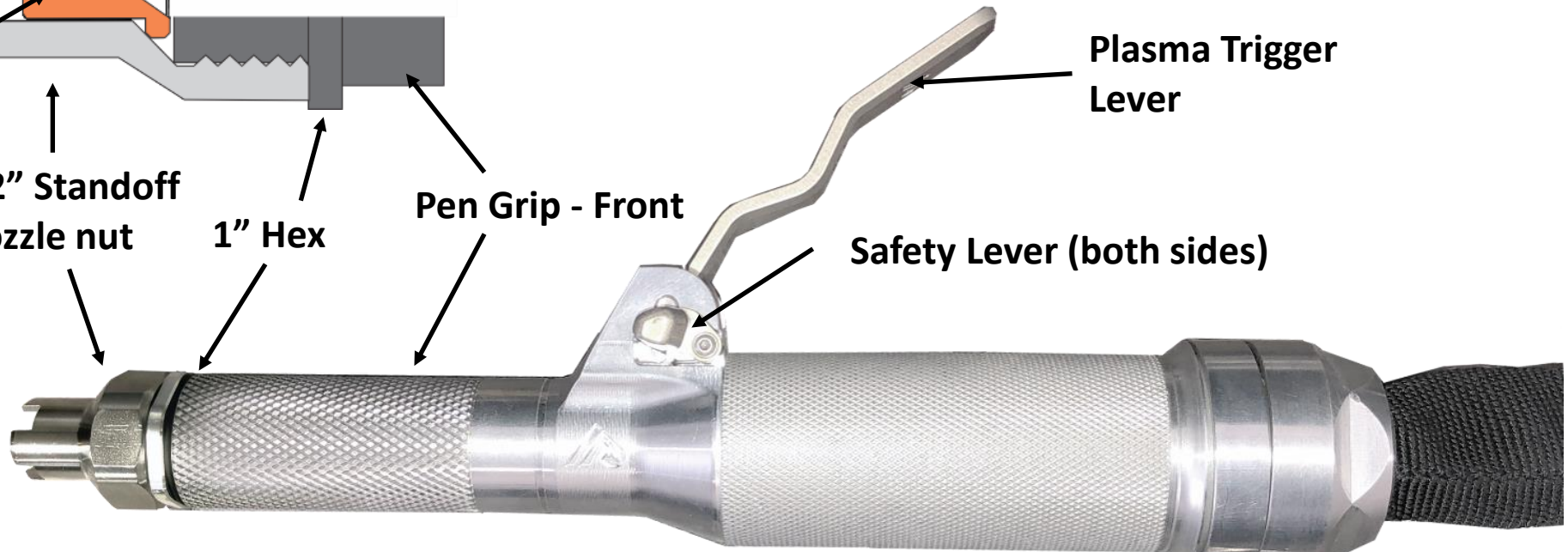
0.2” Standoff Nozzle nut

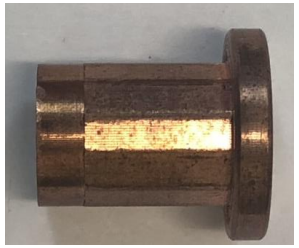
1” Hex

Pen Grip - Front

Plasma Trigger Lever

Safety Lever (both sides)





Electrode (inside pen body)

Pen Body

Pen Grip - Rear

Attachment Loop

Maintenance of Plasma Pen: Maintenance Alarms

Consumable parts – nozzles and plasma electrodes – wear with use and require regular maintenance.

- regular nozzle cleaning and inspection to determine the level of wear
- regular replacement of nozzles and electrodes.

The time between replacements is defined as the “life” of a consumable part and is expressed in hours of “plasma-on” time.

The recommended replacement schedule is:

Nozzle = **<u>8 hours</u>** of plasma-on time

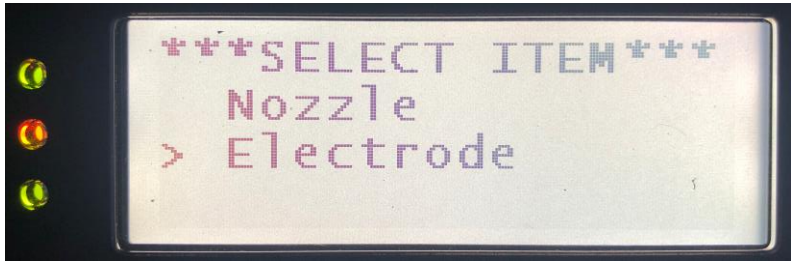
Electrode = **<u>100 hours</u>** of plasma-on time

Maintenance of Plasma Pen:

Maintenance Alarms

PB7000-M system keeps track of plasma-on time and the “life” of currently installed nozzle and electrode remaining after the last replacement.

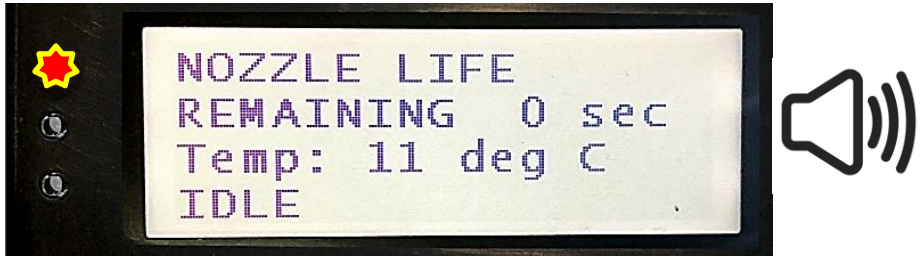
The time remaining for the life of each item can be accessed from Maintenance Menu:



Maintenance of Plasma Pen:
Maintenance Alarms (Cont'd)

Starting at 75% of the life of a consumable part (nozzle or electrode) Maintenance Alarm will be activated:

- Time remaining on the life of the part will appear on the display
- Top and/or bottom LEDs will light up according to the alarm level (more information on next slide)
- Audio alarm will sound at 125% life of part



- ❑ When a consumable part is under Maintenance Alarm condition the Status Display screens will alternate between Plasma status screen and Maintenance Alarm screen.

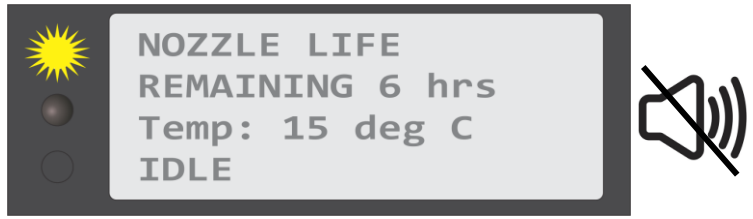
- ❑ If both Nozzle and Electrode are under Maintenance Alarm condition the Status Display screens will alternate between Plasma status screen and both Maintenance Alarm screens.

- ❑ The Maintenance Alarm screen(s) will not be displayed, and the audio alarm is silenced while plasma is firing to avoid distractions to the operator. When the plasma is off, the screen(s) and the sound alarm will resume.

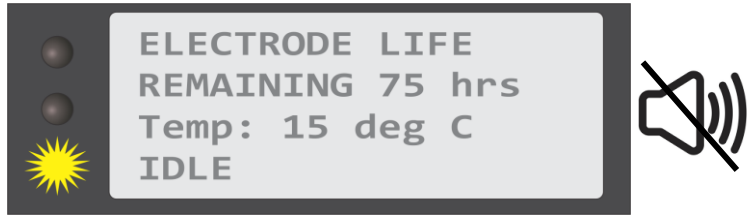
Maintenance of Plasma Pen:

Maintenance Alarm Levels

Level 1:
The part is approaching the end of life – 75% is reached

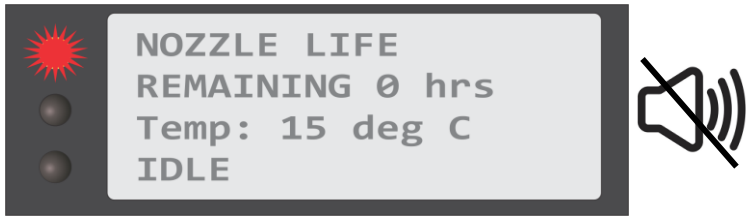


Nozzle: *Top LED is lit YELLOW, no sound alarm*

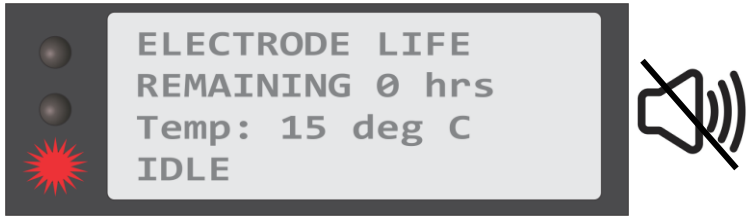


Electrode: *Bottom LED is lit yellow, no sound alarm*

Level 2:
The part reached the end of life – 100% is reached

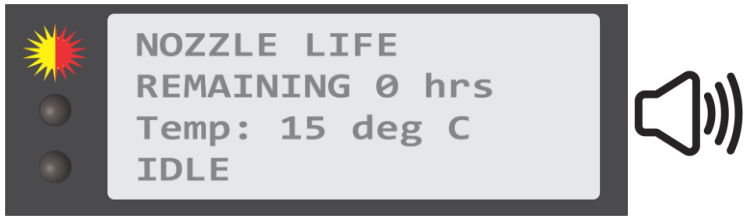


Nozzle: *Top LED is lit RED, no sound alarm*

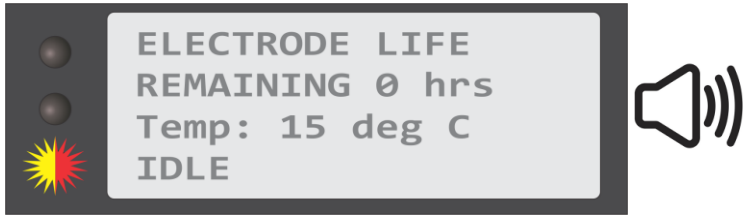


Electrode: *Bottom LED is lit yellow, no sound alarm*

Level 3:
The part exceeded its life – 125% is reached



Nozzle: *Top LED is flashing alternating RED and YELLOW, alarm sounds**



Electrode: *Bottom LED is flashing alternating RED and YELLOW, alarm sounds**

*The audible alarm can be silenced if desired, by accessing Maintenance - > Silence Alarm *(more info in Resetting alarms section).* It will resume after system reboot.

Maintenance of Plasma Pen:

Maintenance Alarm Levels (Cont'd)

Replace the respective part <u>at or before*</u> Level 2 alarm

***Maintenance Alarms are calculated service intervals. Consumable parts (especially nozzles) can wear faster or slower than calculated. The actual wear of the nozzle is determined through regular visual inspection (next section). Maintenance alarms do not substitute regular visual inspections.**

Maintenance alarms <u>do not</u> prevent PlasmaBlast unit from operating and generating plasma. However, operating the unit with nozzles or electrodes that exceeded their life <u>can cause damage</u> to both the PlasmaBlast® unit and the substrate being treated.

WARNING: APS is not responsible for any damage caused by operating the system with consumable parts that have exceeded their recommended life

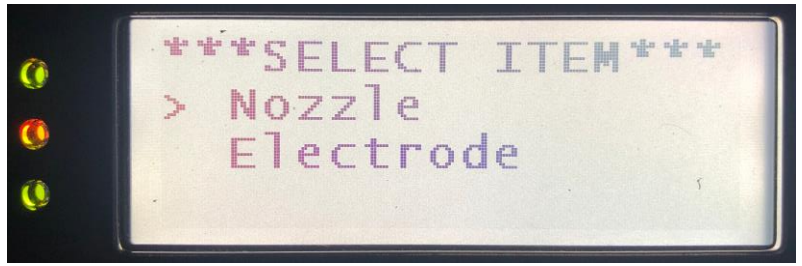
Maintenance of Plasma Pen:

Resetting Maintenance Alarms

Maintenance Menu allows the user to: 1) Silence audio alarm is necessary 2) Reset a consumable part life after it was replaced, by navigating to respective menus:

Silences audio alarm at Level 3 Maintenance alarm until the next system reboot.

Once a maintenance item is replaced the life of the part needs to be RESET. Pressing Enter/Select button on this screen resets the time remaining after replacement of a nozzle or an electrode. Nozzle life resets to 8 hrs., electrode life - to 100 hrs.

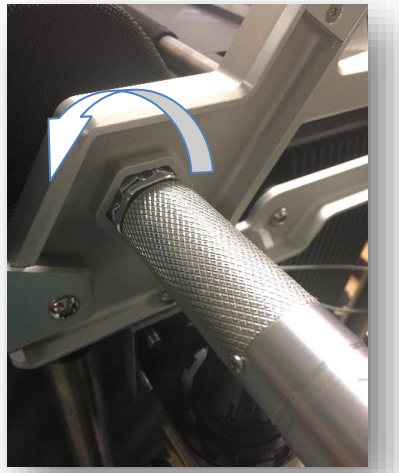


Maintenance of Plasma Pen: Nozzles

Plasma Pen Nozzle Inspection

Inspect the plasma pen nozzle daily, note any irregularities (e.g asymmetric shape of the plasma beam)

1. Unscrew the nozzle nut using hexagonal opening in the frame (Built-in nozzle nut removal tool). Do not use conventional tools.



2. Remove the nozzle nut and the nozzle.

3. Note all damage and wear to the nozzle and nozzle opening:

- 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;

Maintenance of Plasma Pen: Nozzles (Cont'd)

- If nozzle nut has seized, do not try to force it off. Contact APS.

Plasma Pen Nozzle Cleaning

- If debris found during the inspection, clean the nozzle by blowing compressed air through the nozzle or using 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 Nozzle Replacement section below.

Maintenance of Plasma Pen: Nozzles (Cont'd)

Plasma Pen Nozzle Replacement

- Generally, a plasma nozzle should be replaced approximately every 8 hours of plasma-on time.
- Excessive wear on nozzle will reduce removal rate, cause excessive wear on internal electrode, and spread out the plasma beam making it less effective.
- The wear consistent with this level of use can be identified through visual inspection.

New | **Worn** | **Replace** | **Over-worn, Replace immediately**

Maintenance of Plasma Pen: Nozzles (Cont'd)

Plasma Pen Nozzle Replacement

To 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. Drop a new nozzle into the nozzle nut as shown.

4. Add anti-seize compound to the threads and re-attach the nozzle nut.

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

6. Tighten the nozzle nut by hand, using <u>only 2 fingers.</u> It must not be over tightened.
<u>DO NOT USE NOZZLE NUT REMOVAL TOOL FOR TIGHTENING</u>!.

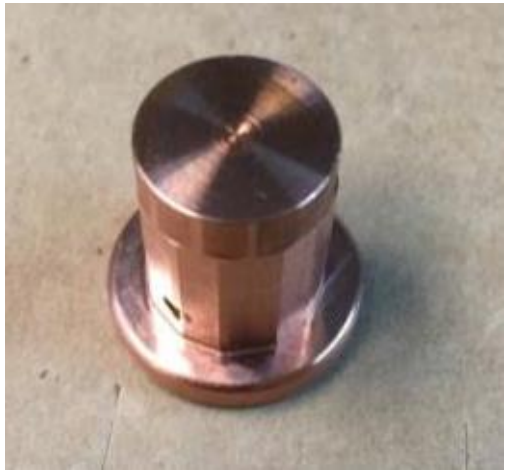
Maintenance of Plasma Pen: Electrode Replacement

Electrode Replacement

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.

Let the pen cool down sufficiently before starting the procedure



- This procedure must be performed in a clean and dry area.

- You will need the following tools:
  - Deep well ½” 6-point socket with handle (provided)
  - Small Phillips screwdriver (provided)
  - Anti-Seize compound included with consumable nozzles kit (provided)
  - 3/8” drive torque wrench (10 -50 inch-pound range, not provided)

L

Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

Plasma Electrode should be replaced at least every 6 months of typical use of the system

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 Philips screwdriver. 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 supplied with the system.

While holding the pen, turn the wrench counter-clockwise to **loosen**.

Once loosened, unscrew the front of the pen using fingers, and then remove the part.

Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

4. Identify the electrode inside the pen body.

5. Use a deep well 6-point socket (provided) to loosen the electrode. Once loose, you can turn it by hand.

Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

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

New Electrode

Interior Electrode Stud

Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

7. Insert a new electrode into the pen body using the 1/2" deep well, 6-point socket, carefully start threading it in by turning clock-wise. Thread in carefully by hand. There should be very little resistance.

CAUTION! <u>DO NOT over-tighten as this will strip the threads.</u>
Use the 3/8" drive torque wrench in place of socket handle to tighten to a maximum torque of 30 inch-pounds or 3.95 Newton/meters.

New Electrode

Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

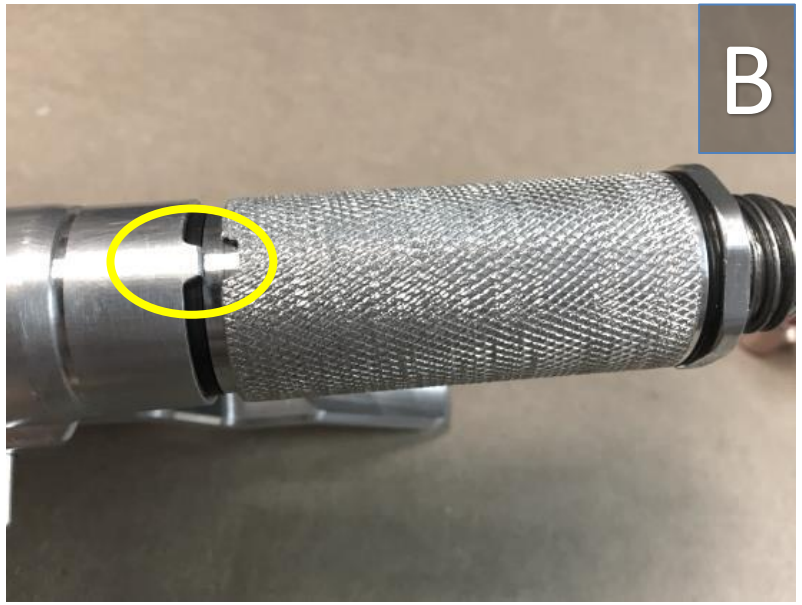
8. Replace the front pen assembly into the pen body. (image A)

Make sure the O-rings and threads are clean do not have debris attached. To clean the o-ring use a clean dry cloth to remove any residue. There is a small amount of o-ring lubricant in these locations. After cleaning re-apply a light coating of lubricant to the o-ring surface only.

9. Screw front body assembly back in by hand.

Make sure, as you thread it on, that the notch in the grip goes into the locking feature on the pen body. (image B)

Tighten by hand, then use the included 1" hex wrench on the hex to tighten further. (image C)



Maintenance of Plasma Pen: Electrode Replacement (Cont'd)

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.

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 amounts 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.

Pressure Regulator Maintenance (Cont'd)

<u>If water/debris are observed in the filter bowl, clean the regulator filter as follows:</u>

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).

Pressure Regulator Maintenance (Cont'd)

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.

Troubleshooting Discussion

Fault Codes

Fault Code	Probable Cause	Solutions
0	No Faults, normal operation	
7	Interlock open 1. Pen cable interlock not fastened.	1. Remove 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 or torch. 4. Shorted cable.	1. Increase or decrease air pressure to within recommended range. (80-100 psi) 2. Connect air. 3. Perform nozzle maintenance. Let pen cool. 4. Inspect and replace cable if necessary.
35	Switching current is 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 is too high during ignition state. 1. Internal overheating. 2. Cable Capacitance is too high. 3. Electrodes 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 is out of Range 1. Generator or Line Voltage is too low or too high.	Check line voltage, must be within 208-240VAC or 440-480VAC depending on the model. 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 too high or too low. 2. Air not connected.	1. Set air pressure 85-105 PSI 2. Verify air is connected to unit.

Common Issues and Troubleshooting

- System does not power on:
  - Check power cable connections on power supply and outlet.
  - Check breaker box/generator.
  - Check the voltages of the power source. Check the power plug wiring.
- System powers on but doesn't purge air:
  - Check air pressure on regulator.
  - Check airline connections and hoses.
  - Check for obstruction in pen nozzle and along airline connections.
- System powers on and purges air but doesn't fire plasma:
  - Check pen connection.
  - Check power connections.
  - Check air pressure.
  - Test your portable generator.
  - Check voltages and frequencies of power source (generator or wall power).

Common Faults: Air Pressure Fault

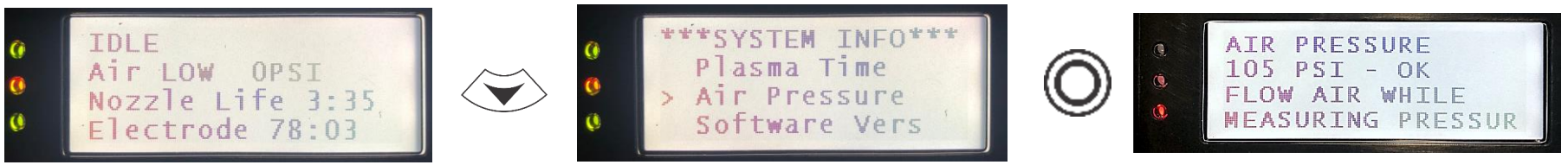
FAULT 42: Check Air Pressure

Description: The unit is powered up, the air is flowing, but the unit is not generating plasma

Reason: Air pressure out of safe range or air not connected

Troubleshooting:

1. Verify air is connected to unit.
2. Navigate to AIR PRESSURE Menu screen, read the pressure displayed on the screen.



3. In the reading is outside of the safe range of 80 psi to 100 psi – adjust input air pressure using procedure described in System Setup, step 20.
4. Verify the source of compressed air is producing consistent pressure/flow at >90psi/3.5 CFM

Portable Compressor Issues:

If you operate PlasmaBlast® with a portable air compressor 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 **PlasmaBlast System Setup – Testing Portable Air compressor.**

Common Faults: Power Issues

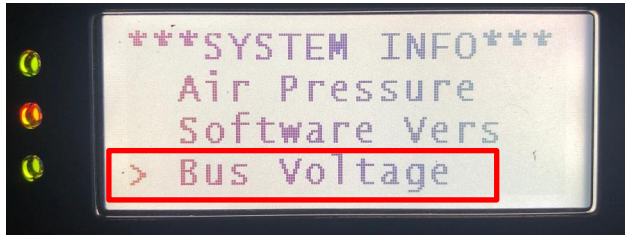
FAULT 39: Line Voltage is Out of Range

Description: The unit is powered up, the air is flowing, but the unit is not generating plasma

Reason: Line voltage is out of safe range or Unit sustained a permanent damage to internal electronics.

Troubleshooting:

1. Ensure the unit is powered up.
2. Navigate to Bus Voltage Menu and read the Bus Voltage value displayed on the screen.



Normal Operating Ranges:
PB7000-M-48 …… 570VDC – 713VDC

1. If the Bus Voltage value is outside the safe range for the model of PlasmaBlast you are using, but not 0, ensure that your power source outputs appropriate line voltage.
2. **If the Bus Voltage value is 0 –** the unit sustained severe damage and must be sent to APS for repair. **Please contact APS immediately. Do not attempt to open the unit, There are no user-serviceable parts inside.**

Summary


AN INNOVATION IN
SURFACE PREPARATION
PlasmaBlast®
SURFACE PREPARATION SYSTEM
REMOVES COATINGS
CLEANS SURFACES
PROMOTES ADHESION
PORTABLE ▪ PRECISE ▪ POWERFUL
ATMOSPHERIC PLASMA
SOLUTIONS

Hands-on Training Expectations

Goal: Develop proficiency with the tool, capable of achieving proper removal of several coatings across different surfaces.

Training Expectations:

- Proficiency of coating removal techniques, testing boundaries of speed, height, angle, etc. on at least two coatings
- Achieve optimal production rate with consistent coating removal down to bare metal
- Remove at least two different coatings, one of which is on a work piece with complex geometry (i.e. lift point, angle bracket, weld bead, threaded fastener, etc.)

Goal: Understand set-up and maintenance of system

Training Expectations:

- Set-up and break down system at least twice, ensuring proper coating removal capabilities once tool is set-up
- Practice nozzle and electrode replacement procedures at least twice
- Proficiency with system console screens and common troubleshooting steps

Training Checklists

The following checklists are to be used during new user training.

Each list outlines key points and required proficiencies to pass the training and use the PlasmaBlast 7000-M safely and effectively.

It is highly recommended to have trainers print out and progress through the checklists during the two training segments:

1. Classroom section with APS training reference slides
2. Hands-on practice with the PlasmaBlast 7000-M

Questions?

Contact Us:

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info@apsplasma.com

www.apsplasma.com

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