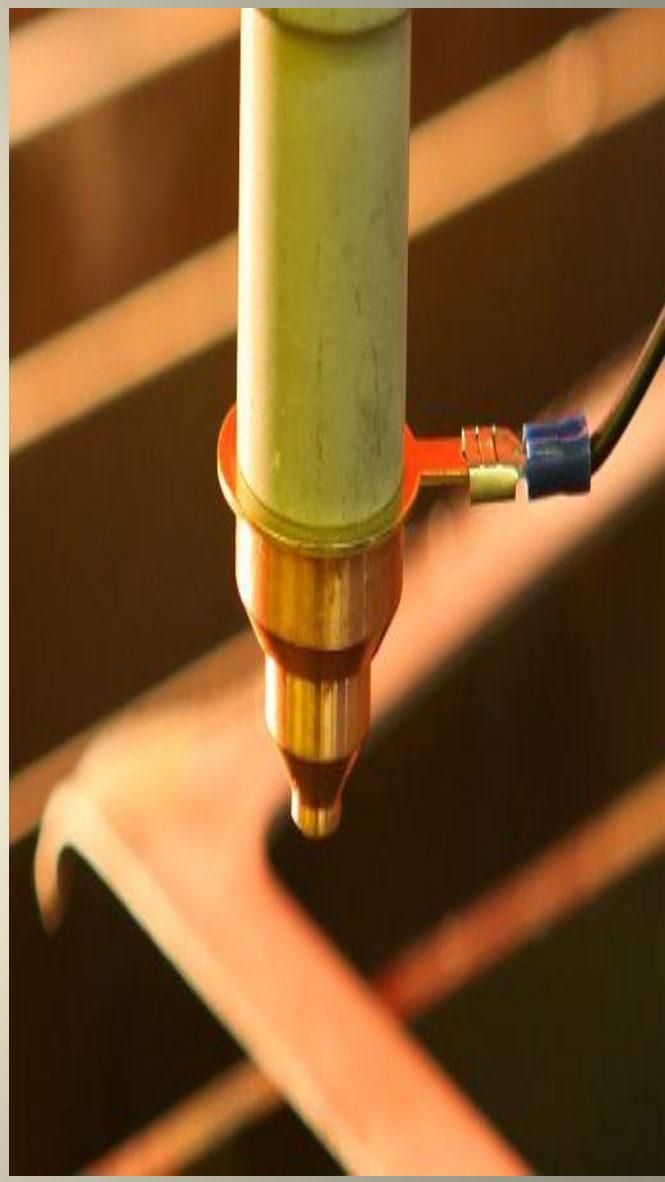
CNC CUTTING SYSTEMS

Plasma Operation

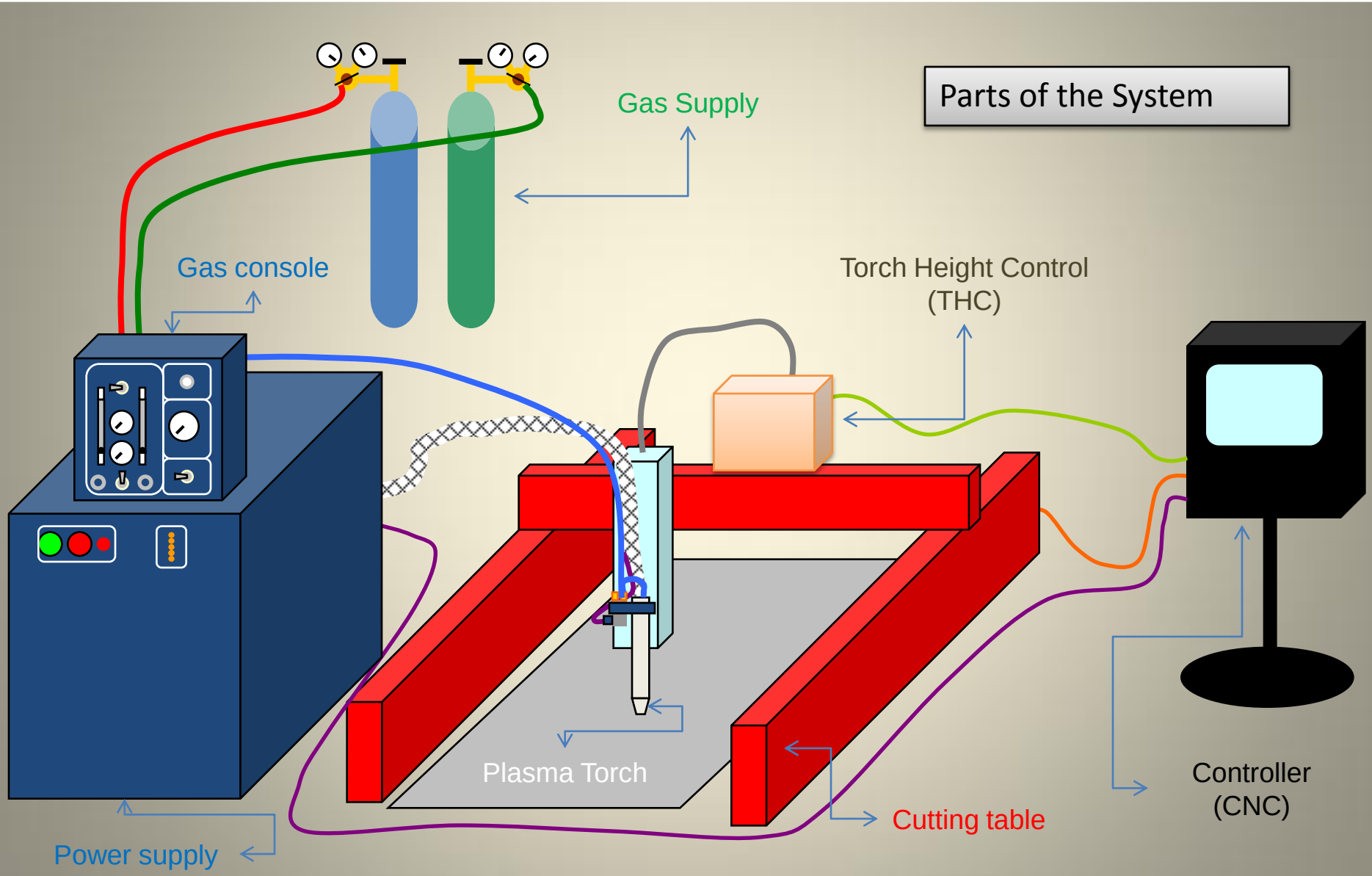
REV. 1 6/10

Introduction

- Goals: The purpose of this class is to
- Understand *what* plasma is
- Discuss and demonstrate the value of proper machine operation.
- Present to you your plasmas recommended settings as a starting point on various materials.
- Maintain quality parts through proper maintenance of the System

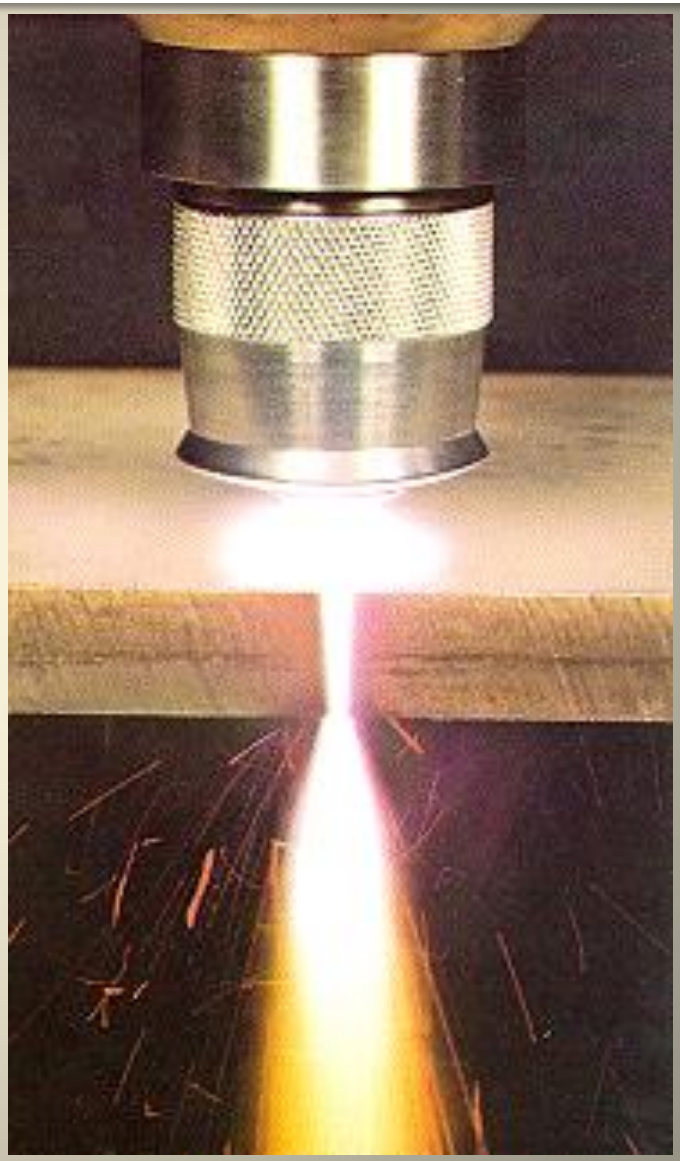


CNC Cutting System



The *Important* Stuff

- The plasma arc is what you use. The entire Plasma power supply and torch exist only to make and control the plasma arc.



What it is

What is plasma?

- **On the practical side:**

- It's hot
- ***This is how it cuts the metal***

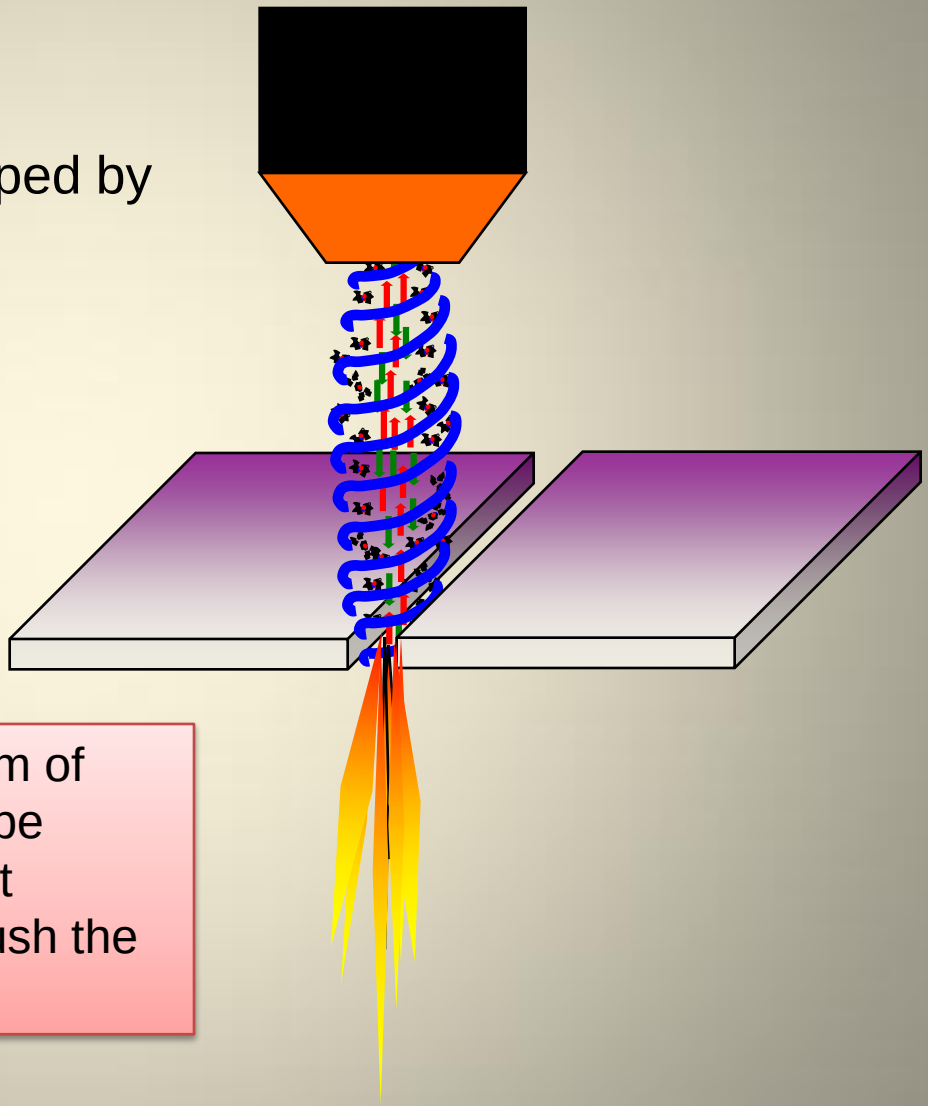
- It's like a gas
- ***This makes it possible to shape the arc***

- It conducts electricity.
- ***It's part of the circuit***

What it is

A bolt of lightning in a tornado

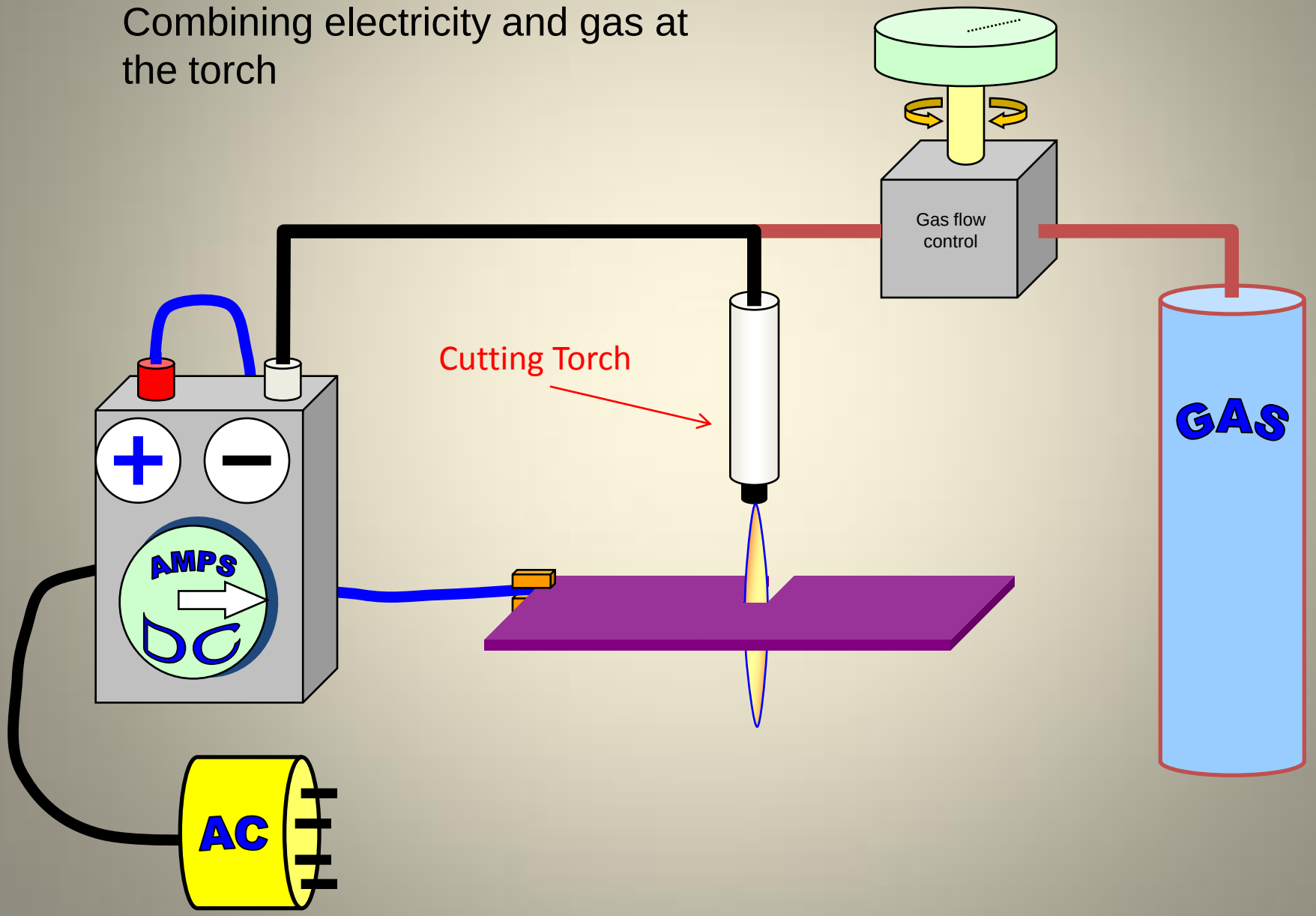
A conductive column of plasma shaped by the flow of the gas it's made from



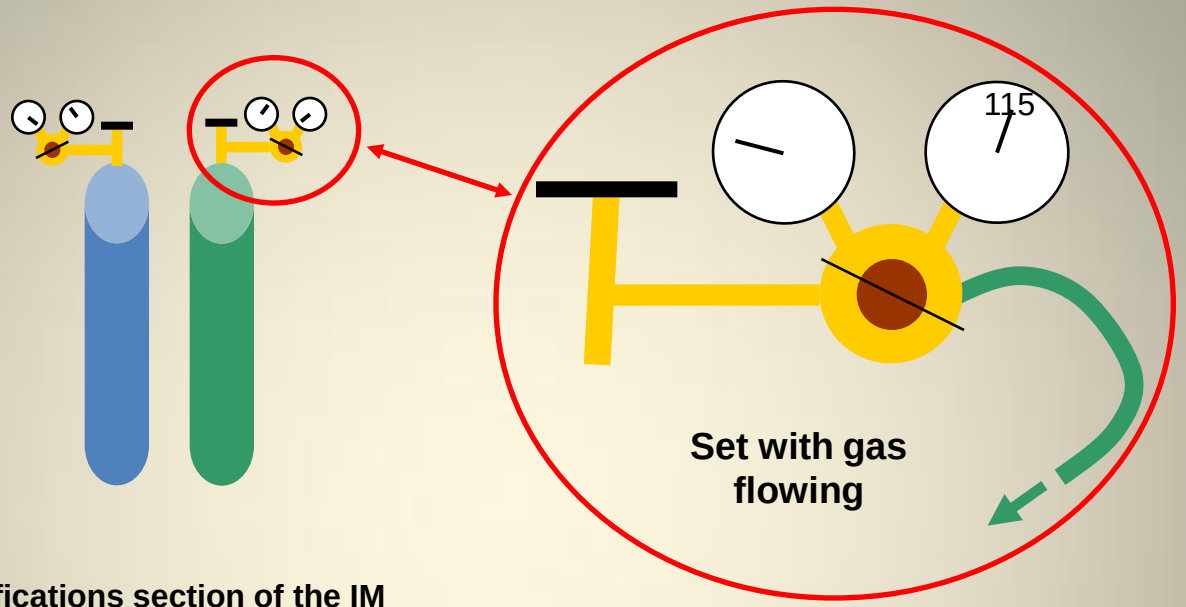
The plasma exists in a swirling stream of gas. This gas provides the atoms to be ionized, the non-ionized cool gas that surrounds the arc and the force to push the molten metal out of the kerf.

How it works

Combining electricity and gas at the torch



Setting Gas Pressures

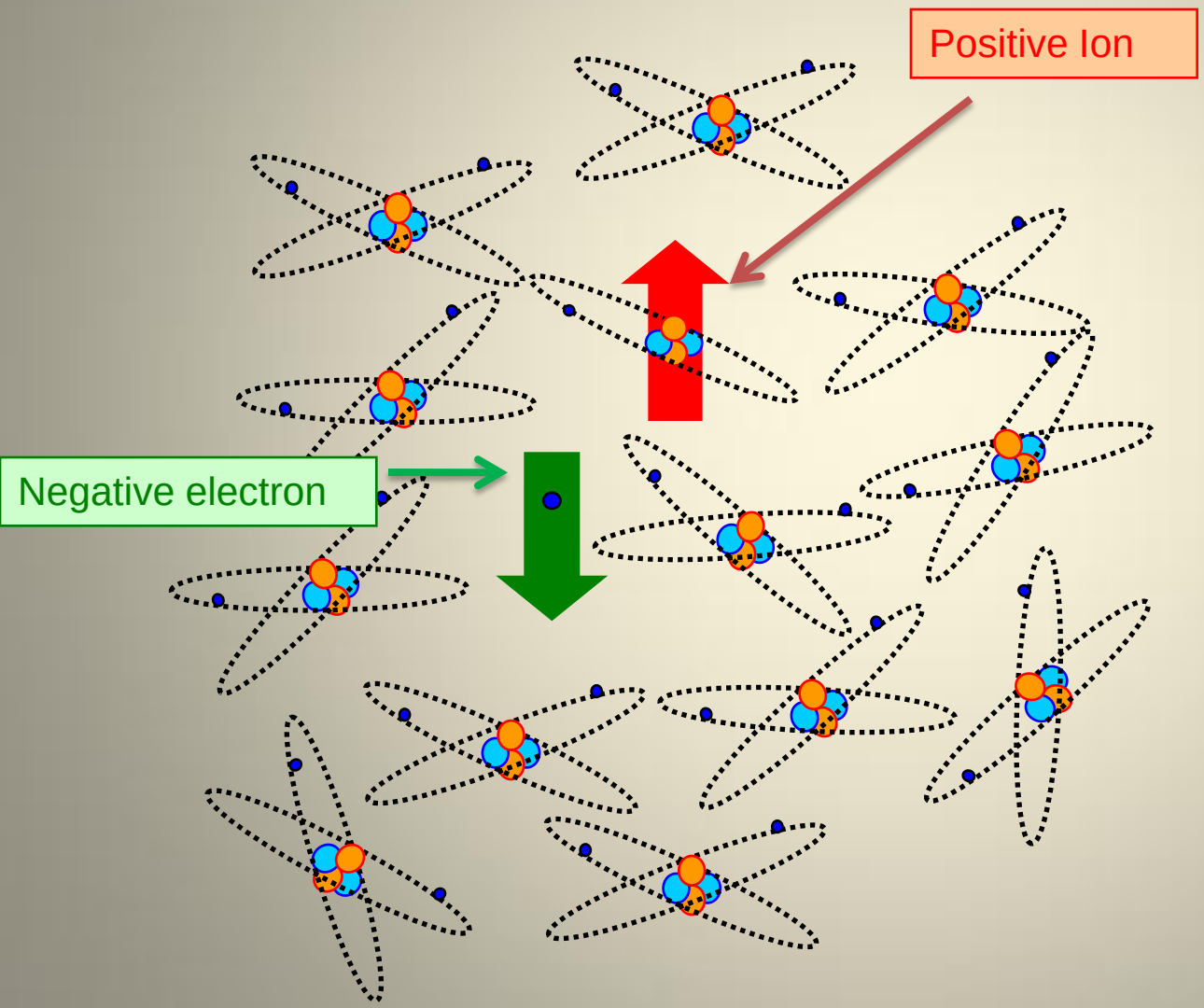


HPR260 Auto Gas Specifications section of the IM

Gas quality and pressure requirements				
	Quality	**Grade****	**Pressure +/- 10%**	**Flow rate**
O_2 Oxygen*	99.5% pure Clean, dry, oil-free	G	827 kPa / 8.3 bar 115 psi	4250 l/h 150 scfh
N_2 Nitrogen*	99.99% pure Clean, dry, oil-free	E	827 kPa / 8.3 bar 115 psi	9910 l/h 350 scfh
Air*	Clean, dry, oil-free	K	827 kPa / 8.3 bar 115 psi	9910 l/h 350 scfh
H35 Argon-hydrogen	99.995% pure (H35 = 65% Argon, 35% Hydrogen)	Ar = A H_2 = A	827 kPa / 8.3 bar 115 psi	4250 l/h 150 scfh
F5 Nitrogen-hydrogen	99.98% pure (F5 = 95% Nitrogen, 5% Hydrogen)	N_2 = E H_2 = A	827 kPa / 8.3 bar 115 psi	4250 l/h 150 scfh

All systems have their incoming gas requirements listed in the specification section of that manual

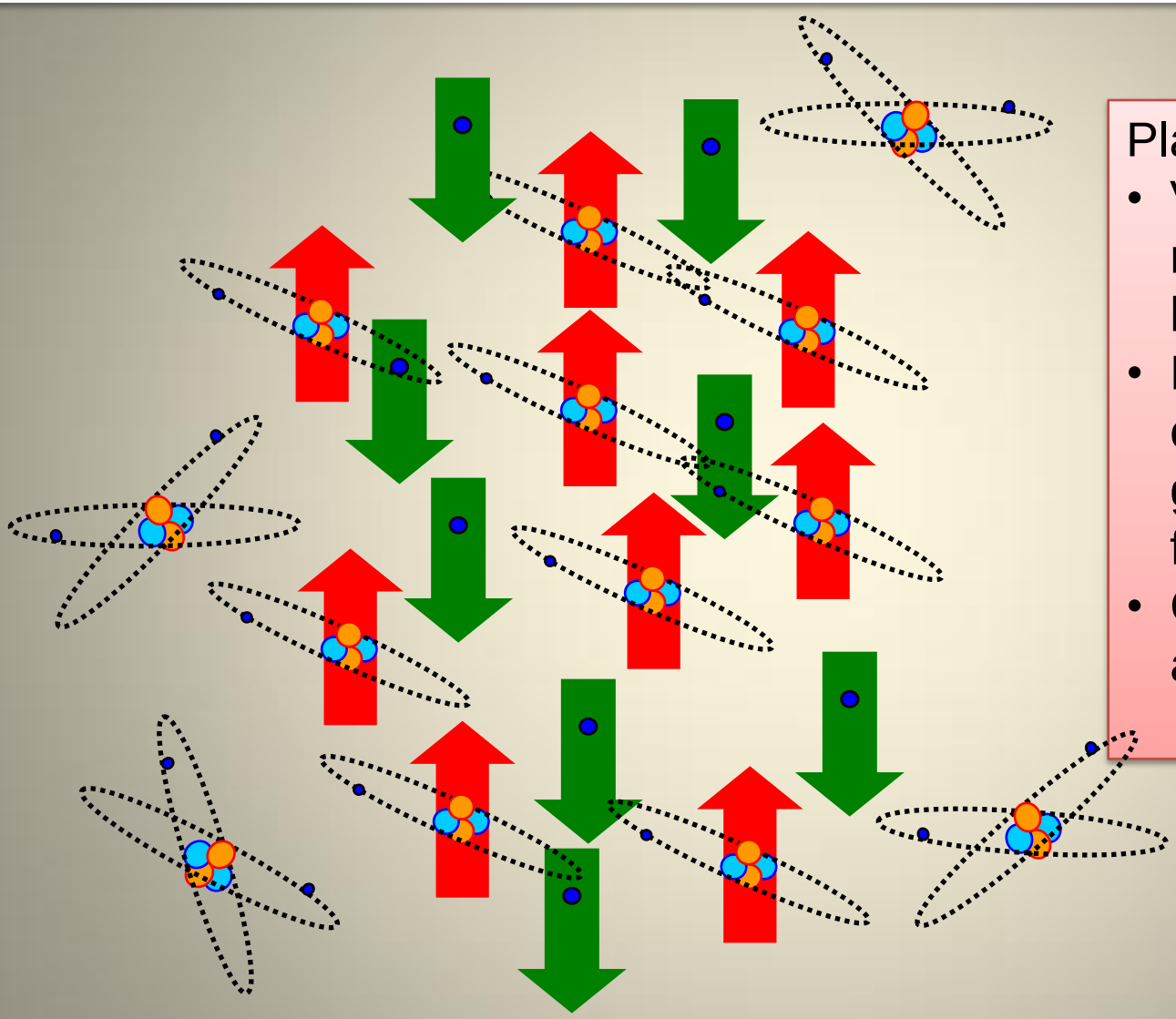
Making Plasma / Adding Gas/Air



Arc formation:

- Electrical field present
- Any free electron will move toward positive
- Any positive ion will mover toward negative
- Collisions with balanced atoms create free electrons and ions

Making Plasma / Adding Gas/Air



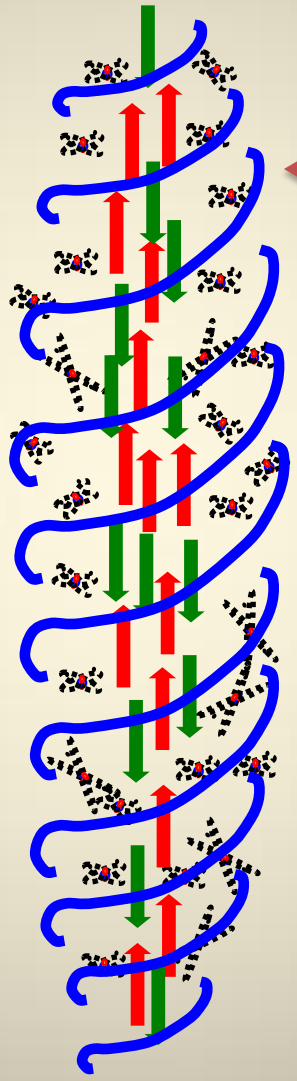
Plasmas:

- Very high motion means very high heat
- High speed collisions continue to generate ions and free electrons
- Can be compressed and made hotter

Making Plasma / Adding Gas/Air

Electrode

The high speed collisions continue to generate ions and free electrons that are energized for say. The Plasma generator sparks this cyclone. Like a lighting bolt it ignites. The generator then just keeps it ignited through out the duration of the cut.

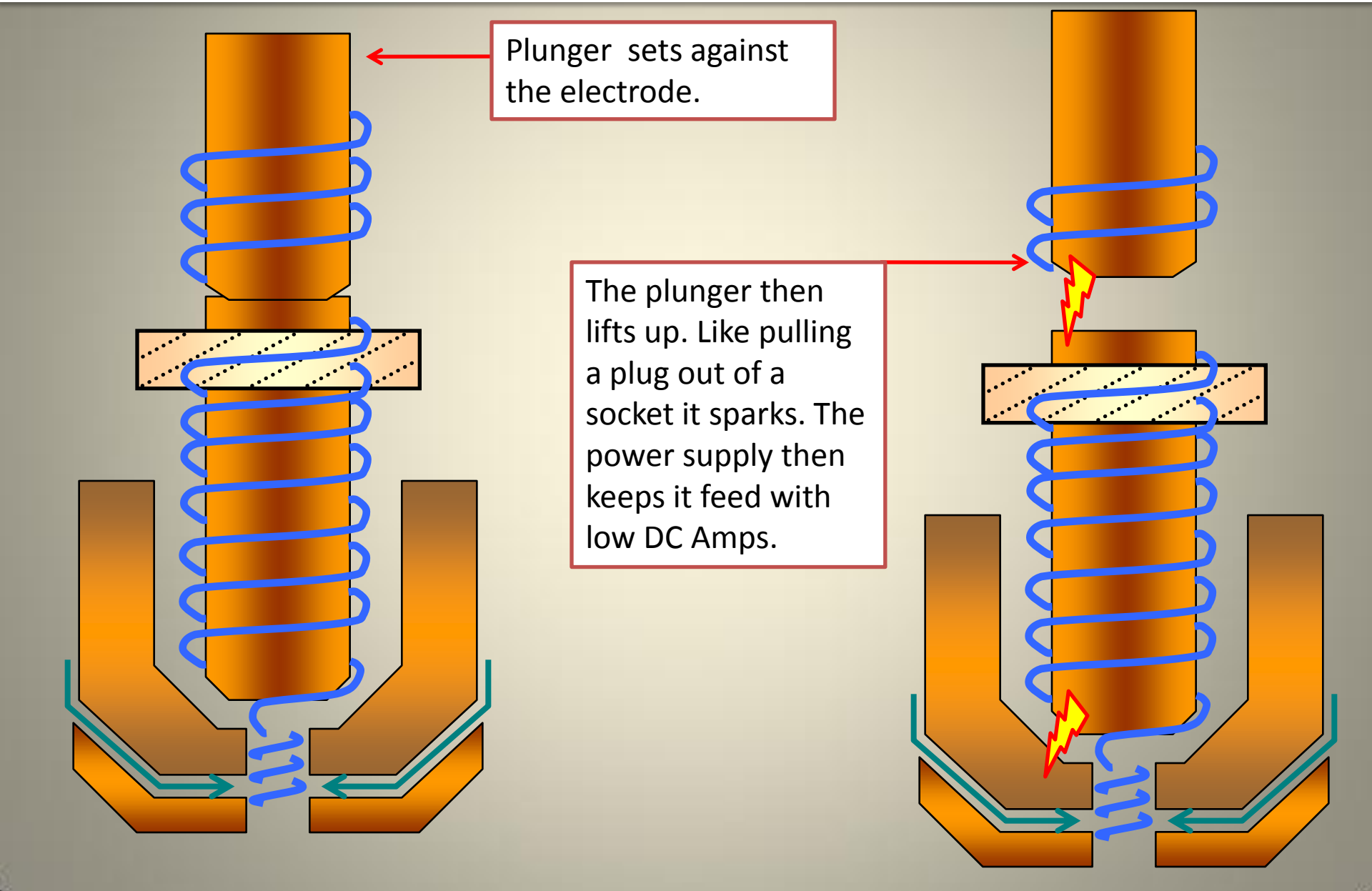


The air/gas that is the fuel is also used to form the shape of the plasma.

In larger Plasma units a Shield Gas helps form the plasma to a tighter more compressed shape. This makes it hotter and allows for thicker cutting and/or cleaner cuts.

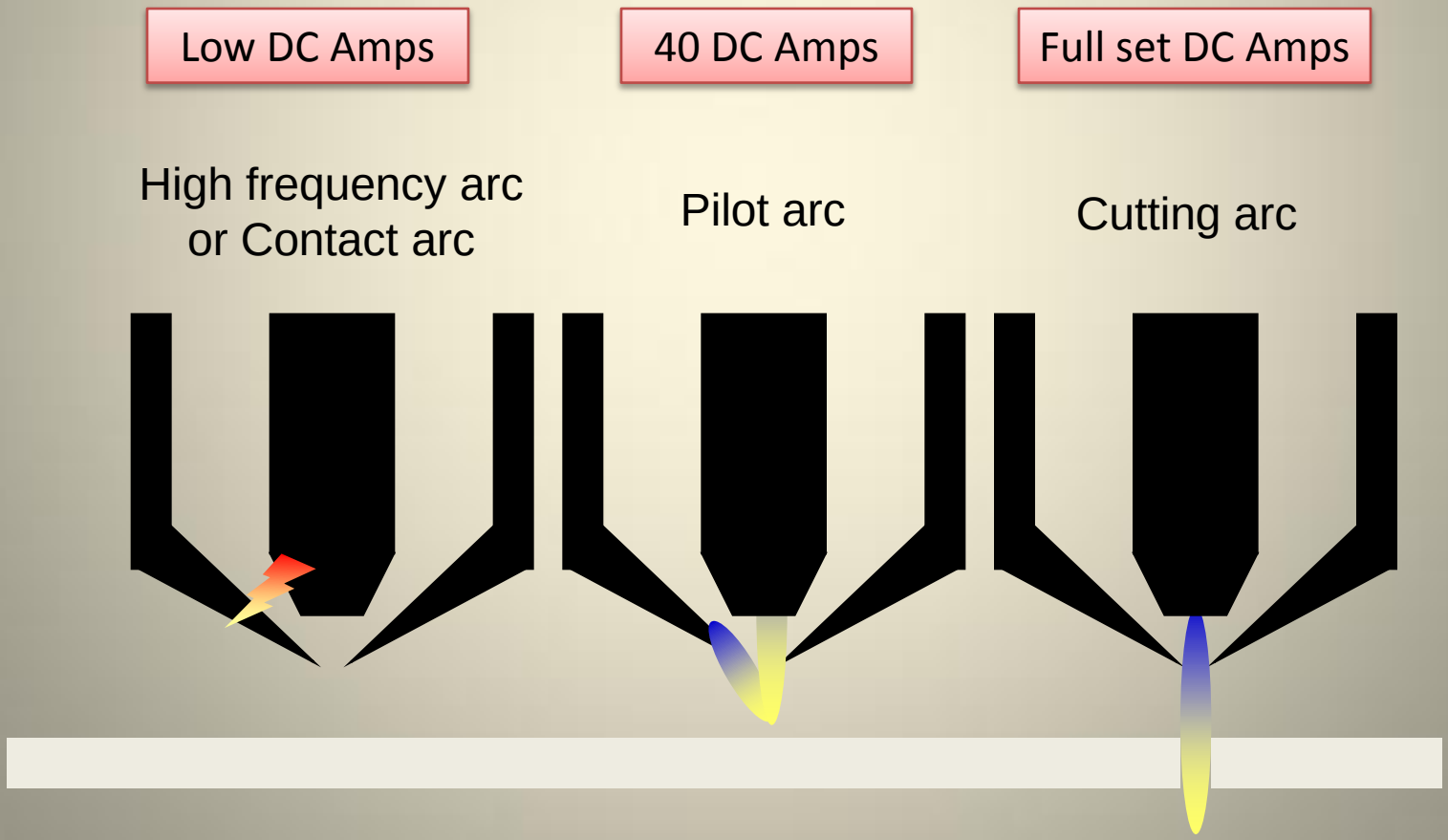
Work

Making Plasma / Adding DC Amps



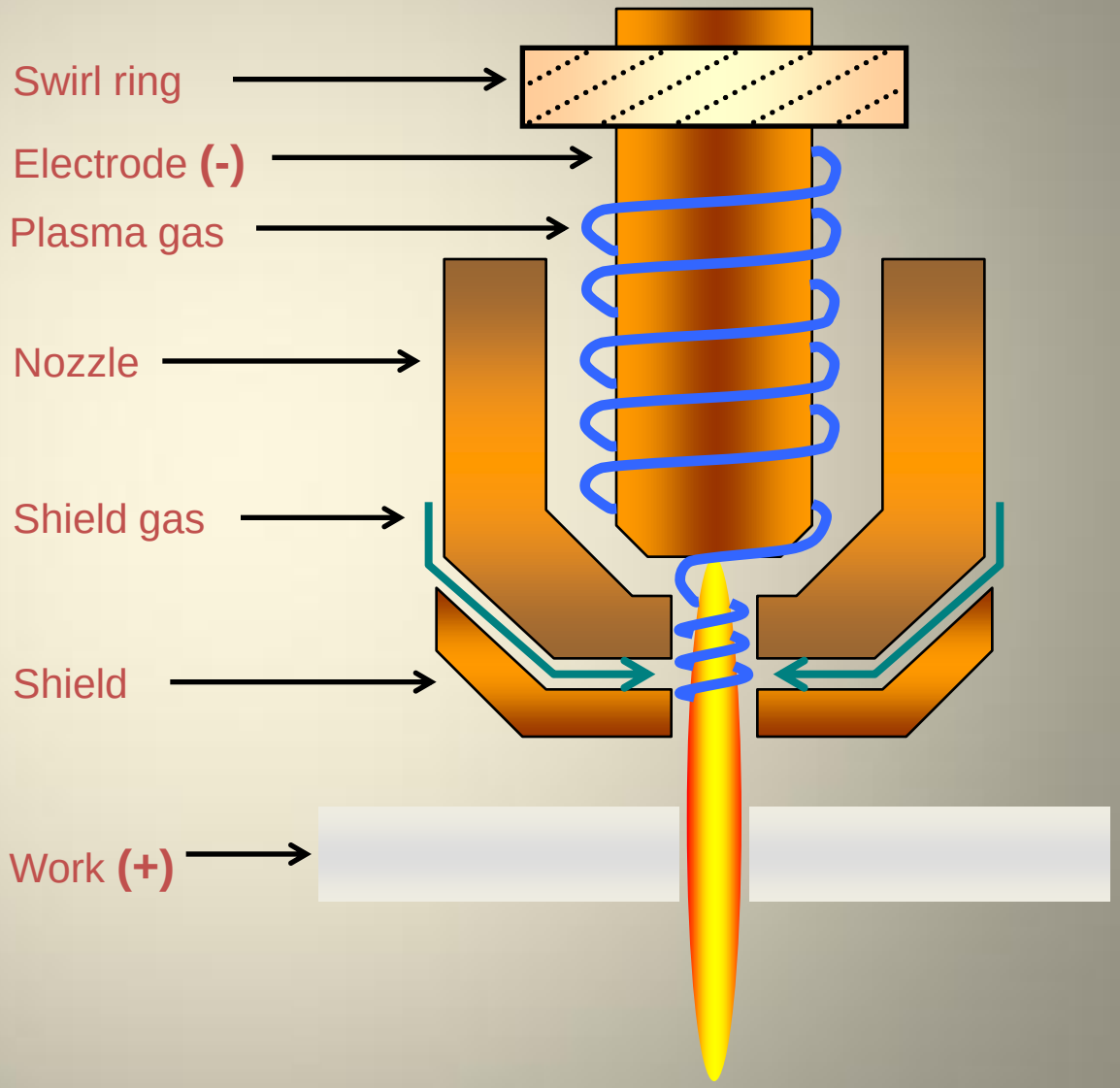
How it Works

- **There are three distinct arcs in a plasma arc cutting system**

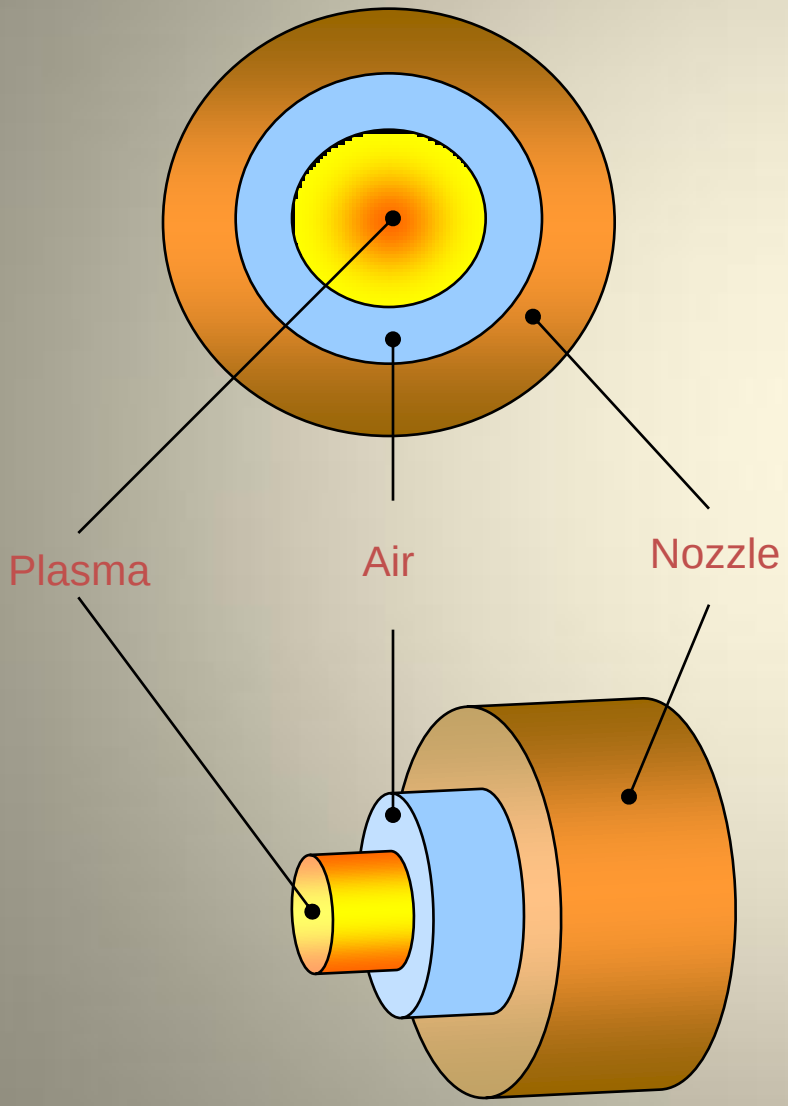


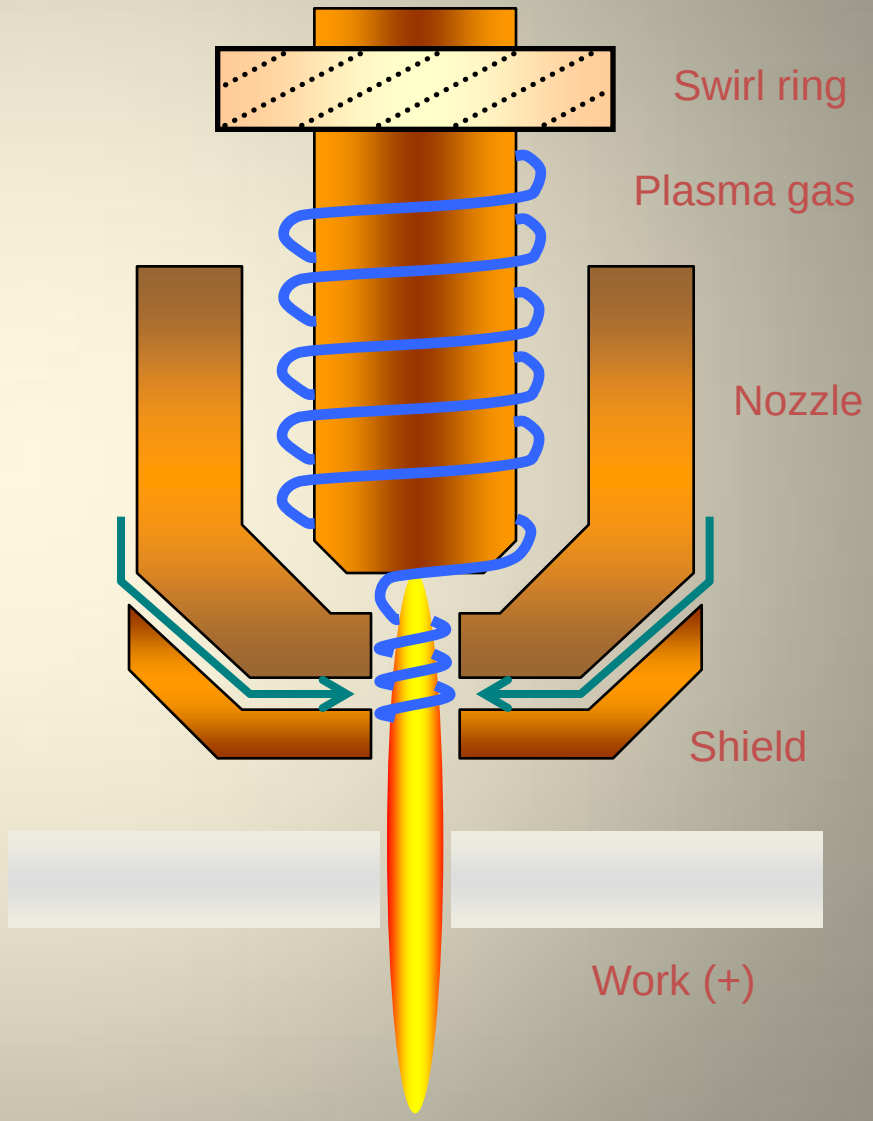
How it Works

- No matter what the Plasma Generator you have they all follow the same steps to making plasma.
- The difference comes to how they move the gas or air to form it and sustain the plasma.



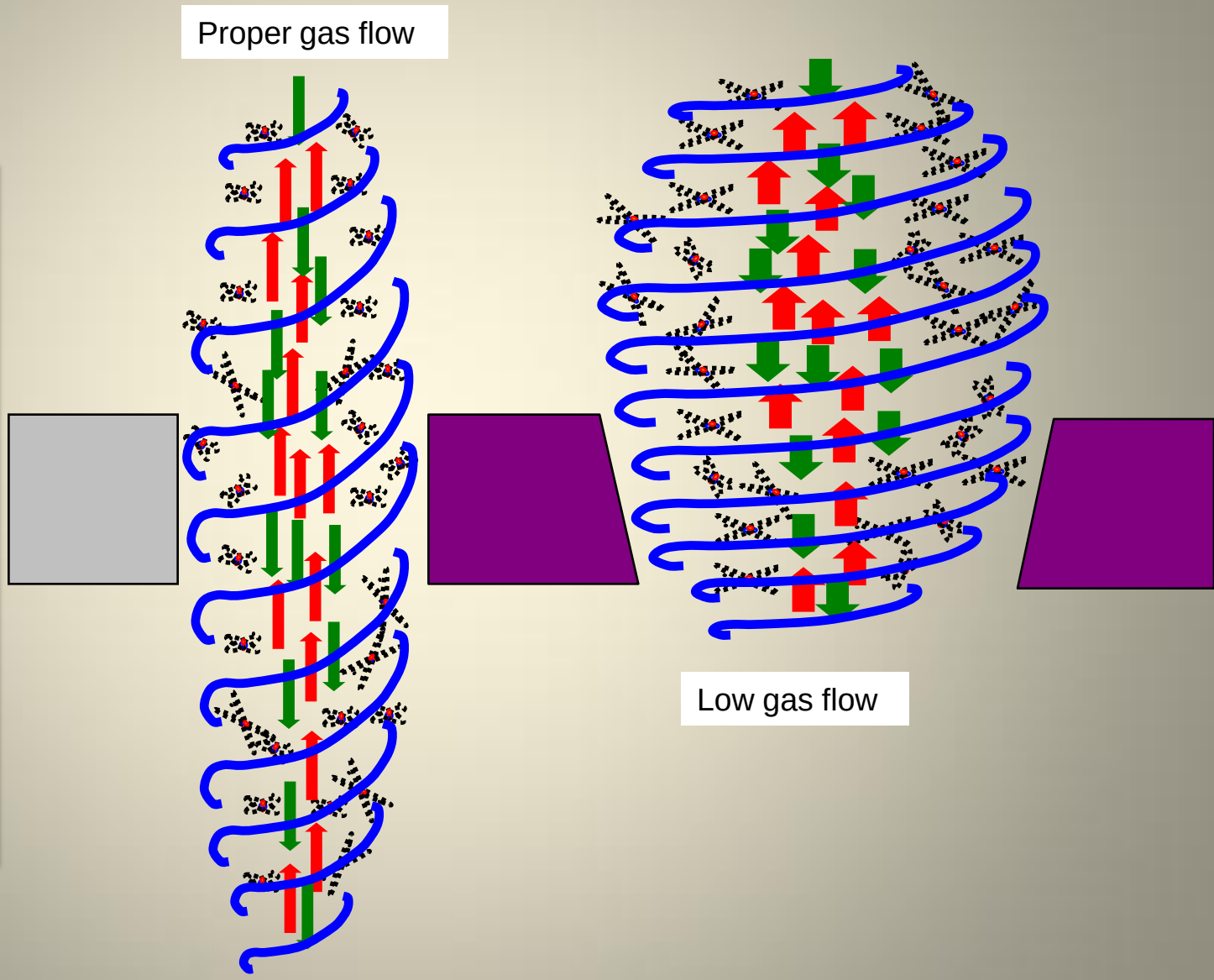
The Forming of Plasma





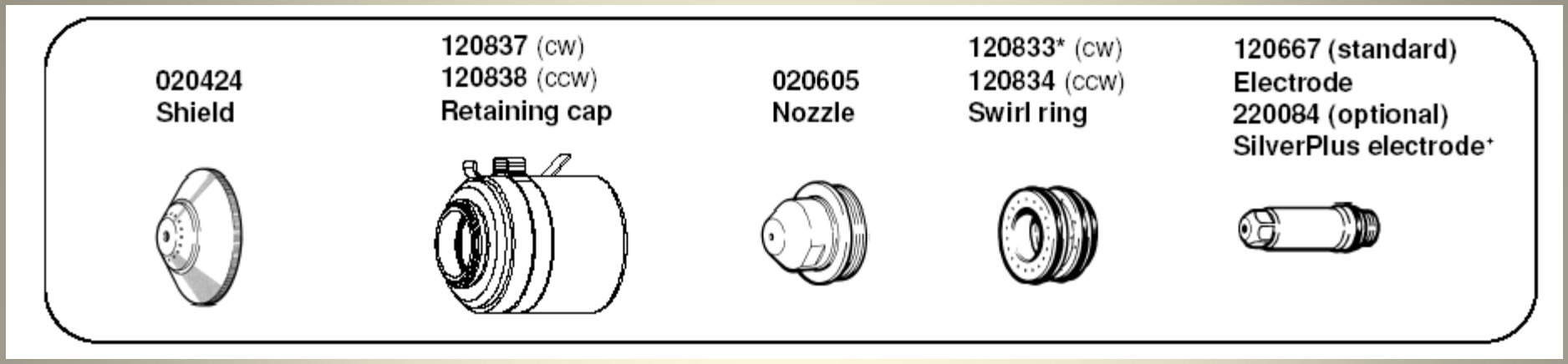
Gas Flow / Consumable ware

- **Gas flow**
- In general the higher the gas flow the more constricted the arc.
- Low gas flow usually is a result of consumable wear.



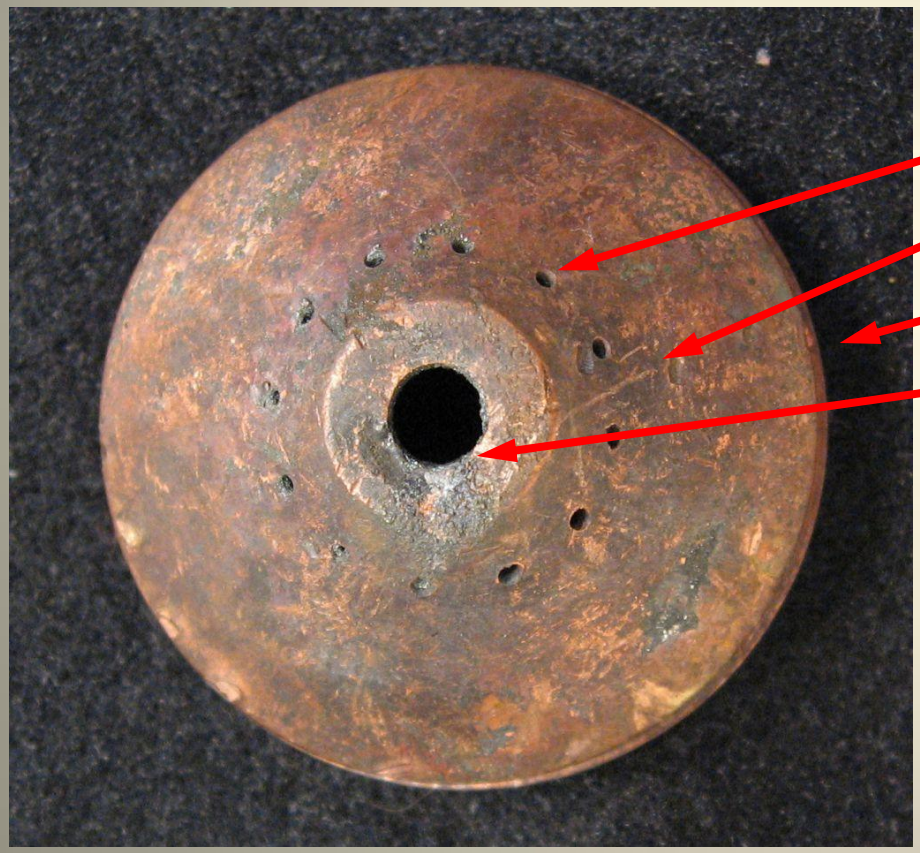
Check, Replace, Install Consumables

- Consumable set for a typical process



The Shield

- HT2000 Shield



Things to look for:

Plugged vent holes

Evidence of contact with the plate or table

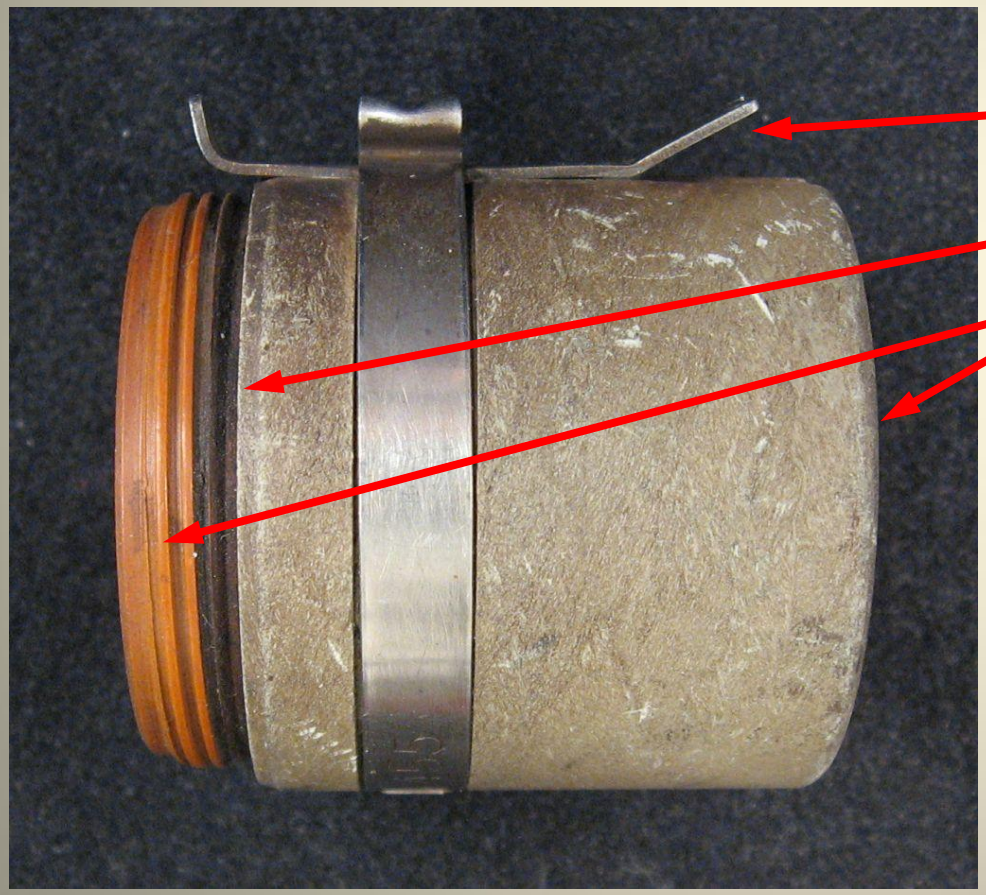
Galled or stripped threads (hard to install or remove)

Orifice out of round

Dross accumulation

The Retaining Cap

- HT2000 Retaining cap



Things to look for:

Bent or broken Ohmic contact wire tab

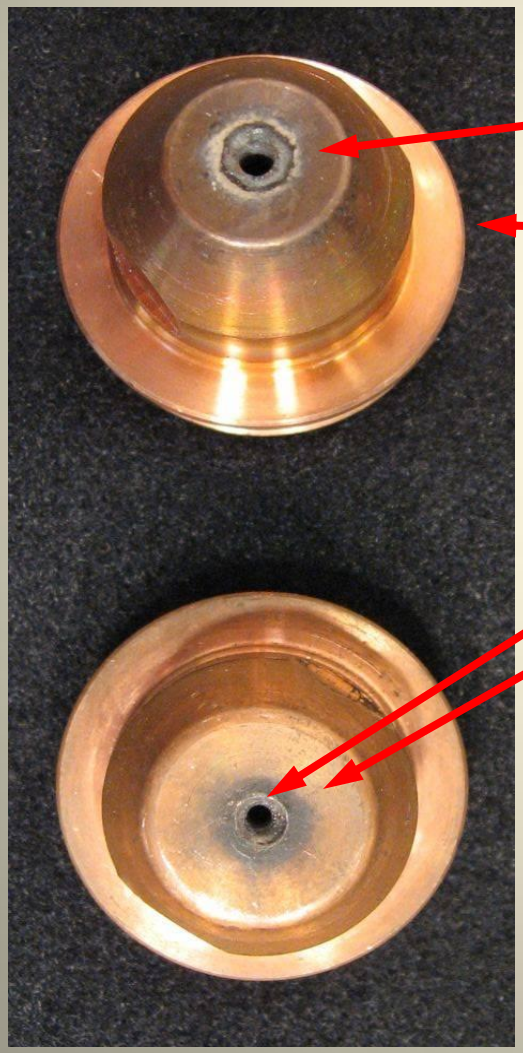
Separation of parts

Galled or stripped threads (hard to install or remove)

Leaking coolant or gas

The Nozzel

- HT2000 Nozzle



Things to look for:

Orifice out of round

Signs of high heat (these do NOT show signs of high heat)

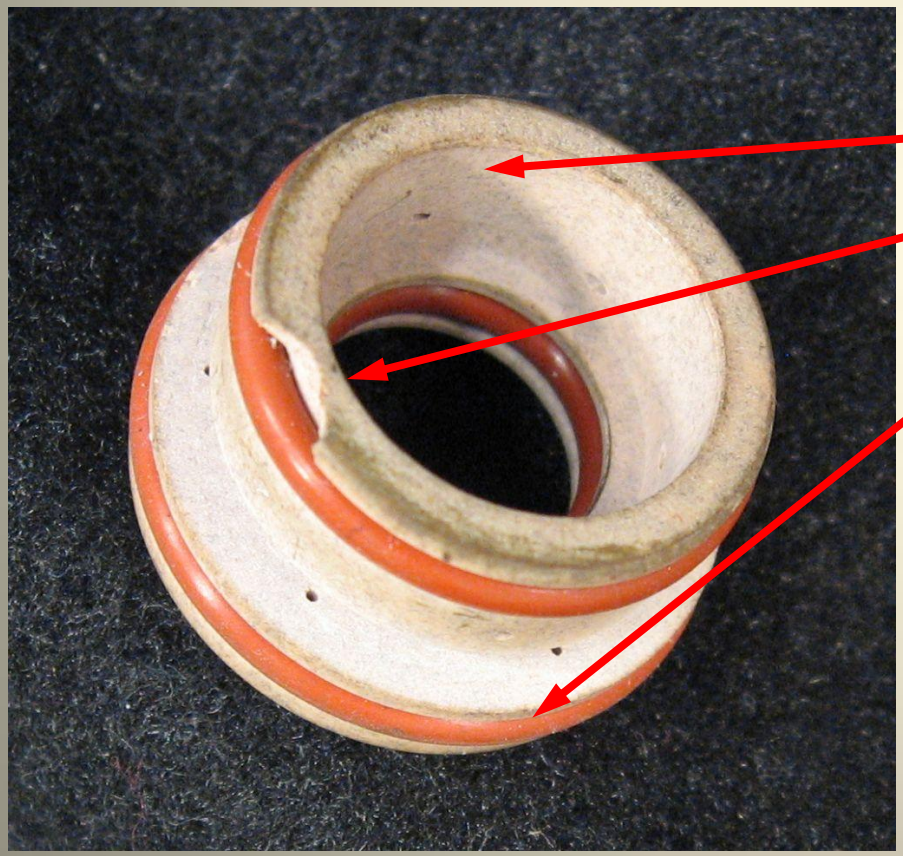
Galled or stripped threads (hard to install or remove)

Orifice walls damaged

Groove or shoulder around orifice

The Swirl Ring

- HT2000 Swirl Ring



Things to look for:

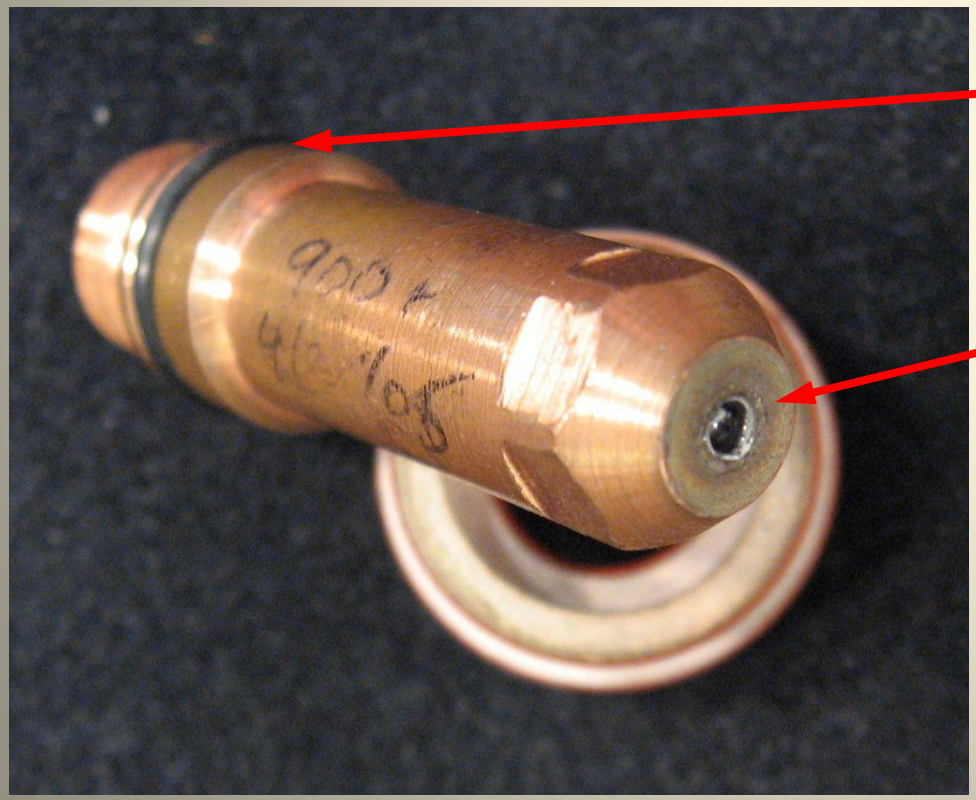
Plugged gas passages

Broken or chipped body

Missing or damaged O-rings

The Electrode

- HT2000 Electrode



Things to look for:

O-ring missing or damaged

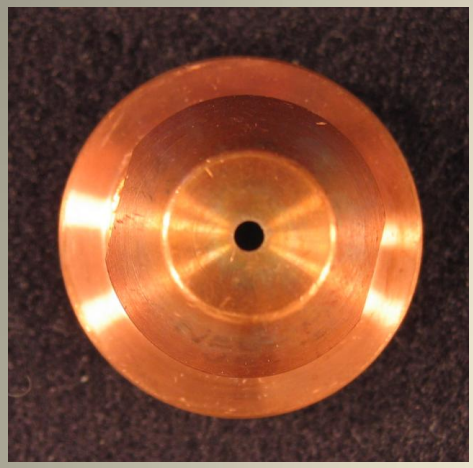
Signs of high heat (this one does NOT show signs of high heat)

Pit depth greater than .040”

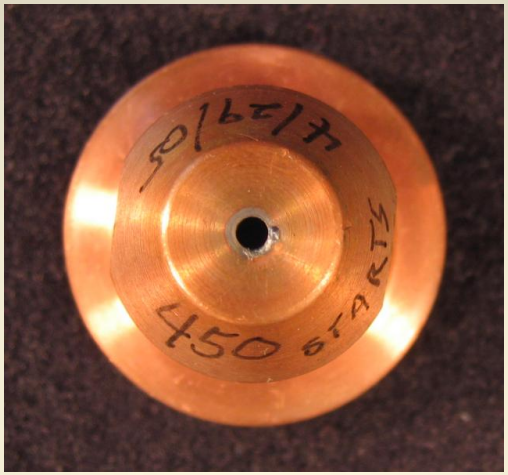
Signs of copper erosion around the hafnium insert (not shown here)

Consumables

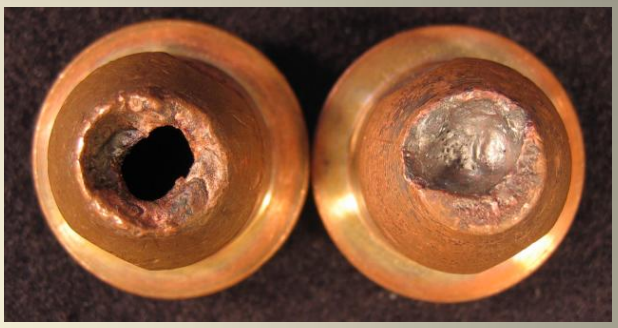
- Top Nozzle, Bottom Electrode



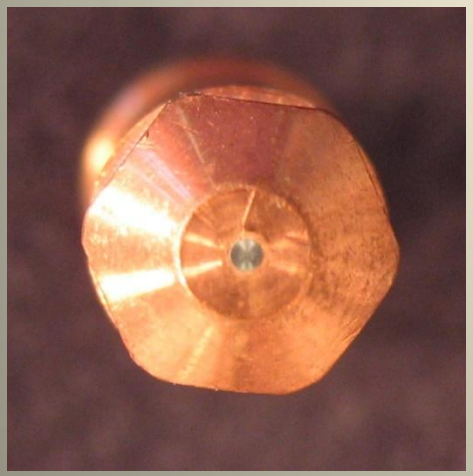
New



Oval orifice



Blown nozzles



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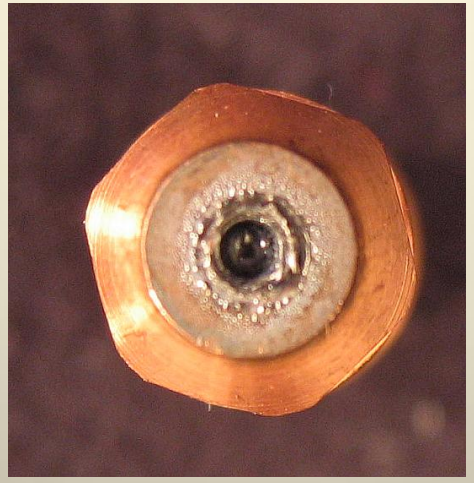
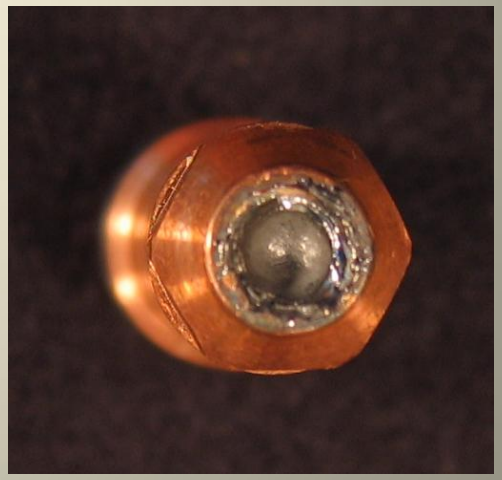


End of life



Overused

Consumables

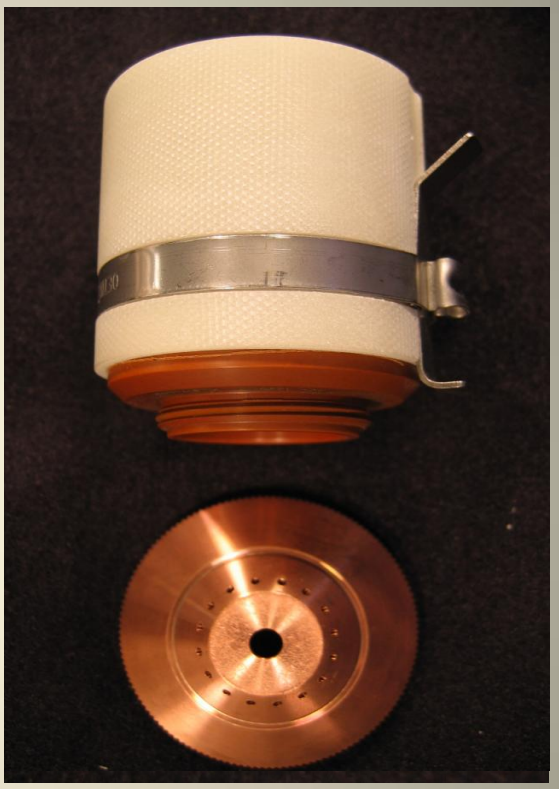
- **Routinely change these as a pair.**
- **How do you know when to change consumables?**
- Sound?
- Arc color?
- Cut quality?
- Number of starts?

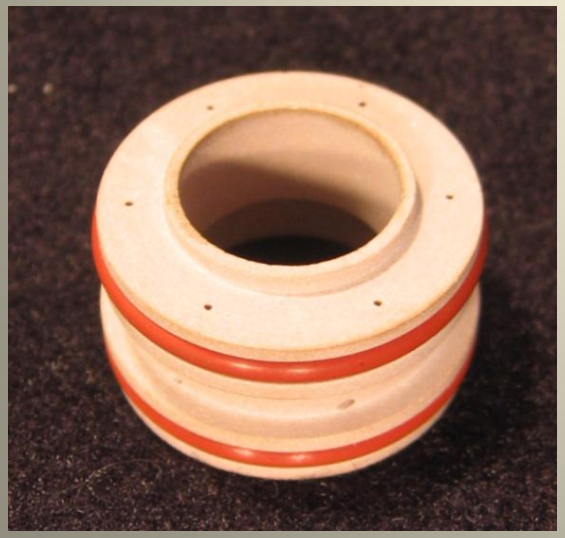
Secondary Consumables

- *These are changed less often*

Retaining cap:
- Replaced if it leaks or is damaged

Shield cap:
- These do wear out
- Inspect for dross build up regularly





Swirl ring:
- Replace if damaged or fouled.
- Replace if changing the nozzle and electrode doesn't fix the problem

Consumable Care

- **O-Lube**

- Use only non-conductive non-flammable O-lube Silicone
- Use sparingly
- Clean up excess

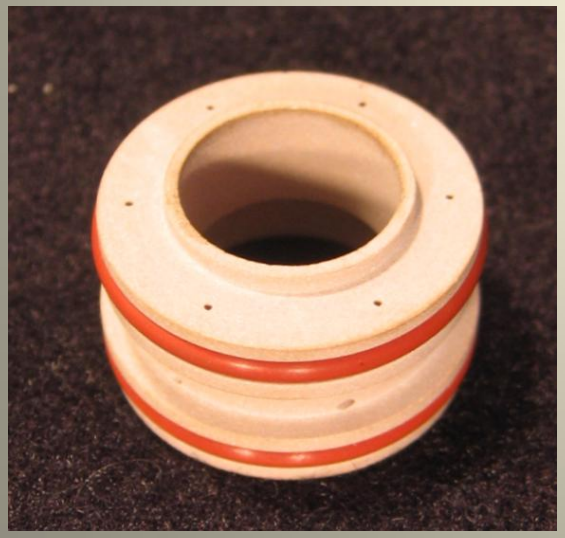
Torch body:

Good:

- Prevents cracking
- Makes a better seal

Bad:

- Attracts cut dust
- Runs when hot



Swirl ring:

Good:

- Makes removal easier
- May prolong life, less likely to get cracked

Bad:

- Same as above

Check, Replace, Install Consumables

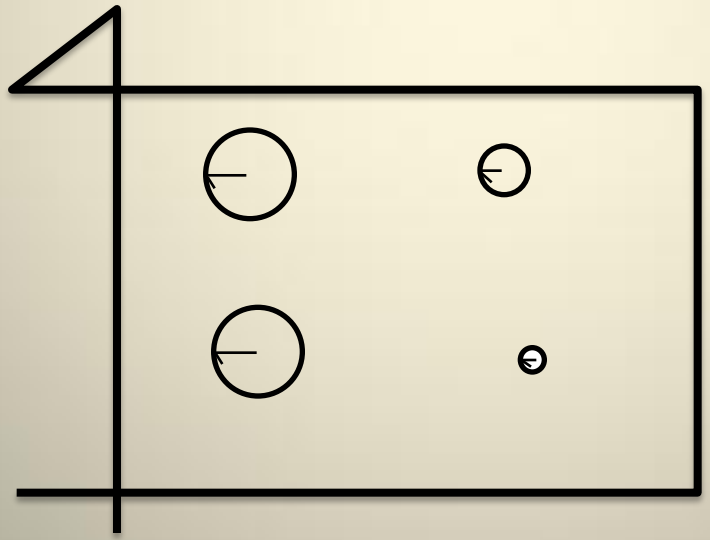
- **Over the life of the equipment there will be times when consumable life is affected by normal wear and tear on the equipment**

- Gas leaks

- **Other non-gas flow problems that can affect consumable life**
- THC issues
- Pilot arc circuit issues
- Grounding issues
- Coolant flow problems

Preparing to Cut Parts

- To decide on the best process we must know,
- What material is the part made of?
- How thick is the material?
- What's the critical quality factor?



Process selection depends on what material is being cut.

For mild steel use O2
For thick stainless H35
For thin stainless F5
For aluminum Air, N2 or H35.

Preparing to Cut Parts

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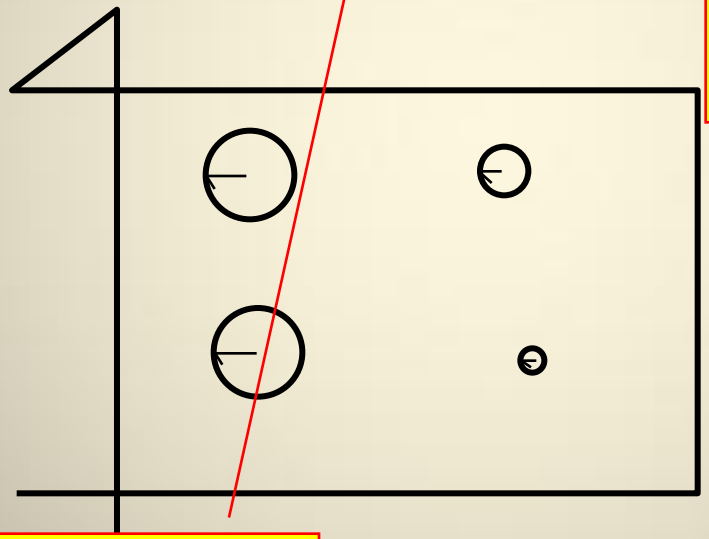


Process selection depends on how thick the material is

Thicker material: higher amperage

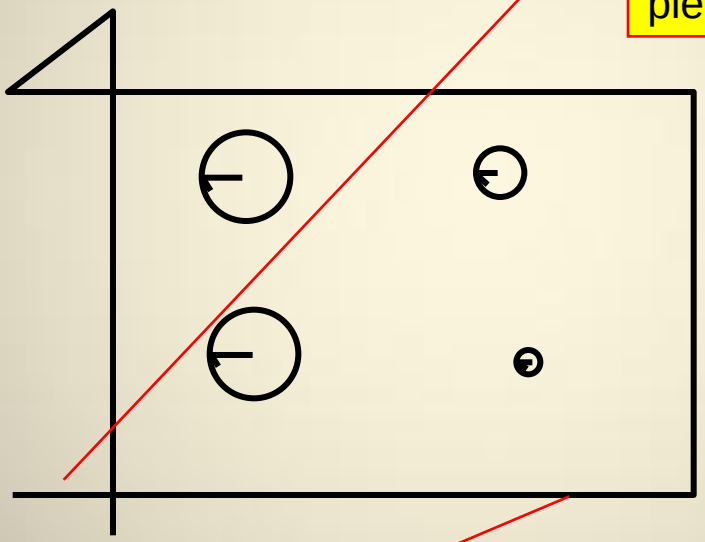
Thinner material: lower amperage

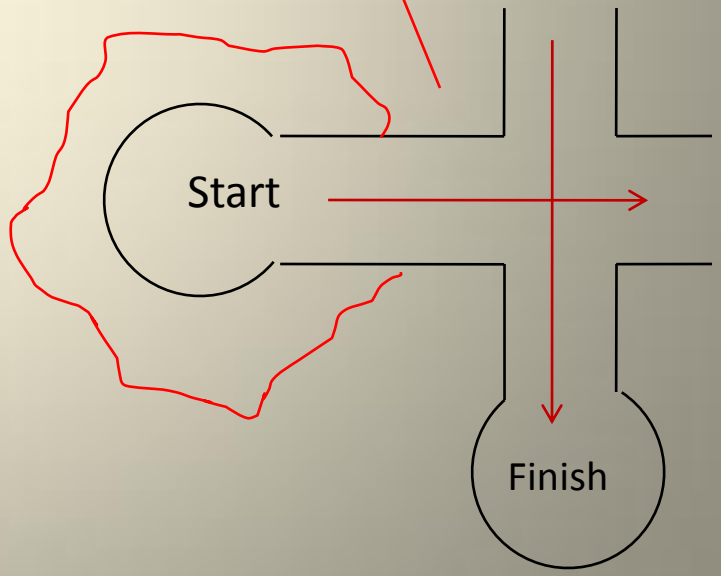
Feed rates vary within a amperage range.
For best overall cut quality choose a process where your thickness is in the middle of the cut chart.

Preparing to Cut Parts

- To decide on the best process we must know,
- What material is the part made of?
- How thick is the material?
- What's the critical quality factor?

For best cut angularity:
Use a lower amperage process
Make lead ins as long as possible
Be sure the kerf doesn't cross the pierce puddle

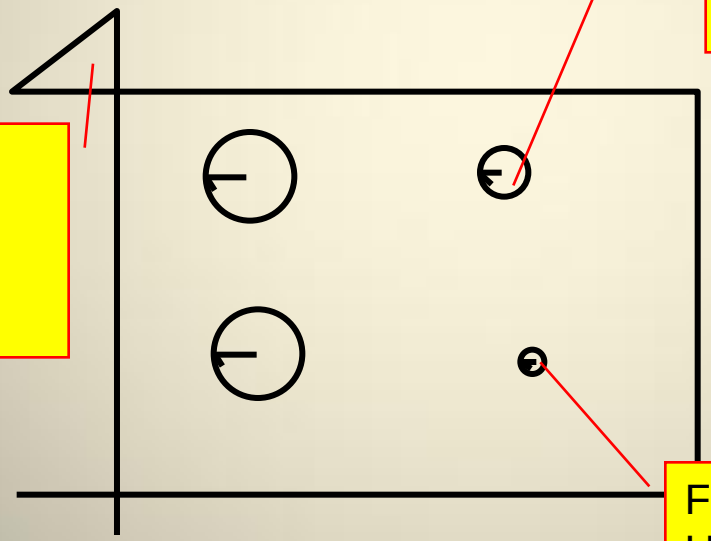




For the least amount of dross:
Experiment to find the optimum feed rate.
Don't use shot blasted plate
Don't use hot plate

Preparing to Cut Parts

- To decide on the best process we must know,
- What material is the part made of?
- How thick is the material?
- What's the critical quality factor?



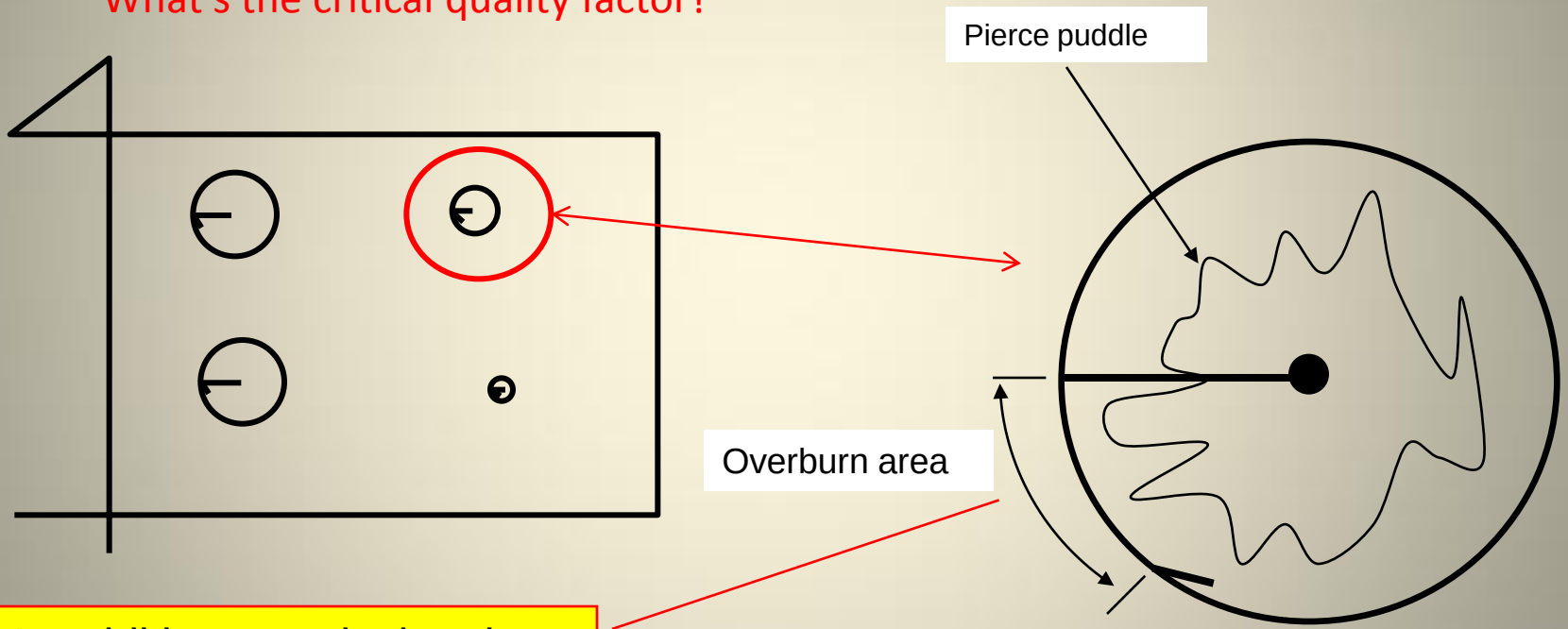
For less taper in holes: Cut slower (20% or more) than "book"
Lock out the THC

For the squarest possible corners you may want to "loop" them

For very small holes:
Use a smaller amperage process
Slow down even more
Lock out the THC

Preparing to Cut Parts

- To decide on the best process we must know,
- What material is the part made of?
- How thick is the material?
- What's the critical quality factor?

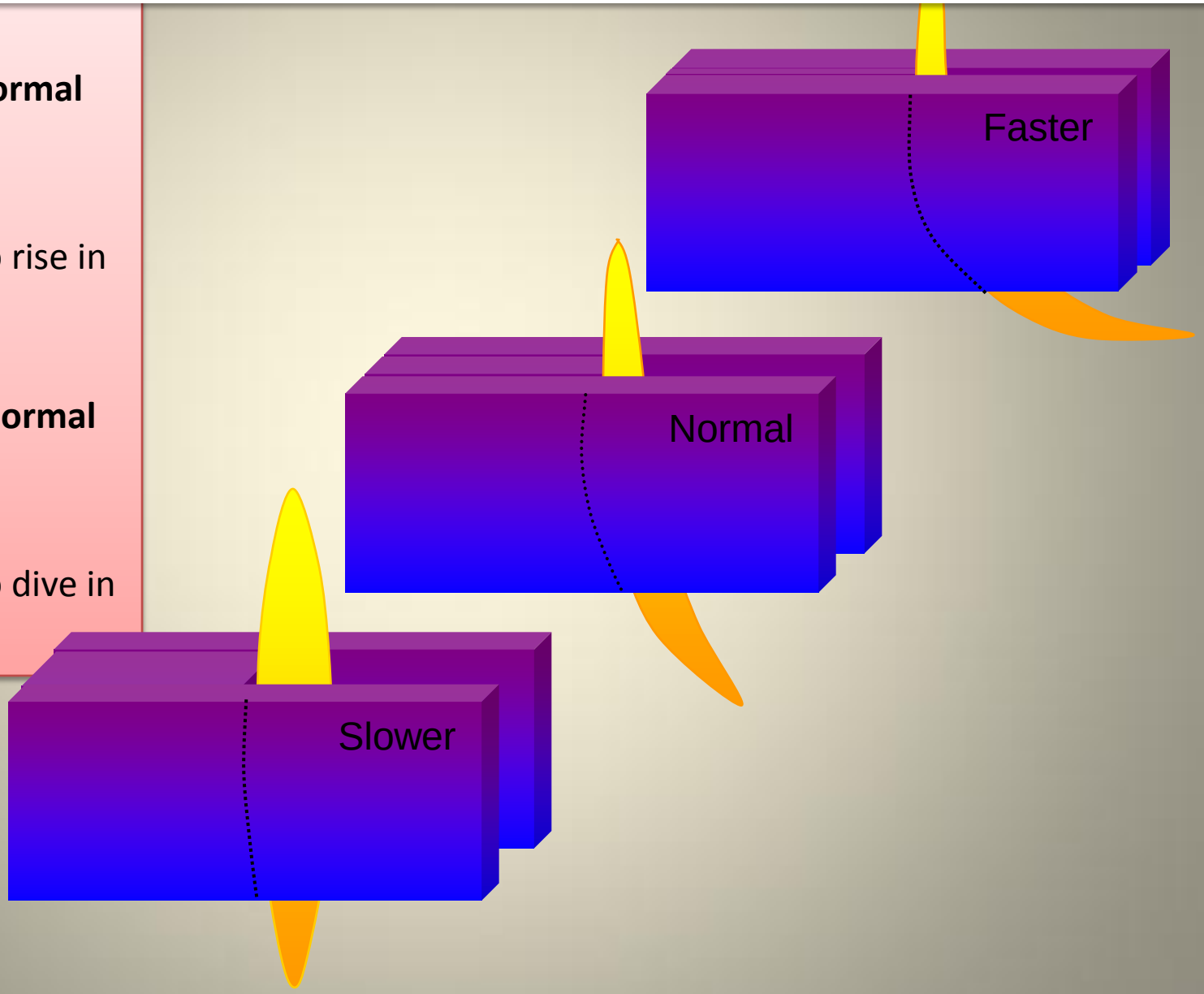


In addition to reducing the amount of taper in the hole there are ways to reduce divots and protrusions.

Feed Rate

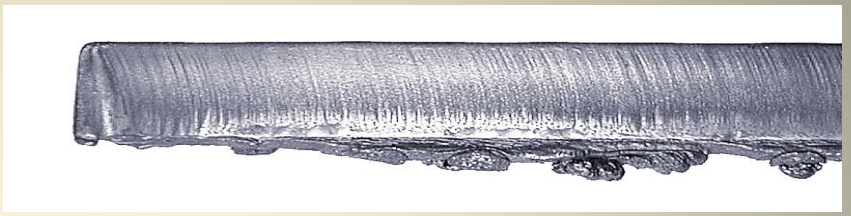
- **Feed rate**
- **Faster than normal**
- Narrower kerf
- Excess dross
- Torch tends to rise in THC mode

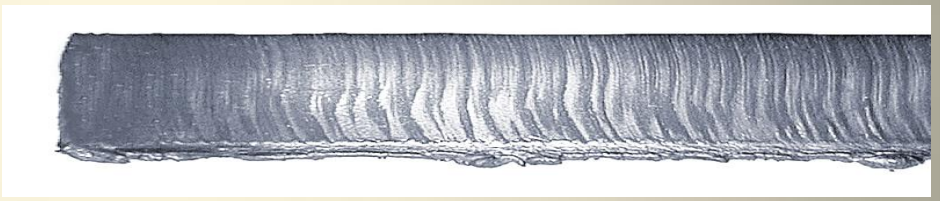
- **Slower than normal**
- Wider kerf
- Excess dross
- Torch tends to dive in THC mode

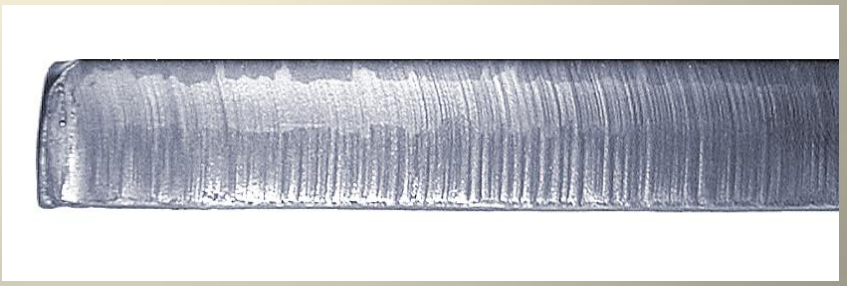


Feed Rate

- Low speed
- The dross you see at the end of consumable life
- Black, burnt, easy to remove
- May result from low feed rate
- High speed
- Rare
- Re-solidified metal
- Will not chip off
- Dross free
- There may still be spots of dross in the corners and at starts and stops

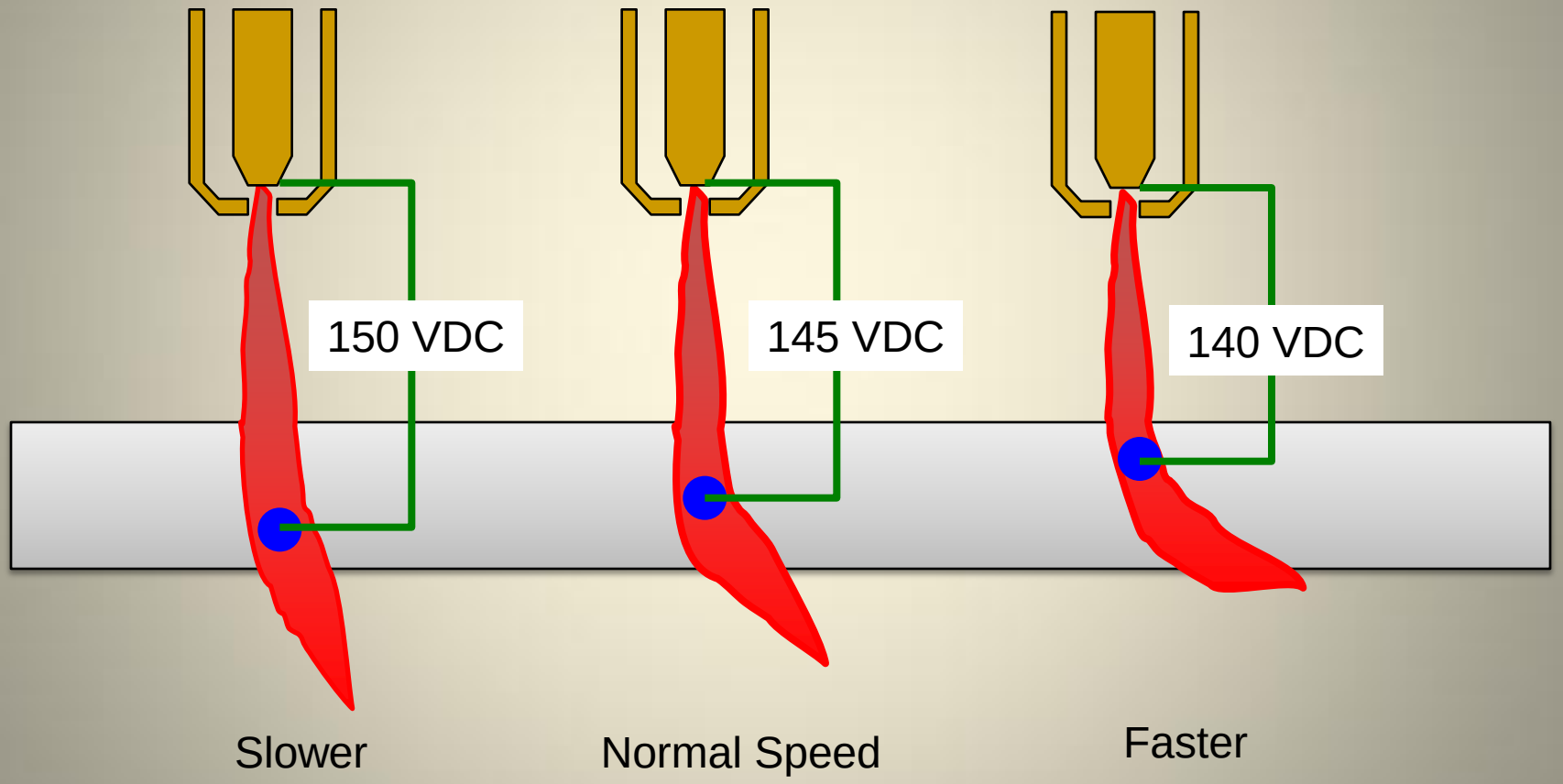






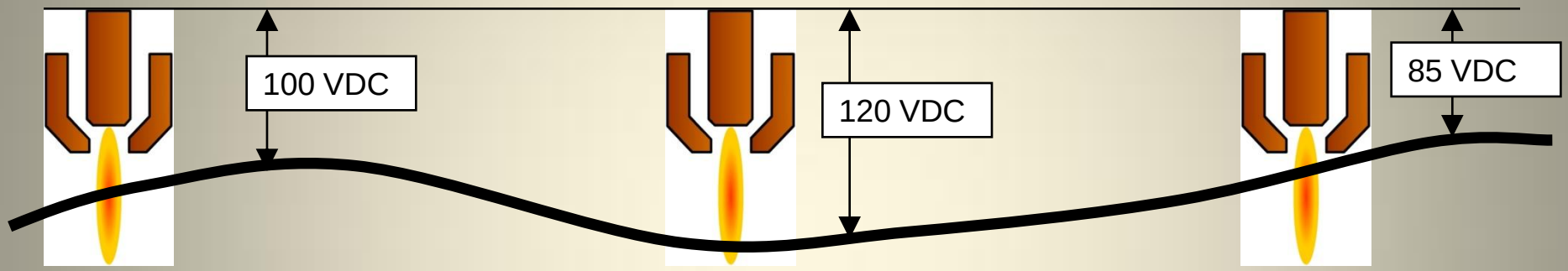
Feed Rate / Voltage (THC)

Speed Affects Arc Voltage

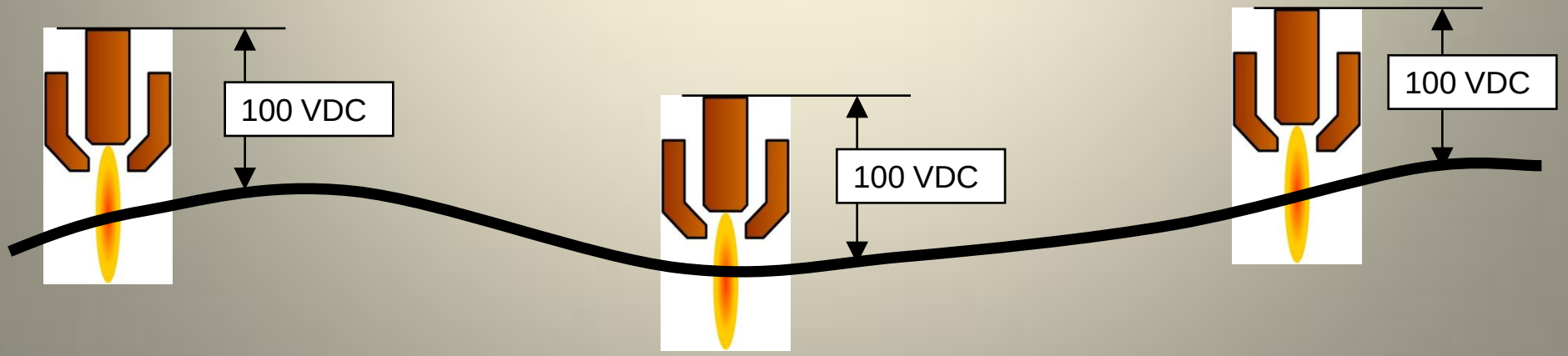


Cutting Height / THC

- Without torch height control

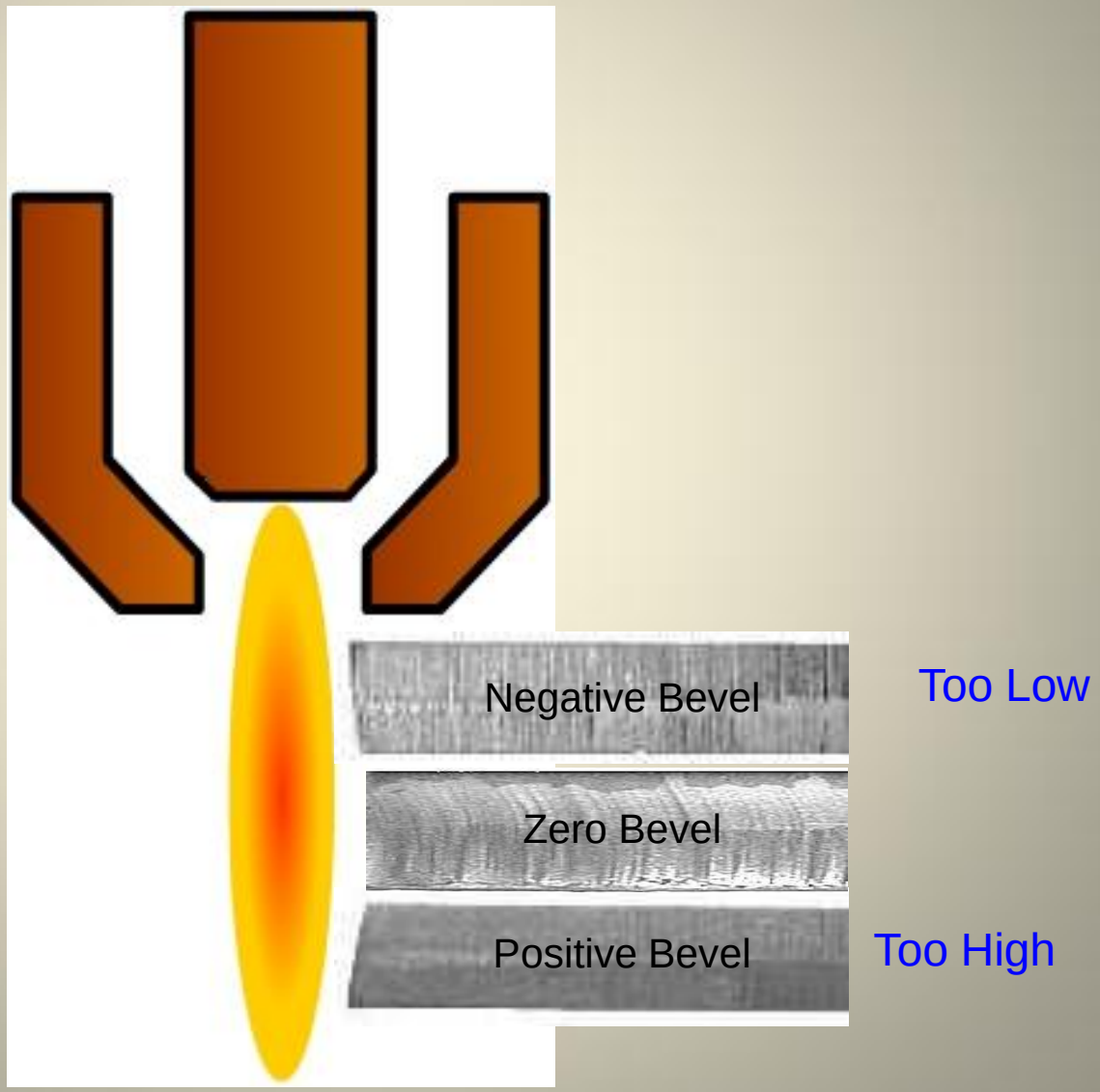


With torch height control



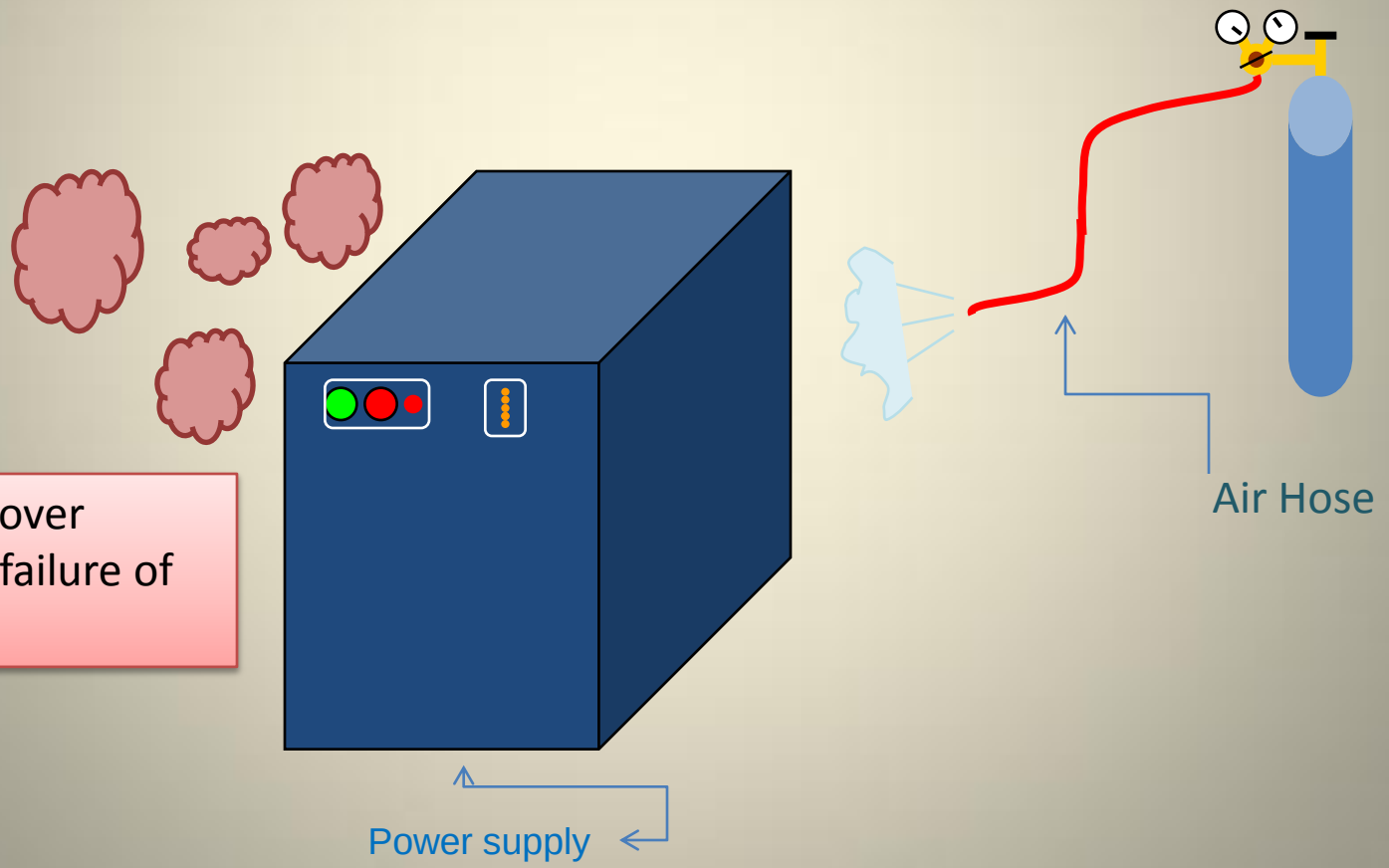
Cutting height / THC

- **Torch height**



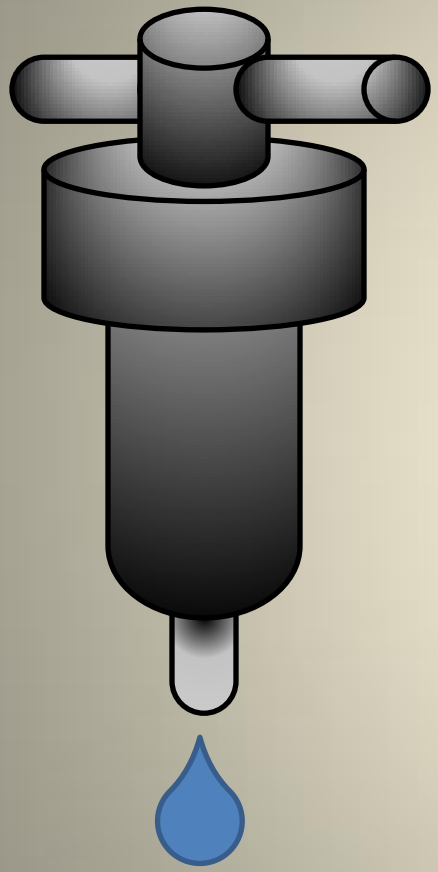
Maintenance

TRUN POWER OFF BEFORE PERFORMING ANY MAINTENANCE!!!
Disconnect power to the unit. The plasma units have coils that hold power. Let stand with out power for 5 minuets before performing maintenance.
Take cover or panel off Plasma generator and blow out dust with clean dry air.



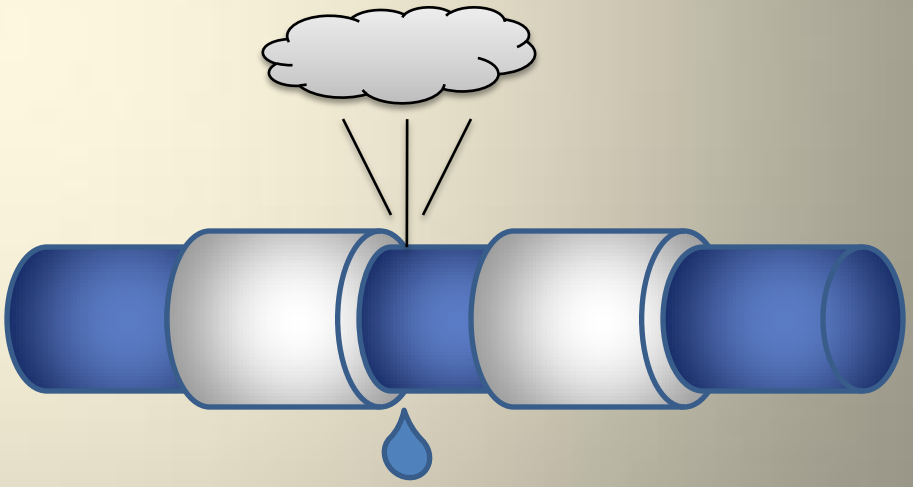
Dust can cause over heating and/or failure of components.

Maintenance



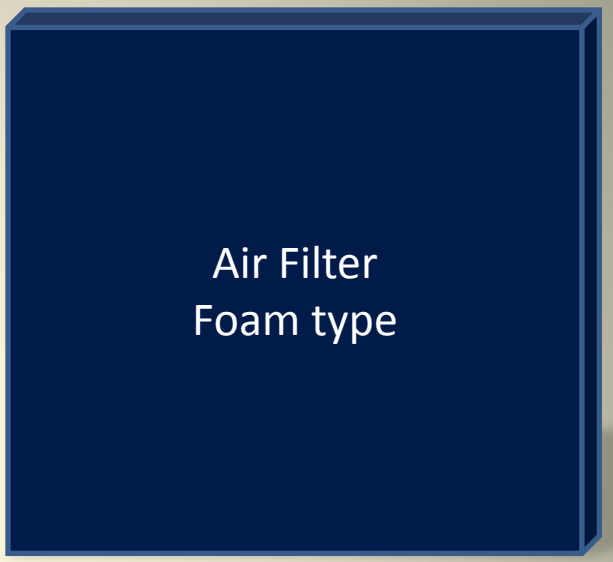
Check all water traps for water and drain as needed. At times these units need to be cleaned if water is not very clear.

Check connections of air lines or gas lines to plasma generator for leaks.



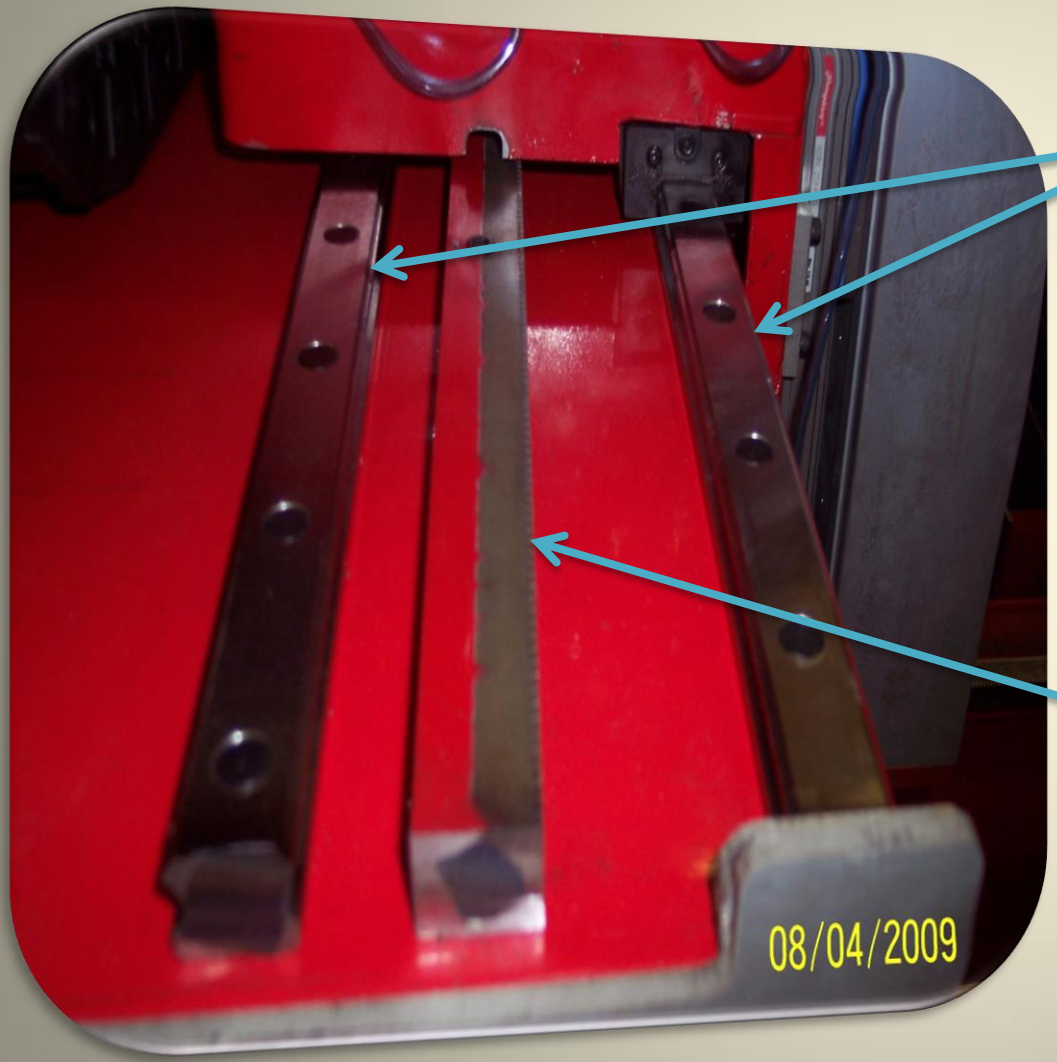
Maintenance

Check Air filters as recommended by Plasma generators maintenance section.



Some Generators do not supply filters. The Filters may need to be purchased separately and installed by you.

Maintenance



Keep the Linear Guide Rails wiped clean with a rag coated lightly with W-D 40. To much will collect dust.

Use a Brass wire brush to clean out Gear rack of dust and debris. Do this on the Gear rack on your table and gantry. Also brush off the Pinion gears.

Reveiw

1. What about plasma makes it useful for cutting metal?
2. Why is there normally dross in sharp corners?
3. Why would you adjust arc voltage over the life of the consumables?
4. Why are proper gas flows important?
5. When would you change a swirl ring?
6. What, besides worn consumables, would cause excess cut angle?
7. How much O-lube is enough?
8. How does feed rate affect torch height in systems with THC?