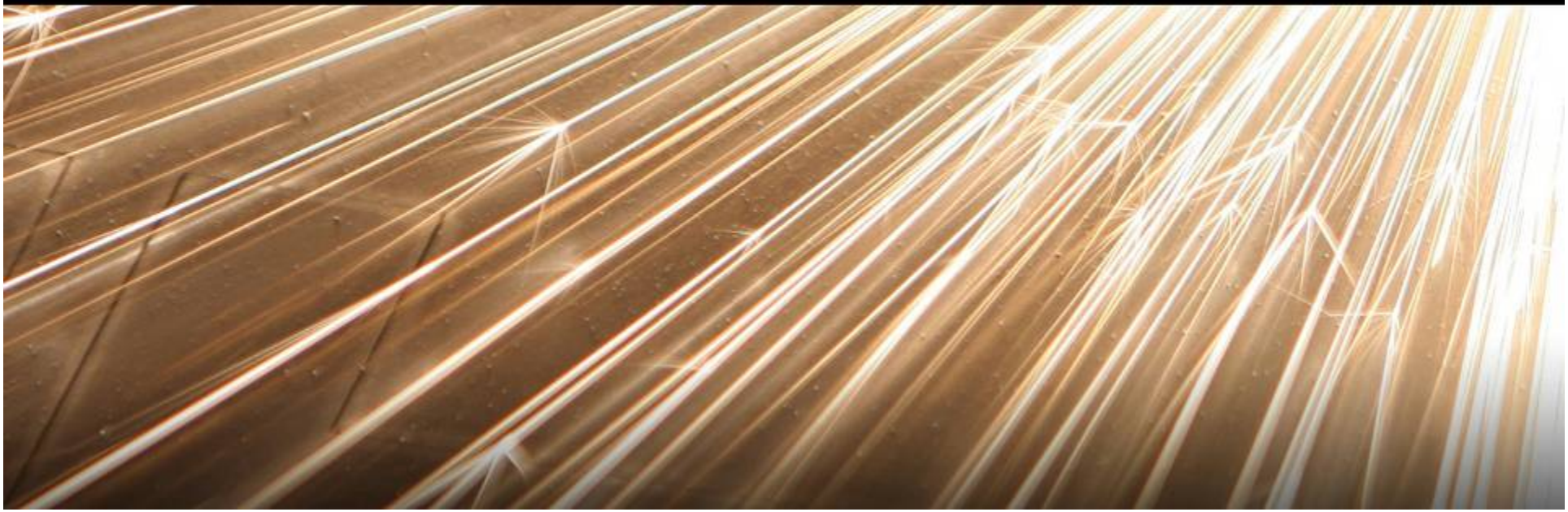
Hypertherm®

Consumables Inspection

Best practices for getting the best life from your consumable parts

Jim Colt



Mechanized Plasma Cutting

Hypertherm

With today's Long-Life oxygen cutting technology, plasma is the most productive, cost effective way to cut carbon steel from gauge to 1 1/4” thickness.

But…to get the highest performance, operators need to ensure the consumables in the torch are inspected and maintained to high standards.

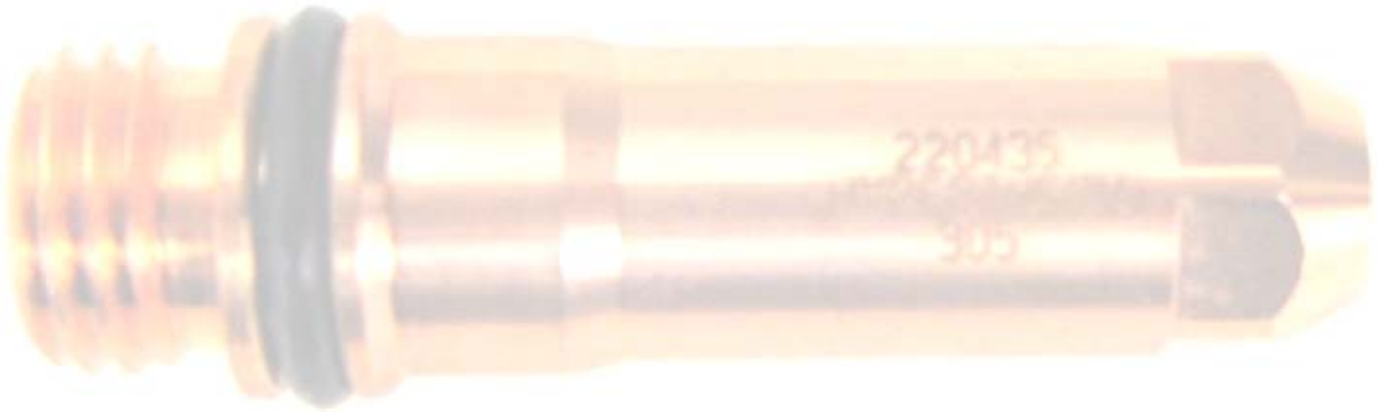
Electrode

- Function
- Critical features
- What can go wrong
- Measuring wear
- How to get the best life

Electrode: Function

Primary function: provide power to the plasma arc.

- The electrode is connected to the negative output from the power supply.



Electrode: Function

Secondary function: electrode conducts high voltage (aka, high frequency) energy during the starting sequence

- Energy ionizes the cutting gas, allowing plasma arc to start
- Since the electrode is the main contact point for the plasma arc, it gets very hot.
- The end emitter on an oxygen electrode, made of the element hafnium, can reach temperatures exceeding 3000 degrees F.
- Most plasma cutting electrodes used at over 100 Amps of cutting current are liquid cooled, as opposed to gas cooled in smaller mechanized and hand held plasma systems.

Electrode

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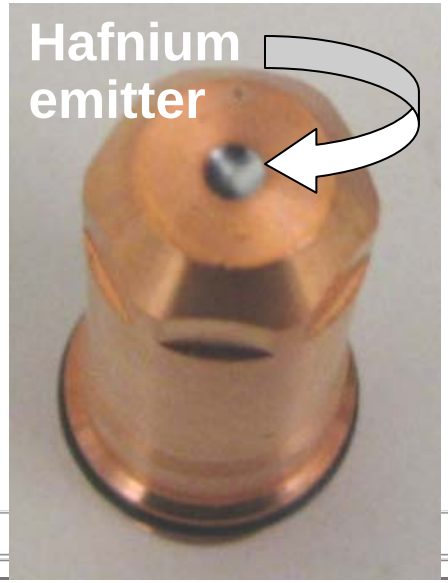
Electrode: Critical Features

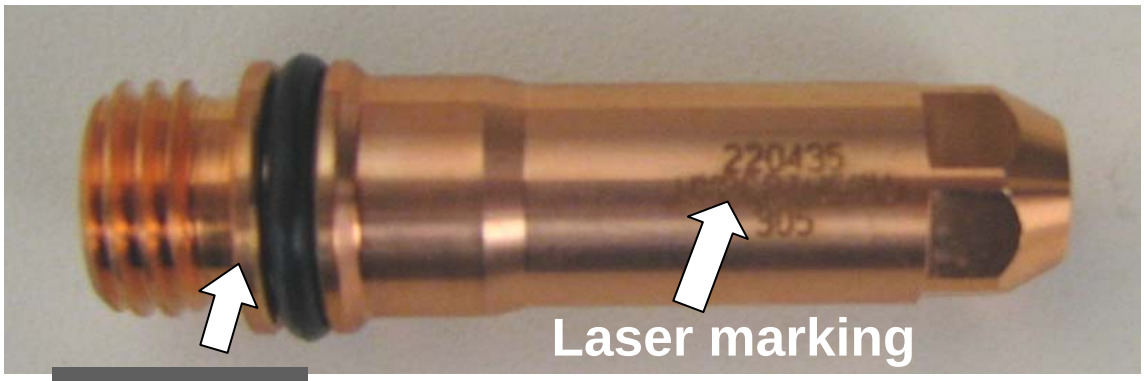
- Hafnium emitter is the single most important part.
- Since hafnium is a poor thermal conductor, it is bonded to the copper body of the electrode using a proprietary process that ensures an excellent thermal and electrical connection
- Hypertherm electrodes use a patented process that matches the diameter of the hafnium emitter to the power level it is designed for, ensuring the most efficient heat transfer.



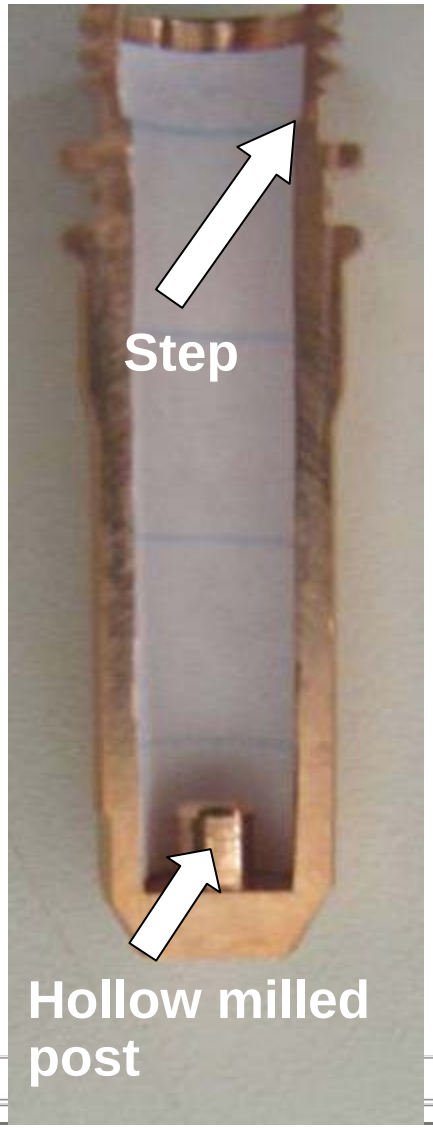
- Dimensional stability is very important to ensure cut quality is repeatable, and electrode fits up well to the other internal torch components.
- Incorrect length or diameter will affect alignment and impact cut quality.

Electrode: Critical Features

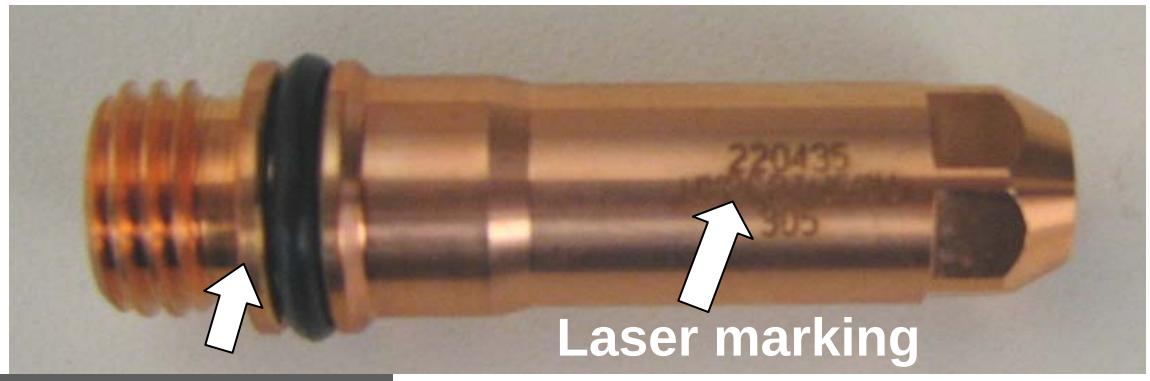
- Internal to the electrode is a very accurately machined bore and step.
- Step insures superior cooling as a result of perfect alignment of the coolant tube to the hollow milled post in the electrode bottom
- Alignment provides for a very concentric coolant flow around the high temperature hafnium emitter.



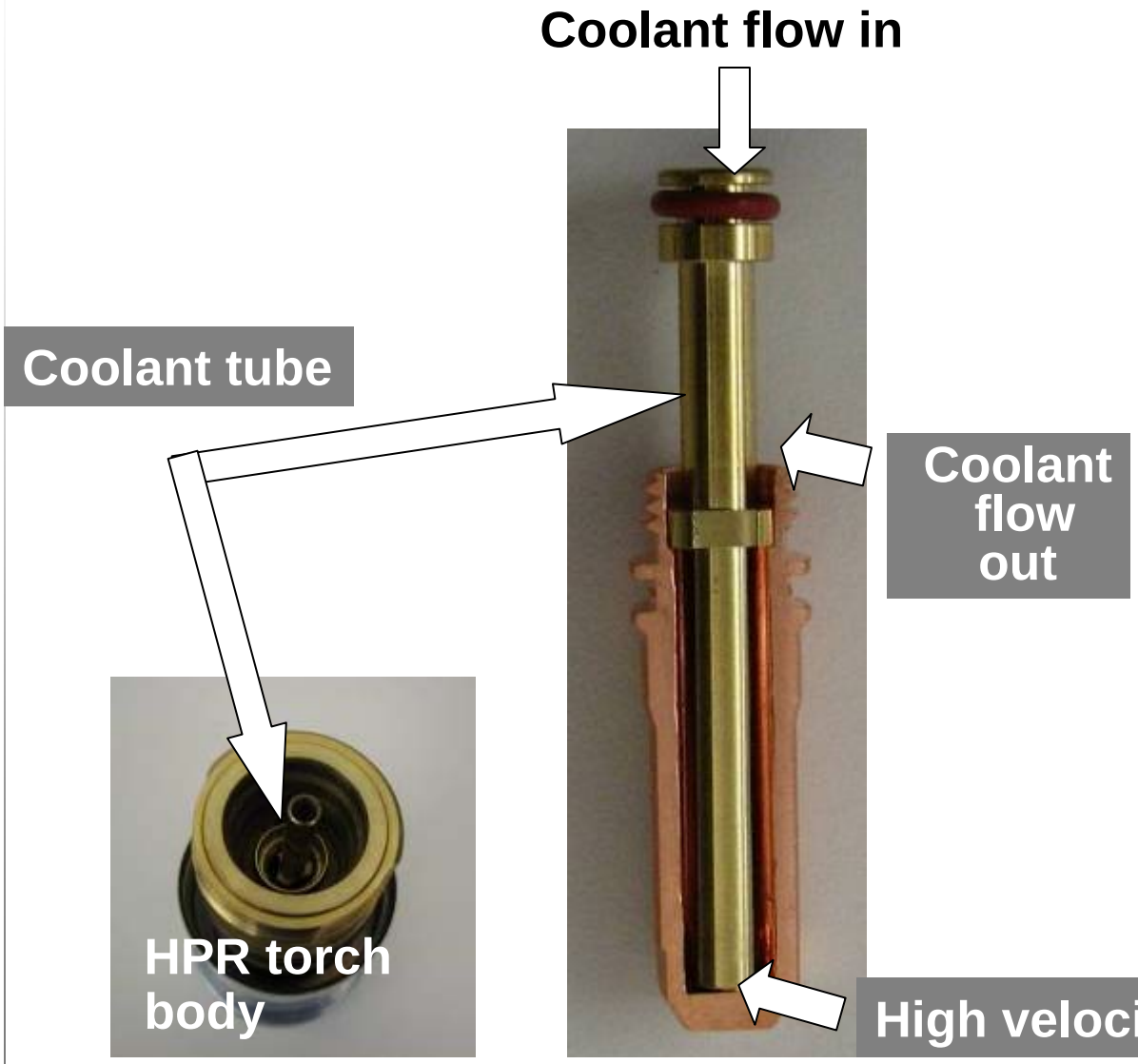
Electrode: Critical Features



- All Hypertherm electrodes have a laser etched part number and a batch code clearly marked to ensure proper part matchup
- Threads and locating shoulder are designed to ensure perfect concentricity with nozzle and swirl ring when installed in torch.

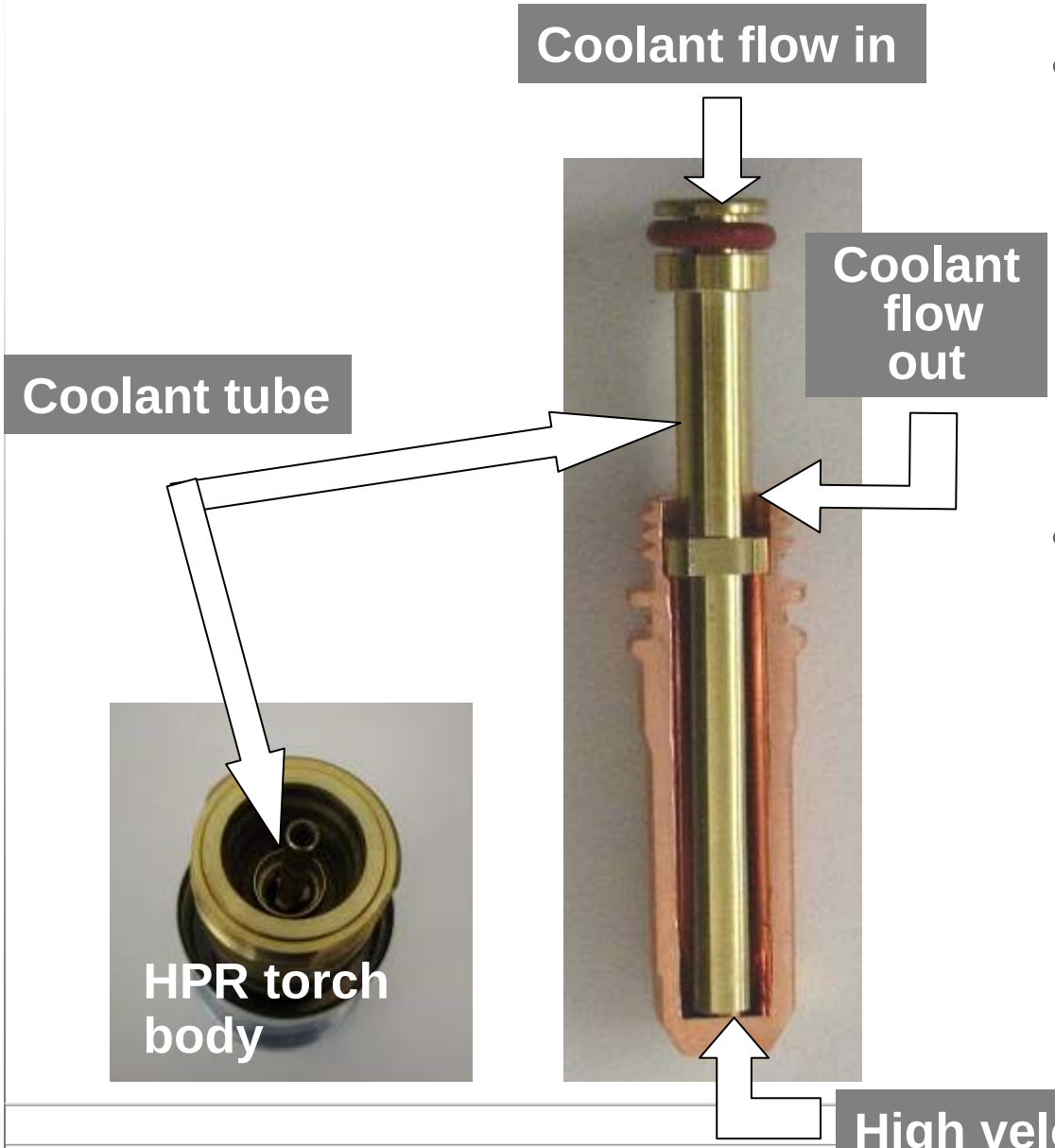


Electrode: Critical Features



- Key feature of both the electrode and torch design is a floating coolant tube.
- Tube is loosely installed in the torch and when the electrode is installed the coolant tube self aligns and positions itself to the internal features of electrode.

Electrode: Critical Features



- Coolant enters top of tube at relatively high pressure and is forced through a tight fit around the hollow mill of the electrode.
- Squeeze increases coolant velocity, effectively causing the coolant to strip away steam buildup around the hot hafnium, for very efficient heat removal

Electrode

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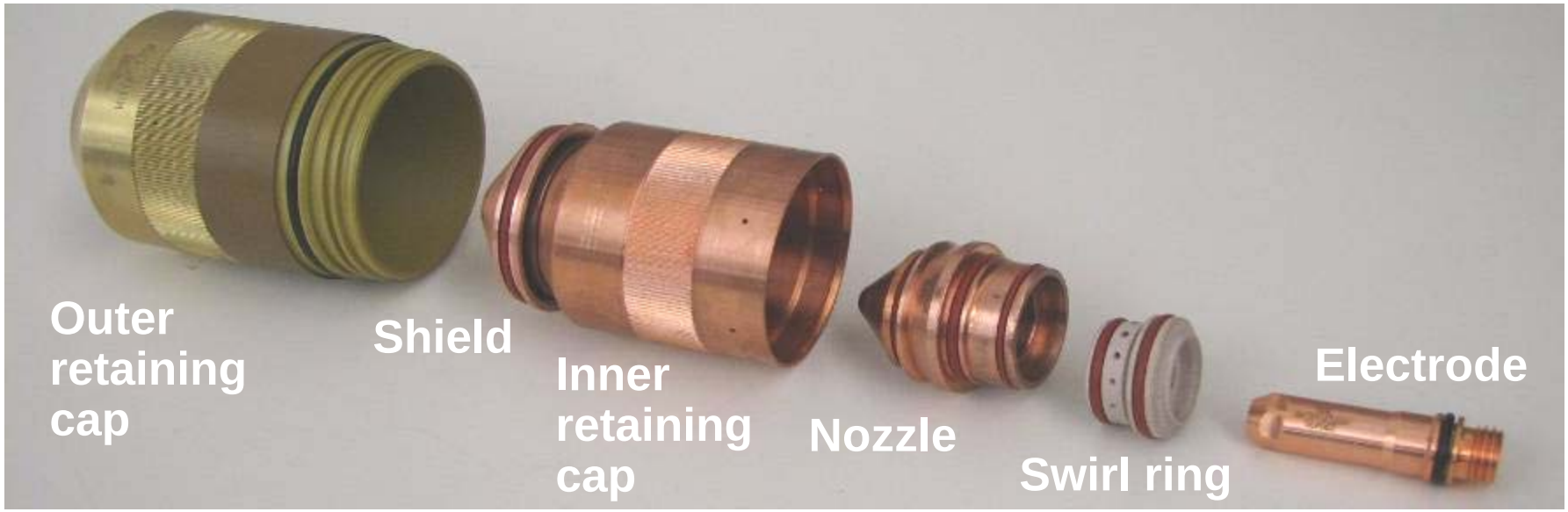
Electrode: What Can Go Wrong

- Incorrect match-up with other consumable parts.
- Most common issue with poor performance in terms of cut quality, cut speed or life of a plasma cutting electrode.
- Each different cutting process is clearly outlined in the HPR operators manual, and the proper mix of consumable parts are pictured and listed in the manual and on the operators station monitor if the system is equipped with the automatic gas feature.

Electrode: What Can Go Wrong

- Use only parts suggested by the operators manual to work together
- Any substitutions will cause cut quality and consumable life problems, and could cause damage to the torch.



Electrode: What Can Go Wrong

Gas delivery system leaks or restrictions

- Even a minor leak in the HPR gas system, a loose hose fitting or a split or kinked hose will cause both cut quality and consumable life issues
- HPR gas control is designed to supply gases to the torch at very accurate pressures and flows
- Changes to the design pressures and flows will cause the plasma arc characteristics to change
- Inlet pressure for plasma and shield gases should be checked daily
- Compressed air (when it is supplied from a local compressor) must be clean, dry and oil free

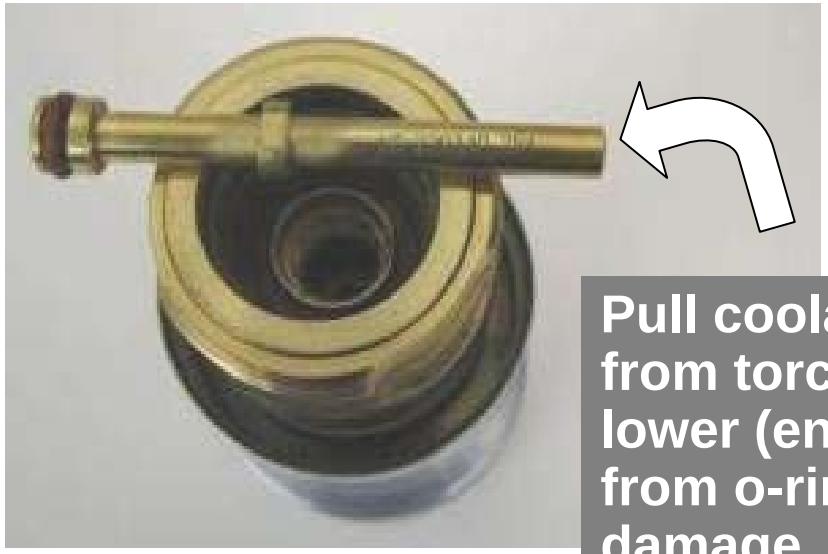
Electrode: What Can Go Wrong

- Electrode (and other consumable parts) should be handled with relatively clean hands. Electrodes that are dirty or greasy when installed in the plasma torch can cause stray electrical tracking that eventually can lead to torch failure.
- Do not over-tighten the electrode: it has an o-ring seal. The electrode is installed properly when you feel the locating shoulder bottom in the torch…excessive tightening is not necessary…and can cause tolerance issues within the torch.

Electrode: What Can Go Wrong

- Inspect end of coolant tube, especially if a catastrophic electrode failure took place
- Look for nicks or notches (end should be very concentric)
- If damaged, replace tube (a damaged coolant tube will cause short life from uneven coolant flow around hollow milled post)

Nick or burn in edge



Pull coolant tube from torch. Inspect lower (end away from o-ring) end for damage, replace if necessary.

Electrode

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Electrode: Measuring Wear

- Normal wear is observed by looking at the hafnium emitter.
- New electrode will have a dimple machined in the hafnium.
- Done to force the arc attachment point to a dead center position on the emitter to provide more consistent cut quality.

- The partially used electrode on the right has a pit that is .023” deeper than the new one.
- Pit due to evaporation of the hafnium during starting and steady state cutting.

Electrode: Measuring Wear

There are quite a few factors that can affect the life of an electrode. This particular electrode is being used in a laboratory life evaluation.

- The electrode cuts continuously for 15 minutes, then stops, re-pierces, and cuts again for 15 minutes.
- Currently, there are 34 of these 15 minute cycles on the electrode shown here, which equals 8.5 hours of arc on time, and about 6800 linear feet of ½” steel cut!
- Electrode is approximately ½ consumed.

Electrode: Measuring Wear

The standard oxygen electrode as used in the HPR plasma systems should be changed when the pit depth (as compared to a new electrode) has reached around .040”.

Electrode: Measuring Wear

Main reasons for changing when the pit reaches this depth:

1. Cut quality changes take place (dross and angularity)
2. Somewhere between .045” and .050” there will be catastrophic electrode failure. This failure will damage the nozzle and the shield and possibly the coolant tube.

Electrode: Measuring Wear

- This set was used in a test until catastrophic failure.
- When electrode pit depth gets too deep the heat transfer properties start to fail and the electrode melts rapidly.
- The nozzle and the shield (which probably could have been re-used) also are destroyed.
- If the operator does not hit the stop button quickly, the electrode could melt the end of the cooling tube.

Test consisted of 20 second cut duration at 260 Amps. The failure occurred on the 914th cut cycle. This set had over 5 arc hours and the equivalent of over 4000 linear feet of ½ “ steel cut.

Electrode: Measuring Wear

Cutting machine operators generally learn to notice a change in cut quality, or a change in sound from the plasma system, indicating that there is something wrong with the consumables. Some operators will change just one consumable part; others change them all.

- Many plasma operators are under pressure to get the longest life out of their consumable part to lower operating costs.
- In most cases changing the electrode before it fails allows the nozzle and the shield to last longer effectively lowering operating costs while maintaining high cut quality levels.

Electrode: Measuring Wear

In some cases, companies decide to switch from the technically superior genuine Hypertherm parts to an aftermarket supplier that provides consumables at a discounted price. These consumables do not have the patented innovations that allow both long life and excellent cut quality throughout the useable life.

Electrode: Measuring Wear

- The best way to cut plasma cutting costs without also sacrificing quality and throughput is to fully utilize the consumable parts for the HPR plasma system.
- Learning to gauge electrode wear, which will determine the most cost effective time to change the electrode, will allow dramatically longer use of the other consumable parts, nozzle, swirl ring, and shield.

Electrode pit depth can be measured accurately with a dial indicator.

Electrode: Measuring Wear

- First, use a new electrode with the same part number as the partially used electrode that you need to measure.
- Electrodes with different part numbers appear very similar, but have a different overall length.

Electrode: Measuring Wear

- Center the pointed tip of the indicator in the center of the dimple of the hafnium emitter. Adjust the indicator dial to “0”
- Now that the indicator is zeroed to a new electrode, perform the same measurement with the partially used electrode.

Electrode: Measuring Wear

The used electrode shown here has .023” wear as compared to a new electrode with the same part number. Expect the electrode to continue cutting with good quality until .040” wear.

New electrode
Indicator at 0

Used electrode
Indicator at .023”

Electrode: Measuring Wear

- A new electrode wears rapidly for the first 10% (approx.) of it's life and also wears rapidly for the last 10%.
- In the middle, electrode wear is slow and predictable.
- Longer cuts = less overall expected starts per electrode.
- .020" to .025" is approximately half the expected life (end of life is .040").

Electrode: Measuring Wear

Hypertherm

Observations

- It is common to have a black swirl mark (or multiple marks) that start at the hex and swirl around the perimeter of the electrode toward the emitter.
- Usually caused by some coolant or dirt that was left inside the torch during a change of consumables.

Electrode: Measuring Wear

- If the black swirl marks are very prominent and occur on all electrodes and are etched into the copper electrode body then it could indicate that the torch is very dirty or that there is an internal coolant leak in the torch. It could also indicate badly contaminated plasma gas.

Electrode: Measuring Wear

- Copper body should remain clean and shiny even at end of life. Signs of grayish heat discoloration could indicate a cooling issue within torch.
- When inspecting a used electrode, carefully view the relation of the pit in the hafnium. It should be perfectly centered. An off center pit indicates a gas flow issue that may be related to an incorrect or damaged swirl ring or incorrect gas pressure (flow) settings.
- Always inspect the integrity of the o-ring

Electrode

- Function
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Electrode: Getting the Best Life

Hypertherm

Ramp down errors

- HPR systems utilize a patented end of cut ramp down process that coordinates gas and current levels as the torch ends each cut cycle.
- Process serves to re-solidify the hafnium emitter and dramatically increase life.
- For successful ramp down, plasma arc must remain attached to work piece.

Electrode: Getting the Best Life

- As an example, when small holes are cut and the part is programmed with a lead out at the end of the hole, often the slug will drop down into the cutting table before the plasma arc completes its ramp down.
- This is detrimental to electrode life, and it is highly recommended that holes are programmed with no lead out to minimize this issue.

Electrode: Getting the Best Life

- It is acceptable to have up to 10% of starts with ramp down errors without a large affect on life.
- Always use electrodes with current (Amps) and gas settings at exactly the recommended book settings for the material you are cutting.
- Increasing the current or using different gas settings will affect the life of the electrode.
- Always use the electrode in the correct combination with other consumables, as listed in the operators manual.
- Mixing part numbers will affect life.

Nozzle

- Function
- Critical features
- What can go wrong
- Evaluating wear
- How to get the best life

Nozzle: Function

- The HPR plasma nozzle is a very complex design that has to deal with the physics of high temperature gas flows, and still last for a reasonable time under very high temperature conditions.
- Primary function is to constrict a very high temperature plasma gas so it increases energy density and velocity and provides excellent cut quality.
- The nozzle also becomes part of the electrical process that ionizes the plasma gas before the actual cutting arc starts.
- As plasma cutting goes, the HPR nozzles are very unique due to a patented, vented two piece design: an engineering masterpiece that provides for HyDefinition class cut quality with extremely long life.

Nozzle: Function

When you think about the temperature of the HPR plasma arc that exits through the orifice of this nozzle you may wonder how an approximately 25,000 degrees F electrically energized arc can exit through this copper nozzle without instantly melting it!

Nozzle: Function

- Nozzle design utilizes proprietary gas swirl techniques to create a centrifugal effect that effectively creates a cool layer of un-ionized gas between the arc and copper nozzle to increase useable life.
- Uses a double constriction two piece design that increases energy density, releases some gas pressure to atmosphere, and increases the energy density again to up to 4 times the density of conventional plasma.
- Most of these features were invented and patented at Hypertherm and are not available on aftermarket nozzles.

Nozzle

- Function
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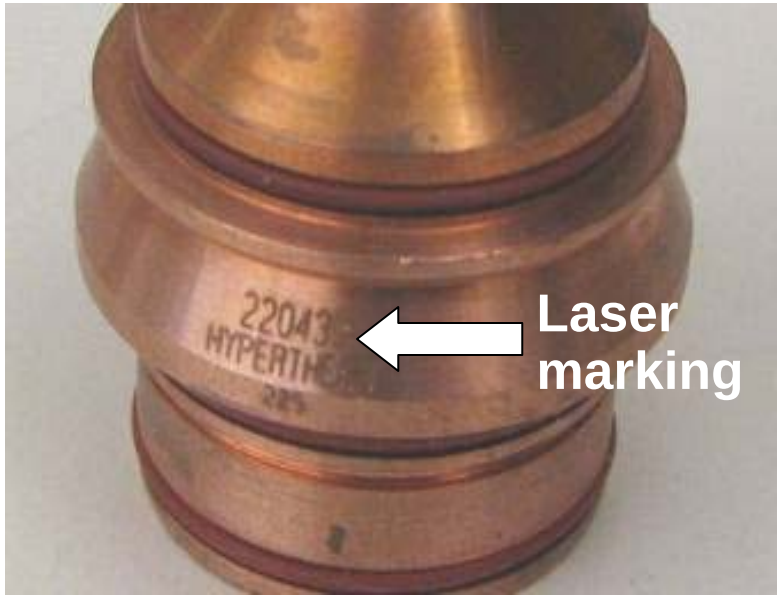
Nozzle: Critical Features

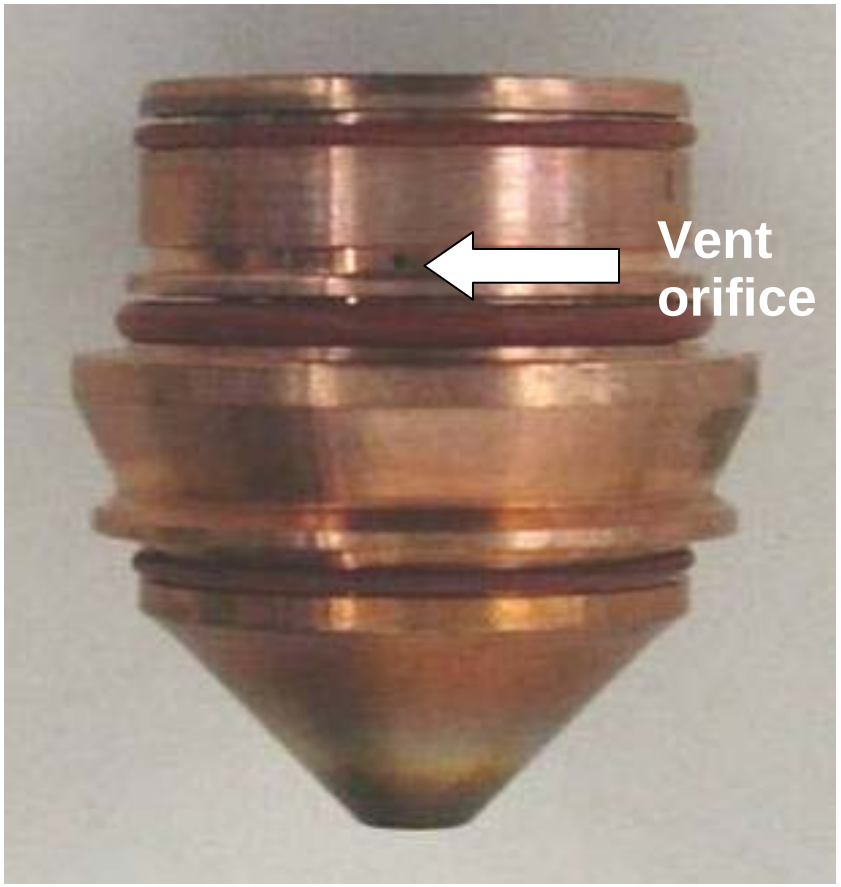
The HPR oxygen nozzle has a variety of integrated features that separate it from other plasma cutting systems; all are designed to promote cut quality and increase nozzle life simultaneously.

- Floating alignment between nozzle, swirl ring and electrode assures accurate concentricity improving repeatability.
- Vented design offers HyDefinition cut quality throughout the power range without sacrificing life as other systems do.
- Superior cooling features to further increase life.
- Each nozzle clearly marked with part number and batch code.

Nozzle: Critical Features

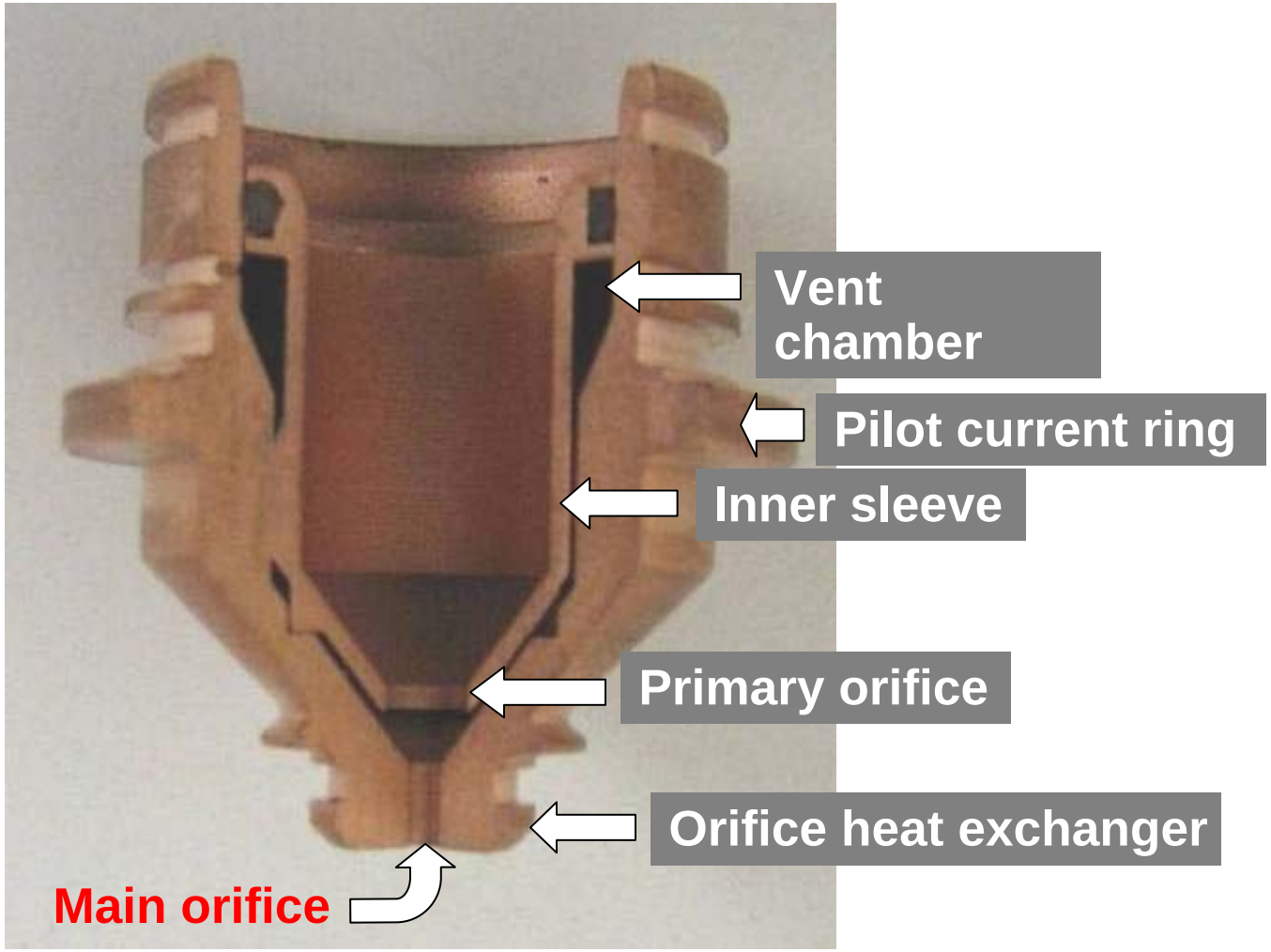


260 Amp Nozzle

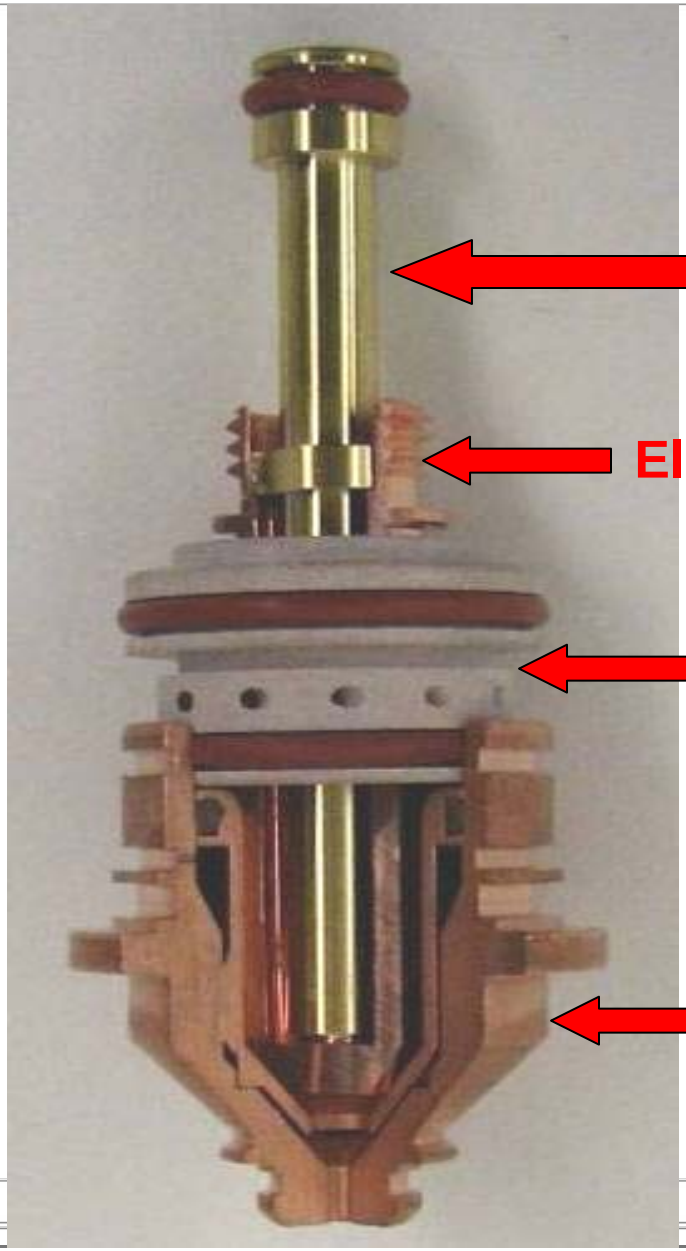


Nozzle: Critical Features

130 Amp Nozzle



Nozzle: Critical Features



- Consumable parts alignment is critical to achieve consistent cut quality.
- HPR consumables are manufactured to strict tolerances following CTF (critical to function) quality monitoring procedures.
- Only part numbers designed to work together (as suggested in the operators manual) will produce the best results.

Nozzle

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Nozzle: What Can Go Wrong

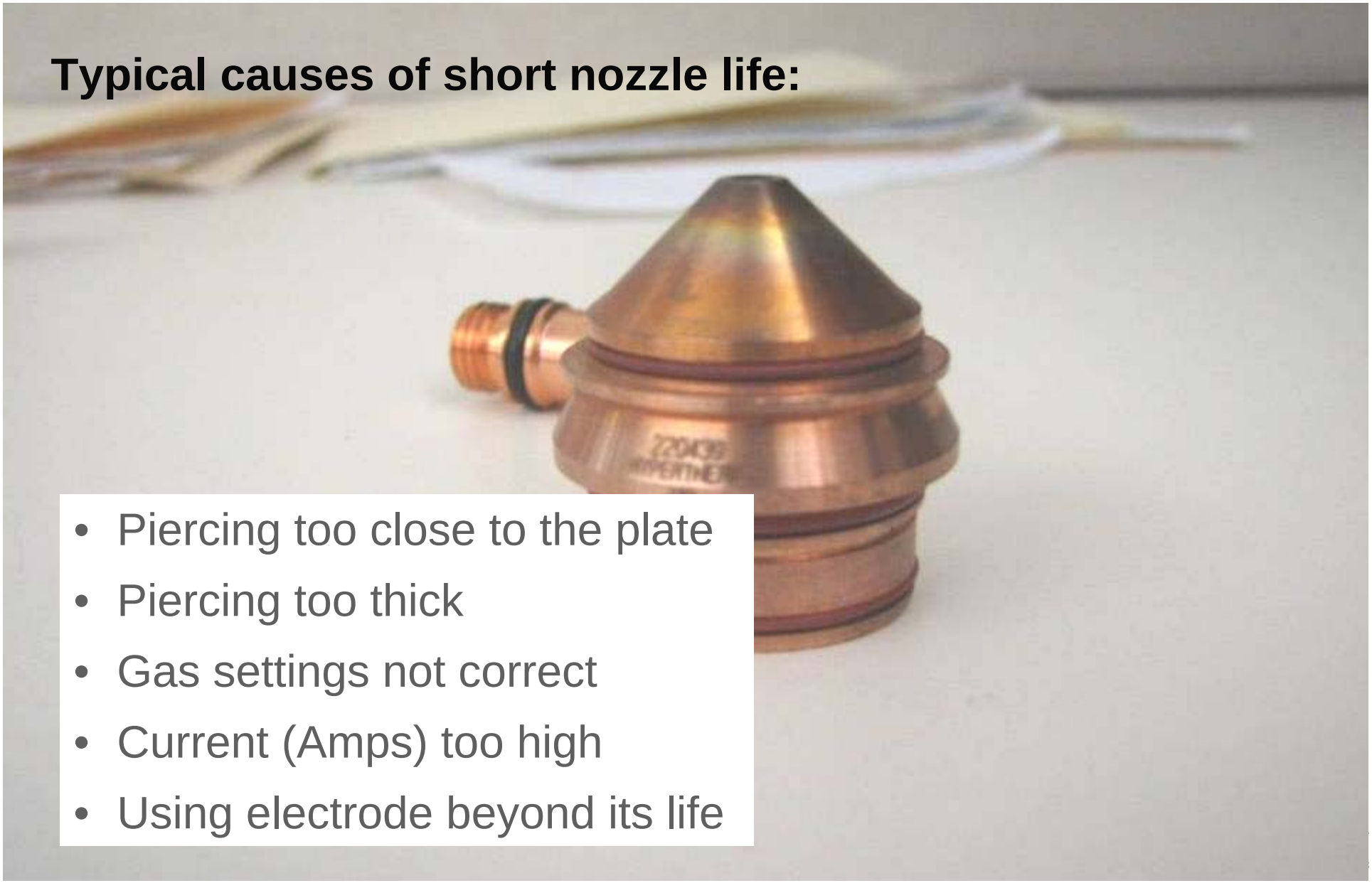
- Incorrect match-up with other consumable parts is the most common issue with poor performance in terms of cut quality, cut speed, and nozzle life.
- Each different cutting process and the proper mix of consumable parts is clearly outlined in the HPR operators manual.

Nozzle: What Can Go Wrong

- Any substitutions will cause cut quality and or consumable life problems, and could cause damage to the torch.

Nozzle: What Can Go Wrong

Hypertherm



Typical causes of short nozzle life:

- Piercing too close to the plate
- Piercing too thick
- Gas settings not correct
- Current (Amps) too high
- Using electrode beyond its life

Nozzle

- Function
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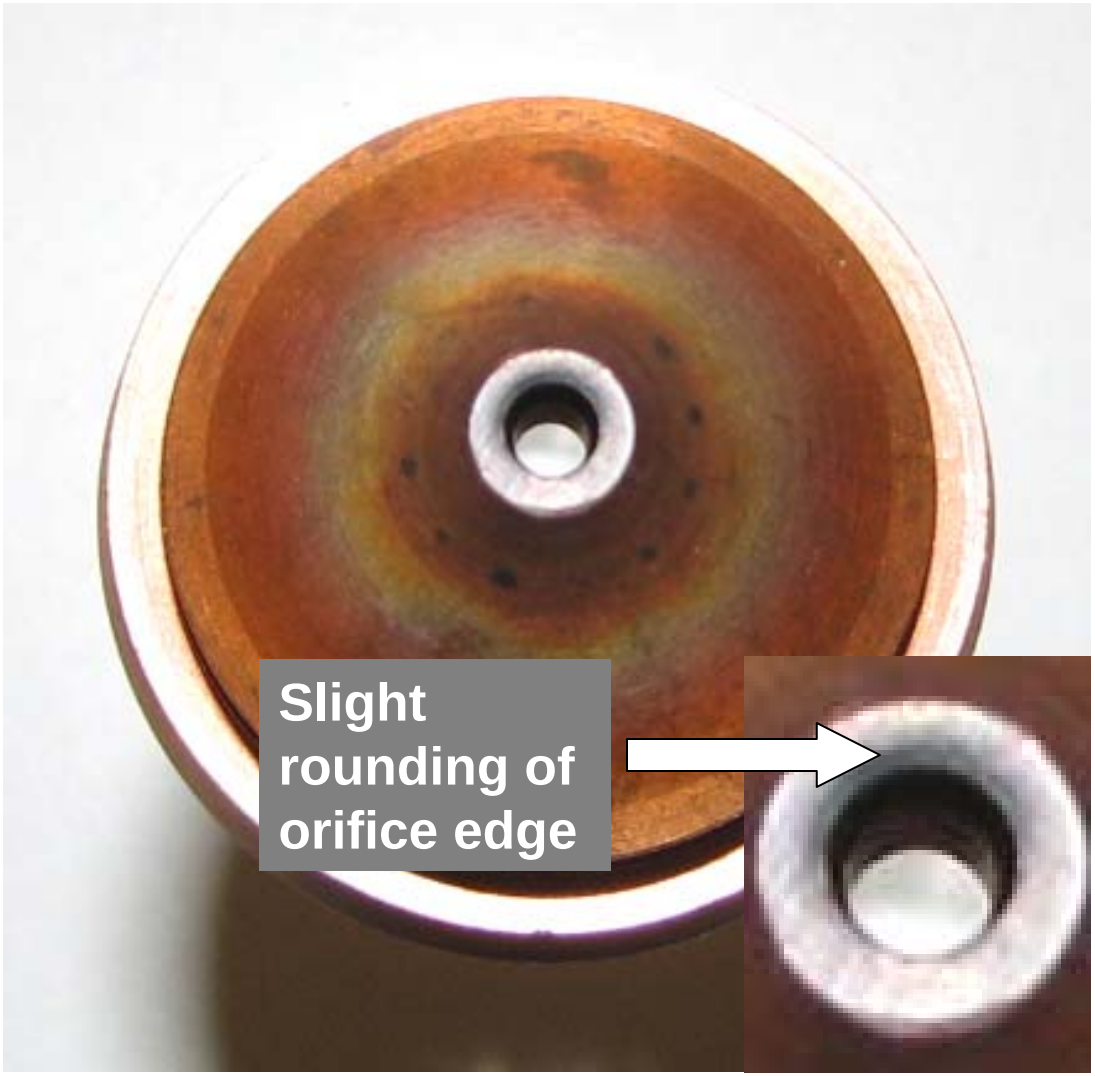
Nozzle: Evaluating Wear

- When inspecting a plasma cutting nozzle the focus should be on the orifice shape on the outside and inside.
- On the outside, ensure that the orifice bore is perfectly round with no nicks.
- A new nozzle will have very sharp edges on the orifice.
- After some wear the orifice edges will start to get rounded eventually affecting cut quality.
- A jewelers eye loupe or a microscope may be necessary to view the orifice for defects.

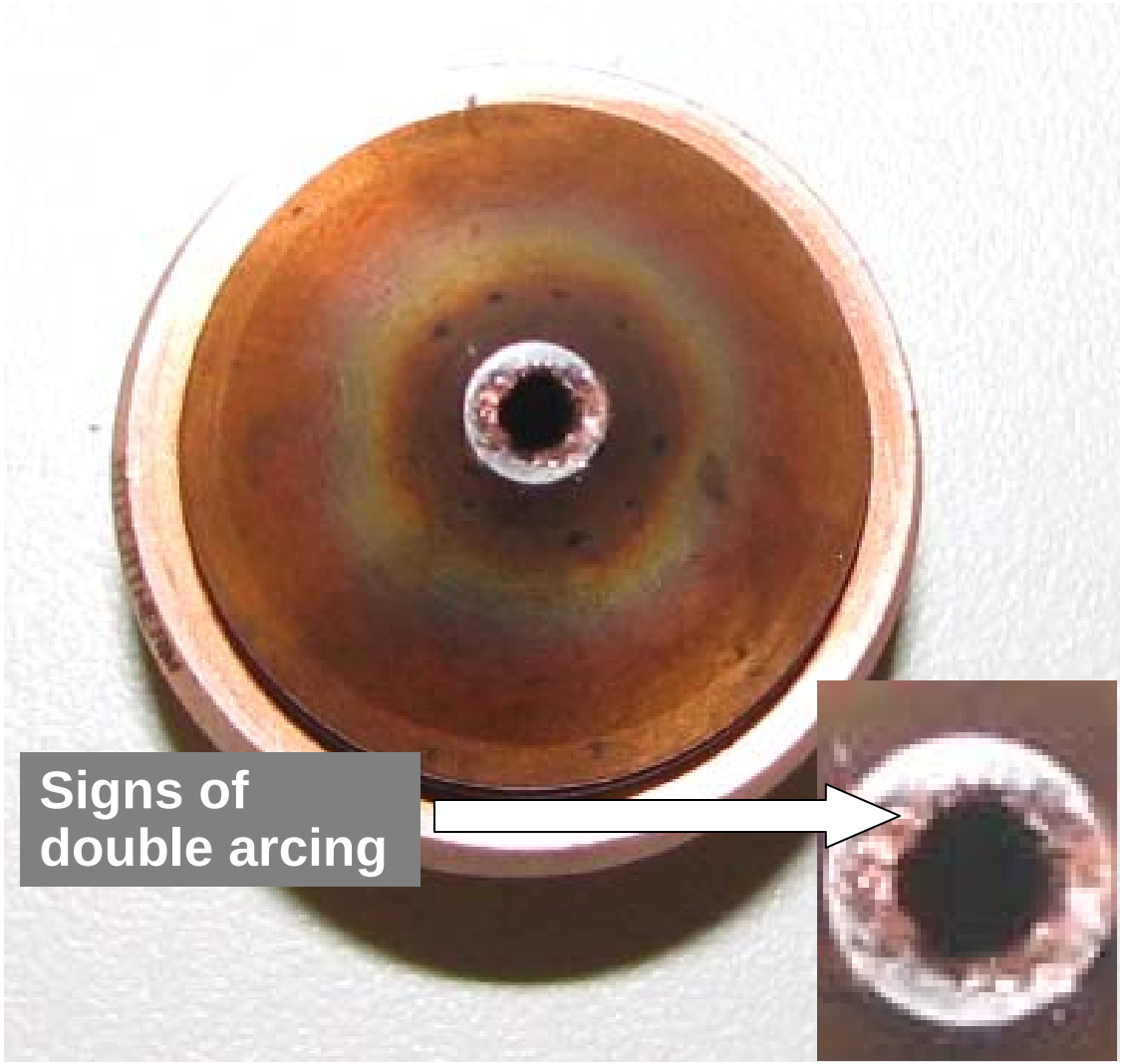
Nozzle: Evaluating Wear

- This is normal wear, but as this rounding gets worse, cut quality will be affected.
- Orifice has no nicks, appears round.



Nozzle: Evaluating Wear

This nozzle will no longer produce good cut quality.



Nozzle: Evaluating Wear

Hypertherm

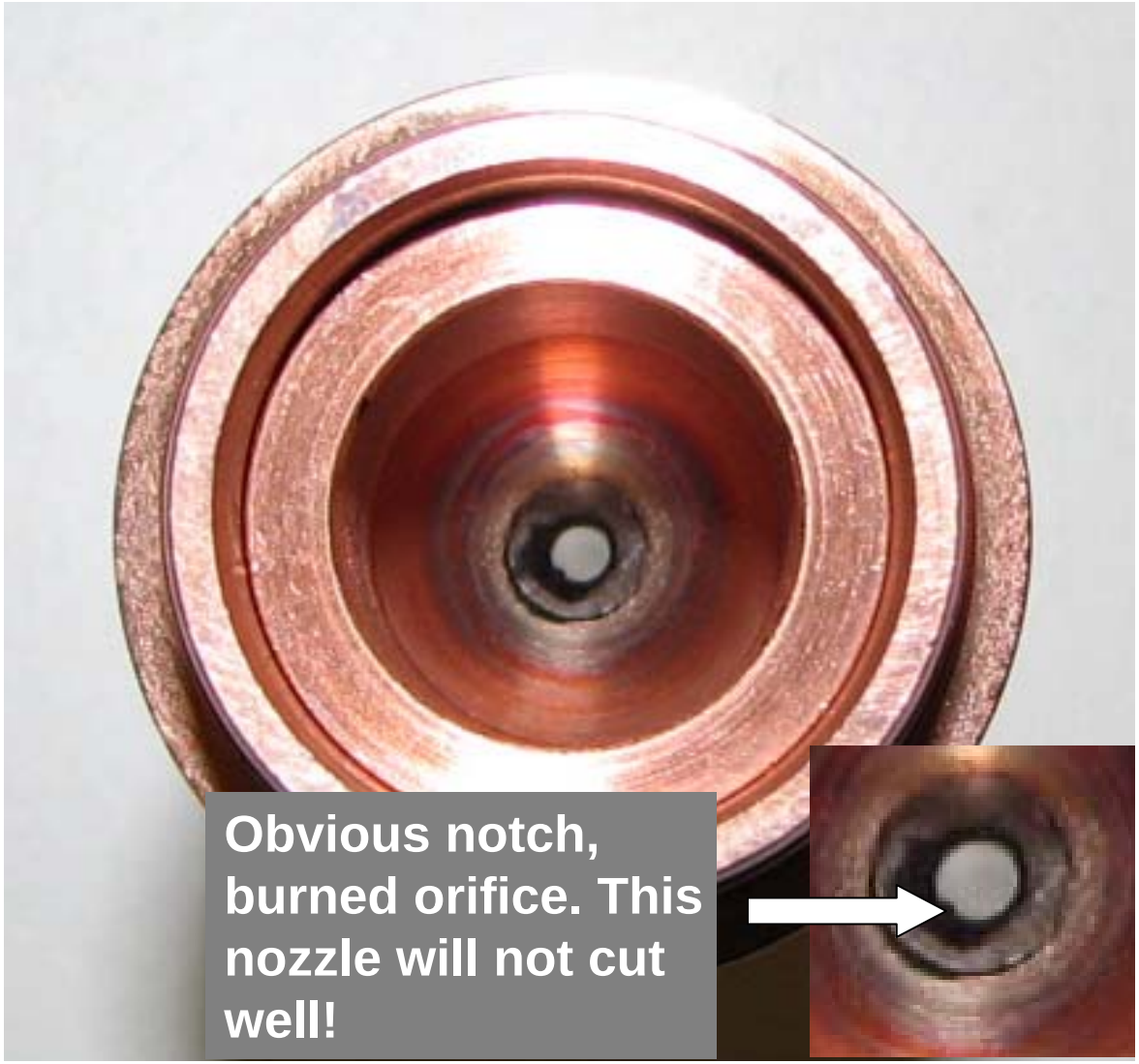
Inner bore of the nozzle is equally important

- Look for perfectly round orifice with no nicks or heavy arc marks
- Normal to have a white or grayish residue in the bore and some black or gray swirl marks
- The white material is hafnium oxide and can easily be cleaned out with a pencil eraser

Nozzle: Evaluating Wear

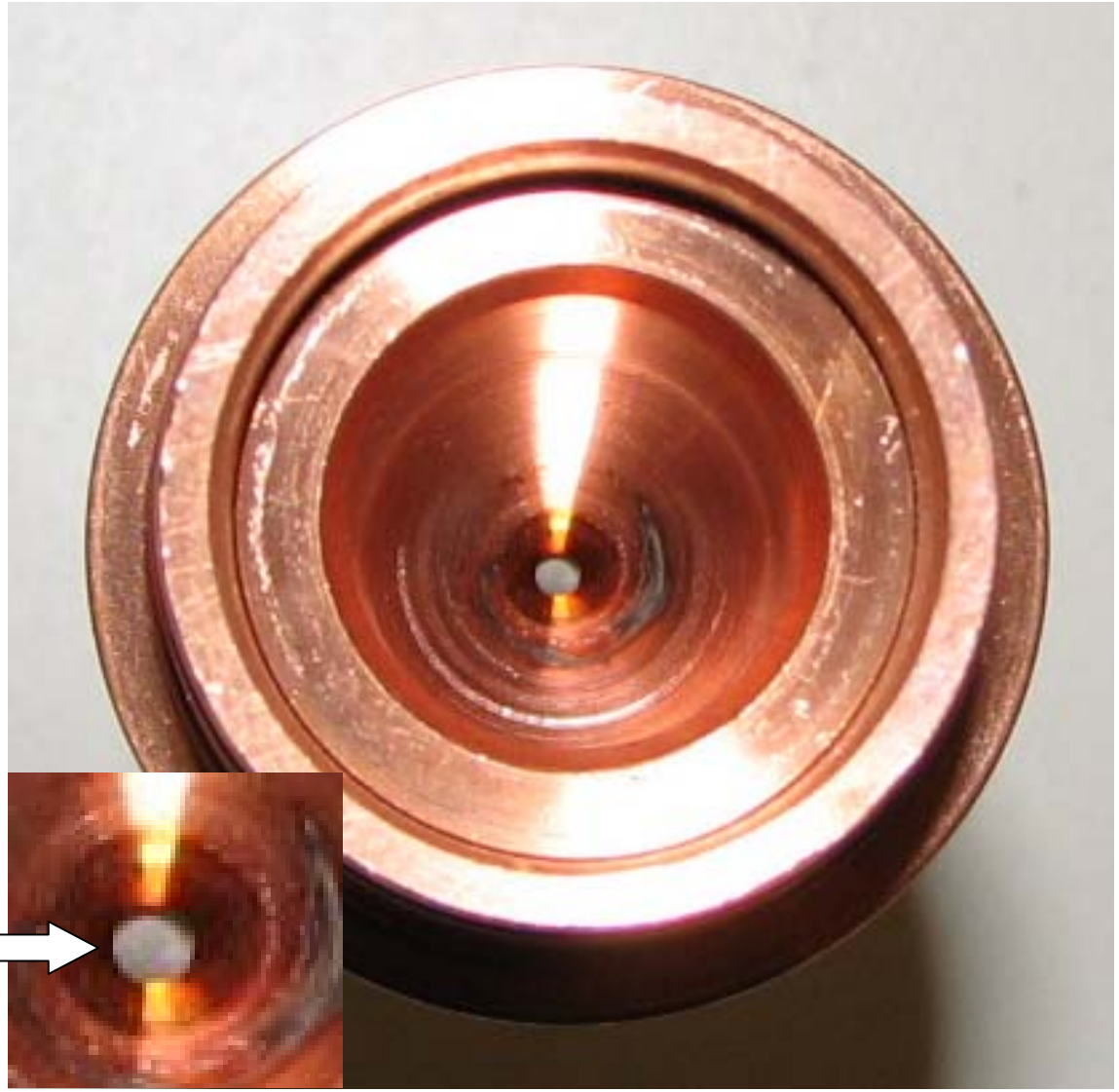
- The black or gray swirls are carbon tracks formed during the start of the arc, usually from some drops of coolant from the last consumable change
- Do not scratch the inner bore of the nozzle with a sharp tool, or attempt to clean the orifice with a tip cleaner. This will affect performance

Nozzle: Evaluating Wear



Nozzle: Evaluating Wear

Hypertherm



Normal re-useable orifice. Notice the white flecks of hafnium oxide and the grayish swirl marks

Nozzle

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Nozzle: Getting the Best Life

- Look at the operator's manual!
- Piercing at the recommended height is imperative. One pierce too close to the plate will damage the nozzle.
- Pierce delay time is important. This function allows the pierce to be completely through the workpiece before machine motion starts, and before the pierce gas settings change to cut settings.
- If done correctly, the blowback from piercing does not affect the life of the nozzle.
- Never operate the current (Amps) at a higher setting than the nozzle is designed for. A 130 Amp nozzle should never be used above 130 Amps.

Nozzle: Getting the Best Life

- Always set the gas flows at the specifications suggested in the manual (unless an authorized Hypertherm tech service engineer has suggested alternative settings for your application). Improper gas flow, especially plasma gas will damage the nozzle orifice.
- Never fire the torch in the air. This causes overheating of the front of the nozzle orifice, dramatically affecting life and performance.
- Installing clean consumables with clean hands in a clean torch body will improve longevity!

Nozzle: Getting the Best Life

- The 260 Amp nozzle and electrode shown here have cut the equivalent of more than 6800 linear feet of ½” steel.
- Nozzle has minimal orifice rounding and electrode has a pit depth of .023”.

- This set, is about ½ consumed, but will still produce excellent cut quality.

Often, a nozzle will last longer than an electrode if the electrode is changed before it fails. Keeping close track of electrode life and changing it before failure can lower your nozzle usage, and overall consumable costs.

Swirl Ring

- Function
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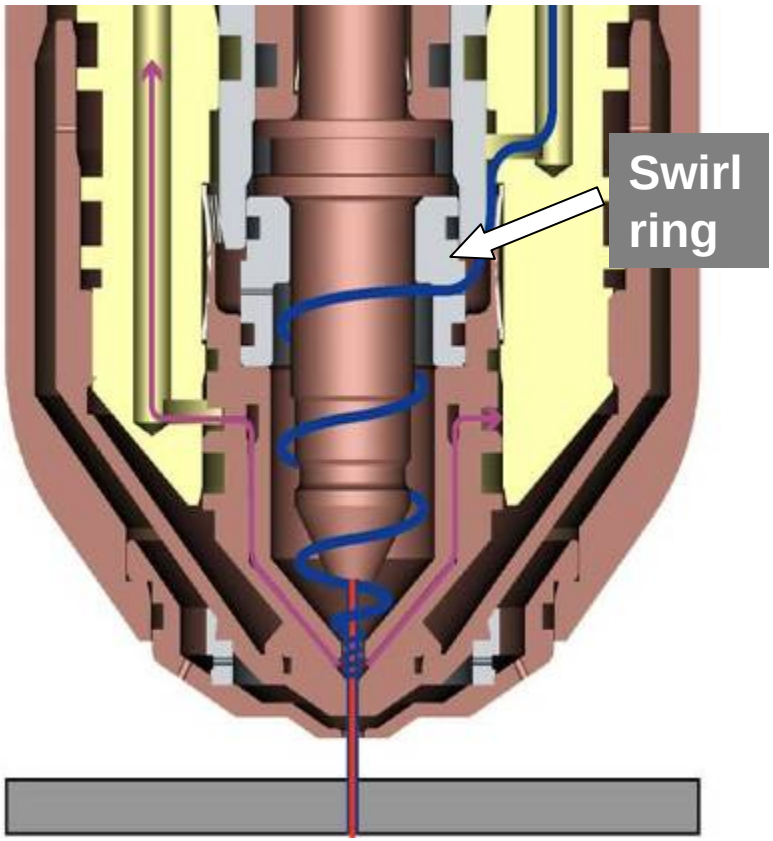
Swirl Ring: Function

Primary function: control and swirl the plasma gas flow around the electrode and into the nozzle in order to:

1. Control the arc attachment point on the electrode emitter,
2. Control gas flow through nozzle orifice in a way that improves edge angularity
3. Create a centrifugal effect that slings heavier, unionized gas molecules to the edges of the nozzle orifice, effectively increasing nozzle life.

Secondarily, but just as important, the swirl ring ensures the alignment between the nozzle orifice and the electrode emitter, and electrically insulates the negatively charged electrode from the positive nozzle.

Swirl Ring: Function



- Meters and swirls the plasma gas around the electrode
- Positions electrode and nozzle to near perfect concentricity
- Controls the arc attachment point on the electrode emitter
- Using centrifugal force, improves nozzle life by slinging cooler gas particles to the outer wall of the nozzle orifice.
- Electrically insulates the nozzle from the electrode

Swirl Ring

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Swirl Ring: Critical Features

- Made from volcanic lava; precision machined and baked for durability
- Material used due to it's electrical insulating properties and ability to withstand heat
- Critical features include precision orifices, dimensional stability and o-ring seals (particularly inside o-ring).
- Different swirl ring for every different process and power level so laser marking of high importance for ID purposes.

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Swirl Ring: What Can Go Wrong?

Swirl rings are fairly fragile!

Be careful when inserting and removing from torch.

Swirl Ring: What Can Go Wrong

The most common swirl ring related problem is when a customer uses the incorrect part number swirl ring.

Do not substitute swirl rings!

All HPR swirl rings are similar in appearance but the critical dimensions and number, size, and angularity of the orifices have subtle differences that make each process perform in terms of edge angularity, smoothness, dross formation and consumable life.

Swirl Ring: What Can Go Wrong

- Many aftermarket suppliers do not attempt to manufacture these parts as it is very difficult to hold accurate tolerances.
- Some companies manufacture swirl rings from composite or plastic materials. These swirl rings are not designed to work in a pure oxygen atmosphere inside the torch body.
- High temperatures and high voltage are also present
- If materials other than lava or ceramic are used for this part, be concerned with catastrophic torch failure due to rapid combustion in the oxygen environment!
- Materials other than lava should not be used when cutting with oxygen.

Swirl Ring

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Swirl Ring

- Inspect for cracks and chips that will affect gas flow
- Inspect all o-rings, especially inner one: look for cuts, flat spots, etc.
- Carefully inspect all metering and swirl holes for foreign material that could impede flow.
- Ensure that the swirl ring is not dirty or greasy.
- Swirl rings generally don’t wear out but are prone to breakage or plugging. With careful use and clean hands, a swirl ring can last for 50 electrode/nozzle changes!
- Use a very small amount of o-ring lubricant on a new swirl ring; just enough to be shiny on your fingers and be careful to only put it on the external o-rings!

Shield

- Function
- Critical features
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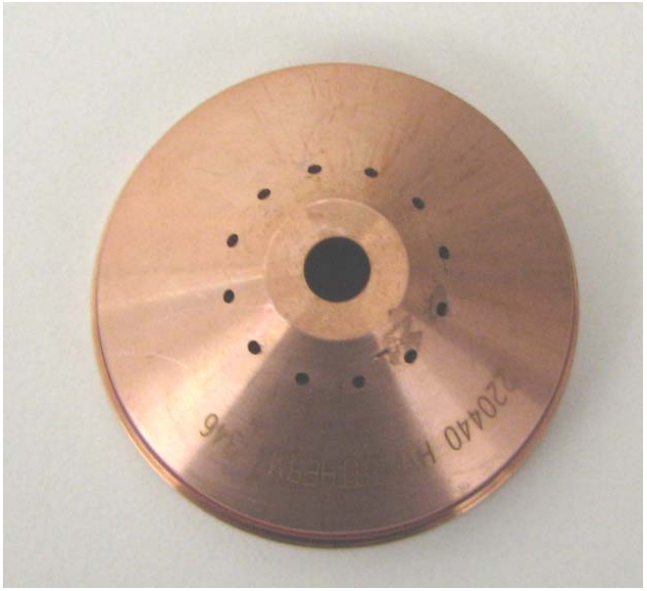
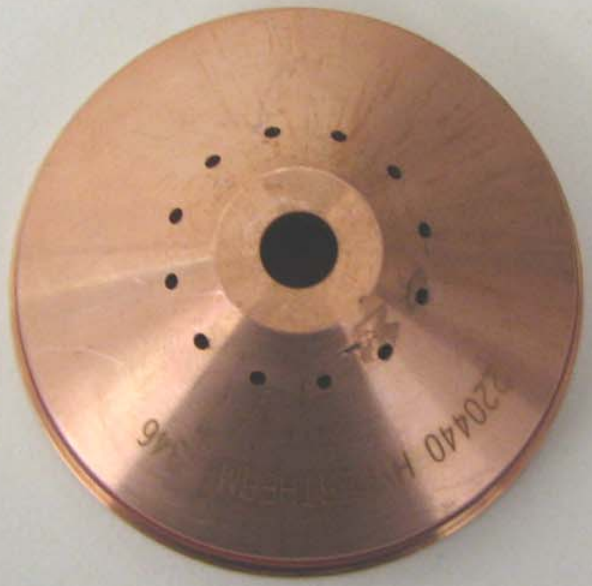
- Evaluating wear
- How to get the best life



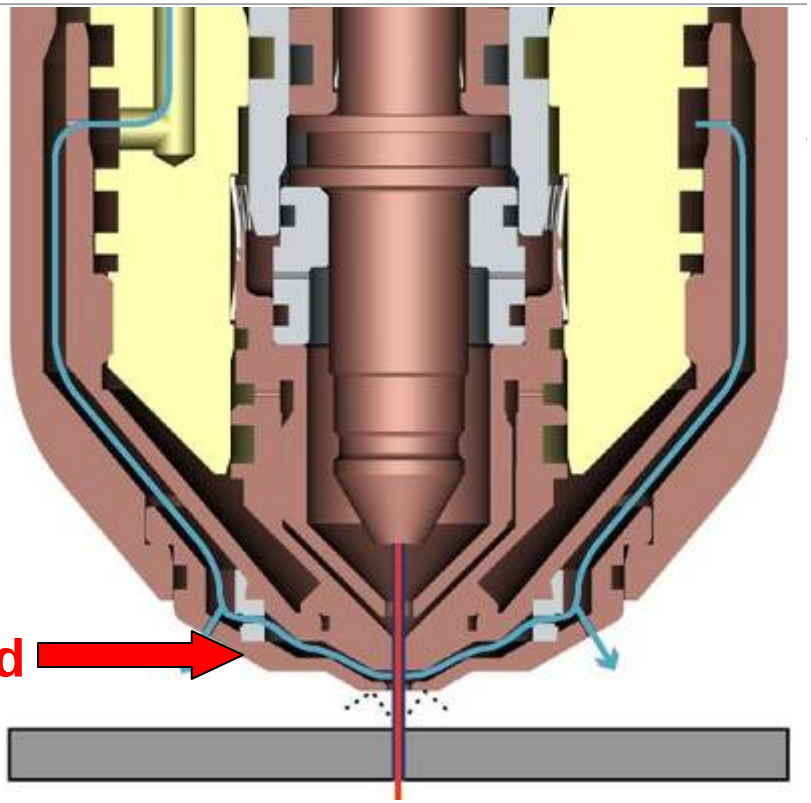
Shield: Function

Primary function: shield the nozzle from double arcing during piercing or in the event of contact during steady state cutting.



Secondarily, the shield helps to cool the nozzle and helps to control the edge squareness of the cut.

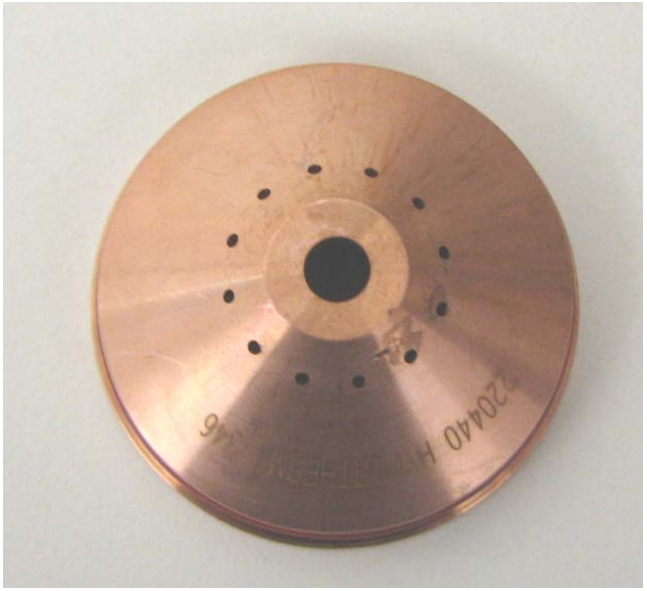
Shield: Function



- Works with inner cap to become double insulated from nozzle.
- Directs secondary gas flow to cool the nozzle and help control the arc, providing squarer cut edges.
- Improves piercing capability.

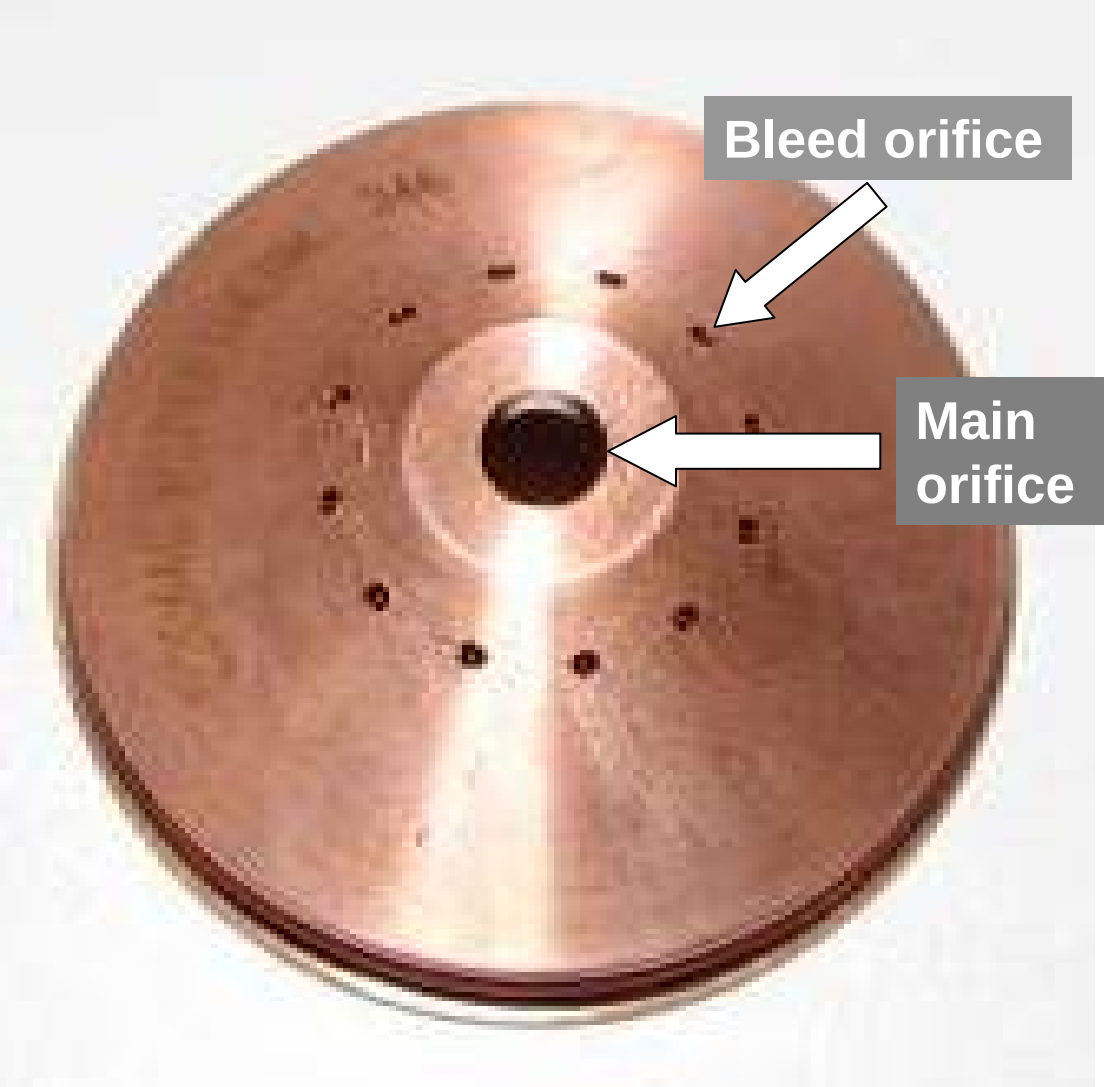
Shield

- Function
- Critical features
- What can go wrong
- Evaluating wear
- How to get the best life



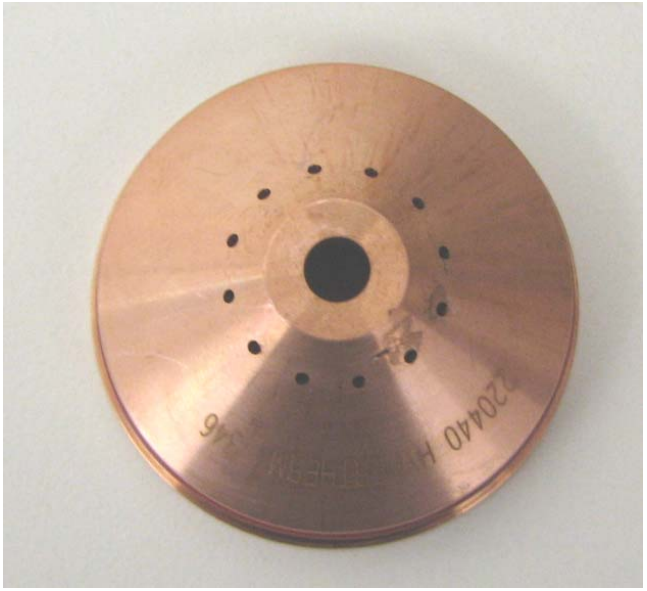
Shield: Critical Features

- The main orifice must be perfectly centered to the main orifice in the nozzle
- The bleed orifices are critical to control cut edge angularity
- Overall dimensions are held to tight tolerance bands



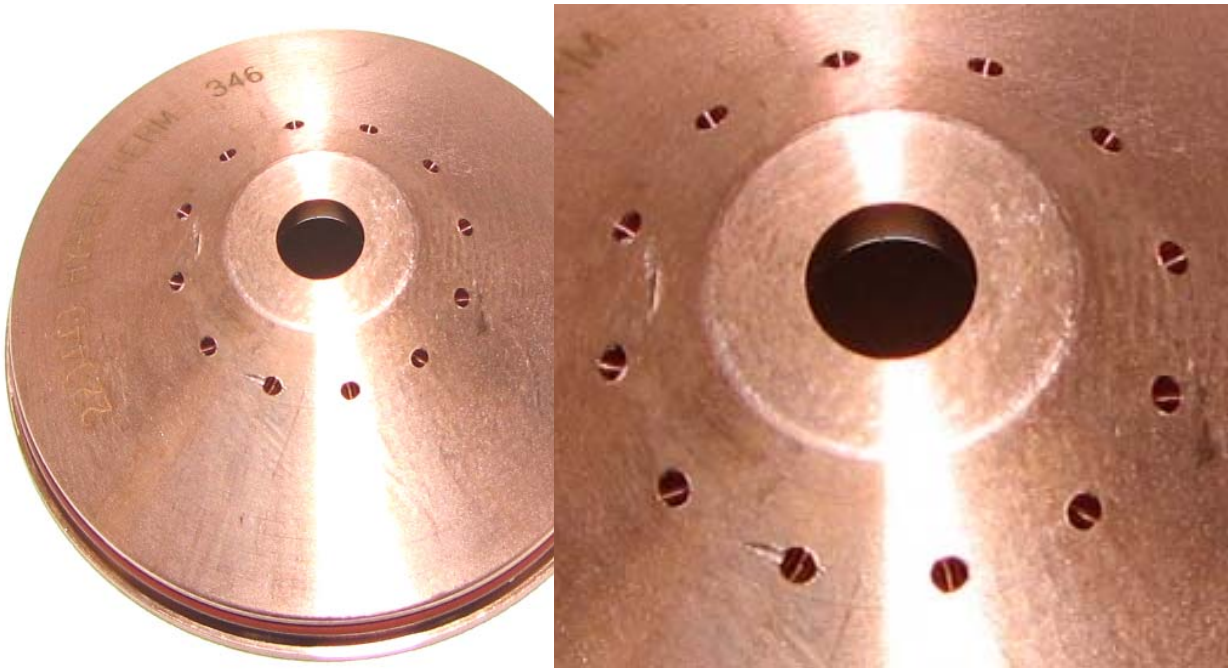
Shield

- Function
- Critical features
- What can go wrong
- Evaluating wear
- How to get the best life



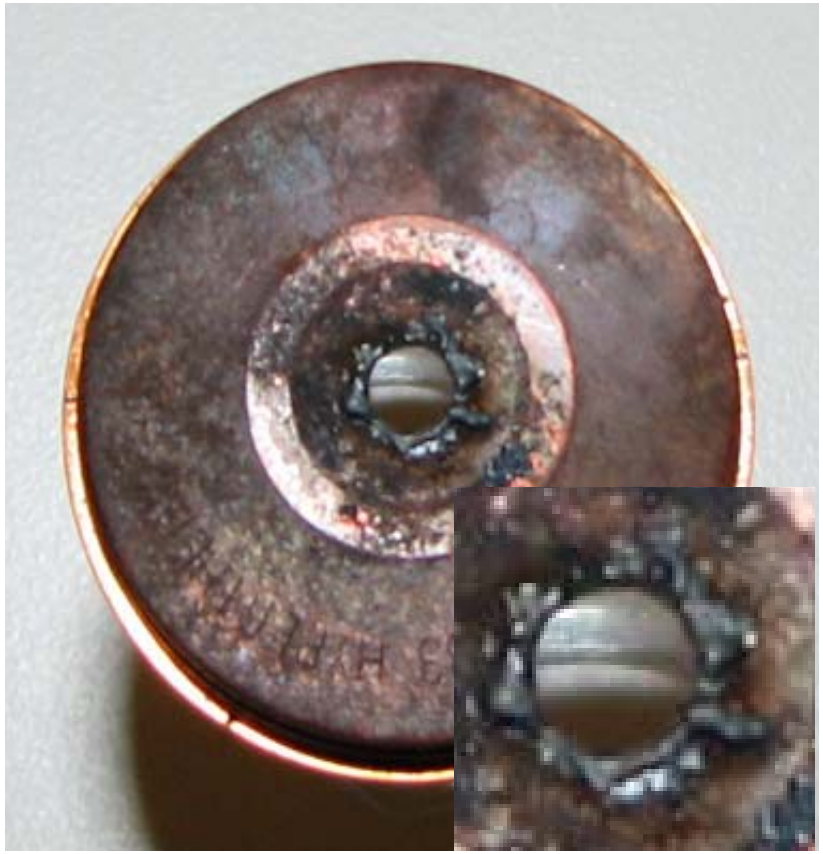
Shield

- Main orifice must be perfectly round and with sharp edges
- Bleed orifices must not be plugged



Shield

This 130 Amp HPR shield shows signs of steel plated around the orifice, indicating it pierced too close to the plate.



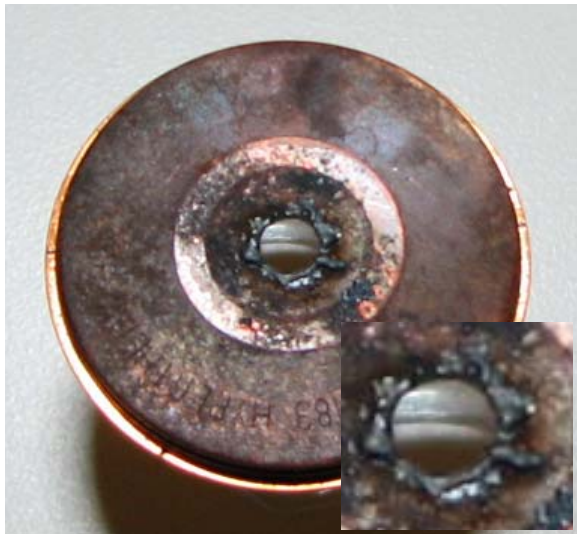
Outside view

Inside view

Shield

Sometimes you can easily pick the steel off the copper and if the orifice is still perfectly round (inspect from inside and outside of the shield) re-use it.

It is good practice to polish the front face of the shield with a Scotchbrite pad to minimize spatter sticking to it.

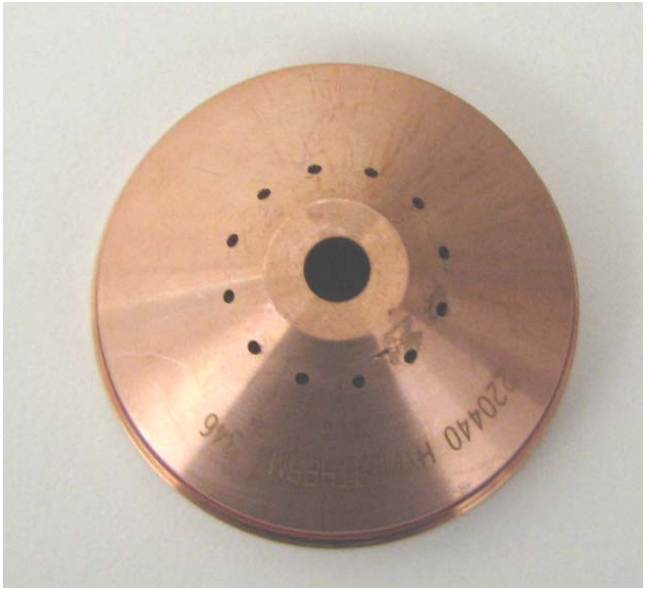


Outside view

Inside view

Shield

- Function
- Critical features
- What can go wrong
- Evaluating wear
- How to get the best life



Shield: Getting the Best Life

- The primary cause of shield failure is with piercing to close to the plate. Follow the operators manual specifications for pierce height settings and pierce delay times and periodically verify that the torch height control system, especially the initial height sensing (IHS), is operating properly.
- The secondary cause of shield failure is when the electrode is allowed to operate until catastrophic failure. When this occurs the electrode, nozzle, shield, and sometimes the coolant tube will need replacement

Shield: Getting the Best Life

- If the shield orifice is round, and the bleed holes are not plugged then clean up your partially used shield with a Scotchbrite pad and continue use.
- It is good practice to use a water based (not silicone or oil based) mig welding anti spatter spray on the front of the shield (light spray) after it is installed on the torch. This can minimize spatter build-up on the shield.

Inner Retaining Cap

- Function
- Evaluating wear
- How to get the best life

Inner Retaining Cap: Function

Primary function is to hold the nozzle and swirl ring in place while directing coolant flow to the exterior of the nozzle.

Front composite piece is designed to mount the shield concentric to the nozzle orifice, and to route the secondary gas to the shield.

Inner Retaining Cap

- Inspect composite ring for signs of burning or cracking
- Inspect holes in composite ring for plugging
- Ensure that nozzle hole is round and has a smooth sealing surface for the front nozzle o-ring

Inner Retaining Cap

- Inspect base for bleed holes (some caps do not have holes)
- Keep this part very clean, especially the composite ring. Dirt or grease can cause carbon tracking and burning.
- Part should last for over 100 electrode/nozzle change-outs

Outer Retaining Cap: Function

- Outer retaining cap holds shield in place over the inner retaining cap, and directs secondary (shield) gas flow to shield.
- Cap also has a contact tab that is used on some torch height controls (THC) as an ohmic or electrical contact to the plate.

Outer Retaining Cap

- Inspect the integrity of the area where the shield o-ring seals; should be perfectly round with no nicks or arc marks.
- Ensure threads are in good shape on the composite section and inspect and or replace the ohmic contact tab if necessary.

Outer Retaining Cap

- Clean spatter off front of cap after use (Scotchbrite works well)
- Use a small light coat of mig welding (water based) anti-spatter spray on the face of cap and the shield.
- If spatter is periodically removed from the face, this cap will last for over 100 electrode/nozzle change-outs.

Torch Main Body: Function

The HPR torch main body is a precision manufactured device that serves as the working end of the plasma cutting system. It handles the following functions:

- Holds consumable parts in near perfect concentricity
- Delivers high pressure coolant to the nozzle and electrode, then returns it to the heat exchanger unit in the power supply.

Torch Main Body: Function

- Provides pre-flow, plasma, and shield gases to the consumables
- Creates the path for the 15,000 volt start circuit for gas ionization.
- Delivers the cutting current (up to 260 Amps of DC power) to the electrode

Torch Main Body: Function

While not considered a consumable part, life is directly related maintainance.

Key to long torch body life is cleanliness.

- Dirt or grease can provide a path for stray electrical discharge, which can create a carbon trace path, eventually causing internal arcing and failure.
- The HPR torch makes maintenance easy since it is a quick disconnect design and can be carried to a work bench for easy inspection and cleaning.

Torch Main Body

It is recommended that the torch body is inspected and cleaned with at least once per shift.

HPR130/260 Torch with coolant tube in place

Torch Main Body

To inspect / clean the internal area of the torch:

1. Remove cooling tube
2. Clean interior components with clean cotton cloth
3. Blow out with compressed air at low pressure
4. Inspect cooling tube and re-insert

HPR130/260 Torch with coolant tube in place

Torch Main Body

- Ensure retaining cap threads are clean
- Check integrity of inner cap sealing o-rings
- Should be lightly coated with o-ring lubricant but not enough to attract dirt to the composite insulation

Inner Cap threads

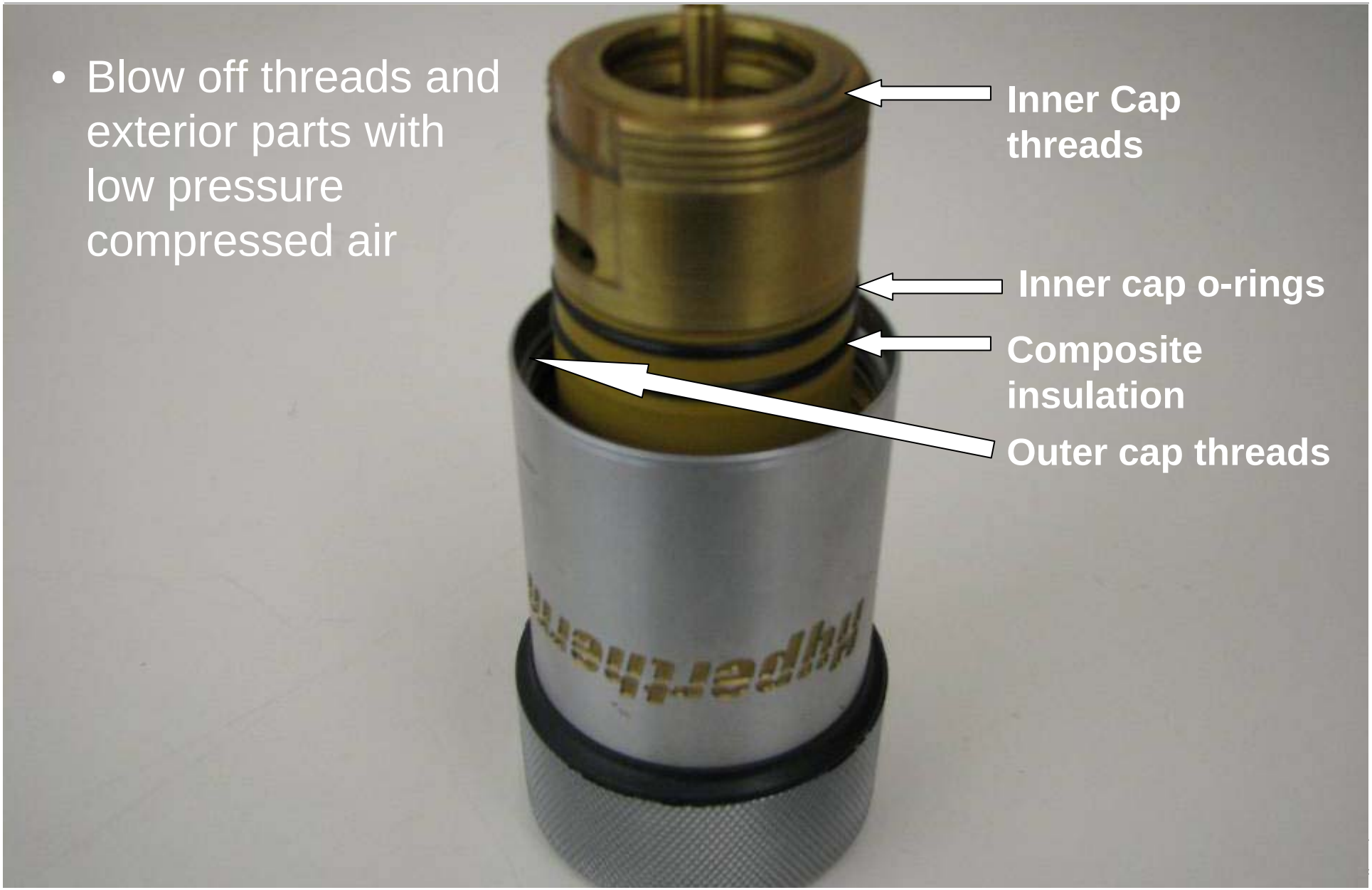
Inner cap o-rings

Composite insulation

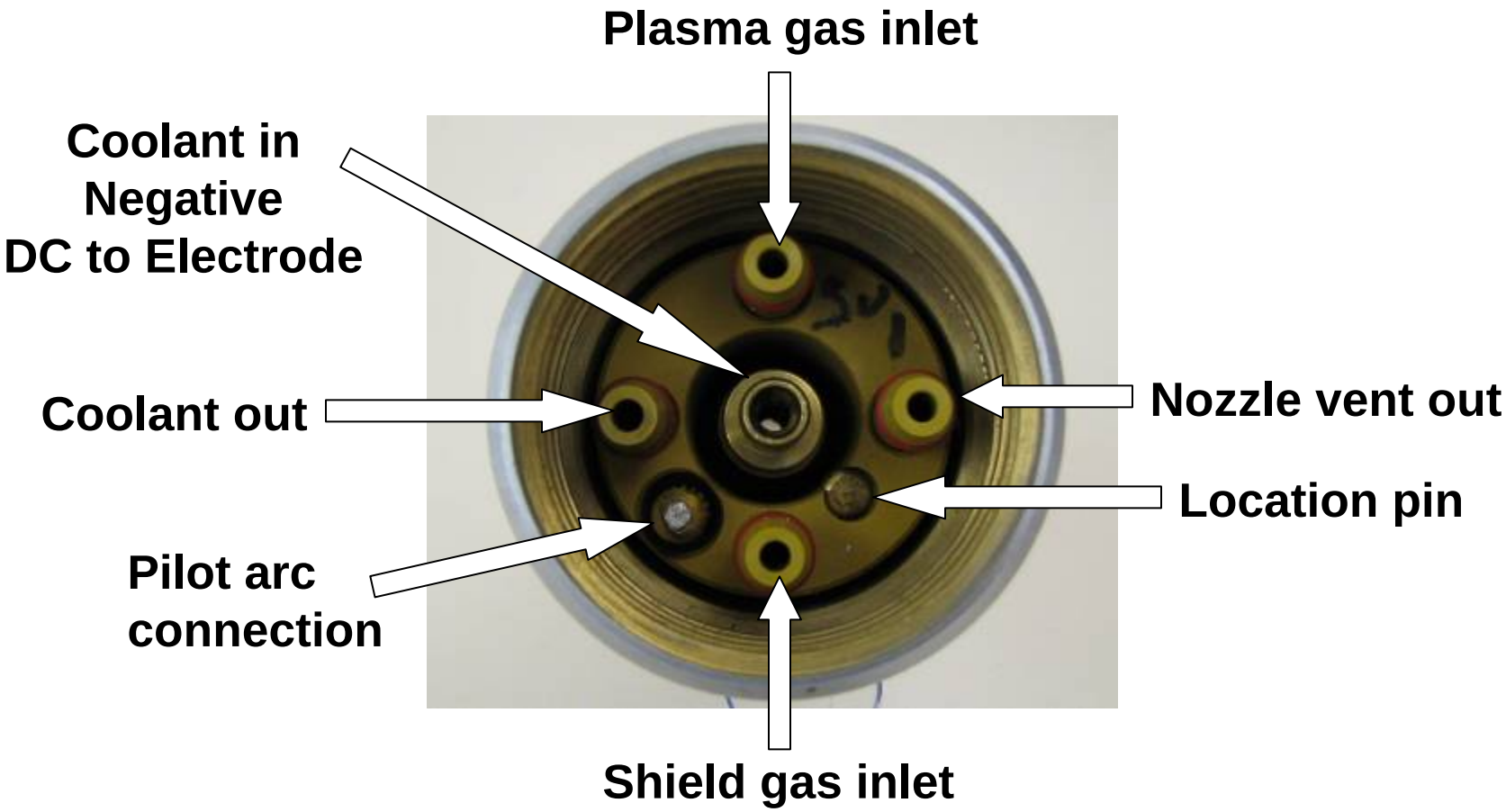
Outer cap threads

Torch Main Body

- Blow off threads and exterior parts with low pressure compressed air



Torch Main Body



1. Clean rear torch connections
2. Check integrity of 4 o-rings on composite posts
3. Blow clean with low pressure compressed air

Thank you!

- Your consumables and torch inspection training is complete!
- Remember, if you use genuine Hypertherm torch parts, the consumables quality inspection starts before the parts are even packaged for shipment.
- Hypertherm prides itself on it's advanced quality control processes and will continue to make advances with thermal cutting technologies in the future.