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REF: Engine Mechanicals

Top End

- [Measure the Volume of a Combustion Chamber](#) (CCing your chamber)

Heads

Alternative to Stock Heads 1992 - 2006 Models

- [Screaming Eagle Pro CNC Ported Heads](#)

Cylinders

Rings

- [Ring Gap Orientation](#)

Pistons

- [Testing the Clearances in Piston Valve Pockets \(reliefs\)](#)
- [Removing / Installing Piston Rings](#)

CP pistons is who makes the pistons for both NRHS and Hammer. ¹⁾

But they are not the same pistons as they each have them made to their own specs.

CP is a custom piston manufacturer like Ross and others. ²⁾

They have a standard line but they also make pistons to their customers' specs.

CP piston from Hammerperf.com. Two wrist pin oilers per side, plus a groove to spread it around. ³⁾



Wrist Pins

CP / Carrillo Wrist Pin (3H-1C)

Supplied with the 1250 kit from NRHS Performance. ⁴⁾



Wrist Pin Retainers

These keep the wrist pin from coming out of the piston and scraping the cylinder walls.

Pins coming out of pistons is an enormously rare event. ⁵⁾

However, if the retainers are not installed properly, they will come out.

CP, in previous years, had some issues with the manufacturing of the pistons.

Wiseco had an issue many years ago also. They weren't putting the appropriate chamfer on the wrist pins for the circlips.

Bottom line, if the clip is installed right, and none of the parts are defective, the clip is a stone reliable solution.

Below is a cylinder that had a wrist pin retainer come loose.



Wrist Pin Lock Rings

These circlips are used with wrist pins that have a chamfer on the ends.

The theory is that the chamfered edge on the wrist pin should push the round circlip into its groove when pushing on it. ⁷⁾



Wrist Pin Buttons

Teflon or nylon buttons can be used instead of circlip retainers.

However, the pistons have to be designed for their use.

Nylon buttons take the place of the retainer rings. ⁸⁾ They can be ordered along with the pistons. ⁹⁾



Pushrods

Alternative to Stock Pushrods

Screaming Eagle Pushrods for Sportsters

- SE "Perfect Fit Pushrods" for Stock Heads 1991-2006 - (18421-06) stock SE length.
- SE "Perfect Fit Pushrods" (18424-06) for Single Plug SE Pro Heads (16677-05) 1992-2006 (published as - 0.050" under stock). However, it appears they may be 0.050" under their stock "Perfect Pushrod" inventory since they are definitely shorter than 50 thou that for 'factory stock pushrods'.

The pic below is a comparison between the suggested 'Perfect Fit Pushrods' and standard rigid Evo 1200 pushrods. The SE pushrods are tapered with a beefier bottom end at 0.434" OD tapering to the standard 0.375" OD at the top. Even though the heads have been shaved 0.050", the intake pushrod was shortened by 0.071" and the exhaust one shortened by 0.065". Length measurements were taken with a 12" Starrett vernier caliper.



SE "Perfect Fit Pushrods" for Dual Plug SE Pro Heads - (16457-96B or 16458-96B) 1992-2003

- Kit # 18421-06 (stock SE length)

Pushrod Tubes

Pushrod Base Upgrade Kits

For 1991-2003 Sportster and 1991-2002 Buell (except Blast):

The stock lower pushrod tube retainer on a 1991-2003 Sportster is a cheapo piece of pot metal that bends and distorts, causing leaks.

Hammer Performance Billet Base Kit

- [Installing Hammer Performance Billet Pushrod Base Kit](#)

10)

These Hammer Performance pushrod tube bases are stronger than the stock parts and replace the cheap stock pushrod bases, but use your stock pushrod tubes.

They are CNC machined by Hammer Performance out of T6061 billet aluminum.

Each kit comes with two bases, the upper o-rings, the lower seals, and four stainless steel screws.



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Zippers Billet Base Kit

Zipper's Performance also makes pushrod tube bases that use the stronger billet aluminum to replace the cheap stock pushrod bases.

The bases are available as standalone parts (with lower seals) or as kits that include new telescoping pushrod covers.



¹³⁾

Aftermarket Rocker Arms

Roller rockers can't do anything but help the valve train. ¹⁴⁾

They can help extend the life of your valve guides and seals.

Take side to side pressure that a normal rocker tip can put on the push rod away.

They may also make your top end more quiet also.

If you look at it the end of the stock rocker arm, it's like the tip of your finger. ¹⁵⁾

As the rocker is pushed down on your valve since it has a curve like your finger tip.

It is also putting some sideways pressure on the valve.

It really gets exasperated when you have high lift cams which put more pressure on the whole valve train.

(especially if you use heavy duty springs)

Most use the beehive springs now so that's not as much of an issue.

S&S Roller Rocker Arms ¹⁶⁾



Aftermarket Gaskets

Cometic

Cometic EST (Extreme Sealing Technology) head, base, and rocker gaskets are constructed of an embossed stainless steel metal substrate coated with a proprietary hi temperature Viton rubber material that virtually eliminates leakage when joining two metal surfaces.^{17) 18)} Head gaskets are a multi layered steel (MLS) design, require no dowel pin O-rings, and are available in .030" and .040" thicknesses. Base gaskets have .005" of high temperature coating on each side and are offered in .010" and .020" thicknesses. Complete kits and top end kits come with .040" head and .020" base gaskets. These base gaskets are not compatible with Millennium cylinders. Cometic EST head and base gaskets are also available separately in different sizes. Each package contains two gaskets. These base gaskets are not for use with Millennium cylinders.

Top End Kits

- **Cometic**
- Top end kit
(.040" head and .020" base gaskets - data from NHRS site)¹⁹⁾

- 88-C9759: 86-90 XL 883.
 - 88-C9761: 86-87 XL 1100.
 - 88-C9762: 88-90 XL 1200.
 - 88-C9760: 91-03 XL 883.
 - 88-C9763: 91-03 XL 1200. 95-02 Buell 1200.
 - 88-C9856: 03-07 Buell XB9/XB12.
 - 88-C9970: 04-06 XL 1200.
 - 88-C9177: 07-up XL 1200.
- Top end kit:
 - (.030" head gaskets - data from NHRS site) ²⁰⁾
 - 88-C9907: 88-90 XL 1200. Buell 1200. *Also fits NRHS 1250 Kits.
 - 88-C9854F: 91-03 XL 1200. 95-02 Buell 1200, *Also fits NRHS 1250 Kits.
 - 88-C9971: 04-06 XL 1200. *Also fits NRHS 1250 Kits.
 - 88-C9177: 07-up XL 1200. *Also fits NRHS 1250 Kits.

James Gasket Kit (17032-91-MLS):



21)

Head Gaskets

Multi Layered Steel (MLS) gaskets are as the name mentions, multiple steel layers held together by a couple rivets.

The rivets should hang off the end of the heads/cylinders when installed.

Sometimes they get squashed under the head and will need to be removed before assembly.

If you are using MLS head gaskets, you need to test fit them before installing the final install of the heads.

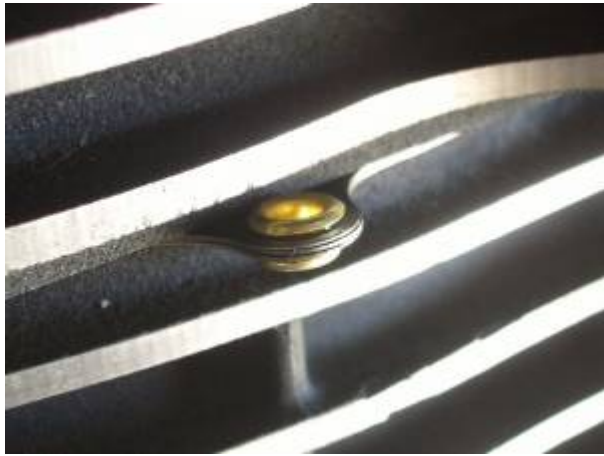
Snug the bolts down lightly, and check the rivets holding the gasket together, you can see them in the pics below.

You want to be sure they are not trapped between the head and cylinder deck.

As long as the rivet is past the head/cylinder joint and doesn't raise the head any, they are fine to use as they are.

If you need to, you can remove the rivets with a Dremil rotary tool with the metal cutting blade.

You just have to go slow and cautious not to cut into the gasket.



22)



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Thickness

If you are adjusting your squish band or compression with different gasket thicknesses, you can mix and match different MLS gaskets for the height you want.

[See more on the squish band here](#) in the REF section of the Sportsterpedia.

Most Cometic MLS layers are .010" each (include coating). They come in either 3 (.030") or 4 (.040") compressed height layer combos.

- **Evo Sportster / BT Head Gaskets:**

- Cometic MLS

- C9205-030: 3.000" bore, .030" compressed thick.
- C9205: 3.000" bore, .051" compressed thick.
- 88-C9688: 3.497 to 3.563 bore, .030" thick. (86-up XL/Buell/XB - data from NRHS site) ²⁵⁾
 - C9688, 3.500" bore, .030" thick (for Evo BTs per Cometic site) ²⁶⁾
- 88-C9692: 3.813 bore, .030" thick. (86-up XL/Buell/XB - data from NRHS site) ²⁷⁾
 - C9692, 3-13/16" bore, .030" thick (for Evo BTs per Cometic site) ²⁸⁾
- 88-C9689: 3.497"- 3.563" bore, .040" thick. (86-up XL/Buell/XB - data from NRHS site) ²⁹⁾
 - C9689, 3.500" bore, .040" thick (for Evo BTs per Cometic site) ³⁰⁾
 - C9689-051, 3.500" bore, .051" thick (for Evo BTs per Cometic site) ³¹⁾
- 88-C9693: 3.813" bore, .040" thick. (86-up XL/Buell/XB - data from NRHS site) ³²⁾
 - C9693, 3-13/16" bore, .040" thick (for Evo BTs per Cometic site) ³³⁾

- C9690, 3.670" bore, .030" thick. (sold for Evo BTs)
- C9691, 3.670" bore, .040" thick. (sold for Evo BTs)
- C9694, 3.750" bore, .030" thick. (sold for Evo BTs)
- C9695, 3.750" bore, .040" thick. (sold for Evo BTs)
- Cometic Carbon Fiber (CFM-20)
 - C9718: 3.512" bore, .043" thick.
- Cometic Copper
 - C9082: 3-13/16" bore, .043" thick. (sold for Evo BTs)
- **Ironhead Sportster Head Gaskets:**
- Cometic Copper
 - Cometic
 - C9698: 3.425: bore, .020" thick. ³⁴⁾
 - C9565: 3.425: bore, .032" thick. ³⁵⁾
 - C9566: 3.425: bore, .043" thick. ³⁶⁾
 - James Gasket
 - JGI-16769-72-A: 1000cc, .016" thick. (1972-E1973 Sportster) ³⁷⁾
 - JGI-16769-73: 1000cc, .016" thick. (1973-1985 Sportster) ³⁸⁾
 - JGI-16769-82: 1000cc, .045" thick. (1982-1985 Sportster) ³⁹⁾

James Gasket MLS:

Layers come in different thicknesses.

- The layers as part of the 16770-84 4-layer (.037") gasket are:
 - Top and bottom layer - .011" ea.
 - Middle coated - .008"
 - Middle bare steel - .007"

Cometic EST MLS compared to James Gasket MLS head gaskets:



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Cometic .040" MLS Gasket on 05 1200C ⁴²⁾



Torque Procedure

Do not use oil in the cap nuts. Only a very light 'touch' on the bolt threads. Else the nuts can hydro-lock and you'll never get to the proper torque.

You must tighten / torque the heads in the sequence in the FSM for evenness around the mating surfaces to keep from warping the heads and causing leaks.

All steps are done in sequence per head.

If you don't follow this sequence while tightening, they can easily back out or warp the heads.

It's also possible and it happens more than not, that; ⁴³⁾

You tighten numbers 1 and 2, then tighten 3 or 4 tighter than you did 1 and 2 and all of a sudden 1 and 2 are both loose.

This is not pulling the head down evenly.

Do one head at a time. Tighten in sequence 1-2-3-4 to the value in each step before moving to the next torque value.

Then do the entire sequence again to each subsequent torque value until you reach full (final) torque.

Torque Sequence:



Head Bolt Removal and Installation Torque Sequence

⁴⁴⁾

Sometimes the studs will stretch upon torque (especially too much torque). ⁴⁵⁾

Be aware that the stud itself could stretch (or twist in the middle). The long studs are weak in the middle. Any bolts that stretch must be replaced.

Pay attention to how the bolts pull. They should not spring back when you let go after turning them.

If this happens, the wrench will say you hit torque, but when you release pressure, the stud spins with you back to it's relaxed state.

You can feel when this happens and it takes longer to get to the torque value due to the stud turning with you in the middle.

In that case, you did not get to final torque on that bolt.

When you reach the point in tightening any bolt that it wants to stop turning and the torque spikes, that is it. ⁴⁶⁾

That's the warning sign that from that point forward you are breaking something. The metal will tell you where it's limit is.

You can also may a mark from each bolt to the head so you will be able to see if the bolts are unscrewing or pulling out. ⁴⁷⁾

NOTE:

Do not recheck final torque as it is un-necessary and possibly even harmful.

Once you end at any torque value, the fastener is then 'set' to that value and has become one with the mating surface.

The load has been spread and it will take more than the current value to move the bolt/nut from there.

So you can over-torque the head bolts by rechecking the final torque.

Then the torque becomes uneven across the head and possible warp-age can occur after the engine heats up.

Torque Specs

The torque values in the FSM are for OEM gaskets.

The torque specs will change with the different type of gasket, manufacturer and most importantly your engine supplier / builder's recommendation.

The torque specs for different type / manufacturers are listed below.

When using the MLS torque specs, you'll find they are not that different from the FSM. ⁴⁸⁾

For instance: After you get to 9 ft/bs, it's about a quarter turn to 14, then about a quarter turn to 22 and so forth.

But using the actual values instead of counting turns gets a more even pull on all sides. It also allows you to feel when something isn't right.

The OEM gaskets offer a squeeze factor unavailable with steel gaskets.

Cometic MLS

- Step 1:

Make sure the surface is free of any oil / debris and the locating pins are not holding the head off the mating surface.

Push down / jiggle the head to make sure it's sitting evenly on the cylinder.
Then snug all four bolts up by hand in sequence.

- Step 2 (first pull):
Torque all bolts in sequence to 9 ft/lbs.
- Step 3 (second pull):
Torque all bolts in sequence to 14 ft/lbs.
- Step 4 (third pull):
Torque all bolts in sequence to 22 ft/lbs.
- Step 5 (fourth pull):
Torque all bolts in sequence to 35 ft/lbs.
- Step 6 (final pull):
Torque all bolts in sequence to 42 ft/lbs.



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Base Gaskets

For comparison, OEM base gasket 16789-04 is .014" thick.⁵⁰⁾

Cometic:

- Evo Sportster base gaskets
- Steel with rubber coating
 - C9100: Std spigot, .010" thick. (86-up 883-1200 XL/Buell/XB 3.497" to 3.563" bore)⁵¹⁾
 - C9553: Std spigot, .020" thick. (86-up 883-1200 XL/Buell/XB 3.497" to 3.563" bore)⁵²⁾
 - C9875: 4" spigot, .010" thick. (86-up XL/Buell/XB 3.813" bore)
 - C9876: 4" spigot, .020" thick. (86-up XL/Buell/XB 3.813" bore)
- Copper
 - C9025: .020" thick.
- James Gasket:
- Steel with bead.

- JGI-16774-96: .020" RCM compressed thickness (86-up Sportster) ⁵³⁾



Alternately in the interest of adjusting squish or compression, you can remove the base gasket altogether and use ThreeBond, TrippleBond, YamahaBond or etc.

Any of these are good for making a seal on the cylinder bases.

If you run with no base gaskets, just remember to account for clearances from your cam / valve train (depends on what cams, valves, gaskets etc., installed).

Remember to subtract the compressed gasket thickness, if using OEM composites (about 20thou?), from your valve to piston clearance to avoid clearance issues. ⁵⁵⁾

It's best (and assumed) to clay the pistons anyway to check where you're at on clearancing.

Links for Purchasing Gaskets

Click on the links below.

-[NRHS Performance](#)
-[Hammer Performance](#)

Go To Technical Menu

1)

NRHS Sales of the XLFORUM

<https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-motor-top-end/132291-awsracing-please-rely-looking-for-advice/page12?t=1409240&highlight=piston+pin+clips&page=12>

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<https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-motor-top-end/132291-awsracing-please-rely-looking-for-advice/page13?t=1409240&highlight=piston+pin+clips&page=13>

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4)

<http://nrhsperformance.com/>

5)

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8)

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<https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/ironhead-sportster-motorcycle-talk-1957-1985/49853-wrist-pin-retaining-clips/page2?t=204460&highlight=piston+pin+clips&page=2>

9)

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<http://www.hammerperf.com/xlvalvetrain.shtml#billetbases>

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16)

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17) 19) 20) 25) 27) 29) 32)

<http://www.nrhperformance.com/partsgaskets.shtml>

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<https://www.cometic.com/>

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<https://www.cometic.com/search.html?q=C9688>

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<https://www.cometic.com/search.html?q=C9692>

30) 31)

<https://www.cometic.com/search.html?q=C9689>

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<https://www.cometic.com/search.html?q=C9693>

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<https://www.cometic.com/search.html?q=C9698>

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<https://www.cometic.com/search.html?q=C9565>

36)

<https://www.cometic.com/search.html?q=C9566>

37)

<https://www.jamesgaskets.com/product/jgi-16769-72-a/>

38)

<https://www.jamesgaskets.com/product/jgi-16769-73/>

39)

<https://www.jamesgaskets.com/product/jgi-16769-82/>

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<https://www.cometic.com/search.html?q=C9100>

52)

<https://www.cometic.com/search.html?q=C9553>

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<https://www.jamesgaskets.com/product/jgi-16774-96/>

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