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Lifter Comparisons

Solids vs Hydraulics and Pushrod Types

Lots of folks have questions on the best type lifters to use in their Sportsters. The easiest answer is to do what the factory did. But in the case of upgraded engine parts, that isn't always the right answer. Below are some Q&As from XLF member, aswracing.

When are applications where you can't use a stock lifter?

When you run out of tappet anti-rotation pin clearance. Red Shift 585's have stock base circles and typically require an aftermarket tappet that has longer anti-rotation flats. SE 575's have almost as much lift, but they have a smaller than stock base circle, so they typically don't cause tappet pin clearance issues. [1)]

What is the advantage of using non-adjustable pshrods?

A non-adjustable pushrod is stronger at a given weight and also less likely to cause “rub” issues, which can be a source of noise. Also, you reduce the potential for leaks by using the stock pushrod tubes instead of collapsibles.

When do you stop using fixed pushrods and switch to adjustables?

The only good reason for adjustables is when you use a solid or travel limited lifter. These types of lifters require a very specific pushrod length that will vary literally every time you put the rocker box on. The only reasonable way to do that is with an adjustable. Quick install pushrods don't work that well on Sportsters, for a couple reasons. I'd avoid them at all costs.
More lift in the cam doesn't affect the centering of the pushrod plunger. The base circle size affects it, as does gasket thicknesses and milling of heads and/or cylinders. But not the total lobe lift. [2)]

Really you should base your decision on the type of lifters you use. If you're using a regular hydraulic lifter, you're better off with non-adjustable pushrods. With higher spring pressures I highly recommend a better set than the stockers, those things are flexi-flyers. But stay with a non-adjustable. A non-

adjustable pushrod is stronger than an adjustable at a given weight, or conversely, lighter than an adjustable at a given strength. Plus you don't have to mess with collapsible covers. [3)]

If, however, you're using a solid or other travel limited lifter (i.e. Hydrosolids, or stock lifters with travel limiters installed), an adjustable is mandatory. There's a specific running clearance you need to achieve. An adjustable is the only reasonable way to do that. [4)]

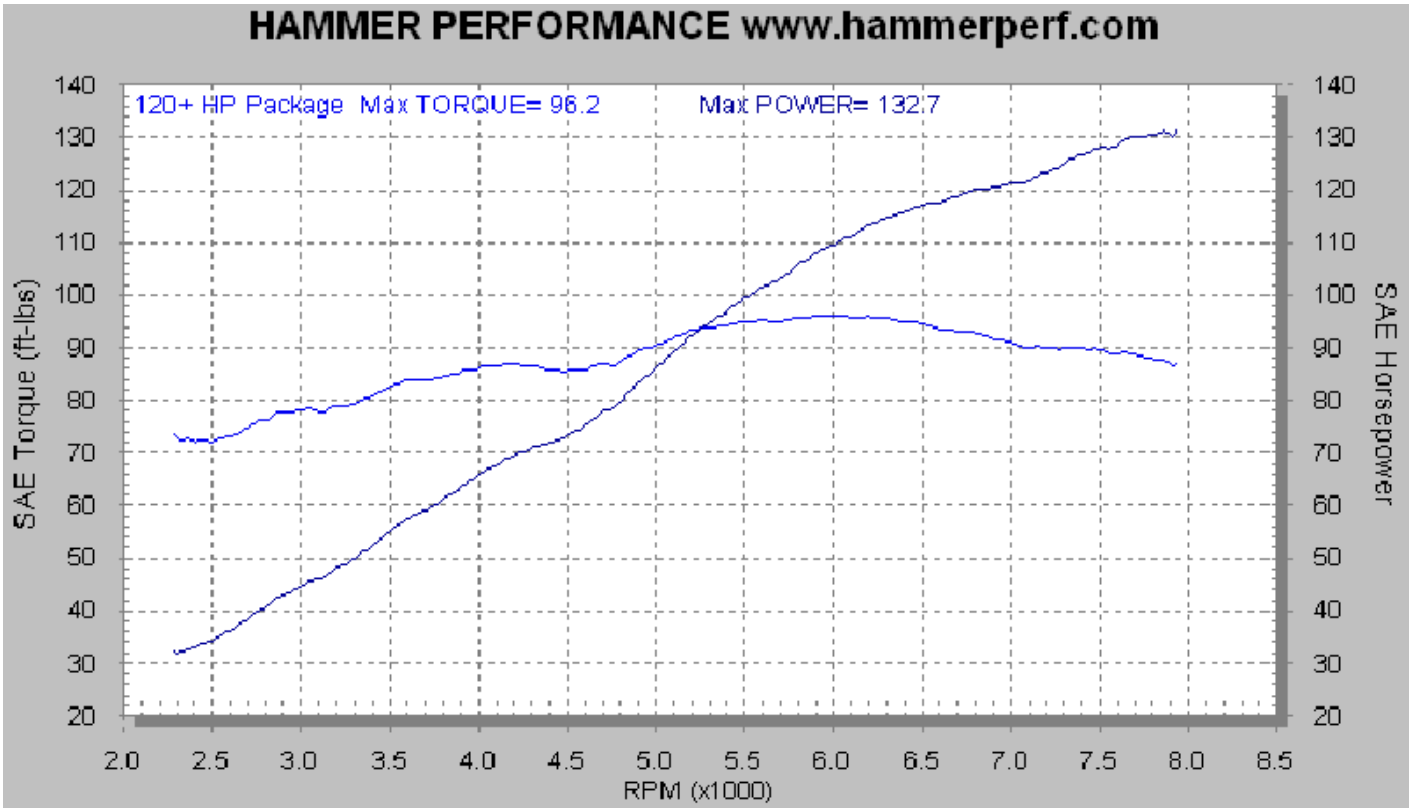
What is a proper argument for using hydraulic lifters?

A hydraulic lifter self-adjusts within a certain range. In other words, if your pushrods are too long, the lifter automatically shortens, and if the pushrods are too short, it automatically lengthens. The hydraulic lifters used in HD motors have about .200“ of plunger travel. As long as it's preloaded between about .050 and .150, it adjusts itself properly. So in other words, there's about a .100” range of pushrod length that works just fine and the lifter will automatically adjust it's length to make it all work properly. Get outside of that range and you're at risk of causing problems. [5)]

If you preload it too far (i.e. pushrods that are too long), for example, the valves won't land on the seats when the lobes are in the full down position, and as such, you'll suffer loss of compression and/or “burnt” valves, where the burn of the fuel gets past the valves and damages the valves and seats. If you don't preload it enough (i.e. pushrods that are too short), every time the valves close there will be significant slack in the valvetrain, causing noise, and if it's bad enough, the pushrods can pop out of their socket on the rocker arm, and lifter rollers will take a pounding the next time the valves open. Plus, you're now landing the valve onto the seat in the wrong area of the cam lobe, which can cause seat bounce, broken valves, and seat recession into the head. You're slamming the valve closed instead of setting it down gently. [6)]

The whole idea of a hydraulic lifter is to self-adjust, to compensate for manufacturing tolerances and top end growth with heat. They do a wonderful job and require no adjustments.

This 2007 Sportster had it's factory stock hydraulic lifters, no travel limiting washers, and non-adjustable pushrods.



8000rpm with excellent valve train control. Tell me again what solid or travel limited lifters bring to the party?
I also own a Buell XBRR factory race bike. 56 of them ever made. It came from the factory with a 9000rpm limit, makes 150hp at 8500rpm, and uses the same hydraulic lifters that came in all 2000+ Sportsters, literally the same part numbers. It's stock pushrods are also non-adjustable and it has one piece pushrod covers.

Another case in point: tens of thousands of Buell XB9 models produced from 2003-2010, every single one of them with a factory 7500rpm rev limit and a warranty, using the exact same hydraulic lifters that come stock in XL's since 2000. Same springs and locks and retainers and guides and pushrods and valves as the 04-up 1200's for that matter. I've never heard of one having a failure. And yet that same hardware breaks at 7000rpm with a different cam grind, as we've seen on the XLForum. The cam profile has a huge amount to do with it. [7)]

It's all about control. When you lose control of the valvetrain, a hydraulic lifter does what hydraulic lifters are supposed to do, it takes up the slack. But if that slack was caused by float or bounce, you're now holding the valve up off it's seat. Commonly referred to as lifter pump-up.

Solid lifters, anti pump-up hydraulic lifters, and travel limited hydraulic lifters, are all just different approaches to dealing with this problem.

But if you never lose control in the first place, the hydraulic works just fine.

Hydraulics only have an issue with high rpm if you get slack in the valvetrain. When that happens, they do what hydraulics are designed to do, they take up the slack. So the lifter becomes too long and the valve doesn't get back to the seat. This is called “pump-up”.

But if you have good control of the valvetrain, which comes from a combination of lobe profile, spring pressure, and lightweight parts, then you don't get slack, and hydraulics work just fine. I maintain that travel limited lifters, adjustable pushrods, and collapsible cover kits are just more things to spend money on that have almost no tangible benefits and multiple disadvantages. Lots and lots of stuff like that out there for Harleys.

Solid tappets require frequent adjustments and they're also noisier.

What is a proper argument for using solid or travel limited lifters?

The one thing that a solid or travel-limited lifter brings to the party is easier starting, since they don't bleed down as the motor sits, thus shortening the intake duration which raises compression. They're great for race motors because there's never any lifter collapse or pump-up to worry about. Lifter collapse when the motor is off can make a high compression motor really difficult to start because it pulls the intake close event back. But I personally would not put solids into a street motor. [8)]

You need to have a running clearance, which you set by adjusting pushrod length while using a feeler gauge positioned between the valve tip and rocker tip. Now it's true, you can slightly alter lift and timing by varying that running clearance, and racers sometimes do this. But you can't move it much without running into the aforementioned issues. Within the range you have to safely work with, it generally has very little effect on the dyno sheet. [9)]

The Hydrosolid is a nice solution for someone who wants the valvetrain control of a solid (especially at high rpm) with the self-adjusting convenience of a hydraulic. They do require adjustable pushrods and collapsible covers, but they'll take a lot less maintenance and run a lot quieter than a solid. [10)]

The quickest and surest way to determine if you have travel limiters is to take them apart. There's a snap ring on the top and they just come apart. The travel limiter is a little steel ring down in the bottom. Personally, I really like Hydrosolids, and use them in all my race motors. Travel limited hydraulic lifters give the benefits of each type. Overkill for most street motors with moderate spring pressures though, and they incur a lot of extra expense by the time you get adjustable pushrods and a collapsible tube kit. [11)]

Tappet Flats

This is in consideration of induced noise from the use of high lift cams.
The factory lifter is up to the job from the point of view of the hydraulics. [12)]
However, the factory lifter's weaknesses are lack of available travel and less durable axle bearings.
It's possible to machine the flat longer on a stock lifter. [13)]
But, it's a difficult piece to clamp and it's also hard as a rock.

Tappet axle failures are the most common problem when you use lots of spring pressure.
Which is why JIMS uses a bigger axle and more rollers and now they're force feeding oil to it.

On 91-05 bikes, the lifters were prevented from rotating via use of tappet “anti-rotation-pins” (which came in two different styles). [14)]
In 2006, they changed the design to a plastic “anti-rotaion-device” or ARD.

One thing you need to pay attention to when using high lift cams is the tappet pin clearance. [15)] [16)]
Without enough clearance, the tappet will contact the pin and make a racket.
The generally accepted minimum clearance is .060“: (with the cam positioned at full lift, lifter sitting on top of it, use a magnet to pull the lifter up until it stops)
You want it to move .060” at least.

A .590“ lift cam on a stock base circle will cause the tappet to run into the pin.
Maybe not on a roll-through, but almost certainly with the motor warm and running.
If you get a lot of valve train noise, check it. Simply unscrew your pins and look for contact marks.
They tend to get a little smiley face impression on them when the tappets are hitting them.
The lifters can hit the pins with less lift than that.
Jims lifters have longer flats on the tappets, but roller failure has been reported while using them.

Pin damage from lifter [17)]	Tappet and pin wear [18)]
	
Stock vs Jims lifter tappet flat comparison. [19)]	Notice how the wear ring extends down below the machined area of this S&S lifter a little. [20)]
	
	

Other Useful Links

Here is a good tech video from Hammer Performance on installing lifters that also addresses the tappet flats.

91-05 Anti-Rotation Pin Upgrade

See also 91-99 Lifter Pin Upgrade to 00-05 Lifter Pin Screws in the EVO section of the Sportsterpedia with pics of the process.

91-05 lifter pins are only supported on the front side. [21)]
The back side of the pin bore is not drilled through so the pin just kind of hangs there near the back wall of the bore.

The 00-05 screw in style is a much better design because it's supported on both ends.
The hole for the pins is drilled into the back side of the bore into the case.
While your engine cases are at the machine shop, you may want to upgrade to the 06 style screw-in pins.
You can also do this yourself at home with a hand drill with some careful planning.
You have to drill each hole deeper and then tap the outer portion to update to the new style.

91-05 vs 00-05 Up lifter pins [22)]	00-05 style pins in a 91-05 engine. [23)]
 On the left is the stock 91-99 tappet pin arrangement. On the right is the improved design as used on 2000-2005 bikes. 91-99 bikes can easily be updated to the newer design.	

Internals

OEM 2000 and Up vs SBC Lifters

Comparison of OEM 02 style Sportster lifter (18538-99A) and an aftermarket Crane Cams lifter (10530)

for small block Chevy's. [24)]

From left to right you can see the retaining clip, pushrod seat, piddle valve, plunger / spring, and lifter body.
The way these parts work is both simple and complex. For a better description, see how a hydraulic lifter works in the Sportsterpedia.

The plunger is inserted into the lifter body, where the clearance is .0002” or so.
The hole in the side of the lifter body is what allows oil to flow into the lifter.
This oil fills the plunger. From there, the oil flows out through the piddle valve and through the hole in the pushrod seat up the pushrods.

As in below, the parts in the stock HD lifter are pretty clear.
As you can see, almost all of the parts are exactly the same.
The only difference is the feed hole in the lifter body.
See the close-up in the third pic below.

The actual size of this hole doesn't particularly matter because the space it feeds is so small.
(remember, .0002“ clearance with a .842” bore does not add up to a lot of oil volume)
The piddle valve is what controls oil flow to the top end, and as you can see that is exactly the same.
The bleed down rate is controlled by plunger-to-body clearance.

Lifter (18538-99A) from an 02 XL883 [25)]	Crane Cams 10530 SBC Lifter [26)]	Crane on left, HD “A” on right. [27)]
		

Aftermarket Lifters

Stock lifters in, most cases, are more than adequate for your engine.
An important factor in when to change lifters is the length of the tappet flats as mentioned above.
This is a critical measurement when installing high lift cams.
Otherwise, on stock motors, it shouldn't be necessary unless you have a lifter fail. And then, replacing with stock lifters should be fine.
As an example, the Buell XBRR uses the stock lifters and it spins 9000rpm. [28)]

High performance lifters are especially helpful as a piece of preventative maintenance when high spring pressures are used. [29)]
The longer flats also allow higher lifts.

Other Useful Links

This is a very good XLFORUM discussion thread on lifters and high lift cams.

Feuling lifters

Gaterman Lifters

Four different models are available for XL's. [30)]
Common features include:

- 3D CAD Designed and CNC Machined for Maximum Accuracy
- Heat Treated Chrome Alloy Steel Lifter Body for High Strength
- Precision Machined and Heat Treated Internal Components
- Check-ball Metering for Precise Control and Low Noise
- 100% Select-fit Components for Precise Leakdown Rate
- 100% Flow Checked Pushrod Socket for Precise Oil Metering
- Hardened, Tempered Certified 52100 Steel Roller, Axle, Needles

The four available models are:

- GP1023
  - High Performance for 00-05 XL's
  - Triple Oil Feeds for Robust Oil Supply and Quiet Operation
  - Single Locator Flat for Proper Orientation to Oil Supply
  - Extended Body and Locator Flat for Higher Lift Capability
  - Oil Feed on Locator Flat to Lubricate Guide Pin
  - Oil Feed to Roller Bearing Needles
  - Slower Bleed Rate for Quiet Operation
- GP1021
  - Stock Replacement for 00-up XL's
  - Precision Staked Axle for Maximum Retention
- GP1022◦Stock Replacement for 91-99 XL's
  - Full-floating Roller Axle for Durability
- GP1020◦High Performance for 86-90 XL's
- Inner Race Style Roller Bearing for Increased Reliability
- Orbital Riveted Axle Clamps Inner Race to Roller Slot
- Superior Durability Compared to “Big Axle” Designs
- Surpasses OEM 18523-86 and S&S® No.33-5341

The GP1021 works great on all 00-up XL's.
It's a nice, high quality piece, and it's priced competitively with the factory lifter.

The GP1023 does not work with the plastic anti-rotation device used on 06-up models.
For one thing, it only has one tappet flat, and the anti-rotation device needs both flats.
It is also lengthened on the top side for use with small base circle cams.
However, that lengthening on the top is another reason it won't work in 06-up models.

Jims lifters

The JIMS lifters have the machined area up higher as compared to the stock lifters. [31)]

S&S Lifters

S&S (33-5350) lifters [32)]

V-Thunder lifters

V-Thunder 850-1 lifters.

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[1] [2] [3] [4]
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-motor-top-end/27298-adjustable-vs-solid-pushrod
[5] [6] [9] [11]
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/59164-i-think-i-screwed-up-with-new-cam-install/page3#post1251154
[7]
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/162254-cannibal-queen-conversion/page39#post3488179
[8] [10]
https://www.xlforum.net/forum/vendors/nrhs-high-performance/41168-adjustable-pushrods-and-solid-lifters#post844954
[12]
aswracing of the XLFORUM
https://www.xlforum.net/forum/vendors/hammer-performance/139198-well-been-doing-some-thinking-excess-valvetrain-noise/page2?t=1510606&page=2
[13]
aswracing of the XLFORUM http://xlforum.net/forums/showthread.php?t=341901
[14]
aswracing of the XLFORUM
https://www.xlforum.net/forum/vendors/hammer-performance/139198-well-been-doing-some-thinking-excess-valvetrain-noise?t=1510606
[15]
aswracing of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/59164-i-think-i-screwed-up-with-new-cam-install?t=322680
[16]
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/43338-base-circle-size?highlight=lifter+pins#post897331
[17]
photo by groovemeisterus of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/153000-bad-tappet-noise-from-high-lift-cams?t=1647586
[18]
photo by groovemeisterus of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/153000-bad-tappet-noise-from-high-lift-cams/page2?page=2&t=1647586
[19]
photos by aswracing of the XLFORUM
https://www.xlforum.net/forum/vendors/hammer-performance/139198-well-been-doing-some-thinking-excess-valvetrain-noise?t=1510606

[20] , [31]
aswracing of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/164458-cannibal-queen-conversion-cam-carnage/page18?highlight=lifter+pins#post3513797
[21]
aswracing of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/177032-a-tale-of-two-sporty-s-and-brand-new-dream-or-1250-was-fun-how-about-100/page3?highlight=lifter+pins#post3827139
[22]
photo by aswracing of the XLFORUM
https://www.xlforum.net/forum/vendors/hammer-performance/139198-well-been-doing-some-thinking-excess-valvetrain-noise?t=1510606
[23]
photo by aswracing of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/60421-what-kind-of-tappets-do-you-recommend?t=341901
[24]
Scuba10jdl of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/159217-lifters-comparison?t=1706033
[25] , [26] , [27]
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https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/159217-lifters-comparison?t=1706033
[28]
aswracing of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/179904-s-s-hl2t-and-jims-hydrosolid-question/page2?t=1933342&highlight=disassembling+lifters&page=2
[29] , [30]
aswracing of the XLFORUM
https://www.xlforum.net/forum/vendors/hammer-performance/160789-gaterman-lifters-now-available-from-hammer-performance?s=73d24db8f0756ef41c6215fd92ad0055#post3437771
[32]
photos by rubine of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/186414-s-s-lifter-identification-help?t=1993359