

Installing a Pre-Pump Fuel Filter in an '06 PSD

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Problem:

The 2006 Ford F-350 SRW 6.0l PowerStroke Diesel (PSD) pickup is equipped with two fuel filters. One is located at the Horizontal Fuel Conditioning Module* (HFCM); the other is located on top of the engine. The nominal filter size for these filters is 10 and 4 microns respectively¹. In addition, the 10 micron HFCM filter is a water separator filter. I chose to add a pre-pump filter between the tank and the HFCM. This paper outlines the choices, the functional design and parts and installation for adding this pre-pump filter to my PSD.

Clean fuel is essential to a long lived and reliable diesel engine, especially advanced diesel engines like the Ford 6.0l PSD. It's almost a given that buying dirty fuel or fuel contaminated with water is not a matter of if, but when. For a good discussion of dirty or contaminated diesel fuel, with pictures, see this article at the Ford Doctors Diesel Technicians Society (FDDTS) site: <http://www.forddoctorsdts.com/articles/article-06-03.php>

Furthermore, I know of one person who spent \$1800 to replace 3 injectors in his 6.0l PSD due to dirty or contaminated fuel. This repair was not covered under warranty due to the contaminated fuel.

Just recently, I had drained samples of dirty fuel from my 6.0l PSD; see Figure 1. The sample on the left was drained from my aux fuel filter that is located between my 90 gallon aux fuel tank and the OEM fuel tank (see Aux Fuel Tank install paper in References and Sources). The sample on the right was drained at the same time from the HFCM drain plug; the picture clearly shows that the aux fuel filter is doing its job. It also clearly shows that I have dirty or contaminated fuel in my aux fuel tank (I've since cycled this fuel through the aux fuel filter to clean it up).

After +24 hours of sitting, the sample on the left looks exactly like sample #3 shown in the FDDTS fuel article cited above.

* The '06 PSD HFCM contains the primary fuel filter, pump, Water in Fuel (WIF) sensor and drain.

¹ 6.0l Bible, page 28

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Figure 1. Two fuel samples recently drained from my 6.0l PSD. The sample on the left was drained from my aux fuel filter, the sample on the right, from the HFCM drain. Compare this pic with the FDDTS fuel samples in the article cited above. (Photo by author)

Given the above experiences, I decided to install a pre-pump fuel filter in my 6.0l PSD. This filter would be installed after the OEM fuel tank and before the pump located in the HFCM.

Fuel Filter Options:

Aftermarket or Do It Yourself?

Adding a pre-pump filter setup is nothing new. There are several vendors that sell a complete pre-pump filter setup. For example, Dieselsite.com has the Dahl 100 and Dahl 150 fuel filter kits with transparent plastic bowl so you can see any water or other debris that it's captured. ITP Diesel has a similar setup, except using Baldwin filters and filter mount. Nicktane has a filter kit for the Duramax diesel, using a very large Caterpillar filter. I have no

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experience with any of these pre-pump fuel systems, but these vendors are highly thought of on the various diesel forums. If you use biodiesel in your truck, check with the vendors to ensure they use SAE-J30R9 fuel injection hose; more on this later.

Since the basic setup is a filter, filter mount, fuel hose and some simple plumbing parts coupled with careful design and installation, I chose to put my system together using the components discussed below.

Which Filter?

The next step was to decide which type and size of filter to install. For convenience, selection, cost and ease of maintenance, using a spin-on type fuel filter was the hands down winner as far as the type of fuel filter to use.

For selecting the specific fuel filter I used the Fleetfilter.com (see sources) to select the spin on fuel filter. I use the Wix #33406/Napa #3406 spin-on filter for my aux fuel tank filter and for redundancy purposes I wanted to use a similar sized filter with the same filter threads (i.e. 1"-14). I also wanted a fuel filter with a water separator and a drain so I could drain the filter periodically to examine the fuel for water and debris. Being able to see fuel contamination as shown in Figure 1 clearly shows the advantage of a filter that has an easy-to-use drain in a diesel fuel system.

Using the Fleetfilter.com site, I was able to determine all the spin-on fuel filters with 1"-14 threads that would fit a Wix 24770/Napa 4770 filter mount and contained a water separator and drain. I put all these filters on one Excel spreadsheet along with size, nominal micron rating, cost etc.; see Figure 2 for a snapshot of this spreadsheet².

² This spreadsheet includes all Wix spin on type fuel filters with ¾"-16, 1"-12 and 1"-14 threads. For a copy of the full Excel spreadsheet, please e-mail me requesting a copy.

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Wix #	Napa #	Thread	Micron Rating	Water Sep/Drain?	Height	Diameter	Cost @ FF	Wix/Napa Filter Base
33005	3005	1-14	3	Y	7.389	3.69	\$11.52	24770/4770
33244	3244	1-14	16	Y	5.692	3.694	\$6.07	24770/4770
33367	3367	1-14	30	Y	7.600	3.673	\$5.75	24770/4770
33405	3405	1-14	12	Y	7.219	3.698	\$9.86	24770/4770
33406	3406	1-14	5	Y	9.805	3.677	\$12.50	24770/4770
33407	3407	1-14	5	Y	7.980	3.68	\$12.50	24770/4770
33411	3411	1-14	5	Y	5.791	4.263	\$17.21	
33412	3412	1-14	12	Y	5.747	4.285	\$25.18	
33414	3414	1-14	6	Y	4.426	3.663	\$14.92	24770/4770
33417	3417	1-14	12	Y	4.918	4.263	\$17.14	
33422	3422	1-14	2	Y	9.378	3.657	\$17.62	24770/4770
33426	3426	1-14	6	Y	5.640	3.69	\$19.90	24770/4770
33439	3439	1-14	12	Y	8.419	3.698	\$12.44	24770/4770
33522	3522	1-14	10	Y	7.452	3.775	\$7.50	24770/4770
33604	3604	1-14	8	Y	9.730	3.69	\$22.00	24770/4770
33780	3780	1-14	6	Y	11.308	4.39	\$24.57	
33786	3786	1-14	3	Y	9.983	4.25	\$19.04	
33787	3787	1-14	3	Y	10.080	4.25	\$18.57	

Figure 2. List of Wix/Napa spin-on fuel filters with 1"-14 threads and a drain sorted by part number. All of these fuel filters come with a water separator drain and most use the 24770/4770 fuel filter mounting base. The Wix 33005 is the filter I currently use for my aux fuel filter; I've since replaced that with the 33406 filter for more capacity.

Using this spreadsheet, the best-fit filter turned out to be the Wix #33405/Napa #3405 12 micron fuel filter. Its 7.2" length provides good capacity while not hanging below the bottom of the frame.

Bear in mind that most suppliers and users are going away from using nominal micron ratings due to inconsistent test methods and procedures between fuel filter manufacturers plus the fact that the micron ratings don't really tell how well the filter actually filters in the real world. Read the article titled "Marine Fuel Filtration – "The Seaboard Way"³" for an excellent discussion on this issue.

Fuel Hose

There are two important attributes of fuel line hose that you need to be aware of: Size and material compatibility.

Size, i.e. inner diameter of the fuel hose, is important to prevent pump cavitation and injector starving, neither of which will do your vehicle any good. In no case should you use fuel line that has a smaller inner diameter than the OEM fuel line. The outer diameter of the steel

³ See Sources and References for link.

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OEM fuel supply line on my '06 PSD is 5/16", while the tank and HFCM lines are 3/8" OD. I decided to upsize my fuel supply line to 3/8" ID to increase fuel line size plus fit over the ends at the fuel tank and HFCM.

Material compatibility: I had first planned to use SAE J30R7 fuel line hose, typical of the fuel line hose available at any auto parts store. However, I've learned that this hose is not rated for use with biodiesel and it will degrade with extensive use of biodiesel above B20; therefore I decided to upgrade the fuel hose for the pre-pump filter to SAE-J30R9 hose, also known as "fuel injection hose".

SAE-J30R9 is a low permeable fuel hose, rated for use with biodiesel. This hose is available from Auto Zone et al and costs about 4 times as much as 30R7 hose (i.e. about \$4/foot). If you are planning on using +B20 in your diesel truck, or live in a state where bio is mandated (i.e. MN) I'd highly recommend the use of SAE-J30R9 rated hose for your fuel lines if you choose to install a pre-pump filter in your truck. The other advantage to using 30R9 rated hose is that it's working pressure is 100 psi vs. 50 psi for 30R7 hose.

Ball valves

I decided to add ball valves to both ends of the 4770 filter head. These two valves offer three distinct advantages: Fuel shutoff when changing out the filter; reduces the amount of fuel leakage when draining the OEM HFCM drain plug and can be used as a theft prevention device.

There are two disadvantages to having these valves: cost and they lengthen the installation footprint. See Figure 4 to see how long the valves add to the length of the filter head installation. Fortunately, the cost of each valve is only about \$6 from McMaster-Carr and there is more than enough room inside the truck frame area to accommodate the valves.

Functional design and installation:

- Functional Design:

Figure 3 below shows the functional design of my PSD's fuel system, including the aux fuel tank and aux fuel filter I previously added (see aux fuel tank install paper in References). A lot of the parts are common with the aux fuel tank install; usually typical plumbing and fuel filter mounts.

Parts List:

1. NT/RDS 72118 Aux fuel tank
2. 3/4"-3/8" NPT reducer
3. 3/8" NPT barb
4. 3/8" ball valve McMaster P/N 4912K48 or equivalent; Note: 3/8" nipples & reducers, if needed, not shown
5. 3/8" ID SAE-J30R9 fuel hose
6. 1/2" - 3/8" barb
7. Perma-Cool Fuel filter head P/N 81794 (Wix 24770/Napa 4770/Summit Racing P/N PRM-81794) with 1"-14 threads and 1/2" NPTF ports
8. Water Separator/Fuel Filter (NAPA P/N FIL 3005/WIX 33005 or equivalent) 3 micron nominal
9. 1/2" - 5/16" NPT barb
10. 5/16" ID SAE-J30R9 fuel hose
11. NT/RDS gravity feed kit "Tee" with ball check valve.
12. OEM fuel fill hose
13. OEM main tank
14. Pre-vent cap (Tractor Supply P/N 08-28212, Cim-Tek 60002* or equivalent)
15. Various hose clamps, Teflon sealant tape & 3/8" Grade 5 bolts and nuts (not shown)
16. Notes: You may or may not need 3/8" nipples and 90 degree elbows depending on hose routing.

* Available from JMEsales.com

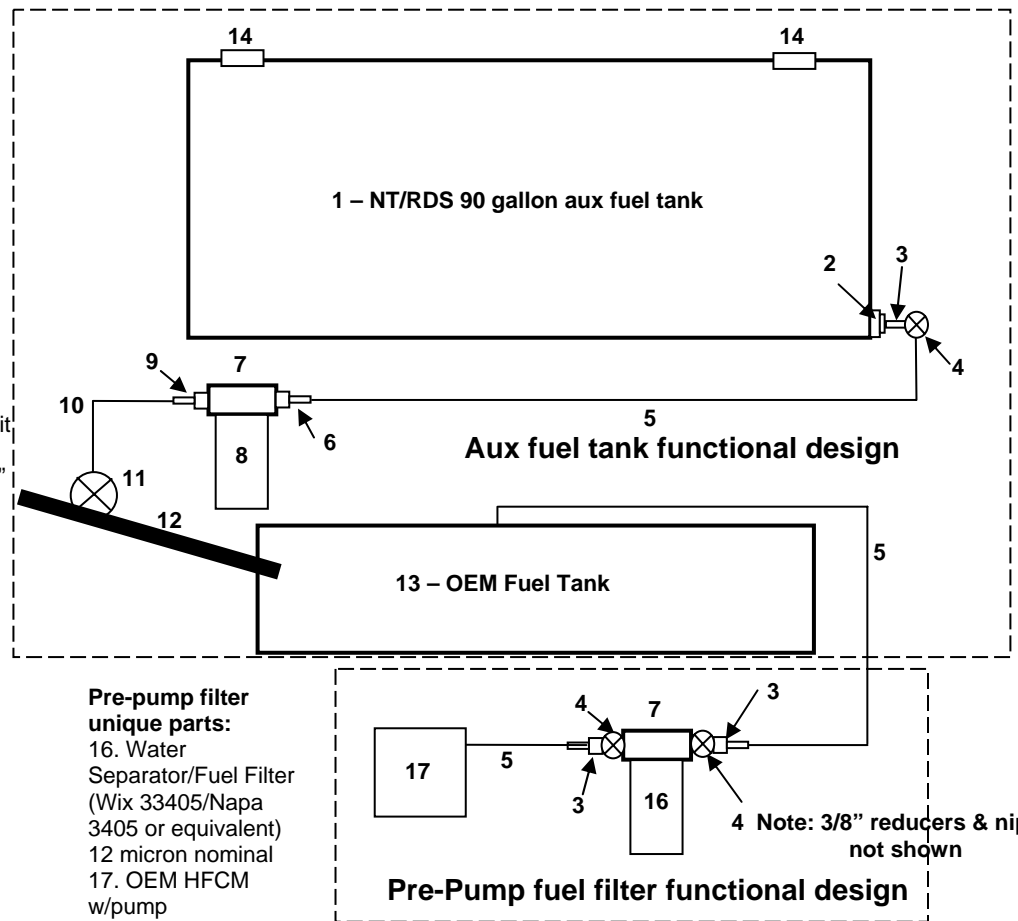


Figure 3. Functional diagram of my aux fuel tank system (top) and pre-pump fuel filter (bottom). Most parts for both installations are common and commonplace. Note that this diagram shows the Wix 33005 for the aux fuel tank filter; this has since been changed to the Wix 33406 filter.

- Installation:

Installation is pretty straightforward in the '06 PSD. There is plenty of space on the inside of the driver's side frame rail. Just forward of the fuel tank and the bed, there is a high spot in the body. The area also has a several existing 5/16" diameter holes in the frame, thereby

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eliminating having to drill into the frame to install the fuel filter mount. I made a mount for the Wix 34770 fuel filter head from a piece of scrap 3/16" 2"x4" angle, reinforced with gussets. See Figure 4, 5 and 6 for pictures of the mounted filter. I used 5/16" Grade 8 bolts and nuts in existing frame holes to attach the filter head mount. With this arrangement, the filter head is about 1/4" from the body, leaving room for body flexing without interference plus tucking the filter up as high as possible.



Figure 4. Wix 33405/Napa 3405 fuel water separator mounted under a 6.0l PSD; fuel flow is from left to right. Note the use of double hose clamps and 3/8" ball valves. The valves help prevent fuel leakage and loss while changing out the filter. You eyes aren't deceiving you: the filter head and filter are tilted slightly to the left. This was done to ensure the fuel line coming from the tank would clear the frame crossmember and keep the hose as straight as possible.



Figure 5. Wix 33405/Napa 3405 fuel water separator filter, Wix 24770/Napa 4770 filter head and mount. The bottom of the filter is just above the bottom of the frame, providing protection. The lower steel fuel line on the right center is the main OEM fuel supply line; note that it has been left stock.



Figure 6. The filter head mount outside the frame. The two Grade eight 5/16" bolts (one unseen in this pic) use existing frame holes, eliminating the need to drill the frame. Simple 3/16" x 2" stock welded to scrap 3/16" x 2" x 4" angle.

I decided to replace the entire OEM fuel line from the tank to the input of the HFCM. Doing this has several advantages: the OEM fuel line is steel with an outer diameter of 5/16" – the fuel line I'll be replacing it with has an inner diameter of 3/8", a 20% increase in fuel line diameter. Furthermore, the 3/8" fuel hose ended up with less bends and turns than the OEM steel lines, further reducing pressure drop to the HFCM.

On the '06 6.0l, the fuel supply line is the larger of the two fuel lines on the HFCM and on the fuel tank. See Figure 7 for a picture of the HFCM, you can see the direction of fuel by the arrows on the HFCM. Make sure to make your connections to the correction fuel tank and HFCM connections.

One difficulty in replacing the OEM fuel supply line in its entirety is installing the 3/8" ID fuel injection hose over the quick disconnect ridges on the fuel connection ends. You can just see this ridge in Figure 7, to the extreme left under the SAE-J30R9 hose. When I did this

installation, it was about 45-50 degrees F... I used hot water to soften the hose, but it was still pretty difficult to get the hose to slide over the ridge.

Except for the HFCM connection shown in Figure 7, I used two hose clamps to ensure no air leaks into the suction side of the HFCM. There simply wasn't enough room for my hands to force the fuel hose completely over the connection with room for two hose clamps. If you have smaller hands or do the install while it's warmer, you may have better luck.

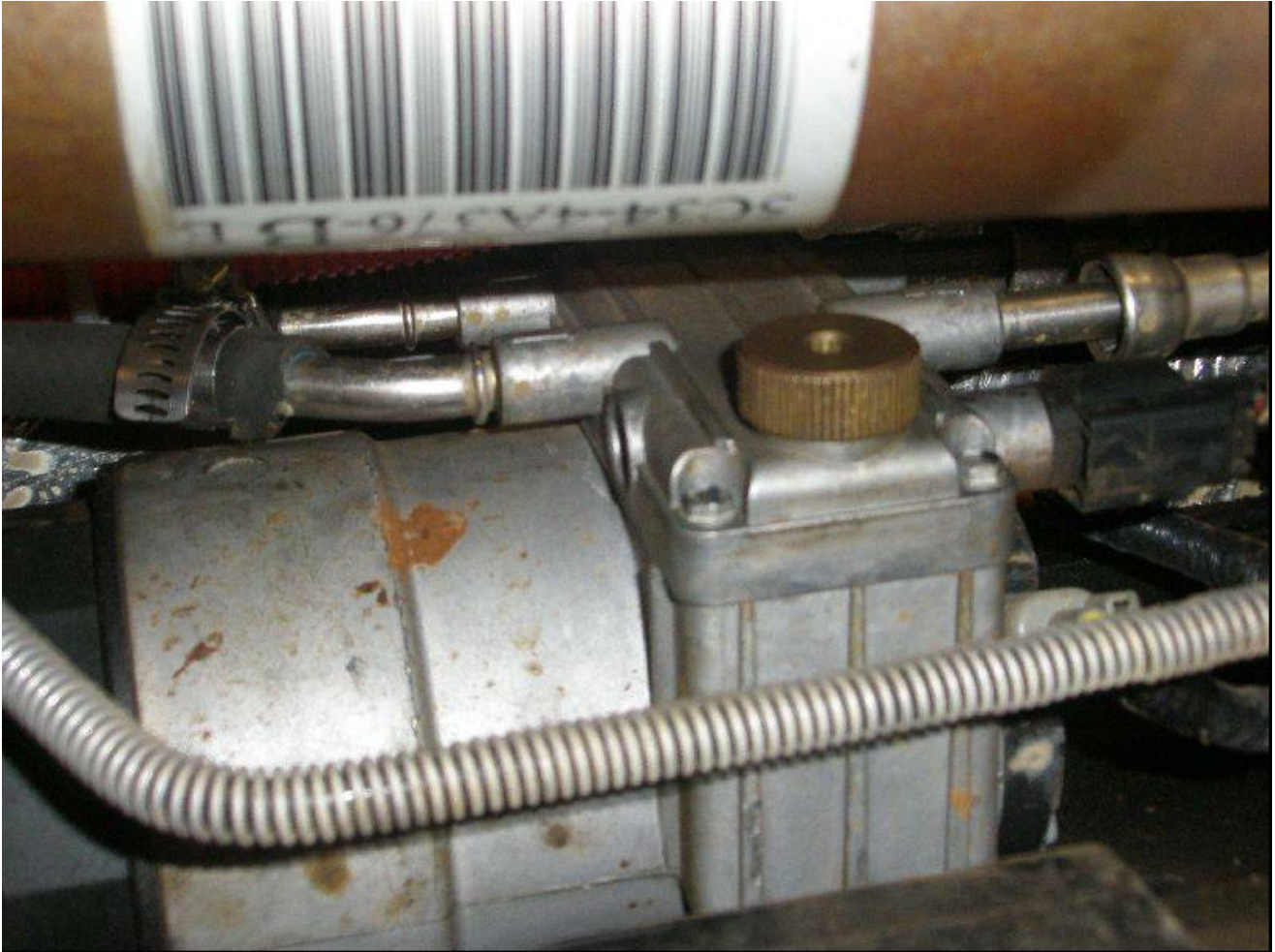


Figure 7. The 6.0l HFCM. The fuel supply line is the line with the rubber hose on the left. The output of the HFCM is to the right, note the direction arrows at the line connections and the quick disconnect on the extreme right. The fuel supply line connections here are 3/8" OD. If you look closely, you can see the ridge underneath the SAE-J30R9 fuel line hose on the left. The HFCM output line quick disconnect is visible at center right. Note the brass aftermarket IH drain plug – a much recommended mod to the '06 PSD HFCM (see sources).

Another big advantage of replacing the OEM fuel supply line is that it eliminates the quick disconnects on the vacuum side of the fuel system. These quick disconnects operate fine when under pressure i.e. on the downstream side of the pump but do not completely seal

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when used on the vacuum side of the fuel system, thereby leaking air into the fuel system – never a good thing on a diesel engine. This phenomena was discovered on the 7.3l PSD's and a number of fuel kits and modifications to the 7.3s focus on eliminating this problem.

One more advantage of replacing the OEM fuel line was that the OEM fuel line is left undamaged. This way, if I ever decide to remove the pre-pump fuel filter and return the OEM fuel system to stock, I simply disconnect the 3/8" hose and reconnect the OEM fuel line at the tank and at the HFCM – of course this will require dropping the fuel tank again. I left the OEM fuel line in place and just closed off the ends to keep bugs and dirt out of the line.

There are two disadvantages to replacing the OEM fuel line: Fuel line and quick disconnect tool costs and the need to drop the fuel tank. SAE-J30R9 fuel hose costs about \$4/ft. For a 10 foot length of hose, that works out to about \$45 – the single highest cost to this whole project. I used SAE-J30R9 fuel injection hose for the simple reason that it is rated for biodiesel fuel. SAE-J30R7 fuel line hose, typical of what's found in every auto parts store, is not. I like to run B5 in my PSD due to its superior fuel lubricity, the fact that it's usually cheaper than regular diesel and it makes the truck run smoother, quieter and cleaner.

In addition is the cost of the fuel line disconnect tool, if you don't already have it. For the fuel supply lines, you'll need the 3/8" fuel line disconnect tool; for the fuel return line, you'll need the 5/16" tool. I just bought a package deal that had various sizes to ensure I had the right tool; cost was about \$20 at the local auto parts store.

Dropping the tank to gain access to the top fuel line connection will be a blessing for most: while the tank is down, you can also perform the Harpoon mod (for 6.0s and 7.3s) and the Hutch mod (7.3s only). However, since I almost always refuel from my aux fuel tank, and therefore for the most part don't care about OEM tank refueling times, I decided to not do the Harpoon mod. Dropping the tank was by far the hardest part of installing this filter on the truck.

Project Costs:

SAE-J30R9 fuel injection hose (10 feet – used about 6):	\$40
Filter mount:	\$20
Filter:	\$12.50
3/8" ball valves (2):	\$12
Quick Disconnect tool set:	\$20
Misc. plumbing:	\$10
Total:	\$114.50

Results:

At the same I did the mod, I also replaced my OEM fuel filters. After doing the requisite 3 turns of the ignition key to prime the fuel system, the truck started right off the bat. While running, the truck seems to run smoother and quieter. I expect this is due to the larger suction line at the input to the HFCM, less turns and less sharper turns in the fuel line and less air sucked in at the quick disconnects. However, I don't have any fuel pressure data to compare, just seat of the pants impression. As usual, the truck runs like a scalded cat when the need, or desire, arises.

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Northern Tool: <http://northerntool.com/>

Perma-Cool: <http://perma-cool.com/Catalog/Contents.html>

Powerstroke.com (HFCM drain plug):
<http://catalog.powerstrokes.com/partlocator/index.cfm?action=MorePartInfo&PartID=356110&siteid=214083&catalogid=3660>

RDS: <http://www.rdsaluminum.com/homepage.html>

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