

Installing an In-Bed Aux Fuel tank in an '06 PSD

Al Dolney

March, 2007

Content:

- Problem Statement
- Upgrade Options
- Functional Design, parts and installation
- Final Product and Results
- Epilogue
- Appendix

Problem Statement:

The 2006 Ford F-350 SRW PowerStroke Diesel (PSD) long bed pickup, like my truck, comes stock with a 38 gallon fuel tank. To take advantage of lower fuel prices when available, convenience during long trips and to have an emergency backup fuel source during disasters, I wanted a higher fuel capacity in my PSD. Another important, but secondary priority, was to add significant fuel filtering capability to ensure clean fuel for the 6.0l diesel engine. Another priority was to minimize parts or installation impacts to the OEM fuel system. This paper outlines the choices, the functional design and parts and installation I chose to solve this problem and the results that I've experienced as a result.

Upgrade Options:

Here are some of the options to higher fuel capacity in my PSD, as I researched the problem:

- Leave stock
- Replace OEM tank with a larger aftermarket fuel tank
- Add an auxiliary fuel tank underneath the rear bed, replacing the spare tire.
- Add an in-bed auxiliary fuel tank

Leaving stock doesn't meet any of the problems as I've outlined in my problem statement: 38 gallons just isn't enough.

Replacing the OEM fuel tank with an aftermarket higher capacity fuel tank would appear to be an obvious choice: No appreciable change to vehicle size, does not take up bed space, an already engineered solution: just write the check and install. There are, however, a number of disadvantages: high cost for relatively low increase in fuel capacity (i.e. +\$800 or more for perhaps 12-19 gallons extra fuel), more changes to the OEM fuel system that I was comfortable with *probably* requiring professional installation (more \$\$) and no increase in fuel filtering capability. The first disadvantage is the main reason I discarded this option.

© 2007 Al Dolney. All photos by Al Dolney, except as noted. All rights reserved. Comments, suggestions or questions, e-mail me at aldolney@bellsouth.net

Disclaimer: This document provided for information only. No warranty express or implied that this modification will work in your or any other vehicle. Commercial use of this document expressly forbidden. Reproduction is allowed, as long as full credit is given.

Adding a second tank underneath the bed in the rear in the spare tire area also has some advantages: I've already done this mod to two other vehicles ('85 Nissan pickup and '85 Toyota 4Runner), so the process and structural requirements were already familiar to me; relatively low cost of a used Excursion tank with 42 gallon capacity and engineering the structural and plumbing parts myself. This option also allowed the addition of significant fuel filtering capability. Main disadvantages: having to find another secure location for the spare tire (i.e. the bed) and the need for active controls and a pump to move the fuel from the aux tank to the main OEM tank. This option is probably best if you have a need for significant extra fuel capacity without impacting bed space.

Adding an in-bed aux fuel tank was the final option I looked at since it has some significant advantages as well: there is a large selection of relatively low cost in-bed fuel tanks on the market with significant fuel capacity available (40-100 gallons); relatively simple physical installation of the tank and simple plumbing to the main tank (i.e. gravity feed) and additional fuel filtering capability is available. The main disadvantage is it takes up bed space.

Functional design, parts selection and installation:

- Functional Design:

The functional design for my aux fuel tank is pretty simple: in-bed aux fuel tank, 3/8" ball valve, filter mount and filter and interface to the OEM tank fill hose and 3/8" and 5/16" fuel hose to connect it all. Fuel fill to the aux fill tank is via one of the two tank fill ports located on top of the tank on either side. See figure 1 for a functional diagram of my aux fuel tank system.

Gravity-feed: Is it Legal?

There is probably more confusion on this subject than any other in the discussion of aux fuel tanks for pickup trucks. What follows here is the relevant regulation from the Department of Transportation (DOT) Code of Federal Regulations (CFR). However, I am not a lawyer nor is any of this discussion to be construed as legal advice; it's simply provided for your use as a basis for further investigation for your own information and use.

The relevant portions of the DOT CFR codes that apply to gravity feeding of fuel tanks are 49CFR393.65 Fuel Systems and 49CFR393.67 Liquid Fuel Tanks. The relevant portions of these sections are as shown below. For a complete copy of the entire texts, see the link for the DOT in the Appendix and then follow the link to the 393 section of 49CFR.

49CFR393.65, Fuel Systems: "(d) Gravity or siphon feed prohibited. A fuel system must not supply fuel by gravity or siphon feed directly to the carburetor or injector." [Ed. Note: misspelled word corrected.]

Note that 393.65(d) title makes a declarative and complete sentence with an adjective, noun and verb i.e. "Gravity feed prohibited". Quoted out of context, it is easy to see how people say that "DOT prohibits gravity feed". However, this sentence is not a regulation, it's a paragraph title and it is completely negated by the actual regulation that follows it i.e. "... must not supply fuel by gravity ... feed directly to the carburetor or injector." Since I am supplying fuel via gravity feed to the OEM fuel fill line and not directly to any carburetor or injector, I see no violation of 393.65.

49CFR393.67, Liquid Fuel Tank (partial): "(c) Construction of Fuel Tanks, (5) Fuel withdrawal fittings. Except for diesel fuel tanks, the fittings through which fuel is withdrawn from a fuel tank must be located above the normal level of fuel in the tank when the tank is full."

Since I am withdrawing diesel fuel and only diesel fuel from the bottom drain fitting of my aux fuel tank, I see no violation of 393.67 with my aux fuel tank functional design.

There are other regulations that apply to fuel tanks and systems at the Federal level, mainly Federal Motor Vehicle Safety Standards and environmental regulations. Vehicle safety standards for gravity feed mainly follow DOT as far as I've seen; if so, I see no violation there. Environmental regulations have to do primarily with leaking fuel.

There are a number of regulations that you need to be aware in installing your aux fuel tank; these are called out in 49CFR393.65, Fuel Systems. Examples include not having any fuel lines near flame or heat sources (i.e. the exhaust system); not having fuel lines outside the body of the vehicle or in the interior/passenger area of the vehicle. Anyone installing an aux fuel tank in their vehicle should review these regulations in their entirety to ensure their installation meets all DOT and Federal Safety requirements.

Basically, if you install the aux fuel tank using the same or similar workmanship and parts standards as the OEM design, you should have no problems with either safety standards or with leaking fuel. Note that any leaking fuel is a violation regardless of whether or not your fuel system is completely OEM or has been modified with the addition of an aux fuel tank.

For a definitive answer on the legality of gravity feed of diesel fuel, see the letter at the end of this paper from the US Department of Transportation (DOT) Federal Motor Carrier Safety Administration (FMCSA) that specifically addresses this issue.

- Major Parts:

Parts for my aux fuel tank installation included the fuel tank, a 3/8" ball valve, the Northern Tool/RDS gravity feed kit, the fuel filter mount and filter and various plumbing hardware, hose clamps and 3/8" and 5/16" fuel line hose as described here.

Northern Tool has a good selection (see Appendix for all sources), as do many aftermarket and truck accessory companies. The fuel tank I chose is the RDS 72118 (NT P/N 34901071). This tank is 60in.L x 14in.W x 26in.H and has a 90 gallon capacity. See figure 2 for a picture of this tank.



Figure 2. Picture of the 90 gallon RDS 72118 aux fuel tank. Note the two fuel fill ports; as supplied from NT, these are just PVC 2" threaded caps; you'll need to replace these with vented caps available from Tractor Supply et al; the roll-over valve-vent is not shown in this pic. (Photo courtesy of Northern Tool)

To connect my aux fuel tank to the OEM main tank, I used a NT/RDS gravity feed kit, see figure 3 for a picture of this kit.

© 2007 Al Dolney. All photos by Al Dolney, except as noted. All rights reserved. Comments, suggestions or questions, e-mail me at aldolney@bellsouth.net

Disclaimer: This document provided for information only. No warranty express or implied that this modification will work in your or any other vehicle. Commercial use of this document expressly forbidden. Reproduction is allowed, as long as full credit is given.



Figure 3. NT/RDS Gravity Feed kit for the Ford PSD truck. The large “tee” in the center of the pic contains the check valve that prevents the aux fuel tank from overflowing the OEM main fuel tank. (Photo courtesy of Northern Tool)

This kit costs about \$60 or so on sale from NT. While the kit appears to be complete, it does have some problems that you need to be aware of. The output of the ball valve shown in the pic above has a 3/8” OD hose barb end and the fuel hose provided is also 3/8” ID fuel hose; so far, so good. However, the input to the check valve on the large tee has a 5/16” ID barb! You can just barely see this 5/16” barb in the picture above.

This proved, in my opinion, not a safe or sound engineering solution. For my application, the filter mount between these two items allowed me to transition from 3/8” ID hose to 5/16” ID hose at the inputs and outputs, respectively, of the fuel filter mount.

Furthermore, the RDS aux fuel tank comes installed with a 3/4” NPT female port on the bottom right of the tank as the tank drain. However, the RDS ball valve has a 3/8” NPT male fitting, requiring a NPT reducer to fit the ball valve to the tank. Granted, it’s a small issue, but you would think someone marketing and selling both the tank and the gravity feed kit would include all necessary parts to fit these two parts together. I used a 3/4” male NPT to 3/8” female NPT reducer from McMaster-Carr since this part was not available from the local home improvement stores. Furthermore, due to space constraints, I used a 3/8” female-to-female ball valve from McMaster instead of the RDS supplied ball valve.

One of the major advantages I wanted in adding an aux fuel tank was additional fuel filtering capability. I decided on the Perma Cool 81794 fuel filter mount available from Summit Racing et al (Summit Racing p/n PMR-81794) that mounts a water separator fuel filter Wix 33405/NAPA 3405 or equivalent. This mount has 1/2” female NPT threaded ports and a designed flow rate of 25 gpm, far higher than needed in my gravity feed system. This fuel filter is rated to 12 microns nominal and is designed to separate out water from the fuel; this

contrasts with the PSD primary filter at 10 microns and the secondary fuel filter at the engine of 4 microns. See figure 4 and 5 for a pic of the Perma Cool mount and filter.



Figure 4. Pic of the Perma Cool 81974 fuel filter mount and 81000 equivalent to the Wix 33005 /NAPA FIL 3005 water separator fuel filter (this filter has since been replaced with a Wix 33405/NAPA 3405 filter). Note the drain on the bottom of the fuel filter; this filter is far easier to drain than the HFCM fuel drain for the '06 PSD. Incoming fuel comes through the hole on the lower left to the 3/8" NPT brass fitting top center; output to the OEM fill hose comes out of the top right 5/16" NPT brass fitting. (Photo by author).



Figure 5. Another pic of the filter and filter housing. You can see the RDS check valve at the top center in the OEM fuel fill hose (note the use of radiator hose to protect the valve and fuel hoses). The 3/8" fuel input line is seen on the right. Despite its open location, I've never seen any physical damage to the fuel filter after over 20K miles of driving, including many miles on gravel roads. Note how the easy accessibility of the filter drain. (Photo by author).

Miscellaneous parts needed not discussed above include 5/16" fuel hose, various hose clamps, zip ties and protective hose sleeves (I used 5/8" and 3/4" heater hose as necessary) and various NPT threaded and barbed fittings. All of these are available at most home improvement or auto parts stores. In addition, there are 3/8" Grade 5 bolts and nuts needed to install the tank and filter mount (if you decide to install a filter).

- Installation:

Installation of the tank itself was straightforward although tight. The width of the tank is 60" leaving only a few inches on either side for both the tie down bolts and the ball valve on the passenger side of the tank.

© 2007 Al Dolney. All photos by Al Dolney, except as noted. All rights reserved. Comments, suggestions or questions, e-mail me at aldolney@bellsouth.net

Disclaimer: This document provided for information only. No warranty express or implied that this modification will work in your or any other vehicle. Commercial use of this document expressly forbidden. Reproduction is allowed, as long as full credit is given.

I used 3/8" Grade 5 bolts and nuts to secure the tank to the bed with large "fender" washers. I double nutted all bolts to ensure that the tank stayed secure over time. You can see one of these double nutted bolts in Figure 4 above on the left.

One important note about fuel tank installation: My aux fuel tank drain port is on the right hand side facing forward. The OEM fuel fill hose is on the left. This requires that the 3/8" fuel line cross from one side of the vehicle to the other. I made sure this was a safe installation by crossing inside the pickup bed so that the fuel line was no where near the exhaust system on the right hand side of the truck.

Final Product and Results:

Advantages: There are a number of obvious and not so obvious advantages to having an aux in bed fuel tank in your truck. From my experience here is what I've discovered over the last year.

Added fuel range: Having a fuel range of over 1300 miles (depending on mileage) is an obvious advantage. For most of the life of the fuel filter and with the aux fuel tank at least half full, the gravity feed system will keep up with fuel usage while driving long distance. Normally, however, I only "refuel" while the truck is not moving, just as an extra safety measure.

Refueling when it's convenient, when fuel prices are low, fueling up with biodiesel when available; all make life easier and more convenient.

Convenience is further enhanced by the fact that I can refuel from both sides of the truck, vs. just the left with the OEM fill port.

Having the extra water separator/fuel filter helps ensure clean dry fuel is delivered to a very expensive diesel engine. The aftermarket fuel filter is rated at a nominal 5 microns vs. 10 and 4 for the primary and secondary fuel filters on the truck. Draining the aftermarket fuel filter is much easier than the stock filter system also. I put almost 100% of my fuel through the aux tank and then the aftermarket fuel filter before it ever gets to the stock fuel system.

Being able to mix fuel is a not so obvious advantage. For example, FMC warrants biodiesel up to a max of B5 (i.e. 5% bio). Most BD sales are for either B20 or B100 and, at least in north Alabama, is not readily available forcing me to buy it when I can. With the aux fuel tank, I can "pre-mix" the B20 or B100 with regular diesel fuel and worry less about the B5 warranty limit. The same is true when adding diesel fuel additives and lubricants: the aux tank ensures the fuel and additive are fully mixed prior to entering the OEM fuel tank.

Disadvantages: Like advantages, there are obvious and not so obvious disadvantages to an in bed aux fuel tank.

The most obvious is the reduction in bed space. My 90 gallon tank takes up 14" of an 8 foot bed, about a 15% reduction. This means not only a reduction in bed space but also it limits a use of a topper without added expense for special fill adapters and hoses. Plus, using a topper as a camping space is contraindicated: sleeping with a fuel tank isn't a good idea. An in bed fuel tank pretty much limits installing a pickup bed camper also. If these things are important to you, you'll need to find an alternative to an in bed fuel tank.

Filling up a 90 gallon fuel tank can take your breath away, cost-wise. \$300 fill-ups are not unusual. This is mitigated by the fact that I can avoid having to buy higher priced fuel. For example, while on a 2006 summer trip, I was able to avoid having to buy any fuel in California even though I drove over 500 miles while in that state. At that time, diesel was about 70 cents more expensive in California vs. Nevada or Arizona. On the other hand, having a 90 gallon aux tank in you pickup bed does not mean you have to fill it every time you refuel. For example, except for long trips, I never fill my aux tank; typically it's 30-35 gallons at a time when convenient for in-town driving.

Leaving the aux fuel tank valve open all the time, constantly feeding the main fuel tank will cause the PSD computer to throw a code (P0460). What happens is if the fuel quantity sensor does not drop after 200 miles, the computer thinks the sensor is faulty and throws the code. Therefore, I don't leave the aux fuel tank valve open all the time.

I find that the last 10-15 gallons in the aux tank won't flow via gravity to the main tank. I believe this is caused by back pressure in the aux fuel filter element. I mitigate this problem by having a super siphon with me in case I need that last 10 or 15 gallons; so far it hasn't been a problem.

I also find that fuel flow via gravity is notably slowed near the end of the fuel filter's life (I change all fuel filters every 15K miles).

Epilogue:

Parts List:

- 1. NT/RDS 72118 Aux fuel tank; 90 gallon capacity**
- 2. 3/4"-3/8" NPT reducer**
- 3. 3/8" NPT nipple**
- 4. 3/8" ball valve McMaster P/N 4912K48**
- 5. 3/8" fuel line**
- 6. 1/2" - 3/8" barb**
- 7. Perma-Cool Fuel filter mount P/N 81794 (Summit Racing P/N PRM-81794)**
- 8. Water Separator/Fuel Filter (NAPA P/N FIL 3005/WIX 33405 or equivalent)**
- 9. 1/2" - 5/16" NPT barb**
- 10. 5/16" hose**
- 11. NT/RDS gravity feed kit "Tee" with ball check valve.**
- 12. Vented fill port caps (qty. = 2); 2" NPT (Tractor Supply P/N 08-28212)**

© 2007 Al Dolney. All photos by Al Dolney, except as noted. All rights reserved. Comments, suggestions or questions, 10 e-mail me at aldolney@bellsouth.net

Disclaimer: This document provided for information only. No warranty express or implied that this modification will work in your or any other vehicle. Commercial use of this document expressly forbidden. Reproduction is allowed, as long as full credit is given.

13. All quantities above are one, except as noted; various hose clamps, Teflon sealing tape and 3/8" Grade 5 bolts and nuts.

Notes: You may or may not need 3/8" NPT or barb 90 degree elbows depending on hose routing.

Sources:

McMaster-Carr: <http://www.mcmaster.com/>

NAPA auto parts: <http://napaonline.com/MasterPages/NOLWelcome.aspx>

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

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

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

Summit Racing: <http://summitracing.com/>

Wix filter lookup: <http://www.wixfilters.com/filterlookup/index.asp>