Superformance GT-40 Drive Train Removal & Replacement

5/11/2013 2:01 PM

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Introduction

The purpose of this document is to guide the competent amateur mechanic in the steps needed to remove the engine and transaxle from a Superformance GT40. For the purposes of this document we will assume that the engine is 351 Windsor-based and the transaxle is a ZF or RBT. Given that, the author needs to make the disclaimer that his experience is with an FE engine with a Quaife "ZF-Q" transaxle. Therefore, when the specifics of the Windsor and ZF subsystems are addressed the reader can expect some vagueness and/or qualifications to appear. However, I do not believe that the guidance provided herein is substantially weakened by this lack of experience since, after all, what is at

issue here is more the specifics of the Superformance GT-40 chassis and how they interface to the engine and transaxle.

There is no “correct” or “ideal” order in which to proceed, other than to avoid attempting operations that simply cannot be carried out ahead of some other operations. Most of these are visually obvious, such as removing the exhaust system before attempting to remove the rear cross-member. I believe there is really only one important strategic decision that needs to be made, and that is whether to separate the transaxle from the engine before or after removal from the chassis. When the time comes I will discuss that issue.

Required Tools and Facilities

Aside from the usual auto mechanic tools (sockets, open and box end wrenches in inch and metric, pliers, punches, soft faced hammer, straight and Phillips screwdrivers, etc.) I will list here the tools that are needed that are specific to this job and less likely already to be in the reader’s possession:

1. Shop Crane: the combined engine and transaxle weigh roughly 700 lb., 500 for the engine and 200 for the transaxle. The smallest commonly available crane or crane has a capacity of 1 ton (2,000 lb) which is clearly structurally sufficient. However, given a choice, the higher-rated cranes usually have a longer reach and are stiffer. If you have never used one before you may be surprised how “bouncy” such a heavy-looking steel structure is when it is holding several hundred pounds. This occurs at very low frequency, e.g. just a few cycles per second and can interfere with attempting to guide the engine into close quarters. Exacerbating this is the fact that the engine has such high mass that it can be moving very slowly and still do considerable damage if it collides with another object. So, bigger is better if you have a choice in selecting your crane. Also be aware that the rating applies only with the crane fully retracted. As you extend it that rating progressively lower (typically in 500 lb increments). Another desirable feature in the crane is for all four wheels to be casters rather than in fixed orientation. This allows the crane to be shifted from side to side in small amounts while in position. Here is a picture of a suitable crane.


PITTSBURGH

2. Engine Crane Leveler: This is sometimes included with the crane. It is used to allow the engine to be tipped in order to allow it to ascend out of the engine bay nose down, since it cannot be dropped in from directly above. Here is a typical one in place hanging from the crane and ready to be attached to the engine.

3. Engine Stand: presumably you are going to disassemble the engine to some degree, so you need something to hold it. This is usually an engine stand as shown below.

4. 8-point (double-square) wrench: this is needed only if the screws used to attach your half shafts have an 8-point socket. If they are anything but a hexagon, be very carefully about what wrench you use, since the wrong kind (e.g. Torx or 12-point) can easily strip the screw head.
5. Jack stands: you should plan on doing most of the work with the car on jack stands and all four wheels removed so you will need four jack stands.
6. Large pan, ideally about 4” deep, to slide under the front of the engine for capturing coolant.

Basic Preparation

Put the Car on Jack Stands

It is helpful to have the front of the car elevated as far as is convenient, since this reduces the tipped-forward angle you need to establish for the engine while it is on the hoist. Jack stand placement at the front is not critical. Recently I've been using the anti-roll bar bushing mounts since they fit rather nicely in the saddle of a typical jack stand. You can use a quick-lift hook to raise each front corner with your floor jack.

The placement of the rear pair of jack stands is important because the front wheels of the crane need to fit either between or around them and they will be adjacent to the engine. So probably best is to jack up the rear of the car between the quick-lift jack hooks and place the jack stands on either side of the "hoop" (the circular structure of the frame around the bell-housing). There is no reason to raise the car any higher than what is needed to remove the wheels. You should be able to accomplish the entire job without crawling underneath the car, but that is not guaranteed.

Remove Things In the Way

- Remove the rear shell ("clip"). Don't forget to unplug the tail light wiring first.
- Remove the rear wheels.
- Remove the seats.
- Remove the firewall cover (the large sheet metal plate behind the seats).
- Remove the smaller covers below the main firewall opening; you will probably need these out in order to disconnect the main coolant lines and possibly in order to access your ignition unit or EFI controller.
- Optional: remove the rear window as a safety measure to prevent some part of the engine hitting it. The roof drain tube will keep you from removing it completely but getting it just a little into the cabin will provide some peace of mind.
- Optional: drain the fuel tanks. An easy and relatively safe way to do this, if your fuel plumbing allows, is to disconnect the plumbing somewhere downstream from the fuel pump, connect a longer hose to the pump output, and turn the pump on to move that gasoline into storage containers (or another car). I do this just because I don't like working around large quantities of gasoline no matter how they're stored; there are just too many ways all that fuel can accidentally leak or get spilled and catch fire.
- Disconnect the battery positive cable, and enclose the battery positive terminal in a very secure way so that there is no chance that anything will come into contact with it. Even better, remove the battery entirely.
- Disconnect the main coolant lines and drain the coolant.
  What to do here varies. You might want to drain the bulk of the coolant in a more controlled fashion, for example, by disconnecting one of the joints up in front while the front of the car is still on the ground. No matter what you do, with a stock Superformance GT40 there is no easy way to drain and capture the coolant. At some point I got tired of this and installed a tee junction in my front heater line and added a plugged hose so that I can pull that hose out the

side of the chassis, aim it over a tray and remove the plug in order to drain the system without getting coolant all over the frame.

In any event at some point you will have to disconnect the engine's main coolant lines so it's mostly a question of how much coolant will come out when you do that, and clearly you don't want more coming out than your pan can hold. How you do this disconnection depends on how your coolant lines were run between the engine and the two aluminum pipes that run the length of the center tunnel. These pipes end just at the rear end of the tunnel, so access to the hose clamps, via the smaller openings on either side of the tunnel, can be awkward. If I remember how the 351 installation kit works, there are two rubber elbows on the ends of the aluminum tunnel pipes so you could disconnect the side end of one of those elbows and let the coolant flood the very rear of the frame with coolant almost all of which, with the nose elevated will flow over the rear lip and into the pan. As-delivered there is no drain hole in the frame in that vicinity (we should probably all drill one, I think, in case of any leak in the tunnel). So, inspect your coolant lines and see if there is another joint further to the rear that you can disconnect and that will drain directly down into your pan.

- Disconnect the heater line at the engine.
- Remove A/C Compressor. This is awkward, but it's probably better than disconnecting the compressor and thus having to discharge and recharge the system with refrigerant. Disconnect the compressor clutch wire. Once the compressor is free of the engine you can probably bring it into the cabin through a firewall opening still connected to its refrigerant lines.
- Remove Alternator. This is debatable because it is awkward to do from inside the cabin, but may save you some effort during engine removal. Disconnect any wiring first.
- Remove the starter. This may not be strictly necessary, but there is a vulnerable brake line pressure switch for the brake lights located right next to the starter, so removing the starter now may help prevent that switch and its terminals from being damaged. If you do remove it at this point, disconnect the starter signal wire and starter high current cable at the starter first.
- Remove the rear subframe. Inspect it for any wiring or plumbing that is attached, and detach those. The subframe is held to the hoop by six bolts, four at the bottom and two on top. Probably best to start with the ones at the bottom. The outer two also retain the inner ends of the rear lower lateral links. Thus, when you pull them out the rear suspension will drop a little in a way that could strain the rear brake lines. You can deal with this by supporting the rear hubs, or by having an assistant support them as you pull the bolt out. Mind the cylindrical bushings on either side of the ball joint that the bolt goes through, those can fall out and roll away. Since the positions of the holes in the subframe likely do not align with those in the hoop, there can be substantial lateral tension such that some bolts may require tapping out with a punch, pulling out with clamping pliers (vise-grips), or prying the subframe away from the hoop.
- Disconnect the half shafts from the transaxle. You should need to disconnect only the inner (transaxle) side and let the half shafts rest on the floor. However, this exposes the CV joint so you should take some precautions to prevent foreign matter from getting into the CV joint. As noted above you may need an 8-point ("double square") wrench to remove the bolts. You may want the transaxle in gear and/or the handbrake set to help prevent the half shaft from rotating.

- Remove the exhaust system. You can probably leave the mufflers attached to the collectors. Detach the mufflers from their support bracket (usually held down by a spring). Remove the four allen screws and nuts that hold each collector to each of its four exhaust pipes. The collector-to-pipe joint is a "double slip" joint meaning the collector side is a pair of concentric tubes. It may take some tapping, levering, penetrating oil, etc., to get this joint to come apart. The fastener lugs make convenient levering points, as well as possibly allowing you to insert a threaded rod with two nuts and using the nuts to spread the lugs apart.
- Remove the exhaust header pipes. These are quite interwoven so there are only a few sequences of removal that work. Start by unfastening each header from the head. The best order, by cylinder number, in which to remove the pipes is probably:
    - 1 and 5, then
    - 4 and 8, then
    - 6 and 7, then
    - 2 and 3.

    If you are concerned about scratching the headers you will want to slide on some plastic sleeve, or apply tape, etc., to protect the headers. They tend to collide with the corners of the frame and with each other's flanges.

This should account for all the mechanical obstructions and access requirements in order to proceed with disconnecting the various smaller items.

Disconnections

- Shift Cables. This probably requires disconnecting both the inner cable and the outer cable (sheath, jacket) from the cable brackets. In both cases you want to try to preserve the shift cable adjustment if possible, so try to mark with paint or tape the positions of any nuts, etc., that establish that adjustment. Alternatively, you could leave the outer cable in its bracket and remove the bracket itself, thus preserving at least that adjustment. Place the detached cables on the floor or tied away such that they will not be in the way of the shop crane when you roll it in.
- Electrical connections. This of course will vary from car to car but here are the connections on or near the engine I can think of.
    - Distributor from ignition box or coil
    - A/C compressor clutch signal (probably already disconnected above).
    - Alternator charge wire at alternator
    - Alternator indicator wire, if any, at alternator
    - Starter signal cable (usually pull off at starter solenoid)
    - Starter high-current cable (usually unscrew at starter solenoid)
    - Ground cable (at engine head or block)
    - EFI harness
    - Oil pressure sender (for electronic gauges)

    - Oil Temperature sender (“)
    - Water temperature sender (“)

  Carefully drape or tie these loose wires out of the way.

- Fuel connections. Not my area of expertise, but the lines supplying your injectors are probably under high pressure so take some precaution to release that pressure in a controlled way, and be ready to catch the fuel in the lines if they run uphill from your disconnection point.
- Instrument temperature lines. If you have the original Superformance-supplied gauges, you will have two corrugated-looking capillary tubes running to your oil and water temperature sensing points. These bulbous metal sensors unscrew at the engine. Be careful not to kink or unnecessarily flex the capillary tubes, and tie them out of the way.
- Oil pressure line. The yellow oil pressure line is actually a 3/16” clear nylon line enclosed in a yellow protective sheath. It is probably best to disconnect the tubing itself from whatever threaded adapter attaches it to the engine (typically via a pipe thread). It is connected with a hollow brass nut and ferrule, so unscrewing the brass nut should allow you to pull out the inner clear nylon tube with its brass ferrule in place on the end of the tube. Oil may dribble out depending on how the tube is routed. Cover or plug both sides of this connection.
- Clutch Hydraulic Line. I like to avoid breaking hydraulic connections when possible, so consider unfastening the slave cylinder and setting it aside rather than uncoupling the hydraulic line.
- Transaxle breather line, if any. Best to disconnect at the transaxle in order to avoid things dangling from it during removal.
- Engine breather line, if any.

Removing the Drive Train

At this point the only things still physically connecting the engine and transaxle to the car should be the two engine mounts and the two transaxle mounts at the top of the hoop.

Order of Separation

At this point we need to address the question of whether to separate the transaxle from the engine and remove it first.

Separating First

I prefer this method basically because the operation of the crane is probably the most dangerous (to you and the car) phase of the project and I’d rather maneuver with a smaller and lighter object dangling from the crane. Also, connecting the crane to just the engine is simpler, and because it is shorter it is easier to establish its tilt angle when you are maneuvering it out of the frame. Access to the bell housing fasteners with the engine in place is still quite good.

Separating After

This requires a more difficult process of hooking the crane to the drive train since you want the crane hook located over the center of gravity (approximately at the rearmost exhaust ports). You have to

establish an attachment point at the rear of the transaxle, and use longer chains or straps. The whole thing is heavier, so crane bouncing is slower and higher in amplitude. The whole thing has a larger polar moment of inertia, so swinging induced by any motion of the crane is worse. The whole thing is larger so you have a larger area to watch for collision while maneuvering it in. The benefit is that you have complete and open access to the rear of the engine while attaching the transaxle.

Removal Steps

I am going to proceed on the assumption that we separate the transaxle first. At this point it might be worthwhile to lower the rear of the car almost to the ground, since this further reduces the amount of lifting you have to do and increases the relative tilt between engine and car. Just don't lower it so far that you can't pull the transaxle out to the rear.

Remove Transaxle

Support the transaxle at the rear, and unscrew the nuts from the studs passing through the urethane bushings at the center of the cross member. You want the front nuts to unscrew first; if they don't, you can push the studs forward enough to use pliers on them while removing the front nuts, or put jam nuts at the rear, or cut slots in the ends of the studs at the rear and use a large screwdriver to restrain the studs from turning. Pull the studs out and catch any metal bushings on either side of the urethane bushings.

Detach the bell housing from the block,and pull the transaxle off, with the usual caution about protecting the input shaft from any strong bending loads. The engine balances pretty well on its two mounts, so there should be no drama from it when you separate the transaxle. If however the engine mounts are trying to tip the engine forward enough so that the input shaft resists slipping out of the clutch splines, you might want to put a jack under the front of the engine to help remove that tension. Loosening the engine mount-to-block fasteners can also help the engine rock back.

One method for supporting the transaxle during removal is to place a mover's dolly or similar (see below) underneath with suitable supporting blocks; for safety's sake strap the transaxle to the dolly to prevent its rolling off.

Unfasten and Support Engine

Remove the hoop cross member (four bolts).

Roll the crane into place, exactly centered left-to-right, with the hook positioned over the center of the engine, or just slightly to the rear. On my FE with Edelbrock heads there are threaded holes at the front and rear of both heads, and these make ideal attachment points. Hopefully you will find that or something equivalent. If not, you can make a steel strap (say, 1” by 1/8” by 6”) with holes that bolt to the exhaust manifold studs or bolts and reaches upward for attachment to the chains. To prevent stud or head damage, make sure it is tightened down against the head, and try to use at least two attachment points at each exhaust port.

Another important thing to be careful of is the effect of the chains as they wrap over any corners (e.g. the valve covers), so if that occurs insulate the chains from the engine with pieces of wood or thick plastic or fabric. The pressure between the chain and any corner it rests on is very high, and it moves during maneuvering so there is real potential for deep scratches, denting or bending damage.

Raise the crane until it just starts to take some load from the engine mounts. Attempt to remove the two long longitudinal bolts from the engine mounts. Try raising and lowering the engine in little bits until one of the bolts feels loose. If so, remove it and then do the same with the other. If that doesn't seem to be happening, take most of the load off the crane and either loosen or remove the bolts/nuts holding the mounts to the block. If you removed them the engine should then lift away cleanly. If you just loosen them, you should now have a broader range of motion over which the longitudinal bolt is free. If so, remove it. If not, abandon it, and just unbolt the mount from the block.

Remove Engine

Now you are free to raise the engine out of the car. Basically its path out of the car is one sloping upward from front to rear, like the slope of the firewall, with the front of the engine tipped down. The most likely points of collision are the shoulder belt bar, the rear edge of the roof, the slanting sides of the engine bay and the upper ends of the hoop where cross member was. Be especially careful of the stop lamp switch next to the starter motor.

Since your crane has only two primary axes of motion (up/down hydraulically, forward/back by rolling the whole thing) you end up following this path in vertical and horizontal increments. However, you want to establish a forward tilt since that reduces the elevation you need. So, first raise it a little and see which way it tilts on its own. Then using the balance crank, tilt the engine forward from level a little. Then raise it a little, roll it back a little, and see if it would help to tilt it forward. Keep repeating that cycle until it is an inch or two up and you have a good feel for the dynamics of the crane and its engine-pendulum. An assistant can be very useful both in watching out for potential collisions and in damping the engine's tendency to swing after each motion you make with the crane. Just make you assistance knows to watch his/her fingers particularly around the points of collision mentioned above.

If the Windsor block is similar to the FE in having lateral protrusions at the rear for attaching to the starter and bell housing, you will notice that rather than raise the engine entirely above the rear hoop, there is a height at which the block will pass through the area formerly occupied by the cross member. So, continue to raise, roll back and tilt while watching for the least altitude that lets the engine pass between the ends of the now-open hoop. Once you get it to that altitude and tilt, you should be able simply to roll the crane and engine all the way back entirely removing it from the car. At this point you probably want to maneuver the crane and engine so that you can bolt it to your engine stand at the bell housing bolt locations.

Replacement

Assuming you haven't waited too long to replace the drive train, you almost certainly remember what you need in order to do so. Here are a few additional tips:

- The sub frame is likely to be difficult to reinstall due to misalignment of the six mounting holes. The key trick is to start all six fasteners by a few threads but not to further tighten them until they are all started. For future maintainability you may want to correct these misalignments while you have the sub frame off via suitable grinding and/or welding or brazing.
- Reinstallation of the header pipes goes in the opposite order:
    - 2 and 3, then
    - 6 and 7, then
    - 4 and 8, then
    - 1 and 5.
- You made need to take some steps to get all the air out of the cooling system after your initial fill. The Superformance cooling system is inherently self-bleeding since it has bleed lines at all the high points in the system. However, you can pretty well shop-bleed it by alternately raising the front and rear ends of the car so the bubbles are motivated to run to one end or the other. It also seems to help to repeatedly pressurize and de-pressurize the system in each raised position. This requires a cooling system pressure test tool such as a Stant 12770 (~$70) which is really just a hand pump and an adapter to fit the header tank neck. There are also cooling system evacuation tools that other owners have reported as being useful. Once the car is running you can help it to self bleed by revving the engine, braking hard and accelerating hard in order to "slosh" the coolant from one end to the other.
- With typical engines the half-shaft fasteners are loaded near their limits so be sure properly to prepare their and the CV joint threads and to torque them to an appropriate value. The Porsche community discusses this issue with CV joint fasteners in some detail on their various internet forums such as http://forums.pelicanparts.com/.
- I recommend treating the suspension fasteners the same way: making sure the threads are clean and dry, or clean and lubricated, and using suitable torque values for whichever regime you choose.
- All critical fasteners should be rechecked after a few vigorous drives and heat cycles.