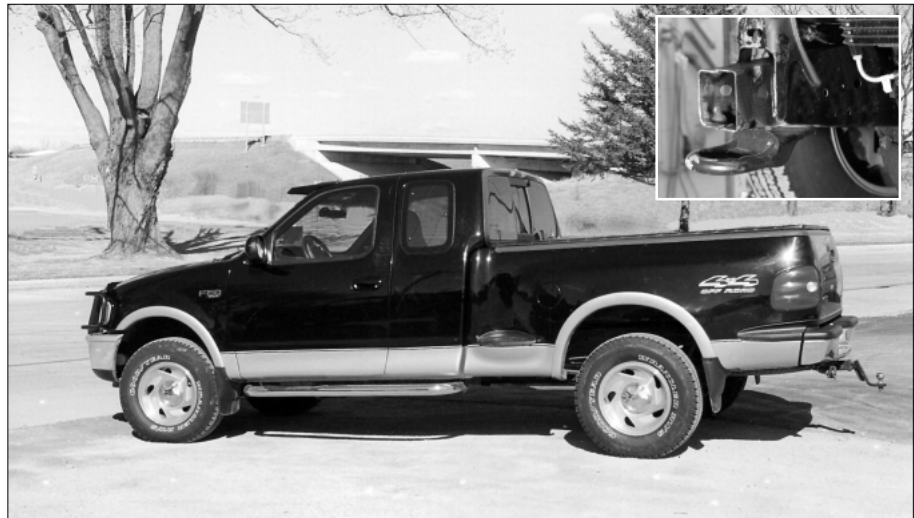


Ford Full Frames –Straight Talk About Repairs



Several questions surround repair of the Ford F-150 frame.

I-CAR was founded 20 years ago to help settle repair issues on the unibody vehicle. Ironically, the full-frame vehicle is the subject of at least one-third of the inquiries received today at the I-CAR Tech Centre. And 90% of those inquiries concern the Ford F-150 frame (see above Figure). Add the Ford Ranger/Explorer frame, and the list is even longer.

Why all the questions? To start with, three of the top five selling vehicles have full frames and the Ford F-150 has been on the top of the list the past several years.

Another reason for all the questions is that the frame comprises a large,

expensive, structural member. The repair shop (not to mention the insurance company) usually doesn't want to be told that this part has to be fully replaced. So the inquiries usually involve how unibody repair procedure guidelines apply to frame repairs. These include questions on sectioning, the use of heat when straightening, high-strength versus mild steel, and the kink versus bend rules. Other design issues and repair recommendations for these frames that add to the questions include: convolutions in the front frame rails, reinforcements that Ford says can be welded, stress cracks in the frame, and replacing rivets with bolts.

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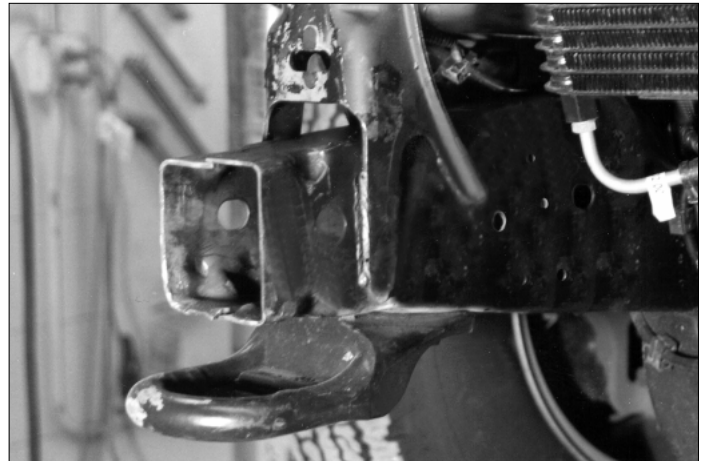
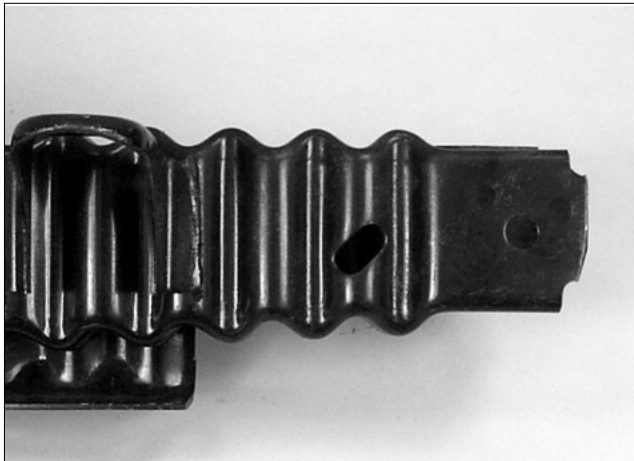


Figure 1— Whether the exaggerated ripples on the pre-1996 frame ends (left) or the more subtle crush initiators (right), the rule is still to not straighten these areas.

Each subject alone is usually easily understood. But together, combined with recommendations from other vehicle makers and information providers, and the lack of an OEM collision repair manual on these vehicles, add up to some confusion when a frame-damaged vehicle comes in for repair. This article tries to clean up some of this confusion, by presenting Ford's repair recommendations for its full frames. The repair information in this article is based on our conversation with a Ford frame engineer.

CRUSH INITIATORS

Crush initiators help manage collision energy. These are designed-in collapse zones that absorb some of the energy during a frontal collision. The crush initiators combine with other designed-in frame features, such as kick-up areas or offsets, to direct the energy of a collision around the passenger compartment. These energy-management strategies became a federal mandate in 1992. On 1996 and later Explorer and F-150 frames, the crush initiators don't have near the same physical appearance as the more exaggerated convolutions found on earlier frames (see Figure 1). The same rule still applies, however.

That rule is: DO NOT REPAIR CRUSH INITIATORS. This area is from the front to about 600 mm (24") back. If the frame is bent in this area, straightening is not an option. Ford maintains that the integrity of these areas is crucial to proper airbag deployment, and therefore these areas should not be repaired.

SECTIONING RECOMMENDATIONS

The sectioning procedures sanctioned by Ford (see the timeline in Figure 2) include the front frame horn extensions for the 1992–1995 Explorer, 1992–1997 Ranger, and the 1992–present Econoline van. These right and left replacement sections, which include the front rail convolutions, are available from Ford to avoid replacing the entire frame (see Figure 3).

The sectioning procedure with these kits involves GMA (MIG) welding a butt joint with backing, using backing pieces supplied with the kit (see Figure 4). The thickness of the rail adds requirements to the welding procedure. To ensure proper weld penetration, the rail edges should be beveled all around for a V-groove joint. The root gap should be a consistent 4 mm ($5/32$ "). The GMA (MIG) welder

must be capable of producing 200 amps at a 40% duty cycle. The welding wire should be rated ER70S-3, with a 0.8 mm (.035") diameter. These capacity requirements dictate a 220-volt welder.

There is also a front frame sectioning kit available for all 1997 and later F-Series 250 and 350 models. The kit

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FORD FRAME TIMELINE

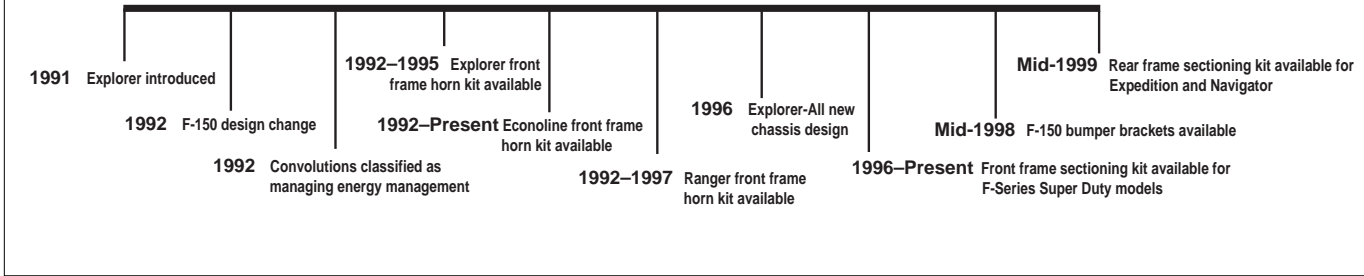


Figure 2—Timeline for the Ford frames.



Figure 3—Front frame horn sectioning kit. The small pieces are the butt-joint backing sleeves. (Courtesy of Tech-Cor)

consists of the front frame rails and crossmember. With this kit, bolts are used to replace rivets at the side member joints.

There are no front rail repair kits available for any other model year of F-series pickups, Expedition, or Navigator. Chassis engineers are reluctant to authorize a front rail sectioning procedure for the 1996 and later F-150, Expedition, and Navigator because the entire frame

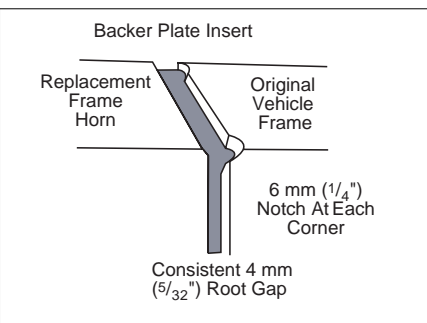


Figure 4—The frame horn kit is installed with a GMA (MIG) welded butt joint with backing. (Courtesy of Tech-Cor)

structure up to the cab is designed to manage collision energy. Any sectioning performed in this area could potentially affect crash performance. There is a rear frame sectioning kit for all model years of the Expedition and Navigator targeted for release in the second quarter of 1999.

It's questionable how valuable these extension kits are, especially the front extension kits. Any collision that collapses the convoluted areas is likely to cause secondary damage farther into the frame. This damage requires straightening, whether the front ends are cut off and replaced or not. The question is: when is it more feasible and cost-efficient to replace the entire frame?

STRAIGHTENING ISSUES

There are other issues confusing the straightening option, including:

- Do kink vs. bend rules apply?
- How much heat can be used?
- What cracks can be repaired with the use of reinforcements?
- What size and strength of bolts are used to replace rivets?
- Are these frames high-strength or mild steel?

Kink Vs. Bend

Ford agrees that the I-CAR kink vs. bend rule should apply to frame assemblies. So when determining whether straightening is possible,

the first question should be whether the frame is bent or kinked outside of the crush initiator areas.

To review these definitions:

- A **bend** is when the change in the shape of the part, between the damaged and undamaged area, is smooth and continuous, and can be straightened without permanent deformation.
- A **kink** is a sharp bend of more than 90° that can't be straightened without permanent deformation or cracking (see Figure 5).

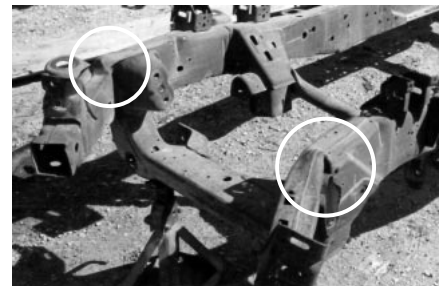


Figure 5—These folds in the frame rail are classified as kinks and cannot be repaired.

Bends can usually be straightened with little or no heat applied. Kinks will usually tear or crack during straightening. Often a kink is work-hardened to the point where the deformation is permanent. The only repair for a kinked frame member is replacement of the damaged section or complete frame.

Use Of Heat

Ford has remained consistent on heat recommendations. If heat must

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be applied to relieve stress in structural parts, the hot working temperature should not exceed 650° C (1,200° F). This is described in the service manual as heat that forms “a dull red glow.” This is not much heat, and it’s very difficult to stay within that range. It’s for this reason several vehicle makers say heat should never be used for straightening. I-CAR recommends that a temperature measuring device, such as a thermal paint or crayon, be used to measure the temperature rather than relying on eyesight alone.

If more than the allowable amount of heat is necessary to straighten a bent frame rail, that’s an indication that it’s too severely bent to straighten. A technician can often get the rail physically straightened, and computer measurements will verify the rail is back to its original dimensions. But the part may have grain-structure damage and may not perform the same as an undamaged part in the next collision. If you have to exceed these heating recommendations to straighten the rail, the frame should be replaced.

Reinforcements On Cracks

Ford’s service manual recommendations to reinforce cracked frame members states:

“After a bent frame has been straightened, inspect the member closely for cracks. If any cracks show, the frame member should be reinforced or replaced.”

This says that cracks caused by collision damage or straightening can be repaired by welding on a reinforcement plate. This does not refer to cracks caused by attempting to straighten a kinked area. Kink vs. bend must be considered first. The recommendation for cracks caused by kinks is to replace the frame.

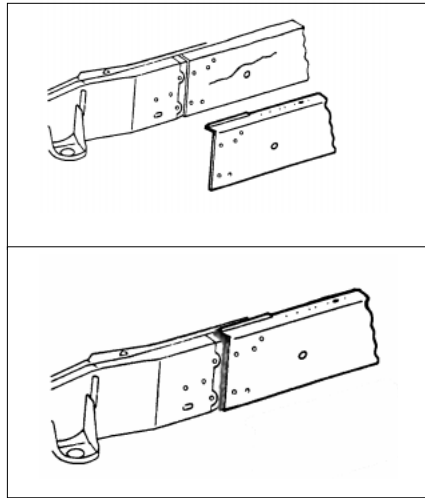


Figure 6—The reinforcement is welded to the outside of the stress-cracked rail. (Courtesy of Ford Motor Company)

The service manual says the reinforcement should be the same material and thickness as the frame member being reinforced. Ideally, the reinforcement should be cut from the corresponding area of a similar frame. Also, the reinforcement should extend 100–150 mm (4–6") to either side of the crack.

The frame reinforcement procedure described in the service manual calls for installing the reinforcement on the outside of the rail (see Figure 6). There is no reference to installing the reinforcement on the inside. The first step is to drill a 6 mm (1/4") hole at a point 12 mm (1/2") beyond the root of the crack.

This is to stop the crack from spreading. You then grind out the

full length of the crack from the backside to form a V-shaped slot, and weld the crack shut. Clearance holes are drilled in the reinforcement, where necessary to clear rivets and bolts. The reinforcement is clamped to the rail and welded to the rail all around its perimeter. Undercoating applied to the outside of the repair provides the necessary corrosion protection.

Where the crack extends to more than one frame surface, two pieces of flat-stock reinforcement are used. The two pieces, one for each surface, are welded together where they join.

This type of reinforcement repair is possible only on the “C” channel portion of the rails, where there’s full access to both sides (see Figure 7). Fortunately, this is where the stress cracks caused by overloading or fatigue normally occur.

To repair a crack on a closed-frame section, V-groove the crack from the outside. Weld the crack shut, and dress the weld flush with the surface. Apply a reinforcement plate to the outside, just as on the three-sided channel repair. Again, this can only be done outside of the crush initiator area.

Also on the issue of cracks, Ford states that frame replacement is required if there are cracks in the steering gear area. This includes

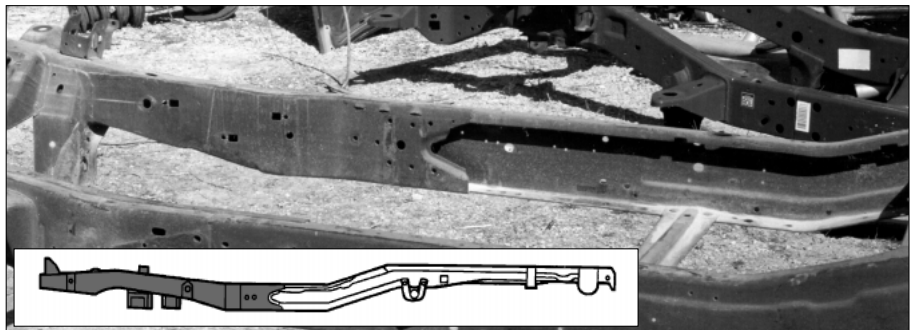


Figure 7—Crack repairs are only possible on the three-sided portion of the rail, which is only about half the frame’s length.

Bolt Selection Chart					
Rivet Diameter	Bolt Size	Bolt Part Number	Washer Part Number	Nut Part Number	Torque Specs.
3/8-Inch and 10mm	7/16-14x1.25	56561-S2 (Class S)	Not Req.	382400-S2 (Class RG)	33-50 Lb-Ft (45-68 N-m)
3/8-Inch and 10mm	7/16-14x1.25	56563-S2 (Class C)	Not Req.	382400-S2 (Class RG)	33-50 Lb-Ft (45-68 N-m)
7/16-Inch	1/2-13x1.5 (Grade 5)	56783-S100 (Class S)	Not Req.	33773-S2 (Class S)	53-75 Lb-Ft (72-102 N-m)
7/16-Inch	1/2-13x2.0 (Grade 8)	383896-S2 (Class BS)	44879-S2 (Class BS)	33773-S2 (Class S)	53-75 Lb-Ft (72-102 N-m)

Figure 8—This chart shows the bolt size to use when replacing bolts with rivets (Courtesy of Ford Motor Company).

cracks in the frame rail near the top and bottom flanges of the steering gear, or near the steering gear mounting bolt heads.

If there is a tear on a flange, such as from a bolt hole to the flange edge, Ford also considers this repairable. After straightening, remove any excess metal caused by stretching. Then weld a reinforcement or backing from the inside of the frame rail to cover both the hole and the tear. The reinforcement length should extend about 75 mm (3") to either side of the tear. Weld the tear shut from the outside. Finally, drill a hole through the backing, if necessary.

Bolts And Rivets

The recommendation is to replace bolts with the same grade and using the same torque specifications as the original bolts. Reaching the same torque specifications usually requires installing new bolts.

If rivets are removed, they should be replaced with Property Class 10.9 metric (Grade 8) nuts, bolts, and washers of the next larger size (see Figure 8). This requires line drilling of the holes to the same diameter as the new bolt. On the subject of drilling holes, do not drill holes in flanges. This can form a weak area that may crack easily when stressed.

Steel Strengths

The center section of the 1996 and newer F-150 is specified to be high-strength steel, at least 50,000 psi minimum yield strength. The front and rear sections are specified to be at least 36,000 psi minimum yield strength, which is classified as mild steel.

Ford specifies a minimum yield strength for the steels used in its frames. The steel that is delivered may range from the minimum to a higher yield strength. This means that, although a mild steel specification is given, the yield strength will typically be in the range of 40,000–42,000 psi. This fact reinforces a longtime I-CAR general rule when working with steel: treat it all like high-strength steel.

Bumper Brackets

The F-150, F-250, Expedition, and Navigator have welded-on bumper brackets that may bend during even a mild frontal collision. Bumper brackets are an integral part of the frame and play an important role in the proper operation of the airbag system. Therefore, bumper brackets should not be repaired. The use of salvage bumper brackets is not recommended by Ford. For some model years, replacement bumper mounting brackets were not available. The only recommendation for those years was frame replacement.

Bolted-on replacement bumper brackets became available in the middle of 1998. Models approved for these brackets are:

- 1997 F-250
- 1997–1998 Expedition
- 1997–1998 F-150
- 1998 Navigator

The part numbers are:

- F85A-17N775CA for the passenger side
- F85A-17N775DA for the driver side

CONCLUSION

This article addressed some of the most frequently asked questions on Ford full-frame vehicles. Briefly, the answers are:

- Do not straighten the crush initiator portions of the front frame rails.
- Yes, kink vs. bend applies to Ford full frames. If it's bent, it's possible to straighten it. If it's kinked, it should be replaced.
- Cracks can be repaired using a welded-on reinforcement. This includes cracks that become noticeable after straightening a bend or cracks caused by overloading or fatigue that occurred before the collision.
- Replacement bumper brackets are available for some frames.
- The only sectioning recommended by Ford is the available front frame horn extensions.

Body repair information for Ford full-frame vehicles is included in service manuals for these vehicles. **A**