SVE BULLETIN

SPECIAL VEHICLE ENGINEERING – BODY BUILDERS ADVISORY SERVICE

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Guidelines for Modifying Ford Light Truck Wheelbases

I. INTRODUCTION

Ford publications do not attempt to design specialty vehicles for intermediate and final stage manufacturers. It is Ford's judgement that deviations from its recommendations or guidelines will likely have an adverse effect on vehicle operation, durability, or reliability. However, Ford recognizes that it is the intermediate and final stage manufacturers that may have unique knowledge of their customers' needs and the best expertise in the design and construction of the specialty vehicles in which each manufacturer concentrates his business. With this in mind, the intermediate and final stage manufacturer should exercise sound engineering judgement, regarding vehicle modifications, to avoid adversely affecting vehicle design in ways that may require additional Federal Motor Vehicle Safety Standards (FMVSS) certification.

The final responsibility for determining the compliance of the completed vehicle rests with the final stage manufacturer who is required by law to certify, as prescribed in Section 567.5 of Title 49, Code of Federal Regulations, that the completed vehicle conforms to all applicable FMVSS. The following recommendations are intended to assist intermediate and final stage manufacturers in supplying their customers with safe and reliable completed vehicles, which meet their special needs. NOTE: This document is only intended to address Ford E-Series chassis cabs, cutaways, and basic (stripped) chassis; F-Series (F-350, F-450, F-550) chassis cabs; and F53 motorhome basic (stripped) chassis. Refer to Pages 7 and 8 of this document for greater vehicle clarification.

The following sections contain guidelines that are surrounded by either a single box or a double box. Those items in a double box are considered "Minimum Requirements" (MR) and must be followed by participants in the various Ford quality programs in order to remain in compliance with program requirements. Those in a single box are considered "Other Quality Focused Characteristics" (OC) and are optional, but strongly recommended.

"Minimum Requirements" (MRs)

"Other Quality Focused Characteristics" (OCs)

Special Notes:

Shortening a wheelbase to a length shorter than the shortest available factory wheelbase for the model under consideration is against Ford Truck Quality Program (FTQP) policy. Braking and handling issues are likely.

Any wheelbase extension that results in a wheelbase that exceeds the longest wheelbase for that model cannot use the FMVSS 105, Hydraulic and Electric Brake Systems, compliance statement in the Incomplete Vehicle Manual. An independent FMVSS 105 test must be conducted to verify compliance.

II. COMPLETED VEHICLE WEIGHT ANALYSIS

Ford requires a weight analysis to be performed on the complete vehicle. Some considerations for such analysis are as follows:

- The **Maximum Vehicle Loading** should include the **Unloaded Vehicle Weight** (UVW), 150 pounds for each passenger in all designated seating positions and sufficient payload capacity for reasonable assumptions of cargo and trailer tongue weight. The maximum vehicle loading shall not exceed the OEM chassis **Gross Axle Weight Rating** (GAWR), nor the **Gross Vehicle Weight Rating** (GVWR), as identified on the front cover of the "Incomplete Vehicle Manual" (IVM).
- Avoid rear frame extensions or vehicle configurations that may allow the customer to distribute the vehicle load so that significant front unloading can occur. Ford recommends no less than 35 percent of the total loaded vehicle weight be maintained on the front axle for most vehicles included in this report. The E-450 should be no less than 32 percent. The F53 with a GVWR of 20,500 pounds or more should be no less than 34 percent (or 30 percent for any F53 with a tag axle). Inadequate front-end loading could adversely affect the steering and braking characteristics of the vehicle.
- A road test should be conducted on a completed vehicle with a payload representative of the user's likely worst-case application. This test is recommended to qualify the ride and handling characteristics and support the weight distribution analysis.

III. CHASSIS DISASSEMBLY AND PREPARATION

Note: When disassembling E-450 vehicles, before disconnecting the wiring, brake lines, or fuel lines, first remove the left-hand gusset between the frame rail and the rear shock mount crossmember. This step is necessary to protect the lines and wires routed behind the gusset.

Electrical System Disconnection:

Method 1: Cut all chassis wiring at the frame cut location and splice in the new wiring.

- Disconnect the battery, negative cable first.
- It is strongly recommended that wiring, brake lines, and fuel lines be removed from areas of extensive chassis rework or from areas where welding operations are to be performed prior to these operations.
- The Powertrain Control Module (PCM) must be disconnected before any electrical cutting or welding is performed. Otherwise, module damage may result.
- Remove the long harness sheath ('organizer") used to organize, route, and protect the fuel, brake, and electrical lines. Do not throw it away. The organizer will be reinstalled in a later operation. **Note:** F-Series trucks do not have "organizers." The lines are fastened directly to the frame side rail. Therefore, ignore references to organizers when considering F-Series vehicles.
- Note or label all wiring connections before disconnecting them.
- Cut all electrical wiring at the recommended frame splice cut location and remove it from the area. **Note:** All wiring is enclosed in high temperature (125ºC) convoluted tubing. Cut the tubing first to expose the electrical wiring as required.
- Shield or protect all wiring and wiring convolute before the frame splice operation begins.

Method 2 for E-Series only: Only cut the ABS wiring at the frame splice location. Use Ford connectors and the rear of the wiring harness to extend the remaining wiring.

- Follow the guidelines in Method 1; delete the wire cutting operation and proceed as follows:
- Cut the Anti-Lock Brake System (ABS) twisted pair wiring at the recommended frame splice cut location. Do not cut any other chassis wiring. Extend it using the open connectors at the end of the wiring harness.
- Remove all wiring from the area of the frame splice and protect it during the frame-cutting operation.

Fuel System Disconnection:

WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

WARNING: Fuel in the fuel system remains under high pressure, even when the engine is not running. Before repairing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent the accidental spraying of fuel, which would result in a fire hazard and possible personal injury.

- Refer to the Ford Light Truck Shop Manual for detailed direction and recommended procedures relative to fuel system disconnection. The major steps involved are outlined below.
- Clearly label supply and return fuel lines before disassembly. For non-return fuel systems, this step may be omitted.
- Relieve fuel line pressure.
- Remove the fuel supply and (where applicable) return fuel lines between the fuel sender and the intermediate or forward chassis connection points, leaving the frame area to be cut free of fuel lines.

All fuel and vapor lines must be capped or plugged prior to welding or drilling operations. This is required to prevent contamination as well as for safety.

- For a more detailed definition of the fuel line connector types, disconnection, and installation, refer to the Ford Truck Shop Manual.

Service Brake System Disconnection:

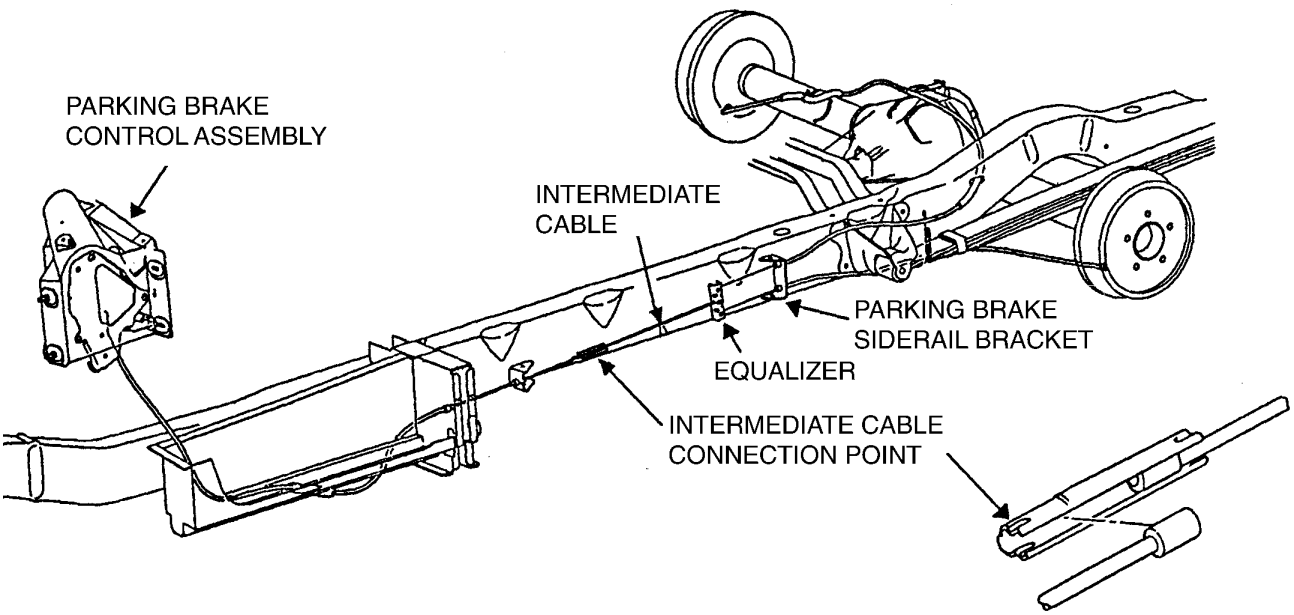
- Before and after cutting the brake lines, drain, recover, clean up, and remove all the brake fluid, including drippings, from the area. Brake fluid is flammable. Remove all the recovered fluid, prior to the frame cutting operation, to prevent a potential fire hazard. Do not reuse the brake fluid. Discard all drained fluid appropriately.
- Remove the steel brake line from the frame clips near the splice zone. Avoid bending or crimpling the lines.
- Cut the brake lines on a straight segment parallel to the frame in the vicinity of the frame splice. Some brake lines have a hardened wire wrap for chafe protection. It is recommended that the wire wrap and the brake line be cut by grinding. Other industry cutting methods are acceptable as long as tubing integrity is maintained, and care is taken to prevent contaminants from entering the lines.
- All splicing of brake tubing must be done with steel tubing, threaded fittings, double flared joints, and brass unions of equivalent OEM quality.

Parking Brake System Disconnection – E-350 and F-350:

- Refer to the Ford Light Truck Shop Manual for detailed direction and recommended procedures relative to parking brake system disconnection.
- Remove the parking brake cables from the area of the welding operation to avoid heat damage. These cables are particularly sensitive to heat.

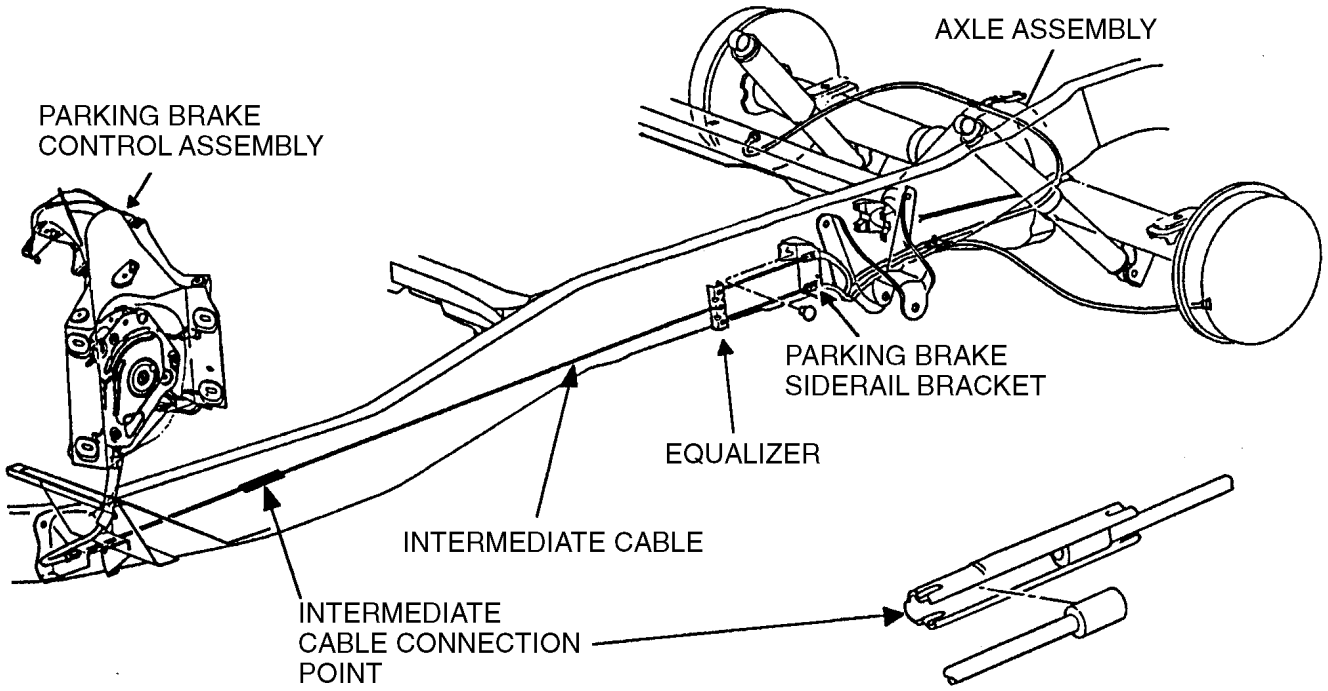
Measure and record the exact position of the parking brake cable side rail bracket relative to the forward edge of the rear spring front hanger bracket (see Figures 1 and 2). This will only be necessary if the frame splice cut location is positioned so that movement of the parking brake cable side rail bracket is required (see Figure 3 for the recommended frame splice cut location). This dimension is critical to the reconnection procedure, as the bracket must be remounted in the original OEM position relative to the spring hanger bracket.

- If necessary, remove the parking brake cable bracket located on the frame side rail of both the E-350 and F-350 vehicles. Otherwise, there may be interference with the frame-cutting procedure. Care should be taken when removing the bracket to maintain its integrity and shape since this component will be remounted after completion of the splice welding.
- **Note:** The E-450, F-450, and F-550 chassis cab, and the F-550 basic (stripped) chassis parking brake system will not require disconnection since the parking brake system is transmission mounted.



ECONOLINE PARKING BRAKE SYSTEM

FIGURE 1



F-SERIES PARKING BRAKE SYSTEM

FIGURE 2

Exhaust System Disconnection:

- The original positions of the catalytic converter, muffler, and outlet pipe assembly, relative to their surrounding components, are to be maintained for purposes of ground clearance, emissions, and heat transfer.
- Where possible, disconnect the muffler inlet pipe at the rear of the catalytic converter by removing the clamp or disconnecting the pipe flange. Do not reuse the exhaust system clamps, fasteners, or gaskets. Replace them with new parts. Use Ford replacement parts or equivalent.

Retain the OEM heat shields and hangers.

- Proper exhaust system alignment and support is important. Do not modify or change the relative positions of the muffler or exhaust hangers.
- If it is necessary to cut the exhaust pipe, use a saw or tube cutter, not a torch. Torch cutting leaves an uneven surface, which is a potential cause of exhaust leaks.
- Cut only on a horizontal straight segment of pipe.

Exhaust pipe extensions must be of equivalent diameter, gauge, and material as that originally provided by Ford. This will maintain proper corrosion protection and durability.

Driveline System Disconnection:

- Match-mark the driveline attachment at the transmission and rear axle before it is removed. This will assure identical reinstallation that is critical to driveline balance and phasing.
- Retain and tape the bearing caps to the universal joints to assure needle bearing integrity.

IV. PERFORMING THE FRAME SPLICE

Frame splices are often made too rigid. Good frame splice design will allow the frame to flex and twist along its entire length. It is recommended that the frame splice technique described here be adopted to retain splice joint integrity.

The critical aspects of frame splicing are cut location, alignment, and fit. A flat level work area is recommended. Jack stands should be properly located to stabilize the vehicle during the cutting operation. All of the tires should be blocked front and rear.

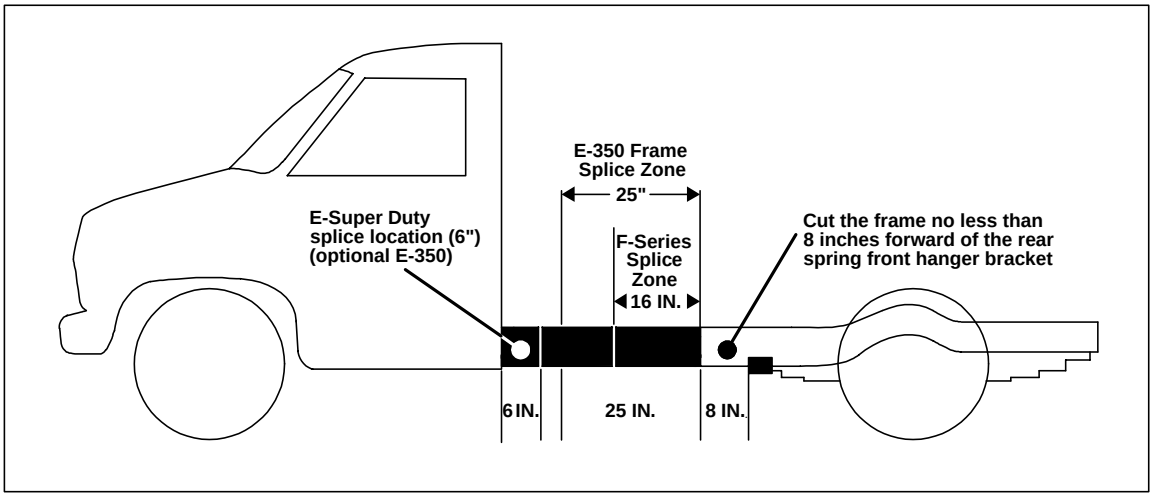


Figure 3

Altering the Wheelbase:

The recommended location for the frame splice on F-Series and E-350 vehicles is in a straight segment of the frame rail just forward of the rear spring front hanger bracket, as noted in Figure 3. The recommended location for the frame splice on the E-450 is approximately six inches rearward from the rearmost edge of the cab floor per Figure 3. This same location may be used on the E-350 to commonize processes. These locations have been chosen as the optimum locations for the following reasons:

A. They minimize exhaust, fuel, brake, and electrical modifications.
B. They minimize driveline modification issues concerning excessive drive angles and misalignment.
C. They are optimum locations when the maintenance of frame strength and integrity is considered.
D. They maintain minimum weld spacing from the spring hanger bracket preventing rivet hole deformation.

Proceed as follows:

- First disconnect the battery negative cable(s) and the PCM, if this has not already been done.
- All Ford OEM frames are e-coated for improved corrosion protection. This paint must be ground off locally before the welding operation begins.
- The cut location must account for the outer reinforcement, which will be added in a later operation. The reinforcement should extend beyond the frame by a minimum of 6 inches on either end.
- Scribe or mark the frame for cutting (Figure 4). All dimensions for gauging or fixturing should be recorded at this time.
- Attach a cutting fixture to the frame for increased cut accuracy.

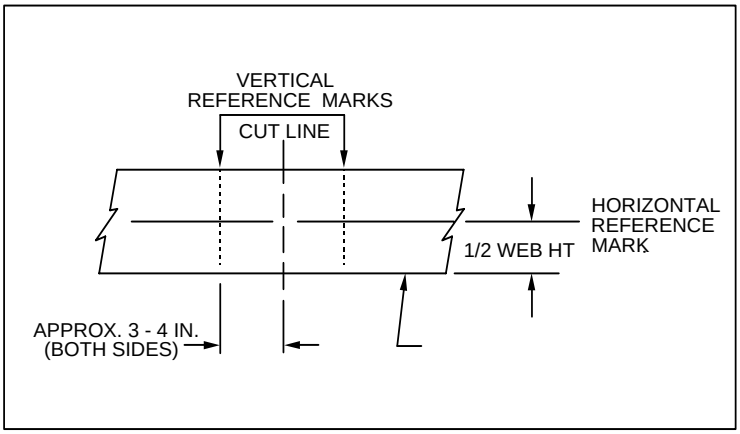


FIGURE 4

Locate a specific splice cut location. Avoid cutting on uneven sections of the frame within the designated zone, such as frame forms or irregular bends or depressions. Cut the frame in the "Frame Splice Zone" defined below and in Figure 3. If another location within the splice zone is used, a stress analysis must be completed.

--- **E-350** --- The Frame Splice Zone is 8 to 25 inches forward of the rear spring front hanger bracket. See E-450 for an optional Frame Splice Zone.

--- **E-450** --- The Frame Splice Zone is approximately six inches rearward of the rearmost edge of the cab floor.

--- **F-Series** --- The Frame Splice Zone is 8 to 16 inches forward of the rear spring front hanger bracket.

2004 E-Series and F-Series Frame Data

1017 Steel (SAE J406) -- Minimum Yield = 36,000 psi.

Code	Description	Wheelbase (inch)	Minimum Frame Gauge (inch)	Minimum Sleeve Gauge (inch)(1)
C35	E-350 Chassis Cab (70 CA)	138.0	0.219	
	(90 CA)	158.0	0.219	
	(108 CA)	176.0	0.219	
E35	E-350 Cutaway (80 CA)	138.0	0.219	
	(100 CA)	158.0	0.219	
	(118 CA)	176.0	0.219	
		138.0	0.219	
E39	E-350 Commercial Basic (Stripped)	158.0	0.219	
	Chassis	176.0	0.219	
C45	E-450 Chassis Cab (90 CA)	158.0	0.240	
	(108 CA)	176.0	0.240	
E45	E-450 Cutaway (100 CA)	158.0	0.240	
	(118 CA)	176.0	0.240	
E49	E-450 Commercial Basic (Stripped)	158.0	0.240	
	Chassis	176.0	0.240	
F36	F-350 Regular Cab 4X2 (60 CA)	140.8	0.280	
	(84 CA)	164.8	0.280	

X36	F-350 Super Cab 4X2 (60 CA)	161.8	0.280	
W36	F-350 Crew Cab 4X2 (60 CA)	176.2	0.280	
F37	F-350 Regular Cab 4X4 (60 CA)	140.8	0.280	
	(84 CA)	164.8	0.280	
X37	F-350 Super Cab 4X4 (60 CA)	161.8	0.280	
W37	F-350 Crew Cab 4X4 (60 CA)	176.2	0.280	
F46	F-450 Regular Cab 4X2 (60 CA)	140.8	0.319	
	(84 CA)	164.8	0.319	(2)
	(108 CA)	188.8	0.319	0.280
	(120 CA)	200.8	0.319	0.280
X46	F-450 Super Cab 4X2 (60 CA)	161.8	0.319	(2)
W46	F-450 Crew Cab 4X2 (60 CA)	176.2	0.319	
	(84 CA)	200.2	0.319	(2)
F47	F-450 Regular Cab 4X4 (60 CA)	140.8	0.319	
	(84 CA)	164.8	0.319	(2)
	(108 CA)	188.8	0.319	0.280
	(120 CA)	200.8	0.319	0.280
X47	F-450 Super Cab 4X4 (60 CA)	161.8	0.319	(2)
W47	F-450 Crew Cab 4X4 (60 CA)	176.2	0.319	
	(84 CA)	200.2	0.319	(2)
F56	F-550 Regular Cab 4X2 (60 CA)	140.8	0.319	(4)
	(84 CA)	164.8	0.319	0.280 (2,3)
	(108 CA)	188.8	0.319	0.280
	(120 CA)	200.8	0.319	0.280
X56	F-550 Super Cab 4X2 (60 CA)	161.8	0.319	(2)
W56	F-550 Crew Cab 4X2 (60 CA)	176.2	0.319	
	(84 CA)	200.2	0.319	(2)
F57	F-550 Regular Cab 4X4 (60 CA)	140.8	0.319	(4)
	(84 CA)	164.8	0.319	0.280 (2,3)
	(108 CA)	188.8	0.319	0.280
	(120 CA)	200.8	0.319	0.280
X57	F-550 Super Cab 4X4 (60 CA)	161.8	0.319	(2)
W57	F-550 Crew Cab 4X4 (60 CA)	176.2	0.319	
	(84 CA)	200.2	0.319	(2)
F53	F53 Motor Home Chassis	178.0	0.250	
		190.0	0.250	
		208.0	0.250	
		228.0	0.250	

(1) Sleeved frames are not recommended for wheelbase modification.
(2) Not recommended for frame stretch.
(3) Sleeve used on 19,000-pound GVWR only.
(4) The 19,000-pound GVWR is not recommended for frame stretch.

- Grind the cut edges of the frame smooth for a line on line fit. This will ensure a good and a clean metal surface for the welding operation.

Frame inserts must be the same dimensional shape, gauge, material, and yield strength as the original side members. The Frame information Chart on Pages 7 and 8 displays pertinent frame data.

- Chamfer the outside edges of both the frame cut and the insert ends at a 30º angle, leaving half of the thickness (Figure 5).

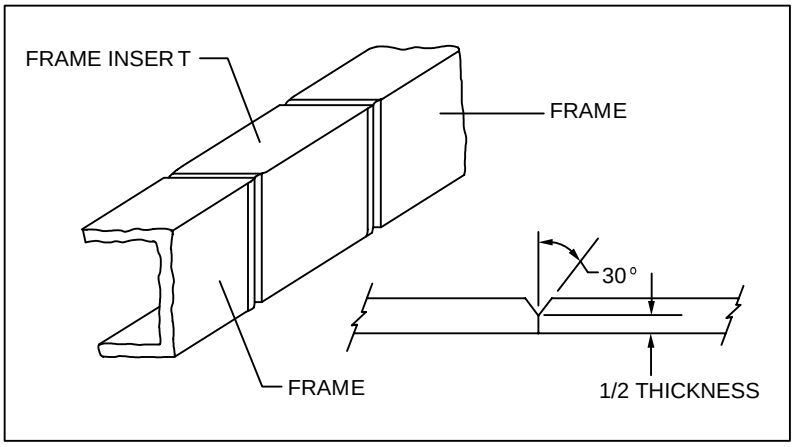


FIGURE 5

- Move the rear frame section of the vehicle in order to allow placement of the frame insert.
- Fixture and clamp the insert to ensure correct alignment (Figure 6). Dimensional checks to the predetermined reference marks (Figure 4) should be used to prevent any possible error.
- Tack weld run-on blocks to the edge of the upper and lower flanges of the frame and frame insert (Figures 7 and 8). This procedure is recommended to eliminate joint edge burnout and to prevent movement during the butt weld procedure.
- Butt weld the ends of the frame insert to the frame. Grind the visible welds on both sides to the parent metal. Butt welds on the outside surface of the frame should be done with a single pass, vertical, up (Figure 7).
- Butt weld the inside of the joint with a single pass, vertical, up (Figure 8).

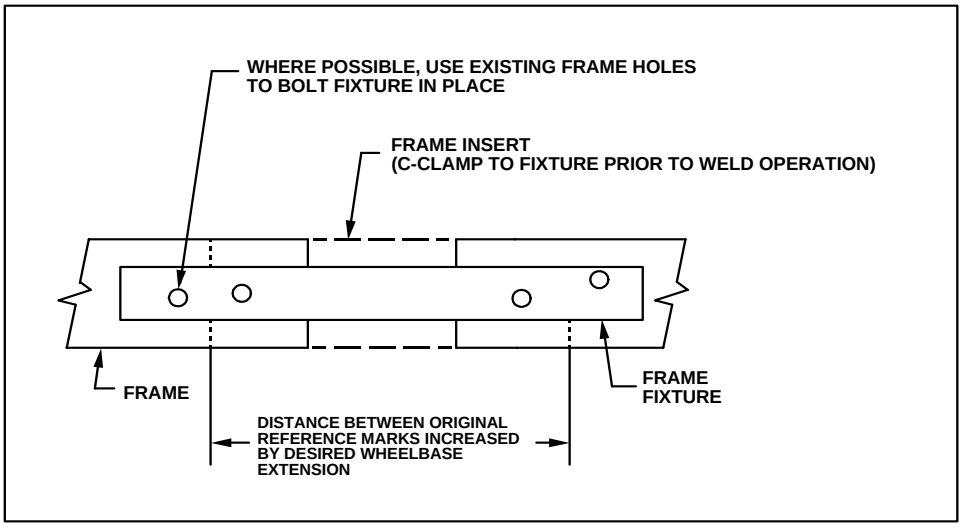


FIGURE 6

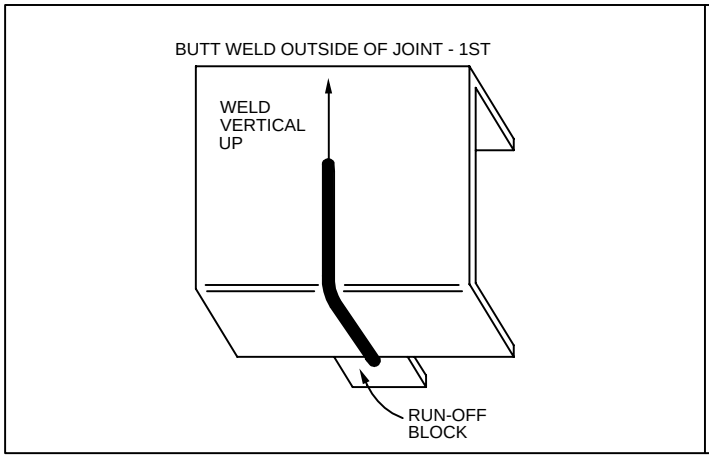


FIGURE 7

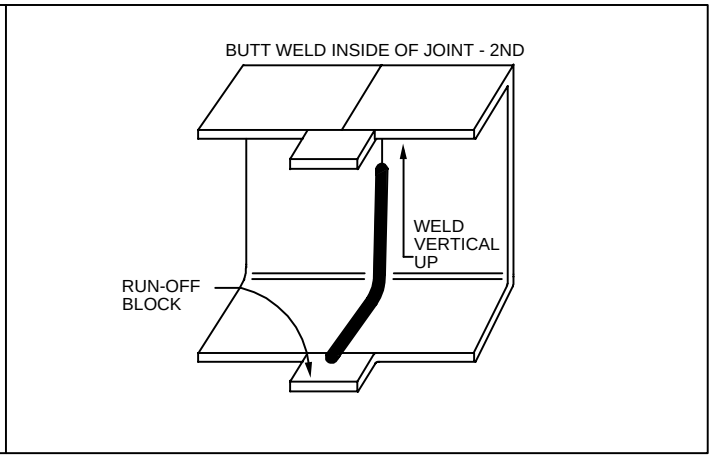


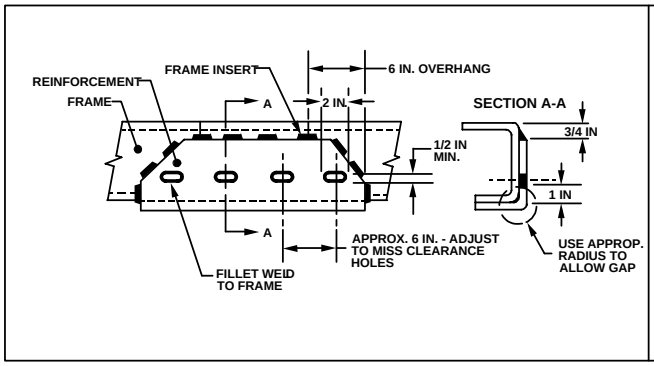
FIGURE 8

- Variations in equipment and welding materials make it difficult to recommend a specific amperage, electrode specification, or welding speed. Therefore, this procedure should be established and tested by qualified welder or consultant service. Standard industrial practices apply.
- Visually inspect all the welds for defects. Maintain high quality welds, as they are critical to joint integrity.
- Remove the run-off blocks and chip or grind the joint smooth. Grind marks are to be parallel to the length of the frame. The finished joint should be the same thickness as the side member.
  Note: The outside surface of the frame weldment must be as smooth as the rest of the frame to provide for a flush fit of the reinforcement.
- The splice location and the length of the insert define the outer reinforcement length with a minimum 6-inch overlap on each end. This reinforcement is not to encroach on the rear leaf spring front hanger bracket. Welding within 2 inches of this area could shrink the spring bracket rivets, causing a loose joint. The reinforcement should have an L-shaped cross section and be of the same material and thickness as the frame. The reinforcement height must allow for the weldment and not extend above the tangent of the radius for the band at the upper flange of the frame. **Note:** The reinforcement height must also allow for frame rail forms (fuel tank strap depressions in the frame side rail left over from older vehicle options), if applicable, in order to provide a flush fit. The width should not exceed the lower flange width.

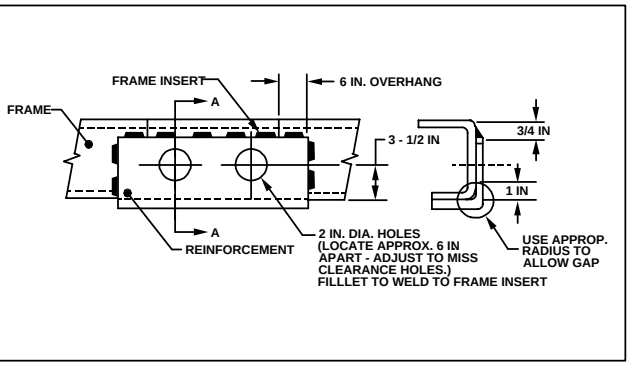
- Reinforcement slots or holes must be added to provide extra welding surface area for increased strength.

- The inside reinforcement bend radius must be larger than the inside radius of the frame to provide a gap at the bend. Refer to Figures 9 and 10 for greater detail.
- Add clearance holes to the reinforcement for all rivets, fasteners, or retention clips in the frame side member.
- Duplicate any frame identification number or VIN lost to the stretching or shortening of the wheelbase on the reinforcement or side member of the finished frame.
- Clamp the L-section reinforcement to the outside of the frame rail. There should be no visible gaps between the frame rail and the reinforcement other than at the bend. Fillet weld the reinforcement to the frame rail by using a skip weld technique. (A 2-inch weld followed by a 2-inch space continuous along the reinforcement – Figures 9 and 10.)

- Leave the corners, bends, and radii "free" to flex. Welding in these locations can create stress risers that often lead to weld cracking.
  --- Do not weld within 1 inch of the corners or bends of the reinforcement.
  --- Do not weld the lower flange of the frame, neither on the flange nor at the edge.



Preferred Method
FIGURE 9



Minimum Acceptable Method
FIGURE 10

- For the final weld operation, fillet weld the reinforcement slots or holes to the frame as shown in Figures 9 and 10. Although perfectly acceptable, it is not necessary to fillet weld the entire circumference of the slots or holes. Performing a fillet weld only on the bottom half (for 180º) will provide sufficient strength.
- **Note:** Although Figure 10 ("Minimum Required Method") is acceptable, the method illustrated by Figure 9 ("Preferred Method") is preferred for the reinforcement fabrication and weldment for the following reasons:
  A. The slots are smaller and can be positioned to avoid clearance holes in the frame more easily.
  B. The chamfered sides diminish stress concentrations in corners reducing the chance of weld crack propagation.
- After final welding, re-paint the exposed portion of the frame. Although mentioned here, the final welding operation should be in either the "Parking Brake System Installation" section or the "Extending the Frame (Rear Overhang)" section. Apply this re-painting step after all alterations and weldments on the vehicle are complete.

Extending the Frame (Rear Overhang)

- Caution should be taken when lengthening rear frame extensions to avoid adversely affecting vehicle performance in the following areas:
  --- Excessive rear frame extension may cause a customer to significantly unload the front end of the vehicle. This could result in customer dissatisfaction with vehicle braking or steering and handling. Follow the requirements for a completed vehicle weight analysis at the beginning of this document.
  --- Rear frame extensions need to be long enough to protect vulnerable components such as fuel tanks, and short enough to avoid frame contact with the ground when the vehicle is fully loaded. Refer to the "Ground Clearance" section for greater detail.
- If the vehicle has the potential for additional rear loading, such as that resulting from trailer towing, the extension should be completed with both the standard butt weld technique, previously described in the section labeled "Altering the Wheelbase," and a rear extension reinforcement. (Remember to locally grind off the frame paint before welding.) For rear extension reinforcement plate construction and attachment, refer to Figure 11 and adhere to the following specification:
  --- Material: Grade 1017 Steel (SAE J406), Yield = 36,000 psi.
  --- Size: Height = 4 inches (minimum)
  Length = 12 inches
  Thickness = ¼ inch
  Note: The height may vary depending on the particular frame web height. It should not exceed the tangent to the radii at both the upper and lower flanges.
  --- Attachment: All rear reinforcement plates should be skip welded to the frame in the same manner as previously described.

Method A --- Reinforcements should contain two 1½-inch diameter holes fillet welded to the frame.

Method B --- Reinforcements should contain four 7/16- inch holes for bolting to the frame.

- To maintain frame structural integrity, it is strongly recommended that an additional crossmember be added to all rear overhang extensions extending 36-inches, or more, beyond the last OEM crossmember.
- If it is anticipated that a trailer hitch will be installed on the frame extension, the integrity of the extension and hitch combination should be verified.

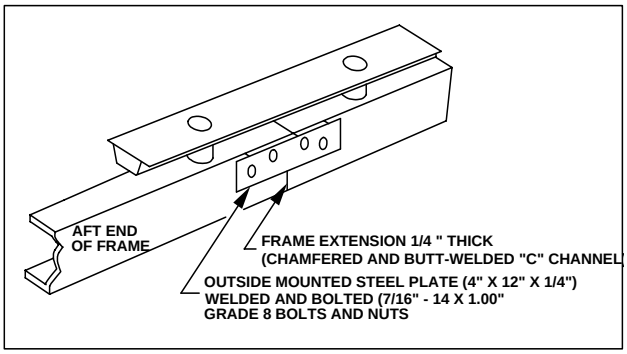


FIGURE 11

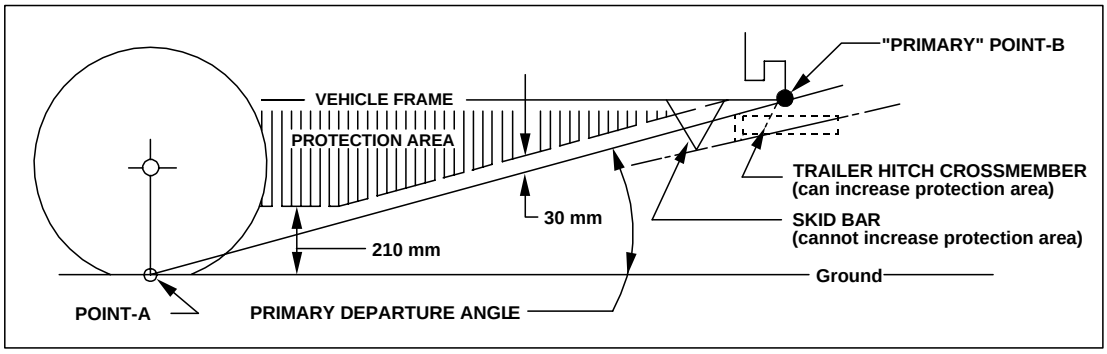


FIGURE 12

- If large diameter body puck holes are to be added to the top flange of the rear extension, a ⅞-inch hole spacing from the outside edge of the frame web and inside edge of the frame must be maintained. This will help to avoid stress cracks in the frame web and upper flange regions.
- After final welding, re-paint the exposed portion of the frame.

Ground Clearance

The following will be used to evaluate body builder designs of the rear overhangs relative to ground clearance.

Definition: Angle of Departure --- A departure angle is an angle between the ground line and a line formed by the two points "A" and "B," as shown in Figure 12. It is measured with the vehicle loaded

simultaneously to both the maximum front and rear GAWR. Point "B" is any point on the vehicle rearward of the rearmost laden tire. The "Primary Departure Angle" defines ground clearance.

Definition: Vulnerable Components --- Vulnerable components are any part of the vehicle system which is likely to be damaged if the vehicle contacts the ground and, as a result, adversely affects the operation of the vehicle.

Guidelines

1. Vulnerable components should remain within a "protected area" defined by a minimum ground clearance line. It shall be at least 1¼-inchs (30 mm) above the line defined as the Primary Departure Angle (PDA) and no less than 8¼-inchs (210 mm) above the ground.

2. The PDA will use the end of the frame or rear bumper as Point B. Skid bars may not be used to redefine the PDA. However, a trailer hitch may be used to redefine the PDA under the following conditions:
   - Only Class II, III, or IV hitches can be used to redefine the PDA.
   - The only component of the hitch assembly that may be used to redefine the PDA is a metal hitch mounting crossmember that extends the full width of the chassis frame. The hitch mounting brackets and the ball or tube receiver may not be used to redefine the PDA.
   - The trailer hitch assembly must be welded to the chassis frame. If it is otherwise fastened, the trailer hitch cannot be used to redefine the PDA.
3. A spare tire, rear entrance step, or other "easily removable part" may extend below the PDA to the limit of a 9º departure angle.
4. The exhaust system can extend outside the PDA provided the system is free to lift clear of the departure angle.
5. Skid bars may not be used to increase the protection zone for vulnerable components.

V. CHASSIS REASSEMLY

Electrical System Reassembly

Method 1: Cut all of the chassis wiring at the frame cut location and splice in additional wiring.

- Refer to the **Body Builders' Layout Book**, Electrical Wiring Section, General Practices when modifying or altering the electrical system in any way.
- The following is a summary of the guidelines mentioned above and is applicable when splicing and extending chassis wiring:
  1. All added electrical wiring is to be of the same gauge or a larger gauge than the original wiring.
  2. All added wiring is to be cross-linked polyethylene, high temperature (125º C minimum) insulated wire. SAE Specification J1128 Type SXL, GXL, or TXL wire is recommended.
  3. All added wiring is to be color-coded or clearly labeled to match the original wiring being spliced to aid in identification and servicing.

  Note: The use of "quick splice" connectors is unacceptable.
- When it is necessary to splice a wire for repair or circuit revisions, the following steps should be followed:
  1. Wire ends should be stripped, making certain that individual conductor strands are not damaged.
  2. When soldering, make sure an adequate mechanical joint exists before applying solder. Use only rosin core solder, never acid core.
  3. For crimp joints, use butt-type metal barrel fasteners and a proper tool (such as Motorcraft Crimp Tool S-9796) specifically designed for this type of work.
  4. Splice joints are to be sealed and insulated. Heat shrink tubing is highly recommended to cover soldered and bare metal, barrel-crimp joints.
  5. The most durable splice joint will be bare metal, barrel-crimped, flow-soldered, and covered in shrink tubing. Use this whenever possible.

Critical: When splicing or extending the anti-lock brake system (ABS) twisted pair SXL wiring, the OEM specification of one full twist per inch must be maintained as originally provided.

- Smooth all weld flash in the areas where wiring is commonly routed.
- Secure all extended wiring along the frame rail in order to avoid loose or slack wiring.
- Protect exposed wiring with high temperature (125ºC minimum) convoluted tubing. Use high quality electrical tape to wrap and join the convoluted tubing extension to the original tubing provided.
- (E-Series) Reinstall the long plastic harness ("Organizer"), originally provided by Ford, to protect, route, and organize the fuel, brake, and electrical lines.

Method 2: (For E-Series only.) Cut only the ABS wiring at the splice location. Use Ford connectors at the rear of the wiring harness to extend the remaining electrical wiring.

- Only cut the anti-lock brake system twisted pair SXL wiring at the recommended frame splice location. Do not cut any other chassis wiring. Rather, extend the wires using the open connectors ant the end of the wiring harness.
- Secure all wiring to the frame side rail to avoid loose or slack conditions.
- Reinstall the OEM electrical wiring harness organizer to the frame side rail.
- Protect all exposed wiring according to these guidelines.

Fuel System Reassembly

- Mid-ship fuel tank location:
  On F-Series vehicles equipped with a mid-ship fuel tank, the tank and fuel line system must remain in the same position relative to the OEM rear frame and axle assembly as originally designed. This requirement helps assure fuel system integrity and provides for optimum use of the OEM fuel system attaching components. This will require the modifier to develop and install a new forward cross member for supporting the mid-ship tank when the frame is lengthened.
- General guidelines for all fuel line installations:
  --- Changing the length of a fuel line can consist of either replacing the intermediate OEM fuel line assemblies with new OEM equivalent assemblies, or the use of OEM equivalent extensions. In either case, Ford recommends that all fuel line components and materials used for line extensions be purchased from Ford's OEM fuel component supplier as follows:
  TI Automotive --- 586-755-8313
  --- It is recommended that any flexible line extensions allow approximately one inch of additional length, in excess of the frame extension, to provide for routing and installation ease. This additional length will avoid a stretch-to-fit situation when reconnecting the fuel lines.
  --- Any fuel lines which have been kinked must be replaced.
  --- Do not allow any flexible fuel lines to coil or otherwise be routed inboard of the frame side rails. Fuel routings should remain inside the frame side rails, similar to the OEM routings, and be secured to the frame for maximum protection and safety.
  --- Secure all added fuel lines to the frame with clips and clip spacing consistent with the original fuel line routing.
  --- Evaporative system lines must not be kinked or routed in a manner which could cause them to collapse. Retention of evaporative lines must be consistent with the original line clip types and spacing. Extensions must made of material similar to the original equipment.
  --- Inspect the installation for possible chafe and rattle condition with the frame, fasteners, and other lines.
- Stainless steel tubes and braded stainless steel with Teflon tube flex lines.
  --- Refer to the Light Truck Shop Manual for steel fuel line push connect details.
  --- Cutting and splicing of stainless steel fuel tubes or braided flex lines is unacceptable. All lines must make use of OEM type fuel line connectors and be of OEM equivalent material quality and design.
  --- Do not coil or bend the braided flex line tighter than a five inch diameter. Excessive bending or mishandling can result in fuel hose kinks and permanent damage.

--- E-Series diesel engine vehicles may not use nylon jumper lines.

Service Brake System Reassembly

- Check the brake tubes for contamination. Clean them appropriately before continuing.

- Use only SAE J526 or J527 steel tubing or equivalent.
- Do not kink or crack tubing when forming extensions of the existing OEM tubing.
- Flare tubing per the Ford Light Truck Shop Manual or an equivalent procedure.
- Tube junctions must be double flared.

- Secure the brake lines to the frame with clips and clip spacing similar to that used with the original brake tubing.
- Inspect the modified brake lines for possible chafe or rattle conditions with the frame, fasteners, or other lines. Wire wrap tubing in the areas that may require additional protection.

- Do not reuse recovered brake fluid as it may contain contaminants. Always replace the fluid with new OEM equivalent brake fluid. (DOT 3 – Ford Engineering Specification Number ESA-M6C25-B as outlined in the Owner's Guide.) (The 20,500 pound and 22,000 pound GVWR F53 chassis use "Super DOT 4" – Ford Engineering Specification Number ESD-M6C57-A (Part Number YS4Z-19542-AA).) Super DOT 4 fluid may be added to DOT 3 fluid, but DOT 3 fluid may not be added to Super DOT 4.

- Bleed the brake lines; check for leaks after applying brakes four times with approximately 150 pounds, noting pedal bleed down or warning light indication. Verify the system operation and function.

Refer to the Electrical System Reassembly section on Page 13 for guidelines regarding Anti-Lock Brake System installation.

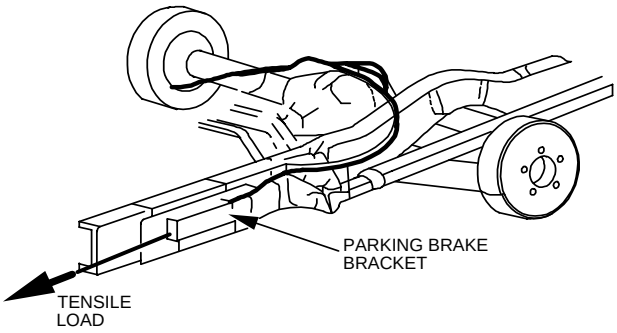
Parking Brake System Reinstallation

- Reinstallation of the parking brake system should be done in accordance with the Light Truck Shop Manual.

- A new intermediate cable, modified in length consistent with the frame change, will be required.
- The new brake cable must be of OEM quality or equivalent.

- Ford's current OEM supplier of parking brake cable may be a potential source for the final stage builder:
  Dura Automotive Systems, Inc.
  2791 Research Drive
  Rochester Hills, Michigan 48309
  Phone: 248-299-7500
- See Figures 1 and 2 from the Parking Brake System Disconnection section for reference when following the guidelines below.
- Perform this step only if the parking brake bracket was removed. Reinstall the parking brake bracket on the frame side rail in the same position relative to the front edge of the rear spring front hanger bracket. This dimension should have been recorded as part of the Parking Brake Disconnection section on Page 3.
  --- E-350 parking brake cable brackets should be welded to the frame, as originally provided by Ford, avoiding welding in the corners, and utilizing standard industry practices for maximum weld integrity.
  --- F-350 parking brake cable brackets should be welded to the frame as stated above for the E-350 vehicles, with the following differences: Original holes provided for bolting the bracket to the should be fillet-welded to the frame rather than bolted. **Note:** The F-Series bracket can be replaced with an E-Series bracket, if so desired.
  --- **E-350 and F-350** parking brake cable bracket attachment to the frame must be able to withstand a tension load of 800 pounds, without any significant deflection. It is recommended that the final

stage manufacturer pull test their bracket attachment to verify the quality of the attachment itself. See Figure 13.



If reattached, the parking brake bracket must withstand a tensile load of 800 lbs. without permanent deformation.

FIGURE 13

- After final welding, repaint the exposed portion of the frame.
- Reinstall the parking brake cables.

Exhaust System Reinstallation

- EXHAUST PIPE MATERIAL

Exhaust pipe segments spliced into the OEM exhaust system must be equivalent size and made of stainless steel. The OEM engine to catalyst distance must be maintained.

- HEAT SHIELDING

Retain all Ford mounted heat shields.

New exhaust pipe segments must include equivalent grass heat shields and top mounted heat shields originally provided by Ford. These added shields must be of equivalent quality. This is intended to provide heat protection integrity.

--- Tack welding heat shields to exhaust components is acceptable, provided the weld wire material is equivalent to the OEM exhaust component material and is compatible with the heat shield material.

Driveline System Reassembly

- DRIVESHAFT REQUIREMENTS
  --- Proper driveshaft modification is necessary to maintain vehicle safety, reliability, and customer satisfaction.
  --- Driveshaft usage is determined based on the vehicle's maximum speed, driveshaft length, driveshaft diameter, and axle ratio.
  --- For driveshaft modification, refer to Bulletin Q-14, Guidelines for Modifying Light Truck Drivelines and Q-40, Econoline Driveline Angles.

VI. CUSTOMER SUPPORT

It is the responsibility of the final stage manufacturer to assure that all labels for certification be permanently affixed to the vehicle. Refer to the NTEA Certification Guide and the Ford Incomplete Vehicle Manual (IVM) for detailed labeling information. In addition, Ford Motor Company recommends any wheelbase change be identified, either on a separate label or on the Completed Vehicle Safety Certification Label. This information will assist in vehicle maintenance and service part identification.

IF YOU SHOULD HAVE ANY QUESTIONS, PLEASE CALL THE BODY BUILDERS ADVISORY SERVICE ON 877-840-4338.

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