BODY BUILDER INSTRUCTIONS

Mack Trucks

Chassis, Body Installation
MD
Section 7

Introduction

This information provides specifications for chassis body installation for MACK vehicles.

Note: We have attempted to cover as much information as possible. However, this information does not cover all the unique variations that a vehicle chassis may present. Note that illustrations are typical but may not reflect all the variations of assembly.

All data provided is based on information that was current at time of release. However, **this information is subject to change without notice**.

Contents:

Chassis

Body Mounting

Body Mounting Considerations

CAUTION

The addition of a body to a vehicle frame must not adversely affect the safe operation and handling characteristics of the vehicle.

When mounting a body to a particular type of chassis, the following design considerations must be considered for each type of chassis:

- Accessibility to the various critical locations, including lubrication (grease) points and fuel tank.
- Ease of removal of the various powertrain and suspension components.
- Allow for rear wheel maximum spring movement.
- Ensure proper ventilation and subsequent cooling of brake drums, and the battery within the battery box.
- Do not block, or partially cover the engine air intake or the frontal area of the cab/hood in a way that would block the flow of air through the radiator grille opening. Maintain clear access and free flow of air to these areas (while the vehicle is moving).
- Free movement and safe operation throughout the range of movement for all moving parts of the frame (i.e., springs, driveshafts, etc.) must be maintained.
- Maintain proper load distribution between the right- and left-hand sides of the vehicle.
- The body installation must not cause excessive frame rail deflection. Contact MACK Trucks, Inc. Customer Service for assistance in obtaining approval for an installation on a specific chassis. Be prepared to supply detailed information concerning intended weight distribution of the completed vehicle.
- Body attachment fasteners must be tightened gradually in progressive steps, using an alternating pattern.
- To avoid any sudden change of inertia, sectioning of subframes or underframes must decrease progressively toward the chassis front.
- Tank bodies must be mounted on a full-length subframe.
- Any body that is mounted to the chassis by U-bolts must have stops at the rear of each frame side member to restrain the body installation and prevent it from exerting undue stress on the U-bolts during a panic stop. These stops will also help to restrain the body if the U-bolts break or loosen.

  There should be two stops per frame rail, one mounted at each end of the body.

- If wheel removal is necessary, take the following precautions.
  1 Do not paint the wheel bearing surfaces of the hubs. Particularly in the case of hub-piloted wheels, the faces of the hub, flange mounting surfaces of the wheels, and mounting surfaces of the flange nuts must be clean and free of any foreign material or excess paint.
  2 Do not paint the wheel nut bearing surfaces, or the surfaces of the wheel nuts themselves.
  3 When remounting hub-piloted wheels, anti-seize compound may be applied to the hub pilot pads to prevent corrosion. Apply two drops of oil to the joint between the nut and flange of each flange nut and a small amount of oil to the lead threads of the stud. On stud piloted ball socket disc wheels, the wheel nuts are installed dry.
  4 Tighten the wheel nuts, using proper wheel nut tightening procedures.
  5 After any operation that requires removal and reinstallation of the wheel assemblies, the wheel nuts must be retightened with an accurately calibrated torque wrench during the first 800 Km (500 miles) of use.

Body-to-Chassis Matching

Properly matching a truck body and/or accessory equipment to a chassis is important to ensure that the completed vehicle will perform as intended without adversely affecting handling characteristics or weight distribution. Typically, 60 – 70% of the body weight should be forward of the centerline of the rear axle(s). This percentage can be adjusted by either moving the center of gravity forward, which places more weight on the front axle, or moving the center of gravity rearward, which places more weight on the rear axle(s). The addition of a body, associated equipment and the payload should never result in the GAWRs and/or GVWR being exceeded.

When choosing a chassis for a body, the following must be considered:

- How much weight can be placed on the front and rear axles (GAWR).
- How much the vehicle can weigh, including the vehicle with full capacities of fuel, oil, coolant, etc., the driver and passenger if applicable, all associated equipment and the body's payload (GVWR).
- Curb or tare weight, or how much the chassis weighs before the body and/or equipment are installed. Tare weight includes the weight of all options, fuel, lubricants and coolants.
- Cab-to-axle (CA). This is the dimension from the back of the cab to the centerline of the rear axle, or the centerline of the rear tandem axle assembly.
- Wheelbase (WB). This is the dimension between the centerline of the front axle and the centerline of the rear axle (or the centerline of the tandem axle assembly). This dimension is important because it affects body installation, vehicle performance and whether a particular axle is overloaded.
- Back-of-cab (BOC). The distance between the back of the cab and the body.
- Body length (BL). This is the dimension from the front to the rear of the body.
- Overall vehicle length state regulated for straight trucks. If in doubt, contact the appropriate State Department of Transportation.

Specifications

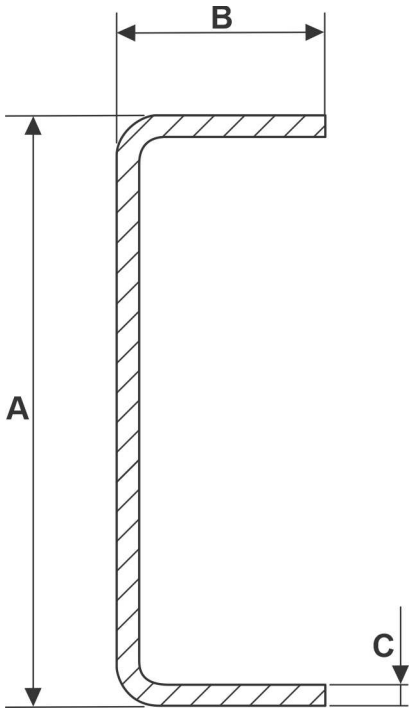
Frame Rails

Material . . . . . .827.3 MPa (120,000 psi) yield heat treated steel

Distance between rails	MD6	260 X 70 X 7 mm
	MD7	260 X 70 X 8 mm

Frame rail end taper . . . . . 27°

Frame Options



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Frame Rail Web	**A**	260 mm (10.47 in)
Frame Rail Flange	**B**	70 mm (3.25 in)
Frame Rail Thickness	**C**	**MD6:** 7 mm (0.275 in)
		MD7: 8 mm (0.312 in)

Notes

Incorrectly sized bolt holes weaken a bolted connection and can lead to a dangerous situation when the bolts are holding heavy weight. The two types of bolt holes are pass-through and tapped. Each has different clearance specifications that determine the strength of the connection. The type of material and connection will determine the type of hole needed to secure the materials with the bolt. Using the wrong type of hole will have an adverse effect on the holding ability of the bolt. The chart below are some examples of the ASME B18.2.8-1999 - “Clearance holes for bolts, screws and studs" standard. Please refer to this standard for additional information.

Fastener Size Standard	Mounting Hole Diameter
3/8 in	13/32 in
7/16 in	15/32 in
1/2 in	9/16 in
5/8 in	11/16 in
3/4 in	13/16 in
7/8 in	15/16 in
1 in	13/32 in

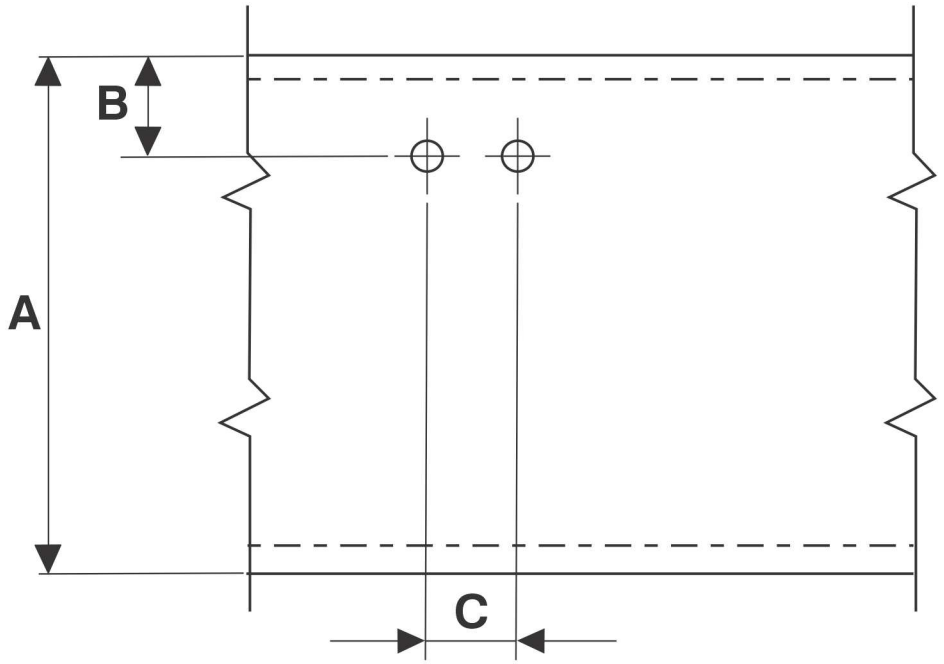
Fastener Size Metric	Mounting Hole Diameter
M14	15.5 mm
M16	17.5 mm
M20	22 mm

Bolt Hole Patterns

Hole spacing . . . . . 60 mm (2.26 in.) (vert) x 50 mm (1.97 in.) (horiz)

(applicable only from 1685 mm (65.2 in.) from front edge of the rail and rearward). Some components may occupy non-grid locations.

Note: Hole size for this spacing must be 15.5 mm (0.61 in.) diameter.



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A 260 mm (10.24 in.)
B 60 mm (2.36 in.)
C 50 mm (1.97 in.)

Dimension Calculations Body Length

When selecting a body for an existing chassis, use the following formula to calculate body length:

$$BL = \left[\frac{(GAWR.R - CWR) \bullet WB}{GVWR - CW} - WB + CA - BOC \right] \bullet 2$$

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Formula for Calculating Body Length

Where:

GAWR.R =	Gross axle weight rating of the rear axle
CWR =	Amount of curb weight at the rear of the chassis
WB =	Chassis wheelbase
GVWR =	Gross vehicle weight rating of the chassis
CW =	Curb weight of the chassis
CA =	Dimension between the rear of the cab and the centerline of the rear axle or tandem
BOC =	Distance between the back of the cab and the front of the body

Wheelbase (WB)

Mack Medium Duty has eight wheelbases[1]							
150 in (3810 mm)	166 in (4216 mm)	186 in (4724 mm)	206 in (5232 mm)	221 in (5613 mm)	236 in (5994 mm)	251 in (6375 mm)	270 in (6858 mm)

1 Wheelbase selection should be based on specific weight distribution.

Wheelbase Changes

Vehicle wheelbase dimensions may be changed by moving the rear axle and suspension assembly to the new, desired location on the frame. When the axle assembly is moved, the suspension should be remounted to the frame, using as many existing drillings in the frame as possible. The number of new drilling in the frame rails should be limited. All unused drilled holes in the frame must be filled with a proper size bolt, nut and hardened washers. Tighten the hardware to proper specifications.

Wheelbase Changes and Drive shaft Length

Wheelbase changes affect drive shaft length, driveline angularity and size requirements. To avoid potential vibration problems and failures, the driveline for the new wheelbase dimension must maintain the correct drive shaft angle, size and length.

Wheelbase Changes and ABS/ATC Systems

An important factor in maintaining MVSS 121 complying brake timing is keeping the brake valves in the same relative position to the rear axle brake assemblies. Particularly with ABS/ATC chassis, the ABS/ATC components (modulator valve) for the rear axle must be moved to correspond with the increase or decrease in wheelbase length. The relationship between the rear axle and the modulator valve must be kept the same. Additionally, the service brake relay valve must be moved to maintain the same distance between the modulator valve and the relay valve.

Do not cut and splice harnesses for the ABS/ATC speed sensors and modulator valves to compensate for changes in chassis wheelbase. Extension harnesses are available in 2, 4 and 6 foot lengths. Contact a MACK dealer, service dealer or parts dealer for necessary extension harness part numbers.

Wheelbase Changes and Steering Geometry

Changes to vehicle wheelbase will affect steering geometry (specifically, Ackerman angle), and may require a different cross-steering lever and cross-steering tube. For additional information, contact MACK Trucks, Inc. Product Support.

Sub-frames

Sub-frame Design

CAUTION

Do NOT mount bodies directly to the chassis side members by drilling the frame flanges because this weakens the frame and may result in frame failure.

The body must be secured to the chassis frame so that both static and dynamic stresses are transmitted without causing excessive localized stress which could result in frame damage, or affect road handling of the vehicle.

The body unit must be mounted to the chassis frame using a sub-frame assembly. The illustration below shows some typical sub-frame design cross sections.

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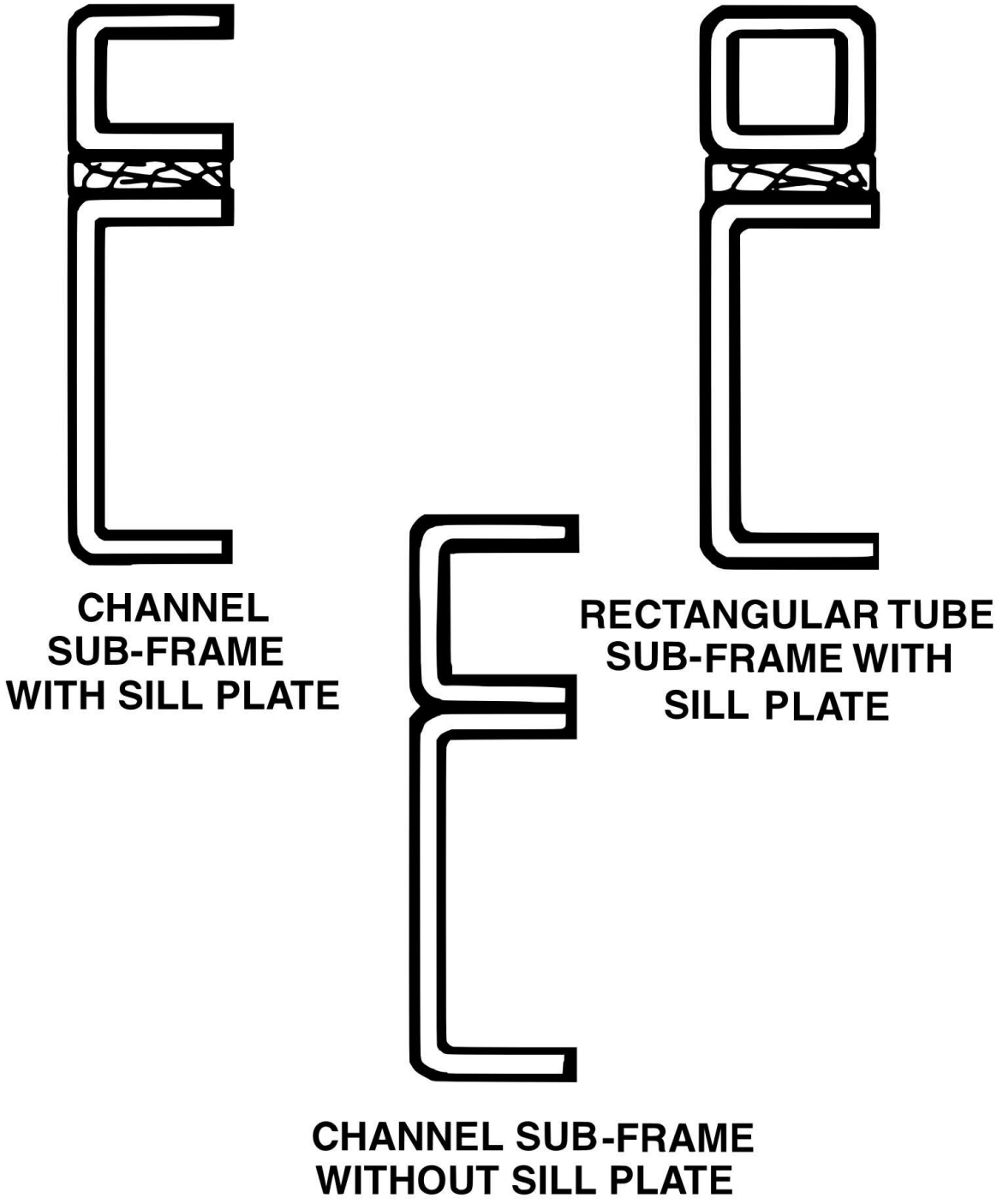
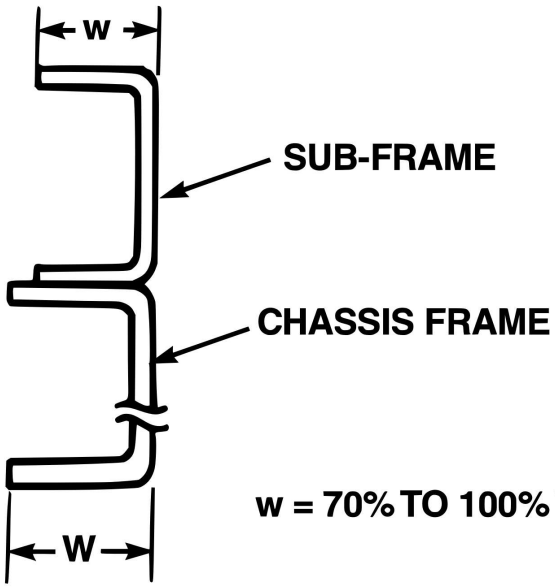


Typical Subframe Cross Sections

Sub-frame Construction

The sub-frame should be fabricated from channel steel to form a continuous longitudinal channel. The width of the sub-frame flange must be between 70 – 100% of the frame rail flange width.



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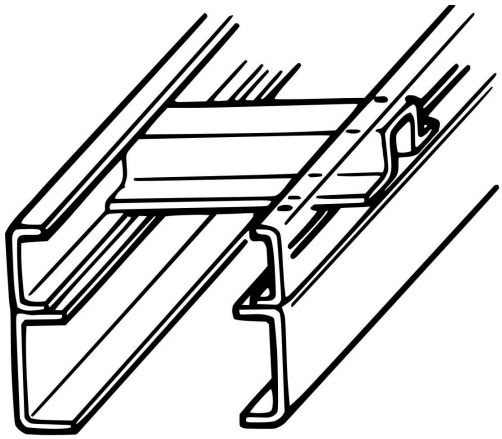
Subframe Flange Width

The lower sub-frame flange must be mounted flush with the upper flange of the chassis side member. Do not mount the sub-frame at an angle to the chassis. Use either cross members, or the body unit itself, to connect the sub-frame sides together. (Refer to the Body Builder; Chassis, Frame bulletin for additional information.)



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Subframe Crossmember

The sub-frame channel opening should face inward toward the longitudinal center line of the chassis. Also, the sub-frame web surface should align with the frame rail web as shown in the following illustration.

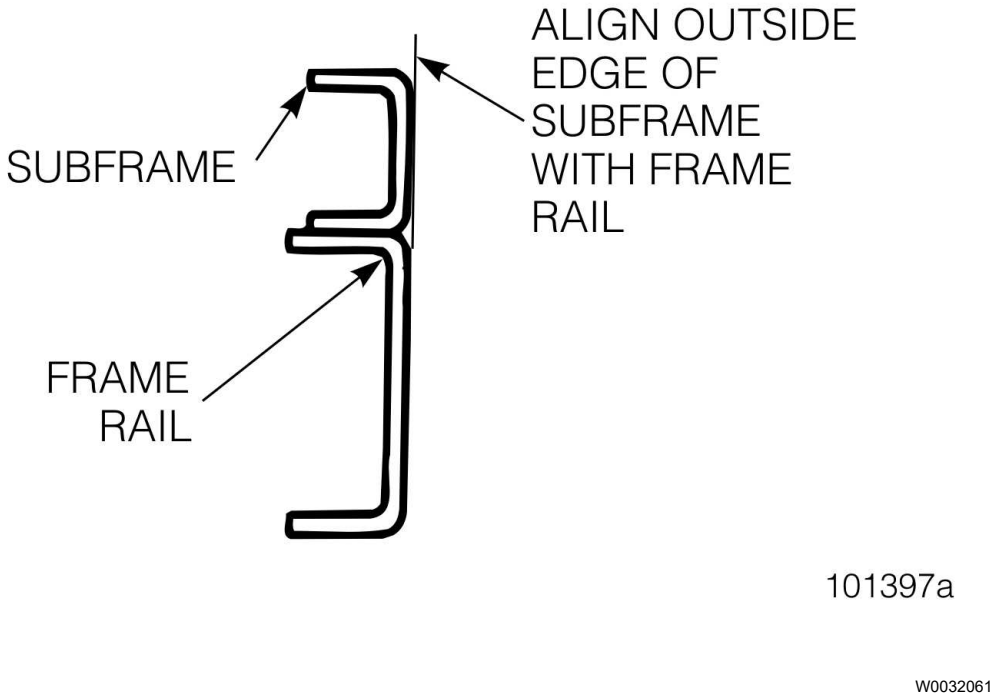

Fig. 1 Align Sub-frame to Frame Rail

Notes

Sub-frame End Shape

To reduce the possibilities of stress concentration on the chassis frame, the front end of the sub-frame should be shaped so that rigidity gradually decreases. Additionally, the front end of the sub-frame should extend as far forward as possible. The following three figures illustrate three different types of sub-frame end design.

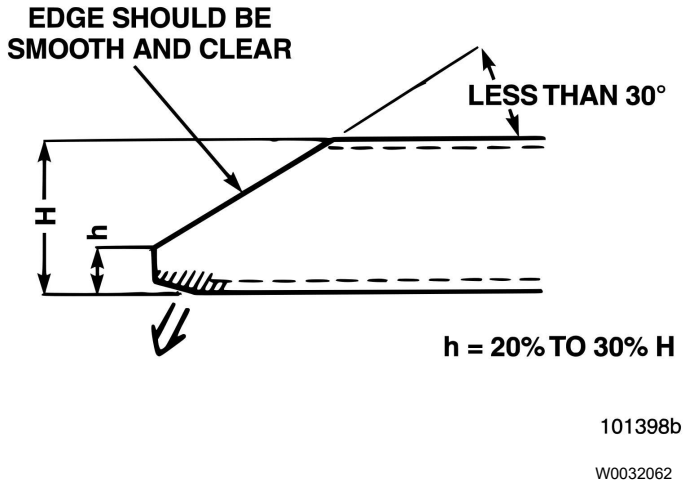

Fig. 2 Preferred Sub-frame End Design

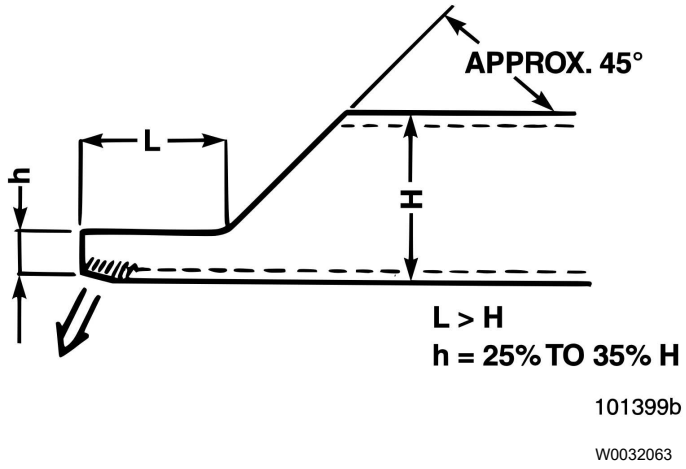

Fig. 3 Alternate Sub-frame Design

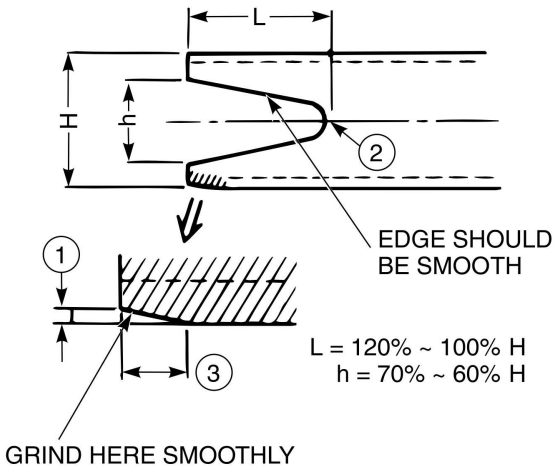

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Fig. 4 Alternate Sub-frame End Design

1. 1 mm (0.04 in) 2. R = 20 mm – 30 mm (0.79–1.18)	3. 15 – 20 mm (0.59 – 0.79 in)

If the sub-frame is fabricated from square or rectangular tubing, the end should be cut as shown.

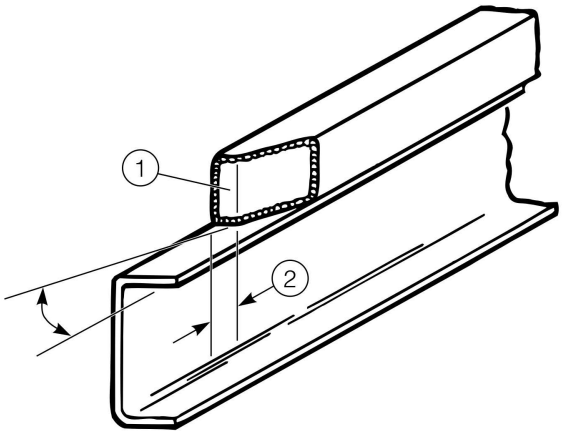

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Fig. 5 End-Cut Design for Square or Rectangular Tube Sub-frame

1. Blank Off with 1.5 mm (0.06 in) Thick Sheet Metal	2. 15 – 20 mm (0.59 – 0.79 in)

Sub-frame designs shown in figures above are recommended. If body design or other factors prevent any of these designs from being used, the sub-frame shape shown in figure below may be used.

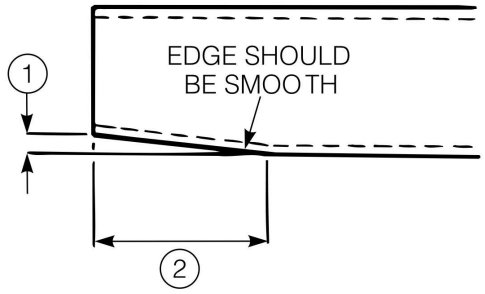

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Fig. 6 Alternate Design

1. 57 mm (0.06 in)	2. Approximately 200 mm (7.9 in)

If mounting a tank or other rigid type of body, the sub-frame shapes shown in Figure 2,3 and 4 must be used.

Notes

Sub-frame Attachment

A variety of methods can be used to secure the sub-frame assembly to the chassis frame. They include U-bolts, flexible attachments and bolted plates. When the sub-frame is installed, however, a mounting sill plate made of hardwood or other suitable material may be installed between the sub-frame and the chassis frame to protect the flange surfaces, and to allow for irregularities in the surfaces of the two frame members.

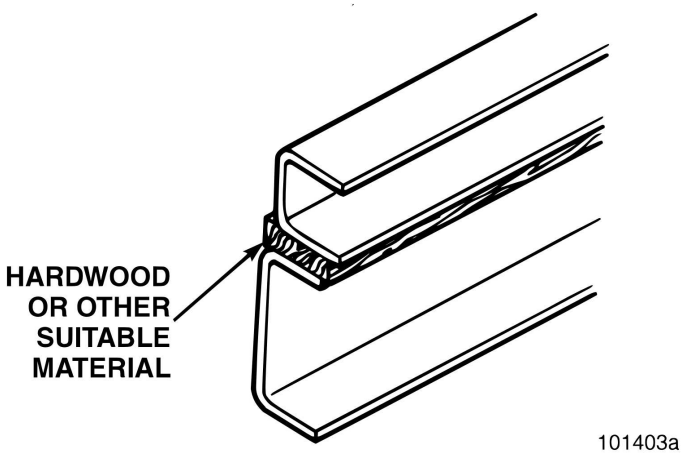

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Fig. 7 Sub-frame Sill Plate

Sills must be chamfered 1/2 in at the front end, and tapered approximately 25.4 mm (1 in) from the front end of the sill.

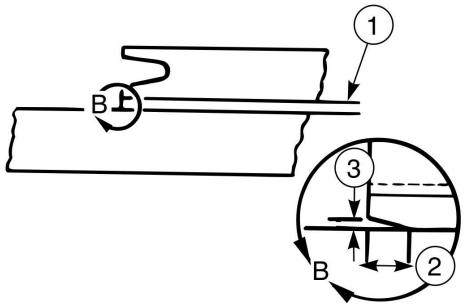

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Fig. 8 Sill Plate Chamfer

1. Hardwood Sill Plate Thickness 12.75 mm (0.5 in) 2. Approximately 30.5 mm (1.2 in)	3. 23 mm (0.91 in)

U-Bolts, Tie Bars and Other Types of Clamping Devices Attachment

Note: U-bolts, tie bars and other similar types of clamping methods rely on friction and a maintained clamping force for attachment. When using these methods of attachment, the surfaces must be free from oils, grease and other agents that could allow slippage and adversely affect the attachment.

When using U-bolts, tie bars or other similar types of clamping methods, install an anti-crush spacer inside the side members to prevent distorting, or crushing the frame when the bolts are tightened. These spacers should be fabricated from seamless angle irons or rectangular/cylindrical tubing, and suitably spot welded into position.

CAUTION

Do not use U-profile (angle iron) spacers having welded construction. Anti-crush spacers must be of one-piece, seamless construction design.

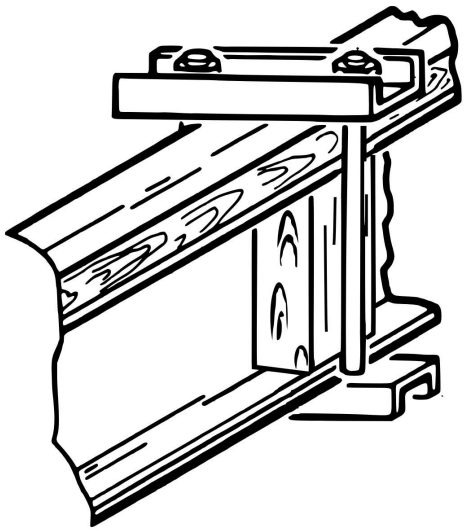

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Fig. 9 Tie Bar Type Attachment with Anti-Crush Spacers

Notes

When round U-bolts are used for body attachment, rounded shims that follow the curvature of the U-bolt must be used.

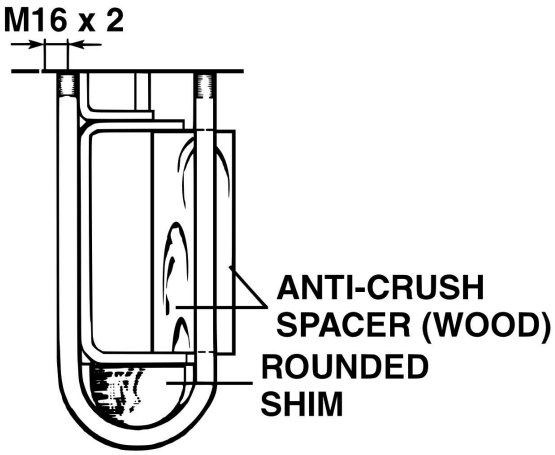

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Fig. 10 U-Bolt with Rounded Shim and Anti-Crush Spacer

Body clamps (U-bolts, tie bars, etc.) must not be located in the vicinity of the rear axle or suspension. Additionally, the U-bolts or anchor bolts must not contact the frame rail side member.

CAUTION

Do NOT notch the frame rail flanges in order to make a U-bolt or anchor bolt fit. If the frame rail flanges are too wide for the U-bolt, select another size U-bolt or another method of attachment.

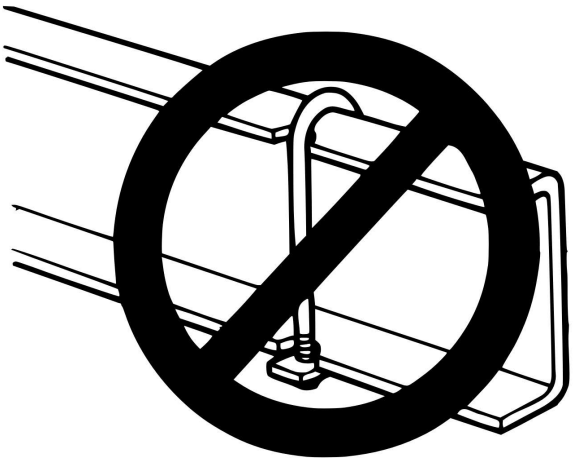

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Fig. 11 Do Not Notch Frame Rail Flange

Bolted Methods of Attachment

The two bolted methods of attachment are rigid mounting and flexible mounting. Both of these methods include clips, brackets and other types of mountings, which are bolted to non-critical areas of the frame rail web. The use of existing holes in the frame is encouraged. But when this is not possible, holes in the frame must be drilled in accordance with the frame drilling methods as outlined earlier in this section.

As a rule, holes in the frame should be located no closer to the top and bottom frame flanges than existing holes that were drilled at the assembly plant.

Rigid Mounting

Rigid types of mounting should be used for mounting vans or other similar types of bodies. A rigid type of mounting arrangement consists of a bolted plate or bracket welded to the subframe assembly and bolted to the chassis frame. Brackets must be bolted, not welded, to the chassis frame.

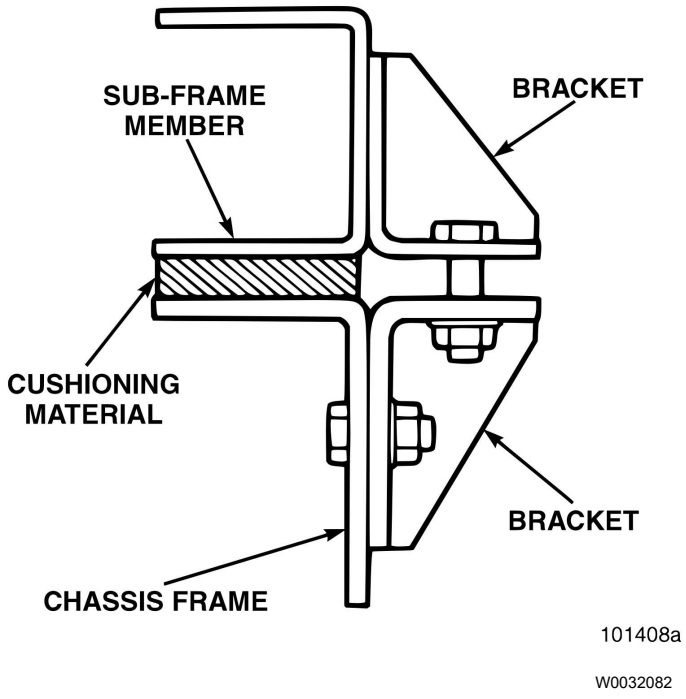

Fig. 12 Bracket-Style Rigid Mount

Notes

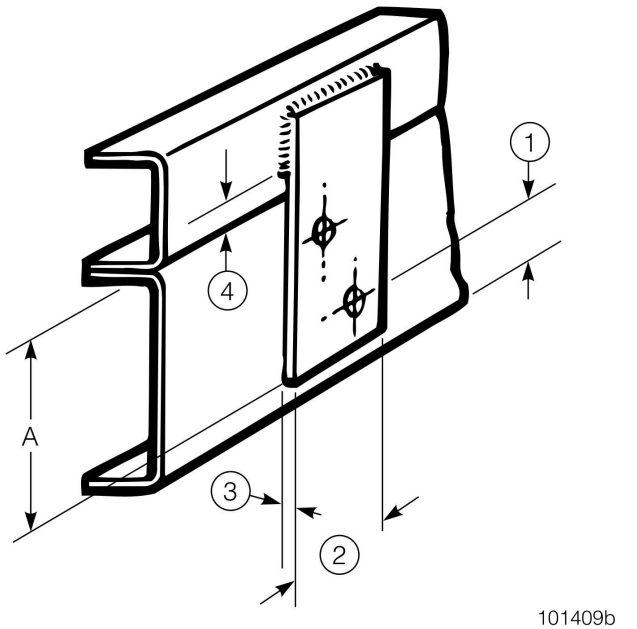

Fig. 13 Bolted-Plate-Style Rigid Mount

1. 25.4 mm (1.0 in) 2. 60 mm (2.36 in)	3. 3.8 mm (0.31 in) 4. 15 mm (0.59 in)

Flexible Mounting

For torsionally stiff types of bodies, such as tanks or refuse bodies, the mounting must allow some flexing of the frame under normal driving conditions. Flexible mounting should be used. Flexible mounting is accomplished by using rubber suspensions or spring-loaded brackets.

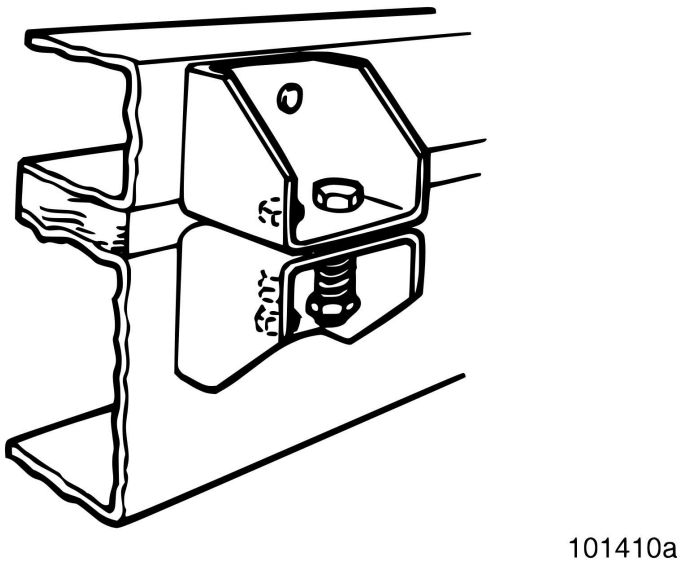

Fig. 14 Flexible Mounting Arrangement

Fasteners

Fasteners Flange Head, Metric

All metric flange head cap screws used by MACK Trucks, Inc. are zinc or cadmium plated. All metric nuts are cadmium plated and waxed. Torque should be applied to the nut whenever possible. No lubricant is to be used. Where sealer (Alumilastic or equivalent) is used between aluminum and ferrous surfaces, the threads on the bolt must be wiped clean after insertion, and before threading the nut onto the bolt.

Torque to be applied when the flanged fastener spins on steel plate or ferrous castings:

Screws in Property Class 8

Size	Torque ft-lb (Nm)
M6	10 ± 1.5 Nm (7.4 ± 1.1 ft-lb)
M8	24 ± 4 Nm (18 ± 3 ft-lb)
M10	48 ± 8 Nm (35 ± 6 ft-lb)
M12	85 ± 11 Nm (62.7 ± 8.1 ft-lb)
M14	140 ± 25 Nm (103.2 ± 18.4 ft-lb)
M16	220 ± 35 Nm (162.2 ± 25.8 ft-lb)
M18	290 ± 45 Nm (214 ± 33.1 ft-lb)
M20	430 ± 70 Nm (317. 1 ± 51.6 ft-lb)
M22	580 ± 90 Nm (428 ± 66.3 ft-lb)
M24	740 ± 120 Nm (545.8 ± 88.5 ft-lb)

Screws in Property Class 10.9

Size	Torque ft-lb (Nm)
M6	12 ± 2 Nm (8.9 ± 1.5 ft-lb)
M8	30 ± 5 Nm (22.1 ± 3.7 ft-lb)
M10	60 ± 10 Nm (44.3 ± 7.4 ft-lb)
M12	105 ± 20 Nm (77.4 ± 14.8 ft-lb)
M14	175 ± 30 Nm (129 ± 22.1 ft-lb)
M16	275 ± 45 Nm (203 ± 33.1 ft-lb)
M18	360 ± 55 Nm (265.5 ± 40.6 ft-lb)
M20	540 ± 90 Nm (398 ± 66 ft-lb)

Frame

Frame Welding and Cutting

CAUTION

The only acceptable method of lengthening a frame is by adding a section behind the rear axles. Cutting and splicing the frame ahead of the rear axles will severely weaken the frame in the area of the splice and will result in frame failure. DO NOT splice a frame.

Certain frame modifications, such as lengthening and shortening, require welding and cutting the frame. In general, frame welding is not recommended. However, for modifications that do require cutting or welding the frame such as frame lengthening, shortening, etc., the following welding and cutting practices are recommended by MACK Trucks, Inc.

Frame Cutting

Mechanical sawing is the preferred method for cutting the frame. However, the oxygen gas process (either oxygen and acetylene or oxygen and MAPP) is acceptable.

Surface areas of the parts to be joined must be ground smooth to prepare them for welding. Edges must be beveled to a 30 ° angle with a 1.588 mm (1/16 in) land.

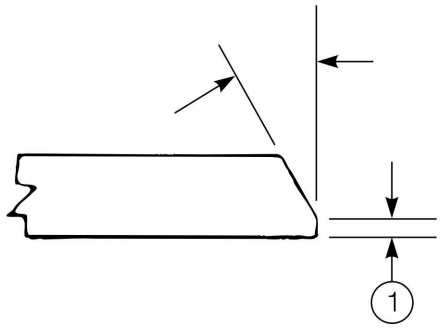

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Fig. 15 Joint Preparation

1. 1.588 mm (1/16 in)

When joining frame members, the bevel must be away from the frame. Parts being joined must be brought as close together as possible. A gap of approximately 1/16 in (1.588 mm) should be maintained. Align the sections and clamp them with a piece of scrap channel.

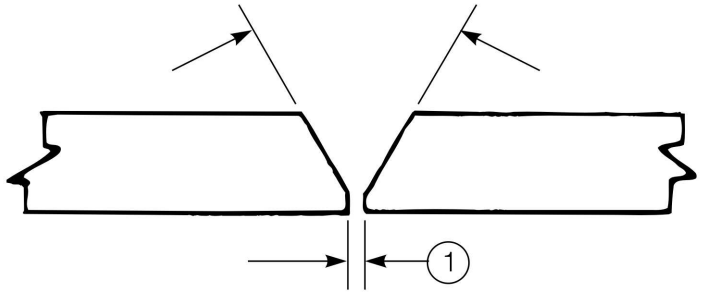

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Fig. 16 Aligning Joints for Welding

1. 1.588 mm (1/16 in)

When the gap between parts is greater than 1.588 mm (1/16 in), edges may be built up by welding and grinding. DO NOT use fillers.

Notes

Frame Welding

CAUTION

Before welding the frame, disconnect all battery cables, and all harnesses to any electronic controls to avoid serious damage to the electrical system and sensitive electrical components. When disconnecting the batteries, disconnect the negative battery cable first, then the positive cable. Do NOT disconnect the batteries while the engine is running.

Note: On vehicles equipped with CUMMINS engine, it will be necessary to reprogram the date and time, if the vehicle batteries are disconnected. Refer to the appropriate CUMMINS User Guide for programming information.

Weld using a 2.3 mm (3/32 in), E11018M welding rod with either direct or alternating current, reverse polarity and a positive electrode. Use the following voltage and current for either process:

- Volts 21 – 24
- Amperes 70 – 120

When assembling or joining parts by welding, the procedure must be completed to minimize distortion and shrinkage. For multiple pass welds, slag must be completely removed before proceeding with subsequent weld passes. Slag must be completely removed from finished welds, and the finished weld must be ground completely smooth on both sides of the joint.

Cracks, porosity, overlaps and deep undercuts greater than 1.588 mm (1/16 in), must be ground out and rewelded. Craters, unacceptable undercuts (less than 1.588 mm [1/16 in]) and undersized welds can be corrected by additional welding.

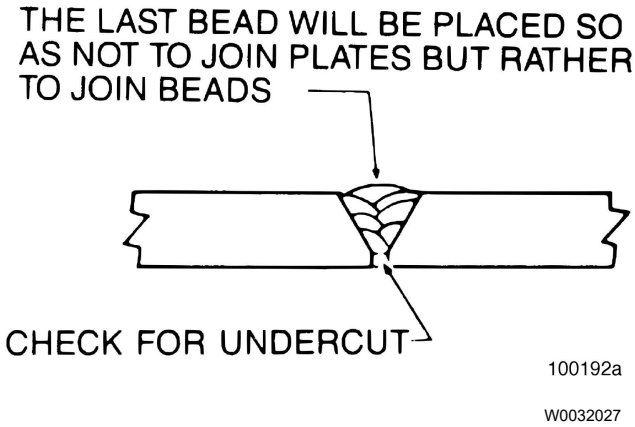

Fig. 17 Proper Weld

Weld Quality

The following figures illustrate acceptable and unacceptable weld profiles for both fillet and butt welds.

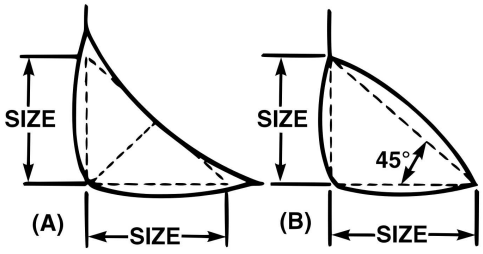

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Fig. 18 Desirable Fillet Weld Profile

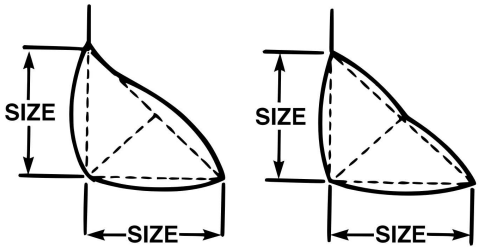

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Fig. 19 Acceptable Fillet Weld Profile

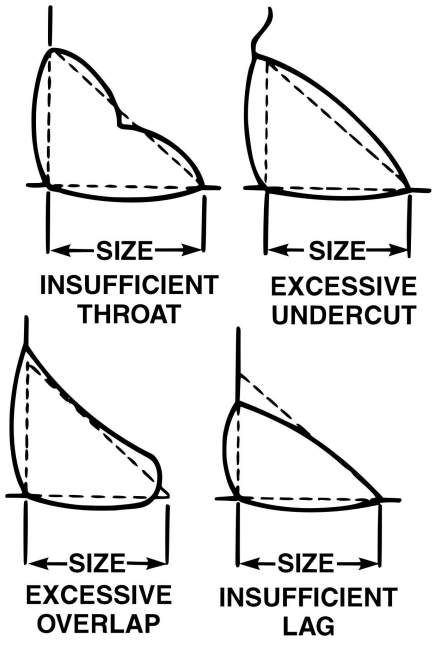

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Fig. 20 Unacceptable Fillet Weld Profiles

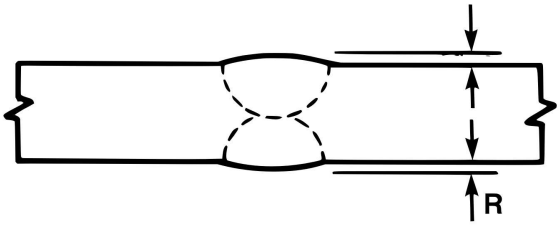

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Fig. 21 Acceptable Butt Weld Profile

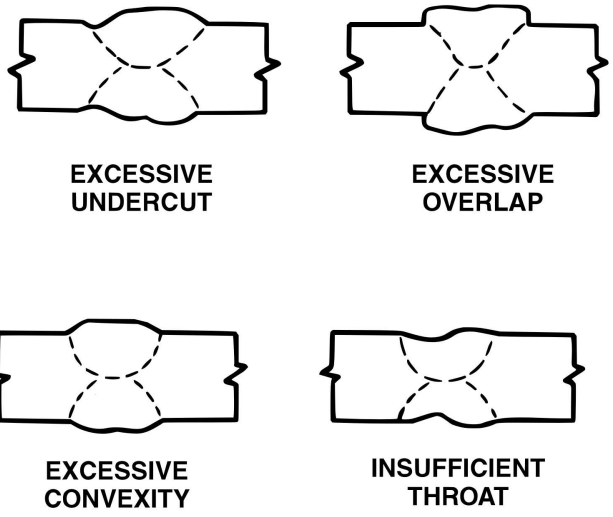

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Fig. 22 Unacceptable Butt Weld Profiles

Notes

Frame Reinforcement

Frame Reinforcement Design

For some modifications, it may be necessary to install reinforcement plates. As weight is applied to the chassis, the frame has a tendency to flex. Where the frame is not directly supported by the suspension, it flexes downward. As this occurs, one frame flange stretches (tension flange), while the other flange is compressed (compression flange).

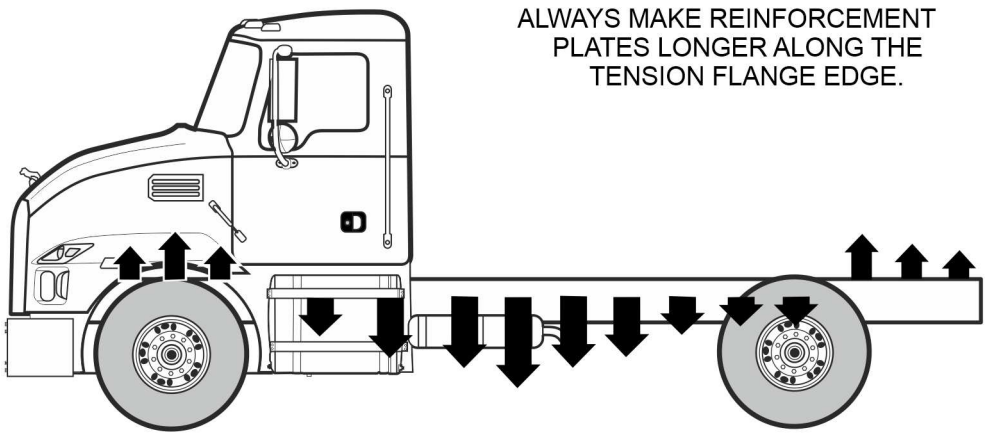

Fig. 23 Frame Flexing

Because frame stress is greatest at the tension flange, reinforcement plates must be longer on the tension flange edge to provide additional support to this area.

Frame reinforcement plates must be free of any cracks, nicks and burrs. Prepare the edges of the plate by grinding smooth. Avoid load concentrations on all body mounting brackets and supports.

Reinforcement plates must be long enough to extend beyond the critical area so that the ends can be cut on an angle rather than square across the frame section as shown in the illustration below.

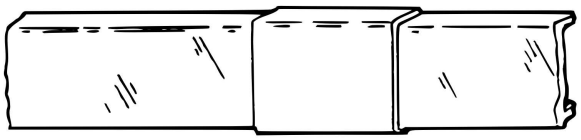

Fig. 24 Unacceptable Reinforcement Plate Design

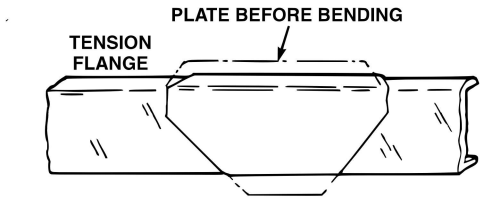

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Fig. 25 Acceptable Reinforcement Plate Design

Avoid section gaps between the reinforcement plate and the ends of adjacent brackets or crossmember gussets. Always extend the reinforcement plate as far as necessary to align with the end of an adjacent bracket or crossmember gusset.

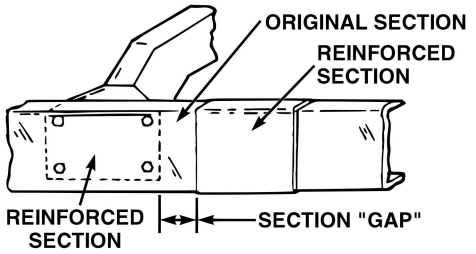

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Fig. 26 Unacceptable Reinforcement Plate Location

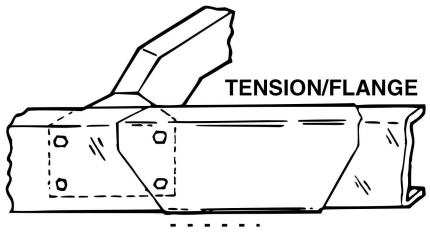

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Fig. 27 Acceptable Reinforcement Plate Location

Never leave a sharp internal angle when cutting a reinforcement plate, or when modifying structural members. Cutting a radius is acceptable, but cutting the plate at an angle is preferred.

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Fig. 28 Sharp Internal Angle (Unacceptable)

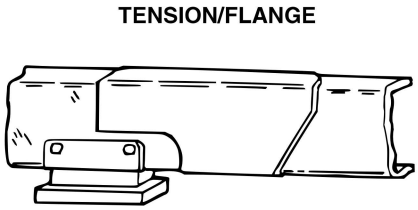

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Fig. 29 Internal Angle Cut on Radius (Acceptable)

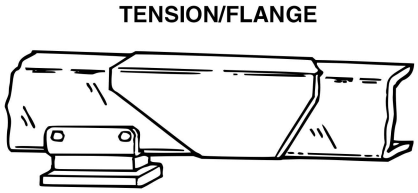

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Fig. 30 Plate Cut on Angle (Preferred)

Frame Reinforcement Attachment

CAUTION

Use bolts to attach reinforcement plates to the frame. Do NOT attach reinforcement plates by welding to the frame, as this creates stress risers in the area of the weld and may result in frame failure.

In critical areas, use bolts with hardened washers to attach the reinforcement plate to the frame. Bolts require reaming the hole to a non-standard size to effect an interference fit for the bolt. HUCK fasteners can also be used in these instances.

Avoid several holes in direct vertical alignment, or holes that are too close together, because this weakens the frame in the area of the drilling. A staggered bolt pattern with good spacing and sufficient edge distance is most desirable.

Refer to the frame reinforcement section for additional information.

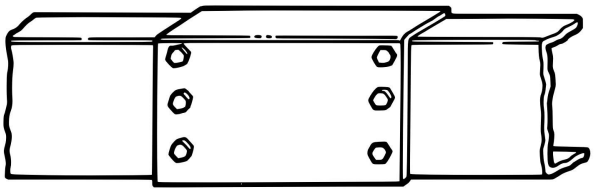

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Fig. 31 Bolt Holes in Vertical Alignment (Unacceptable)

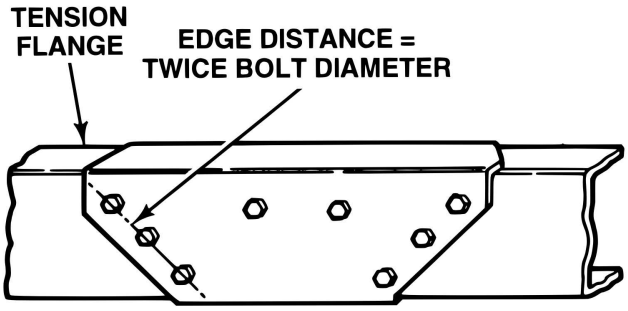

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Fig. 32 Staggered Bolt Pattern (Acceptable)

Frame Length Changes

Note: Lengthening or shortening a frame will require cutting and/or welding. In general, frame welding is not recommended.

The frame may be shortened by simply cutting the side members to the desired length. The only way a frame can be lengthened is by adding to the afterframe. DO NOT splice a frame by adding a section ahead of the rear suspension because this severely weakens the frame in the area of the splice and may lead to frame failure.

The additional lengths of frame are added to the existing frame by butt welding the two pieces together and grinding the weld inside the frame rail smooth. A length of inside channel is then added to support the new afterframe. The inside channel should extend from the center of the rear suspension bracket/crossmember, picking up at least one set of mounting holes, and extending to the end of the afterframe. The inside liner must be secured in place with either bolts or HUCK fasteners.

If the chassis is already equipped with inside frame liners, they should be replaced with new liners long enough to reach the end of the new afterframe section.

All parts, such as frame rail sections, inside liners and other components, should be properly prepared, primed and painted to eliminate the possibility of corrosion between the inside channel and the frame side member. Cut ends of the frame rail and inside channels must be chamfered as described in the welding section of this guide. The chamfers must face inward on the chassis.

Frame Lengthening Additional Crossmember

Crossmember must be added to a new afterframe section to provide acceptable frame rigidity for the assembly. Due to added equipment, wheelbase changes and other modifications, it may also be necessary to add crossmembers to provide acceptable support and frame rigidity. The distance between crossmembers should not exceed a maximum of 1200 mm (47.25 in) between crossmember centers. Crossmember should be secured to the frame using bolts or HUCKS.

Notes

Relocating or Removing Cross Members

WARNING

Removing frame cross members can affect the structural integrity of the vehicle. The use of a flashlight to remove rivets is discouraged. Heat damage could also affect the integrity of the frame and could void frame rail warranty.

Removal of Rivets

The following procedure shows the proper way of removing the rivets and securely relocating the cross members.

Grind the rivet head.

T7163352

Mark center point of rivet for drilling.

T7163353

Annular cutting bit with pilot is **highly recommended**, ½ diameter.

T7163354

Drill out center of rivet.

T7163355

Punch rivet out of hole.

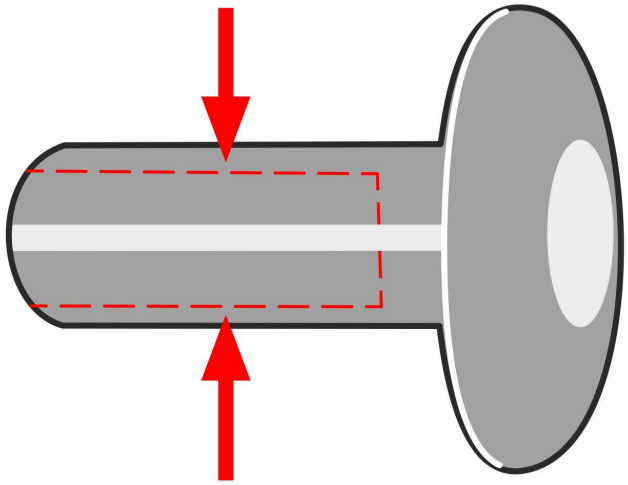
T7163356

Note: This method is highly recommended and has yielded the best results, but may be modified if necessary.

If using a regular drill, a smaller diameter punch is needed to fit in the cavity. The rivet needs room to narrow when being punched through hole.

It is NOT recommended to completely drill neck of rivet, as the hole in frame could be damaged.

If necessary, touch up the paint on the frame to prevent corrosion.



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Hardware to replace rivet

- Flange Screw M12*1.75*40 (Mack p/n 984816)
- Flange Nut M12*1.75*20 (Mack p/n 990946)

If adding spacer or aftermarket part, a longer bolt will be needed:

- Flange Screw M12*1.75*50 (Mack p/n 984850)
- Flange Screw M12*1.75*60 (Mack p/n 984817)
- Flange Screw M12*1.75*80 (Mack p/n 984818)

Install bolt from inside of frame and install nut on outside of frame rail.

Torque bolts to 105+/-20 Nm (77 ft lb).

T7163358

Notes

Frame Drilling

CAUTION

Do not drill the frame flanges, as this may result in frame failure.

Body attachment, frame lengthening, shortening or any other type of modification, requires drilling holes in the frame side members. Whenever holes are drilled in the frame, certain precautions must be taken to maintain the strength and integrity of the frame.

When drilling the frame, observe the following guidelines to avoid frame damage:

- The hole center line must not be closer than 45 mm (1 3/4 in) from the top or bottom frame flange.
- Hole center lines must be at least 75 mm (3 in) apart. Additionally, there should be no more than two holes on the same vertical line. Ideally, holes should be staggered as shown in the illustration below.

Location	Dimension mm (in)
A	45 (1 3/4)
B	75 (3)
C	75 (3)
H	260 mm

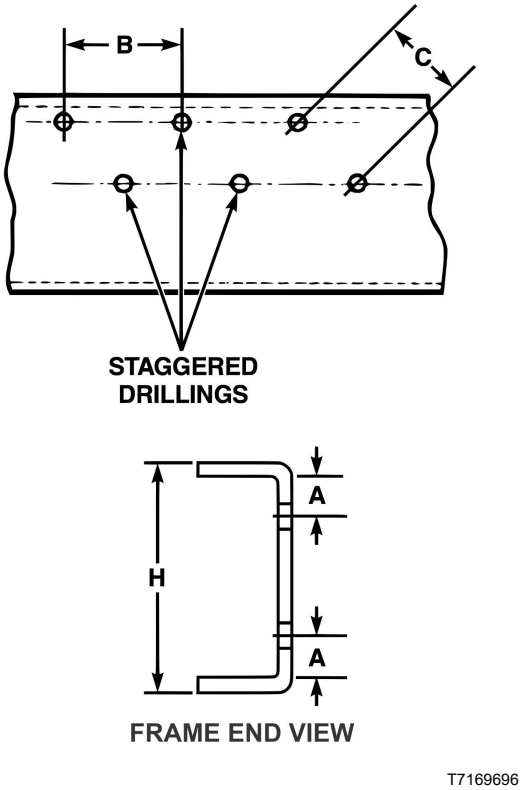

Fig. 33 Drilling Locations in Frame Webs

- Holes must be no larger than existing holes in the frame, such as holes for the spring bracket bolts.
- Use proper drill bits. Cobalt high-speed drills are superior to conventional high-speed drill bits for frame drilling operations. Drills should be sharpened to give 150 ° included angle with 7 to 15 ° lip clearance. This prevents localized overheating of the frame in the area of the drilling operation.
  When a pilot hole is drilled, it should not be enlarged in successive stages, as rapid wear of drill bits will occur. Also, stop drilling before fully breaking through. Remove the remaining lip with a reamer.
- Never cut holes into the frame with a flashlight.
- Do not drill holes near any high-stress points such as locations around the spring brackets.
- Holes must be de-burred and reamed to no more than 0.946 mm (1/32 in) larger than the intended fastener.