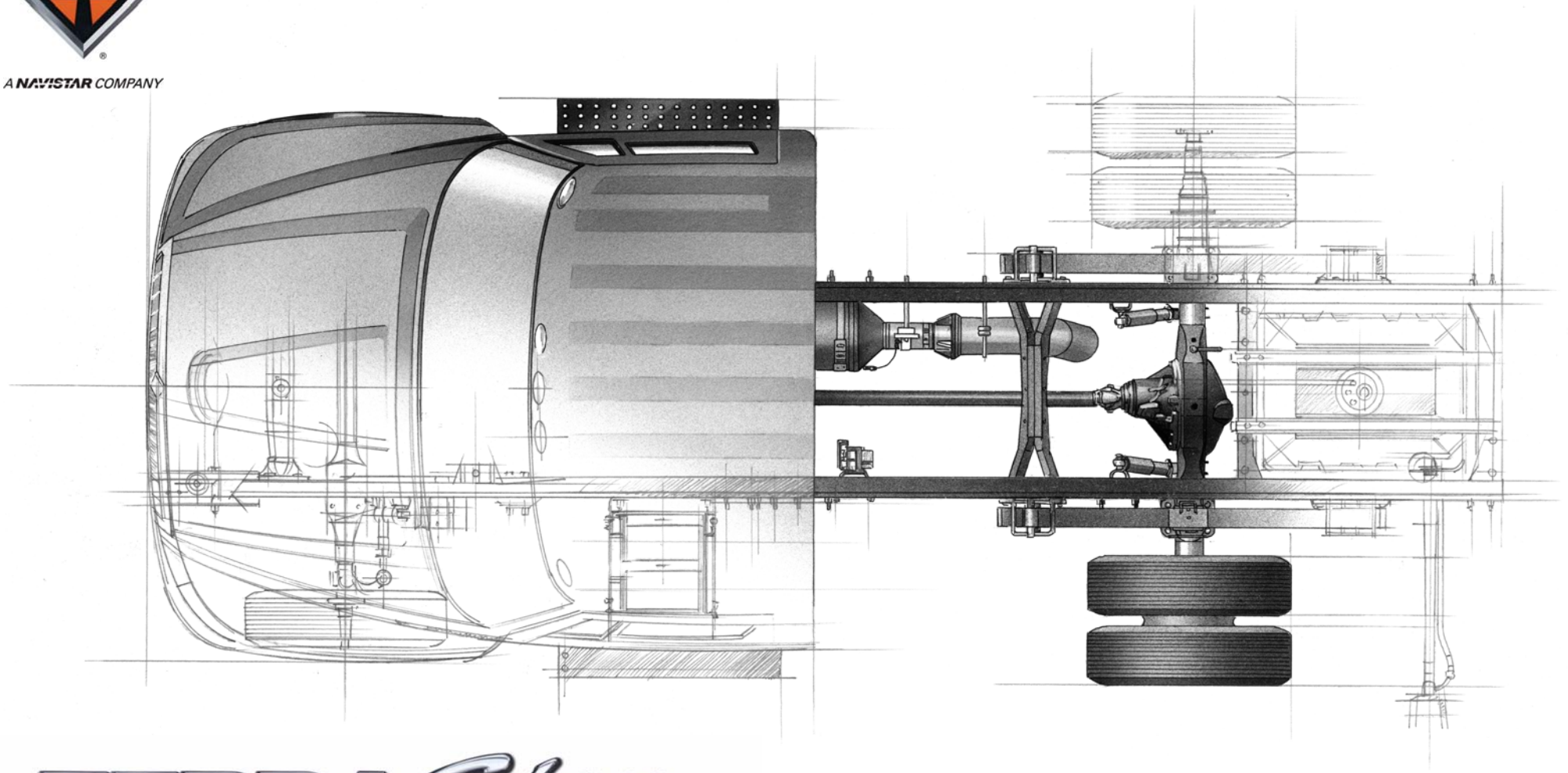
A NAVISTAR COMPANY



TERRAStar®

Medium Conventional

Body Builder Book
January 2013 Edition
PBB-44100

TABLE OF CONTENTS

PREFACE

FOREWORD

The CT-471 – Body Builder Books are a set of publications of which this **TerraStar® Series Medium Conventional** Body Builder is a part. The complete set contains information related to the features and specifications for each truck in the International® product line.

Disclaimer

The Body Builder Books provide product information to assist those who wish to modify these products for individual applications. Navistar, Inc. does not recommend or approve any firm or party nor make any judgements on the quality of the work performed by a particular firm or party. Individuals who use the services of a Body Builder must satisfy themselves as to the quality of the work.

The party installing a body, a fifth wheel, any other equipment, or making any modifications to complete the vehicle for delivery and make it road-ready is responsible to see that the completed vehicle complies with all applicable certification procedures and safety standards, as may be set forth in Federal, State, and local statues, rules and regulations.

Specifications, descriptions and illustrative material in this literature are as accurate as known at time of publication but are subject to change without notice. Navistar, Inc.cannot accept responsibility for typographical errors which may have occurred. Illustrations are not always to scale and may include optional equipment and accessories but may not include all standard equipment.

PUBLICATION ORDERING INFORMATION

You can easily order the CT-471 set or any of its components by accessing the Marketing Resource Center and clicking the “Order Brochures” link, using your regular User ID and password.

Revisions to the following product publications are available automatically by subscribing to the Product Information Revision Service. Also, additional copies of product publications can be ordered individually on a one-time basis. When ordering, include the publication number, description and quantity required.

Body Builder Books – Complete Set **CT-471**

Body Builder Books CD – Complete Set on CD **CT471-CD**

UC Commercial Bus: Cutaway Bus Chassis Body Builder Book **PBB-39100**

DuraStar® Series: Medium Conventional Body Builder Book **PBB-43100**

TerraStar® Series: Medium Conventional Body Builder Book **PBB-44100**

PayStar® Series: Premium On/Off Highway Conventional Body Builder Book **PBB-45100**

WorkStar® Series: Medium & Heavy Conventional Body Builder Book **PBB-50100**

Diamond Logic® Control Systems **PBB-71000**

INTERNATIONAL
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GOVERNMENT REQUIREMENTS

Your Obligations Under The Law

The important information in this section will acquaint you with U.S. and Canadian safety and emission standards that apply to Navistar, Inc. vehicles sold in the two countries, of those laws that established these standards, and the identity of the parties responsible for certification of compliance for both **Complete Vehicles** and **Incomplete Vehicles**. To the best of International's knowledge, it is correct as of the date of this printing. International, however cannot accept responsibility for it's completeness and currency. User must ascertain this on his own.

The National Traffic and Motor Vehicle Safety Act of 1966, in the U.S., gave rise to the Federal Motor Vehicle Safety Standards (FMVSS). In addition, The Environmental Protection Agency, through the Environmental Policy Act of 1969, set forth environmental protection standards.

In Canada, the Motor Vehicle Safety Act of 1970 established the Canadian Motor Vehicle Safety Standards (CMVSS) Act.

These standards place the responsibility for compliance of a **Complete Vehicle** on the vehicle and engine manufacturers. Any vehicle purchased from International, as a **Complete Vehicle** as defined by section 568.3 of Title 49 of the Code of Federal Regulations (CFR) is certified by International to comply with all applicable safety standards provided modifications or additions to the vehicle do not result in non-compliance with applicable U.S. and Canadian standards to which Navistar, Inc. has certified compliance. Also, it is the responsibility of every International dealer to assure that the service work or modifications that can affect compliance, performed on a new vehicle prior to delivery to the customer, meets the requirements specified by all mandated standards.

It is the responsibility of the Final-Stage Manufacturer who typically installs a body, a fifth wheel, or any other equipment, or makes any modifications to an **Incomplete Vehicle** supplied by International to certify compliance with the applicable standards for the vehicle when completed. Further, it is the responsibility of the Final-Stage Manufacturer to determine, and fully comply with, any additional requirements of the several States and Provinces. In addition, the Final-Stage Manufacturer must certify compliance with any other standards set forth in U.S. and Canadian regulations, statutes and ordinances.

Penalties For Violations

Violation of the provisions contained within the U.S. Federal Motor Vehicle Safety Standards is subject to fines of up to $5,000 per vehicle or up to a maximum of $15,000,000. The following violations are subject to these penalties:

1. Any manufacturer who knowingly or unknowingly produces for sale a motor vehicle subject to the law, but which does not meet all the applicable provisions of the law.

2. Any party who sells or offers for sale a motor vehicle built after the effective date of a standard, which in the knowledge of the selling party does not comply with the standard.
3. Any party (manufacturer, dealer, body builder or other) who completes a vehicle for sale in compliance with the law but fails to certify the completed vehicle in the prescribed manner.
4. Any party who knowingly certifies a vehicle as complying, which does not in fact meet the requirements of the law.

Situations where the government was intentionally misled in regards to safety related defects are criminal violations and are punishable by a maximum of 15 years in prison.

The U.S. Department of Transportation has declared its intent to institute procedures periodically to inspect vehicles subject to the law, and to implement enforcement procedures that will permit detection of violations.

The requirements of the law are stringent and the penalties for violation are severe. It is therefore mandatory that all personnel involved in any of the following aspects of motor vehicles become familiar with the provisions of the law as they relate to their responsibilities.

- Installation of equipment sub-assemblies and/or bodies (Intermediate and Final Stage Manufacturer)
- Sales
- Preparation for delivery
- Modification or conversion (Alterer)
- Maintenance and repair

Violation of the Canada Motor Vehicle Safety Standards law carries similar penalties.

NOTE: The Canadian, Mexican, and U.S. vehicle standards, which regulate the manufacture of vehicles for sale in their respective countries, may at any time exceed all or a portion of the mandated requirements of one or both of the other two countries. This situation exists due to established standards or regulatory revisions in one country, which have not yet been incorporated by the other(s).

Each of these countries require that any vehicle crossing its border(s) in commerce must comply with all applicable standards of their country and comply with the standards that were in effect as of the date of manufacture of that vehicle.

Federal Motor Vehicle Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS)

The following standards of Title 49 of the CFR apply to all liquid fueled vehicles having a GVWR greater than 10,000 pounds. Presently, all International® trucks and buses are powered with diesel engines and have been designed to have a GVWR of greater than 10,000 pounds.

For any vehicle manufactured by and purchased from International and defined by section 567.3 of Title 49 of the CFR as an Incomplete Vehicle, consult the Incomplete Vehicle Document (IVD) provided with each Incomplete Vehicle to determine those particular safety standards with which the vehicle complies. Any standards, with which International cannot certify compliance because of the level of completion of that vehicle, become the responsibility of the Intermediate Manufacturer or Final-Stage Manufacture or both.

Table 1.1

SAFETY STANDARD IDENTIFICATION (Applicable to all completed vehicles greater than 10,000 LBS.)	**VEHICLE TYPE**		
	TRUCK	**BUS**	**SCHOOL BUS**
FMVSS 101, CMVSS 101 - Controls, Telltales, and Indicators	X	X	X
FMVSS 102, CMVSS 102 - Transmission Shift Position Sequence, Starter Interlock and Transmission Braking Effect	X	X	X
FMVSS 103, CMVSS 103 - Windshield Defrosting and Defogging Systems	X	X	X
FMVSS 104, CMVSS 104 - Windshield Wiping and Washing Systems	X	X	X
FMVSS 105, CMVSS 105 - Hydraulic and Electric Brake Systems	X	X	X
FMVSS 106, CMVSS 106 - Brake Hoses	X	X	X
FMVSS 108, CMVSS 108 - Lamps, Reflective Devices and Associated Equipment	X	X	X
FMVSS 111, CMVSS 111 - Rearview Mirrors	X	X	X
FMVSS 113, CMVSS 113 - Hood Latch System	X	X	X
U.S. 49 CFR part 565, CMVSS 115 - Vehicle Identification Number Requirements	X	X	X
FMVSS 116, CMVSS 116 - Motor Vehicle Brake Fluids	X	X	X
FMVSS 119, CMVSS 119 - New Pneumatic Tires for Vehicles other than passenger cars	X	X	X
FMVSS 120, CMVSS 120 - Tire selection and Rims for vehicles with a GVWR of more than 4,536 Kilograms (10,000 pounds)	X	X	X
FMVSS 121, CMVSS 121 - Air Brake Systems	X	X	X

* N/A – Not Applicable

Table 1.1

SAFETY STANDARD IDENTIFICATION (Applicable to all completed vehicles greater than 10,000 LBS.)	VEHICLE TYPE		
	TRUCK	BUS	SCHOOL BUS
FMVSS 124, CMVSS 124 - Acceleration Control Systems	X	X	X
FMVSS 125, CMVSS 125 - Warning Devices	X	X	X
FMVSS 131, CMVSS 131 - School Bus Pedestrian Safety devices	* N/A	* N/A	X
FMVSS 205, CMVSS 205 - Glazing Materials	X	X	X
FMVSS 206, CMVSS 206 - Door Locks and Door Retention Components	X	* N/A	* N/A
FMVSS 207, CMVSS 207 - Seating Systems	X	X	X
FMVSS 208, CMVSS 208 - Occupant Crash Protection	X	X	X
FMVSS 209, CMVSS 209 - Seat Belt Assemblies	X	X	X
FMVSS 210, CMVSS 210 - Seat Belt Assembly Anchorages	X	X	X
FMVSS 213, CMVSS 213 - Child Restraint Systems	X	X	X
FMVSS 217, CMVSS 217 - Bus Emergency Exits and Window Retention and Release	* N/A	X	X
FMVSS 220, CMVSS 220 - School Bus Rollover Protection	* N/A	* N/A	X
FMVSS 221, CMVSS 221 - School Bus Body Joint Strength	* N/A	* N/A	X
FMVSS 222, CMVSS 222 - School Bus Passenger Seating and Crash Protection	* N/A	* N/A	X
FMVSS 225, CMVSS 225 - Child Restraint Anchorage System	x	x	X
FMVSS 301, CMVSS 301 - Fuel System Integrity (Liquid Fuels)	* N/A	* N/A	X
FMVSS 302, CMVSS 302 - Flammability of Interior Materials	X	X	X
FMVSS 403 - Platform Lift Systems for Motor Vehicles	X	X	X
FMVSS 404 - Platform Lift Installations in Motor Vehicles	X	X	X

* N/A – Not Applicable

Table 1.2
Required Vehicle Lighting Equipment For Trucks and Buses with an Overall Width of 80 inches or more

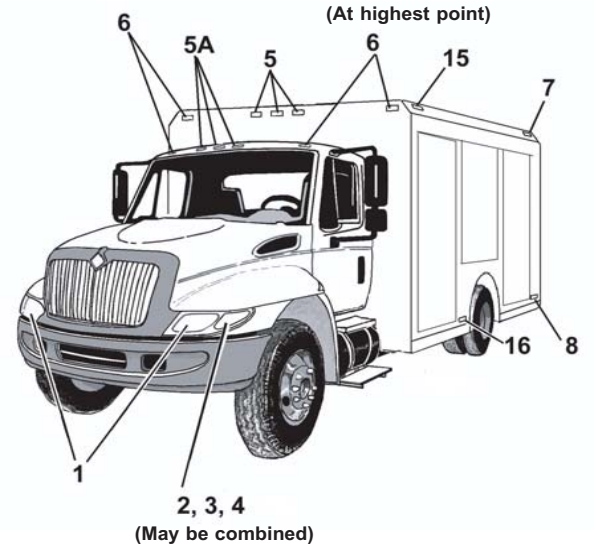
REQUIRED LIGHTING EQUIPMENT	QUANTITY	COLOR	LOCATION	POSITION	HEIGHT ABOVE ROAD SURFACE (In inches measured from the center of the lamp on vehicle at curb height.)
Headlamps	2 at least	White	Front	On the front at the same height, an equal number at each side of the vertical centerline as far apart as practicable.	Not less than 22 or more than 54.
Turn signal (Front)	2	Amber	At or near front	One on each side of the vertical centerline at the same height and as far apart as practicable.	Not less than 15 or more than 83.
Identification Lamp (Front)	3	Amber	Front	As close as practicable to the vertical centerline of the vehicle or the vertical centerline of the cab where different from the centerline of the vehicle.	All three on same level as close as practicable to the top of the vehicle with lamp centers spaced not less than 6 inches or more than 12 inches apart.
Tail Lamp	2	Red	Rear	One lamp each side of the vertical centerline at the same height and as far apart as practicable.	Both on the same level between 15 and 72.

Table 1.2
Required Vehicle Lighting Equipment For Trucks and Buses with an Overall Width of 80 inches or more (Continued)

REQUIRED LIGHTING EQUIPMENT	QUANTITY	COLOR	LOCATION	POSITION	HEIGHT ABOVE ROAD SURFACE (In inches measured from the center of the lamp on vehicle at curb height.)
Stop Lamp	2	Red	Rear	One lamp each side of the vertical centerline at the same height and as far apart as practicable.	Both on the same level between 15 and 72.
Front Clearance Lamps	2	Amber	One on each side of front	One on each side of the vertical centerline to indicate width.	Both on the same level as high as practicable.
Rear Clearance Lamps	2	Red	One on each side of rear	One on each side of the vertical centerline to indicate overall width.	Both on the same level as high as practicable.
Side Marker Lamp, Intermediate	2	Amber	One on each side	At or near midpoint between front and rear side marker lamps, if vehicle over 30' in length.	Not less than 15.
Reflex Reflector Intermediate (Side)	2	Amber	One on each side	At or near midpoint between front and rear side reflectors if over 30' in length.	Between 15 and 60.
Reflex Reflector (Rear)	2	Red	Rear	One on each side of vertical centerline, as far apart as practicable.	Both on the same level, between 15 and 60.
Reflex Reflector (Rear Side)	2	Red	One on each side (rear)	As far to the rear as practicable.	Between 15 and 60.
Reflex Reflector (Front Side)	2	Amber	One on each side (front)	As far to the front as practicable.	Between 15 and 60.

Table 1.2
Required Vehicle Lighting Equipment For Trucks and Buses with an Overall Width of 80 inches or more (Continued)

REQUIRED LIGHTING EQUIPMENT	QUANTITY	COLOR	LOCATION	POSITION	HEIGHT ABOVE ROAD SURFACE (In inches measured from the center of the lamp on vehicle at curb height.)
License Plate Lamp Rear	1	White	At rear license plate	To illuminate the license plate from the top or sides.	No requirements.
Side Marker Lamp (Front)	2	Amber	One on each side	As far to the front as practicable.	Not less than 15.
Side Marker Lamp (Rear)	2	Red	One on each side	As far to the rear as practicable.	Not less than 15.
Turn Signal (Rear)	2	Amber or Red	Rear	One lamp on each side of the vertical centerline as far apart as practicable.	Both on the same level, between 15 and 83.
Identification Lamp (Rear)	3	Red	Rear	One as close as practicable to vertical centerline. One on each side.	All three on the same level as close as practicable to the top of the vehicles with lamp centers spaced not less than 6" or more than 12" apart.
Vehicular Hazard Warning Flashing Lamps	2	Amber	Front	One lamp on each side of vertical centerline as far apart as practicable.	Both on the same level, between 15 and 83.
	2	Amber or Red	Rear		
Backup Lamp	1	White	Rear	Rear	No requirement.



LEGEND

1. Headlamps (2) – White (4 optional)
2. Side marker lamps. Front (2) – Amber
3. Side reflectors. Front (2) – Amber
4. Turn signal lamps. Front (2) – Amber

4a. Turn signal lamps. Front (2) – Amber (Optional location)

5. Identification lamps. Front (3) – Amber

5a. Identification lamps. Front (3) – Amber (Optional location)

6. Clearance lamps. Front (2) – Amber
7. Side marker lamps. Rear (2) – Red
8. Side reflectors. Rear (2) – Red
9. Identification lamps. Rear (3) – Red
10. Clearance lamps. Rear (2) – Red
11. Reflectors Rear (2) – Red
12. Stop lamps. Rear (2) – Red
13. License plate lamp. Rear (1) – White
14. Backup lamp. Rear (1) – White (location optional provided optional requirements are met)
15. Side marker lamps. Intermediate (2) – Amber (if vehicle is 30' or more overall length)
16. Side reflectors. Intermediate (2) – Amber (if vehicle is 30' or more overall length)
17. Turn signal lamps. Rear (2) – Amber or Red
18. Tail lamps. Rear (2) – Red

Figure 1.1

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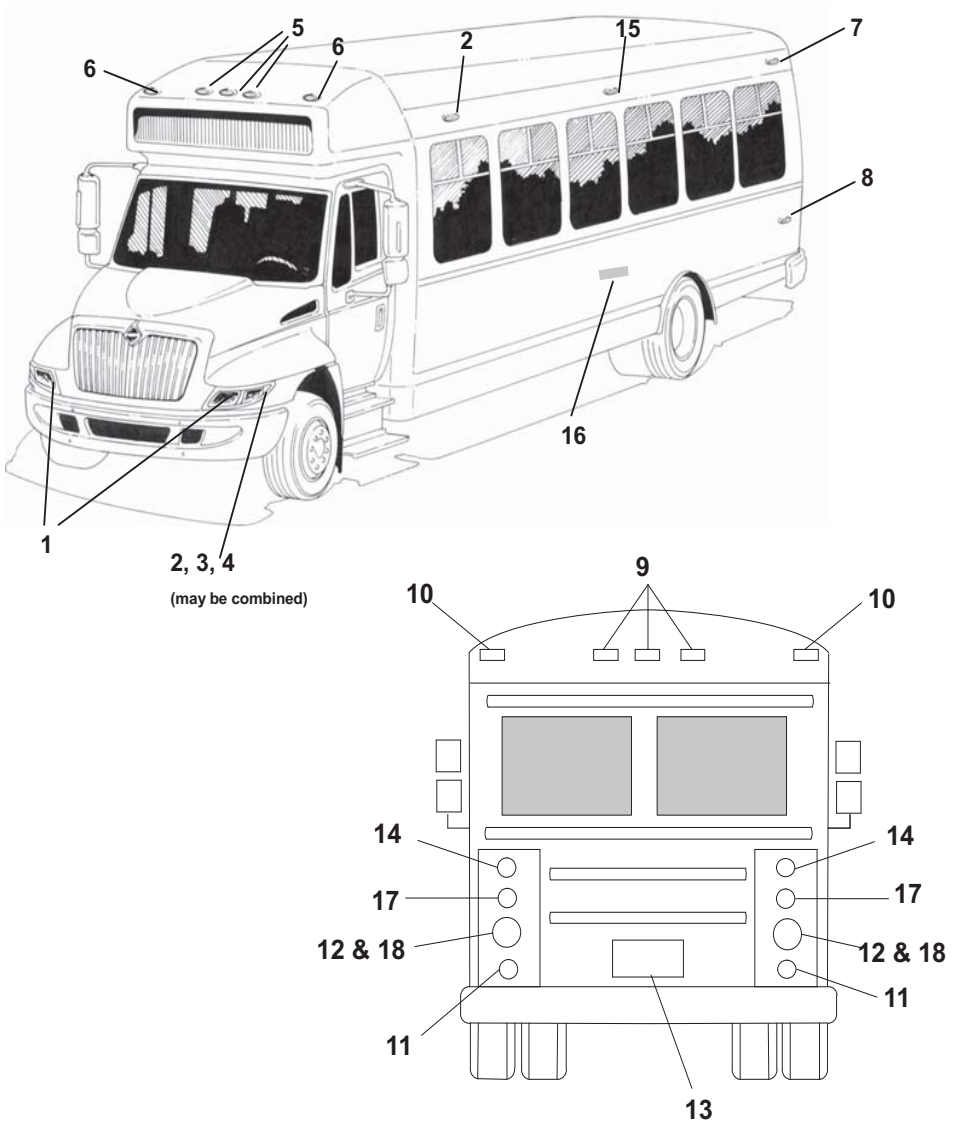

LEGEND

1. Headlamps (2) – White (4 optional)
2. Side marker lamps. Front (2) – Amber
3. Side reflectors. Front (2) – Amber
4. Turn signal lamps. Front (2) – Amber

4a. Turn signal lamps. Front (2) – Amber (Optional location)

5. Identification lamps. Front (3) – Amber

5a. Identification lamps. Front (3) – Amber (Optional location)

6. Clearance lamps. Front (2) – Amber
7. Side marker lamps. Rear (2) – Red
8. Side reflectors. Rear (2) – Red
9. Identification lamps. Rear (3) – Red
10. Clearance lamps. Rear (2) – Red
11. Reflectors Rear (2) – Red
12. Stop lamps. Rear (2) – Red
13. License plate lamp. Rear (1) – White
14. Backup lamp. Rear (1) – White (location optional provided optional requirements are met)
15. Side marker lamps. Intermediate (2) – Amber (if vehicle is 30' or more overall length)
16. Side reflectors. Intermediate (2) – Amber (if vehicle is 30' or more overall length)
17. Turn signal lamps. Rear (2) – Amber or Red
18. Tail lamps. Rear (2) – Red

Figure 1.2

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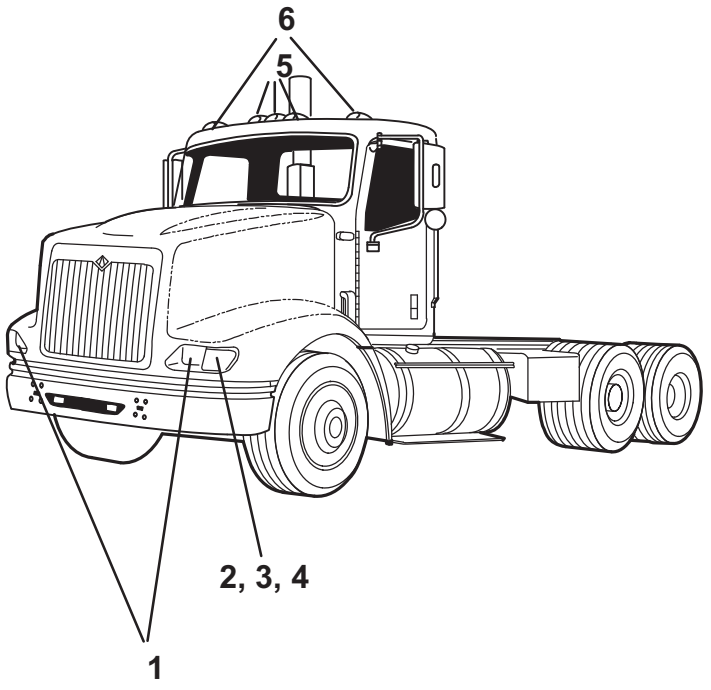

LEGEND

1. Headlamps (2) - White (4 optional)
2. iSide marker lamps. Front (2) - Amber
3. Side reflectors. Front (2) - Amber
4. Turn signal lamps. Front (2) - Amber
5. Identification lamps. Front (3) - Amber
6. Clearance lamps. Front (2) - Amber

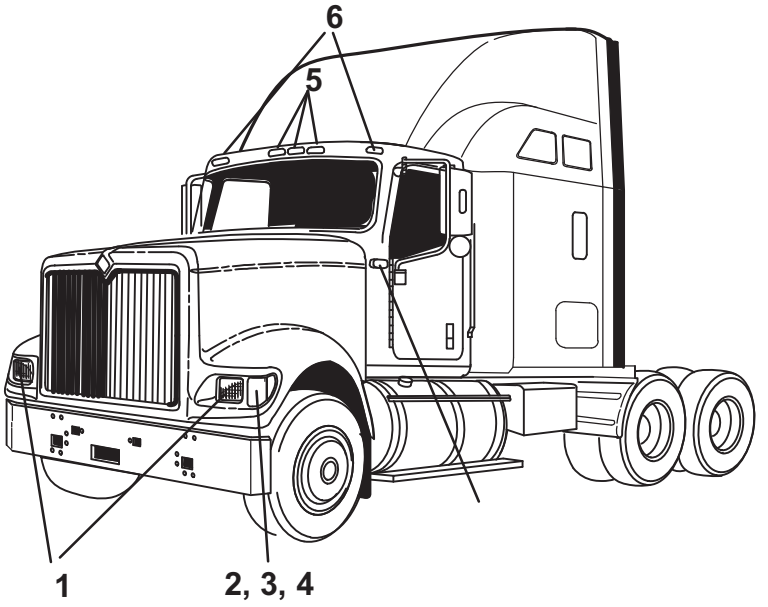

Figure 1.3 Truck Tractor

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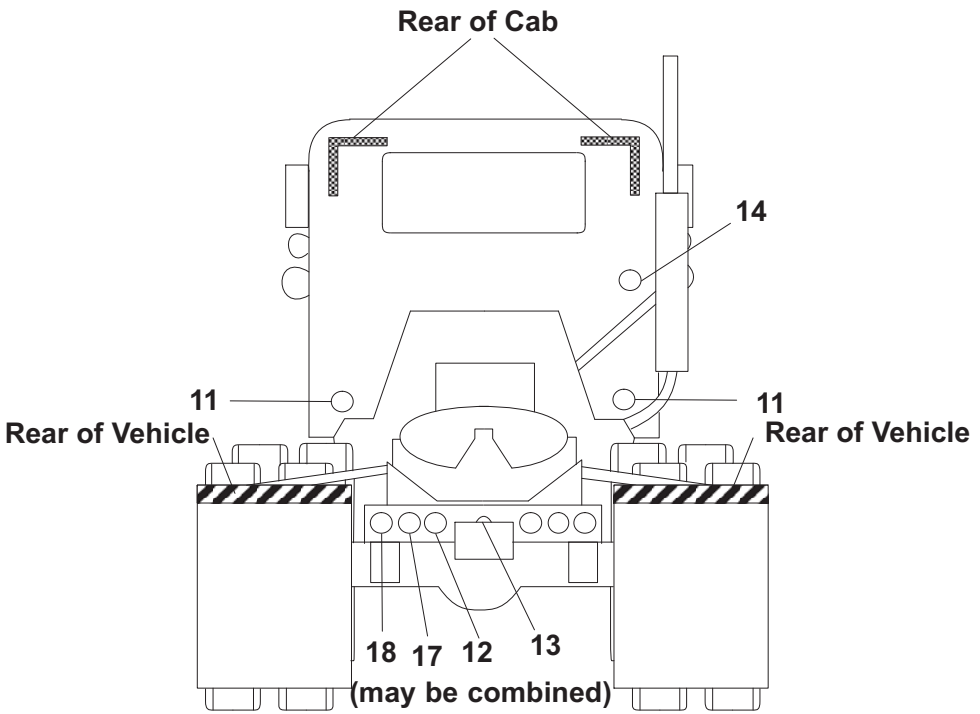


LEGEND

11. Reflectors. Rear (2) – Red
12. Stop lamps. Rear (2) – Red
13. License plate lamp. Rear (1) – White
14. Backup lamp. Rear (1) – White (location optional provided optional requirements are met)
17. Turn signal lamps. Rear (2) – Amber or Red
18. Tail lamps. Rear (2) – Red

Figure 1.4 Truck Tractor 0_0006

Additional Requirements: EPA

EPA Part 205 Subpart B, CMVSS 1106 – Noise Emission For Medium And Heavy Trucks

Incomplete Vehicles identified as a **Chassis Cab** by Navistar, Inc.**,** and all **Complete Vehicles** will comply with the requirements specified by EPA PART 205 SUBPART B and CMVSS 1106 provided that no changes are made to the noise generating and/or suppression equipment installed by International.

EPA Part 86, CMVSS 1100 – Emission Control

Engines provided with International® vehicles will comply with all applicable exhaust emission standards. Modifications to the vehicle and/or engine, which will cause noncompliance, are prohibited by the regulations. For further information see the vehicle owner's manual and the engine manual.

Replacement or Service Parts

The Motor Vehicle Safety Standards primarily specify the requirements and/or performance standards that a Complete Vehicle must comply with. However, certain specific components of the vehicle, when sold by a dealer or distributor as replacement or service parts, are required to comply with the requirements and/or performance standards specified by the standards. Certification of compliance must also be provided for these components and those items that are subject to these procedures are as follows:

- Windshield and window glass – FMVSS/CMVSS 205
- Seat belts – FMVSS/CMVSS 209
- Hydraulic brake hose – FMVSS/CMVSS 106
- Hydraulic brake fluids – FMVSS/CMVSS 116
- Lamps and reflective devices – FMVSS/CMVSS 108
- Warning devices – FMVSS 125 (Reflective Triangle)
- Tires and Wheels – FMVSS/CMVSS 119/120
- Platform Lift System – FMVSS 403

The standards require that all of the above items manufactured for sale, whether for use in the manufacture of a vehicle or for sale as parts, must comply with applicable provisions of the safety standards. Such items when sold by dealers or distributors must be labeled to certify compliance. Such labeling may be placed on the part itself or on the container in which the part is shipped.

The items listed above that are manufactured by or for Navistar, Inc. as service parts will comply with all applicable standards as required.

Certification of Incomplete Vehicles Manufactured by Navistar, Inc.

In accordance with the laws of the United States and Canada all vehicles manufactured for sale and sold for use in these countries must comply with the applicable federal safety standards and certification of compliance must be provided with the vehicle.

Section 567.3 of Title 49 of the CFR defines an **Incomplete Vehicle** as an assemblage consisting, at a minimum, of chassis (including the frame) structure, power train, steering system, suspension system, and braking system, in the state that those systems are to be part of the completed vehicle, but requires further manufacturing operations, to become a completed vehicle. For an **Incomplete Vehicle** manufactured by Navistar, Inc. to be classified as a **Complete Vehicle**, subsequent manufactures must mount a body or other load carrying equipment on the chassis prior to delivery to the end user so that it can perform its intended function.

Incomplete Vehicle Manufacturer

Definition

Section 567.3 of Title 49 of the CFR defines an Incomplete Vehicle Manufacturer as a person who manufactures an incomplete vehicle by assembling components none of which, taken separately, constitute an incomplete vehicle.

Compliance Responsibility

As manufactured by Navistar, Inc., an Incomplete Vehicle is built with all appropriate safety items that comply with the applicable regulatory requirements to the extent that the vehicle's state of completion will permit. To obtain a Complete Vehicle status under section 567.3 of Title 49 of the CFR, an Intermediate or Final-Stage Manufacturer must mount a body or other similar load carrying equipment on the chassis prior to delivery to the end user.

Navistar, Inc. identifies an **Incomplete Vehicle** with one of the following designations depending on the vehicle's state of completion:

- Chassis Cab
- Flat Back Cowl (FBC) Chassis Bus or School Bus
- Partial Cab Bus or School Bus
- Partial Cab Truck
- Stripped Chassis

In accordance with section 568.4 of Title 49 of the CFR, Navistar, Inc. furnishes an **Incomplete Vehicle** Document (IVD) with each **Incomplete Vehicle**. This document provides the following information:

- Name and mailing address of the **Incomplete Vehicle** manufacturer
- Date of manufacture
- Vehicle Identification Number
- GAWR (Gross Axle Weight Rating) for each axle of the intended **Complete Vehicle**

- GVWR (Gross Vehicle Weight Rating) of the intended **Complete Vehicle**
- Vehicle Type into which the **Incomplete Vehicle** may appropriately be manufactured
- Suitable tire and rim choice with inflation pressure
- List of all Federal U.S. or Canadian safety standards applicable to the type of vehicle. (Those standards to which the vehicle complies as produced by Navistar, Inc. will be identified.)

For all Incomplete Vehicles except those without a cab, the IVD is placed in the left hand door dispatch compartment. For Incomplete Vehicles without a cab, the IVD is placed in a clear plastic envelope and strap locked to the radiator stay rod.

In accordance with section 567.5 of Title 49 of the CFR, International will also affix an Incomplete Vehicle Information Label to the hinge pillar, door latch post, or door edge that meets the door latch post, next to the driver's seating position (reference Figure 1.5).

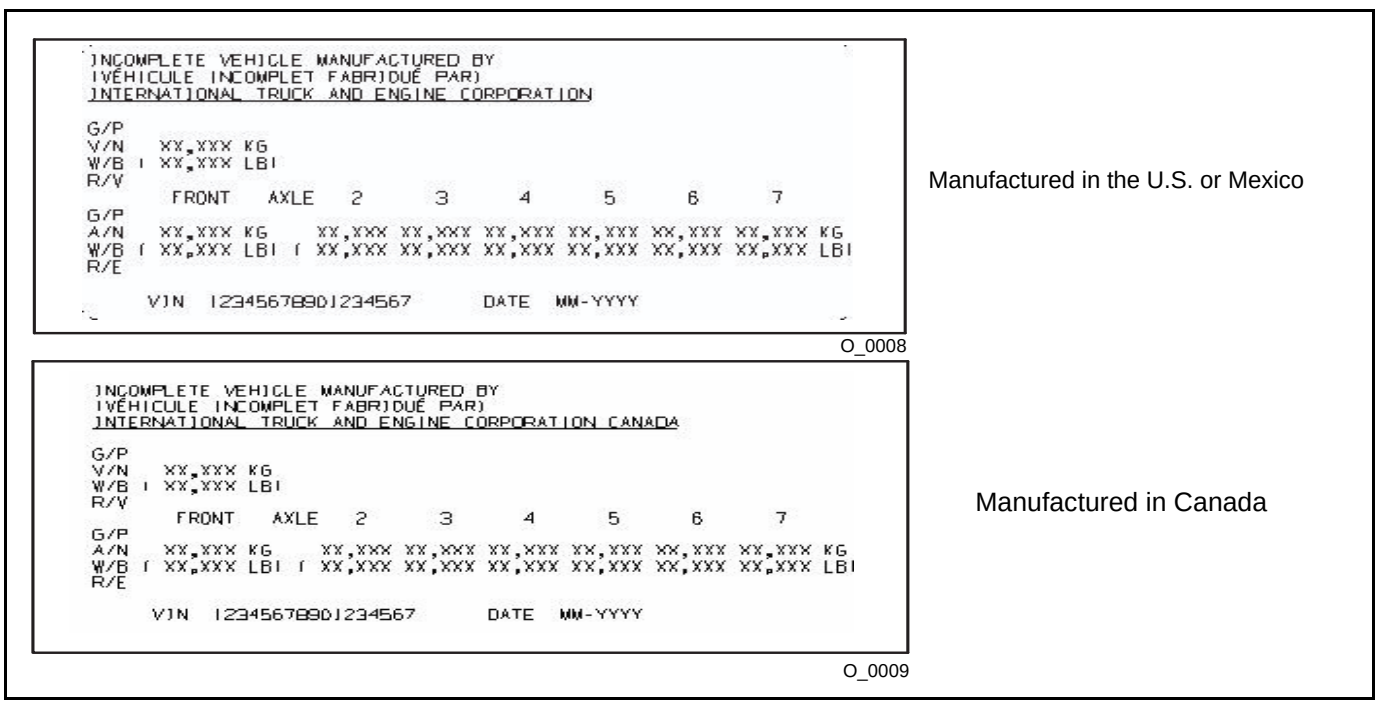


Figure 1.5 Incomplete Vehicle Information Labels

Canada

All International Incomplete Vehicles manufactured and sold in Canada must also have a Canada National Safety Mark and National Emissions Mark affixed to the vehicle (reference Figure 1.6).

O_0010

Figure 1.6 Canada National Safety Mark and National Emissions Mark

Intermediate Manufacturer

Definition

Section 567.3 of Title 49 of the CFR defines an INTERMEDIATE MANUFACTURER as a person, other than the Incomplete Vehicle Manufacturer or Final Stage Manufacturer, who performs manufacturing operations on a vehicle manufactured in two or more stages.

Compliance Responsibility

In accordance with section 568.4 of Title 49 of the CFR, Navistar, Inc. furnishes an Incomplete Vehicle Document (IVD) with each incomplete vehicle. Navistar, Inc. will also affix an information label to the hinge pillar, door latch post, or door edge that meets the door latch post, next to the drivers seating position as specified in part 567.5 of Title 49 of the CFR.

In accordance with section 568.5 of Title 49 of the CFR each intermediate manufacturer is required to provide an addendum to the IVD for any modification made by them to the incomplete vehicle that affects the validity of the compliance statements that appear in the IVD. The addendum must provide the name and mailing address of the intermediate manufacturer and specify the changes that must be made to the IVD to reflect the modifications that they made to the vehicle.

Final Stage Manufacturer

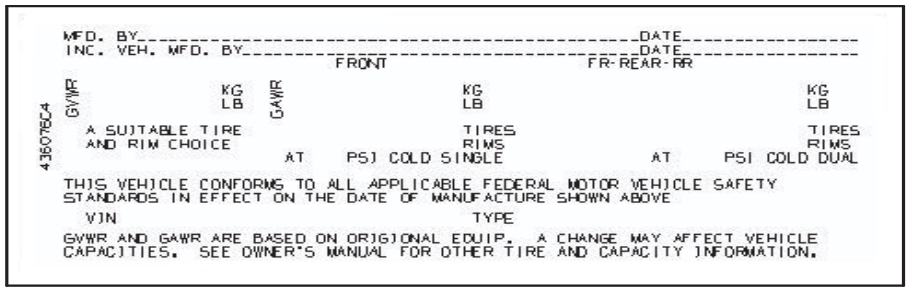
Definition

As defined by section 567.3 of Title 49 of the CFR, a FINAL – STAGE MANUFACTURER is a person who performs such manufacturing operations on an incomplete vehicle that it becomes a complete vehicle.

Compliance Responsibility

Section 568.6 of Title 49 of the CFR requires that the final – stage manufacturer shall complete the vehicle in such manner that it meets all applicable safety standards in effect on the date of manufacture of the incomplete vehicle, the date of final completion, or a date between these dates. It should be noted that a vehicle intended for use as a tractor, is not considered a complete vehicle until the fifth wheel has been installed. When completed, the tractor must comply with all applicable Federal Motor Vehicle Safety Standards. Section 567.5 of Title 49 of the CFR stipulates that the Final Stage Manufacturer is responsible for installing an appropriate certification label that must be securely and permanently affixed to the completed vehicle.

For those situations when an entity other than an International facility certifies a completed vehicle, that entity becomes the Final – Stage Manufacturer and has the option to create its own label or purchase a label from International service parts. Labels purchased from service parts do not have the name of the Final - Stage Manufacturer and information about the vehicle. This information has been left blank. Final – Stage Manufacturers that utilize the appropriate label and protective cover (435654C2) and provide the required information comply with the requirements specified by part 567 of Title 49 of the CFR. The label (Figure 1.7) is referred to as a “Final Stage Manufacturer Certification Label” and is identified with International part number 436076C4 for a vehicle sold in the U.S. or 1698980C2 for a vehicle sold in Canada.



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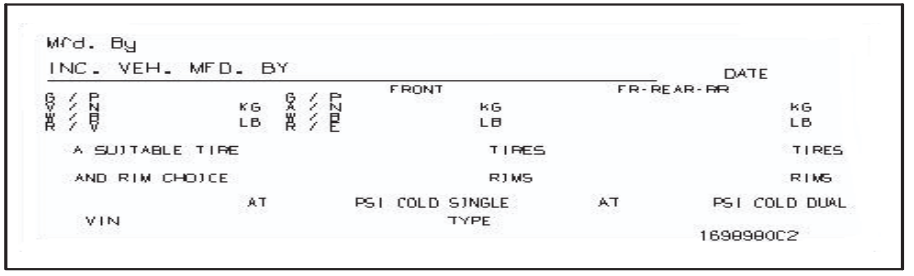
436076C4 – U.S.



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1698980C2 – Canada

Figure 1.7 Final Stage Manufacturer Certification Label

Canada

Certified Final – Stage Manufacturers of Canadian vehicles must affix the Canada National Safety Mark and National Emissions Mark with their identification number installed on it next to the final certification label shown above. Such authorization and identification number must be obtained from the Minister of Transport at Transport Canada. [Reference: Figure 1.6 – *"Canada National Safety Mark and National Emissions Mark"*.]

Alterations to Completed Vehicles

Definition

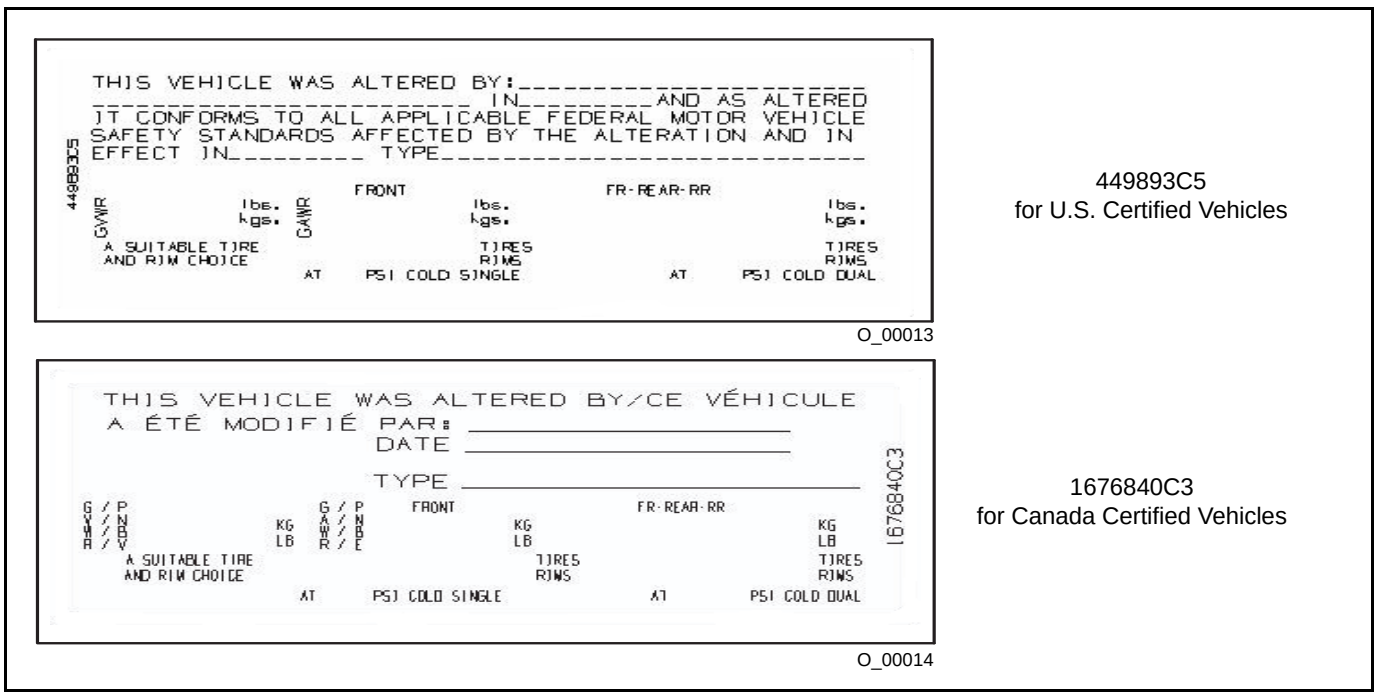
Section 567.3 of Title 49 of the CFR defines an Altered Vehicle as a completed vehicle previously certified in accordance with section 567.4 or 567.5 that has been altered other than by the addition, substitution, or removal of readily attachable components or by minor finishing operations, before the first purchase of the vehicle other than for resale, in such a manner as may affect the conformity of the vehicle with one or more FMVSS or the validity of the vehicle's stated weight ratings or vehicle type classification.

Compliance Responsibility

In accordance with section 567.7 of Title 49 of the CFR, if a person alters a certified vehicle before the first purchase of the vehicle other than for resale**,** the responsibility for compliance of the modified vehicle rests with the Alterer. The vehicle manufacturer's Certification Label and any Information Labels shall remain affixed to the vehicle and the alterer shall affix an additional certification label that will supplement the certification label originally furnished with the vehicle by Navistar, Inc. or the Final – Stage Manufacturer. This certification label must state the following:

> "This vehicle was altered by (name of Alterer) in (month and year in which alterations were completed) and as altered it conforms to all applicable Federal Motor Vehicle Safety Bumper and Theft Prevention Standards affected by the alteration and in effect on the date of (no earlier than the date of manufacture of the certified vehicle as specified on the certification label and no later than the date alterations were completed)."

This label (Figure 1.8) is available from International service parts under Part No. 449893C5 for U.S. Certified Vehicles and Part No.1676840C3 for Canada Certified Vehicles. Protective cover 435654C2 should be installed over this label.



449893C5
for U.S. Certified Vehicles

1676840C3
for Canada Certified Vehicles

Figure 1.8 Vehicle Alterer Certification Label

Alterers of Canadian certified vehicles must apply the Canada National Safety Mark and National Emissions Mark, with their identification number, adjacent to the Vehicle Alterer Certification label. Such authorization and identification number must be obtained from the Minister of Transport at Transport Canada. [Reference Figure 1.6 – *"Canada National Safety Mark and National Emissions Mark"*.]

Exterior Noise Certification Label

Incomplete vehicles identified as a chassis cab by Navistar, Inc. have the vehicle exterior noise label (Figure 1.9) permanently attached in a readily visible position in the operators compartment. For incomplete vehicles other than a chassis cab, the final stage manufacturer must assume responsibility and comply with EPA PART 205 SUBPART B, CMVSS 1106 – NOISE EMISSION FOR MEDIUM AND HEAVY TRUCKS.

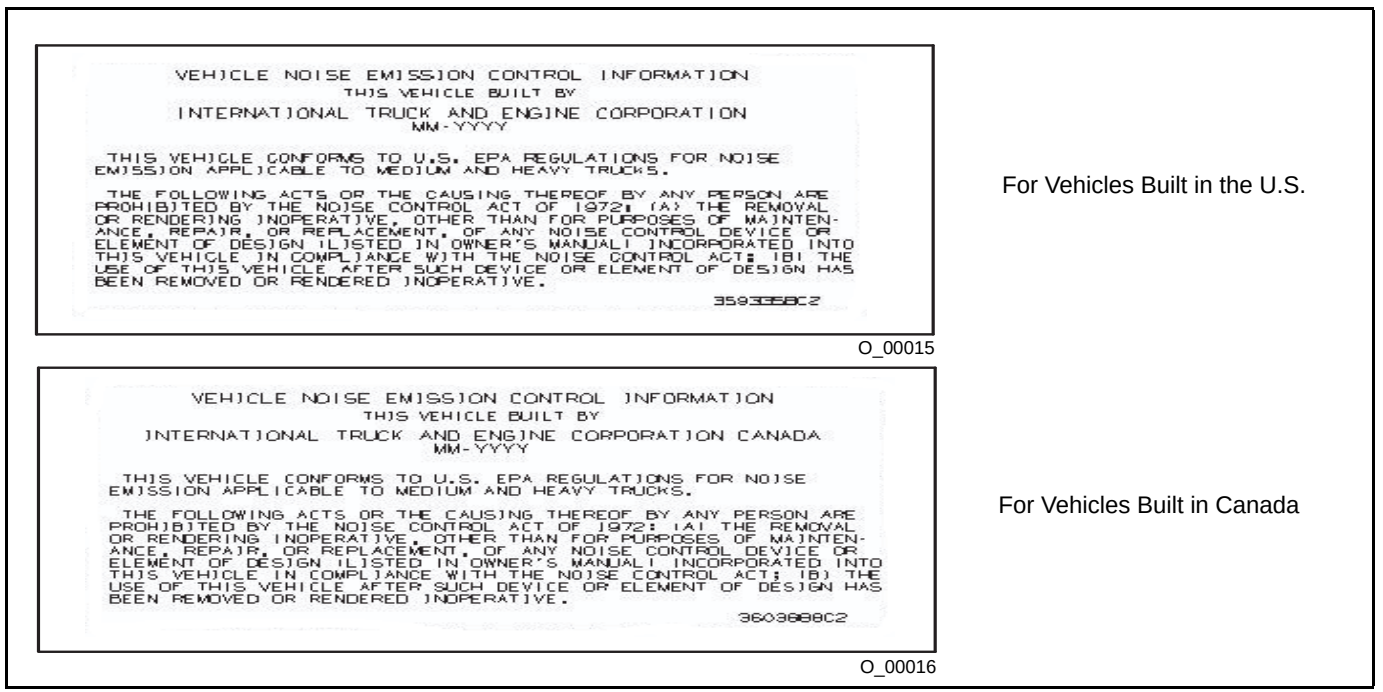


Figure 1.9 Vehicle Exterior Noise Label

Additional Certification Label Information and Instructions

1. All labels must be fully filled out.
2. All labels must be affixed to the vehicle in accordance with Sections 567 of Title 49 of the CFR or Canadian Motor Vehicle Safety Regulations, Sections 6 and 7.
3. No label shall be installed over another label.
4. It is unlawful to affix an incorrect certification label to a vehicle.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CHARTS AND CHASSIS DIAGRAMS

MODEL 4X2

Weight Distribution/Dimensions/Turning Radius Chart

Wheelbase (in.)	Cab	Chassis Weight (lbs.) **			Dimensions (in.)				Turning Radius	
		Front	Rear	Total	CA	CF	AF	OAL	To Curb	w/Bumper Clearance
134	16030				59.6	108.6	49	215.5	19 ft. 6 in.	20 ft. 5 in.
*158	16030	4,681	2,731	7,412	83.6	132.6	49	239.5	22 ft. 6 in.	23 ft. 5 in.
183	16030				107.6	156.6	49	264.5	25 ft. 7 in.	26 ft. 6 in.
195	16030				119.6	168.6	49	276.5	27 ft. 1 in.	28 ft. 0 in.
213	16030				138.6	213.6	75	320.6	29 ft. 4 in.	30 ft. 3 in.
224	16030				149.6	240.6	91	347.6	30 ft. 8 in.	31 ft. 7 in.
160	16CAB				59.6	108.6	49	241.5	22 ft. 9 in.	23 ft. 8 in.
185	16CAB				84.6	133.6	49	266.5	25 ft. 10in.	26 ft. 9 in.
209	16CAB				108.6	157.6	49	290.5	28 ft. 10 in.	29 ft. 9 in.
179	16196				60.7	109.7	49	260.5	25 ft. 1 in.	26 ft. 0 in.
203	16196				84.7	133.7	49	284.5	28 ft. 1 in.	29 ft. 0 in.

NOTE: Chart data based on vehicle with standard equipment. Artwork may show some optional equipment.

* Dimension data and optional add-on weights for this model are based on the 158" wheelbase with 49” after frame unless otherwise noted.

** Weight includes standard chassis, standard tires, oil and water, but less fuel.

MODEL 4X2

Standard Features

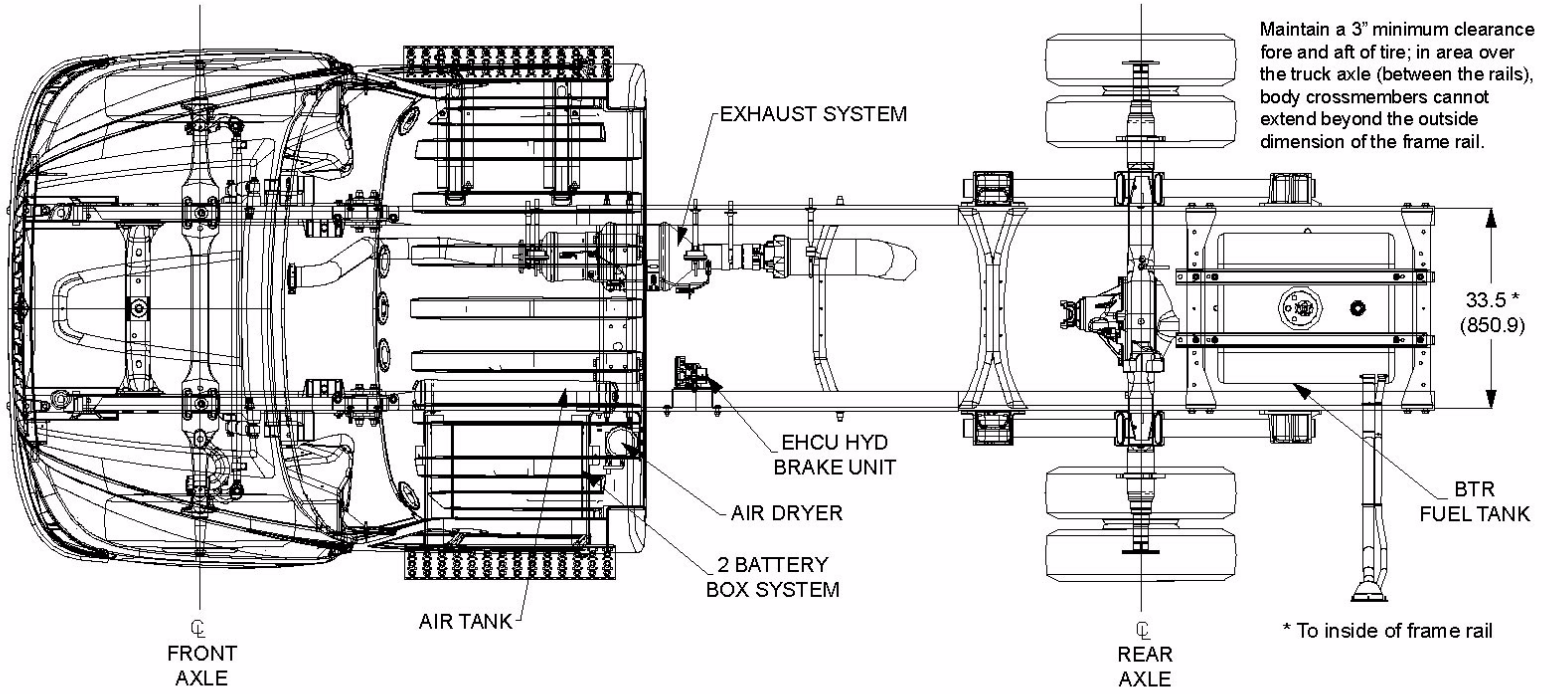
All ground dimensions on this chassis diagram are based on a truck with the following equipment and a loaded chassis.

Item	Specifications
	4x2 (TA005)
Frame	FRAME RAILS High Strength Low Alloy Steel (80,000 PSI Yield); 7.375” x 3.079” x .312” (187.45mm x 78.2mm x 8.0mm) With Transition to 9.125” x 3.079” x .312” (231.8mm x 78.2mm x 8.0mm); Includes 1.2” (30mm) Drop Under Cab; 335.2” (8512.2mm) Maximum OAL (Code 01CDN)
Front Axle	AXLE, FRONT NON-DRIVING {Dana Spicer D600-N} I-Beam Type, 6,000-lb Capacity (Code 02AGN)
Front Suspension	SUSPENSION, FRONT, SPRING Taper Leaf, Shackle Type; 6,000-lb Capacity; With Shock Absorbers (Code 03AGP)
Rear Axle	AXLE, REAR, SINGLE {Dana Spicer S110} Single Reduction, With Offset Housing, 10,000-lb Capacity, 160 Wheel Ends (Code 14ACR)
Rear Suspension	SUSPENSION, RR, SPRING, SINGLE Vari-Rate; 11,000-lb Capacity (Code 14SCG)

MODEL 4X2

Chassis Diagram

Plan View – Standard Cab



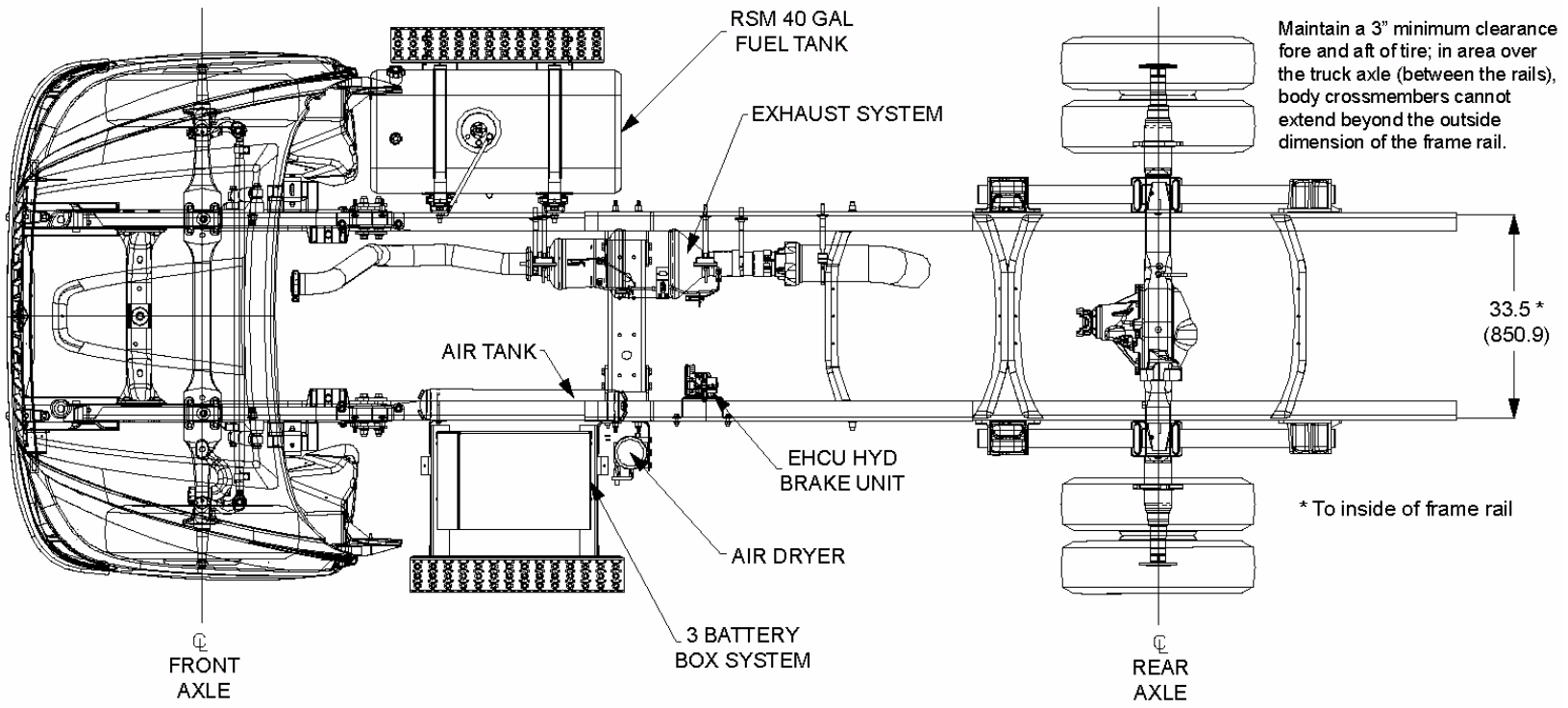
TerraStar_4x2_Std_Cab_Plan_View

NOTE: This drawing ***should not*** be used to determine crossmember locations — that information can be found later in this book.

MODEL 4X2

Chassis Diagram

Plan View – Standard Cab with Optional Right Side Mounted 40 Gallon Fuel Tank



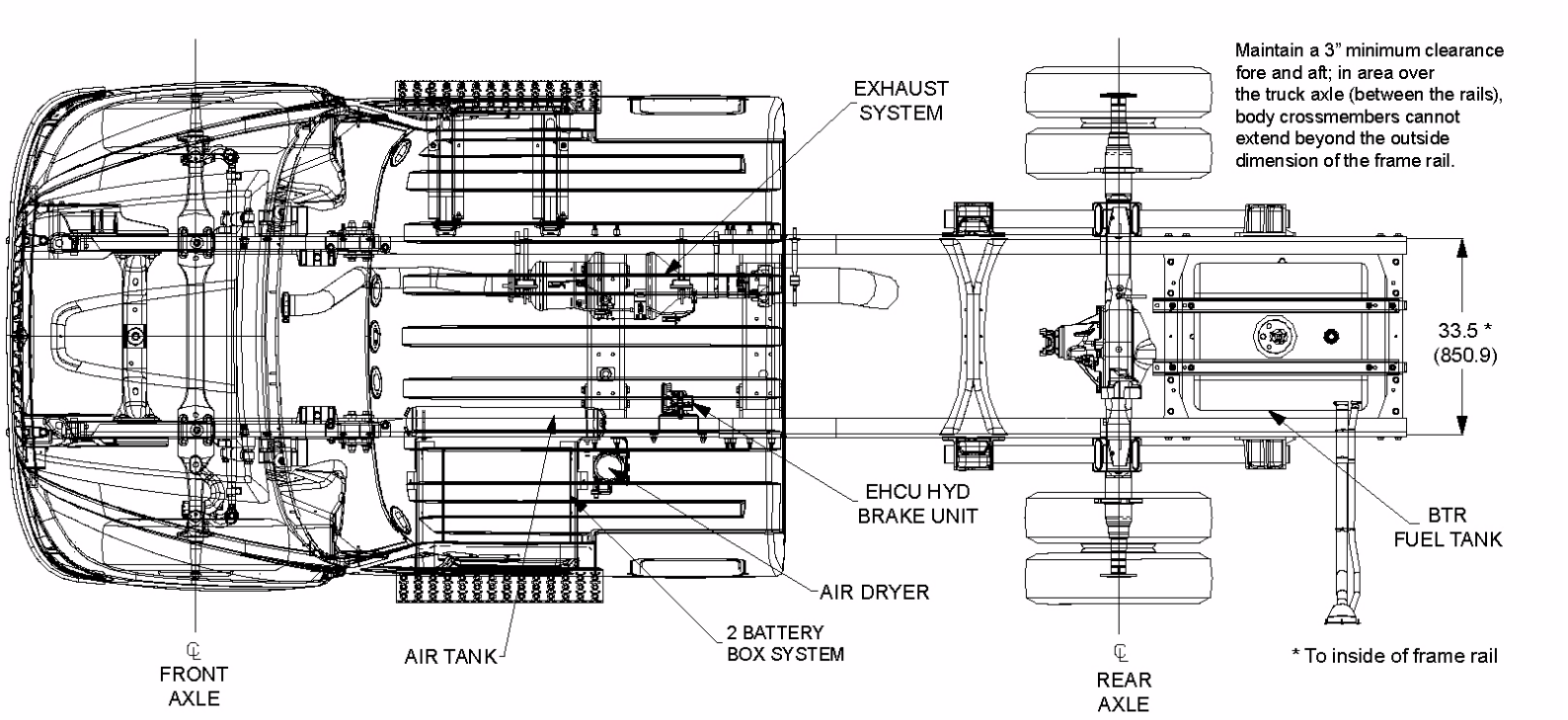
TerraStar_4x2_Std_Cab_Plan_View_40_gal_rsm_fuel_tank

NOTE: This drawing ***should not*** be used to determine crossmember locations — that information can be found later in this book.

MODEL 4X2

Chassis Diagram

Plan View – Extended Cab



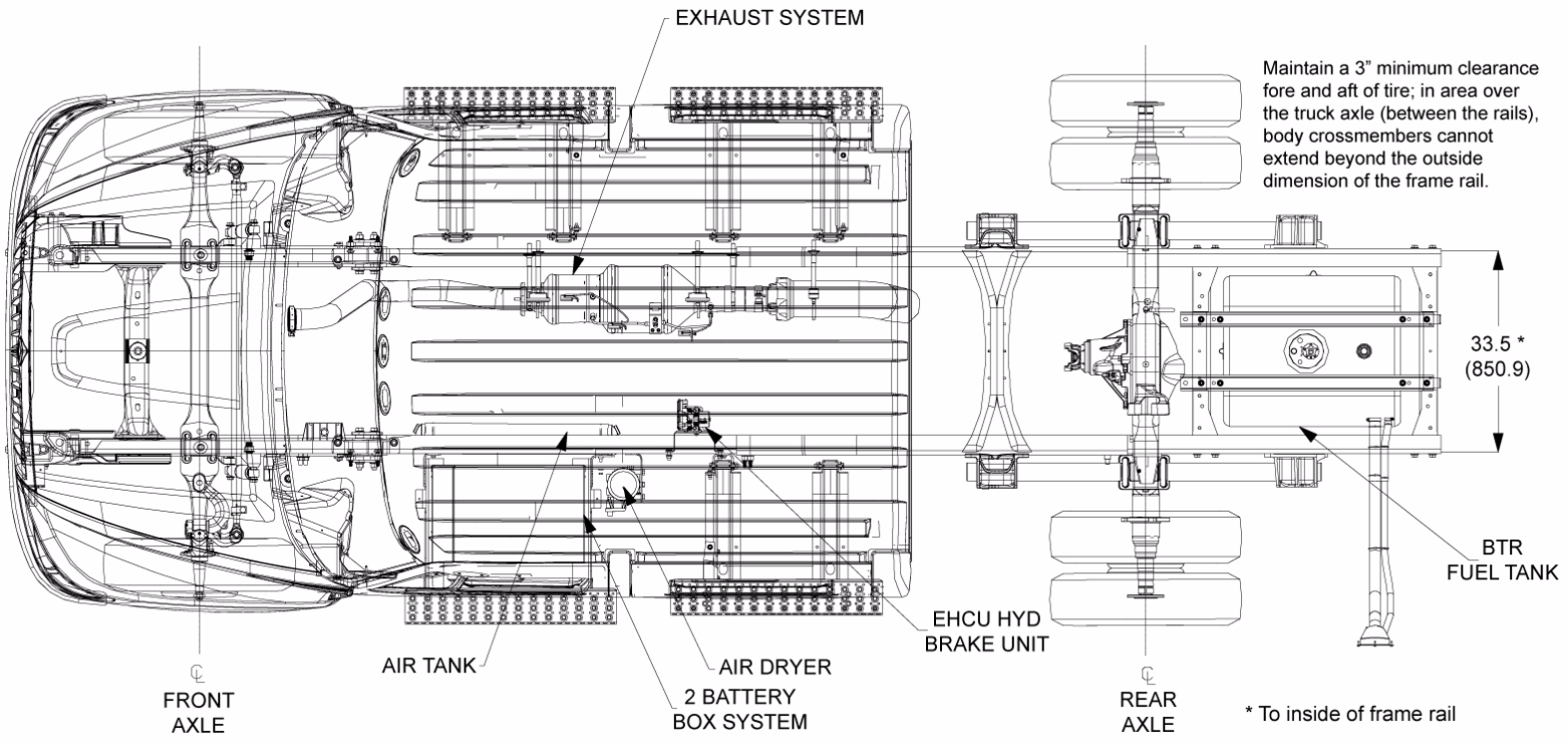
TerraStar_4x2_Extended_Cab_Plan_View

NOTE: This drawing ***should not*** be used to determine crossmember locations — that information can be found later in this book.

MODEL 4X2

Chassis Diagram

Plan View – Crew Cab



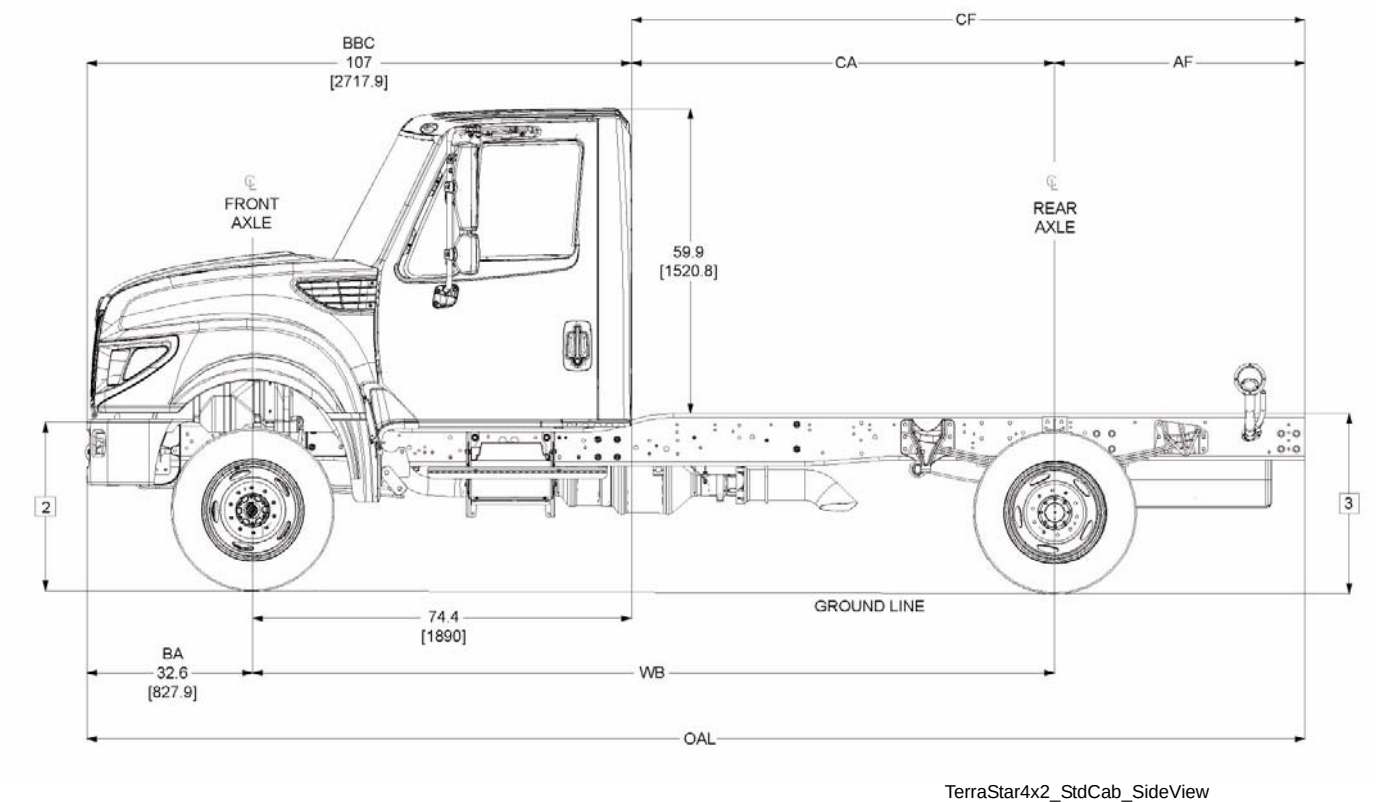
terrastar_crew_cab_plan_view

NOTE: This drawing ***should not*** be used to determine crossmember locations — that information can be found later in this book.

MODEL 4X2

Chassis Diagram

Side View – Standard Cab



TerraStar4x2_StdCab_SideView

[2] Frame Height at centerline of front axle: unloaded – 26.23", loaded – 25.79"

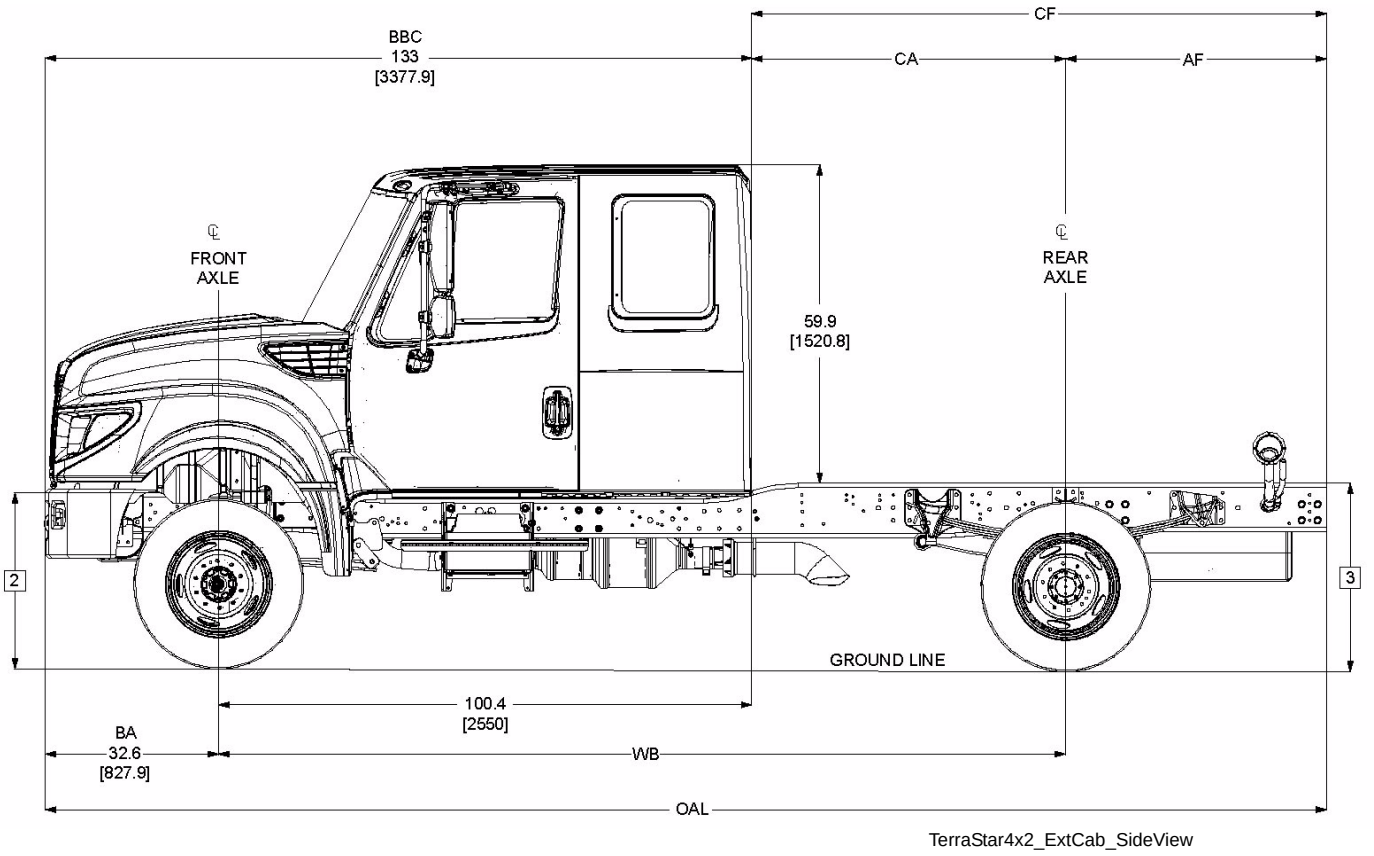
[3] Frame Height at centerline of rear axle: unloaded – 32.14", loaded – 29.30"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X2

Chassis Diagram

Side View – Extended Cab



TerraStar4x2_ExtCab_SideView

[2] Frame Height at centerline of front axle: unloaded – 26.23", loaded – 25.79"

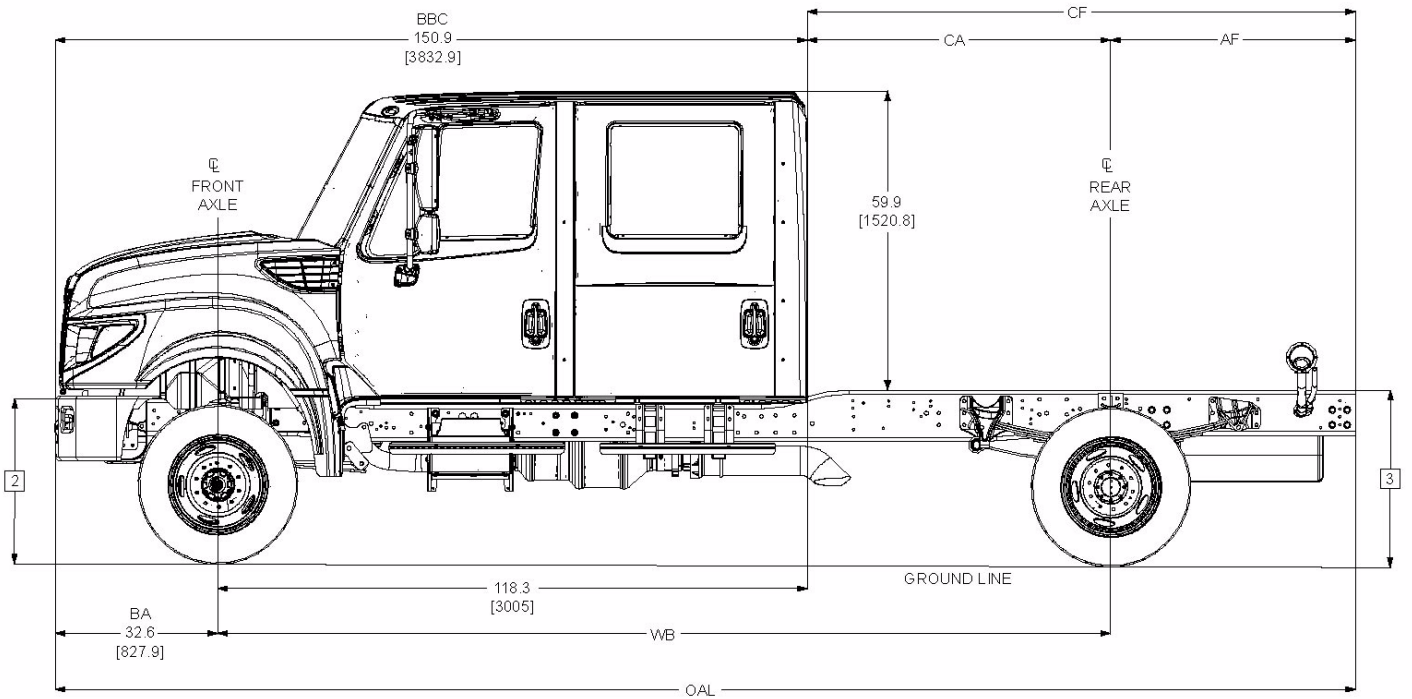
[3] Frame Height at centerline of rear axle: unloaded – 32.14", loaded – 29.30"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X2

Chassis Diagram

Side View – Crew Cab



TerraStar4x2_CrewCab_SideView

[2] Frame Height at centerline of front axle: unloaded – 26.23", loaded – 25.79"

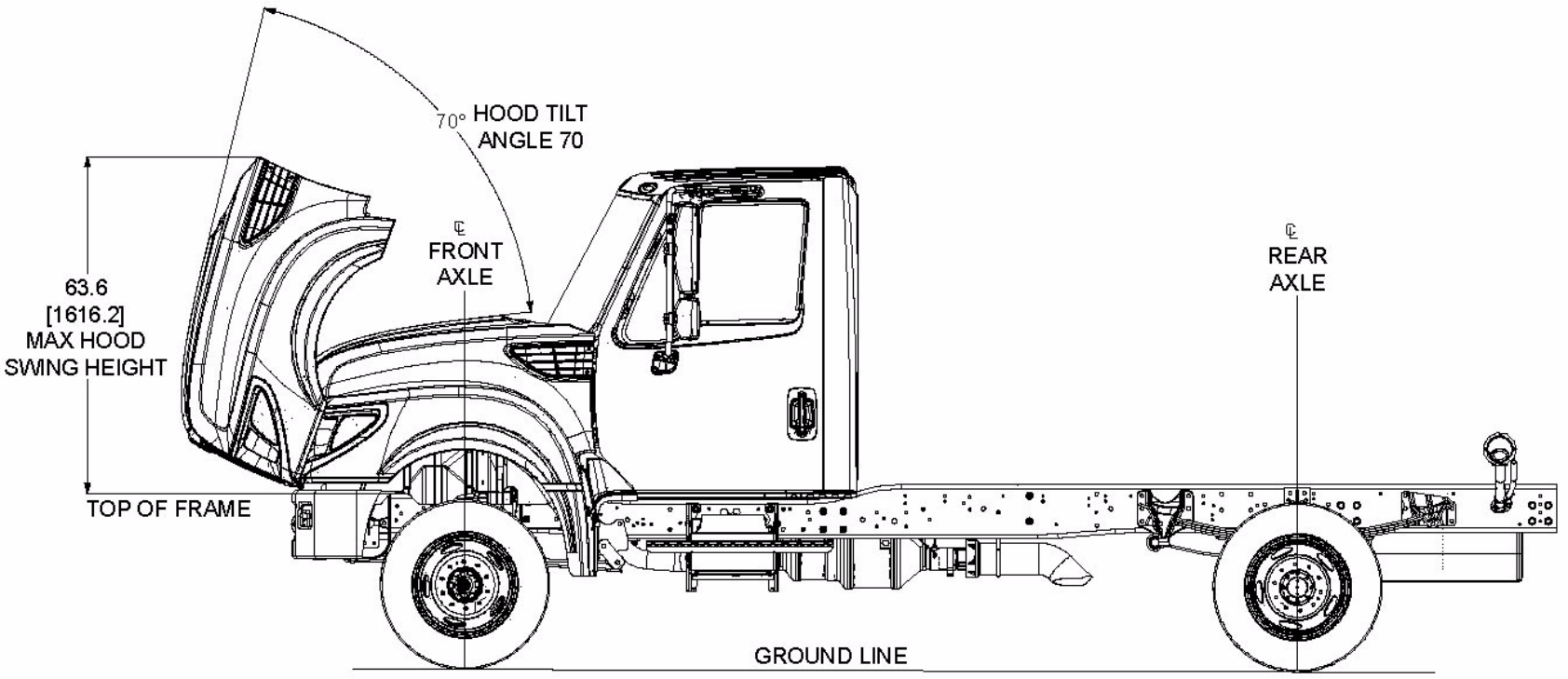
[3] Frame Height at centerline of rear axle: unloaded – 32.14", loaded – 29.30"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X2

Chassis Diagram

Side View – Hood Tilt Dimensions

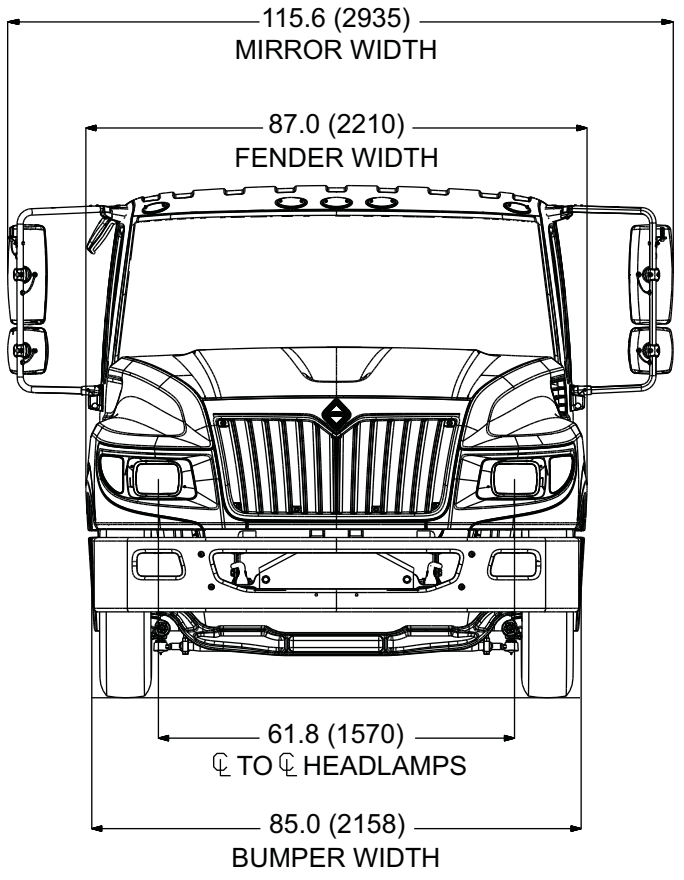


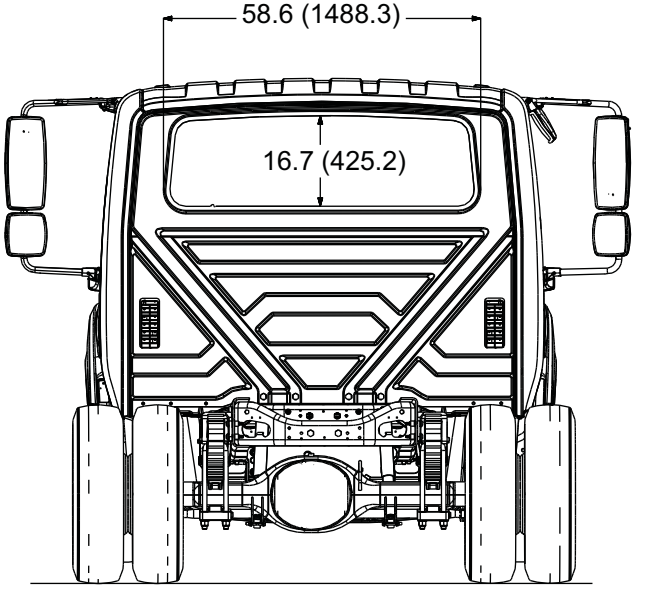
TerraStar4x2_StdCab_HoodTiltView

MODEL 4X2

Chassis Diagram

Front and Rear View





terrastar_front_rear_view

MODEL 4X4

Weight Distribution/Dimensions/Turning Radius Chart

Wheelbase (in.)	Cab	Chassis Weight (lbs.) **			Dimensions (in.)				Turning Radius	
		Front	Rear	Total	CA	CF	AF	OAL	To Curb	w/Bumper Clearance
*158	16030	5,632	2,983	8,615	83.6	132.6	49	239.5	25 ft. 8 in.	26 ft. 6 in.
183	16030				107.6	156.6	49	264.5	29 ft. 2 in.	30 ft. 1 in.
195	16030				119.6	168.6	49	276.5	30 ft. 11 in.	31 ft. 10 in.
213	16030				138.6	213.6	75	320.6	33 ft. 6 in.	34 ft. 5 in.
224	16030				149.6	240.6	91	347.6	35 ft. 1 in.	36 ft. 0 in.
160	16CAB				59.6	108.6	49	241.5	25 ft. 11 in.	26 ft. 10 in.
185	16CAB				84.6	133.6	49	266.5	29 ft. 6 in.	30 ft. 5 in.
209	16CAB				108.6	157.6	49	290.5	32 ft. 11 in.	33 ft. 10 in.
179	16196				60.7	109.7	49	260.5	28 ft. 8 in.	29 ft. 7 in.
203	16196				84.7	133.7	49	284.5	32 ft. 1 in.	33 ft. 0 in.

NOTE: Chart data based on vehicle with standard equipment. Artwork may show some optional equipment.

* Dimension data and optional add-on weights for this model are based on the 158" wheelbase with 49" after frame unless otherwise noted.

**Weight includes standard chassis, standard tires, oil and water, but less fuel.

MODEL 4X4

Standard Features

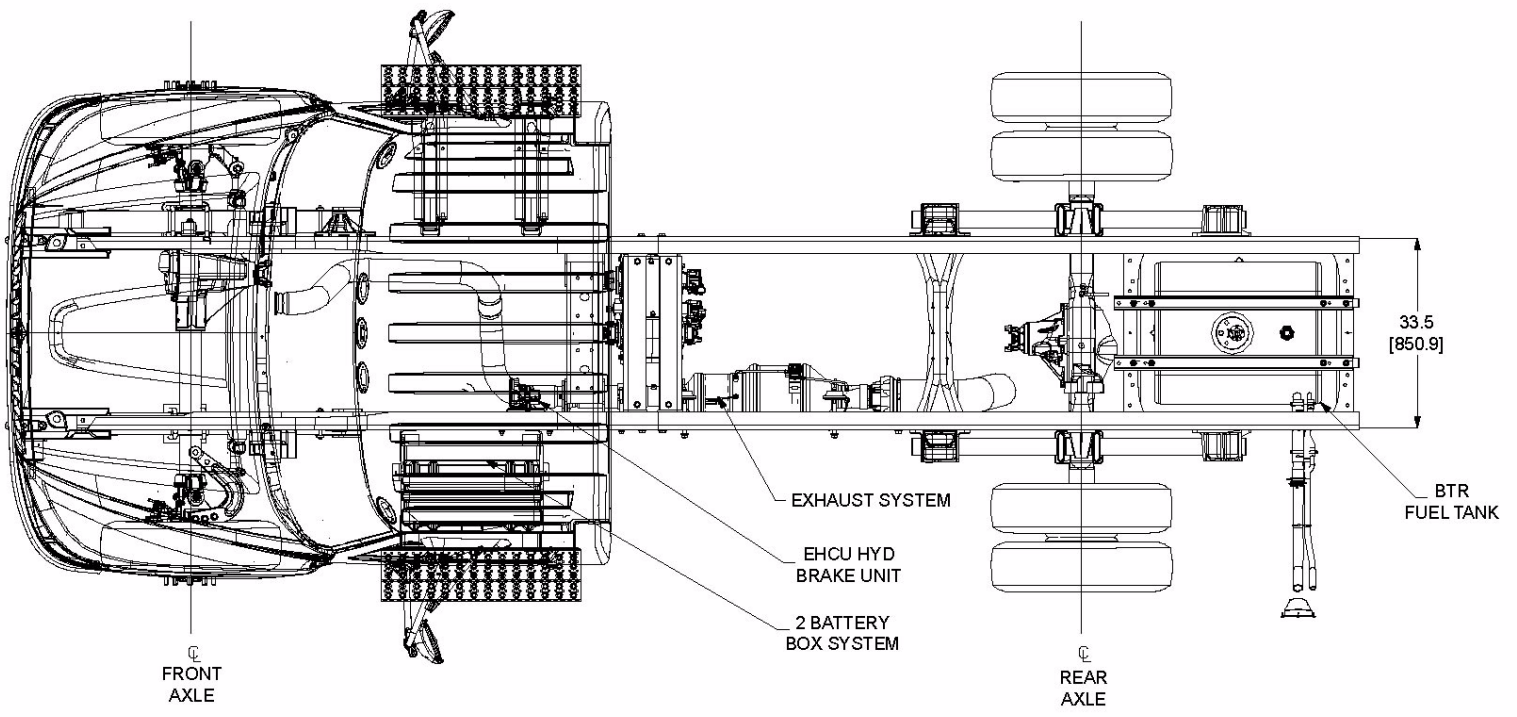
All ground dimensions on this chassis diagram are based on a truck with the following equipment and a loaded chassis.

Item	Specifications
	4x4 (TR005)
Frame	FRAME RAILS High Strength Low Alloy Steel (80,000 PSI Yield); 7.375” x 3.079” x .312” (187.45mm x 78.2mm x 8.0mm) With Transition to 9.125” x 3.079” x .312” (231.8mm x 78.2mm x 8.0mm); Includes 1.2” (30mm) Drop Under Cab; 335.2” (8512.2mm) Maximum OAL (Code 01CDN)
Front Axle	AXLE, FRONT DRIVING {Dana Spicer 70-273} Single Reduction, 8,000-lb Capacity (Code 02EZV)
Front Suspension	SUSPENSION, FRONT, SPRING Parabolic, Taper Leaf; 8,000-lb Capacity; With Shock Absorbers (Code 03ADA)
Rear Axle	AXLE, REAR, SINGLE {Dana Spicer S110} Single Reduction, With Offset Housing, 10,000-lb Capacity, 160 Wheel Ends (Code 14ACR)
Rear Suspension	SUSPENSION, RR, SPRING, SINGLE Vari-Rate; 11,000-lb Capacity (Code 14SCG)

MODEL 4X4

Chassis Diagram

Plan View - Standard Cab



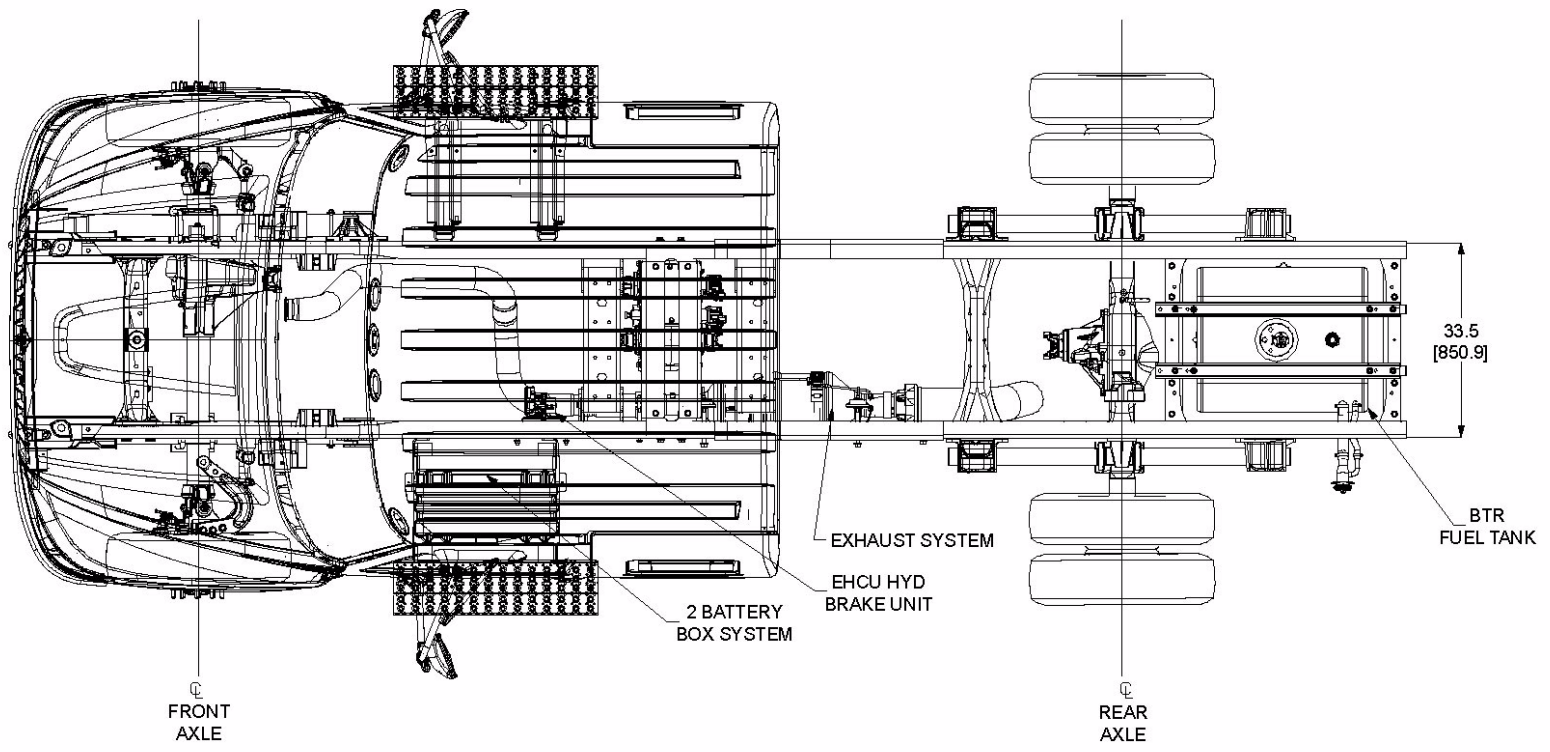
TerraStar4x4_StdCab_PlanView

NOTE: This drawing ***should not*** be used to determine crossmember locations - that information can be found later in this book.

MODEL 4X4

Chassis Diagram

Plan View - Extended Cab



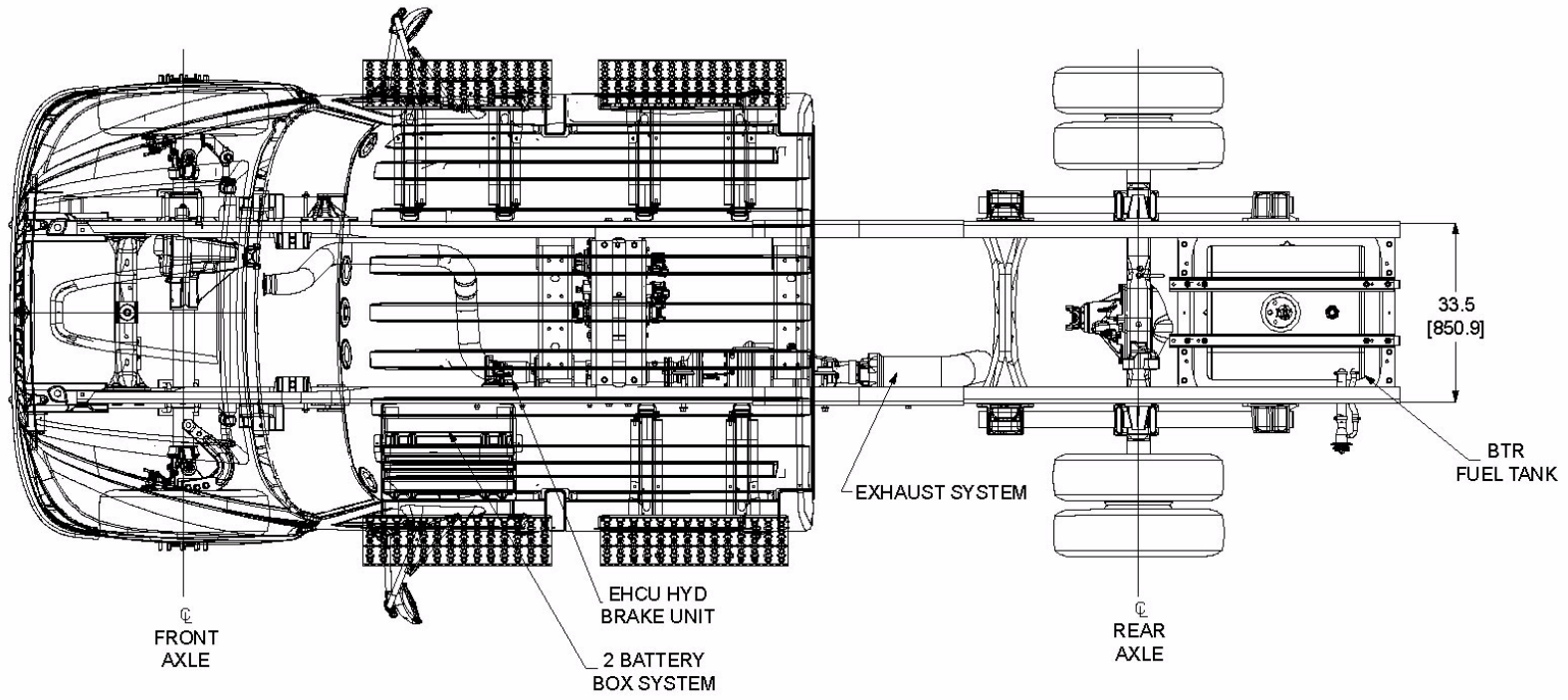
TerraStar4x4_ExtCab_PlanView

NOTE: This drawing ***should not*** be used to determine crossmember locations - that information can be found later in this book.

MODEL 4X4

Chassis Diagram

Plan View - Crew Cab



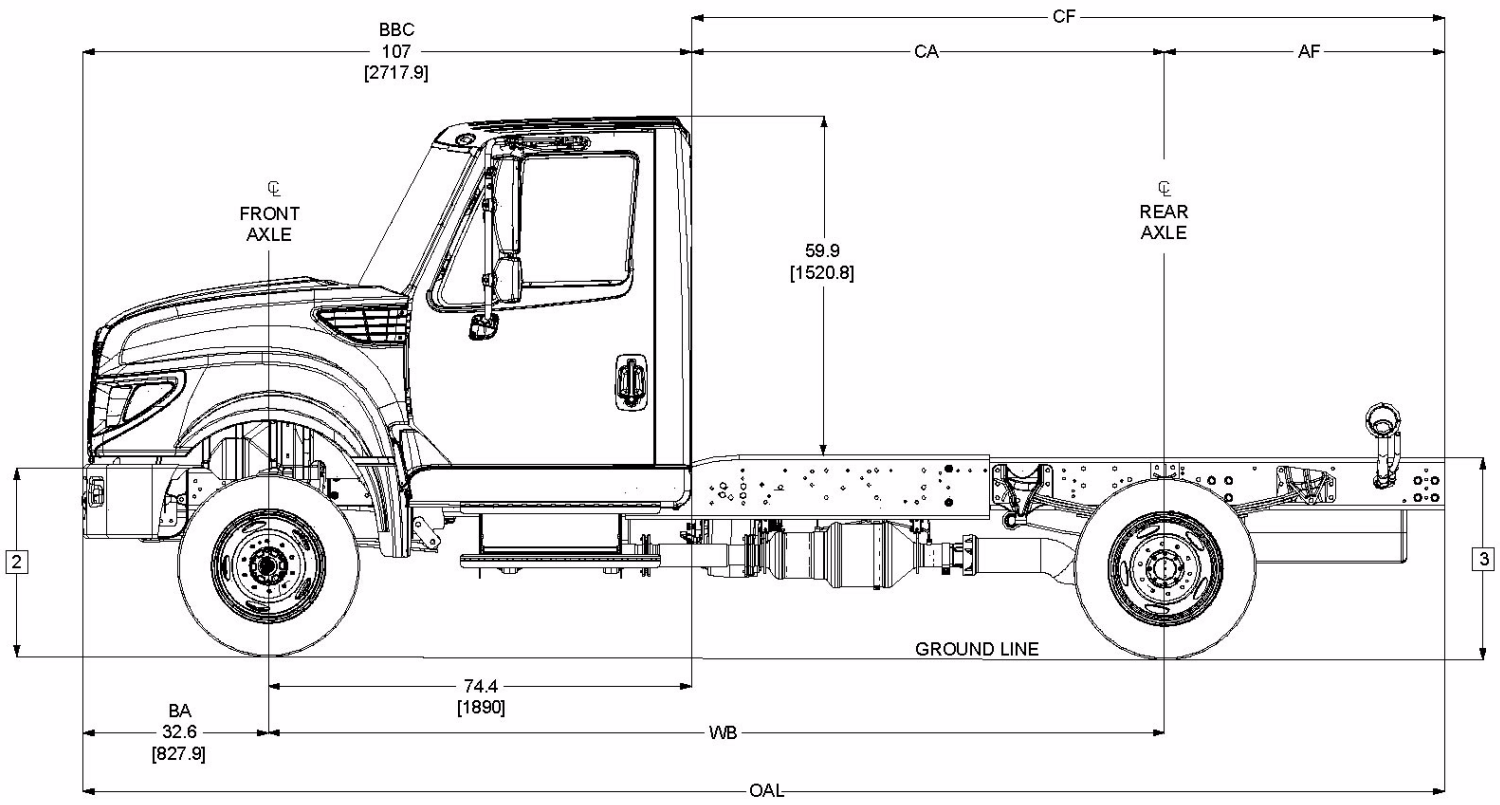
TerraStar4x4_CrewCab_PlanView

NOTE: This drawing ***should not*** be used to determine crossmember locations - that information can be found later in this book.

MODEL 4X4

Chassis Diagram

Side View - Standard Cab



TerraStar4x4_StdCab_SideView

[2] Frame Height at centerline of front axle: unloaded – 34.0", loaded – 32.94"

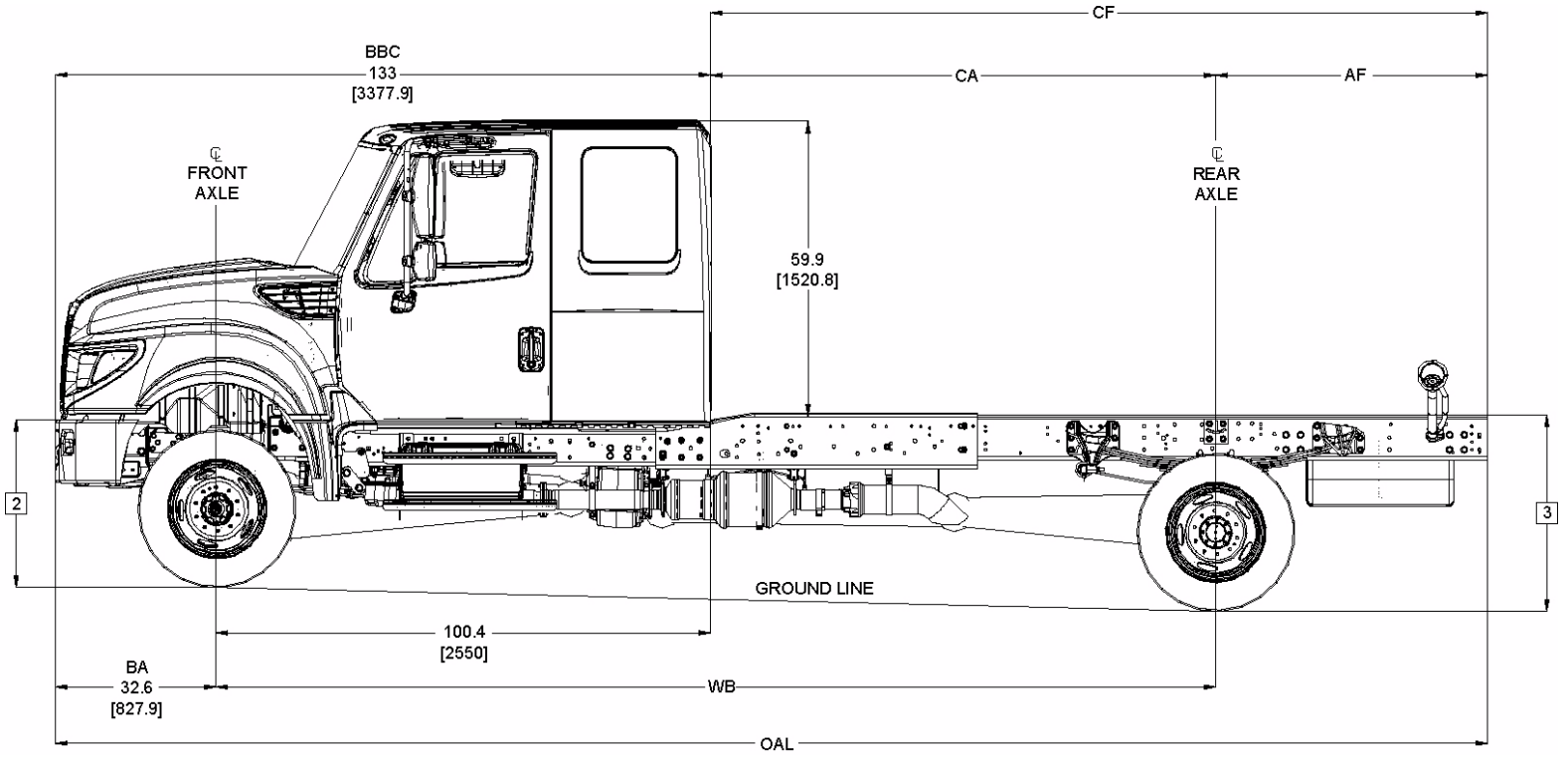
[3] Frame Height at centerline of rear axle: unloaded – 38.58", loaded – 36.08"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X4

Chassis Diagram

Side View - Extended Cab



TerraStar4x4_extended_cab_side_view

[2] Frame Height at centerline of front axle: unloaded – 33.93", loaded – 32.94"

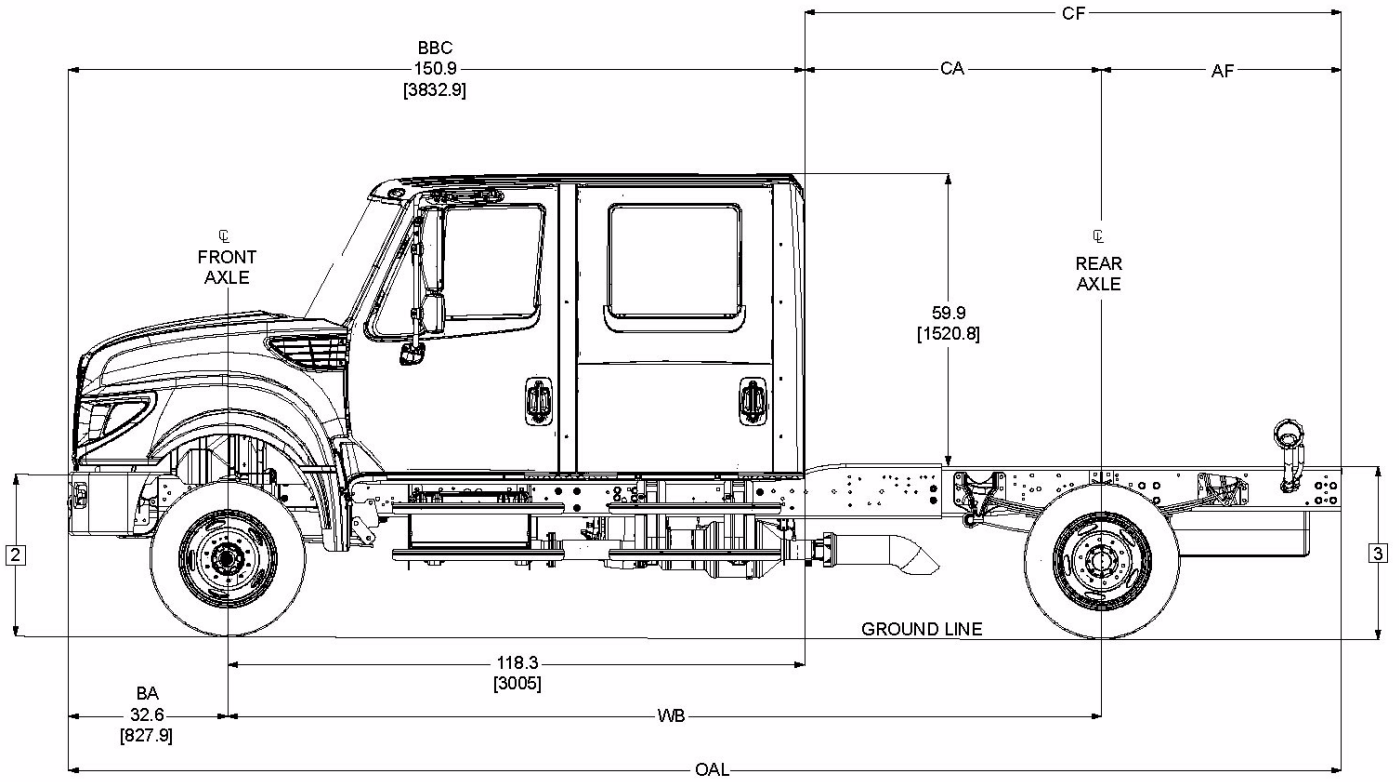
[3] Frame Height at centerline of rear axle: unloaded – 38.27", loaded – 36.08"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X4

Chassis Diagram

Side View - Crew Cab



TerraStar4x4_CrewCab_SideView

[2] Frame Height at centerline of front axle: unloaded – 33.84", loaded – 32.94"

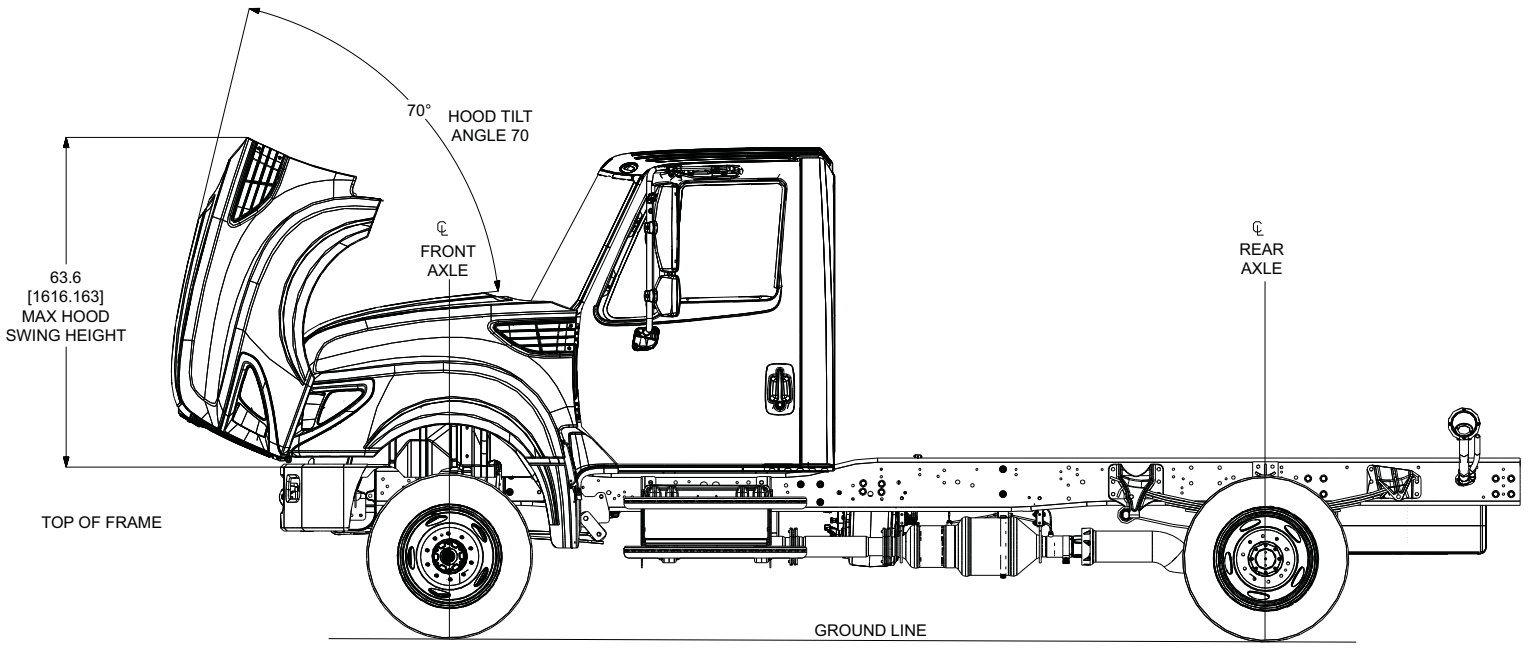
[3] Frame Height at centerline of rear axle: unloaded – 38.14", loaded – 36.08"

NOTE: Due to internal spring friction and manufacturing tolerances, these values may vary up to 0.5 inches. To achieve these nominal values directly after loading or unloading a vehicle, it may be necessary to drive the vehicle for a short period.

MODEL 4X4

Chassis Diagram

Side View - Hood Tilt Dimensions

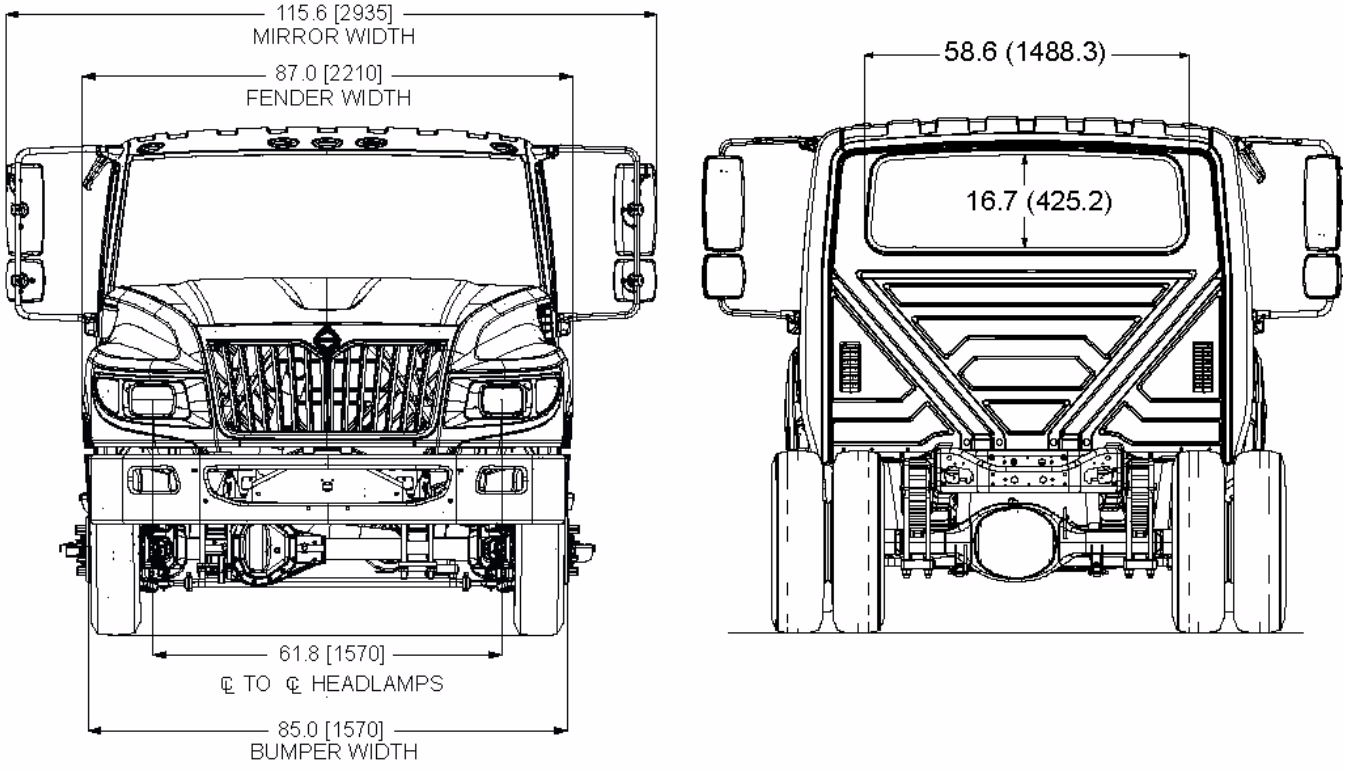


TerraStar4x4_StdCab_HoodTiltView

MODEL 4X4

Chassis Diagram

Front and Rear View



TerraStar4x4_Front_Rear_View

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FRAMES

ALL MODELS

General Frame Information

Introduction

The frame is the structure that carries and supports the rated load under anticipated driving conditions and secures the major components of a vehicle in their relative positions. The frame assembly consists of two sidemembers and depending upon the length of the frame, five or more crossmembers.

General Frame Recommendations

It is very important that the frame be inspected periodically for cracks, buckling, crossmember loosening or other damage that may cause eventual failure of the frame. Additional inspections should be made whenever the chassis has been overloaded or involved in an accident. An alignment check IS NOT SUFFICIENT since local cracks, crossmember loosening or sidemember buckling will not necessarily cause misalignment.

On reinforced sidemember sections, when cracks exist in either of the sidemember sections, the members must be separated for repair. After separation follow the procedures for non-reinforced sections. The two sidemember sections MUST NOT be welded together. After the weld repairs, the sections should be reinforced with the appropriate section and re-assembled with mounting bolts tightened to SAE Grade 8 torque levels.

Drilling or Notching

Sidemembers should not be drilled or notched without approval from Navistar Engineering. Do not exceed the maximum allowable sidemember hole size in the unrestricted zones. See illustrations later in this book.

Welding or Flame Cutting

Welding or flame cutting of the frame components is unacceptable because of the associated loss of fatigue strength. This restriction applies not only to the heat-treated components, but also the high strength low alloy (HSLA) and low carbon steel components.

Exceptions to this are cases with Navistar Engineering approval or for repair operations as described in this service manual section.

To avoid serious personal injury, death or possible engine damage, when welding or using an acetylene torch always wear welding goggles and gloves. Insure that acetylene and oxygen tanks are separated by a metal shield and are chained to a cart. Do not weld or heat areas near fuel tanks or fuel lines. Utilize proper shielding around hydraulic lines.

Reinforcement to Increase Capacity

Reinforcement of the chassis frame to support either additional loading or concentrated loading does not increase vehicle load carrying capacity unless it has been fully verified that all other vehicle components, such as the brake system, steering system, suspension system, etc. can properly and safely support the increased loading.

Increase in Local Stress

In any modification of the chassis frame, the addition of holes, reinforcements, welds, clamps, splices, etc., may cause an increase in the local stress in the frame at the point of the modification, **therefore causing a stress concentration in the frame sidemember(s)**.

These local stress concentrations can significantly affect the life of the chassis frame. The specific effect which the stress concentrator will have on the life of the chassis frame is influenced by the location of the stress concentration, the frequency and severity of the loading, and the magnitude of stress concentration.

Deviation from the repair procedures in this section may void manufacturer's warranty.

Identification of Frame Rail Material

International® chassis are manufactured with frame rails of different alloy steels and some are heat-treated. Each material must be handled in a specific manner to assure maximum service life; therefore, the frame material must be determined before attempting repair or modification.

International chassis are presently manufactured with frame rails of:

- High strength low alloy (HSLA) steel (50,000, 60,000 and 80,000 PSI yield strength)
- Heat treated steel (110,000 and 120,000 psi yield strength)

Each type has different repair procedures. The frame rail material can be determined by inspecting the frame and consulting the dealer vehicle lineset ticket and the sales data book.

Heat-treated rails are marked on the inside of the section with a decal which cautions against welding, flame cutting or the addition of holes in critical zones. These practices are restricted for all frame rails, however, **heat-treated** rails are much more sensitive to these alterations.

Frame Damage

The major sources of frame damage are accidents, overloading the vehicle, and local overstressing due to a variety of causes. In accident cases, the reasons for the damage are readily apparent. Such damage may often be repaired by:

- Straightening and reinforcing the frame.
- Repairing the damaged area and reinforcing the frame sidemember.
- Replacing the frame sidemembers and crossmembers.

Damage to the chassis frame, such as a crack in the frame sidemember or crossmember, which is not associated with impact damage, may be an indication of overloading the vehicle. Damage to the chassis frame may also be an indication of the creation of locally high stresses due to operating conditions or equipment mounting practices. Examples of overloading are:

1. Exceeding either the gross vehicle weight rating (GVWR) or the gross axle weight rating (GAWR) (loading the frame beyond its design capacity).
2. Uneven load distribution.
3. Improper fifth wheel settings.
4. Using the vehicle in operating conditions or with equipment it was not designed for.

Examples of creation of locally high stresses are:

1. Mounting bodies or equipment in a manner that causes stress concentrations and/or abrasive wear in either the flange or web portion of the sidemember.
2. Improper modification or repair of frame components.
3. Equipment which is susceptible to resonant vibration due to excess flexibility of its mounting.

Frame damage may also be caused by corrosion resulting from the contact between dissimilar metals.

Damage to the chassis frame, which is not associated with impact damage, should not be repaired until the cause of the damage has been determined and corrective actions taken to prevent re-occurrence of the non-impact damage.

Welding and Reinforcement

The guidelines below deal with the general procedures for weld repair and reinforcement. Because of the many variables associated with these repairs, it is recommended that your field service representative be consulted prior to undertaking the repair. This will also help to determine whether a specific set of recommendations has already been developed for the case in question.

The essential elements of repairing the sidemembers are the restoring of BOTH the shape and local strength so that the load capacity is at least as good as before the damage occurred. The sidemembers may *look* like new, but may have local strength reduction due to small cracks or material strength reduction. Even if the frame has acceptable alignment and there is no gross deformation, local deformations may reduce the strength in the area to be weld repaired. Examples of this are local bulges in the web (vertical portion) of the section and buckling of the flanges. These local deformations must be repaired by straightening before proceeding with the weld repair.

Welding Precautions

When welding on any vehicle, care must be taken to prevent damage to the electronic components. Vehicles with ELECTRONIC ENGINE CONTROL SYSTEMS require additional precautions.

CAUTION: On any vehicle, disconnect both the positive and negative battery cables from the battery before welding on the vehicle. Attach the welder ground cable as close as possible to the part being welded.

To avoid serious personal injury, death or possible engine damage, when welding or using an acetylene torch always wear welding goggles and gloves. Insure that acetylene and oxygen tanks are separated by a metal shield and are chained to a cart. Do not weld or heat areas near fuel tanks or fuel lines. Utilize proper shielding around hydraulic lines.

With an electronic engine controller (such as Celect), do not connect the ground cable to the control module(s) or the cooling plate. To protect the control module(s), it is mandatory to remove all connectors going to the control modules.

The following is a general guideline for the steel frames:

Welding of the HSLA (50,000, 60,000 and 80,000 PSI yield strength) steel side member and the heat-treated (110,000 and 120,000 PSI yield strength) steel sidemember involves a significant reduction in the strength of the frame in the heat affected zones of the weldment. This means that the frame in the welded region is no longer capable of carrying the same load or stress as the original section.

To restore the strength of the frame rails after welding, the welded area must be reinforced using reinforcements as indicated in “Repair and Reinforcement Recommended Procedures”.

Welding must be done properly to make an effective repair. Therefore, only those who are properly trained and qualified should perform the welding repairs in this section.

Reinforcement Attachment

The reinforcements must never be welded to the original chassis sidemembers. High strength SAE Grade 8 bolts are to be used to fasten the reinforcement to the sidemember. Existing bolt holes in the sidemembers should be used whenever possible.

NOTE: The reinforcements should be bolted to the chassis frame using high strength SAE Grade 8 bolts not less than 0.5 inch (13 mm) in diameter (refer to “Bolt and Torque Information”).

Corrosion

If aluminum and steel are allowed to come into direct contact with each other, a galvanic cell can be formed. In order for the cell to form, the dissimilar metals must be in direct contact and an electrolyte, such as moisture, must be present. Aluminum is anodic with respect to steel and will corrode when in the presence of steel. Corrosion of aluminum frame crossmembers will reduce the load carrying capacity of the frame member and may eventually lead to the failure of the frame.

To prevent the formation of a galvanic cell, isolation techniques such as non-conductive or barrier type spacers or sealers must be used so that the steel and aluminum are not in direct contact.

It is recommended that a sealer, such as Tectyl 400C or equivalent, be painted onto the surface of both the aluminum and steel, as well as on the washers under the head of the bolts and nuts.

Frame Alignment

The frame must be properly aligned as this affects body, axle and suspension mounting. If the vehicle has been involved in an accident or has been overloaded, it is recommended that the frame be checked for proper alignment.

Pre-Alignment Inspection

Before checking alignment, park vehicle on level ground and set parking brake. Inspect frame assembly for loose parts, welds, cracks and bends. Be sure to make all necessary repairs before attempting to check frame alignment.

Method of Checking Frame Alignment

A satisfactory method of checking the frame and axle alignment, particularly when a body and cab is on a chassis, is to:

1. Place a plumb bob against the point of measurement. All measurements must be taken with the plumb bob positioned against bare metal.

2. Tack or tape pieces of paper to the floor directly under each point of measurement on the chassis as indicated by the letter “K” in Figure 2.1.

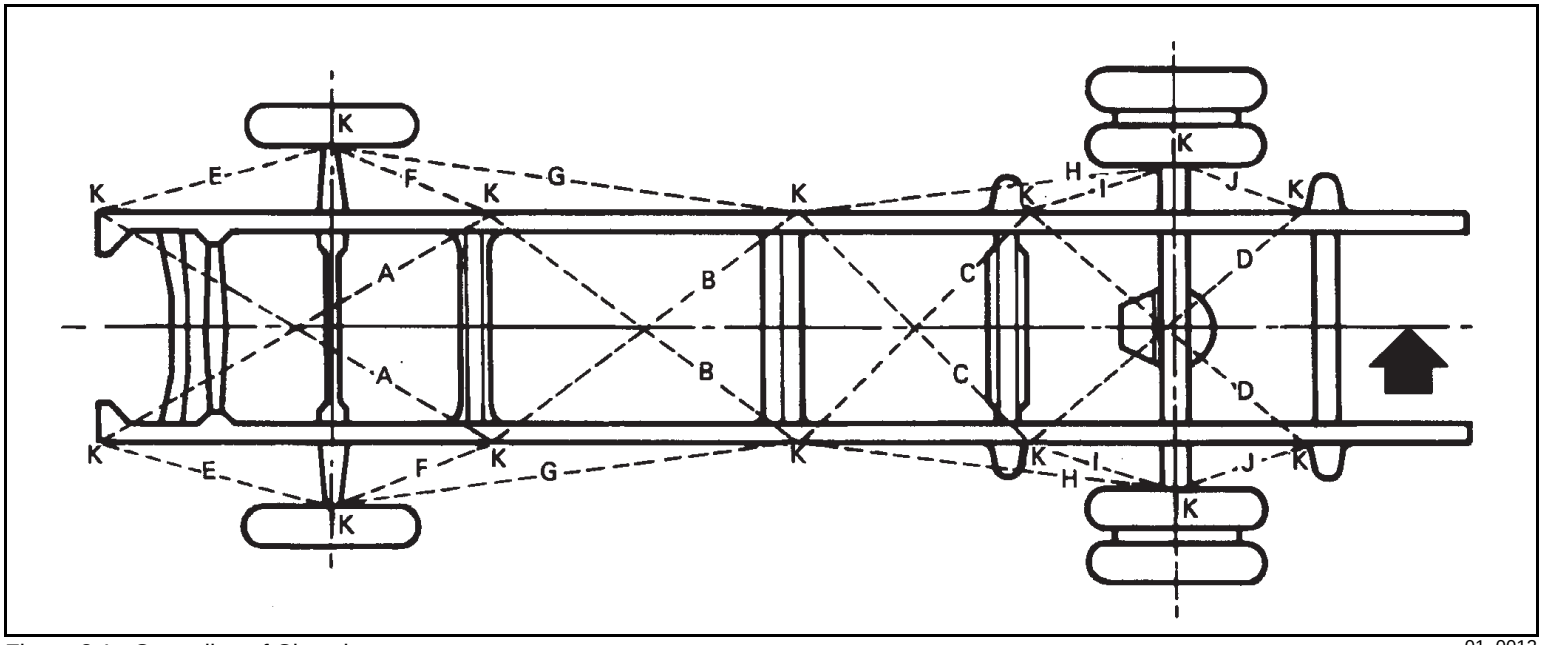


Figure 2.1 Centerline of Chassis

Method of Checking

After each measurement point has been carefully marked on the floor, proceed as follows:

1. Locate centerline of chassis by measuring front and rear end widths, using marks on floor.

If frame widths are within specification, draw centerline on floor, the full length of the chassis and continue with step 2.

If frame widths are out of specification, lay out centerline as follows:

Centerline can be drawn through the intersection of any one pair of equal diagonals (A-A, B-B, C-C, D-D) and center point of one end of frame or through points of intersection of any two pairs of equal diagonals.

2. Measure distance from centerline to opposite points marked over entire length of frame. Measurements should not vary more than 0.12 inch (3.0 mm) at any point.

3. Measuring diagonals (A-A, B-B, C-C, D-D) will indicate point where misalignment occurs. If diagonals in each pair are within 0.12 inch (3.0 mm), that part of the frame included between points of measurement may be considered in satisfactory alignment. These diagonals should intersect within 0.12 inch (3.0 mm) of the centerline.

If the diagonals are not within specification, try loosening and re-tightening all cross-members. Then re-check alignment. Refer to the "Bolt Torque Chart (Phosphate and Oil Coated)". If frame is still out of alignment, the vehicle must be taken to a suitable frame alignment establishment to confirm frame misalignment. If misalignment is confirmed, suitable measures must be taken to repair the damage.

Side Elevation Dimensions

Dimensions for side elevation of the frame should be checked at the points indicated and should not vary more than 0.12 inch (3.0 mm) from side to side. (They will differ fore and aft due to typical frame rake.)

Axle Alignment With Frame

After determining that the frame is properly aligned, the axle alignment with the frame should be checked by comparing diagonals.

If necessary, adjust axle-to-frame alignment.

Frame Straightening

NOTE: Frame straightening should only be performed by a qualified frame alignment facility. Under no circumstance should frame alignment be performed by inexperienced or unqualified service personnel.

Do not use heat to straighten.

Use of heat is not recommended when straightening heat-treated frame sidemembers. Heat will weaken these frame members, consequently, all straightening should be done at room temperature. Add reinforcement per section if heat straightening is done.

Frame members which are bent or buckled sufficiently to show cracks or weakness after straightening should be replaced or reinforced. **Heat-treated frame members must not be intermixed with non-heat-treated members.**

If one sidemember is to be replaced, the new member must match the former frame member in both cross-section and material strength.

Repair and Reinforcement Recommended Procedures

In some cases of frame damage, the sidemembers must be replaced rather than repaired. Examples of this are:

1. When sidemember cracks caused complete separation or a visible deformation of the section.

2. When the sidemembers are extensively deformed. Consult with your field service representative and frame repair specialists if in doubt.

Preparation of Frame for Repair

Bevel Crack to Weld

To assure complete weld penetration, bevel the crack from one side when welding from one side. Bevel the crack from both sides when welding from both sides. The existing crack in the sidemember must be entirely removed (Figure 2.2). Widen the crack its full length to 1/8 inch (3 mm). If required, a rubber backed disc grinder or high speed steel burr may be used.

Clean Surface to Weld

Surfaces to be welded and surfaces adjacent to the weld must be free of loose scale, slag, rust, grease, moisture, paint or other material that could contribute to poor quality welds.

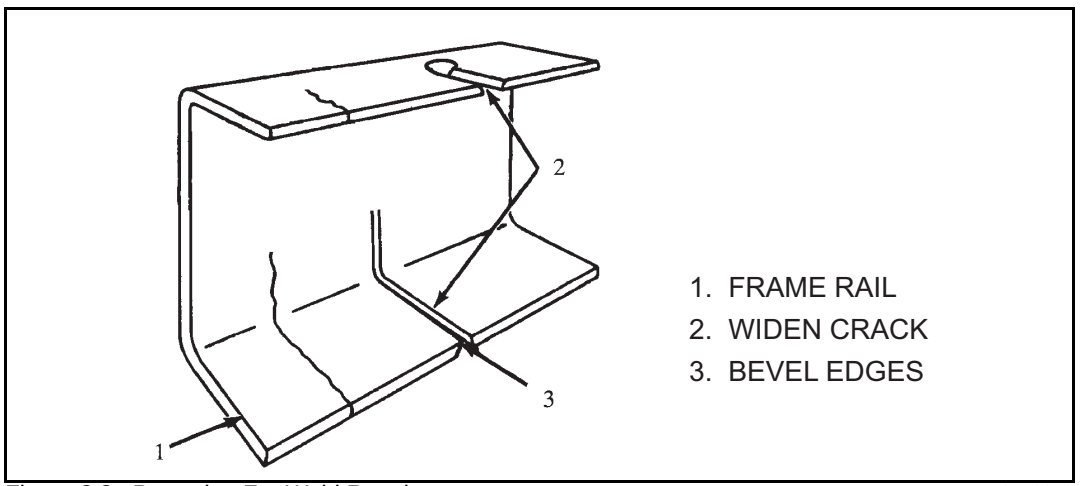


Figure 2.2 Preparing For Weld Repair 01_0013

Welding

Electric arc-welding is recommended for repair of steel frames. The shielded arc method should be used because the heat generated during welding is localized and burning of material is minimized using this method. Additional advantages are that the finished weld can be ground flush and drilled as necessary.

Shielded metal arc welding (SMAW); gas metal arc welding (GMAW), also known as metal inert gas (MIG) welding; gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding; or flux cored arc welding (FCAW) are recommended methods for repair of steel frame members.

To avoid serious personal injury, death or possible engine damage, when welding or using an acetylene torch always wear welding goggles and gloves. Insure that acetylene and oxygen tanks are separated by a metal shield and are chained to a cart. Do not weld or heat areas near fuel tanks or fuel lines. Utilize proper shielding around hydraulic lines.

General Recommendations

IMPORTANT: To properly perform the repair procedure, the following rules must be observed:

All Steel Sidemembers

1. Welding should not be performed when surfaces are wet or exposed to rain, snow, high wind or when repair personnel are exposed to inclement conditions. Frames exposed to inclement weather must be thoroughly cleaned and dried before the repair is made.
2. Surface areas and edges to be joined must be clean and free of oil, grease, loose scale, rust, moisture, paint or other material that could contribute to poor quality welds.
3. Always avoid craters, notching and undercutting.
4. Peen new welds prior to grinding to relieve stresses caused by shrinkage.
5. Grind all welds flush with the surrounding surfaces. Use a coarse grinder followed by smooth grind at 90° to the crack direction to remove all of the coarse grind marks.
6. Inspect the weld repaired area carefully after grinding. Grind out any remaining cracks, notches or undercuts and repeat the finishing and inspections.
7. For welding cracks to the edge of the sidemember flange, locate a run-off block at the edge as in to obtain a continuous weld without undercuts. After welding, the run-off block should be cut off and the weld should be ground and inspected as in steps 5 and 6 above.
8. Weld to the edges of the holes: The weld should continue into the hole to form a plug weld with a copper chill block on the opposite side to help form the plug. The weld should then be finished as in steps 5 and 6 above and redrilled. Chamfer the hole edges. If the hole was open and unused, install a Grade 8 bolt to help attach the weld repair reinforcement.

Invisible ultraviolet and infrared rays emitted in welding can injure unprotected eyes and skin. Protection such as welder's helmet with dark colored filter lenses of the proper density must be used. GTAW or TIG welding will produce intense radiation, therefore, filter plate lenses of the deepest shade providing adequate visibility are recommended. It is strongly recommended that persons working in the weld area wear flash safety goggles. Also wear protective clothing.

9. Electrodes: Only low hydrogen electrodes should be used. These should be purchased in hermetically sealed containers or dried for two hours at a temperature between 450° F (232° C) and 500° F (260° C).

After drying, the electrodes should be stored in an oven at a temperature of at least 250° F (121° C). If exposed to the atmosphere for more than four (4) hours, the electrodes should be dried before use. **Any moisture introduced into the weld could develop porosity or embrittlement, leading to further cracking.** Welding procedures will vary among different frame materials. Outlined below are recommendations for welding of the various types of frames.

1. Preheat the frame member along the prepared weld joint to 500 to 600° F (260 to 316° C). Insure the area is clean and any moisture present is eliminated.

2. Permit heated area to cool to 200° F (93° C) or below before welding is started. The weld repair area must be clean before welding.

3. Either alternating current or direct current reversed polarity, combined with a short arc and beading or narrow weave technique, may be used. Direct current reversed polarity is recommended.

4. Slag should be removed after each pass and an interpass temperature of 200° F (93° C) should be maintained.

5. Grind smooth and flush with surrounding sidemember material. Grind the weld in a direction that is 90° to crack direction (Figure 2.3 D).

6. Add reinforcement.

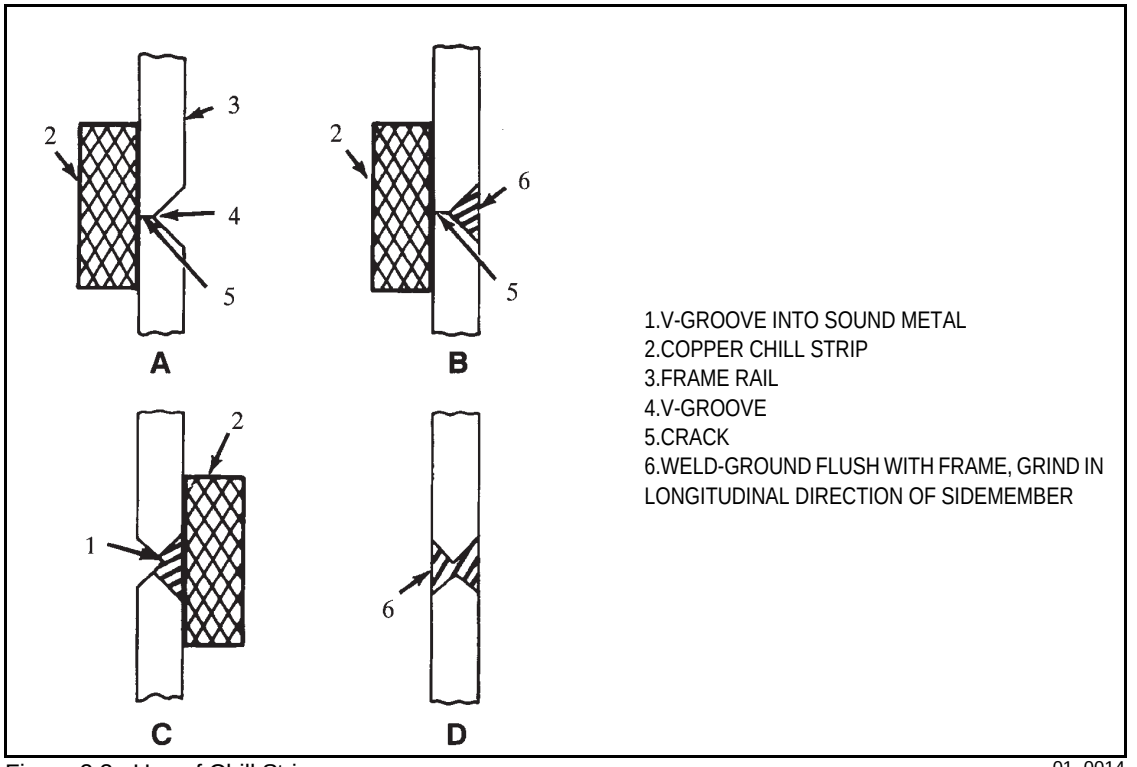


Figure 2.3 Use of Chill Strip

01_0014

High Strength Low Alloy Steel Frames (50,000, 60,000 and 80,000 PSI Yield Strength)

Any of the electric arc methods previously described may be used. The choice of a suitable electrode or wire depends somewhat upon the equipment available for welding and the method selected.

The SMAW and the GMAW methods are preferred for welding the HSLA frames. The use of low hydrogen electrodes is recommended. Refer to Table 2.1 for selection of recommended electrodes and wires, or refer to A.W.S. A.5 standard available from www.aws.org for equivalent strength electrodes, wires or rods and power leads to be used in the welding methods. The double V-notch weld preparation using the weld procedure shown in Figure 2.3 D is the preferred welding method.

Table 2.1 Recommended Electrodes and Wires

Material Strength PSI	Recommended Electrode and Wire	
	SMAW	GMAW
50,000	E7018	E70S-3
60,000	–	E70S-1B
80,000	E8018	E80S-D2

Table 2.2 SMAW Method (HSLA Frames)

Position	Electrode Sizes Inch	Welding Current		Speed (inch/min.)
		Amperes	Volts	
Flat	.125	–	–	–
Horizontal and Vertical	.125	110/140	20/14	24

Table 2.3 GMAW Method (HSLA Frames)

Position	Electrode Sizes Inch	Welding Current		Speed (Inch/Min.)
		Amperes	Volts	
Flat	.035	–	–	350/400
Horizontal and Vertical	.035	190/220	20/30	350/400

7. Preheat frame rail along the weld joint to 500 to 600° F (260 to 316° C) to insure any moisture present is eliminated and to prevent too rapid cooling of weld metal.

8. Direct current, reversed polarity is preferred. Weld using a short arc and a beading or narrow weave technique.

9. Slag should be removed after each pass and an interpass temperature of 200° F (93° C) should be maintained.

10. Grind smooth and flush with surrounding sidemember material. Grind the weld in a direction that is at 90° to crack direction (Figure 2.3 D).

11. Add reinforcement.

Heat Treated Frames (110,000 and 120,000 PSI Yield Strength)

When welding Heat Treated Frames (110,000 PSI and 120,000 Yield Strength), use low hydrogen electrodes which have superior crack resistance and notch toughness similar to AWS-E-11018. This type electrode should be stored in a moisture-free container to avoid porosity during welding.

Table 2.4 SMAW Method (Heat-treated Frames)

Position	Amperes	Voltage
Downhand	130/140	21/23
Overhead	130/140	21/23
Vertical Up	110/120	22/24

A heavy copper “chill” strip should be clamped to the rail side away from the groove to help control the temperature and cooling rate during welding (Figure 2.3). Short lengths of discarded heavy copper electrical bus bars make suitable chill strips.

Preheat the frame rail along the crack area to 500-600° F (260-316° C). Either alternating current or direct current reversed polarity, combined with a short arc and a beading or narrow weave technique may be used. Direct current reversed polarity is recommended.

Slag should be removed after each pass and an interpass temperature of 200° F (93° C) should be maintained. Grind smooth and flush with surrounding sidemember material, in a direction that is parallel to the longitudinal axis of the sidemember (Figure 2.3 D).

A V-groove is ground from the side opposite the repair and the procedure outlined above repeated. “Chill” strips should be used whenever possible. The V-groove ground on the opposite side of the repair should be deep enough to enter the sound metal of the first weld repair as shown in Figure 2.3 C.

Reinforcement

The strength of the sidemember in the weld joint repair region has been reduced by welding and this region must be reinforced sufficiently to insure that the service life of the frame is not shortened. Reinforcement of the frame after welding is intended to reduce the stresses in the weld repair region to a lower level than was previously permitted. Improper drilling will also reduce the strength of the sidemembers. Refer to “Drilling or Notching”.

The type, length, material and attachment techniques for reinforcements vary with the type and location of the crack and with the loading conditions associated with the crack. It is not practical to give specific recommendations for all cases of frame cracking, therefore the various types of reinforcements are identified with general descriptions of their applications and installation procedures. To aid in making the distinctions between the more critical flange area and the less critical web area, critical zones are defined as shown (Figure 2.4 D).

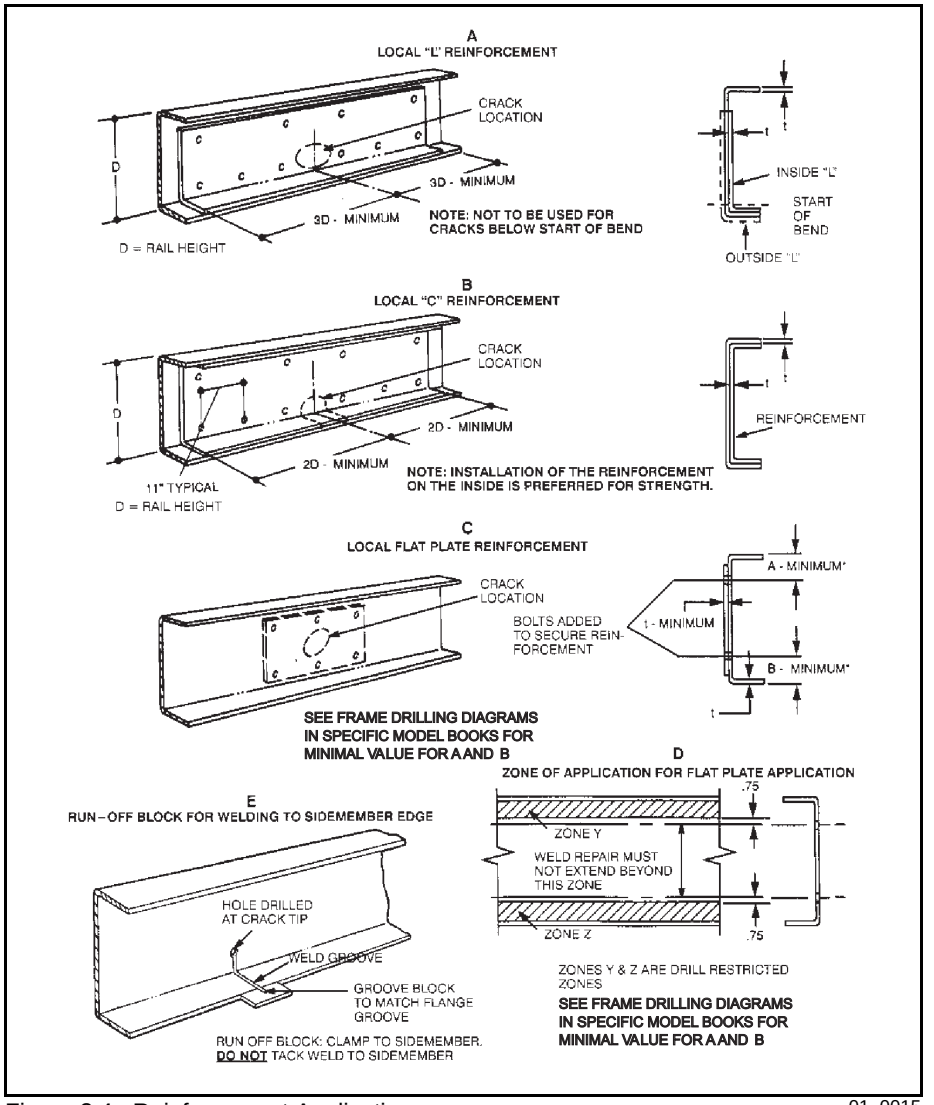


Figure 2.4 Reinforcement Application 01_0015

Cracks which occur in the critical zones have a greater probability of growing vertically through the section, and the reduced strength after weld repair necessitates a more substantial reinforcement.

These guidelines potentially affect the structural integrity of the frame assembly and are intended for those who have the equipment and experience required to qualify as frame repair specialists.

General Weld Repair Reinforcement Procedures

1. The thickness and material strength of the local plate, “L” and channel reinforcements should match the section being reinforced.

2. The corners of the reinforcements which will be in contact with the sidemember along the reinforcement edges must be chamfered to prevent damage to the sidemember.

3. All sidemember reinforcements must be bolted to the web section within the zone shown in the frame drilling guidelines in the specific model body builder book. The bolts must be of SAE Grade 8 or better, with integral flanges or with hardened flat washers and must be tightened to Grade 8 levels.

4. Crossmember modification or replacement may be required if the reinforcement is on the same side as the crossmember.

5. Consider the potential effects of the reinforcements on the various components mounted to the frame. Check clearances for suspension, wiring, plumbing and other controls.

6. For attachment of reinforcements, use existing bolts wherever this is practical.

7. The weld repaired area of the sidemember and all of the reinforcement should be primed and painted before reinforcement installation. For corrosive environments, additional treatment of the interface may be needed.

Full Length Channel Weld Repair Reinforcements

“Full length” channel reinforcements are available through International® dealers for most models. The actual length, starting location and ending location vary from model to model. Different length reinforcements may also be available.

When applied as a repair reinforcement, these reinforcements DO NOT increase the load capacity of the vehicle. Their advantage in this case is their availability. A disadvantage of this type is that it is likely to affect more of the components which mount to the frame. In some cases this disadvantage may be offset by cutting the full length reinforcement to create a local reinforcement.

Recommended Applications

1. Cases of repair of vertical cracks in either the top or bottom flanges at very low mileage.
2. Cases in which the weld repair is accompanied by extensive straightening of heat treated sidemembers.

Full Length "L" Weld Repair Reinforcements

Steps 1 and 2 above also apply to the full length "L" reinforcements available from International. All of these are the inverted "L" type and are designed for installation on the outside of the sidemember section (except 9000 Series) (Figure 2.4 A).

Recommended Applications

This type of reinforcement is recommended for cases of cracking at very low mileage where a web crack has extended beyond the range for a flat plate reinforcement but ends short of the bend radius. It is also applicable to cases in which the cracking is accompanied by flange buckling.

Application Procedures

1. For custom-fabricated full length "L" reinforcements, the section should be oriented up or down so that the flange is on the same side as the damaged area.
2. For maximum strength the flange should be on the outside of the section.
3. Follow the general recommendations above for attachment of the reinforcement.

Local Channel Weld Repair Reinforcements

This type of reinforcement must be custom-fabricated either by cutting lengths from "full length" reinforcements or by forming from flat stock (Figure 2.4 B).

Recommended Applications

1. Cases in which the weld repair extends into the sidemember flange after substantial service life.
2. Cases accompanied by extensive abrasive wear of the sidemember section. In these cases the length of the wear area should be added to the length recommendations below.

Application Procedures

1. The channel should be installed on the outside of the section for greater strength.
2. Figure 2.4 B gives recommended dimensional data and attachment specifications for a typical installation. Holes drilled for the attachment must be within the frame drilling guidelines in the specific model body builder book.

Local "L" or Inverted "L" Weld Repair Reinforcements

This type of reinforcement is also generally custom-fabricated. It has a greater tendency to loosen than a channel reinforcement because, for vertical deflections of the frame assembly, it tends to bend about an axis different from that of the main sidemember section. Because of this its length and/or attachment specifications are typically greater than for the channel type.

Recommended Applications

This type of reinforcement is recommended for cases in which the weld repair is confined to the web of the section but extends beyond the application zone of the flat plate reinforcements shown in Figure 2.4 D.

Application Procedures

1. Figure 2.4 A shows a typical installation for an “L” reinforcement on the inside of a sidemember section along with minimum recommended dimensions.
2. The flange of the reinforcement should be oriented up or down so that flange is on the same side as the damaged area.
3. For maximum strength the reinforcement should be installed on the outside of the sidemember section.

Flat Plate Weld Repair Reinforcements

This reinforcement is intended for the less critical, web portion of the sidemember section where typical cracking is due to local stresses which tend to “diaphragm” or “dish” the web without creating appreciable stresses for overall bending of the section. Typical crack patterns radiate out from the edge of a mounting bracket or crossmember or from a hole in the web. Cracks which radiate from a web hole occupied by a fastener are frequently an indication of a defective joint, whether by the loosening of the fastener or poor joint design (Figure 2.4 C).

Recommended Applications

The flat plate reinforcements are recommended for weld repairs in which the weld does not extend beyond the zone defined in Figure 2.4 D.

Application Procedures

1. A typical installation is shown in Figure 2.4 C. The length and height of the plate will vary with the size of the weld repair area. In general it should be such that it will accommodate an array of reinforcement attachment bolts at a typical 3 to 5 inch (76 to 127 mm) spacing all around the weld repair area.
2. The plate should generally be installed on the side opposite the component which transferred the local bending load into the web.
3. The edges of the plate should be staggered with respect to the edges of other relatively stiff web mounted components to avoid the creation of stress concentrations.

Bolt and Torque Information

Most frames are assembled with bolts and nuts. Others are riveted. **Bolts must always be used when attaching a reinforcement.** Rivets should be replaced by bolts as required when the frame is repaired and reinforced.

In bolted joints, the majority of the load is transferred by frictional force or clamping force between the members of the joint. The bolts must be properly tightened to develop and maintain the desired clamping force. Operation of the joint with loose or improperly tightened bolts can lead to failure of the joint. The bolts and nuts should be inspected periodically to insure that proper torque is maintained.

Bolts of high strength material conforming to SAE Grade 8 bolts should be used on all frames. For installation of reinforcements, 0.5 inch (13 mm) diameter flange head bolts are recommended. The SAE Grade 8 bolt is identified by six radial line markings on the head of the bolt (Figure 2.5). Nuts must be Grade 8 flange type.

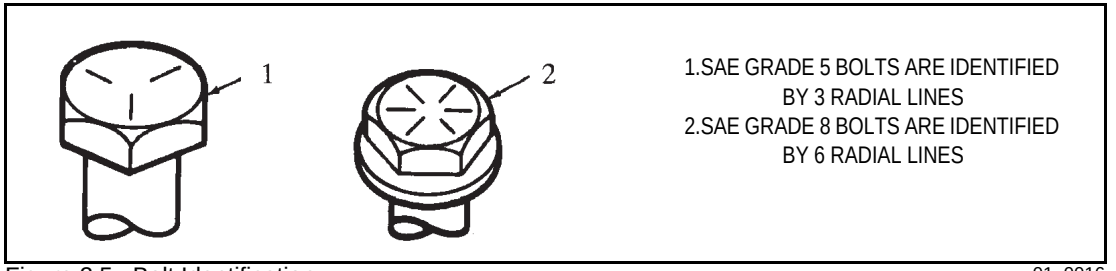


Figure 2.5 Bolt Identification 01_0016

These bolts, 0.5 inch (13 mm) diameter flange head type, should be tightened to 110 to 120 ft-lbs. (149 to 163 Nm) based on new bolts and nuts lubricated with engine oil. Whenever possible, hold the bolt and tighten the nut.

If frame components are aluminum, flange head bolts and nuts, or bolts with hardened flat washers must be used. If modification or repair requires replacement of existing bolts with new bolts or bolts of a greater length, the old flange head nuts should not be used with new standard bolts.

Careful consideration is given to the number, location and sizes of frame bolt holes in the design of a vehicle. The number, location and sizes of additional bolt holes put in the frame subsequent to manufacture of the vehicle can adversely affect frame strength. The adverse effect of additional bolt holes can be minimized by following the guidelines.

Huckbolt Fasteners (HP 8)

Huckbolt HP 8 fasteners are used in various positions in frame rail construction. Advantages to this style fastener are consistent clamp load and a high resistance to loosening due to vibration. The need to recheck fastener torque is eliminated.

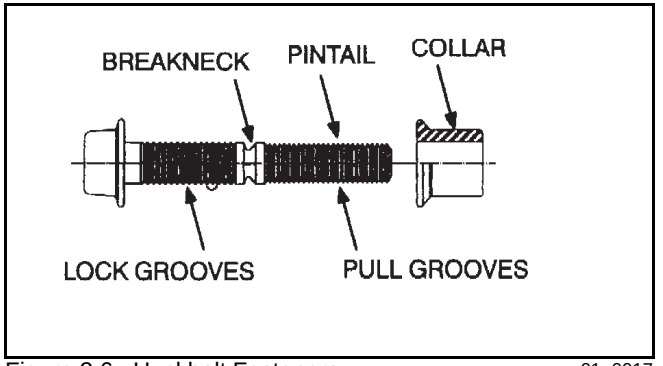


Figure 2.6 Huckbolt Fasteners 01_0017

Removal

The swaged collar cannot be unscrewed due to the locking grooves on the HP 8 fastener. Removal requires a Huck Collar Cutter or the collar can be split with an air chisel while supporting the opposite side of the collar. When the collar is split, the fastener can be driven out with a punch.

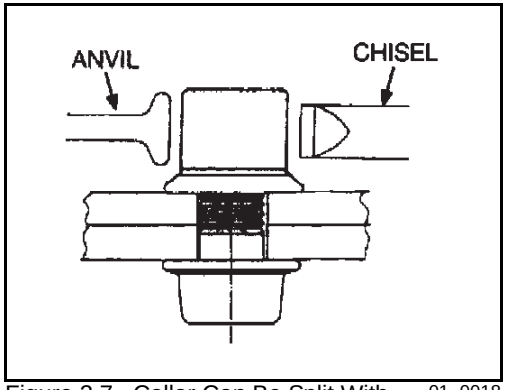


Figure 2.7 Collar Can Be Split With an Air Chisel 01_0018

CAUTION: The HP 8 fastener is not intended for re-use. To do so can result in damage to the vehicle frame or components attached to the frame.

CAUTION: In the event that Huck fasteners are removed, in order to retain the same joint integrity, it is strongly recommended that new Huck fasteners be used for attachment/reattachment of components.

Installation

NOTE: Huckbolt HP 8 fasteners cannot be installed without Huck installation equipment.

1. Install the HP 8 fastener into the component and frame hole.
2. Place the collar over the fastener pintail (See Figure 2.8)

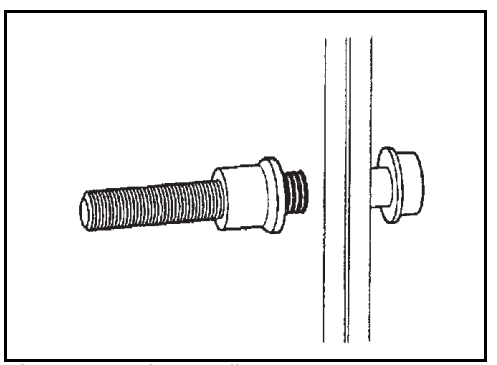


Figure 2.8 Place Collar Over Fastener Pintail 01_0019

3. Place the Huck installation tool over the HP 8 fastener pintail (See Figure 2.9)

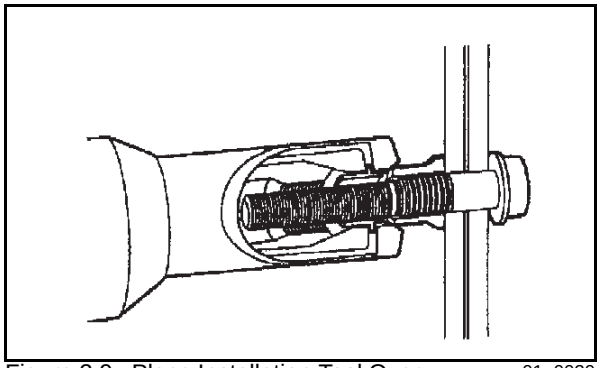


Figure 2.9 Place Installation Tool Over Fastener Pintail 01_0020

4. Activate the Huck installation tool.

NOTE: The Huck installation tool creates a pulling force on the fastener, seating the bolt head and closing the gap between the mating surfaces. The collar is swaged into the pintail locking grooves developing clamping force (See Figure 2.10). As pulling forces further increase, the body of the fastener separates at the breakneck (See Figure 2.11), completing installation.

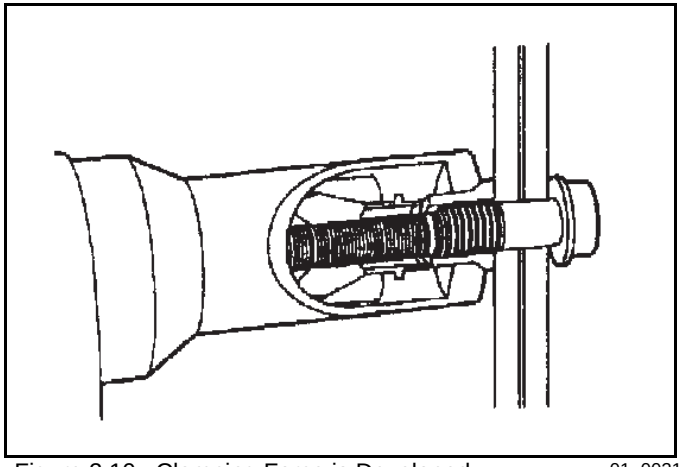


Figure 2.10 Clamping Force is Developed 01_0021

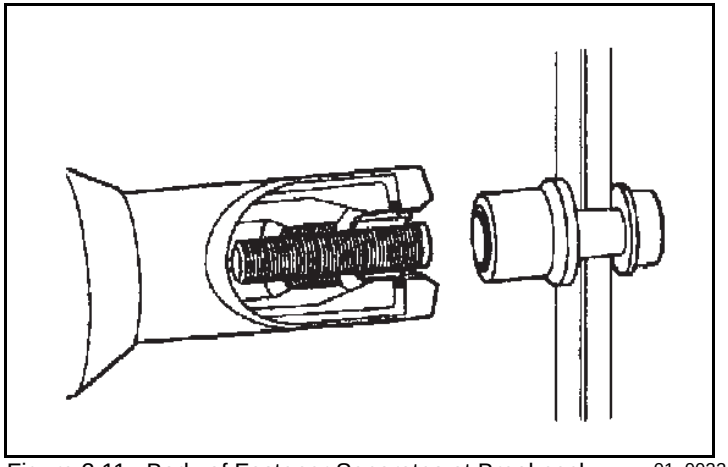


Figure 2.11 Body of Fastener Separates at Breakneck 01_0022

Huck-Spin Fasteners

Description

Huck-Spin fasteners are used in various positions in frame rail construction. The installed fastener has a collar that is cold-worked or swaged over the grooved pin Figure 2.12. Advantages to this style fastener are consistent clamp load and a high resistance to loosening due to vibration. The need to recheck fastener torque is eliminated.

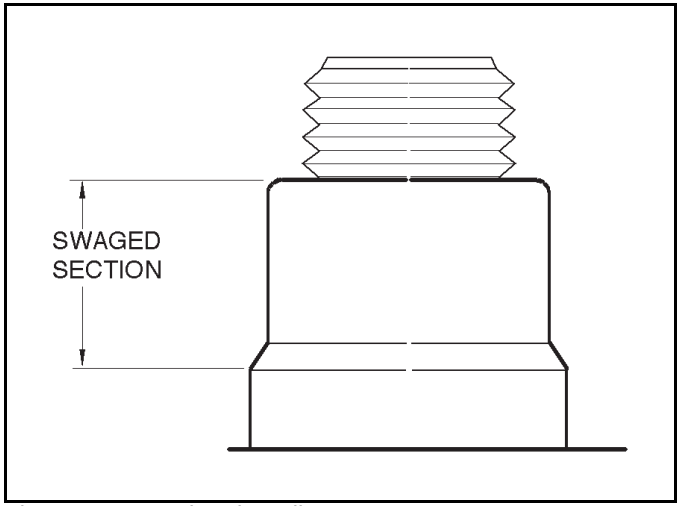


Figure 2.12 Huck-Spin Collar 01_0023

Remove

The collar cannot be removed by twisting or hammering. The collar must be cut longitudinally to the extent of the swaged section. This can be accomplished with a small wheel grinder (Figure 2.13).

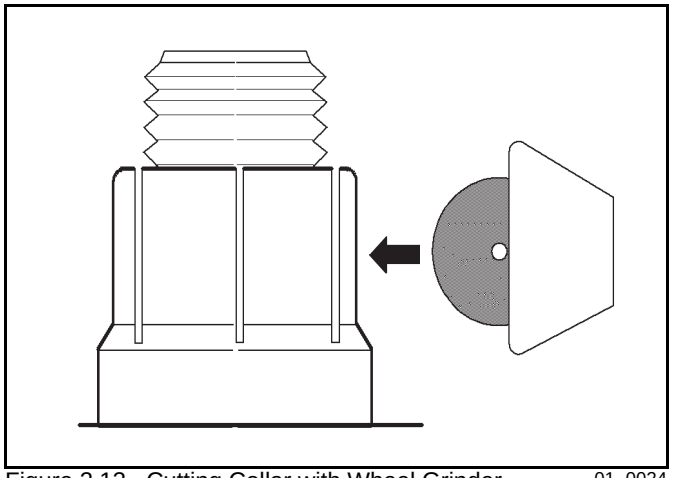


Figure 2.13 Cutting Collar with Wheel Grinder 01_0024

Drilling on opposite sides of the collar may also be used (Figure 2.14).

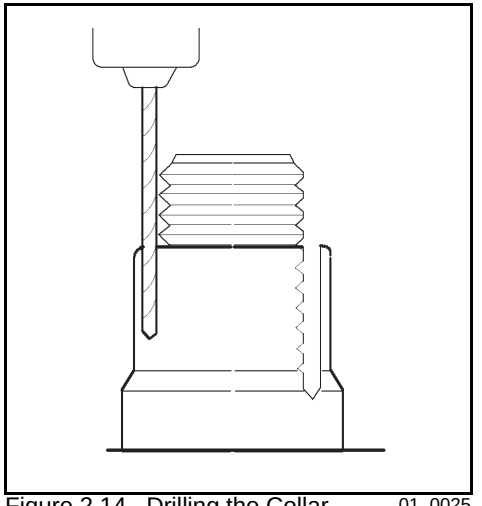


Figure 2.14 Drilling the Collar 01_0025

Another method of splitting the collar is to chisel the walls of the collar (Figure 2.15).

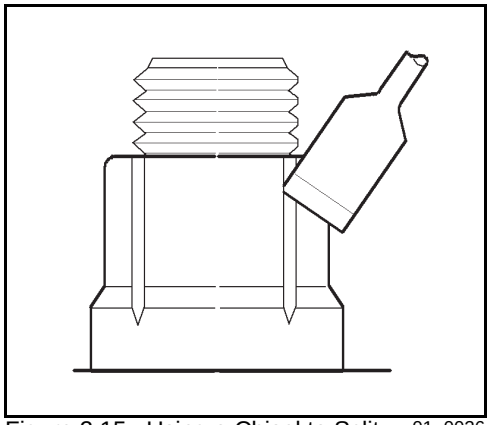


Figure 2.15 Using a Chisel to Split the Collar 01_0026

When the collar has been opened over the length of the swaged portion on two opposite sides (Figure 2.16), the fastener can be removed. The fastener may need to be hammered to remove the collar.

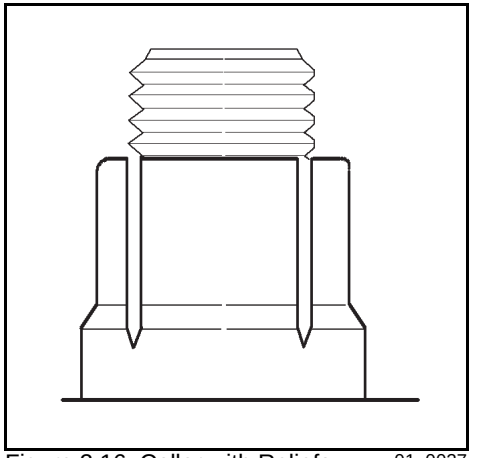


Figure 2.16 Collar with Reliefs for Removal 01_0027

In the event the collar doesn't come loose, use a chisel or suitable tool to peel the collar sections back (Figure 2.17).

The fastener will come free when sufficient collar material has been pulled away (Figure 2.18).

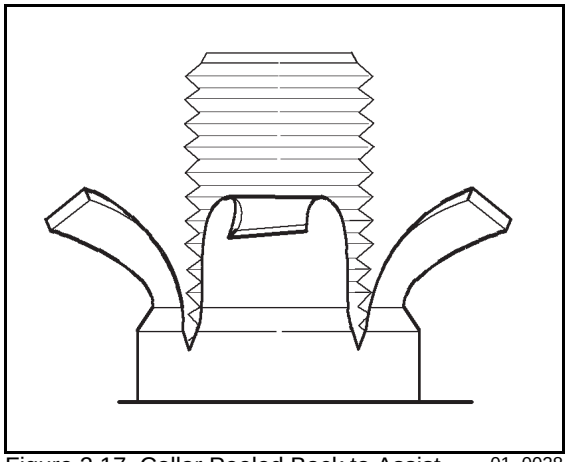


Figure 2.17 Collar Peeled Back to Assist Removal 01_0028

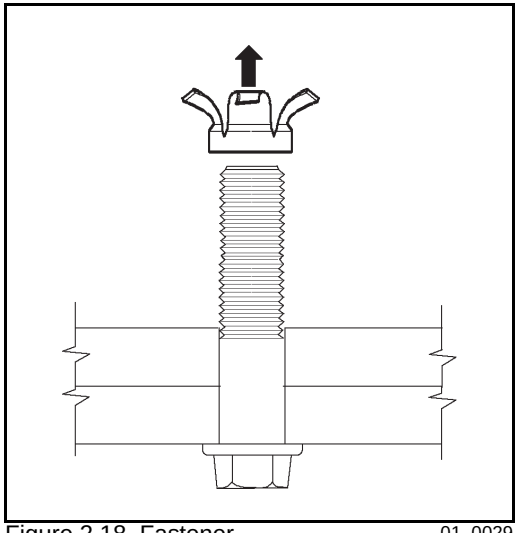


Figure 2.18 Fastener Removed 01_0029

Install

The Huck-Spin is installed by spinning the collar onto the fastener. The pulling action of the Huck-Spin installation tool swages the collar into the grooves of the fastener and then automatically disengages from the fastener (Figure 2.19).

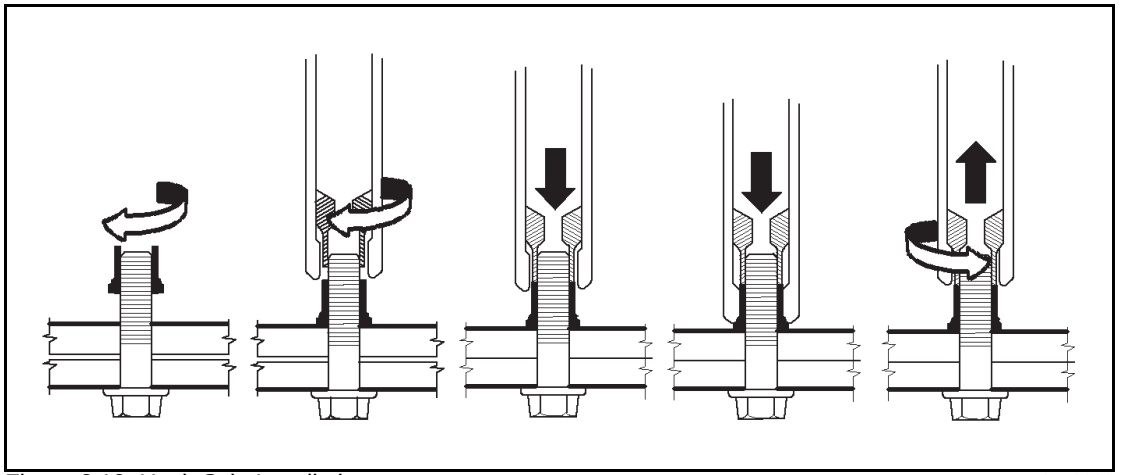


Figure 2.19 Huck-Spin Installation 01_0030

Special Service Tools

Hydraulic Unit – Model No. 940

Used for removal and installation of the Huck Bolt.

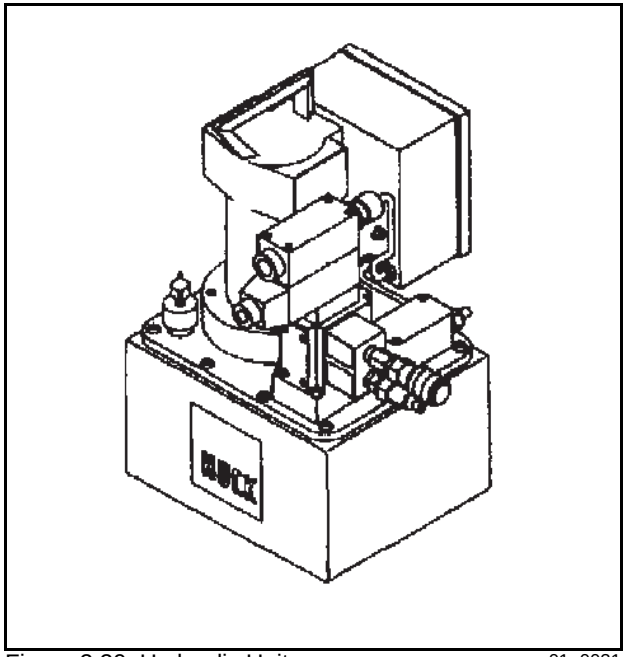


Figure 2.20 Hydraulic Unit 01_0031

Nose Assembly Tool

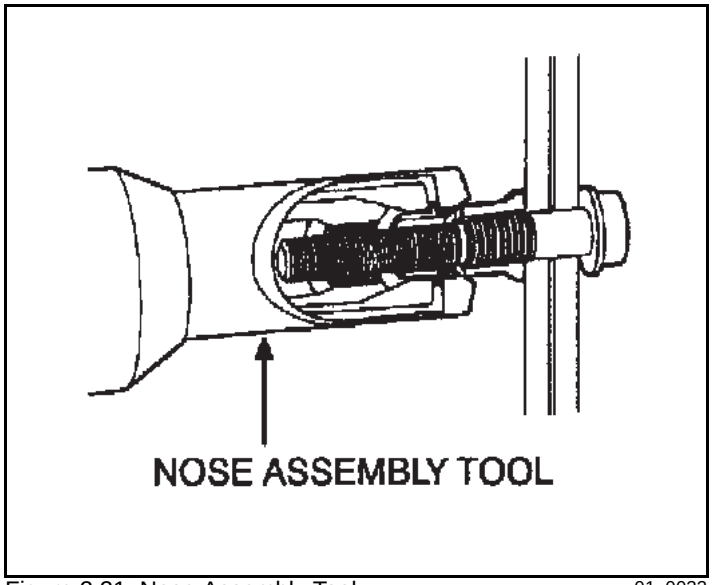


Figure 2.21 Nose Assembly Tool 01_0032

Table 2.5 Nose Assembly Tool

Description	Tool Number
For 1/2 Dia. Fastener	99-1484
For 5/8 Dia. Fastener	99-1481

Hydraulic Installation Tool

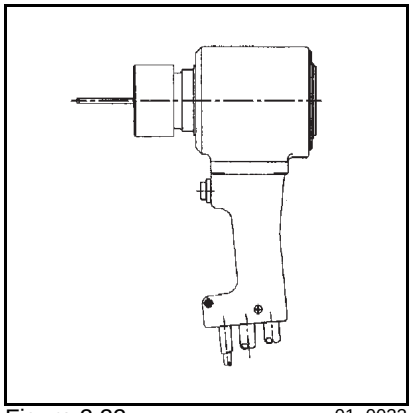


Figure 2.22 Hydraulic Installation Tool

01_0033

Table 2.6 Hydraulic Installation Tool

Description	Tool Number
For 1/2 Dia. Fasteners	557
For 5/8 Dia. Fasteners	585

Table 2.7 Collar Removal Tool

Description	Tool Number
For 1/2 Dia. Fasteners	516
For 5/8 Dia. Fasteners	520

Order tools from:

Huck International, Inc.	Phone: (914) 331-7300
P.O. Box 2270, One Corporate Drive	Fax: (914) 334-7333
Kingston, NY 12401	

After-Market Modifications

Cutting the frame behind the rear axle to shorten the frame is acceptable. Mechanical cutting or sawing is preferred to torch cutting. Whenever it is necessary to cut the frame, the sidemember should be cut at an angle of 90° to the longitudinal axis.

For information on cutting of the frames to lengthen the frames or modify the wheelbase, refer to “Wheelbase Alterations”.

Where mounting angles are to be welded to fifth wheel assemblies, refer to fifth wheel manufacturer's recommendations.

In some cases, specialized equipment such as hoists, winches, lifts, snowplows, pusher and tag axles are added to the vehicle by distributors, installers or dealers. Unless otherwise specified by the customer at the time of assembly, the vehicle is generally equipped with a standard chassis frame and the manufacturer has not made special allowances for the special equipment which is being added.

The addition or installation of this special equipment on the vehicle can significantly affect the loading of the chassis frame. In some cases, it may be necessary to reinforce the frame. Care must be exercised to insure that the gross vehicle weight rating (GVWR) and/or the gross axle weight ratings (GAWR) are not exceeded.

Installation of this special equipment may involve State and Federal requirements which affect vehicle certification for noise emissions, exhaust emissions, brake requirements, lighting system requirements, etc. The specialized equipment installer is responsible for the safety and durability of their product and, in addition, is responsible to insure that the equipment and its installation comply with all applicable State and Federal Department of Transportation requirements and OSHA regulations.

Addition of specialized equipment may have a significant effect on other vehicle components, such as the brake system, steering system, suspension system, etc. Simple reinforcement of the chassis frame may not be adequate to provide safe operation of the vehicle.

In any modification of the chassis frame, the addition of holes, reinforcements, welds, clamps, splices, etc. may cause an increase in the local stress in the frame at the point of the modification. These local stress concentrations can significantly affect the life of the chassis frame. The specific effect which the stress concentrator will have on the life of the chassis frame is influenced by the location of the stress concentration, the frequency and severity of the loading, and the type of stress concentration. Any modification of the frame may void the manufacturer's warranty.

Refer to “Welding and Reinforcement” for additional information.

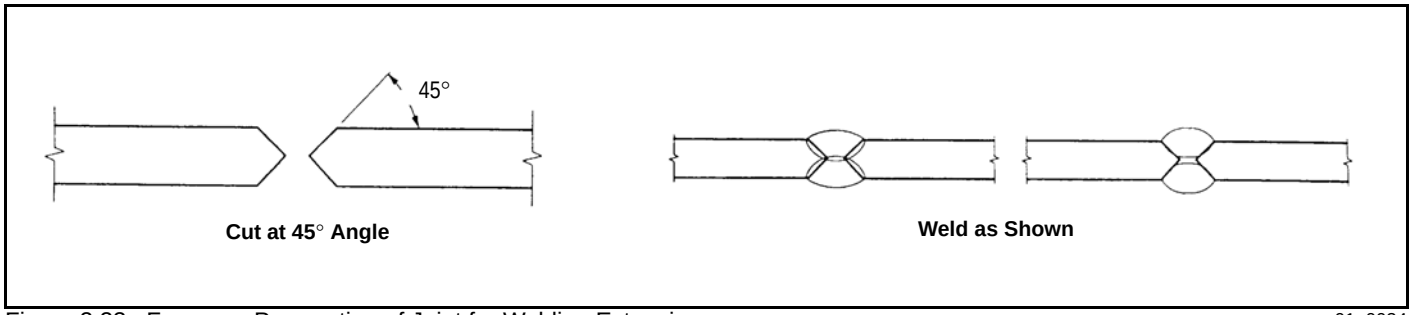


Figure 2.23 Frames – Preparation of Joint for Welding Extension 01_0034

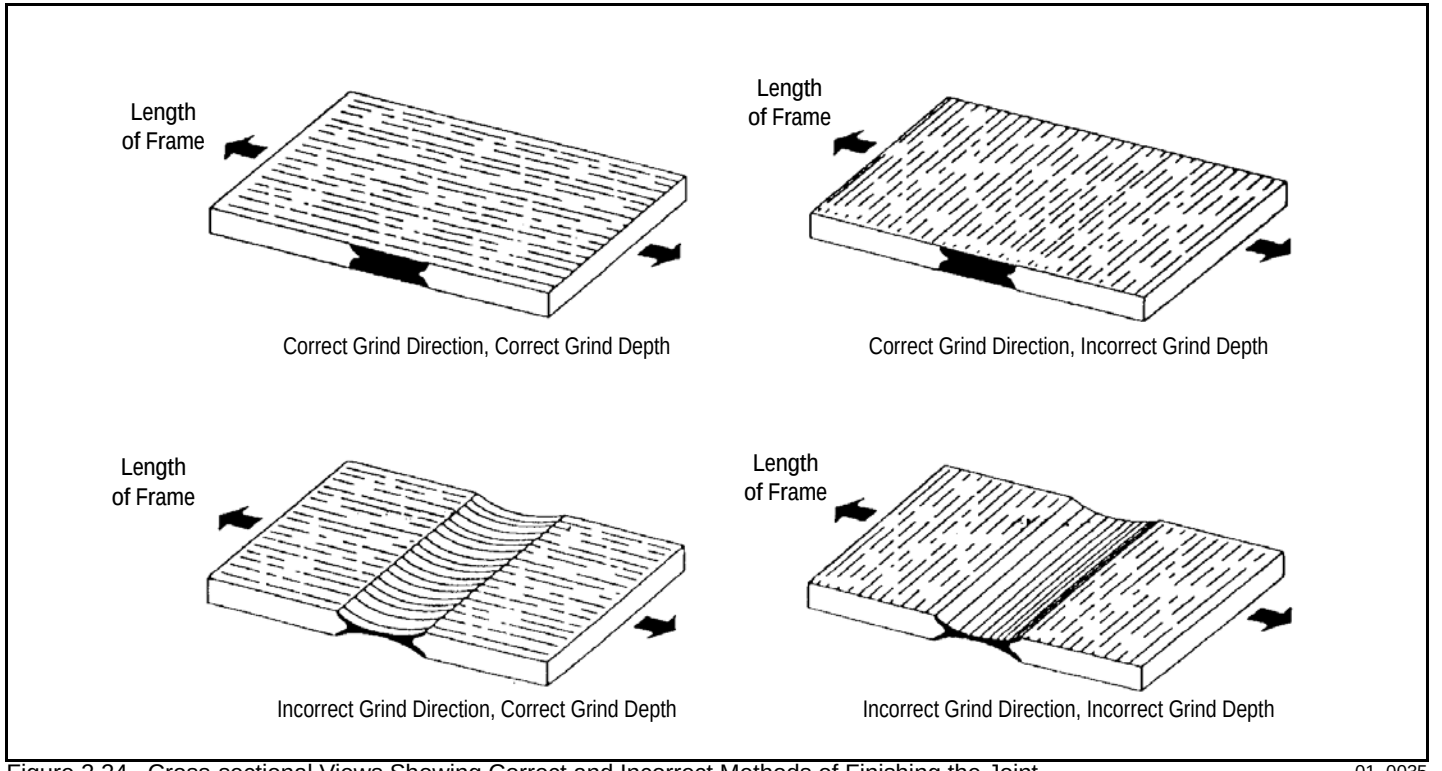


Figure 2.24 Cross-sectional Views Showing Correct and Incorrect Methods of Finishing the Joint 01_0035

Wheelbase Alterations

Shortening or lengthening a wheelbase is an added expense for the customer. Therefore, it is often to the customer's benefit to order a chassis from the factory with the desired wheelbase rather than to alter the wheelbase of the chassis on-site.

The preferred method for altering the wheelbase is to slide the rear axle forward or rearward as required. Invariably, this requires the lengthening or shortening of air lines, brake lines, electrical lines, and driveline. Extreme care should be taken in the modification of the air lines, brake lines, electrical lines and driveline to insure that they operate as reliably as those with which the vehicle was manufactured.

If the wheelbase is lengthened, a reinforcement may be required. Consult your International® dealer before lengthening the wheelbase.

In those instances when it is necessary to cut and weld the frame to alter the wheelbase, the frame must be reinforced with a channel-type reinforcement of the same strength as the original frame material in the area where the frame has been cut, extending at least two feet on either side of the cut and bolted as specified in Figure 2.4 shown earlier in this section.

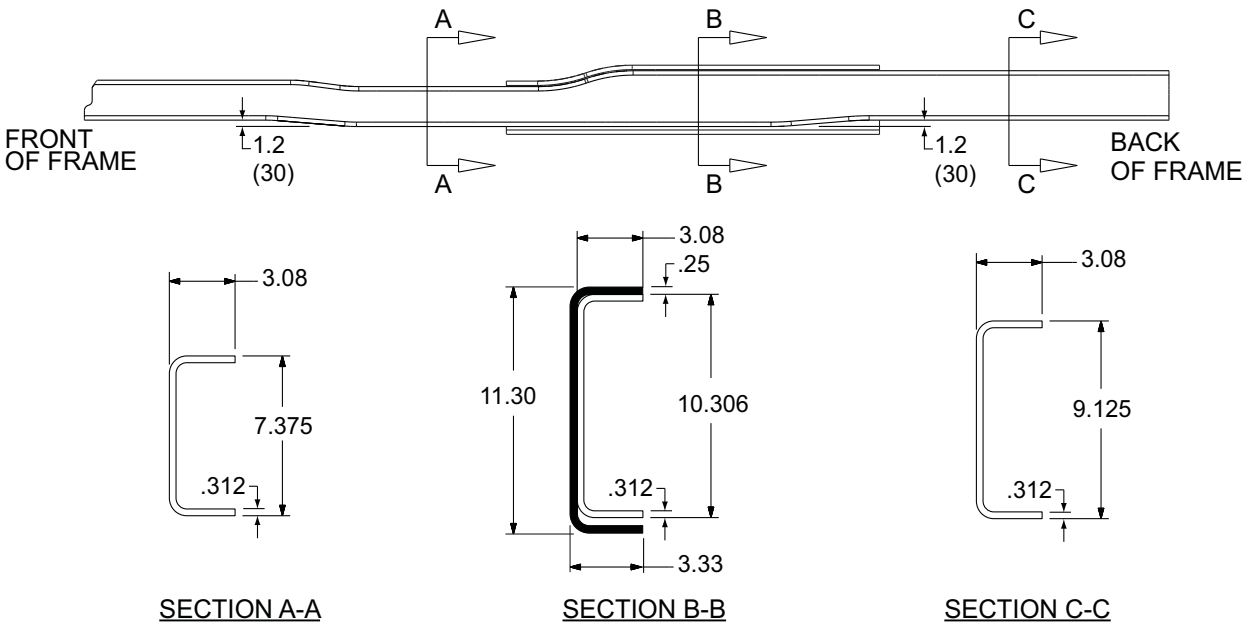
If the frame was built with both a main frame and a reinforcement, the reinforcement should be removed before cutting the main frame. **It is essential that a new one-piece outer channel reinforcement be obtained rather than cutting and re-using the original reinforcement.** The original frame should also be reinforced with an inner channel reinforcement, extending at least two feet beyond the cut(s) on either side of the cut(s). The reinforcement must be of the same material as the original frame. Blank and pre-punched chassis channel reinforcements are available through your dealer parts department.

On both medium and high strength aluminum frames, **re-welding to lengthen the frame is not recommended**. Refer to “Reinforcement” and “Reinforcement Attachment” for additional information.

ALL MODELS

Frame Rail Cross-Section Specifications

*Dark area represents frame reinforcement.



01_0240

Section	Side Rail & *Reinforcement* Description[2]								
	Dimensions (inches)			Yield Strength Nominal (psi)	Material #	Section Modulus [1] (inches^3)		Resisting Bending Moment (In.-Lbs.)	
	Depth	Width	Thickness			Maximum	Nominal	Maximum	Design
Drop Center Side Rail — Kick-Up at Rear Suspension Rearward									
A-A	7.375	3.08	0.312	80,000	B	8.68	8.08	694,700	646,000
B-B	10.306	3.08	0.312	80,000	B	26.05	24.17	2,084,000	1,933,000
	11.30	3.33	0.25	80,000	B				
C-C	9.125	3.08	0.312	80,000	B	11.70	10.93	935,800	874,000

B = High Strength Low Alloy Steel

[1] = Section Modulus: Nominal: Calculated using design dimensions; indicates the design load capacity of the frame.
Maximum Tolerance: All frame dimensions are at maximum tolerance; used by some competitors as advertised values.

[2] = Reinforcement dimensions and specifications are shown in italics.

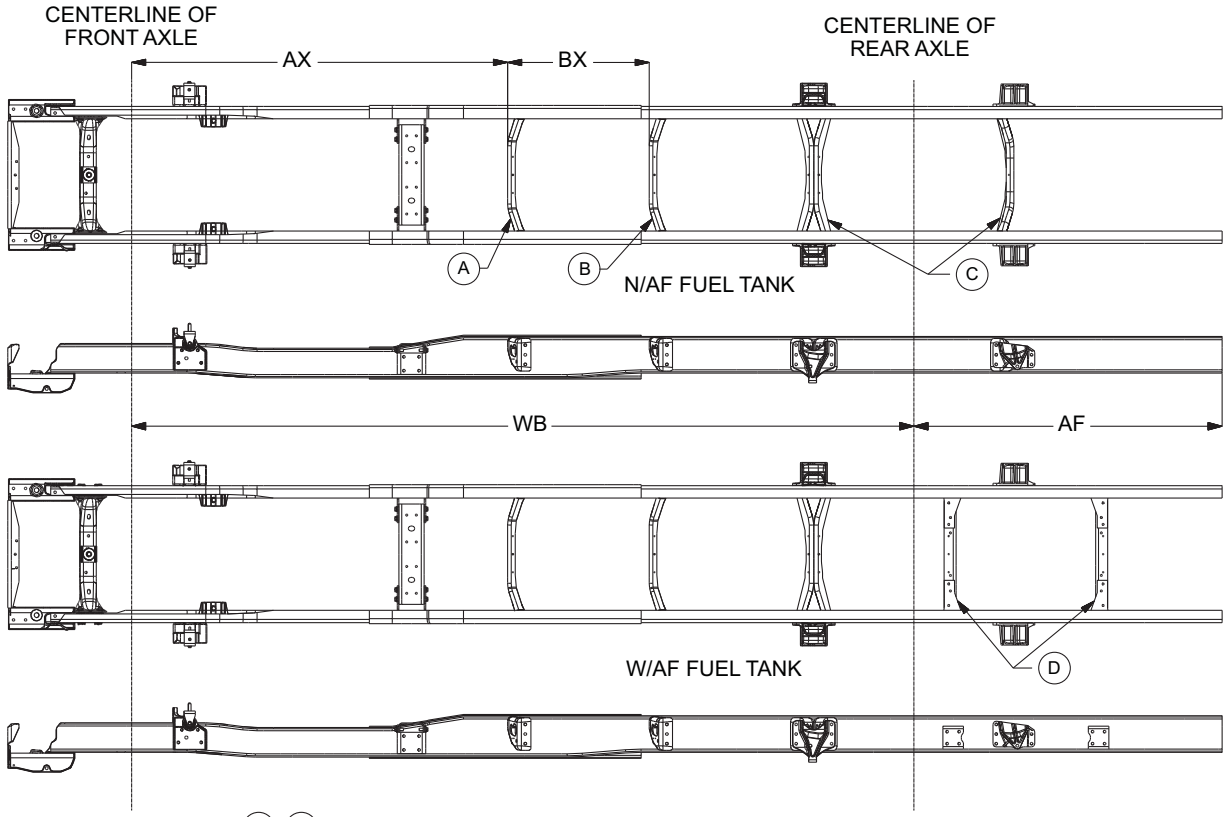
CROSSMEMBERS

MODEL 4X2

Crossmember Location

Standard Cab

Wheelbase	AX	BX	AF
inches			
134	–	–	49
158	102.5	–	49, 63
183	111.3	–	49, 63, 75
195	93.7	35.3	49, 63, 75
213	111.3	53.5	75
224	111.3	53.5	91



(A) (B) SINGLE STAMPED CROSSMEMBER MOUNTED WITH FLAT FLANGE UP AND WEB FORWARD

(C) REAR SUSPENSION CROSSMEMBERS

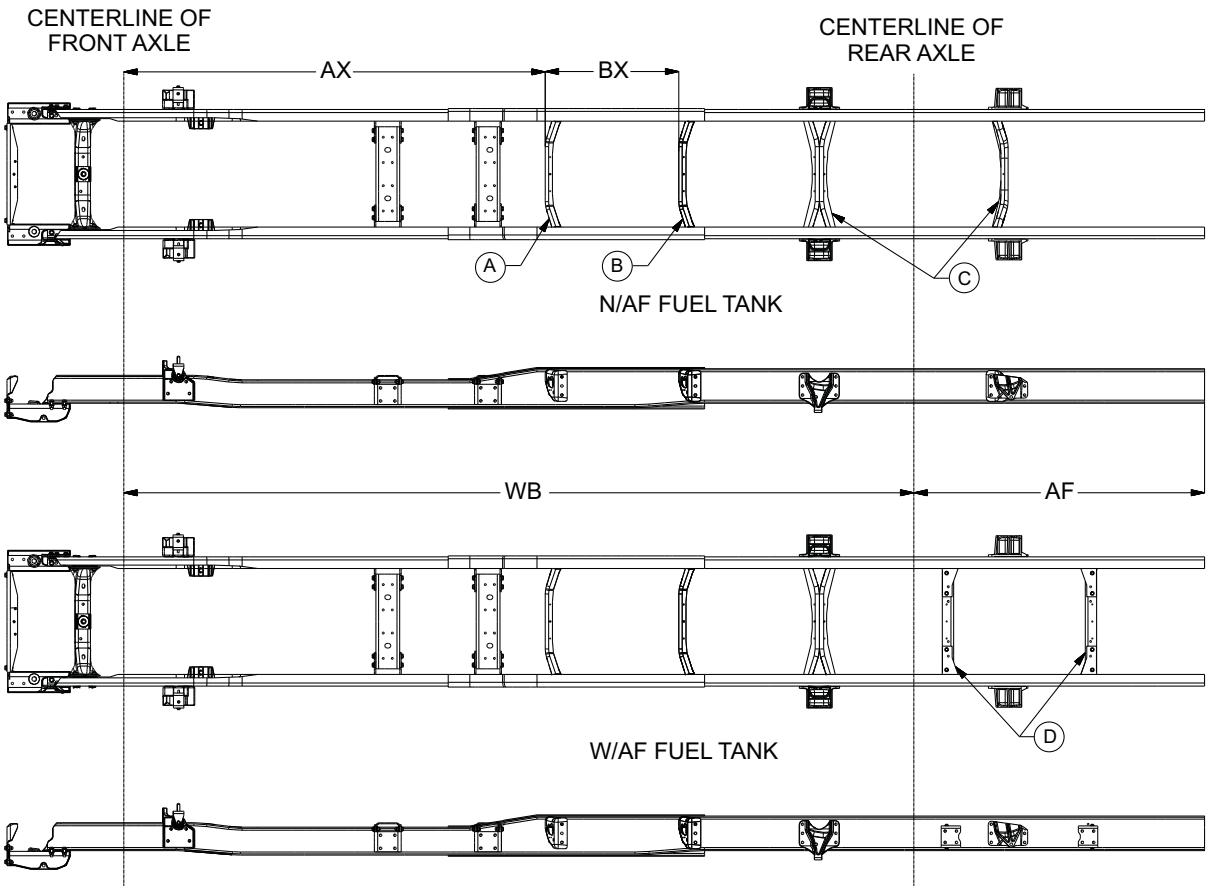
(D) AF FUEL TANK CROSSMEMBERS

01_0242

Crossmember Location

Extended Cab

Wheelbase	AX	BX	AF
inches			
160	–	–	49
185	128.9	–	49, 63
209	111.3	35.3	49, 63, 75



(A) (B) SINGLE STAMPED CROSSMEMBER MOUNTED WITH FLAT FLANGE UP AND WEB FORWARD

(C) REAR SUSPENSION CROSSMEMBERS

(D) AF FUEL TANK CROSSMEMBERS

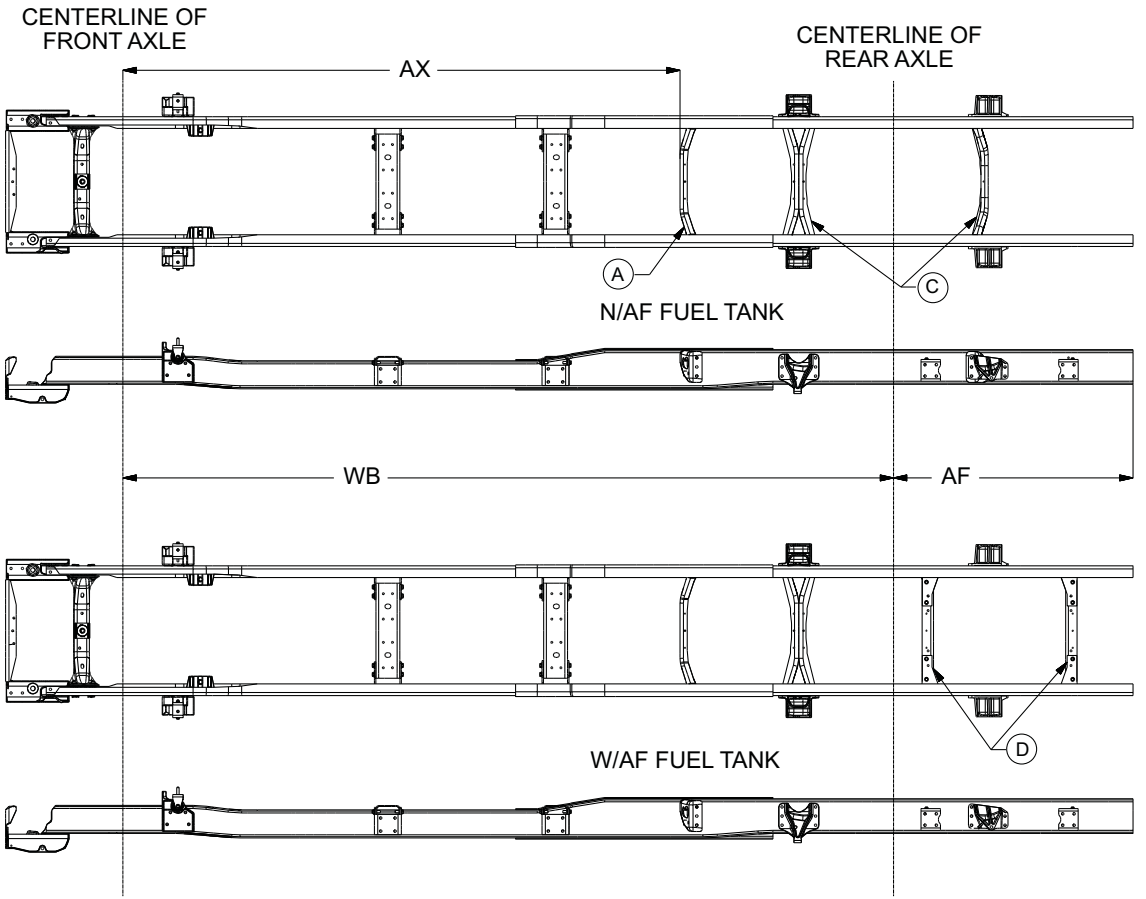
01_0243

MODEL 4X2

Crossmember Location

Crew Cab

Wheelbase	AX	BX	AF
inches			
179	–	–	49
203	146.6	–	49, 63



(A) (B) SINGLE STAMPED CROSSMEMBER MOUNTED WITH FLAT FLANGE UP AND WEB FORWARD

(C) REAR SUSPENSION CROSSMEMBERS

(D) AF FUEL TANK CROSSMEMBERS

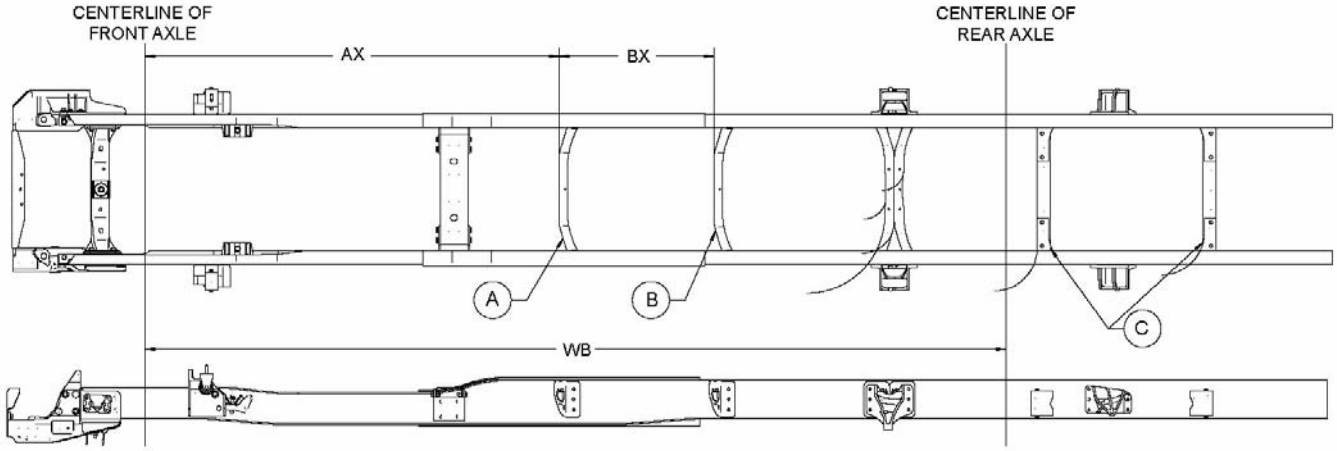
01_0244

MODEL 4X4

Crossmember Location

Standard Cab

Wheelbase	AX	BX	AF
inches			
158	103.2	-	49, 63
183	111.5	-	49, 63, 75
195	94.4	35.3	49, 63, 75
213	111.5	53.4	75
224	111.5	53.4	91



(A) (B) SINGLE STAMPED CROSSMEMBER MOUNTED WITH FLAT FLANGE UP AND WEB FORWARD

(C) AF FUEL TANK CROSSMEMBERS

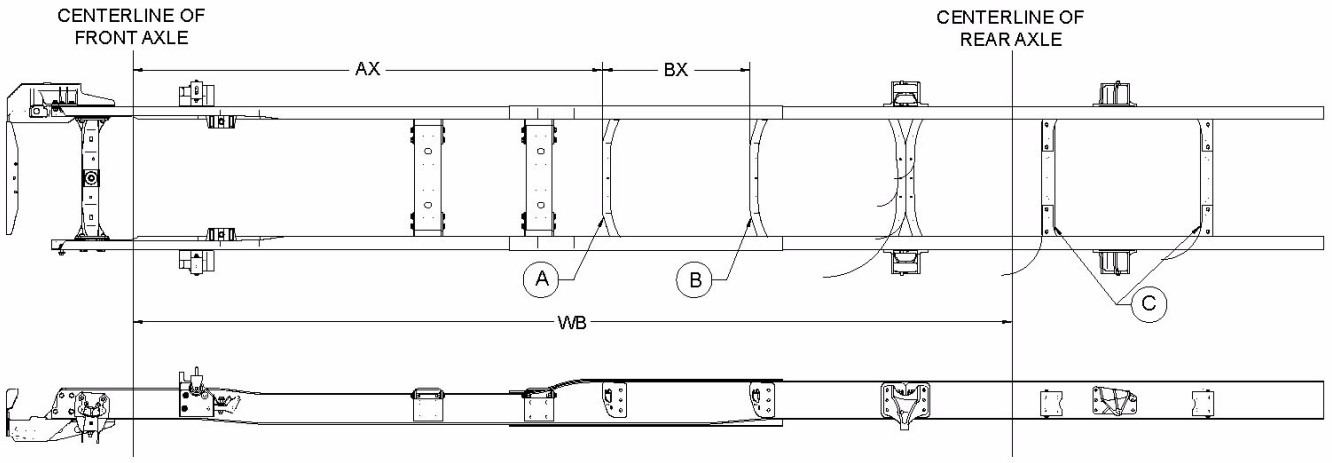
01_0277

MODEL 4X4

Crossmember Location

Extended Cab

Wheelbase	AX	BX	AF
inches			
160	-	-	49
185	129.6	-	49, 63
209	111.5	35.3	49, 63, 75



(A) (B) SINGLE STAMPED CROSSMEMBER MOUNTED WITH FLAT FLANGE UP AND WEB FORWARD

(C) AF FUEL TANK CROSSMEMBERS

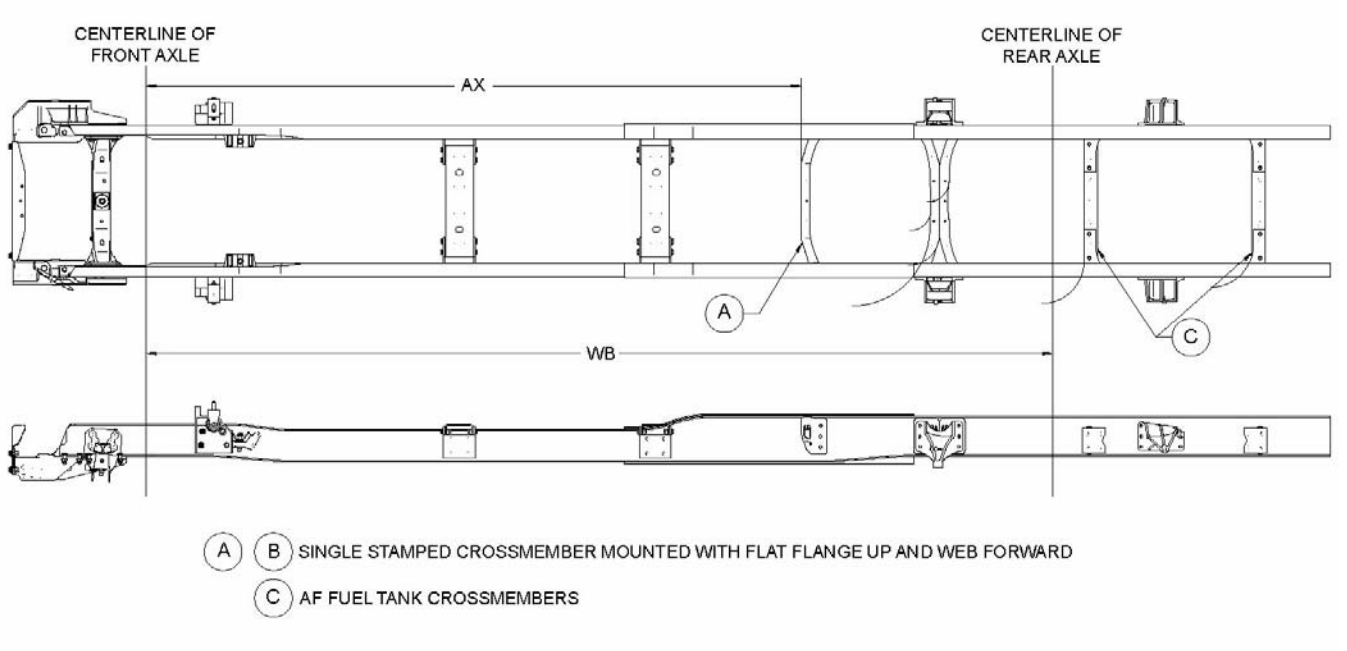
01_0278

MODEL 4X4

Crossmember Location

Crew Cab

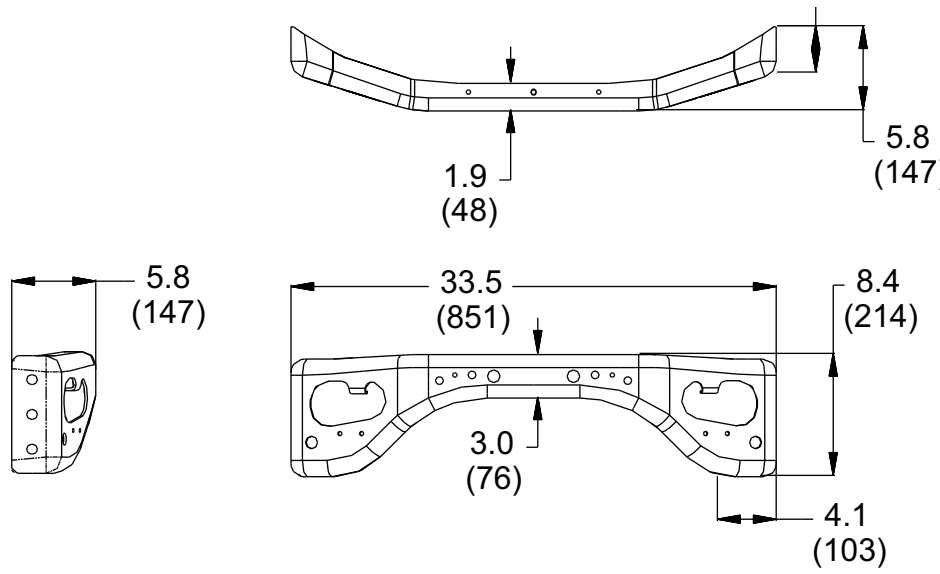
Wheelbase	AX	BX	AF
inches			
179	-	-	49
203	147.3	-	49, 63



01_0279

ALL MODELS

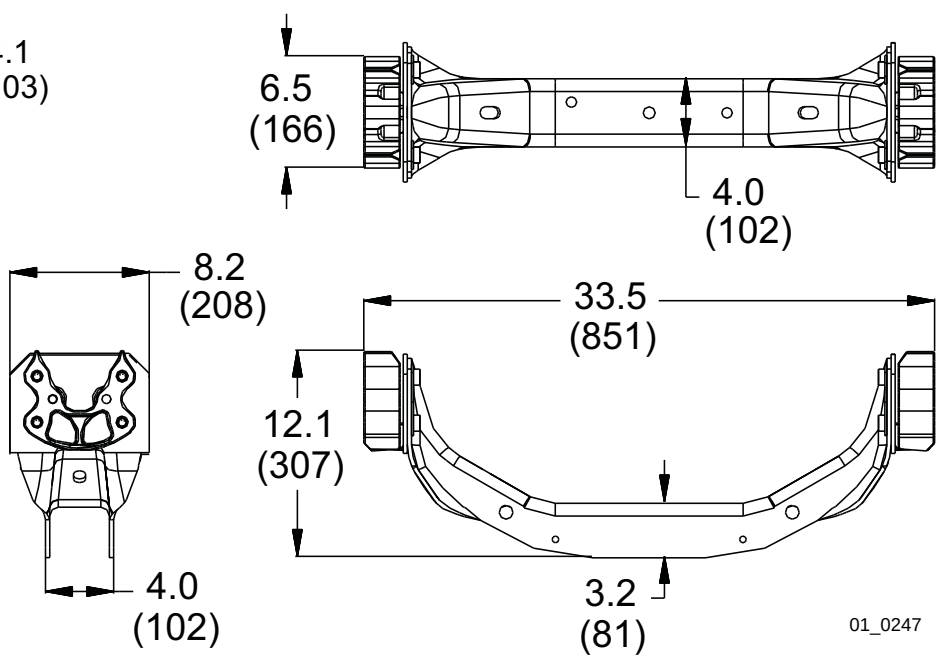
Crossmember Diagrams



SINGLE CROSSMEMBER

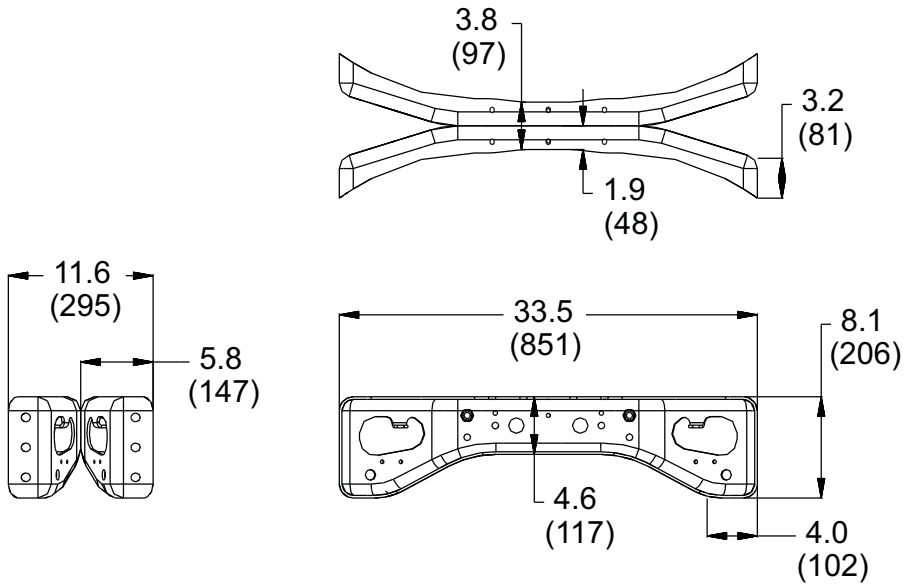
01_0246

ENGINE CROSSMEMBER



01_0247

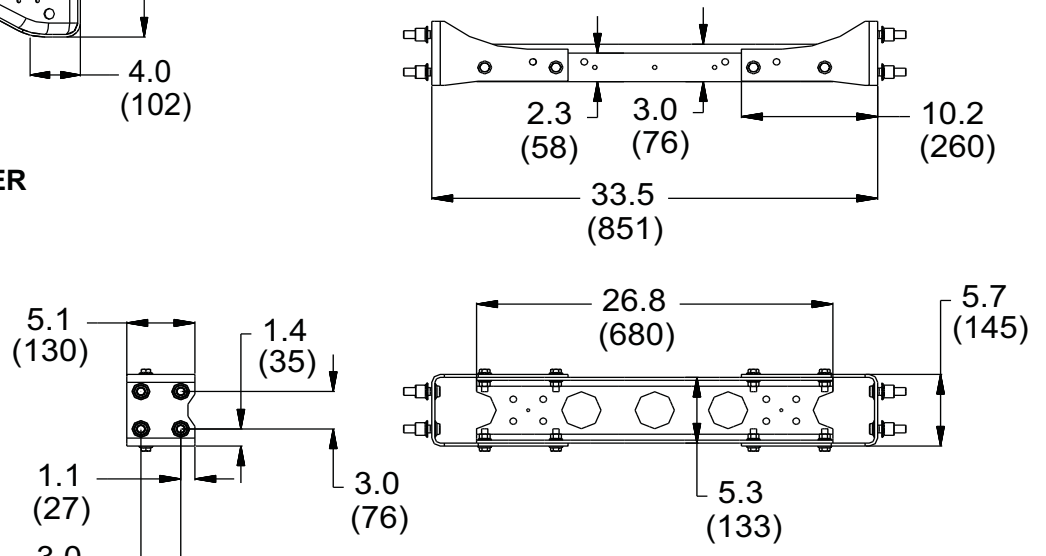
Crossmember Diagrams (Continued)



01_249

DOUBLE STAMPED CROSSMEMBER

"C" CHANNEL AF AND BTR FUEL TANK CROSSMEMBER



01_248

ALL MODELS

Frame Drilling Guidelines

The drilling of the frame sidemember presents no unusual difficulty. Standard high speed steel drills of good quality will serve provided they are sharpened properly and not overheated during sharpening or use.

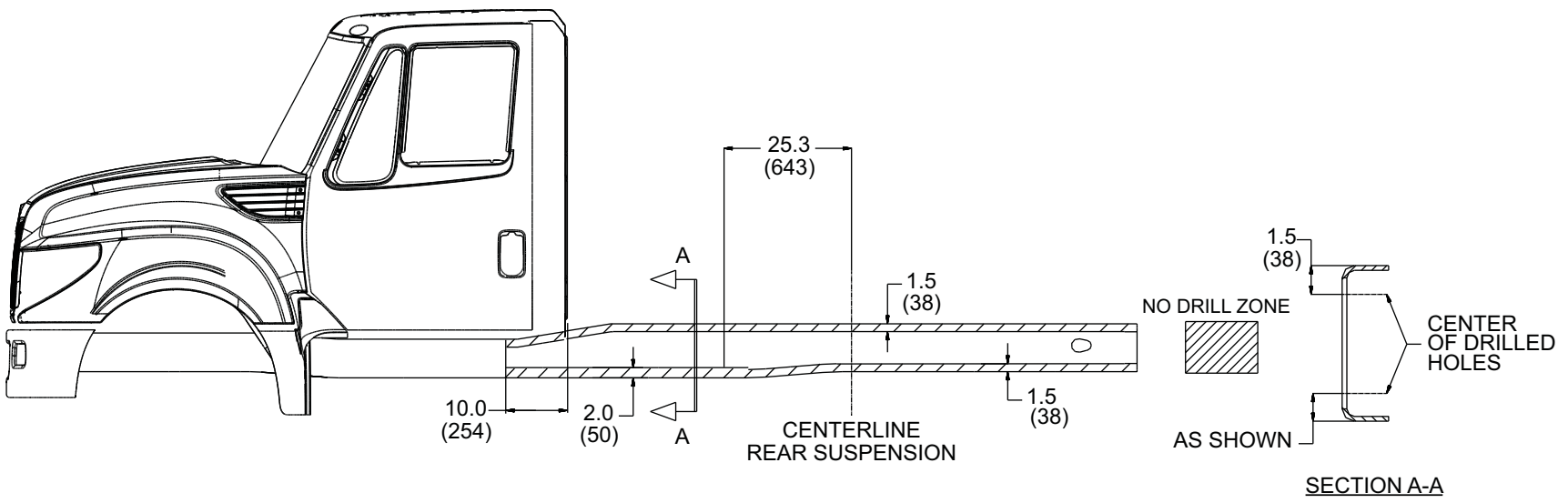
Hole Location Guidelines

1. Never drill holes into the restricted areas of the frame rails. Refer to diagrams on the following pages.
2. Use existing holes whenever possible.
3. Maintain a minimum of 0.75 inch (19 mm) of material between holes.
4. There should not be more than three holes located on a vertical line.
5. Bolt holes should be no larger than is required for the size of bolts being used, in no instance larger than 11/16 (.688 inch).
6. If reinforcements are used, avoid drilling holes closer than 2.0 inches (51 mm) from the ends of the reinforcement.
7. Bolts must be periodically checked to insure that the proper torque and clamping force is maintained.
8. Never drill any holes in the flanges of the frame rail.

ALL MODELS

Frame Drilling Restrictions

Tapered Rails



DO NOT leave less than .75" (19mm) of material between holes

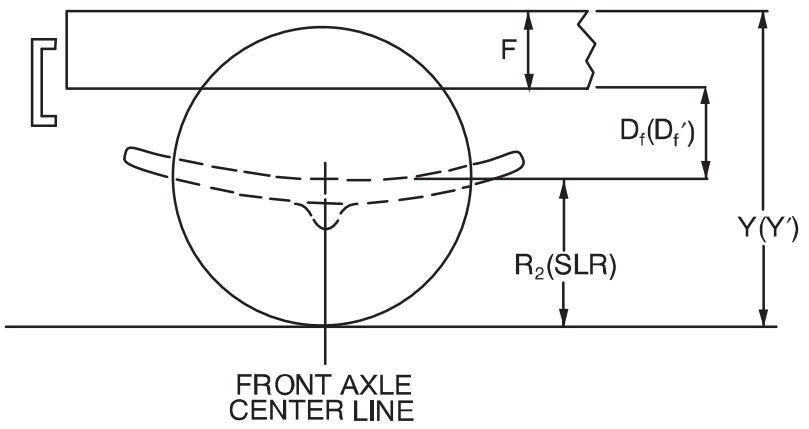
DO NOT drill holes in the following areas:

- Distance from top of top flange to centerline of hole
- Distance from bottom of bottom flange to centerline of hole

Frame Height Calculations

ALL MODELS - AT CENTERLINE OF FRONT AXLE

The front frame height (@ the centerline of the front axle) may be calculated using the following equations. Refer to the illustration for a visual explanation of the symbols used in these calculations.



01_0045

D_f = Wheel axis to bottom of frame in unladen position. Refer to tabulated data.

D_f' = Wheel axis to bottom of frame in loaded position. Refer to tabulated data.

F = Frame rail height. Refer to tabulated data.

SLR = Static Loaded Radius. The distance from the wheel axis to the ground for a properly inflated, fully loaded (loaded to its maximum capacity) tire. To obtain tire dimensions, contact the tire manufacturer.

R_1 = Tire Radius (one half of tire outside diameter) **not** mounted on the vehicle. To obtain tire dimensions, contact the tire manufacturer.

R_2 = Calculated Tire Radius on an unloaded chassis. The value of **R_2** is calculated using the following method.

$$R_2 = R_1 - .2(R_1 - SLR)$$

Y = Front Frame Height at the front axle centerline in unloaded condition.

Y′= Front Frame Height at the front axle centerline in loaded condition.

$$Y = D_f + R_2 + F$$ (for unloaded condition)

$$Y' = D_f' + SLR + F$$ (for loaded condition)

NOTE: Values calculated for **Y** and **Y′** are strictly for the frame height at the front axle centerline. For frame heights at the front of the frame rail, refer to **"Frame Height Calculation - at Front and Rear Rail Ends"** on page 91 in this book.

MODEL 4X2

Frame Height Data – Front

Front Suspension			Spindle to Bottom of Frame	
Type	Capacity	Code	Unloaded – D_f	Loaded – D_f'
Parabolic	6,000-lb	03AGP	5.42"	3.92"
	7,000-lb	03AGN		3.42”

MODEL 4X4

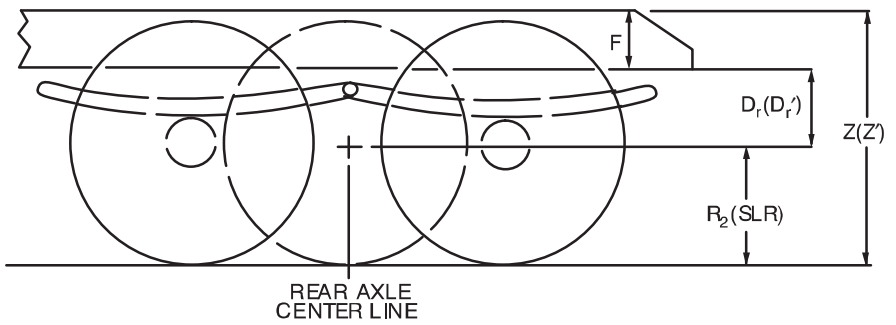
Frame Height Data – Front

Front Suspension			Spindle to Bottom of Frame	
Type	Capacity	Code	Unloaded – D_f	Loaded – D_f'
Parabolic	8,000-lb	03ADA	10.75”	9.6”

Frame Height Calculation

ALL MODELS - AT CENTERLINE OF REAR AXLE

The rear frame height (@ the centerline of the rear axle) may be calculated using the following equations. Refer to the illustration for a visual explanation of the symbols used in these calculations.



01_0046

D_r = Wheel axis to bottom of frame in unladen position. Refer to tabulated data.

D_r' = Wheel axis to bottom of frame in loaded position. Refer to tabulated data.

F = Frame rail height. Refer to tabulated data.

SLR = Static Loaded Radius. The distance from the wheel axis to the ground for a properly inflated, fully loaded (loaded to its maximum capacity) tire. To obtain tire dimensions, contact the tire manufacturer.

R_1 = Tire Radius (one half of tire outside diameter) **not** mounted on the vehicle. To obtain tire dimensions, contact the tire manufacturer.

R_2 = Calculated Tire Radius on an unloaded chassis. The value of **R_2** is calculated using the following method.

$$R_2 = R_1 - .2(R_1 - SLR)$$

Z = Rear Frame Height at the rear axle centerline in unloaded condition.

Z′= Rear Frame Height at the rear axle centerline in loaded condition.

$$Z = D_r + R_2 + F$$ (for unloaded condition)

$$Z' = D_r' + SLR + F$$ (for loaded condition)

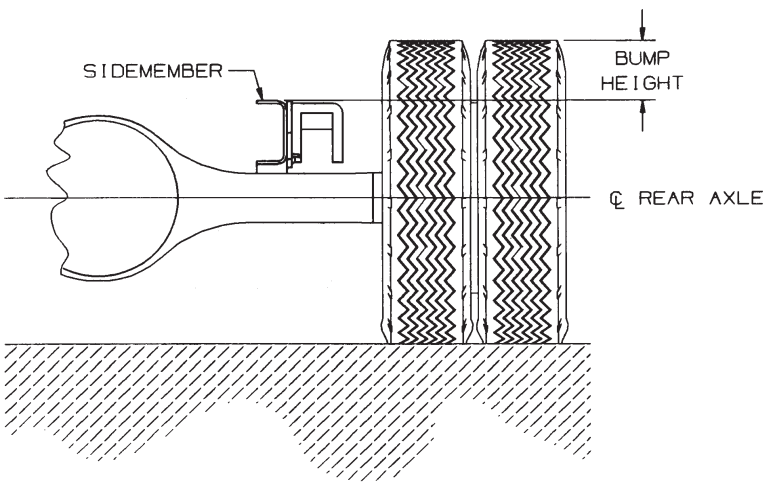
NOTE: Values calculated for **Z** and **Z′** are strictly for the frame height at the rear axle centerline. For frame heights at the rear of the frame rail, refer to **“Frame Height Calculation - at Front and Rear Rail Ends”** on page 91 in this book.

Bump Heights – Rear

"Bump Height" refers to the maximum distance of the tires above the side rails as the rear axle of the truck travels over an object. Bump Heights are important in the selection of truck bodies since it may be necessary to incorporate wheelwells into the body floor to allow adequate clearance for tire travel.

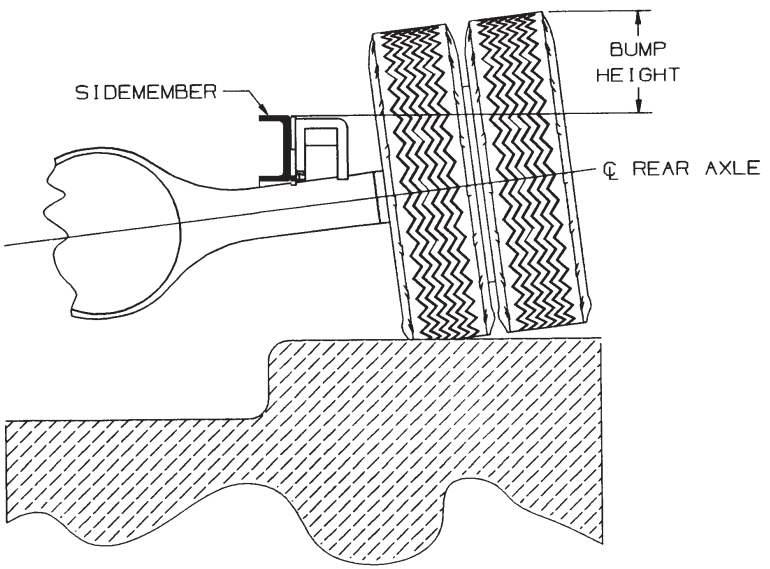
Straight Bump Height is used when both sets of wheels travel over an object at the same time, such as a parking lot speed bump.

Cocked Bump Height refers to the condition that exists when only one set of rear wheels travels over an object — an example of this would be climbing over a curb when turning a corner. The Cocked Bump Height Charts presented here assume a 7° deflection from horizontal.



STRAIGHT BUMP HEIGHT

01_0047



COCKED BUMP HEIGHT (@ 7 ° DEFLECTION)

01_0048

D_r''= Wheel Axis to bottom of frame in straight bump position. Refer to tabulated data.
R_1 = Tire radius (one-half of tire outside diameter) **not** mounted on the vehicle. To obtain tire dimensions, contact the tire manufacturer.
F = Frame Rail Height. Refer to tabulated data.

Straight Bump Height = R_1 - D_r'' - F
Cocked Bump Height = Straight Bump Height + 3.5 In.

MODEL 4X2

Frame and Bump Height Data – Rear

Frame Code	Frame Rail Height (F)	Rear Suspension		Spindle to Bottom of Sidemember		
		Type	Capacity	Unloaded – D_r	Loaded – D_r'	Bump – D_r''
01CDN	9.125"	Vari-Rate	11,000-lb	8.27"	5.62")	3.92"
		Vari-Rate	13,500-lb	7.95"	5.55"	3.70"
		IROS (4x2)	12,000-lb	6.0”	6.0”	3.0”

MODEL 4X4

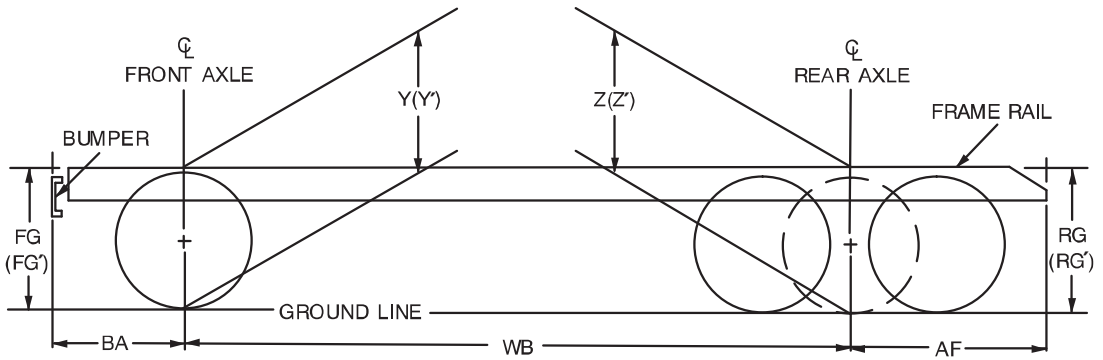
Frame and Bump Height Data – Rear

Frame Code	Frame Rail Height (F)	Rear Suspension		Spindle to Bottom of Sidemember		
		Type	Capacity	Unloaded – D_r	Loaded – D_r'	Bump – D_r''
01CDN	9.125"	Vari-Rate	11,000-lb	13.25"	10.76”	8.92”
		Vari-Rate	13,500-lb	13.48”	10.89”	9.12”

Frame Height Calculation

ALL MODELS - AT FRONT AND REAR RAIL ENDS

Now that we have learned to calculate the frame height at both the front and rear axle centerlines, we can determine the frame height values at both rail ends.



01_0049

First we must determine the rake of the frame (i.e., the slope of the frame from front end to rear end). If the front end of the frame is higher than the rear end (i.e., **Y**>**Z** or **Y′**>**Z′**) then the truck is said to have a negative rake. In this situation, the equations for determining the frame height at the rail ends are:

Frame Height @ Front End of Rail:

$$FG = Y + \left(\frac{Y - Z}{WB} \times BA\right)$$ (for unloaded condition)

$$FG' = Y' + \left(\frac{Y' - Z'}{WB} \times BA\right)$$ (for loaded condition)

Frame Height @ Rear End of Rail:

$$RG = Z - \left(\frac{Y - Z}{WB} \times AF\right)$$ (for unloaded condition)

$$RG' = Z' - \left(\frac{Y' - Z'}{WB} \times AF\right)$$ (for loaded condition)

For situations where the rake is positive (i.e., **Y**<**Z** or **Y′**<**Z′**) the equations for determining frame height at the rail ends are:

Frame Height @ Front End of Rail:

$$FG = Y - \left(\frac{Z - Y}{WB} \times BA\right)$$ (for unloaded condition)

$$FG' = Y' - \left(\frac{Z' - Y'}{WB} \times BA\right)$$ (for loaded condition)

Frame Height @ Rear End of Rail:

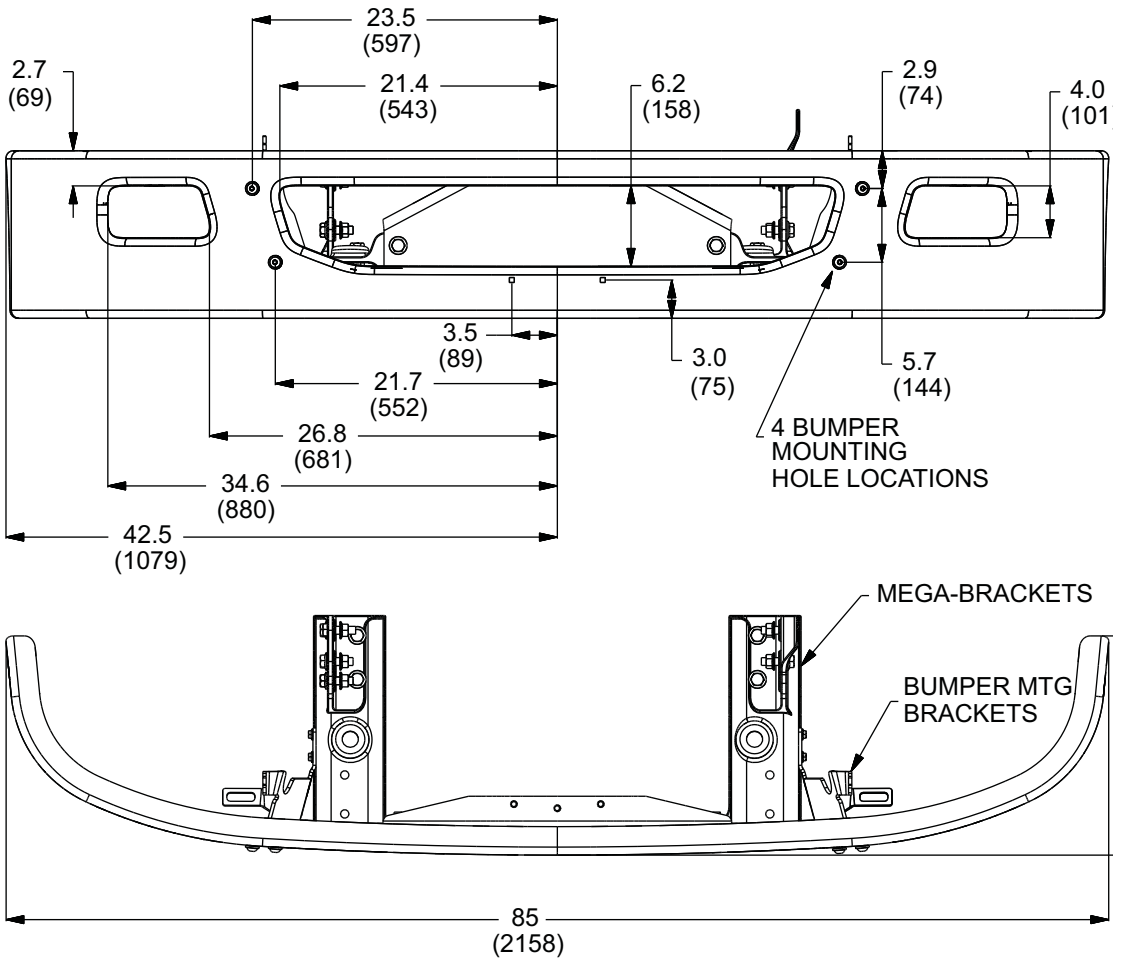
$$RG = Z + \left(\frac{Z - Y}{WB} \times AF\right)$$ (for unloaded condition)

$$RG' = Z' + \left(\frac{Z' - Y'}{WB} \times AF\right)$$ (for loaded condition)

ALL MODELS

Bumpers

Standard Frame Rails and Standard Steel Bumper (01LRR)



01_0241

NOTE: For license plate mounting, use a tapping self-drilling hex head 1/4-14 x 5/8 screw.

ALL MODELS

Overhang Limits for Refuse/Recycler Bodies

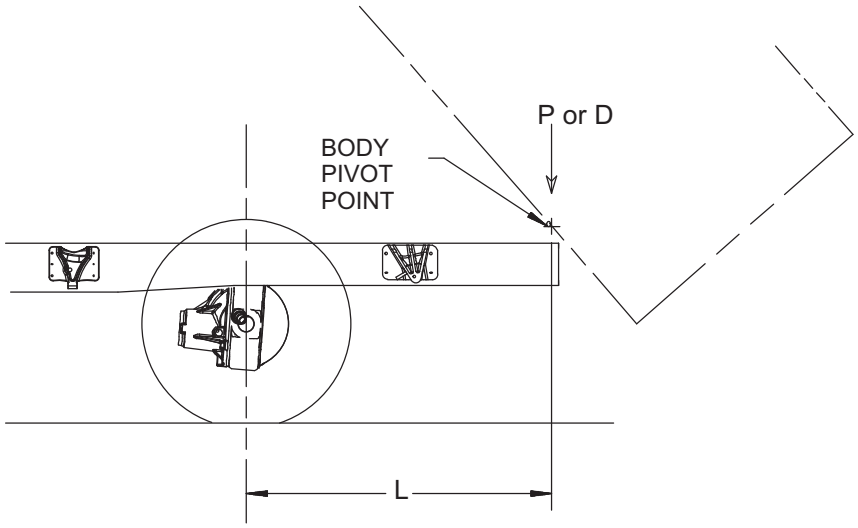
Dump, car carriers, and other pivoting bodies impose a great deal of stress on the frame rails around and aft of the rear suspension area of the frame. In addition, concentrated loads can be applied by the installation and use of equipment such as lift gates, or the placement of heavy objects on a small section of the body. The body installer has the responsibility for determining the magnitude of the pivot pin load and for establishing operating guidelines to avoid exceeding the load limits published in this chart. The limits shown in this chart are for equal loading on both sidemembers, i.e. the center of gravity of the raised body is ideally centered and the chassis is on solid, level ground. If the center of gravity is laterally offset due either to uneven loading, uneven ground, or both, the bending moment on one of the rails could increase substantially. For this reason the body installer should derate the overhang limits to account for the lateral shift if either of these factors apply.

These limits apply specifically to concentrated or pivoting loads supported only by the bare chassis and do not factor in the load support provided by any part of the installed body structure. Any load exceeding these limits must be wholly supported by the installed body structure. Static loading refers to the application of loads without shocks to the chassis or significant dynamic accelerations applied to the chassis. Dynamic loading refers to all loading conditions during which the chassis must absorb a shock, stop a load in motion, or support a load during movement of the vehicle. Examples of dynamic loading would be dumping materials from a dump body, driving the vehicle over uneven surfaces with AF loads, or even operating a loaded liftgate. Because most operations involve dynamic loadings of some kind, the load limits in column “P” should never be exceeded. The load limits in column “D” should be exceeded only when the excess load is supported by rail reinforcement or by the body structure.

“P” (pounds)	“D” (pounds)	Overhang Limit “L” (inches)
Max. Static Vertical Load (1)	Max. Dynamic Vertical Load (2)	Nominal Yield Strength –
Both Rails Combined	Both Rails Combined	80,000 PSI
12480	2775	91
14950	3325	75
17325	3850	63
22050	4900	49

(1) Maximum static vertical load defined as maximum load which can be applied in steady state condition without exceeding yield strength of rails.

(2) Maximum dynamic vertical load defined as maximum load which can be applied during equipment operation to provide adequate margin for shocks and accelerations.



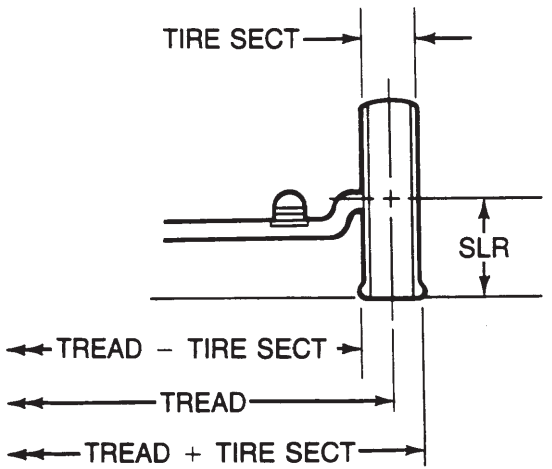
01_0052

INTERNATIONAL
A NAVISTAR COMPANY

FRONT AXLES

ALL MODELS

Front Axle Tread



02_0003

TREAD	= Distance (width) between vertical centerlines of single tires at opposite ends of axle, or between vertical centerlines of dual spacing (D.S.) at opposite ends of axle.
TIRE SECT (Tire Section)	= Overall width of new tire at top of tire under maximum load, including 24-hour inflation growth, and including protective side ribs, bars and decorations recommended by tire manufacturer.
TREAD + TIRE SECT (Tread plus Tire Section)	= Overall Width of axle, rim, and tire assembly at top of tires under maximum load recommended by tire manufacturer.
TREAD - TIRE SECT (Tread minus Tire Section)	= Distance (width) between near sides of tires at opposite ends of axle at top of tire under maximum load recommended by the tire manufacturer.
SLR (Static Loaded Radius)	= Distance from ground to centerline of hub when tires are correctly inflated and under maximum load recommended by tire manufacturer.

The chart shown here lists tread information for various wheel/axle combinations. Tread dimensions are not dependent on tire size. Other dimensions explained here are related to tread and require tire dimensions. Please contact your tire supplier (or consult the Component Sales Data Book PDB-70000) for tire dimensions.

MODEL 4X2

Front Axle Tread

Wheel/Rim			Axle Code	
Type	Size	Material	02ADZ	02AGN
			Hydraulic Brake	
Disc	19.5 x 6.00	Steel	74.00	74.00
		Aluminum	74.45	74.45

MODEL 4X4

Front Axle Tread

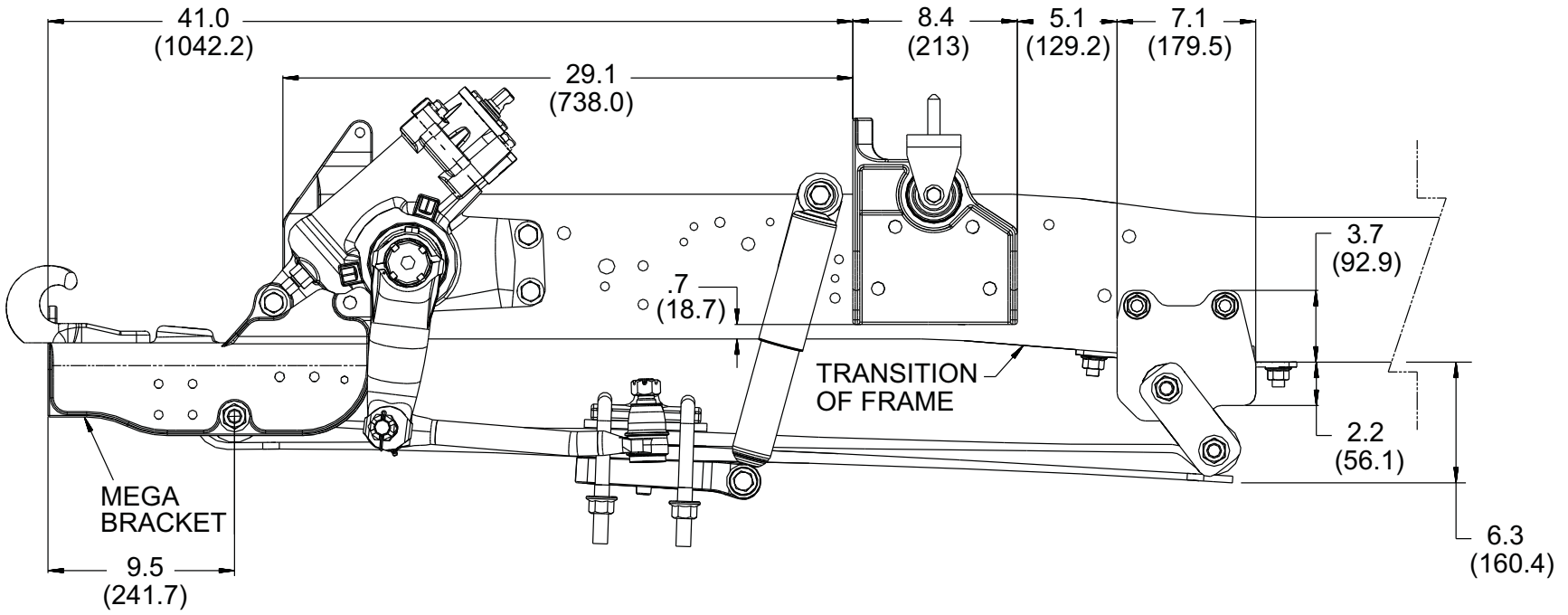
Wheel/Rim			Axle Code
Type	Size	Material	02EZV
			Hydraulic Brake
Disc	19.5 x 6.00	Steel	75.06
		Aluminum	75.51

FRONT SUSPENSIONS

MODEL 4X2

Brackets

With 6,000-lb – 7,000-lb Front Suspension

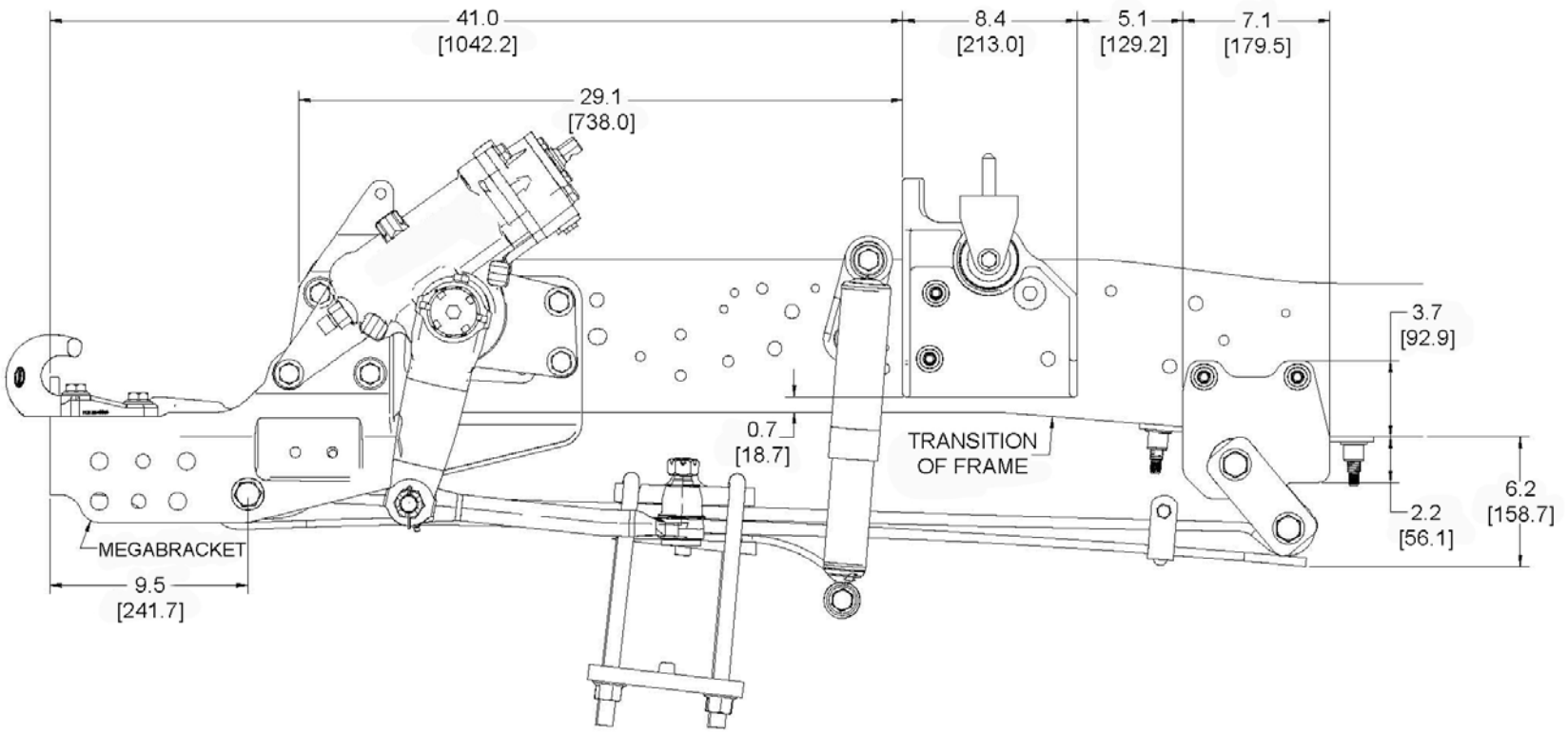


03_0026_1

MODEL 4X4

Brackets

With 8,000-lb Front Suspension



03_0030

BRAKES

ALL MODELS

Brake Restrictions

Safety Measures

Should it be necessary to modify the braking system, for example in connection with a wheelbase alteration, the following must always be observed:

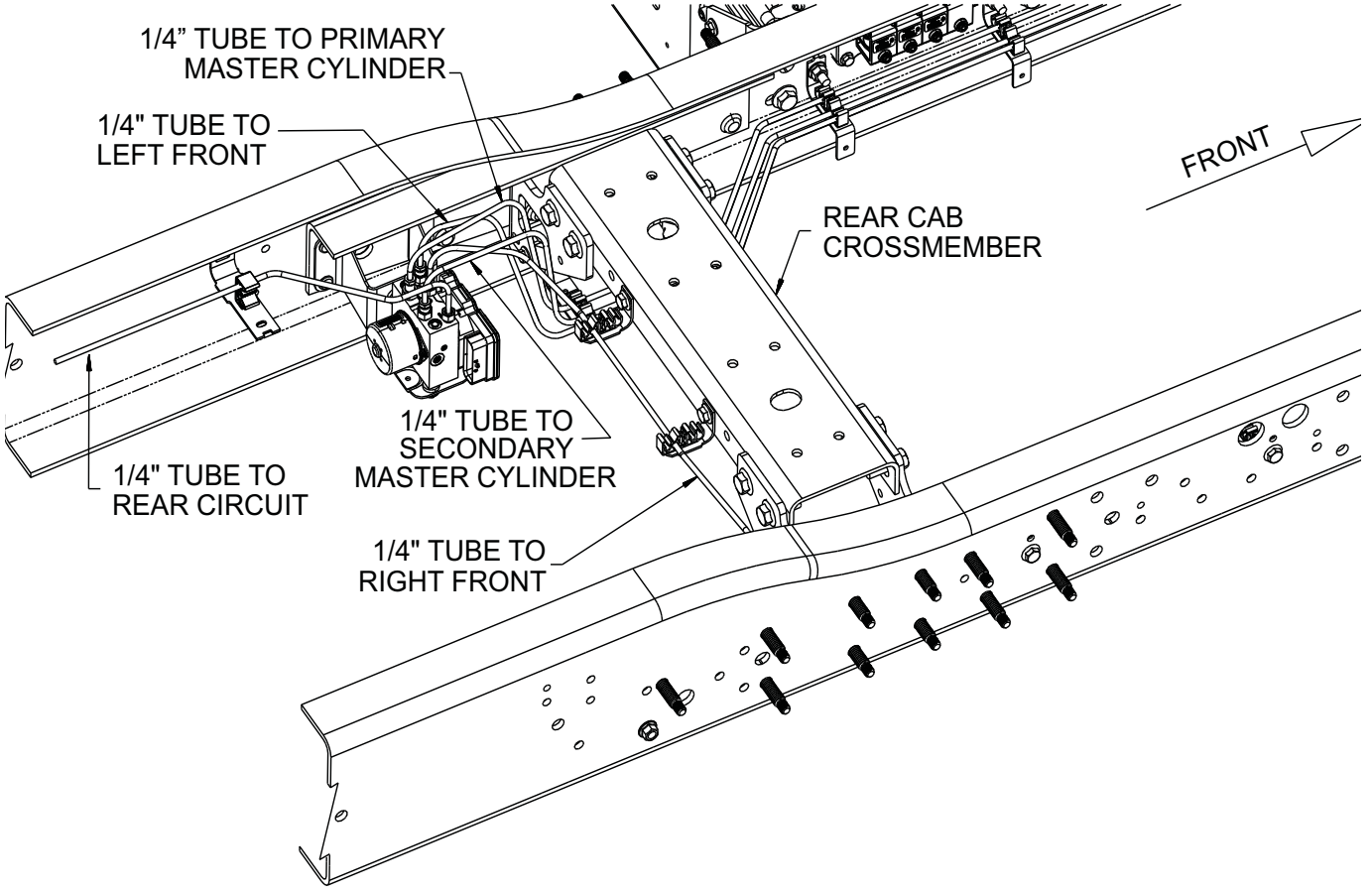
- Make sure that the brake circuits are not altered. Before any part of the braking system is dismantled, mark the brake pipes and connections concerned, or make a sketch showing the original routing.
- Avoid joints, preferably change the entire brake pipe.
- Preferably, use bent brake pipes instead of elbow unions so as not to affect the brake application/release times.
- Install the brake pipes in positions where they are protected against damage and heat.
- Install the air tanks so that the drain valves still function well and are easy to reach.

CAUTION: When a brake pipe is replaced or jointed, use only genuine International parts of the correct type.

NOTE: On trucks with ABS brakes, the sensor cable must not be jointed. If necessary, it must be completely replaced.

ALL MODELS

Hydraulic Control Unit Plumbing



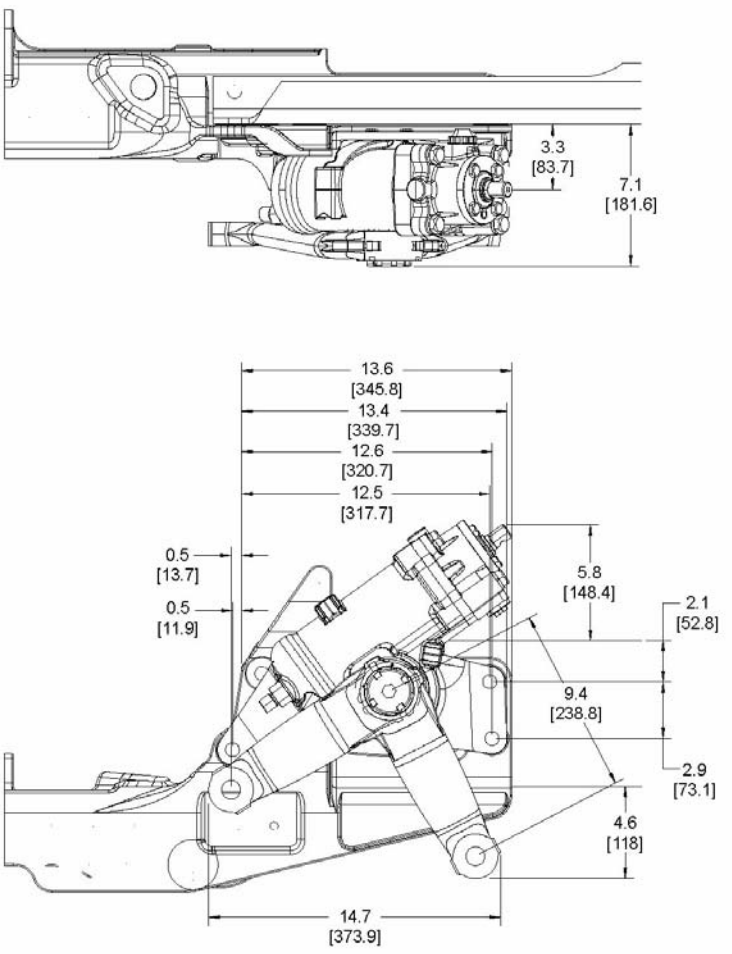
04_0108

STEERING

ALL MODELS

Steering Gear Location/Dimensions

Code 05PSN



05_0042

INTERNATIONAL
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EXHAUST SYSTEM

Guidelines For Aftertreatment

Navistar, Inc. has a responsibility to supply, install and ensure that the engines and aftertreatment emission control devices comply with the certification requirements of the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (ARB). The aftertreatment devices may include a combination of particulate filters, catalysts, catalytic converter, and temperature and pressure sensors, along with other components.

Proper long-term operation of these components requires controlling exhaust stream temperatures and the exhaust flow pattern throughout the system. This controls the required location of the components as well as the insulation of the various parts of the system.

For this reason, application guidelines for aftertreatment and tailpipe installations are much more complex and restrictive than in the past. Navistar, Inc. will ensure correct factory installation of aftertreatment devices to assure compliance with the certification requirements.

Modified systems could damage the engine, aftertreatment system and other truck systems and void the warranty coverage. In that regard, Navistar, Inc.will make it a policy to procure and correctly install the appropriate aftertreatment devices pursuant to applicable specifications and application guidelines. That brings with it the benefit of certified systems that will be fully covered under warranty provided the vehicle is properly maintained and not modified beyond the extent allowed by the Body Builder Book.

The following guidelines are meant to clarify the allowable modifications for aftertreatment systems installed on US 2010 EPA compliant vehicles. Please consult applicable federal, state and local laws and requirements in conjunction with this document to ensure compliance to those requirements. Also, refer to applicable vehicle warranty information before performing any modifications to the vehicle. Non-compliance to the requirements of the warranty may nullify it in its entirety.

- Where possible, trucks first and foremost should be ordered directly from the factory that meets the body installation requirements so that the minimum, or no modification of the exhaust system will be required.
- Where this is not possible, if another exhaust configuration is available from the factory that closer meets the need of the body installation, it is permissible to completely replace one exhaust configuration with the better choice exhaust system provided that would have been available with the same engine, and the clearance guidelines in this reference are followed.
- Exhaust Gas Temperatures may be as high as 650° C during vehicle operation. Precautions should be taken to ensure that materials used in the vicinity of the exhaust system and exhaust gas stream can withstand these temperatures or are safely shielded.

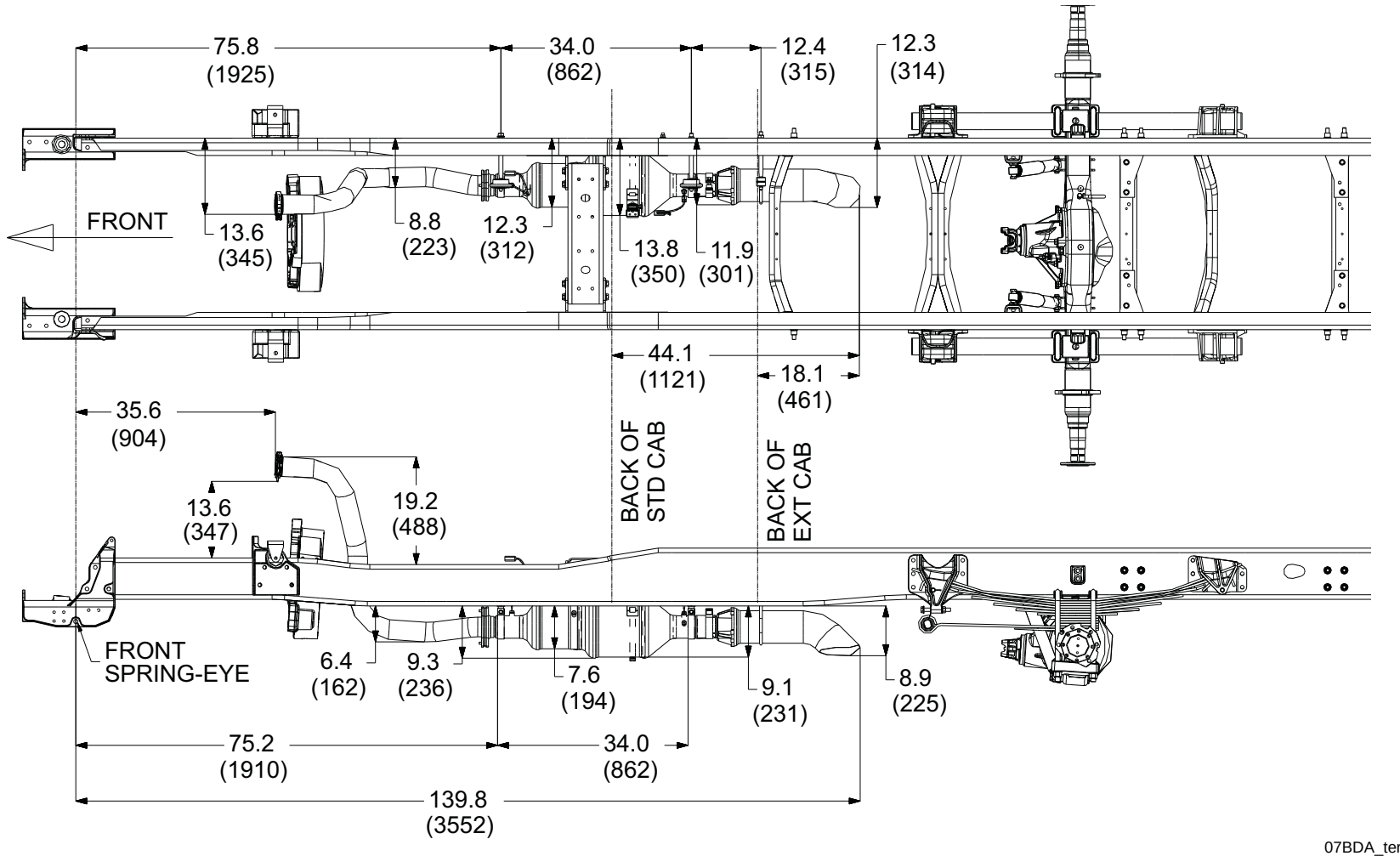
Meeting Legal Requirements

It is the responsibility of the person performing modifications to the vehicle to ensure that the vehicle, in its final configuration, conforms to any applicable law regarding emission control, noise level and applicable safety standards.

MODEL 4X2

Horizontal Aftertreatment

Code 07BDA – Right Side Mounted

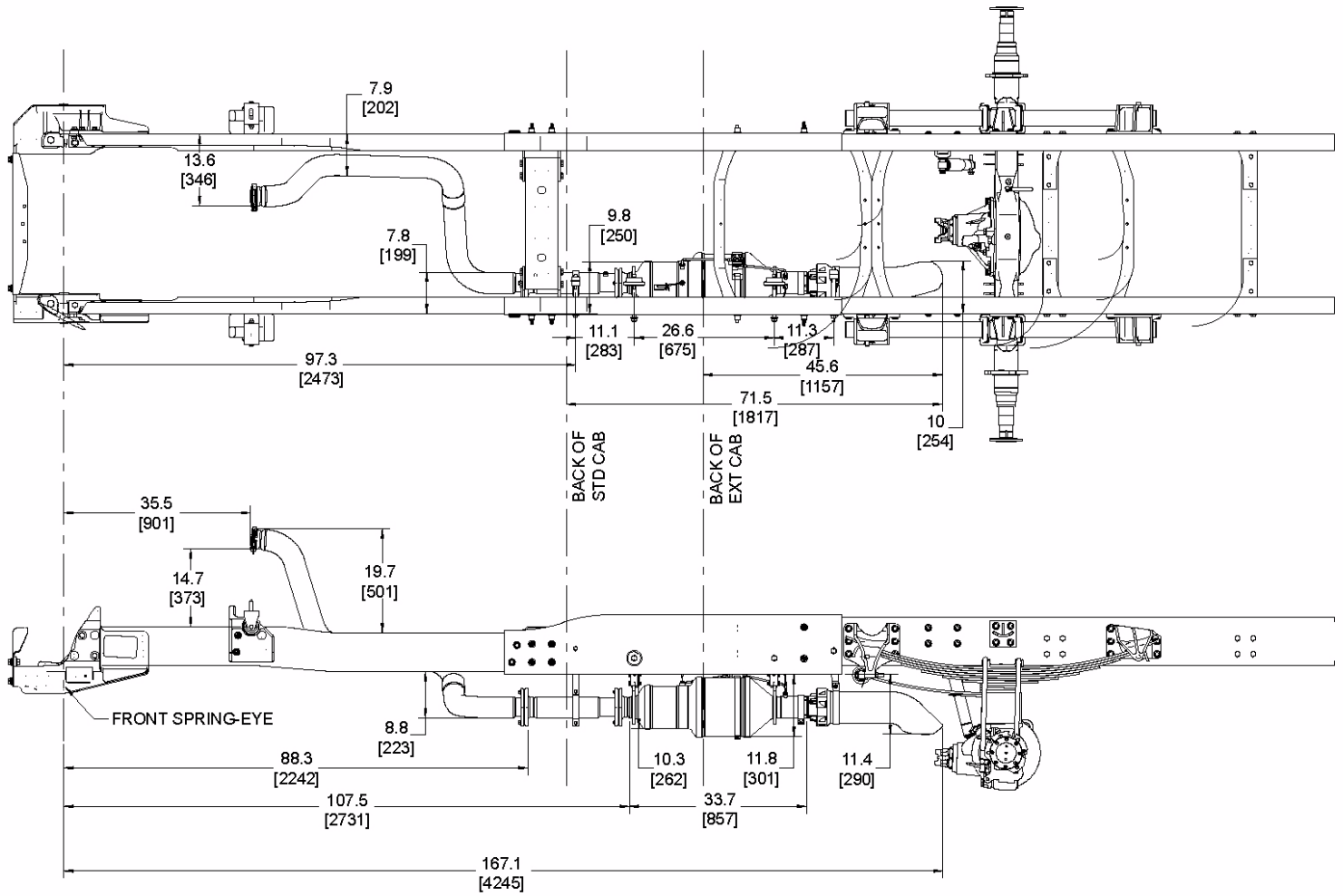


07BDA_terrastar

MODEL 4X4

Horizontal Aftertreatment

Code 07BDE – Left Side Mounted



07BDE_TerraStar

INTERNATIONAL
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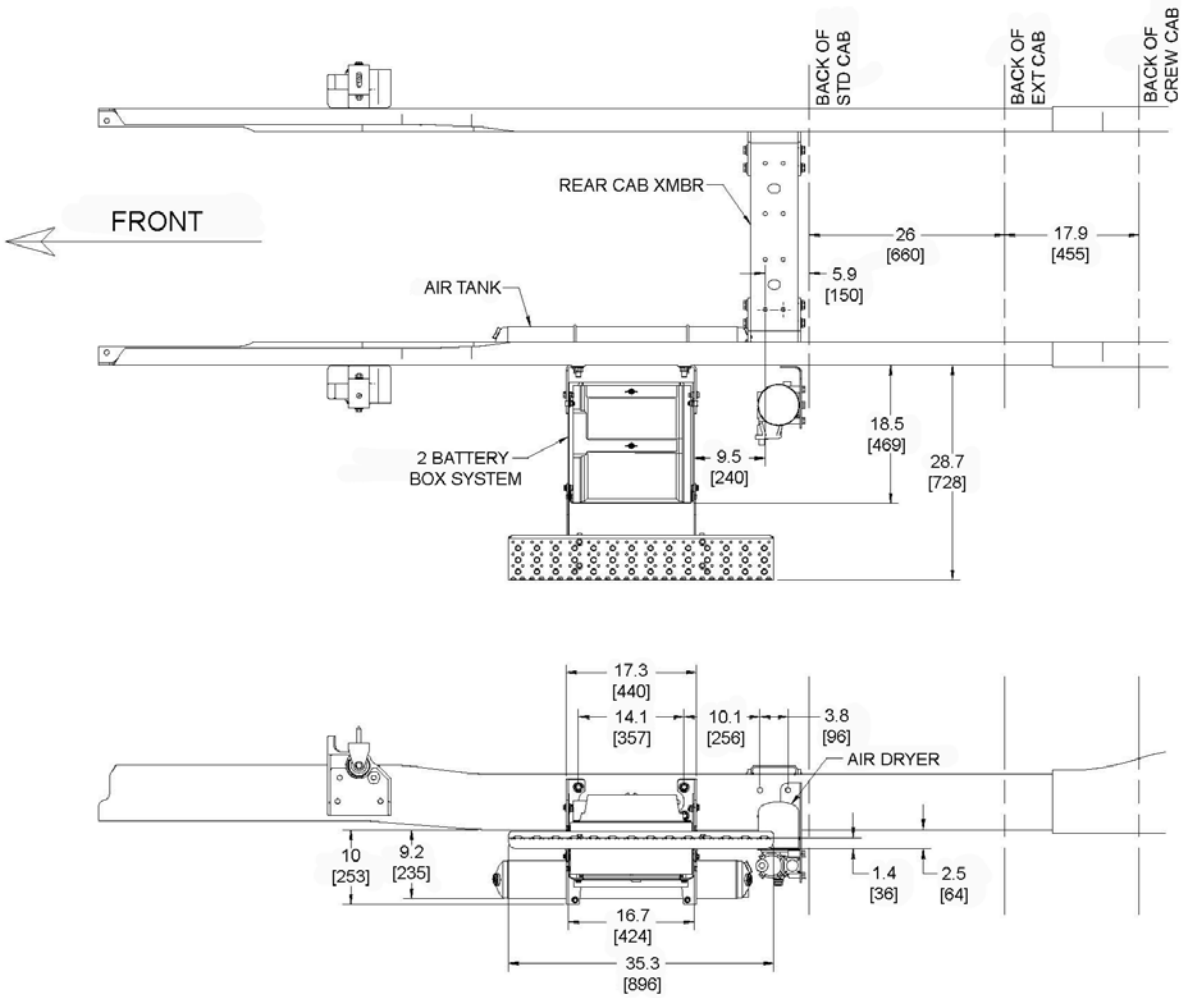
ELECTRICAL

MODEL 4X2

Battery Box Location

Left Side Mounted, Under Cab, 2 Batteries

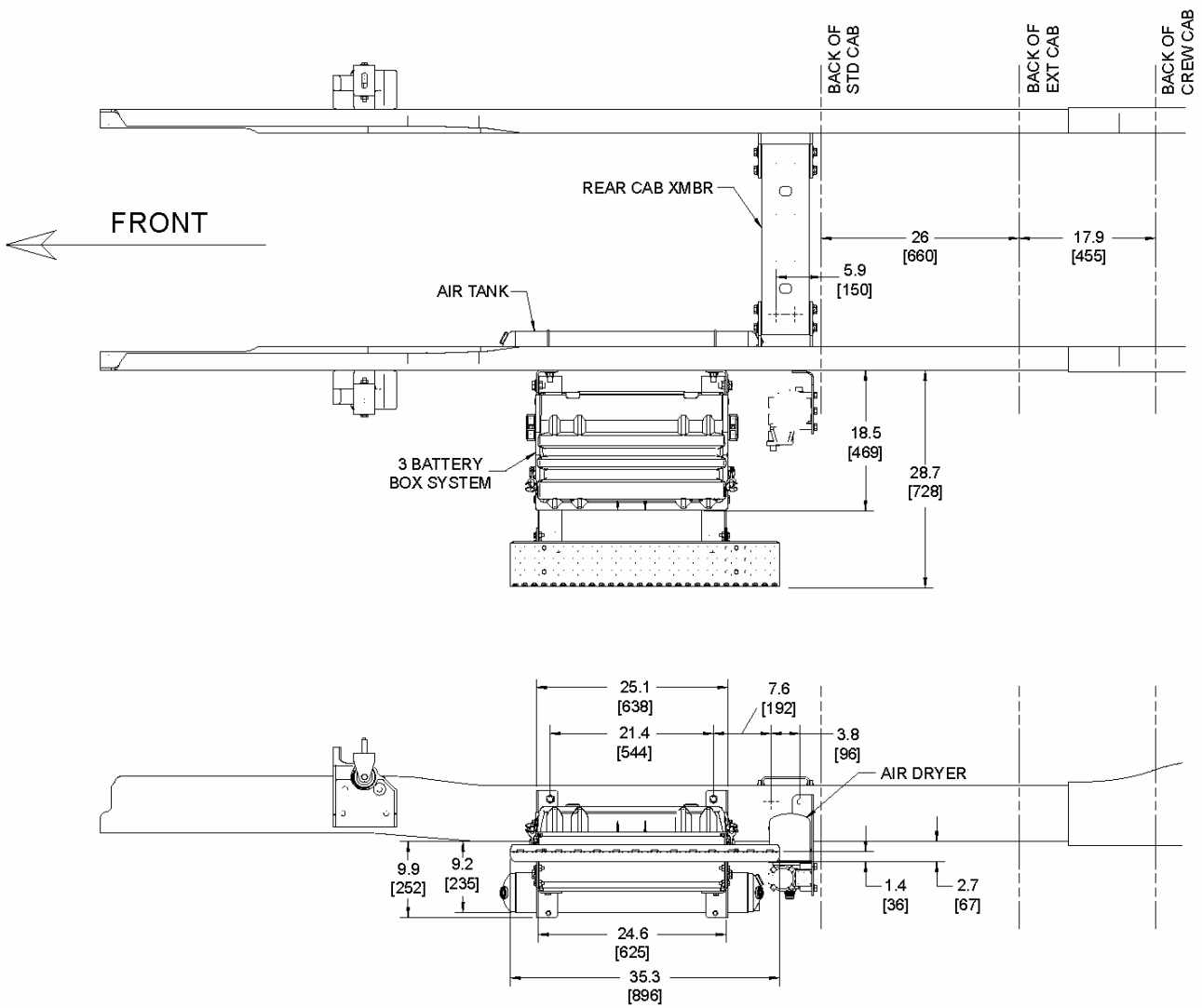


08_0138

MODEL 4X2

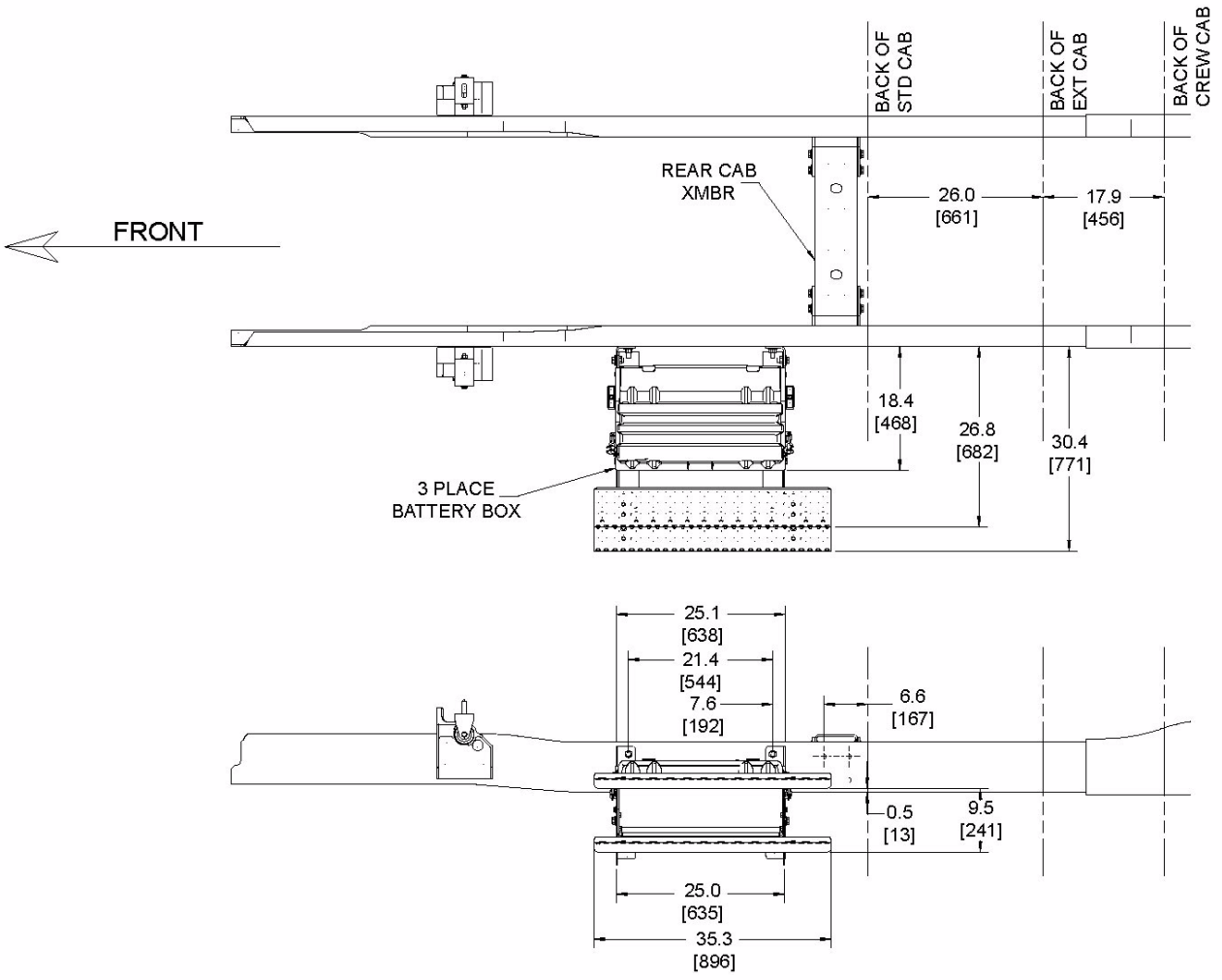
Battery Box Location

Left Side Mounted, Under Cab, 3 Batteries



Battery Box Location

Left Side Mounted, Under Cab, 3 Batteries



08_0139

ALL MODELS

Electrical System - Allison Automatic Transmission

1000/2000 Series

Body builder Input/Output connection for Allison 1000/2000 transmissions is located on the front dash panel, in the engine compartment, on the drivers' side. The table below gives the circuit and connector cavity information. For a complete circuit diagram of the transmission wiring and for connector & terminal part numbers, see vehicle circuit diagram book.

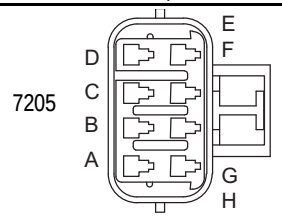
Cavity	Circuit Number	I/O	Maximum Current	Description
Connector Number 7205				
A	92C103	–	–	Signal Ground
B	92#143	Input	–	PTO Enable
C	92#150	Output	500 mAmp	PTO Enable 2
D	47C125	Output	–	Non-Zero Crossing Speedo (16 Pulses/Rev)
E	92#101	Input	–	Auxiliary Function Range Inhibit
F	92#123	Input	–	Auto Neutral for PTO
G	92#145	Output	500 mAmp	Range Indicator
H	92#105	Output		Output Speed Indicator

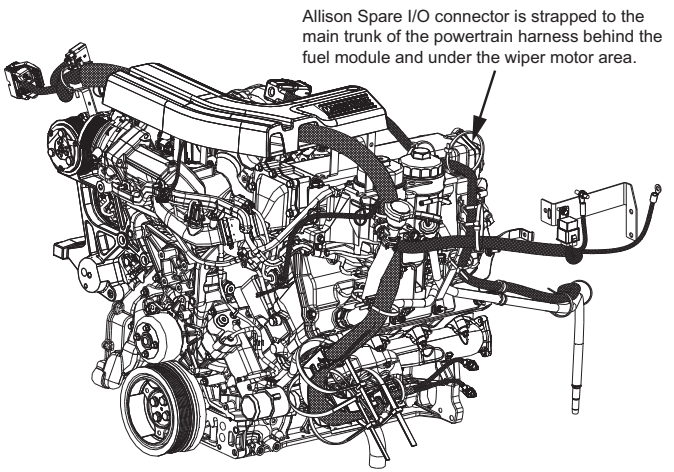
NOTE 1: See Allison technical manual for suggested circuit design.

NOTE 2: See special features table on next page for package content.

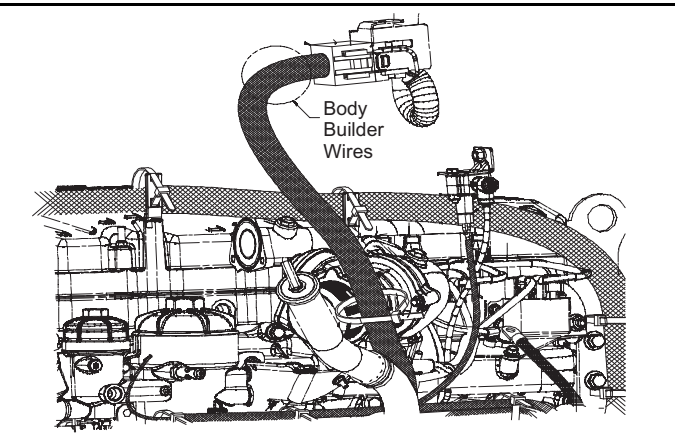
NOTE 3: MUST COMPLY WITH FMVSS STANDARD #102.

Connector 7205 has its mating connector attached and filled with cavity plugs.To use connector, remove cavity plugs and use the following:

Harness Connectors (Viewed from Mating End)	Mating Connector	
 08_0021	Connector 352874C1	Connector Lock 352873C1
	Terminals 1667742C1	Wire Gauge 16, 18, 20
	Cavity Seals 1661872C1	



08_0136

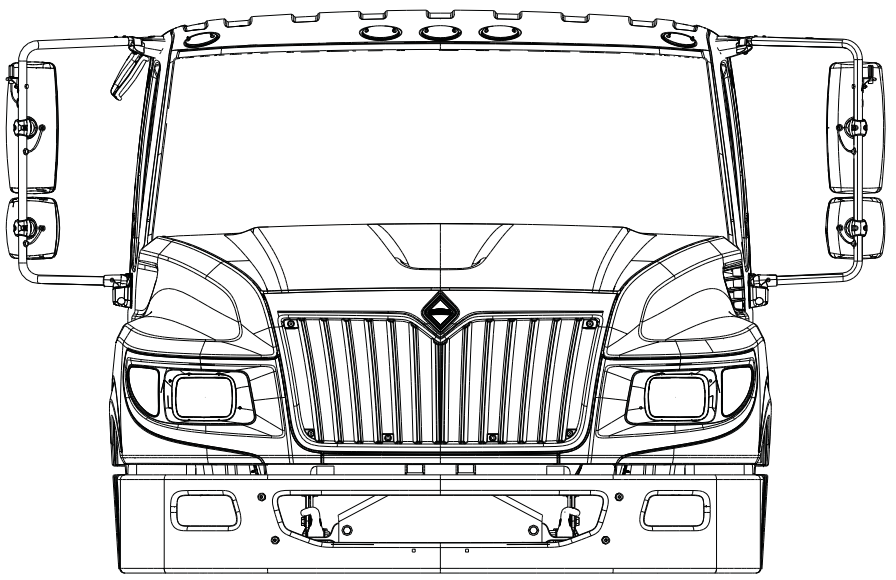


08_0020

ENGINE

ALL MODELS

Cooling Obstruction Guidelines

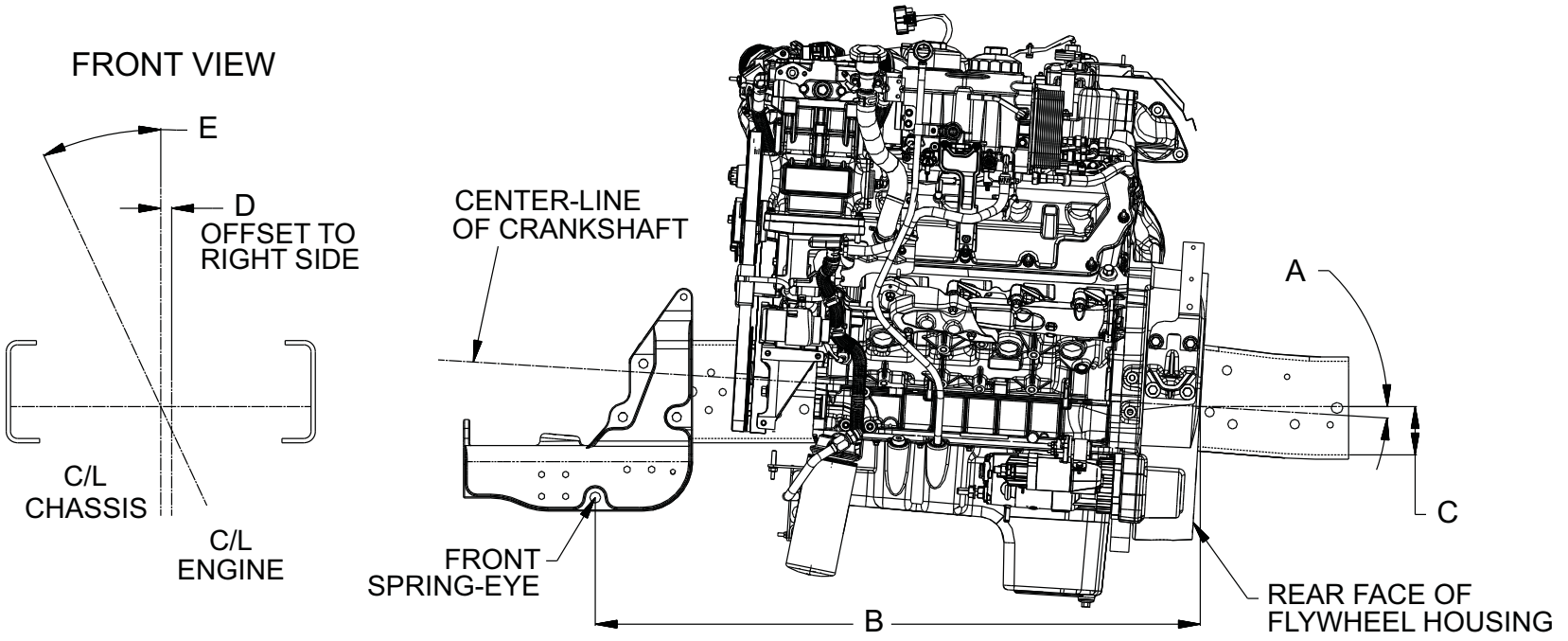


NOTE: DO NOT OBSTRUCT AIR FLOW IN FRONT OF GRILLE OR BELOW BUMPER

12_0223

ALL MODELS

Engine Location



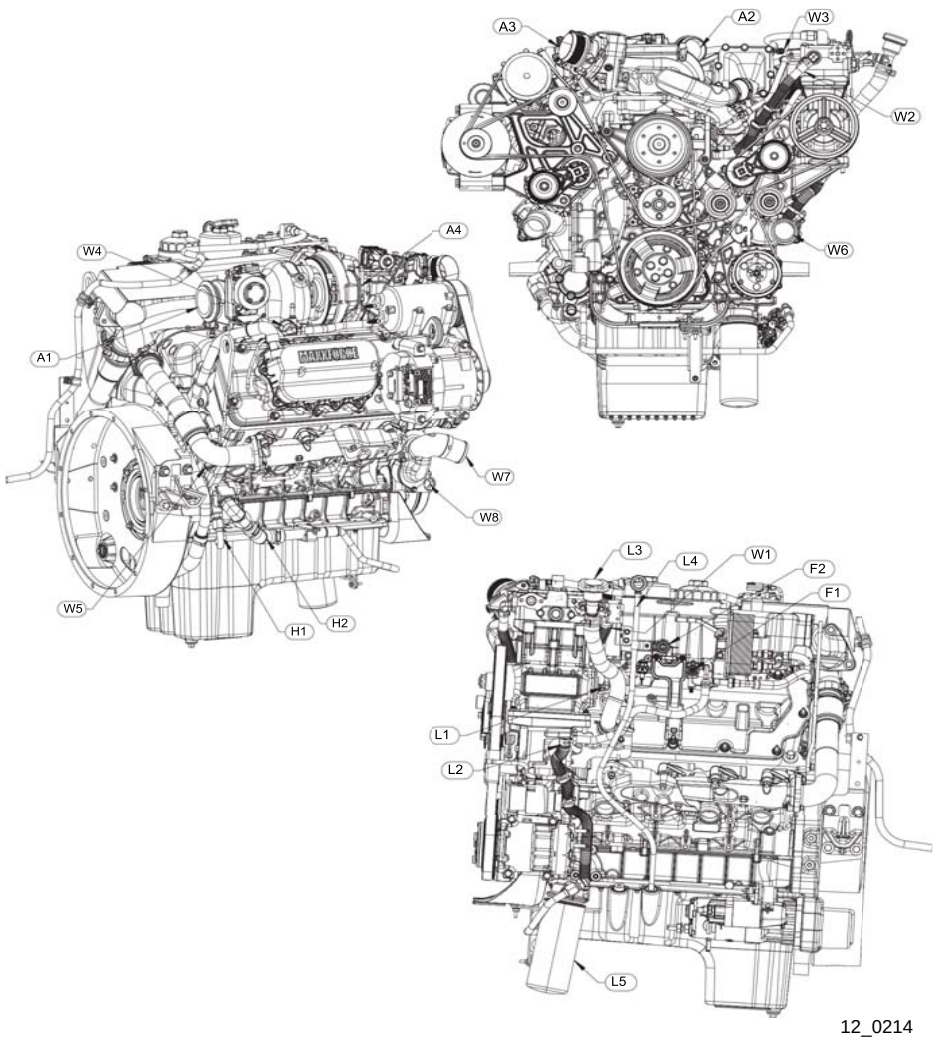
12_0213

Engine	A	B	C	D	E
International® MaxxForce® 7	3.5°	43.7" (1109.3 mm)	3.5" (88.4 mm)	0°	0°

ALL MODELS

Engine Port Location

International® MaxxForce® 7



12_0214

Type	NPTF	Usage
Water		
W1	M18	Air Compressor Water Supply
W2	M18	Air Compressor Water Return
W3	M18	Deaeration Supply
W4	M18	Heater Supply
W5	–	Block Heater
W6	–	Engine Water Inlet
W7	–	Engine Water Outlet
W8	–	Heater Return
Air		
A1	–	Turbo Outlet Exhaust
A2	–	Turbo Air Outlet to Inter-Cooler
A3	–	Engine Air Inlet from Inter-Cooler
A4	–	Engine Air Inlet from Air Cleaner
Oil		
L1	M14	Supply Air Compressor
L2	M18	Return Air Compressor
L3	–	Engine Oil Fill
L4	–	Oil Level Gauge
L5	–	Oil Filter
Fuel		
F1	–	Fuel Supply
F2	–	Fuel Return
Hydraulic		
H1	7/8"– 14	Power Steering Hydraulic Line
H2	–	Power Steering Pump Supply Line


INTERNATIONAL
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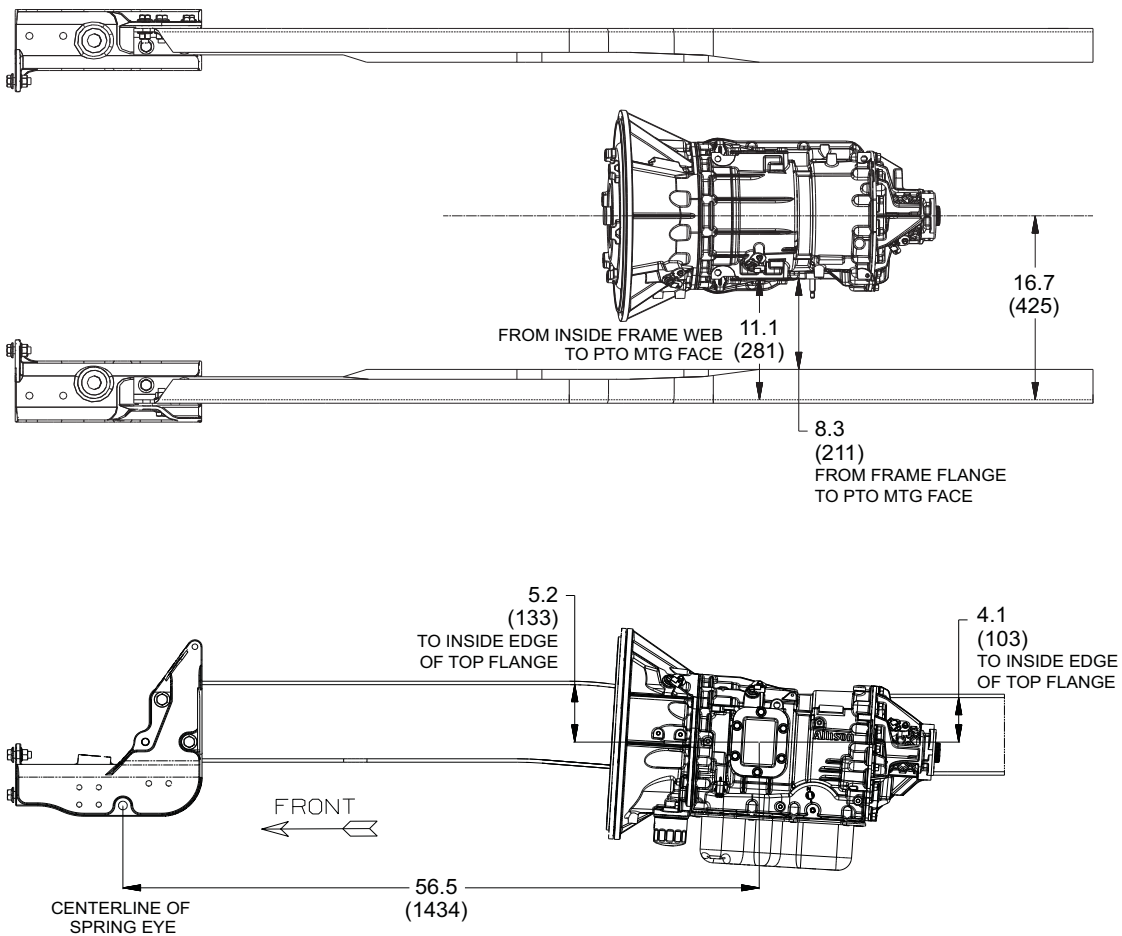
TRANSMISSION

ALL MODELS

Transmission PTO Data

Codes 13AKX,13AKY, 13APW and 13APX

NOTE: Do not reuse PTO cover plate gaskets

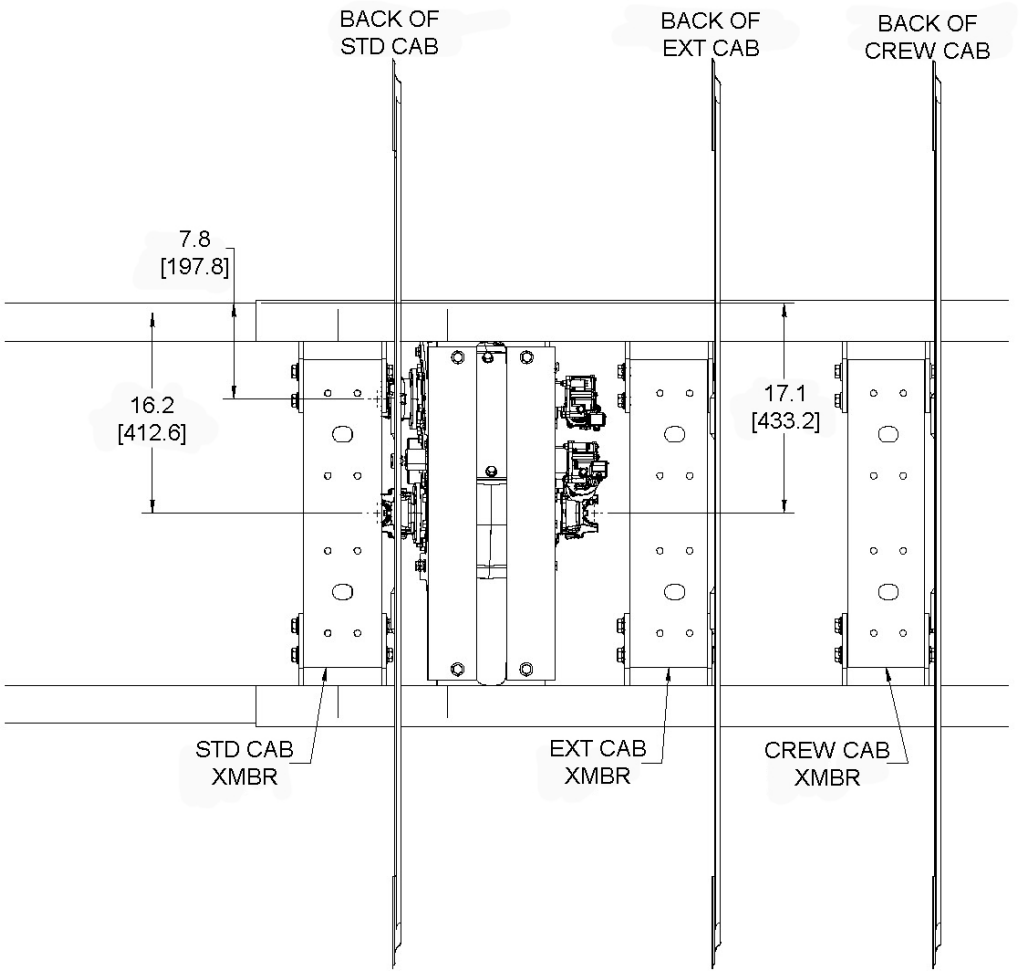


13_0044

MODEL 4X4

Transfer Case

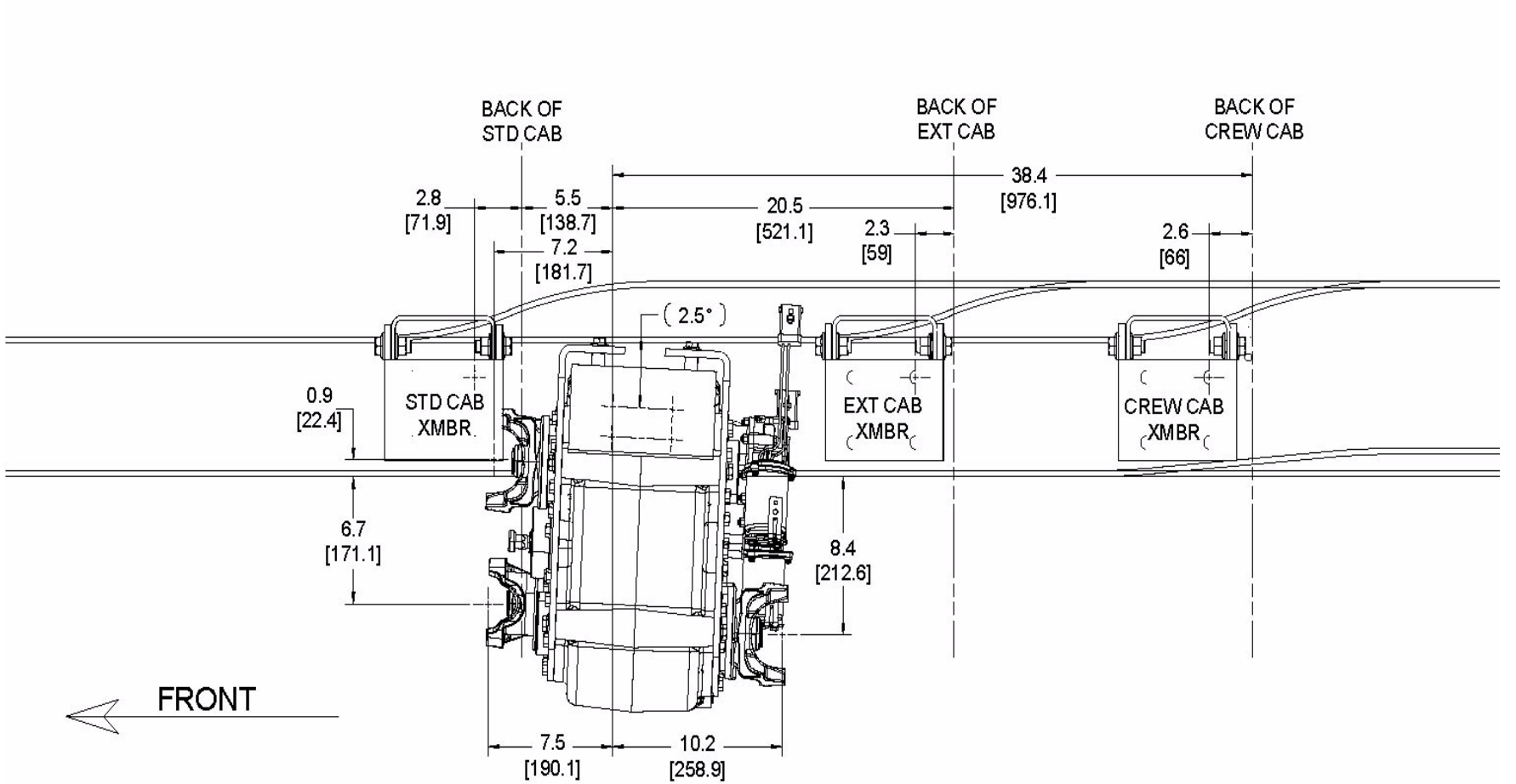
Plan View (Code 13TLK)



MODEL 4X4

Transfer Case

Side View (Code 13TLK)

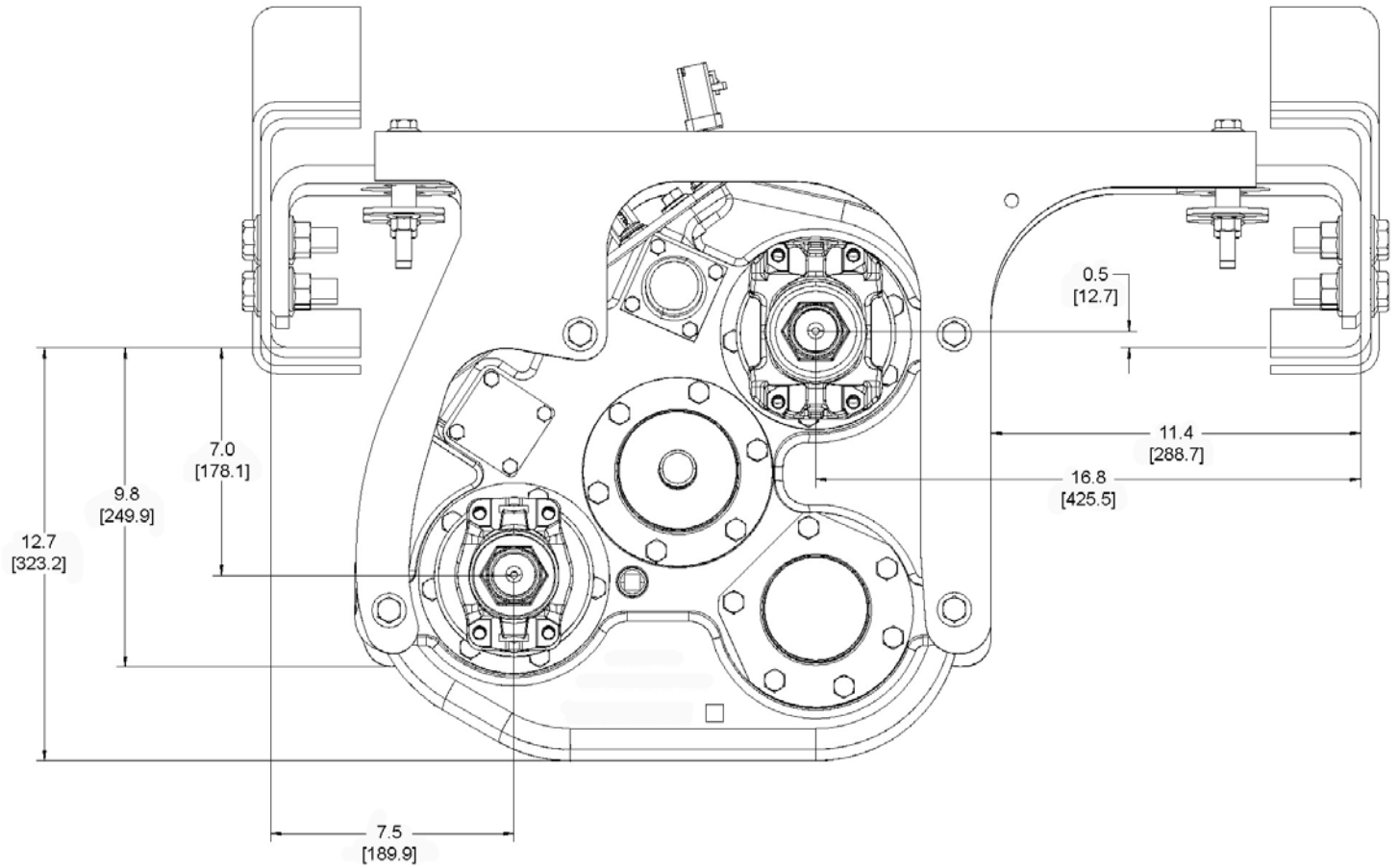


13_0046

MODEL 4X4

Transfer Case

Front View (Code 13TLK)

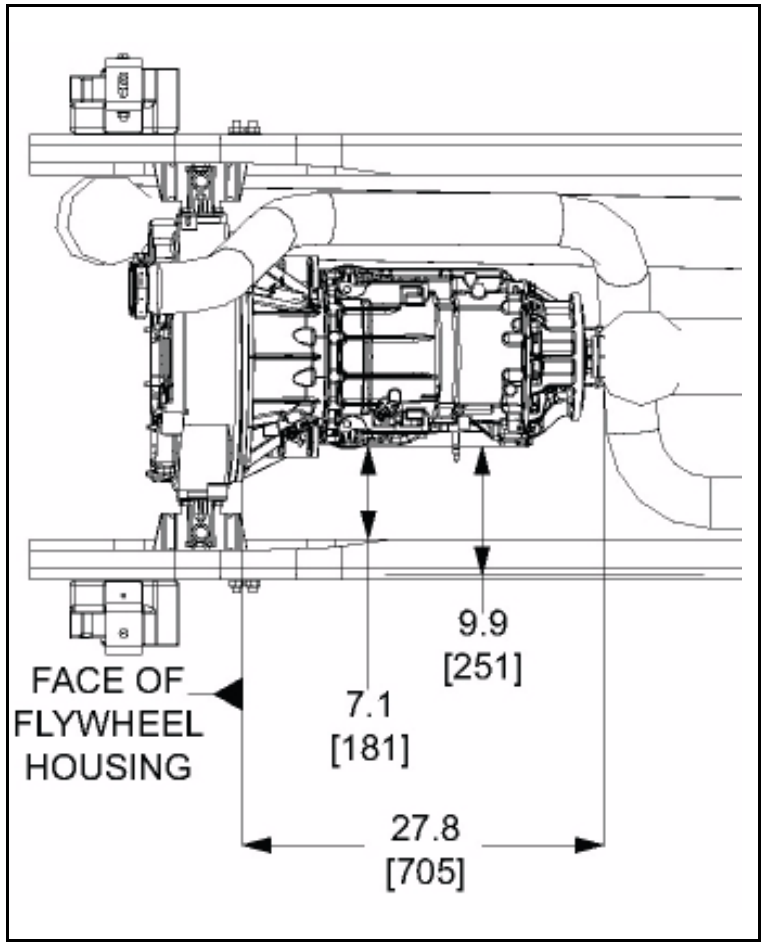


13_0047

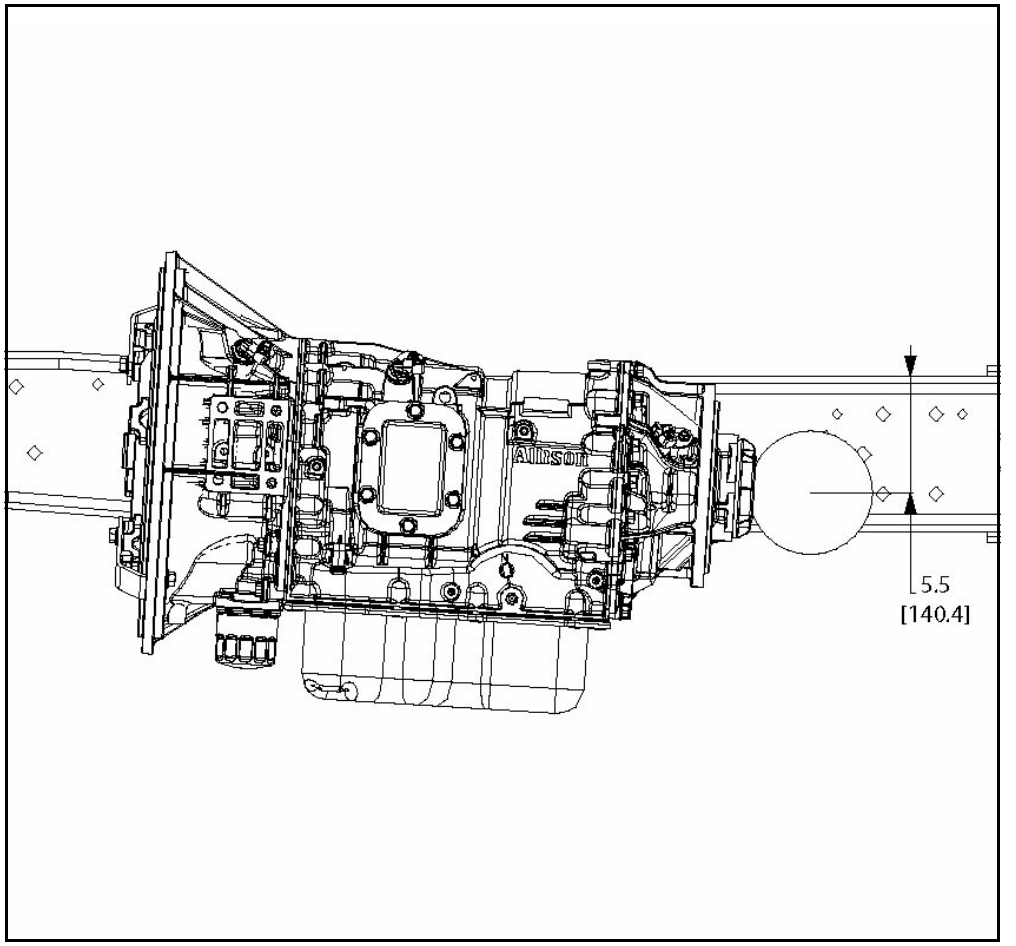
MODEL 4X4

Transmission PTO Opening

(Plan View and Side View)



13_0048



13_0049

INTERNATIONAL
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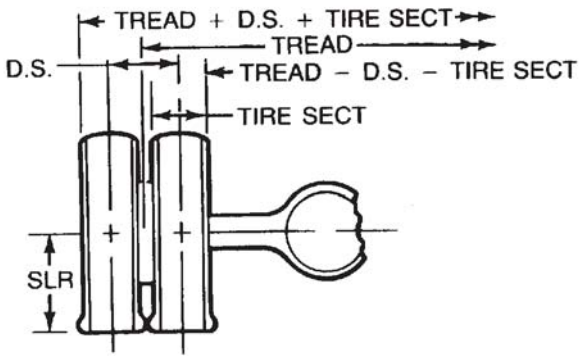
Rear Axle Tread



TREAD	= Distance (width) between vertical centerlines of single tires at opposite ends of axle, or between vertical centerlines of dual spacing (D.S.) at opposite ends of axle.
TIRE SECT (Tire Section)	= Overall width of new tire at top of tire under maximum load, including 24-hour inflation growth, and including protective side ribs, bars and decorations recommended by tire manufacturer.
D.S. (Dual Spacing)	= Dimension (width) between vertical centerlines of two tires (duals) assembled at one end of an axle.
TREAD + D.S. + TIRE SECT (Tread plus Dual Spacing plus Tire Section)	= Overall width of axle, dual rims, and tire assembly at top of tires under load.
TREAD - D.S. - TIRE SECT (Tread minus Dual Spacing minus Tire Section)	= Distance (width) between near sides of inner tires of dual assembly at top of tires under load.
SLR (Static Loaded Radius)	= Distance from ground to centerline of hub when tires are correctly inflated and under maximum load recommended by tire manufacturer.

14_0005

Dual Tires

The charts shown here list tread information for various wheel/axle combinations. Tread dimensions are not dependent on tire size. Other dimensions explained here are related to tread and require tire dimensions. Please contact your tire supplier (or consult the Component Sales Data Book PDB-70000) for tire dimensions.

ALL MODELS

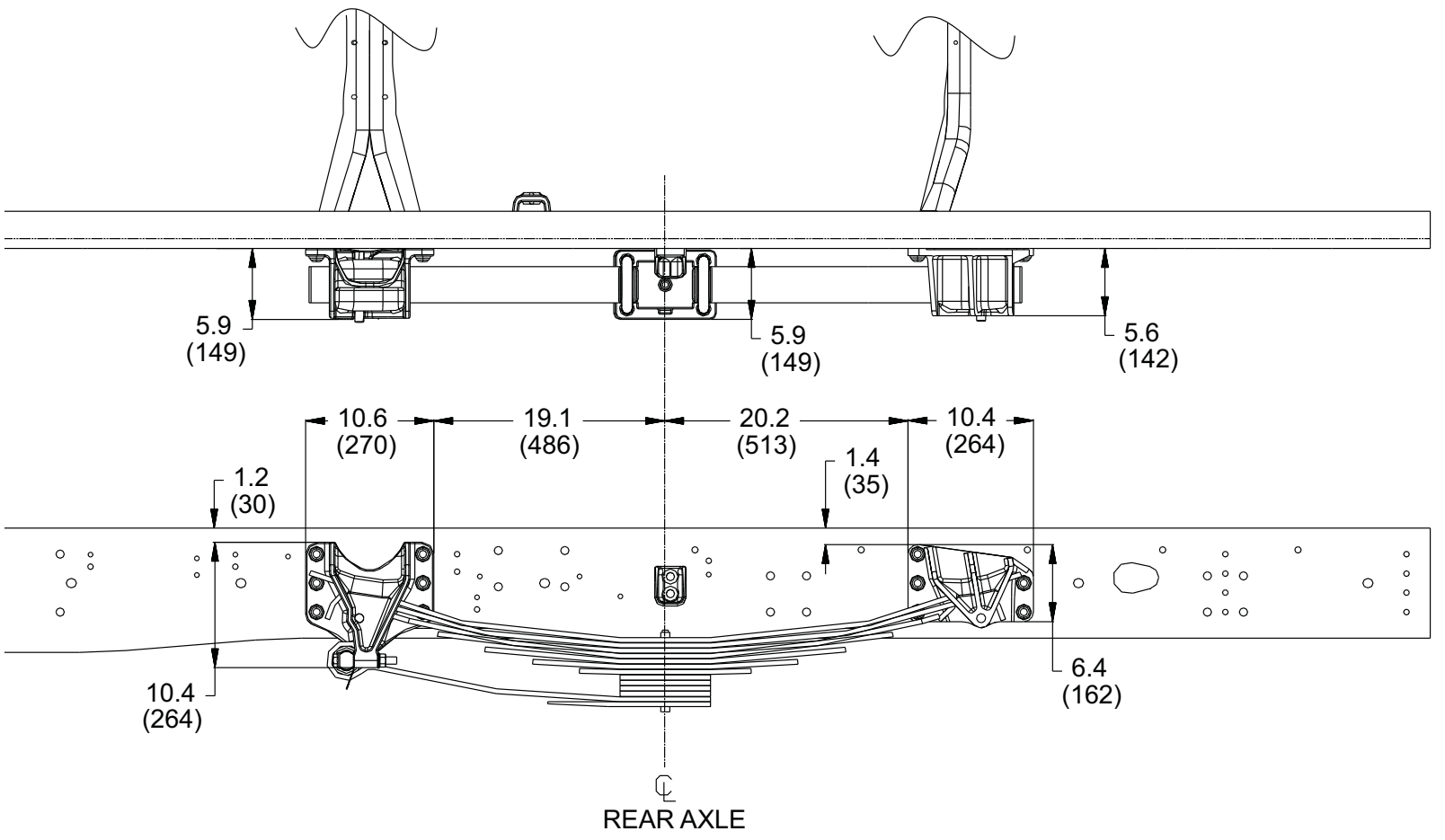
Rear Axle Tread Data

Wheel/Rim				Axle Code 14ACN/14ACP/14ACR
Type	Size	Material	Dual Spacing	Hydraulic Brake
Disc	19.5 x 6.00	Steel	10.70	74.0
		Aluminum		

MODEL 4X2

Rear Suspension Bracket Location

Codes 14SAC and 14SCG - Vari-Rate Steel Suspension

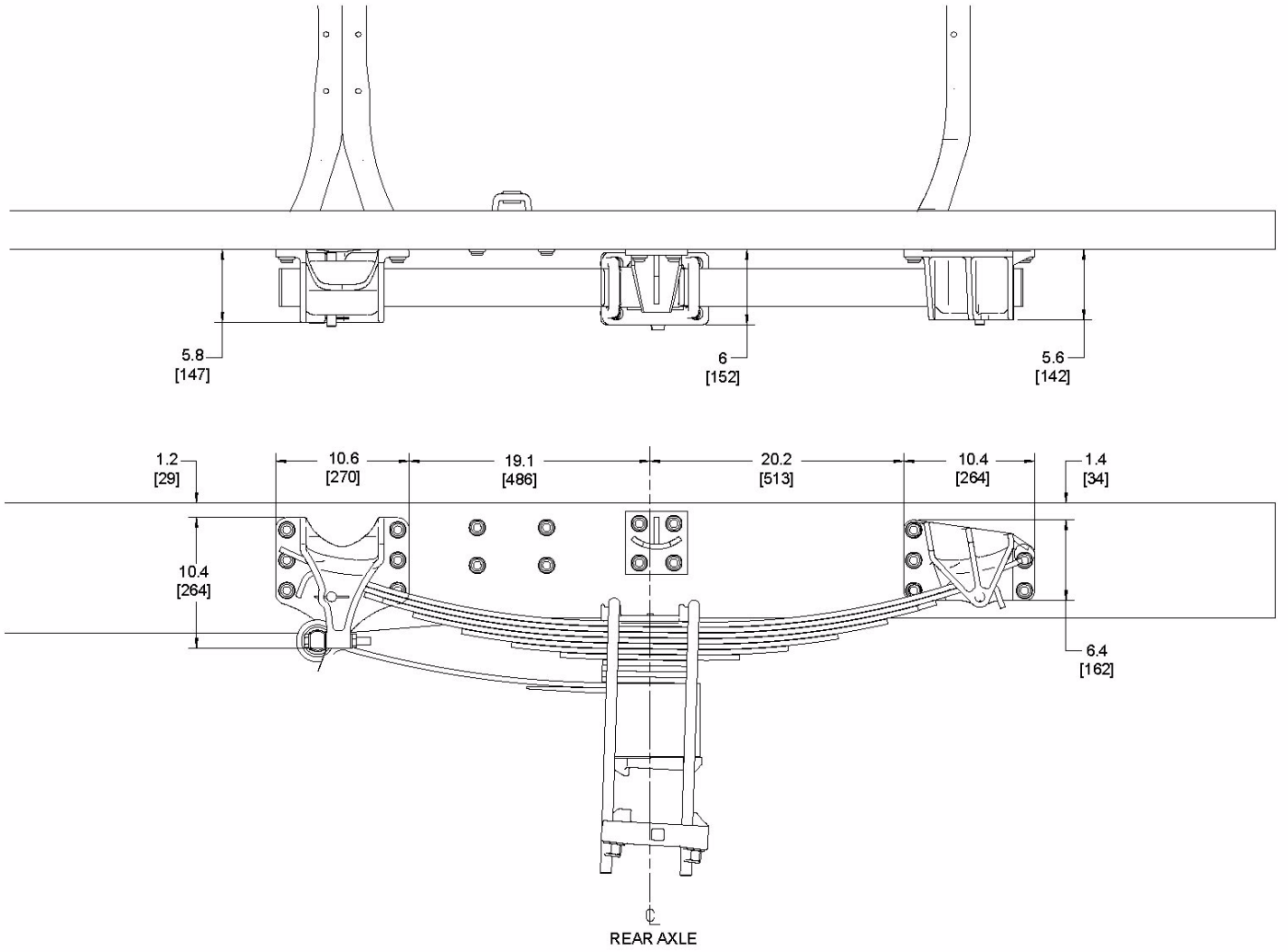


14_0127

MODEL 4X4

Rear Suspension Bracket Location

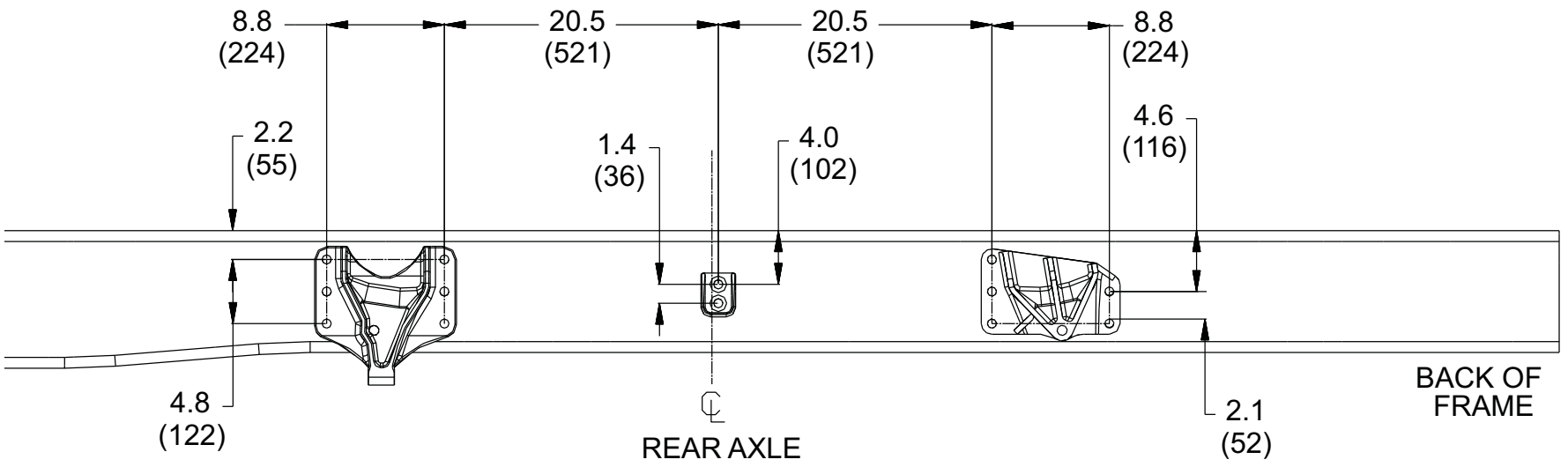
Codes 14SAC and 14SCG with Spacer Block - Vari-Rate Steel Suspension



ALL MODELS

Rear Suspension Drilling

Codes 14SAC and 14SCG - Vari-Rate Steel Suspension

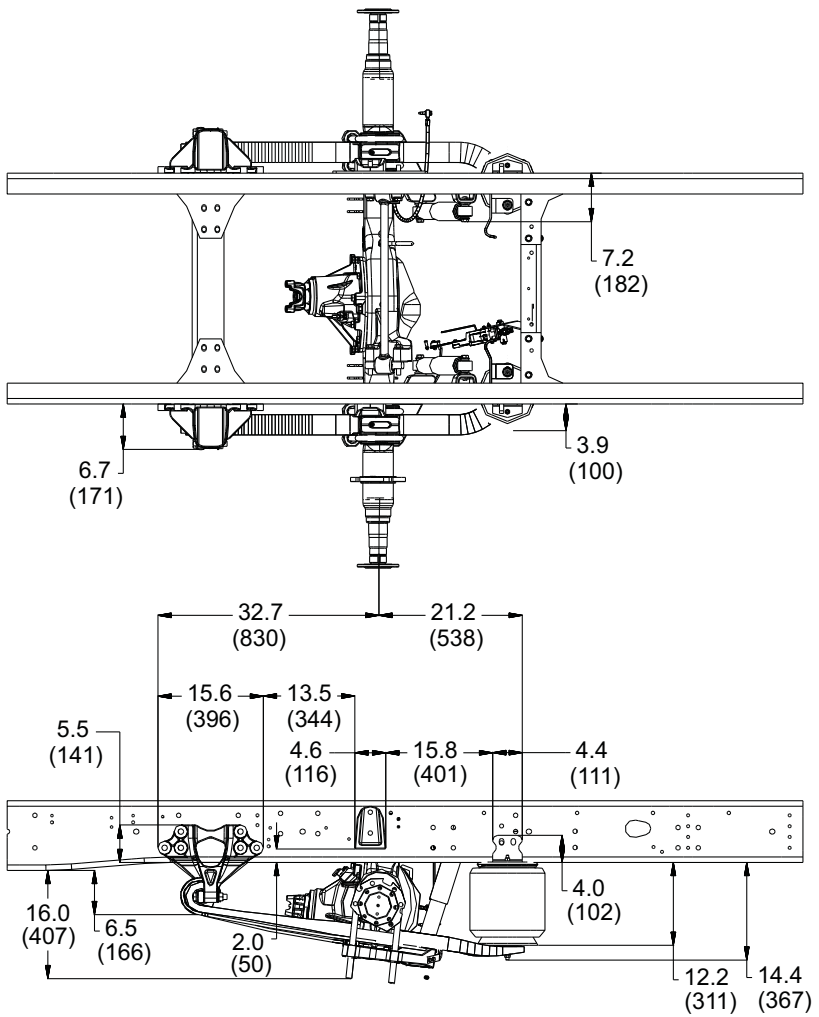


14_0128

MODEL 4X2

Rear Suspension Bracket Location

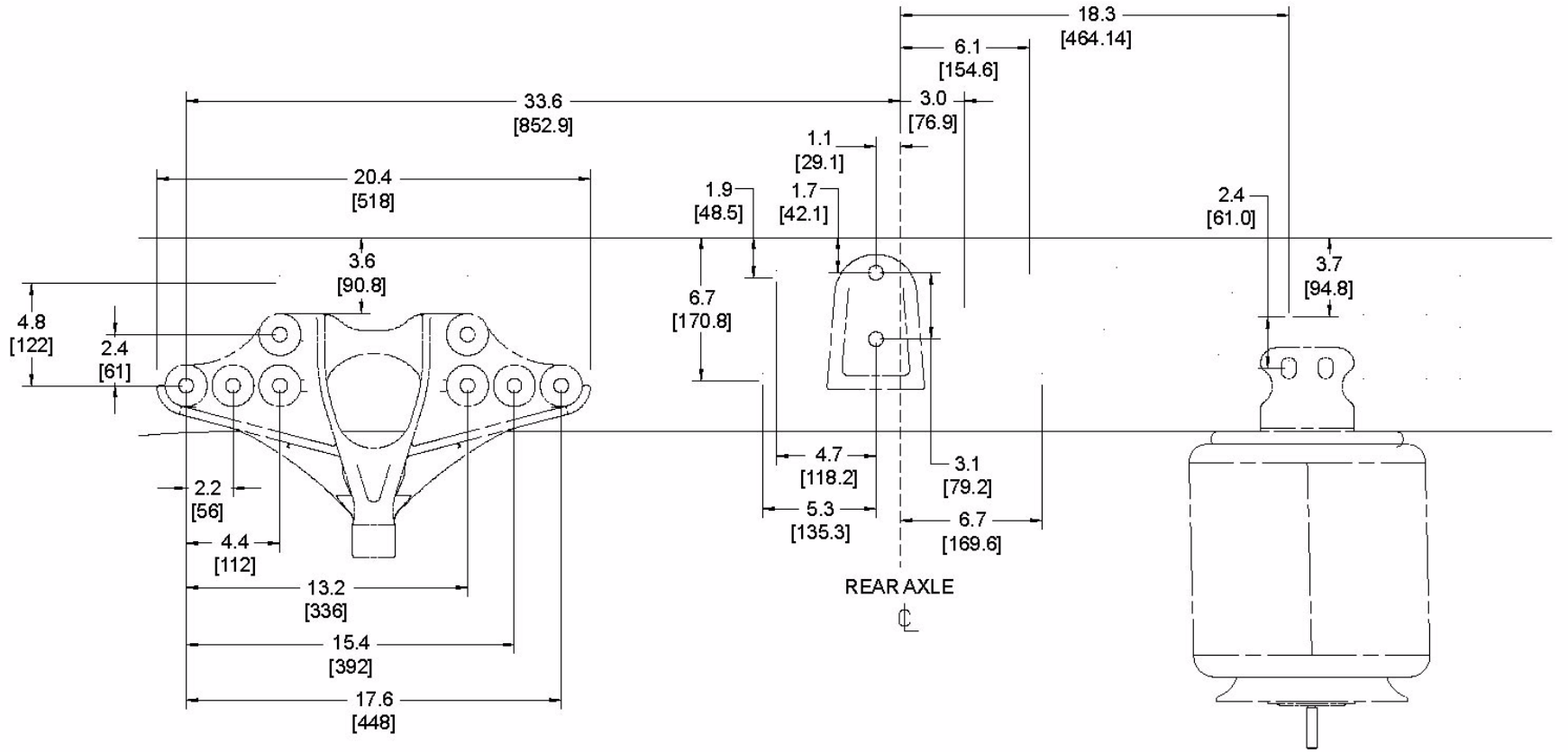
Code 14TCH - International® Ride Optimized Air Suspension, 6.0" Ride Height



MODEL 4X2

Rear Suspension Drilling

Code 14TCH - International® Ride Optimized Air Suspension, 6.0" Ride Height



14_0145

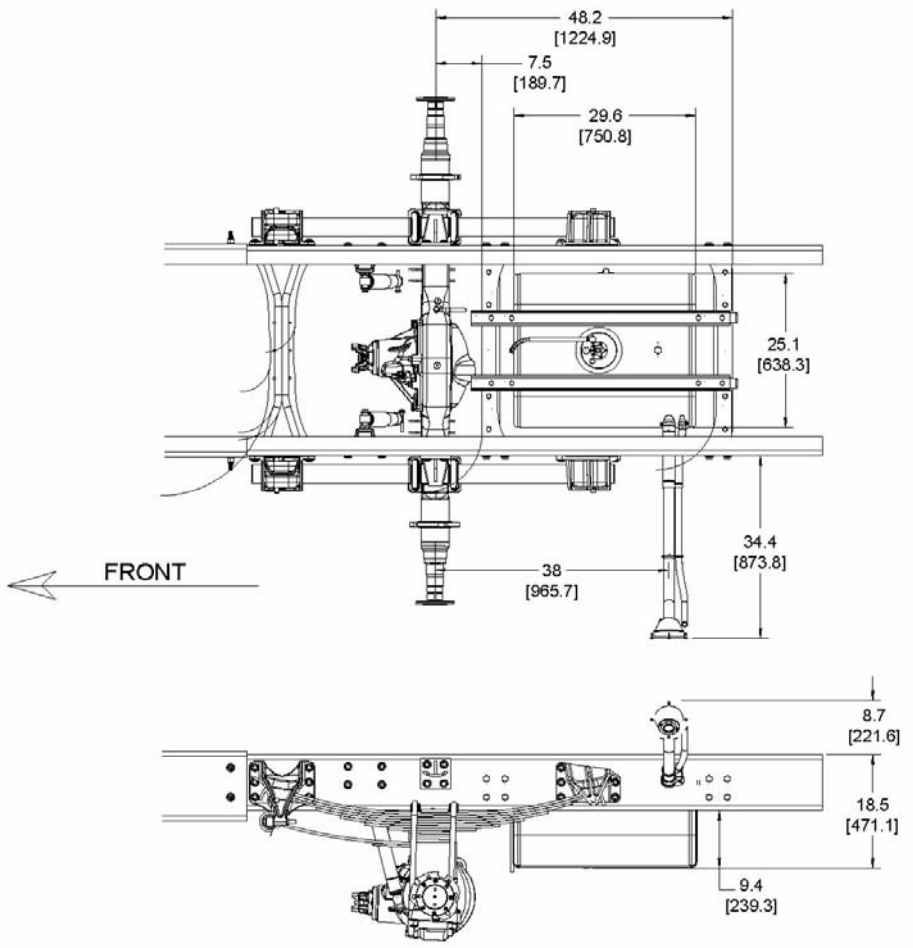
INTERNATIONAL
A NAVISTAR COMPANY

FUEL TANKS

ALL MODELS

Fuel Tank Location

Code 15SSW – Single Mounted Between Rails Behind Rear Axle, 40 Gallon, with Fuel Fill Tube



15_0087

Per EPA Title 40, Part 86, 86:007-35(c), the decal shown below must be installed on the vehicle. Decal is included with Owner's Guide Kit located in the cab glove box.

15_0005

INSTRUCTIONS FOR DECAL PLACEMENT:

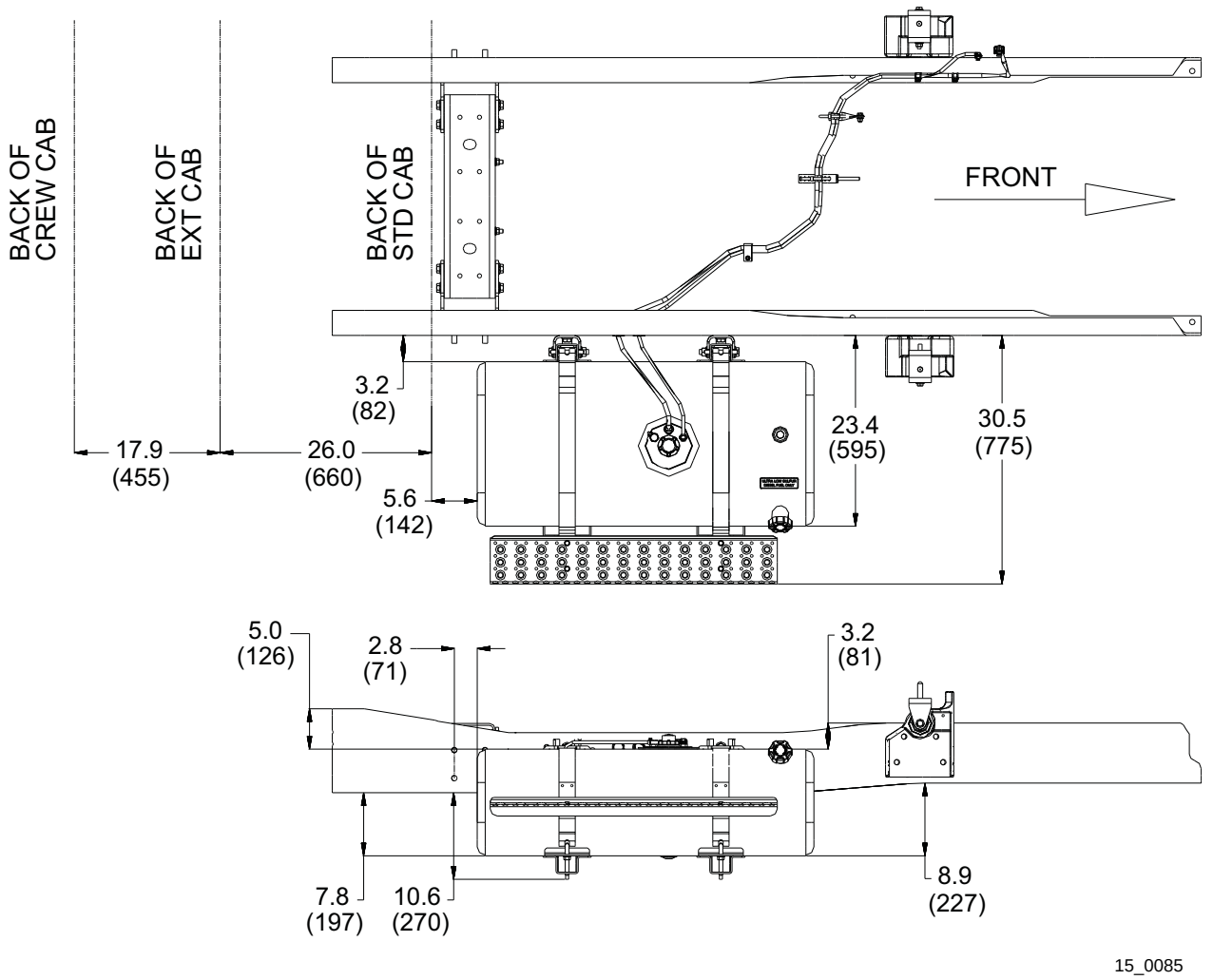
1. The decal must be placed as close as possible to the fuel inlet and be **clearly visible**.
2. The decal should be placed above or to the side of the fuel cap to avoid corrosion by possible contact with fuel.
3. The decal may be placed on aerodynamic fairings, bodies, etc. as long as the decal is clearly visible and in close proximity to the fuel inlet.
4. For installed bodies that have a fuel door (e.g. buses), the decal should be placed above or to the side of the fuel door.

Thoroughly clean the area of all grease, dirt, etc. before application of the decal. Apply the decal at room temperature, 65° to 75° F.

MODEL 4X2

Fuel Tank Location

Code 15SSX – Single Right Side, 40 Gallon



Air Conditioning System Modifications

The HVAC system provided with International® DuraStar®, WorkStar®, TranStar® and TerraStar® Series should not be modified. NO additional components should be added to the factory installed HVAC system as it is delivered from the manufacturer. If additional air conditioning capacity is needed, a completely independent system should be added to handle the additional load requirements of the Body Builder. There are additional costs for a second system; it would however, provide for optimal performance from both HVAC systems.

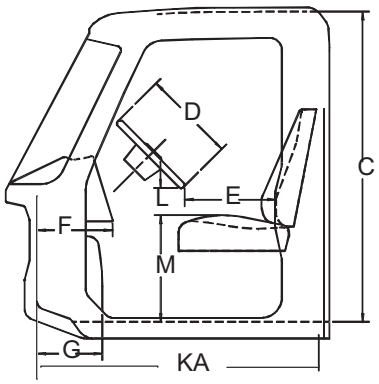
The factory installed system cannot be modified in any manner. Modification of the HVAC system will void the International Warranty on that system.

There are several reasons why HVAC system modifications are not permitted.

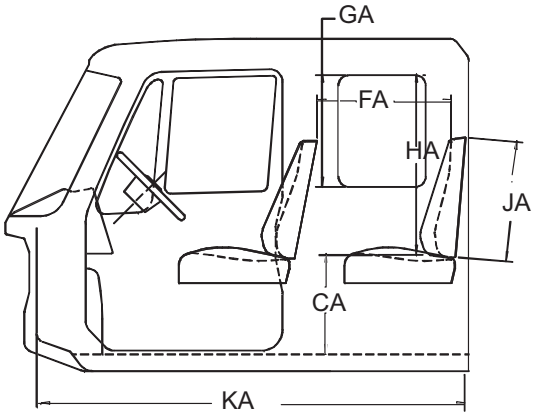
- The factory installed HVAC system is *optimized* for the evaporator, condenser and compressor combination on the vehicle. To introduce an additional evaporator (or other components) into the system will create an imbalance and unsatisfactory performance.
- The Refrigerant Control and Diagnostics (RCD) software that resides in the vehicle's body computer is designed to monitor the factory installed AC system only. Adding any additional equipment or components to the original air conditioning system will introduce conditions that the RCD software will interpret as out-of-specification conditions and cause faults to be logged.
- The factory compressor clutch is cycled by the RCD software residing in the ESC of the vehicle. Modification of this control system to add an auxiliary system could result in damage to other vehicle components.
- Since the HVAC system has been optimized for the factory components, there is no extra condenser capacity available for an auxiliary evaporator.

ALL MODELS

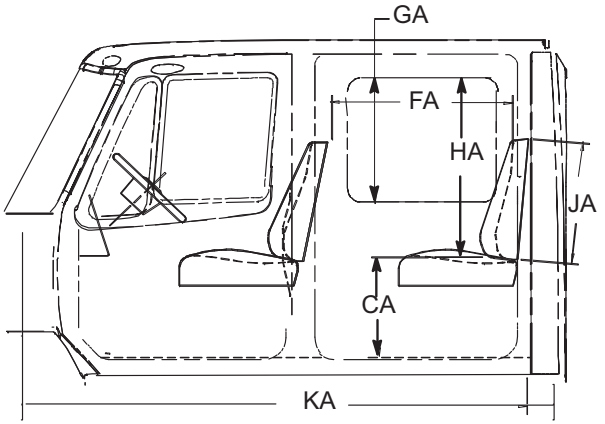
Cab Dimensions



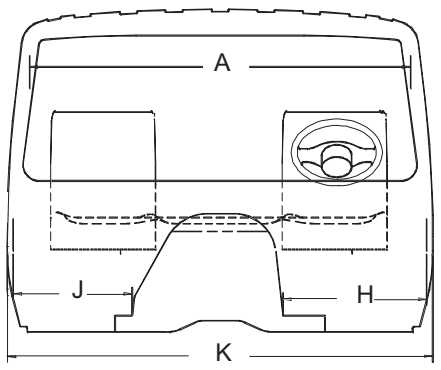
STANDARD CAB



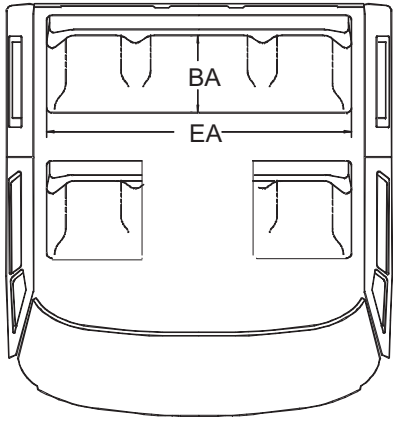
EXTENDED CAB



CREW CAB



FRONT VIEW



TOP VIEW

16_0009

ALL MODELS

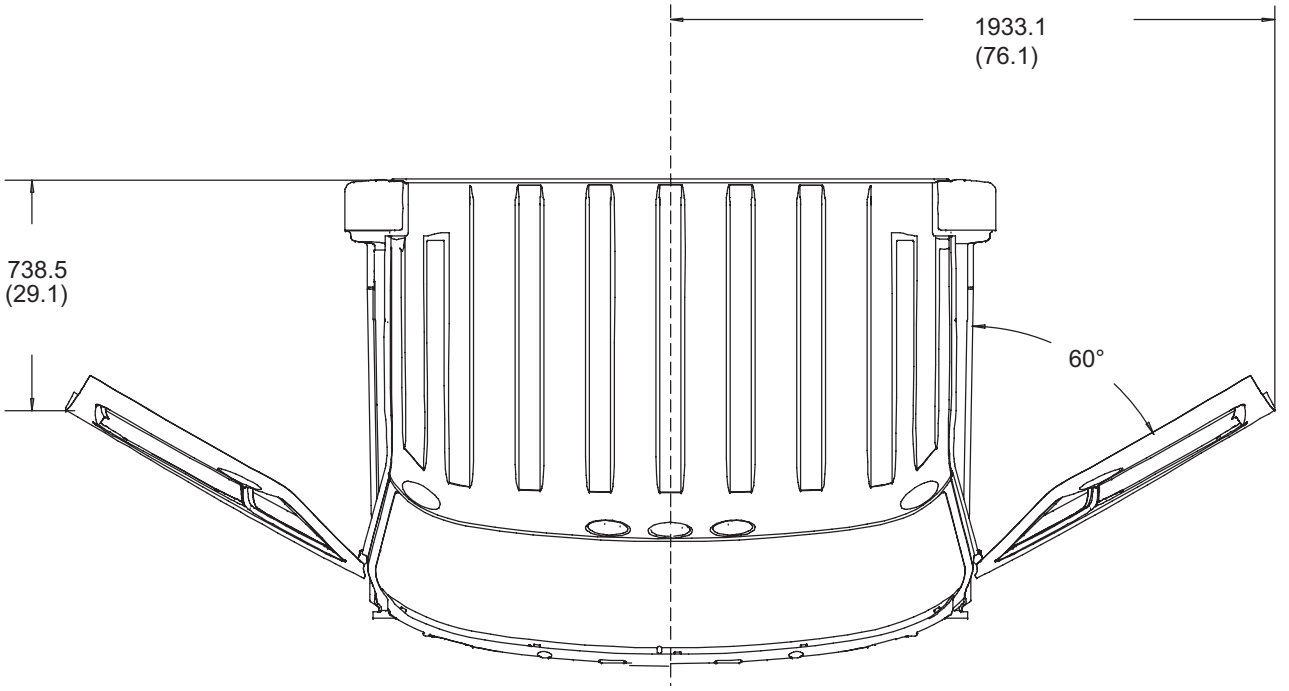
Cab Dimensions

Key	Description	Dimension – Inches		
		Regular Cab	Extended Cab	Crew Cab
A	Shoulder Room	70.6		
C	Inside Height	56.8		
D	Steering Wheel Diameter	18.0		
E	Steering Wheel to Seat Back (Maximum)	18.2		
F	Bottom of Instrument Panel to Dash	13.9		
G	Engine Cover Width	MaxxForce® 7 = 11.2		
H	Lateral Foot Room - Driver	20.2		
J	Lateral Foot Room - Passenger	18.8		
K	Outside Cab Width	82.2		
L	Steering Wheel to Top of Seat Cushion	5.8		
M	Top of Front Seat Cushion to Floor	19.6		
–	Driver Seat Track Travel	Fixed Seat: 7.9" fore/aft Air Suspension Seat: 7.4" mm fore/aft		
BA	Rear Seat Cushion Depth	–	18.0	
CA	Top of Rear Seat Cushion to Floor	–	19.0	
EA	Rear Seat Width	–	65.0	
FA	Rear Seat Spacing	–	23.2	40.2
GA	Rear Side Window Height	–	21.8	21.0
HA	Rear Seat Cushion to Top of Window	–	33.4	32.6
JA	Rear Seat Back Height	–	22.4	
KA	Inside Length	52.4	79.0	96

ALL MODELS

Door Swing Clearance

Standard Cab

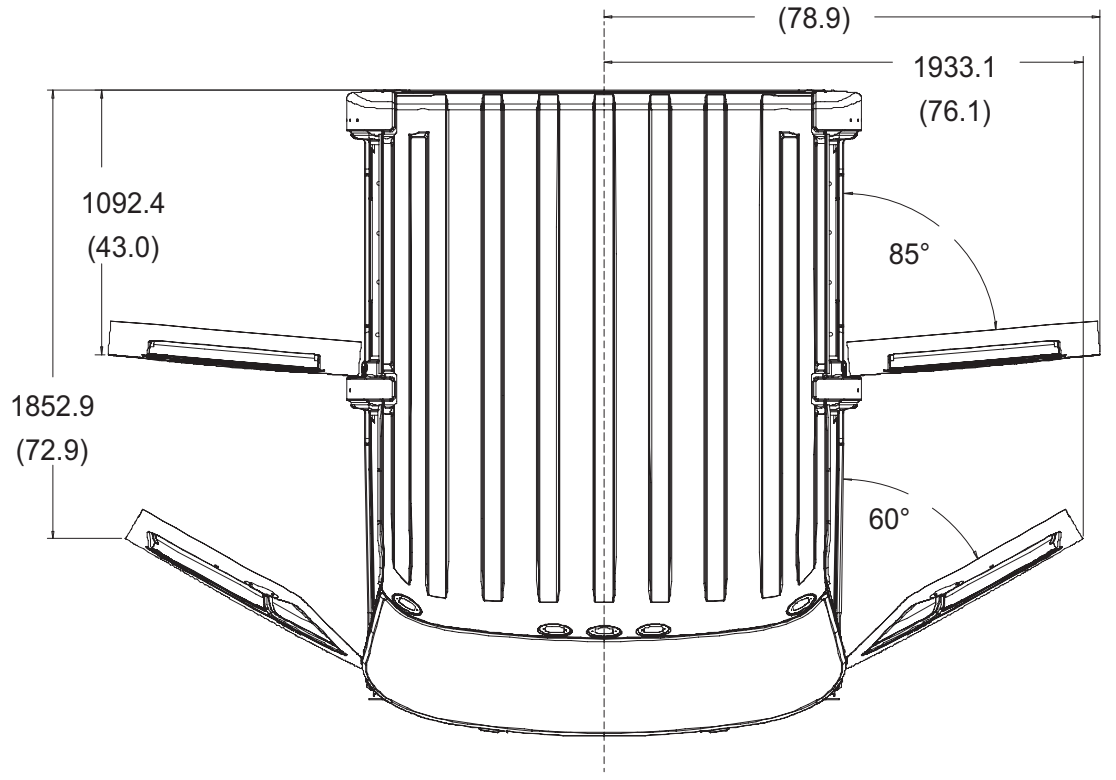


16_0010

ALL MODELS

Door Swing Clearance

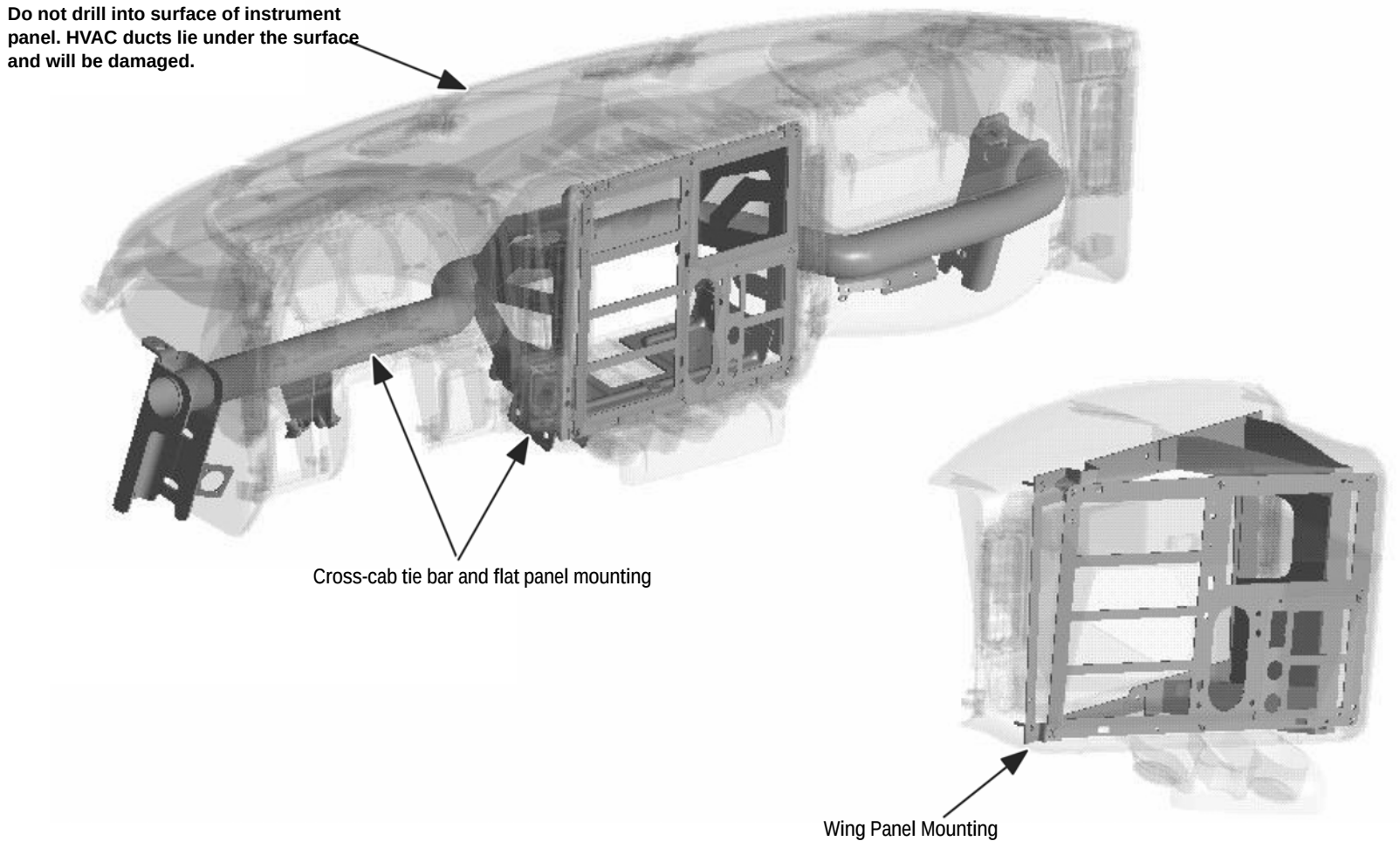
Crew Cab



16_0112

ALL MODELS

Instrument Panel



16_0011

NOTE: It is not recommended to add any accessory to the instrument panel. If an accessory must be added, it must be attached to the tie bar and framework.