



SCHOOL BUS CHASSIS WORKSHOP MANUAL

**Models: Type C SB
FS65**

Foreword

The purpose of this manual is to assist the service technician when the vehicle is serviced. Major drivetrain component service information is not included in this manual, but is located in each manufacturer's service manual.

Instructions and procedures are those recommended by Freightliner Custom Chassis Corporation (FCCC) or the component manufacturer.

Maintenance schedules and additional service information are included in the *School Bus Chassis Maintenance Manual*.

IMPORTANT: Descriptions and specifications in this manual were in effect at the time of printing. Freightliner Custom Chassis Corporation reserves the right to discontinue models at any time, or change specifications and design without notice and without incurring obligation. Descriptions and specifications contained in this publication provide no warranty, expressed or implied, and are subject to revision and editions without notice.

Refer to www.Daimler-TrucksNorthAmerica.com and www.FreightlinerChassis.com for more information, or contact Daimler Trucks North America LLC at the address below.

Environmental Concerns and Recommendations

Whenever you see instructions in this manual to discard materials, you should attempt to reclaim and recycle them. To preserve our environment, follow appropriate environmental rules and regulations when disposing of materials.

NOTICE: Parts Replacement Considerations

Do not replace suspension, axle, or steering parts (such as springs, wheels, hubs, and steering gears) with used parts. Used parts may have been subjected to collisions or improper use and have undetected structural damage.

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Descriptions of Service Publications

Daimler Trucks North America LLC distributes the following major service publications in paper and electronic (via ServicePro®) formats.

Workshop/Service Manual	Workshop/service manuals contain service and repair information for all vehicle systems and components, except for major components such as engines, transmissions, and rear axles. Each workshop/service manual section is divided into subjects that can include general information, principles of operation, removal, disassembly, assembly, installation, specifications, and troubleshooting.
Maintenance Manual	Maintenance manuals contain routine maintenance procedures and intervals for vehicle components and systems. They have information such as lubrication procedures and tables, fluid replacement procedures, fluid capacities, specifications, and procedures for adjustments and for checking the tightness of fasteners. Maintenance manuals do not contain detailed repair or service information.
Driver's/Operator's Manual	Driver's/operator's manuals contain information needed to enhance the driver's understanding of how to operate and care for the vehicle and its components. Each manual contains a chapter that covers pretrip and post-trip inspections, and daily, weekly, and monthly maintenance of vehicle components. Driver's/operator's manuals do not contain detailed repair or service information.
Service Bulletins	Service bulletins provide the latest service tips, field repairs, product improvements, and related information. Some service bulletins are updates to information in the workshop/service manual. These bulletins take precedence over workshop/service manual information, until the latter is updated; at that time, the bulletin is usually canceled. The service bulletins manual is available only to dealers. When doing service work on a vehicle system or part, check for a valid service bulletin for the latest information on the subject. IMPORTANT: Before using a particular service bulletin, check the current service bulletin validity list to be sure the bulletin is valid.
Parts Technical Bulletins	Parts technical bulletins provide information on parts. These bulletins contain lists of parts and BOMs needed to do replacement and upgrade procedures.
Web-based repair, service, and parts documentation can be accessed using the following applications on the AccessFreightliner.com website.	
ServicePro	ServicePro® provides Web-based access to the most up-to-date versions of the publications listed above. In addition, the Service Solutions feature provides diagnostic assistance with Symptoms Search, by connecting to a large knowledge base gathered from technicians and service personnel. Search results for both documents and service solutions can be narrowed by initially entering vehicle identification data.
PartsPro	PartsPro® is an electronic parts catalog system, showing the specified vehicle's build record.
EZWiring	EZWiring™ makes Freightliner, Sterling, Western Star, Thomas Built Buses, and Freightliner Custom Chassis Corporation products' wiring drawings and floating pin lists available online for viewing and printing. EZWiring can also be accessed from within PartsPro.

Descriptions of Service Publications

Warranty-related service information available on the AccessFreightliner.com website includes the following documentation.

Recall Campaigns

Recall campaigns cover situations that involve service work or replacement of parts in connection with a recall notice. These campaigns pertain to matters of vehicle safety. All recall campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Field Service Campaigns

Field service campaigns are concerned with non-safety-related service work or replacement of parts. All field service campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Page Description

For an example of a *School Bus Chassis Workshop Manual* page, see Fig. 1.

A
B
C

Hendrickson HAS
32.03

Main Support Member Removal and Installation

Removal

NOTE: Operation of the HAS suspension will result in wear between the main support member and the spring hanger slipper pad. In normal use, these components will function satisfactorily even though they show some wear. Premature wear may occur, however, and requires the replacement of one or both parts. A main support member should be replaced if it has 3/8-inch (9.5 mm) or more wear at the spring hanger cam contact area.

1. Chock the front tires.
2. Support the axle with a jack stand.
3. Drain the vehicle's air system.
4. Remove the height control valve. Refer to **Subject 120**.
5. Raise the rear of the frame enough to remove the load from the main support member. Support with safety stands.
6. Remove the U-bolt locknuts and washers, then remove the U-bolts.
7. Remove both locknuts and washers connecting the cross channel to both main support members.
8. Lift the cross channel from the main support member with jacks.
9. Remove the main support assembly.

Installation

1. Position the main support member on the axle seat, or on the spacer plate if the vehicle is so equipped, with the main support member center dowel sliding into the hole in the axle seat or spacer plate. The Delrin liner must be positioned on the top of the main support member.
2. Attach the top pad, the U-bolts, the bottom cap, and the washers and locknuts, but do not tighten the U-bolt locknuts.
3. Position the torque rod mounting bolts of the center springs toward the front of the vehicle.
4. Lower the air spring and cross channel mounting bolts into the main support members.

5. Attach the washers and locknuts that connect the cross channel to the main support members. Tighten the locknuts 280 lbf-ft (380 N·m). See Fig. 1.
6. Lower the frame until the spring hangers engage the main support member. Fill the system with air, and center the main support member between the spring hanger legs.
7. Tighten evenly the U-bolt locknuts 425 lbf-ft (576 N·m). While doing so, rap with a hammer the top of the U-bolts, and then retighten to 425 lbf-ft (576 N·m).

IMPORTANT: Do not exceed the specified torque on the U-bolt locknuts.

8. Attach the spring hangers. Tighten the locknuts 60 lbf-ft (81 N·m).
9. Attach the height control valve link, and tighten 125 lbf-ft (169 N·m).
10. Check alignment after the new main support members are installed.

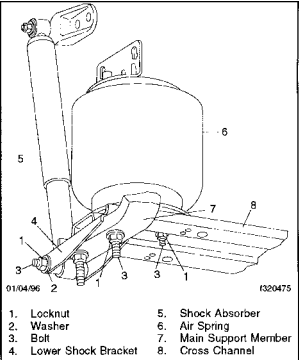


Fig. 1, Main Support Member Assembly

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100/1

D
E
F G

10/02/96

A. Section Title
 B. Section Number (made up of the Group Number—first two digits, followed by a sequence number—last two digits)
 C. Subject Title

D. Manual Title
 E. Release (Supplement) Date
 F. Subject Number
 G. Subject Page Number

fo20055

Fig. 1, Example of a School Bus Chassis Workshop Manual Page

Group No.	Group Title
00	General Information
01	Engine
09	Air Intake
13	Air Compressor
15	Alternators and Starters
20	Engine Cooling/Radiator
25	Clutch
26	Transmission
30	Throttle Control
31	Frame and Frame Components
32	Suspension
33	Front Axle
35	Rear Axle
40	Wheels and Tires
41	Driveline
42	Brakes
46	Steering
47	Fuel
49	Exhaust
54	Electrical, Instruments, and Controls
60	Cab
82	Windshield Wipers and Washer
88	Hood, Grille, and Cab Fenders
98	Paint

List of Abbreviations

The following is a list of definitions for abbreviations and symbols used in Freightliner publications.

A	amperes	CD-ROM ..	compact-disc/read-only memory	ECAP	electronic control analyzer programmer
ABS	antilock braking system	CDTC	constant discharge temperature control	ECAS	electronically controlled air suspension
ABS	acrylonitrile-butadiene-styrene	CEL	check-engine light	ECI	electronically controlled injection
A/C	air conditioner	CFC	chlorofluorocarbons (refrigerant-12)	ECM	electronic control module
AC	alternating current	cfm	cubic feet per minute	ECU	electronic control unit
ACPU	air conditioning protection unit	CFR	Code of Federal Regulations	EDM	electronic data monitor
ADLO	auto-disengagement lockout	CLS	coolant level sensor	EEPROM ..	electrically erasable programmable read-only memory
a.m.	<i>ante meridiem</i> (midnight to noon)	cm	centimeters	EMI	electromagnetic interference
AM	amplitude modulation	cm³	cubic centimeters	EOA	electric over air
amp(s)	ampere(s)	CMVSS	Canadian Motor Vehicle Safety Standard	EP	extreme pressure (describes an antiwear agent added to some lubricants)
AMU	air management unit	Co.	company	EPA	Environmental Protection Agency
ANSI	American National Standards Institute	COE	cab over engine	EPS	engine position sensor
API	American Petroleum Institute	Corp.	corporation	etc.	<i>et cetera</i> (and so forth)
ARI	Air Conditioning and Refrigeration Institute	CPU	central processing unit	ETEC	electronic truck engine control
ASA	American Standards Association	cSt	centistokes (unit of measurement for describing the viscosity of general liquids)	EUI	electronic unit (fuel) injectors
ASF	American Steel Foundries	cu ft	cubic feet	FAS	Freightliner air suspension
ASR	automatic spin regulator	cu in	cubic inches	Fig.	figure
assy.	assembly	CUM	Cummins	fl oz	fluid ounces
ASTM	American Society for Testing and Materials	CWS	collision warning system	FLA	post-1984 advancements Freightliner COE
ATC	automatic temperature control	DC	direct current	FLB	enhanced Freightliner FLA COE
ATC	automatic traction control	DDA	Detroit Diesel Allison	FLC	steel-cab Freightliner 112 Conventional
ATC	automatic transmission control	DDC	Detroit Diesel Corporation	FLD	post-1984 advancements Freightliner 112/120 aluminum-cab Conventional
ATF	automatic transmission fluid	DDE	Detroit Diesel Engines	FM	frequency modulation
attn	attention	DDEC	Detroit Diesel Electronic (engine) control	FMCSA	Federal Motor Carrier Safety Administration
aux.	auxiliary	DDR	diagnostic data reader	FMI	failure mode identifier
av	<i>avoirdupois</i> (British weight system)	DDU	driver display unit	FMSI	Friction Materials Standards Institute
AWG	American wire gauge	DGPS	differential global positioning system	FMVSS	Federal Motor Vehicle Safety Standard
AWS	American Welding Society	dia.	diameter	FRP	fiberglass reinforced plastic
BAT	battery	DIP	dual inline package (switch)	FSA	field service authorization
BBC	bumper-to-back-of-cab	DLA	data link adaptor	ft	feet
BOM	bill of material	DLU	data logging unit	ft³	cubic feet
BTDC	before top dead center	DMM	digital multimeter	ft³/min	cubic feet per minute
Btu(s)	British thermal unit(s)	DOT	Department of Transportation	FTL	Freightliner
C	common (terminal)	DRL	daytime running lights	F.U.E.L.	fuel usage efficiency level
CAC	charge air cooler	DRM	dryer reservoir module	g	grams
CAN	controller area network	DSM	district service manager		
CARB	California Air Resources Board	DTC	discharge temperature control		
CAT	Caterpillar	DVOM	digital volt/ohm meter		
CB	circuit breaker	ea.	each		
CB	citizens' band	EBS	electronic braking system		
CCA	cold cranking amperes				

List of Abbreviations

gal	gallons	LHK	liters per hundred kilometers	OSHA	Occupational Safety and Health Administration
GAWR	gross axle weight rating	LHS	low hydrogen steel	oz	ounces
GL	gear lubricant	LLC	limited liability company	ozf-in	ounces force inches
GND	ground	L/min	liters per minute	p	positive (front axle wheel alignment specification)
gpm	gallons per minute	LPG	liquefied petroleum gas	parm	parameter
GPS	global positioning system	m	meters	PC	personal computer
GVWR	gross vehicle weight rating	max.	maximum	PCB	printed circuit board
HCU	hydraulic control unit	MESA	Mining Enforcement Safety Act	PDC	parts distribution center
HD	heavy-duty	mfr.	manufacturer	PDM	power distribution module
HEPA	high-efficiency particulate air (filter)	mi	miles	PEEC	programmable electronic engine control
HFC	hydrogenated fluorocarbons (refrigerant-134a)	MID	message identifier	PID	parameter identifier
hp	horsepower	MIL	military specification	PLC	power line carrier
hp	high pressure	min.	minutes	PLD	<i>Pumpe-Linie-Düse</i> (pump-line-nozzle)
HRC	Rockwell "C" hardness	min.	minimum	p.m.	<i>post meridiem</i> (noon to midnight)
hr(s)	hour(s)	misc.	miscellaneous	p/n	part number
htr	heater	mL	milliliters	PSA	pressure sensitive adhesive
HVAC	heating, ventilating and air conditioning	mm	millimeters	psi	pounds per square inch
H/W	hardware	mod.	module	psia	pounds per square inch, atmosphere
ICU	instrumentation control unit	mpg	miles per gallon	psig	pounds per square inch, gauge
i.d.	inside diameter	mph	miles per hour	pt	pints
ID	identification	MSHA	Mining Safety and Health Administration	pt	points
IFI	Industrial Fasteners Institute	MVDA	Motor Vehicle Dealers Association	PTCM	pressure time control module
IGN	ignition	n	negative (front axle wheel alignment specification)	PTO	power take-off
ILO	<i>in lieu of</i> (in the place of)	N/A	not applicable	pvc	polyvinyl chloride
in	inches	N-cm	Newton-centimeters	PWM	pulse width modulation
in³	cubic inches	NC	normally closed (terminal or switch)	qt	quarts
Inc.	incorporated	NHTSA	National Highway Traffic Safety Administration	qty.	quantity
inH₂O	inches of water	NIOSH	National Institute for Occupational Safety and Health	R & O	rust inhibitors and oxidants
inHg	inches of mercury	NLGI	National Lubricating Grease Institute	R-12	refrigerant-12 (CFC)
IP	instrument panel	N-m	Newton-meters	R-134a	refrigerant-134a (HFC)
ISO	International Organization for Standardization	NO	normally open (terminal or switch)	RAM	random access memory
k	kilo (1000)	no.	number	recirc	recirculation
kg	kilograms	NPT	national pipe thread	Ref(s).	reference(s)
km	kilometers	NPTF	national pipe thread fitting	RFI	radio frequency interference
km/h	kilometers per hour	NSBU	neutral start/backup	RH	right-hand
kPa	kilo Pascals	NT	nylon tube or nylon tubing	RH DR	right-hand drive
kW	kilowatts	OCV	open circuit voltage	R/I	removal and installation
L	liters	o.d.	outside diameter	RMA	return material authorization
lb	pounds	O.D.	overdrive	ROM	read-only memory
lbf-ft	pounds force feet	OEM	original equipment manufacturer	rpm	revolutions per minute
lbf-in	pounds force inches			R/R	removal and replacement
LCD	liquid crystal display			RSG	road speed governor
LED	light-emitting diode			RTV	room temperature vulcanizing
LH	left-hand				
LH DR	left-hand drive				

RV	recreational vehicle	WB	wire braid
SAE	Society of Automotive Engineers	WI	work instructions
SB	service bulletin	WOT	wide open throttle
SD	severe duty	-	minus or negative
SDU	step deployment unit	+	plus or positive
SEL	shutdown engine light	±	plus-or-minus
SI	service information	>	greater than
SI	<i>Système International</i>	<	less than
SID	subsystem identifier	x	by (used in fastener size descriptions)
SMC	sheet molded compound	"	inches
S/N	serial number	°	degrees (of an angle)
SPACE	seat pretensioner activation for crash survival enhancement	°C	degrees Celsius (centigrade)
SRT	standard repair time	°F	degrees Fahrenheit
SSD	side sensor display	#	number
SST	stainless steel	%	percent
std.	standard	&	and
S/W	software	©	copyright
SW	switch	™	trademark
TAM	thermocouple amplifier module	®	registered trademark
TBS	turbo boost sensor		
TCU	transmission control unit		
TDC	top dead center		
TDR	technician diagnostic routine		
temp	temperature		
TIG	tungsten inert gas		
TPS	thermal protection switch		
TPS	throttle position sensor		
TRS	timing reference sensor		
TSO	truck sales order		
U.D.	underdrive		
UNC	unified national coarse		
UNF	unified national fine		
U.S.	United States		
U.S.A.	United States of America		
USC	United States customary (measures)		
V	volts		
VDC	vehicle data computer		
Vdc	volts, direct current		
VIN	vehicle identification number		
VIP	vehicle instrumentation and protection (Kysor)		
VOC	volatile organic compounds		
VOM	volt-ohmmeter		
VSG	variable speed governor		
VSS	vehicle speed sensor		

General Information

U.S. Customary to Metric			Metric to U.S. Customary		
When You Know	Multiply By	To Get	When You Know	Multiply By	To Get
Length					
inches (in)	25.4	millimeters (mm)	0.03937		inches (in)
inches (in)	2.54	centimeters (cm)	0.3937		inches (in)
feet (ft)	0.3048	meters (m)	3.281		feet (ft)
yards (yd)	0.9144	meters (m)	1.094		yards (yd)
miles (mi)	1.609	kilometers (km)	0.6215		miles (mi)
Area					
square inches (in ²)	645.16	square millimeters (mm ²)	0.00155		square inches (in ²)
square inches (in ²)	6.452	square centimeters (cm ²)	0.15		square inches (in ²)
square feet (ft ²)	0.0929	square meters (m ²)	10.764		square feet (ft ²)
Volume					
cubic inches (in ³)	16387.0	cubic millimeters (mm ³)	0.000061		cubic inches (in ³)
cubic inches (in ³)	16.387	cubic centimeters (cm ³)	0.06102		cubic inches (in ³)
cubic inches (in ³)	0.01639	liters (L)	61.024		cubic inches (in ³)
fluid ounces (fl oz)	29.54	milliliters (mL)	0.03381		fluid ounces (fl oz)
pints (pt)	0.47318	liters (L)	2.1134		pints (pt)
quarts (qt)	0.94635	liters (L)	1.0567		quarts (qt)
gallons (gal)	3.7854	liters (L)	0.2642		gallons (gal)
cubic feet (ft ³)	28.317	liters (L)	0.03531		cubic feet (ft ³)
cubic feet (ft ³)	0.02832	cubic meters (m ³)	35.315		cubic feet (ft ³)
Weight/Force					
ounces (av) (oz)	28.35	grams (g)	0.03527		ounces (av) (oz)
pounds (av) (lb)	0.454	kilograms (kg)	2.205		pounds (av) (lb)
U.S. tons (t)	907.18	kilograms (kg)	0.001102		U.S. tons (t)
U.S. tons (t)	0.90718	metric tons (t)	1.1023		U.S. tons (t)
Torque/Work Force					
inch-pounds (lbf-in)	11.298	Newton-centimeters (N-cm)	0.08851		inch-pounds (lbf-in)
foot-pounds (lbf-ft)	1.3558	Newton-meters (N-m)	0.7376		foot-pounds (lbf-ft)
Pressure/Vacuum					
inches of mercury (inHg)	3.37685	kilo Pascals (kPa)	0.29613		inches of mercury (inHg)
pounds per square inch (psi)	6.895	kilo Pascals (kPa)	0.14503		pounds per square inch (psi)

When You Know	Subtract	Then Divide By	To Get	When You Know	Multiply By	Then Add	To Get
degrees Fahrenheit (°F)	32	1.8	degrees Celsius (°C)	degrees Celsius (°C)	1.8	32	degrees Fahrenheit (°F)

Threaded Fastener Types

The majority of threaded fasteners used throughout the vehicle have U.S. customary threads (diameter and pitch are measured in inches). See Fig. 1. However, the engine may use metric fasteners (diameter and pitch are measured in millimeters).

Most threaded fasteners used on the chassis that are 1/2-inch diameter or larger are plain hex-type fasteners (non-flanged); *all* metric fasteners are non-flanged. Special hardened flatwashers are used under the bolt head, and between the part being attached and the hexnut, to distribute the load, and to prevent localized overstressing of the parts. The washers are cadmium- or zinc-plated, and have a hardness rating of 38 to 45 HRC.

Some fasteners smaller than 1/2-inch diameter are flanged fasteners, which have integral flanges that fit against the parts being fastened. The flanges eliminate the need for washers.

Fastener Grades and Classes

Fasteners with U.S. customary threads are divided into grades established by the Society of Automotive Engineers (S.A.E.) or the International Fastener Institute (I.F.I.). The fastener grades indicate the relative strength of the fastener; the higher the number (or letter), the stronger the fastener. Bolt (capscrew) grades can be identified by the number and pattern of radial lines forged on the bolt head. See Fig. 2. Hexnut (and locknut) grades can be identified by the number and pattern of lines and dots on various surfaces of the nut. See Fig. 3. Nearly all of the bolts used on the vehicle are grades 5, 8, and 8.2. Matching grades of hexnuts are always used: grade 5 or grade B hexnuts are used with grade 5 bolts; grade 8, grade C, or grade G (flanged) hexnuts are used with grade 8 or 8.2 bolts.

Fasteners with metric threads are divided into classes adopted by the American National Standards Institute (ANSI). The higher the class number, the stronger the fastener. Bolt classes can be identified by the numbers forged on the head of the bolt. See Fig. 4. Hexnut (and locknut) classes can be identified by the marks or numbers on various surfaces of the nut. See Fig. 5. Class 8 hexnuts are always used with class 8.8 bolts; class 10 hexnuts with class 10.9 bolts.

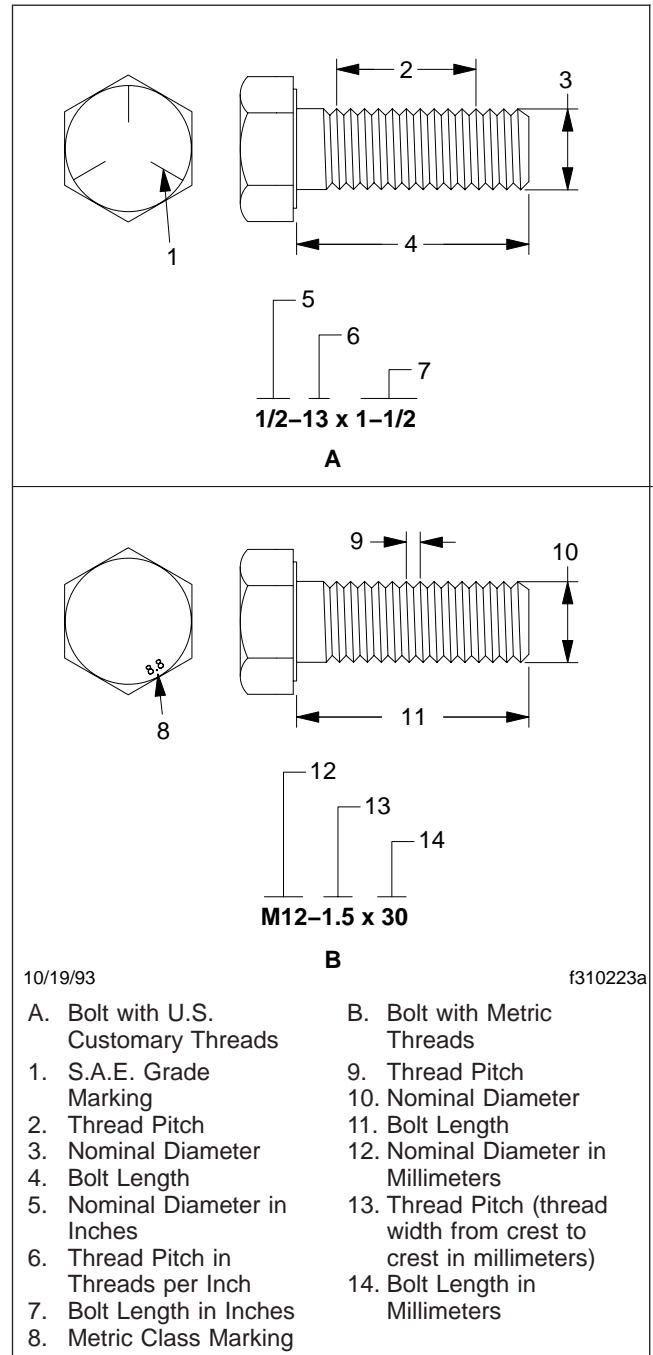


Fig. 1, Fastener Size and Thread Identification

General Information

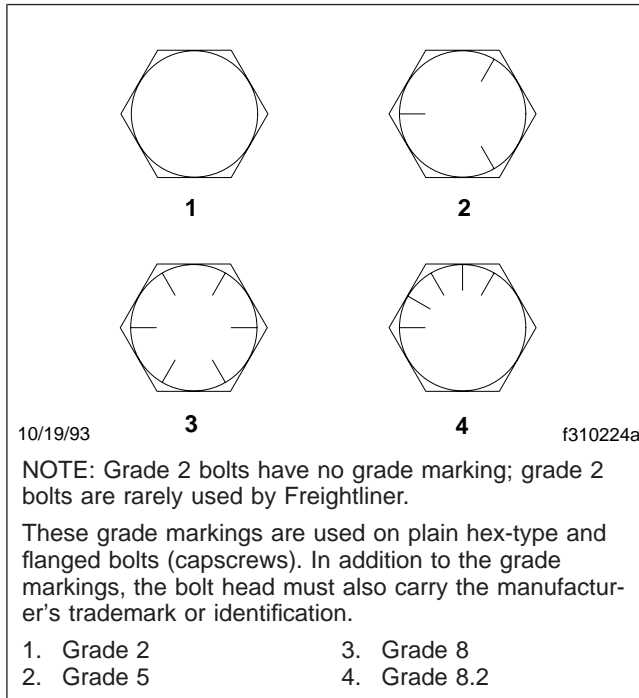


Fig. 2, Bolt Grades

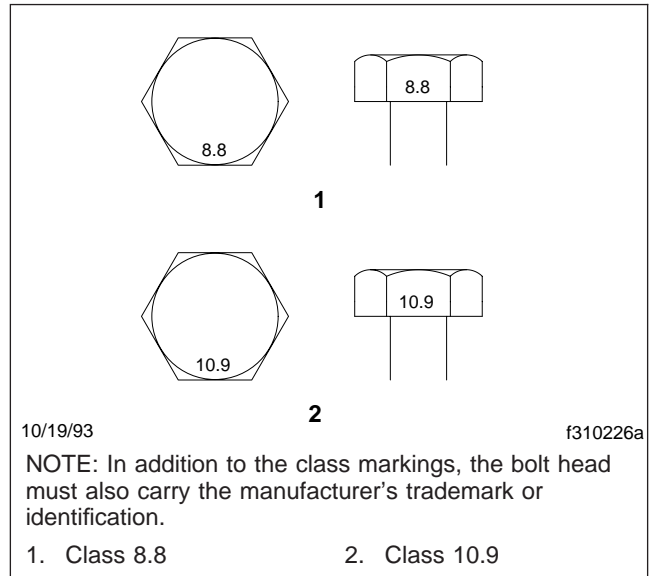


Fig. 4, Bolt Classes

Frame Fasteners

For components attached to the frame, grade 8 and

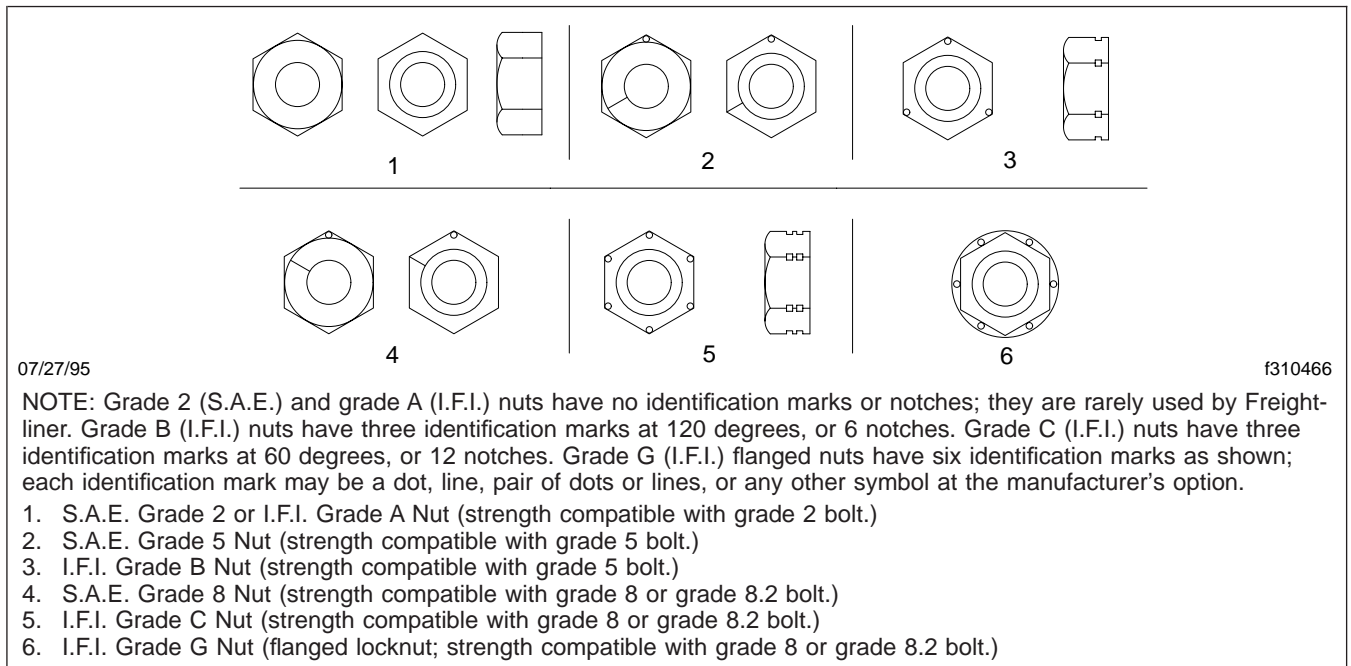


Fig. 3, Nut Grades

8.2 phosphate-and oil-coated hexhead bolts and

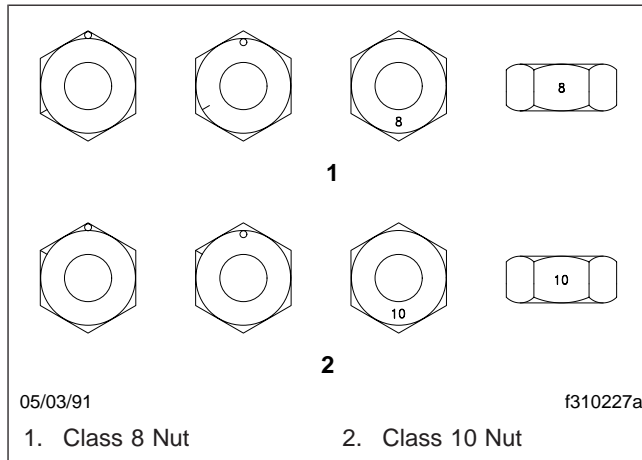


Fig. 5, Nut Classes

grade C cadmium-plated and wax-coated prevailing torque locknuts are used. The prevailing torque locknuts have distorted sections of threads to provide torque retention. For attachments where clearance is minimal, low-profile hexhead bolts and grade C prevailing torque locknuts are used. See [Fig. 6](#).

Tightening Fasteners

When a capscrew is tightened to its torque value in a threaded hole, or a nut is tightened to its torque value on a bolt, the shank of the capscrew or bolt is stretched slightly. This stretching (tensioning) results in a preload that reduces fatigue of the fasteners. The torque values given in the tables in [Specifications, 400](#) have been calculated to provide enough clamping force on the parts being fastened, and the correct tensioning of the bolt to maintain the clamping force.

Use of a torque wrench to tighten fasteners will help prevent overtensioning them. Overtensioning causes permanent stretching of the fasteners, which can result in breakage of the parts or fasteners.

When torquing a fastener, typically 80 to 90 percent of the turning force is used to overcome friction; only 10 to 20 percent is used to stretch the capscrew or bolt. About 40 to 50 percent of the turning force is needed to overcome the friction between the underside of the capscrew head or nut and the washer. Another 30 to 40 percent is needed to overcome the friction between the threads of the capscrew and the threaded hole, or the friction between the threads of the nut and bolt.

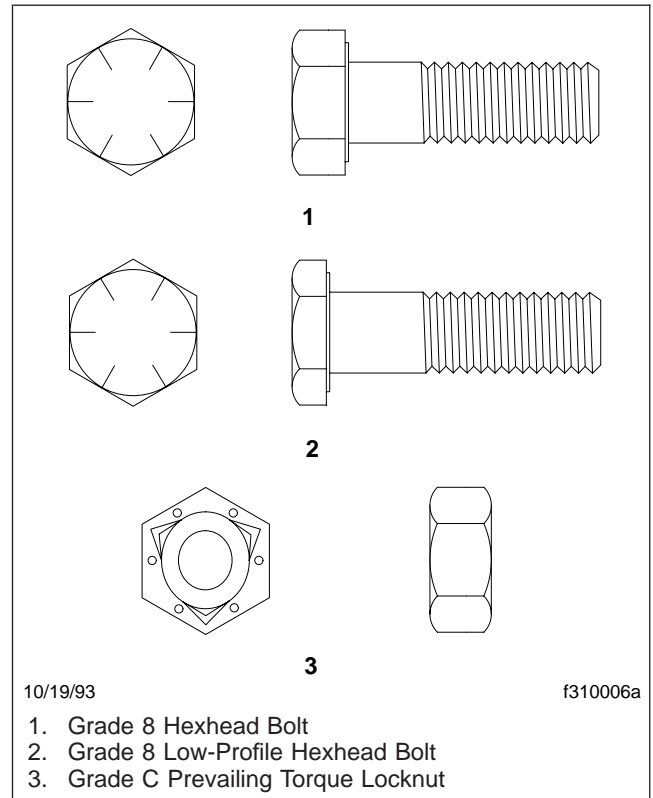


Fig. 6, Frame Fastener Identification

The amount of torque required to tighten a fastener is reduced when the amount of friction is reduced. If a fastener is dry (unlubricated) and plain (unplated), the amount of friction is high. If a fastener is wax-coated or oiled, or has a zinc phosphate coating or cadmium plating, the amount of friction is reduced. Each of these coatings and combinations of coatings has a different effect. Using zinc-plated hardened flatwashers under the bolt (capscrew) head and nut reduces the amount of friction. Dirt or other foreign material on the threads or clamping surfaces of the fastener or clamped part also changes the amount of friction.

Even though each different condition affects the amount of friction, a different torque value cannot be given for each different condition. To ensure they are always torqued accurately, Freightliner recommends that all fasteners be lubricated with oil (unless specifically instructed to install them dry), then torqued to the values for lubricated- and plated-thread fasteners. When locking compound or anti-seize compound

General Information

is recommended for a fastener, the compound acts as a lubricant, and oil is not needed.

Fastener Replacement

When replacing fasteners, use only identical bolts, washers, and nuts; they must be the same size, strength, and finish as originally specified. See the Freightliner Service Parts Catalog for fastener specifications.

When replacing graded (or metric class) bolts and capscrews, use only fasteners that have the manufacturer's trademark or identification on the bolt head; do not use substandard bolts. Inferior, counterfeit fasteners are difficult to identify; buy your fasteners from a reputable supplier.

Fastener Selection and Installation

When using nuts with bolts, use a grade (or class) of nut that matches the bolt.

When installing non-flanged fasteners, use hardened steel flatwashers under the bolt (capscrew) head, and under the hexnut or locknut.

For bolts 4 inches (100 mm) or less in length, make sure that at least 1-1/2 threads and no more than 5/8-inch (16-mm) bolt length extends through the nut after it has been tightened. For bolts longer than 4 inches (100 mm), allow a minimum of 1-1/2 threads and a maximum of 3/4-inch (19-mm) bolt length.

Never hammer or screw bolts into place. Align the holes of the parts being attached, so that the nut and bolt surfaces are flush against the washers, and the washers are flush against the parts.

When installing fasteners in aluminum or plastic parts with threaded holes, start the fasteners by hand, to ensure straight starting and to prevent damaged threads.

Do not use lockwashers (split or toothed) next to aluminum surfaces.

When installing studs that do not have an interference fit, install them with thread locking compound, as instructed in this subject.

When installing parts that are mounted on studs, use free-spinning (non-locking) nuts and helical-spring (split) lockwashers or internal-tooth lockwashers. Do not use locknuts, because they tend to loosen the studs during removal. Do not use plain washers (flatwashers).

Do not use lockwashers and flatwashers in combination (against each other); each defeats the other's purpose.

Use stainless steel fasteners against chrome plating, unpainted aluminum, or stainless steel.

Fastener Tightening

Before installing fasteners, clean all fastener (and parts) threads, and all surfaces being clamped.

To ensure they are always torqued accurately, Freightliner recommends that *all* fasteners be lubricated with oil (unless specifically instructed to install them dry), then torqued to the values for lubricated-and plated-thread fasteners. When locking compound or antiseize compound is recommended for a fastener, the compound acts as a lubricant, and oil is not needed.

Bring parts and fasteners into contact, with no gaps between them, before using a torque wrench to tighten fasteners to their final torque values.

Tighten the nut, not the bolt head. This will give a truer torque reading by eliminating bolt body friction.

Always use a torque wrench to tighten fasteners, and use a slow, smooth, even pull on the wrench. Do not overtorque fasteners; overtightening causes permanent stretching of the fasteners, which can result in breakage of the parts or fasteners.

If specific torque values are not given for countersunk bolts, use the torque value for the corresponding size and grade of regular bolt, as given in [Specifications, 400](#).

Always follow the torque sequence or torque interval when provided, to ensure that clamping forces are even, and parts and fasteners are not distorted.

Thread Locking Compound Application

When the use of thread locking compound is recommended or desired, for studs, capscrews, and bolts with a thread diameter of 1 inch (25 mm) or less, use Loctite® 244 or 271, or Perma-Lok® HM-128.

For thread diameters over 1 inch (25 mm), use Loctite 277.

General Instructions

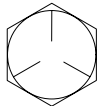
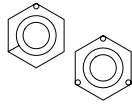
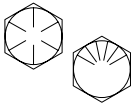
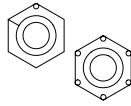
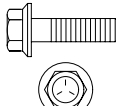
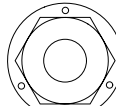
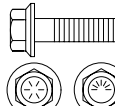
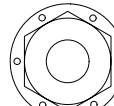
NOTE: Follow the safety precautions given on the locking compound container.

1. Clean the male and female threads of the fasteners, removing all dirt, oil, and other foreign material. If parts are contaminated, use Stoddard solvent for cleaning; then allow the fasteners to air dry for 10 minutes. Be sure solvent is completely gone before applying adhesive.
2. Transfer a small amount of the locking compound from the container to a paper cup or small non-metal dish.
3. Using a plastic brush (a metal brush will contaminate the compound), apply a small amount of compound to the entire circumference of 3 or 4 of the male threads that will be covered by the nut after it has been tightened. Be sure enough compound is applied to fill the inside of the nut threads, with a slight excess.
4. Install and torque the nut. Readjustment of the nut position is not possible after installation is complete, without destroying the locking effect.

NOTE: To disassemble the fasteners, heat the bond line to 400°F (200°C) before removing the nut. Every time the fasteners are disassembled, replace them. If any parts are damaged by overheating, replace the parts.

IMPORTANT: Grade 8 regular hex zinc-yellow plated capscrews and cadmium- and wax-coated prevailing torque locknuts may be tightened to a lower torque value than the grade 8

regular hex fasteners described in [Table 1](#). See [Table 2](#) for torque values for grade 8 regular hex zinc-yellow plated capscrews and cadmium- and wax-coated prevailing torque locknuts.

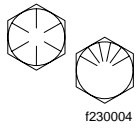
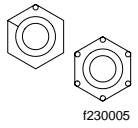
Torque Values for U.S. Customary Thread Fasteners With Lubricated* or Plated Threads†								
Thread Diameter–Pitch	Regular Hex				Flanged			
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 5 Bolt	Grade B Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)	
	 f230002	 f230003	 f230004	 f230005	 f230006	 f230007	 f230008	 f230009
1/4–20	7 (9)		8 (11)		6 (8)		10 (14)	
1/4–28	8 (11)		9 (12)		7 (9)		12 (16)	
5/16–18	15 (20)		16 (22)		13 (18)		21 (28)	
5/16–24	16 (22)		17 (23)		14 (19)		23 (31)	
3/8–16	26 (35)		28 (38)		23 (31)		37 (50)	
3/8–24	30 (41)		32 (43)		25 (34)		42 (57)	
7/16–14	42 (57)		45 (61)		35 (47)		60 (81)	
7/16–20	47 (64)		50 (68)		40 (54)		66 (89)	
1/2–13	64 (87)		68 (92)		55 (75)		91 (123)	
1/2–20	72 (98)		77 (104)		65 (88)		102 (138)	
9/16–12	92 (125)		98 (133)		80 (108)		130 (176)	
9/16–18	103 (140)		110 (149)		90 (122)		146 (198)	
5/8–11	128 (173)		136 (184)		110 (149)		180 (244)	
5/8–18	145 (197)		154 (209)		130 (176)		204 (277)	
3/4–10	226 (306)		241 (327)		200 (271)		320 (434)	
3/4–16	253 (343)		269 (365)		220 (298)		357 (484)	
7/8–9	365 (495)		388 (526)		320 (434)		515 (698)	
7/8–14	402 (545)		427 (579)		350 (475)		568 (770)	
1–8	—		582 (789)		—		—	
1–12	—		637 (863)		—		—	
1–14	—		652 (884)		—		—	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed).

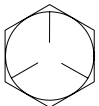
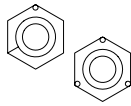
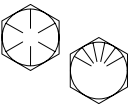
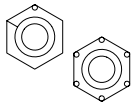
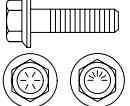
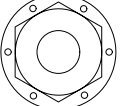
Table 1, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads

Specifications

Torque Values for Grade 8 Regular Hex Zinc-Yellow Plated Capscrews and Cadmium- and Wax-Coated Prevailing Torque Locknuts*		
Thread Diameter-Pitch	Regular Hex	
	Grade 8 or 8.2 Bolt	Grade 8 or C Nut
	Torque: lbf-ft (N-m)	
		
1/4-20	6 (8)	
1/4-28	7 (9)	
5/16-18	13 (18)	
5/16-24	14 (19)	
3/8-16	23 (31)	
3/8-24	26 (35)	
7/16-14	37 (50)	
7/16-20	41 (56)	
1/2-13	56 (76)	
1/2-20	63 (85)	
9/16-12	81 (110)	
9/16-18	90 (122)	
5/8-11	112 (152)	
5/8-18	126 (171)	
3/4-10	198 (268)	
3/4-16	221 (300)	
7/8-9	319 (433)	
7/8-14	352 (477)	
1-8	479 (649)	
1-12	524 (710)	
1-14	537 (728)	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

Table 2, Torque Values for Grade 8 Regular Hex Zinc-Yellow Plated Capscrews and Cadmium- and Wax-Coated Prevailing Torque Locknuts

Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter–Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)	
	 f230002	 f230003	 f230004	 f230005	 f230008	 f230009
1/4–20	8 (11)		10 (14)		—	
1/4–28	9 (12)		12 (16)		—	
5/16–18	15 (20)		22 (30)		22 (30)	
5/16–24	17 (23)		25 (34)		—	
3/8–16	28 (38)		40 (54)		40 (54)	
3/8–24	31 (42)		45 (61)		—	
7/16–14	45 (61)		65 (88)		65 (88)	
7/16–20	50 (68)		70 (95)		—	
1/2–13	70 (95)		95 (129)		95 (129)	
1/2–20	75 (102)		110 (149)		—	
9/16–12	100 (136)		140 (190)		140 (190)	
9/16–18	110 (149)		155 (210)		—	
5/8–11	135 (183)		190 (258)		190 (258)	
5/8–18	155 (210)		215 (292)		—	
3/4–10	240 (325)		340 (461)		340 (461)	
3/4–16	270 (366)		380 (515)		—	
7/8–9	385 (522)		540 (732)		—	
7/8–14	425 (576)		600 (813)		—	
1–8	580 (786)		820 (1112)		—	
1–12	635 (861)		900 (1220)		—	
1–14	650 (881)		915 (1241)		—	

* Threads may have residual oil, but will be dry to the touch.

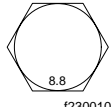
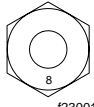
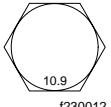
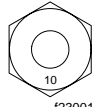
† Male and female threads (bolt and nut) must both be unlubricated and unplated; if either is plated or lubricated, use [Table 1](#) or [Table 2](#). Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

Table 3, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads

00.03

Threaded Fasteners

Specifications

Torque Values for Metric Thread Fasteners With Lubricated* or Plated Threads†				
Thread Diameter–Pitch	Class 8.8 Bolt	Class 8 Nut	Class 10.9 Bolt	Class 10 Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)	
	 f230010	 f230011	 f230012	 f230013
M6	5 (7)		7 (9)	
M8	12 (16)		17 (23)	
M8 x 1	13 (18)		18 (24)	
M10	24 (33)		34 (46)	
M10 x 1.25	27 (37)		38 (52)	
M12	42 (57)		60 (81)	
M12 x 1.5	43 (58)		62 (84)	
M14	66 (89)		95 (129)	
M14 x 1.5	72 (98)		103 (140)	
M16	103 (140)		148 (201)	
M16 x 1.5	110 (149)		157 (213)	
M18	147 (199)		203 (275)	
M18 x 1.5	165 (224)		229 (310)	
M20	208 (282)		288 (390)	
M20 x 1.5	213 (313)		320 (434)	
M22	283 (384)		392 (531)	
M22 x 1.5	315 (427)		431 (584)	
M24	360 (488)		498 (675)	
M24 x 2	392 (531)		542 (735)	
M27	527 (715)		729 (988)	
M27 x 2	569 (771)		788 (1068)	
M30	715 (969)		990 (1342)	
M30 x 2	792 (1074)		1096 (1486)	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed).

Table 4, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads