



*Run Smart™*

## **BUSINESS CLASS M2 WORKSHOP MANUAL**

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**Models: M2 100  
M2 106  
M2 106V  
M2 112  
M2 112V**

## 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 Trucks or the component manufacturer.

Maintenance schedules and additional service information are included in the **Business Class® M2 Maintenance Manual**.

**IMPORTANT:** Descriptions and specifications in this manual were in effect at the time of printing. Freightliner Trucks reserves the right to discontinue models, and to change specifications or design at any time 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](http://www.Daimler-TrucksNorthAmerica.com) and [www.FreightlinerTrucks.com](http://www.FreightlinerTrucks.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.

<b>Workshop/Service Manual</b>	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.
<b>Maintenance Manual</b>	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.
<b>Driver's/Operator's Manual</b>	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.
<b>Service Bulletins</b>	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.  <b>IMPORTANT:</b> Before using a particular service bulletin, check the current service bulletin validity list to be sure the bulletin is valid.
<b>Parts Technical Bulletins</b>	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.	
<b>ServicePro</b>	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.
<b>PartsPro</b>	PartsPro® is an electronic parts catalog system, showing the specified vehicle's build record.
<b>EZWiring</b>	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**

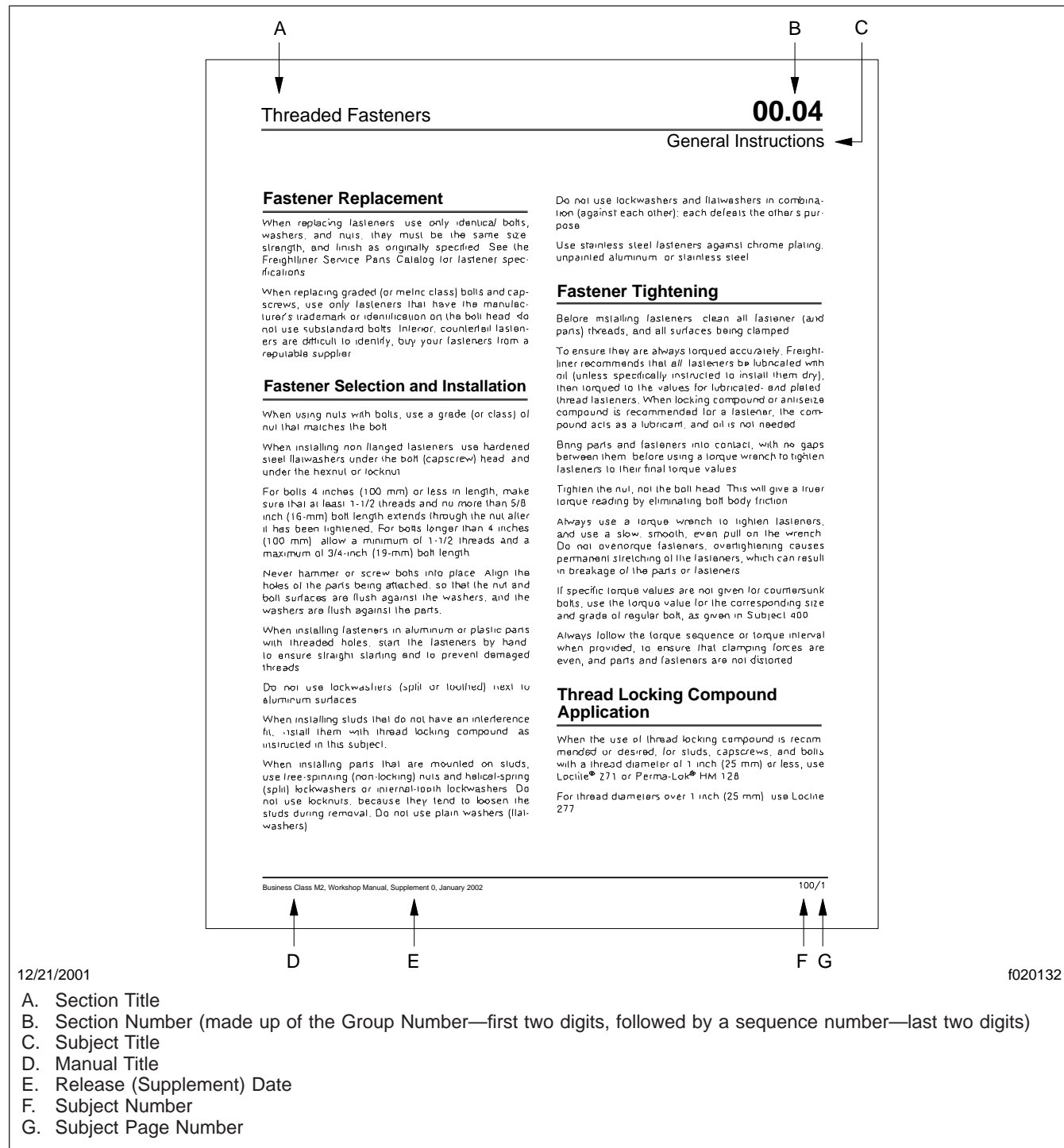
Recall campaigns cover situations that involve service work or replacement of parts in connection with a recall notice. These campaigns pertain to matters of vehicle safety. All recall campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

### **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 *Business Class M2 Workshop Manual* page, see [Fig. 1](#).



**Fig. 1, Example of a Business Class M2 Workshop Manual Page**

<b>Group No.</b>	<b>Group Title</b>
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
72 .....	Doors
82 .....	Windshield Wipers and Washer
83 .....	Heater and Air Conditioner
88 .....	Hood, Grille, and Cab Fenders
90 .....	Fire Suppression Systems
91 .....	Seats and Restraint Systems
98 .....	Paint

## List of Abbreviations

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

<b>A</b> .....	amperes	<b>BBC</b> .....	bumper-to-back-of-cab	<b>CUM</b> .....	Cummins
<b>AAVA</b> .....	auxiliary air valve assembly	<b>BHM</b> .....	bulkhead module	<b>CVSA</b> .....	Commercial Vehicle Safety Alliance
<b>ABS</b> .....	antilock braking system	<b>BOC</b> .....	back-of-cab	<b>CWS</b> .....	collision warning system
<b>ABS</b> .....	acrylonitrile-butadiene-styrene	<b>BOM</b> .....	bill of material	<b>DC</b> .....	direct current
<b>A/C</b> .....	air conditioner	<b>BTDC</b> .....	before top dead center	<b>DCA</b> .....	diesel coolant additive
<b>AC</b> .....	alternating current	<b>Btu(s)</b> .....	British thermal unit(s)	<b>DCDL</b> .....	driver-controlled differential lock
<b>acc</b> .....	accessories	<b>C</b> .....	common (terminal)	<b>DDA</b> .....	Detroit Diesel Allison (obs)
<b>ACM</b> .....	aftertreatment control module	<b>CAC</b> .....	charge air cooler	<b>DDC</b> .....	Detroit Diesel Corporation
<b>ACPU</b> .....	air conditioning protection unit	<b>CAN</b> .....	controller area network	<b>DDDL</b> .....	Detroit Diesel Diagnostic Link
<b>ADLO</b> .....	auto-disengagement lockout	<b>CARB</b> .....	California Air Resources Board	<b>DDE</b> .....	Detroit Diesel Engines
<b>AGM</b> .....	absorbed glass mat	<b>CAT</b> .....	Caterpillar	<b>DDEC</b> .....	Detroit Diesel Electronic (engine) Control
<b>AGS</b> .....	automated gear shift	<b>CB</b> .....	circuit breaker	<b>DDR</b> .....	diagnostic data reader
<b>AG2</b> .....	Aluminum Generation 2	<b>CB</b> .....	citizens' band	<b>DDU</b> .....	driver display unit
<b>a.m.</b> .....	<i>ante meridiem</i> (midnight to noon)	<b>CBE</b> .....	cab behind engine	<b>def</b> .....	defrost
<b>AM</b> .....	amplitude modulation	<b>CCA</b> .....	cold cranking amperes	<b>DEF</b> .....	diesel exhaust fluid
<b>amp(s)</b> .....	ampere(s)	<b>CCR</b> .....	California Code of Regulations	<b>DFI</b> .....	direct fuel injection
<b>AMT</b> .....	automated mechanical transmission	<b>CD-ROM</b> ..	compact-disc/read-only memory	<b>DGPS</b> .....	differential global positioning system
<b>AMU</b> .....	air management unit	<b>CDTC</b> .....	constant discharge temperature control	<b>DHD</b> .....	dealer help desk
<b>ANSI</b> .....	American National Standards Institute	<b>CEL</b> .....	check-engine light	<b>dia.</b> .....	diameter
<b>API</b> .....	American Petroleum Institute	<b>CFC</b> .....	chlorofluorocarbons (refrigerant-12)	<b>DIAG</b> .....	diagnosis
<b>API</b> .....	application programming interface	<b>cfm</b> .....	cubic feet per minute	<b>DIP</b> .....	dual inline package (switch)
<b>ARI</b> .....	Air Conditioning and Refrigeration Institute	<b>CFR</b> .....	Code of Federal Regulations	<b>DIU</b> .....	driver interface unit
<b>ASA</b> .....	American Standards Association	<b>CGI</b> .....	clean gas induction	<b>DLA</b> .....	datalink adaptor
<b>ASF</b> .....	American Steel Foundries	<b>CGW</b> .....	central gateway	<b>DLM</b> .....	datalink monitor
<b>ASR</b> .....	automatic spin regulator	<b>CHM</b> .....	chassis module	<b>DLU</b> .....	data logging unit
<b>assy.</b> .....	assembly	<b>CIP</b> .....	cold inflation pressure	<b>DMM</b> .....	digital multimeter
<b>ASTM</b> .....	American Society for Testing and Materials	<b>CLDS</b> .....	cab load disconnect switch	<b>DOC</b> .....	diesel oxidation catalyst
<b>ATC</b> .....	automatic temperature control	<b>CLS</b> .....	coolant level sensor	<b>DOT</b> .....	Department of Transportation
<b>ATC</b> .....	automatic traction control	<b>cm</b> .....	centimeters	<b>DPF</b> .....	diesel particulate filter
<b>ATC</b> .....	automatic transmission control	<b>cm<sup>3</sup></b> .....	cubic centimeters	<b>DRL</b> .....	daytime running lights
<b>ATD</b> .....	aftertreatment device	<b>CMVSS</b> .....	Canadian Motor Vehicle Safety Standard	<b>DRM</b> .....	dryer reservoir module
<b>ATF</b> .....	automatic transmission fluid	<b>Co.</b> .....	company	<b>DSM</b> .....	district service manager
<b>ATS</b> .....	aftertreatment system	<b>COE</b> .....	cab over engine	<b>DTC</b> .....	diagnostic trouble code
<b>attn</b> .....	attention	<b>Corp.</b> .....	corporation	<b>DTC</b> .....	discharge temperature control
<b>aux.</b> .....	auxiliary	<b>CPC</b> .....	common powertrain controller	<b>DTNA</b> .....	Daimler Trucks North America
<b>av</b> .....	<i>avoirdupois</i> (British weight system)	<b>CPU</b> .....	central processing unit	<b>DVOM</b> .....	digital volt/ohm meter
<b>AWD</b> .....	all-wheel drive	<b>CRT</b> .....	cathode ray tube	<b>ea.</b> .....	each
<b>AWG</b> .....	American wire gauge	<b>cSt</b> .....	centistokes (unit of measurement for describing the viscosity of general liquids)	<b>EBS</b> .....	electronic braking system
<b>AWS</b> .....	American Welding Society	<b>cu ft</b> .....	cubic feet	<b>ECA</b> .....	electric clutch actuator
<b>BAT</b> .....	battery	<b>cu in</b> .....	cubic inches	<b>ECAP</b> .....	electronic control analyzer programmer
				<b>ECAS</b> .....	electronically controlled air suspension

## List of Abbreviations

<b>ECI</b> .....	electronically controlled injection	<b>FM</b> .....	frequency modulation	<b>HVLP</b> .....	high velocity, low pressure
<b>ECL</b> .....	engine coolant level	<b>FMCSA</b> ....	Federal Motor Carrier Safety Administration	<b>H/W</b> .....	hardware
<b>ECM</b> .....	electronic control module	<b>FMEA</b> .....	failure mode effects analysis	<b>Hz</b> .....	hertz
<b>ECT</b> .....	engine coolant temperature	<b>FMI</b> .....	failure mode indicator	<b>IAD</b> .....	interaxle differential
<b>ECU</b> .....	electronic control unit	<b>FMSI</b> .....	Friction Materials Standards Institute	<b>ICS</b> .....	integrated child seat
<b>EDM</b> .....	electronic data monitor	<b>FMVSS</b> ....	Federal Motor Vehicle Safety Standard	<b>ICU</b> .....	instrumentation control unit
<b>EEPROM</b> ..	electrically erasable programmable read-only memory	<b>FRP</b> .....	fiberglass reinforced plastic	<b>i.d.</b> .....	inside diameter
<b>EFG</b> .....	electric fuel gauge	<b>FSA</b> .....	field service authorization	<b>ID</b> .....	identification
<b>EFPA</b> .....	electronic foot pedal assembly	<b>FSM</b> .....	fleet service manager	<b>IFI</b> .....	Industrial Fasteners Institute
<b>EGR</b> .....	exhaust gas recirculation	<b>ft</b> .....	feet	<b>IFS</b> .....	independent front suspension
<b>ELC</b> .....	extended-life coolant	<b>ft<sup>3</sup></b> .....	cubic feet	<b>IGN</b> .....	ignition
<b>EMC</b> .....	electromagnetic compatibility	<b>ft<sup>3</sup>/min</b> .....	cubic feet per minute	<b>ILB</b> .....	intelligent lightbar
<b>EMI</b> .....	electromagnetic interference	<b>FTL</b> .....	Freightliner	<b>ILO</b> .....	<i>in lieu of</i> (in the place of)
<b>EOA</b> .....	electric over air	<b>F.U.E.L.</b> ....	fuel usage efficiency level	<b>in</b> .....	inches
<b>EP</b> .....	extreme pressure (describes an antiwear agent added to some lubricants)	<b>g</b> .....	grams	<b>in<sup>3</sup></b> .....	cubic inches
<b>EPA</b> .....	Environmental Protection Agency	<b>gal</b> .....	gallons	<b>Inc.</b> .....	incorporated
<b>EPS</b> .....	engine position sensor	<b>GAWR</b> .....	gross axle weight rating	<b>inH<sub>2</sub>O</b> .....	inches of water
<b>ESC</b> .....	electronic stability control	<b>GHG</b> .....	greenhouse gas	<b>inHg</b> .....	inches of mercury
<b>ESC</b> .....	enhanced stability control	<b>GHG14</b> ....	greenhouse gas and fuel efficiency regulations	<b>I/O</b> .....	input/output
<b>ESD</b> .....	electrostatic discharge	<b>GL</b> .....	gear lubricant	<b>IP</b> .....	instrument panel
<b>ESS</b> .....	engine syncro shift (transmission)	<b>GND</b> .....	ground	<b>ISO</b> .....	International Organization for Standardization
<b>etc.</b> .....	<i>et cetera</i> (and so forth)	<b>gpm</b> .....	gallons per minute	<b>IVS</b> .....	idle validation switch
<b>ETEC</b> .....	electronic truck engine control	<b>GPS</b> .....	global positioning system	<b>k</b> .....	kilo (1000)
<b>EUI</b> .....	electronic unit (fuel) injectors	<b>GVWR</b> .....	gross vehicle weight rating	<b>kg</b> .....	kilograms
<b>EVA</b> .....	electronic vibration analyzer	<b>HBED</b> .....	hard-braking event data	<b>km</b> .....	kilometers
<b>EXM</b> .....	(chassis) expansion module	<b>HCM</b> .....	hybrid control module	<b>km/h</b> .....	kilometers per hour
<b>E85</b> .....	85% ethanol fuel	<b>HCOE</b> .....	high cab over engine	<b>kPa</b> .....	kilopascals
<b>FAS</b> .....	Freightliner air suspension	<b>HCU</b> .....	hydraulic control unit	<b>kW</b> .....	kilowatts
<b>FCCC</b> .....	Freightliner Custom Chassis Corporation	<b>HD</b> .....	heavy-duty	<b>L</b> .....	liters
<b>FCU</b> .....	forward control unit	<b>HDU</b> .....	hybrid drive unit	<b>lb</b> .....	pounds
<b>FET</b> .....	field effect transistor	<b>HEPA</b> .....	high-efficiency particulate air (filter)	<b>LBCU</b> .....	lightbar control unit
<b>Fig.</b> .....	figure	<b>HEST</b> .....	high exhaust system temperature	<b>lbf-ft</b> .....	pounds force feet
<b>fl oz</b> .....	fluid ounces	<b>HEV</b> .....	hybrid electric vehicle	<b>lbf-in</b> .....	pounds force inches
<b>FLA</b> .....	post-1984 advancements Freightliner COE	<b>HFC</b> .....	hydrogenated fluorocarbons (refrigerant-134a)	<b>LCD</b> .....	liquid crystal display
<b>FLB</b> .....	enhanced Freightliner FLA COE	<b>hp</b> .....	horsepower	<b>LCOE</b> .....	low cab over engine
<b>FLC</b> .....	steel-cab Freightliner 112 Conventional	<b>hp</b> .....	high pressure	<b>LED</b> .....	light-emitting diode
<b>FLD</b> .....	post-1984 advancements Freightliner 112/120 aluminum-cab Conventional	<b>HRC</b> .....	Rockwell "C" hardness	<b>LFL</b> .....	lower flammability limit
<b>FLR</b> .....	forward-looking radar	<b>hr(s)</b> .....	hour(s)	<b>LH</b> .....	left-hand
		<b>HSA</b> .....	hill start aid	<b>LHD</b> .....	left-hand drive
		<b>HSD</b> .....	high-side driver	<b>LH DR</b> .....	left-hand-drive
		<b>htr.</b> .....	heater	<b>LHK</b> .....	liters per hundred kilometers
		<b>HVAC</b> .....	heating, ventilating, and air conditioning	<b>LHS</b> .....	low-hydrogen steel
				<b>LIN</b> .....	Local Interconnect Network
				<b>LLC</b> .....	limited liability company
				<b>L/min</b> .....	liters per minute
				<b>LNG</b> .....	liquefied natural gas
				<b>LPG</b> .....	liquefied petroleum gas



## List of Abbreviations

<b>LPG</b> .....	liquid propane gas	<b>NO</b> .....	normally open (terminal or switch)	<b>POE</b> .....	polyol ester
<b>LPI</b> .....	liquid propane injection	<b>NOAT</b> .....	Nitrited Organic Acid Technology	<b>PRD</b> .....	pressure relief device
<b>LPR</b> .....	low pressure reservoir	<b>NOx</b> .....	nitrogen oxides	<b>PRD</b> .....	product requirements document
<b>LRR</b> .....	low-rolling resistance	<b>no.</b> .....	number	<b>PSA</b> .....	pressure-sensitive adhesive
<b>LSD</b> .....	low-side driver	<b>NPT</b> .....	national pipe thread	<b>PSG</b> .....	pressure sensor governor
<b>LVD</b> .....	low-voltage disconnect	<b>NPTF</b> .....	national pipe thread fitting	<b>psi</b> .....	pounds per square inch
<b>m</b> .....	meters	<b>NT</b> .....	nylon tube or nylon tubing	<b>psia</b> .....	pounds per square inch, atmosphere
<b>max.</b> .....	maximum	<b>NTSB</b> .....	National Transportation Safety Board	<b>psig</b> .....	pounds per square inch, gauge
<b>M-B</b> .....	Mercedes-Benz	<b>OAT</b> .....	Organic Acid Technology	<b>pt</b> .....	pints
<b>MCM</b> .....	motor control module	<b>OBd(s)</b> .....	on-board diagnostic(s)	<b>PTCM</b> .....	pressure time control module
<b>MESA</b> .....	Mining Enforcement Safety Act	<b>obs</b> .....	obsolete	<b>PTO</b> .....	power takeoff
<b>mfr.</b> .....	manufacturer	<b>OC</b> .....	open circuit	<b>PTP</b> .....	powertrain protection
<b>mi</b> .....	miles	<b>OCV</b> .....	open circuit voltage	<b>PTPDM</b> .....	powertrain power distribution module
<b>MID</b> .....	message identifier	<b>o.d.</b> .....	outside diameter	<b>pvc</b> .....	polyvinyl chloride
<b>MIL</b> .....	malfunction indicator lamp (light)	<b>O.D.</b> .....	overdrive	<b>PWM</b> .....	pulse width modulation
<b>MIL</b> .....	military specification	<b>OEM</b> .....	original equipment manufacturer	<b>pwr</b> .....	power
<b>min.</b> .....	minutes	<b>OPD</b> .....	overflow protection device	<b>qt</b> .....	quarts
<b>min.</b> .....	minimum	<b>OSHA</b> .....	Occupational Safety and Health Administration	<b>qty.</b> .....	quantity
<b>misc.</b> .....	miscellaneous	<b>oz</b> .....	ounces	<b>R &amp; O</b> .....	rust inhibitors and oxidants
<b>mL</b> .....	milliliters	<b>ozf-in</b> .....	ounces force inches	<b>R-12</b> .....	refrigerant-12 (CFC)
<b>mm</b> .....	millimeters	<b>p</b> .....	positive (front axle wheel alignment specification)	<b>R-134a</b> .....	refrigerant-134a (HFC)
<b>mod.</b> .....	module	<b>PACE</b> .....	programmable electronically controlled engine	<b>RAM</b> .....	random access memory
<b>mpg</b> .....	miles per gallon	<b>PAG</b> .....	polyalkylene glycol (oil)	<b>RC</b> .....	reserve capacity
<b>mph</b> .....	miles per hour	<b>parm</b> .....	parameter	<b>recirc.</b> .....	recirculation
<b>MSF</b> .....	modular switch field	<b>PAS</b> .....	passenger advisory system	<b>Ref(s).</b> .....	reference(s)
<b>MMT</b> .....	methylcyclopentadienyl manganese tricarbonyl	<b>PC</b> .....	personal computer	<b>regen</b> .....	regeneration
<b>MSHA</b> .....	Mining Safety and Health Administration	<b>PCB</b> .....	printed circuit board	<b>RELS</b> .....	reduced engine load at stop
<b>MVDA</b> .....	Motor Vehicle Dealers Association	<b>PDC(s)</b> .....	parts distribution center(s)	<b>RFI</b> .....	radio frequency interference
<b>n</b> .....	negative (front axle wheel alignment specification)	<b>PDI</b> .....	pre-delivery inspection	<b>RH</b> .....	right-hand
<b>N</b> .....	nitrogen	<b>PDM</b> .....	power distribution module	<b>RHD</b> .....	right-hand drive
<b>N/A</b> .....	not applicable	<b>PEC</b> .....	power electronics carrier	<b>RH DR</b> .....	right-hand-drive
<b>N-cm</b> .....	Newton-centimeters	<b>PEEC</b> .....	programmable electronic engine control	<b>R/I</b> .....	removal and installation
<b>NC</b> .....	normally closed (terminal or switch)	<b>PID</b> .....	parameter identifier	<b>RMA</b> .....	return material authorization
<b>NCG</b> .....	noncondensable gases	<b>PKP</b> .....	Purple-K powder	<b>ROM</b> .....	read-only memory
<b>NHTSA</b> .....	National Highway Traffic Safety Administration	<b>PLC</b> .....	power line carrier	<b>rpm</b> .....	revolutions per minute
<b>NIOSH</b> .....	National Institute for Occupational Safety and Health	<b>PLD</b> .....	<i>Pumpe-Linie-Düse</i> (pump-line-nozzle)	<b>R/R</b> .....	removal and replacement
<b>NITE</b> .....	no idle thermal environment	<b>PNDB</b> .....	power-net distribution box	<b>RSA</b> .....	roll-stability advisor
<b>NLA</b> .....	no longer available	<b>PM</b> .....	particulate matter	<b>RSG</b> .....	road speed governor
<b>NLGI</b> .....	National Lubricating Grease Institute	<b>p.m.</b> .....	<i>post meridiem</i> (noon to midnight)	<b>RSM</b> .....	regional service manager
<b>N-m</b> .....	Newton-meters	<b>p/n</b> .....	part number	<b>RTS</b> .....	ready-to-spray
		<b>PO</b> .....	purchase order	<b>RTV</b> .....	room temperature vulcanizing
				<b>RV</b> .....	recreational vehicle
				<b>SA</b> .....	source address
				<b>S-ABA</b> .....	self-setting automatic brake adjusters

## List of Abbreviations

<b>SAE</b> .....	Society of Automotive Engineers	<b>°C</b> .....	degrees Celsius (centigrade)
<b>SB</b> .....	service bulletin	<b>°F</b> .....	degrees Fahrenheit
<b>SBT</b> .....	seat back thickness	<b>#</b> .....	number
<b>SBW</b> .....	shift-by-wire	<b>%</b> .....	percent
<b>SCA(s)</b> ....	Supplemental Coolant Additive(s)	<b>&amp;</b> .....	and
<b>SCR</b> .....	selective catalytic reduction	<b>©</b> .....	copyright
<b>SCU</b> .....	system control unit (speedometer)	<b>™</b> .....	trademark
<b>SD</b> .....	severe-duty	<b>®</b> .....	registered trademark
<b>SDU</b> .....	step deployment unit		
<b>SEL</b> .....	shutdown engine light		
<b>SEM</b> .....	switch expansion module		
<b>SEO</b> .....	stop engine override		
<b>SHM</b> .....	switch hub module		
<b>SI</b> .....	service information		
<b>SI</b> .....	<i>Système International</i>		
<b>SID</b> .....	subsystem identifier		
<b>SM</b> .....	system malfunction		
<b>SMC</b> .....	sheet molded compound		
<b>S/N</b> .....	serial number		
<b>SOC</b> .....	state-of-charge		
<b>SPACE</b> ....	seat pretensioner activation for crash survival enhancement		
<b>SPG</b> .....	special purpose grease		
<b>SPN</b> .....	suspect parameter number		
<b>sq in</b> .....	square inches		
<b>SRP</b> .....	seating reference point		
<b>SRS</b> .....	supplemental restraint system		
<b>SRS</b> .....	synchronous reference sensor		
<b>SRT</b> .....	standard repair time		
<b>SSD</b> .....	side sensor display		
<b>SSID</b> .....	smart switch identification		
<b>SST</b> .....	stainless steel		
<b>std.</b> .....	standard		
<b>S/W</b> .....	software		
<b>SW</b> .....	switch		
<b>TAM</b> .....	thermocouple amplifier module		
<b>TBB</b> .....	Thomas Built Buses		
<b>TBS</b> .....	turbo boost sensor		
<b>TCM</b> .....	transmission control module		
<b>TCU</b> .....	transmission control unit		
<b>TDC</b> .....	top dead center		
<b>TDR</b> .....	technician diagnostic routine		
<b>TEM</b> .....	truck equipment manufacturer		
<b>temp</b> .....	temperature		
<b>TIG</b> .....	tungsten inert gas		
<b>TIR</b> .....	total indicator reading		
<b>TMC</b> .....	Technology and Maintenance Council		
<b>TPMS</b> .....	tire pressure monitoring system		
<b>TPS</b> .....	thermal protection switch		
<b>TPS</b> .....	throttle position sensor		
<b>TRS</b> .....	timing reference sensor		
<b>TSO</b> .....	truck specification order		
<b>TSU</b> .....	transmission shift unit		
<b>TXV</b> .....	thermal expansion valve		
<b>U.D.</b> .....	underdrive		
<b>ULSD</b> .....	ultralow-sulfur diesel		
<b>UNC</b> .....	unified national coarse		
<b>UNF</b> .....	unified national fine		
<b>U.S.</b> .....	United States		
<b>U.S.A.</b> .....	United States of America		
<b>USC</b> .....	United States customary (measures)		
<b>V</b> .....	volts		
<b>VCU</b> .....	vehicle control unit		
<b>VDC</b> .....	vehicle data computer		
<b>Vdc</b> .....	volts, direct current		
<b>VIMS</b> .....	vehicle information management system		
<b>VIN</b> .....	vehicle identification number		
<b>VIP</b> .....	vehicle instrumentation and protection (Kysor)		
<b>VIW</b> .....	vehicle interface wiring (connector)		
<b>VOC</b> .....	volatile organic compounds		
<b>VOM</b> .....	volt-ohmmeter		
<b>VRS</b> .....	variable resistance sensor		
<b>VSG</b> .....	variable speed governor		
<b>VSS</b> .....	vehicle speed sensor		
<b>VSU</b> .....	vehicle security unit		
<b>WB</b> .....	wire braid		
<b>WI</b> .....	work instructions		
<b>WIF</b> .....	water-in-fuel		
<b>WOT</b> .....	wide open throttle		
<b>-</b> .....	minus or negative		
<b>+</b> .....	plus or positive		
<b>±</b> .....	plus-or-minus		
<b>&gt;</b> .....	greater than		
<b>&lt;</b> .....	less than		
<b>x</b> .....	by (used in fastener size descriptions)		
<b>"</b> .....	inches		
<b>°</b> .....	degrees (of an angle)		

## 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
<b>Length</b>					
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)
<b>Area</b>					
square inches (in <sup>2</sup> )	645.16	square millimeters (mm <sup>2</sup> )	0.00155		square inches (in <sup>2</sup> )
square inches (in <sup>2</sup> )	6.452	square centimeters (cm <sup>2</sup> )	0.15		square inches (in <sup>2</sup> )
square feet (ft <sup>2</sup> )	0.0929	square meters (m <sup>2</sup> )	10.764		square feet (ft <sup>2</sup> )
<b>Volume</b>					
cubic inches (in <sup>3</sup> )	16387.0	cubic millimeters (mm <sup>3</sup> )	0.000061		cubic inches (in <sup>3</sup> )
cubic inches (in <sup>3</sup> )	16.387	cubic centimeters (cm <sup>3</sup> )	0.06102		cubic inches (in <sup>3</sup> )
cubic inches (in <sup>3</sup> )	0.01639	liters (L)	61.024		cubic inches (in <sup>3</sup> )
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 <sup>3</sup> )	28.317	liters (L)	0.03531		cubic feet (ft <sup>3</sup> )
cubic feet (ft <sup>3</sup> )	0.02832	cubic meters (m <sup>3</sup> )	35.315		cubic feet (ft <sup>3</sup> )
<b>Weight/Force</b>					
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)
<b>Torque/Work Force</b>					
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)
<b>Pressure/Vacuum</b>					
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)

## Vehicle Receipt

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Prior to signing for vehicle delivery from a transporter company, the dealer is responsible for checking for transporter-related shortages or damages, and noting these discrepancies on the transporter's delivery receipt.

The dealer is also responsible for ensuring that the vehicle was built according to the Truck Sales Order/ Invoice.

Refer to Section 3 of the Freightliner LLC *Warranty Manual* for details.

## Vehicle Storage

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There may be times when a vehicle is stored for long periods before customer delivery. To protect all vehicles from deterioration and weather, they must be properly maintained. Adequate protection and storage of new vehicles is the responsibility of the dealer.

**Claims arising from loss and damage to improperly stored vehicles will not be reimbursed.**

See Section 3 of the Freightliner LLC *Warranty Manual* for instructions on storage of new vehicles.

## Pre-Delivery Information

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All pre-delivery inspections and services must be performed at an authorized Freightliner LLC facility, assigned to fully qualified service personnel and recorded on the "New Vehicle Pre-Delivery Inspection" form.

Refer to Section 3 of the Freightliner LLC *Warranty Manual* for details.

It is recommended the pre-delivery inspection be performed within 30 days of vehicle receipt.

### 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 and some items attached to the cab use metric fasteners (diameter and pitch are measured in millimeters).

Most threaded fasteners used on the vehicle 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.

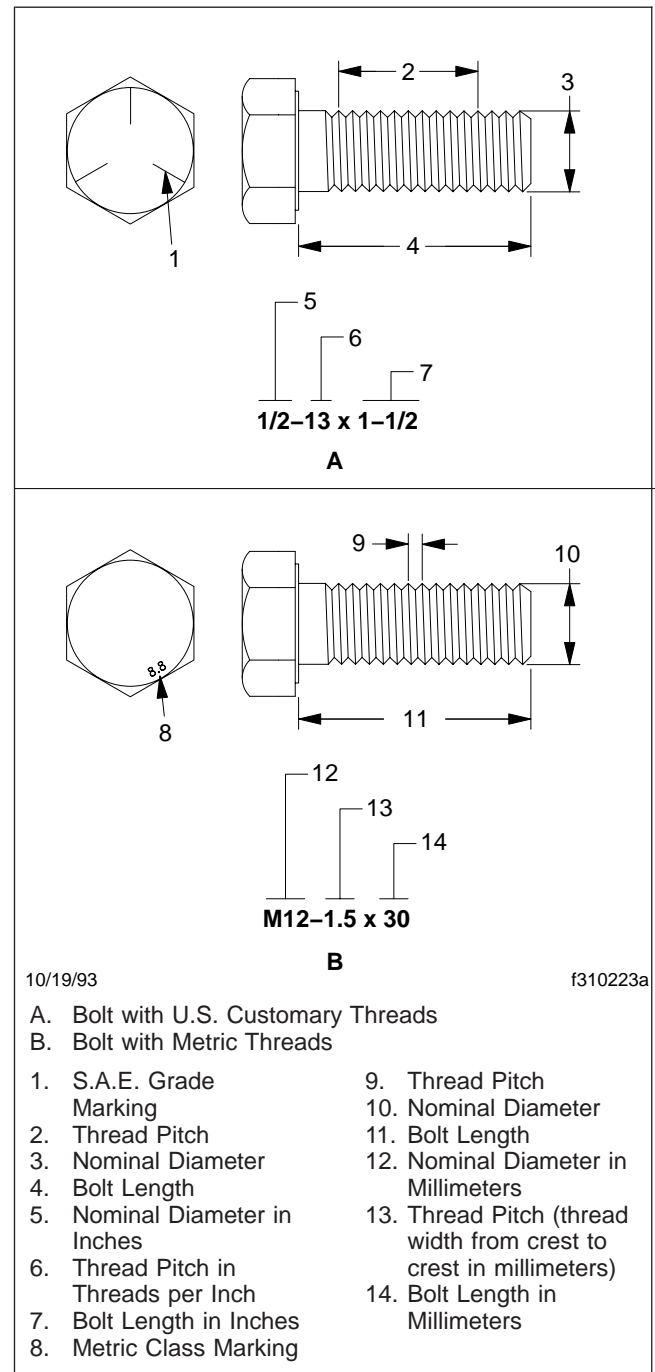
Some fasteners smaller than 1/2-inch diameter are flanged fasteners, which have integral flanges that fit against the parts being fastened. The flanges eliminate the need for washers.

NOTE: The standard fasteners used to assemble the vehicle frame and to attach components to the vehicle frame are threaded lockbolts (Spin Hucks). These fasteners are covered in Section 31.00.

### 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

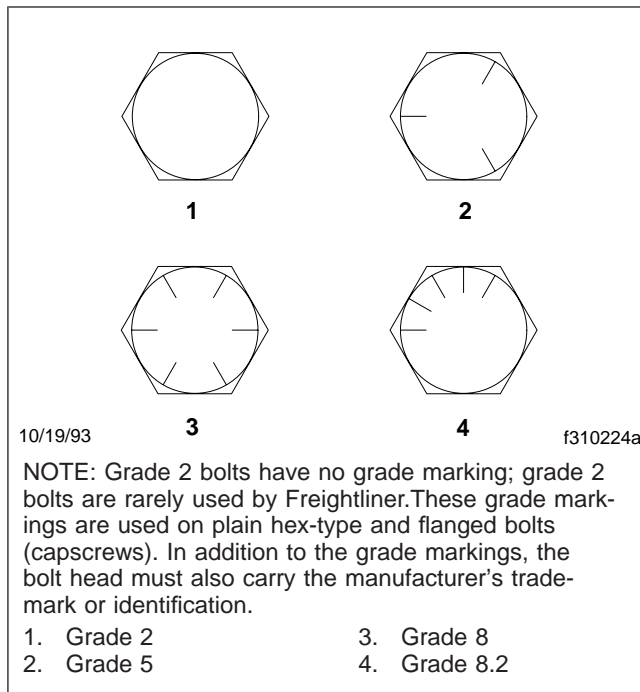


**Fig. 1, Fastener Size and Thread Identification**

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

## General Information

nut. See [Fig. 5](#). Class 8 hexnuts are always used with class 8.8 bolts; class 10 hexnuts with class 10.9 bolts.



**Fig. 2, Bolt Grades**

## Frame Fasteners

The standard fasteners used to assemble the vehicle frame and to attach most components to the vehicle frame are threaded lockbolts (Spin Hucks). These fasteners are covered in [Section 31.00](#).

For some other components attached to the frame, grade 8 and 8.2 phosphate- and oil-coated hexhead bolts and 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.

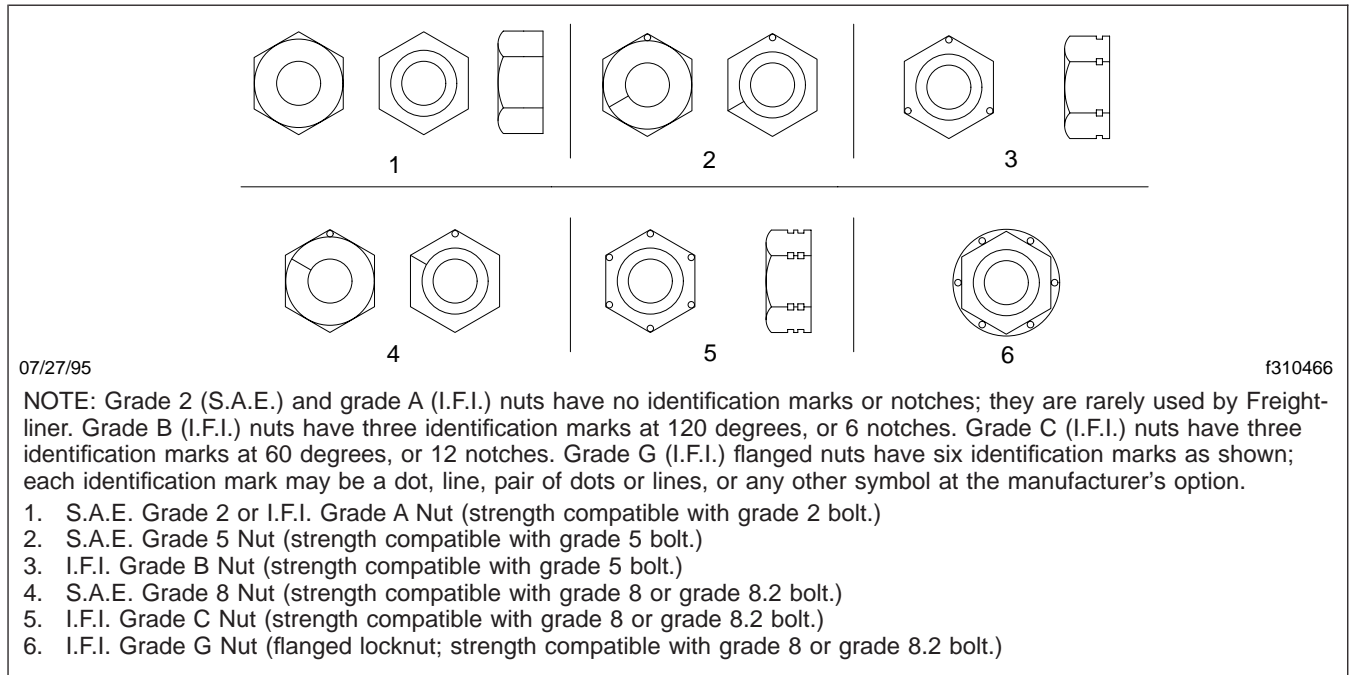
The torque values given in the tables in [Specifications, 400](#) have been calculated to provide enough clamping force on the parts being fastened, and the correct tensioning of the bolt to maintain the clamping force.

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.

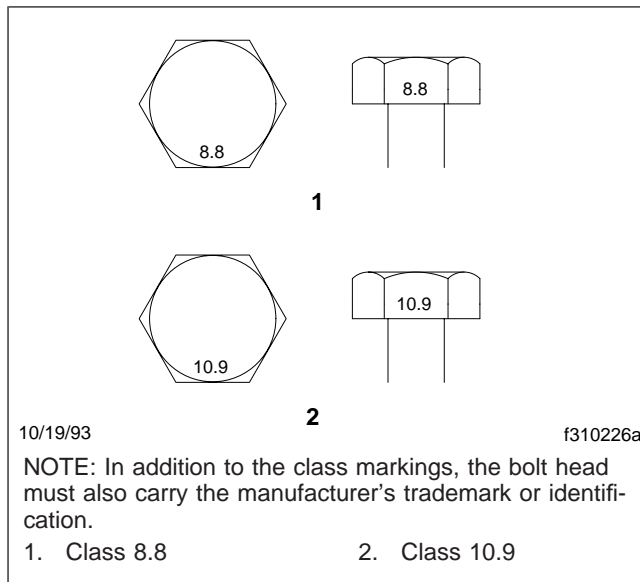
When torquing a fastener, typically 80 to 90 percent of the turning force is used to overcome friction; only 10 to 20 percent is used to stretch the capscrew or bolt. About 40 to 50 percent of the turning force is needed to overcome the friction between the underside of the capscrew head or nut and the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

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.

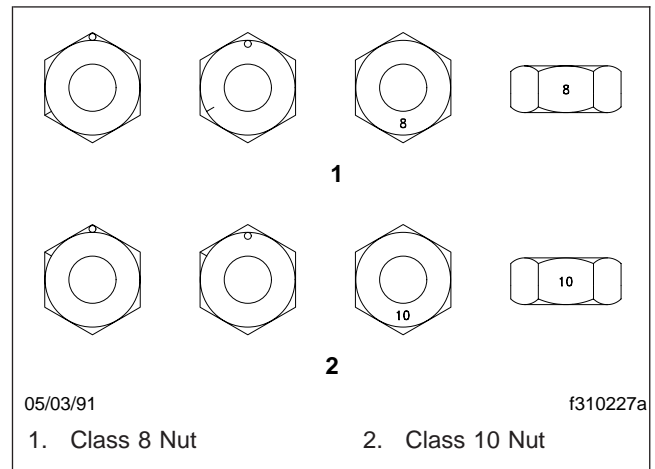
Even though each different condition affects the amount of friction, a different torque value cannot be given for each different condition. To ensure they are always torqued accurately, Freightliner recommends that all fasteners be lubricated with oil (unless specifically instructed to install them dry),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



**Fig. 3, Nut Grades**



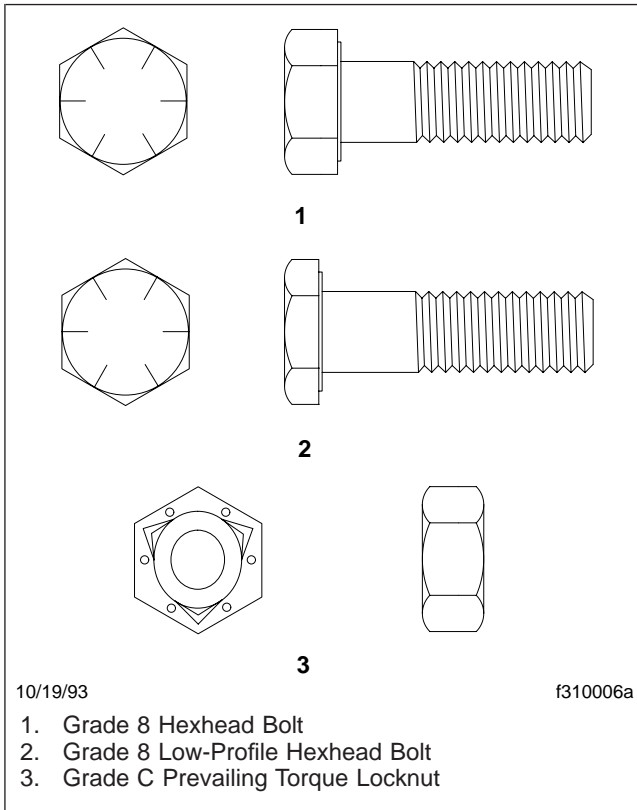
**Fig. 4, Bolt Classes**



**Fig. 5, Nut Classes**



## General Information



**Fig. 6, Frame Fastener Identification**



## Fastener Replacement

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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

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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

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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

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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® 271 or Perma-Lok® HM-128.

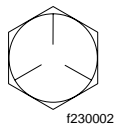
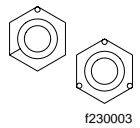
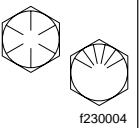
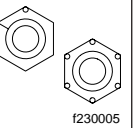
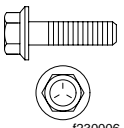
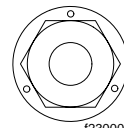
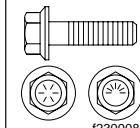
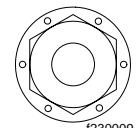
For thread diameters over 1 inch (25 mm), use Loctite 277.

### 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 three or four 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.

TORQUE VALUES FOR U.S. CUSTOMARY THREAD FASTENERS WITH LUBRICATED * OR PLATED THREADS †								
Thread Diameter–Pitch	Regular Hex				Flanged			
	 f230002	 f230003	 f230004	 f230005	 f230006	 f230007	 f230008	 f230009
	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)	
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.

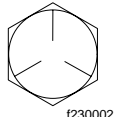
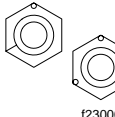
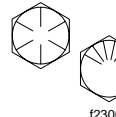
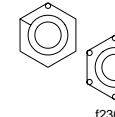
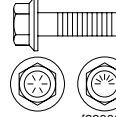
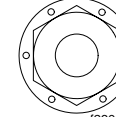
† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed).

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

# 00.04

# Threaded Fasteners

## Specifications

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

**Table 2, Torque Values for U.S. Customary Thread Fasteners with Dry (Unlubricated) Plain (Unplated) Threads**

**TORQUE VALUES FOR METRIC THREAD FASTENERS WITH LUBRICATED \* OR PLATED THREADS †**