



Run Smart™

HEAVY-DUTY TRUCKS SERVICE MANUAL

**Models: FLA COE
FLB COE
FLD Conventional
FLL COE**

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 *Heavy-Duty Trucks 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 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.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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**Daimler Trucks North America LLC
Service Systems and Documentation (CVI-SSD)
P.O. Box 3849
Portland, OR 97208-3849**

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 *Heavy-Duty Trucks Service Manual* page, see [Fig. 1](#).

The diagram shows a page layout for 'Threaded Fasteners' with the following elements:

- A:** Section Title: Threaded Fasteners
- B:** Section Number: 00.06
- C:** Subject Title: General Instructions
- D:** Manual Title: FLA COE & FLD Conventional Service Manual, July 1992
- E:** Release (Supplement) Date: 02/11/98
- F:** Subject Number: 100/1
- G:** Subject Page Number: 1020022

Fastener Replacement

When replacing fasteners, use only identical bolts, washers, and nuts; they must be the same size, strength, and finish as originally specified. Refer to the *Freightliner Parts Book* 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; don't 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 3/8-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.

Don't use lockwashers (split or toothed) next to aluminum surfaces.

When installing studs that don't 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. Don't use locknuts, because they tend to loosen the studs during removal. Don't use plain washers (flatwashers).

Don't 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 anti-seize 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. Don't overtighten fasteners; overtightening causes permanent stretching of the fasteners, which can result in breakage of the parts or fasteners.

If specific torque values aren't given for countersunk bolts, use the torque value for the corresponding size and grade of regular bolt, as given in Subject 400.

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

Tighten frame fasteners periodically to offset the effects of "bedding in" (seating). Continued

Fig. 1, Example of a Heavy-Duty Trucks Service 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
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

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

A	amperes	BTDC	before top dead center	DDR	diagnostic data reader
ABS	antilock braking system	Btu(s)	British thermal unit(s)	DDU	driver display unit
ABS	acrylonitrile-butadiene-styrene	C	common (terminal)	def	defrost
A/C	air conditioner	CAC	charge air cooler	DEF	diesel exhaust fluid
AC	alternating current	CAN	controller area network	DFI	direct fuel injection
acc	accessories	CARB	California Air Resources Board	DGPS	differential global positioning system
ACPU	air conditioning protection unit	CAT	Caterpillar	dia.	diameter
ADLO	auto-disengagement lockout	CB	circuit breaker	DIAG	diagnosis
AGM	absorbed glass mat	CB	citizens' band	DIP	dual inline package (switch)
AGS	automated gear shift	CBE	cab behind engine	DLA	datalink adaptor
a.m.	<i>ante meridiem</i> (midnight to noon)	CCA	cold cranking amperes	DLM	datalink monitor
AM	amplitude modulation	CD-ROM ..	compact-disc/read-only memory	DLU	data logging unit
amp(s)	ampere(s)	CDTC	constant discharge temperature control	DMM	digital multimeter
AMT	automated mechanical transmission	CEL	check-engine light	DOC	diesel oxidation catalyst
AMU	air management unit	CFC	chlorofluorocarbons (refrigerant-12)	DOT	Department of Transportation
ANSI	American National Standards Institute	cfm	cubic feet per minute	DPF	diesel particulate filter
API	American Petroleum Institute	CFR	Code of Federal Regulations	DRL	daytime running lights
API	application programming interface	CGI	clean gas induction	DRM	dryer reservoir module
ARI	Air Conditioning and Refrigeration Institute	CHM	chassis module	DSM	district service manager
ASA	American Standards Association	CIP	cold inflation pressure	DTC	diagnostic trouble code
ASF	American Steel Foundries	CLS	coolant level sensor	DTC	discharge temperature control
ASR	automatic spin regulator	cm	centimeters	DVOM	digital volt/ohm meter
assy.	assembly	cm³	cubic centimeters	ea.	each
ASTM	American Society for Testing and Materials	CMVSS	Canadian Motor Vehicle Safety Standard	EBS	electronic braking system
ATC	automatic temperature control	Co.	company	ECAP	electronic control analyzer programmer
ATC	automatic traction control	COE	cab over engine	ECAS	electronically controlled air suspension
ATC	automatic transmission control	Corp.	corporation	ECI	electronically controlled injection
ATD	aftertreatment device	CPU	central processing unit	ECL	engine coolant level
ATF	automatic transmission fluid	CRT	cathode ray tube	ECM	electronic control module
ATS	aftertreatment system	cSt	centistokes (unit of measurement for describing the viscosity of general liquids)	ECT	engine coolant temperature
attn	attention	cu ft	cubic feet	ECU	electronic control unit
aux.	auxiliary	cu in	cubic inches	EDM	electronic data monitor
av	<i>avoirdupois</i> (British weight system)	CUM	Cummins	EEPROM ..	electrically erasable programmable read-only memory
AWD	all-wheel drive	CWS	collision warning system	EFPA	electronic foot pedal assembly
AWG	American wire gauge	DC	direct current	EGR	exhaust gas recirculation
AWS	American Welding Society	DDA	Detroit Diesel Allison (obs)	ELC	extended-life coolant
BAT	battery	DDC	Detroit Diesel Corporation	EMC	electromagnetic compatibility
BBC	bumper-to-back-of-cab	DDDL	Detroit Diesel Diagnostic Link	EMI	electromagnetic interference
BHM	bulkhead module	DDE	Detroit Diesel Engines	EOA	electric over air
BOM	bill of material	DDEC	Detroit Diesel Electronic (engine) Control	EP	extreme pressure (describes an antiwear agent added to some lubricants)

List of Abbreviations

EPA	Environmental Protection Agency	HEPA	high-efficiency particulate air (filter)	LH	left-hand
EPS	engine position sensor	HEST	high exhaust system temperature	LH DR	left-hand drive
ESD	electrostatic discharge	HEV	hybrid electric vehicle	LHK	liters per hundred kilometers
ESS	engine syncro shift (transmission)	HFC	hydrogenated fluorocarbons (refrigerant-134a)	LHS	low-hydrogen steel
etc.	<i>et cetera</i> (and so forth)	hp	horsepower	LIN	Local Interconnect Network
ETEC	electronic truck engine control	hp	high pressure	LLC	limited liability company
EUI	electronic unit (fuel) injectors	HRC	Rockwell "C" hardness	L/min	liters per minute
EXM	(chassis) expansion module	hr(s)	hour(s)	LPG	liquefied petroleum gas
FAS	Freightliner air suspension	HSD	high-side driver	LSD	low-side driver
FET	field effect transistor	htr.	heater	LVD	low-voltage disconnect
Fig.	figure	HVAC	heating, ventilating, and air conditioning	m	meters
fl oz	fluid ounces	H/W	hardware	max.	maximum
FLA	post-1984 advancements Freightliner COE	Hz	hertz	M-B	Mercedes-Benz
FLB	enhanced Freightliner FLA COE	ICU	instrumentation control unit	MESA	Mining Enforcement Safety Act
FLC	steel-cab Freightliner 112 Conventional	i.d.	inside diameter	mfr.	manufacturer
FLD	post-1984 advancements Freightliner 112/120 aluminum-cab Conventional	ID	identification	mi	miles
FM	frequency modulation	IFI	Industrial Fasteners Institute	MID	message identifier
FMCSA	Federal Motor Carrier Safety Administration	IFS	independent front suspension	MIL	military specification
FMEA	failure mode effects analysis	IGN	ignition	min.	minutes
FMI	failure mode indicator	ILB	intelligent lightbar	min.	minimum
FMSI	Friction Materials Standards Institute	ILO	<i>in lieu of</i> (in the place of)	misc.	miscellaneous
FMVSS	Federal Motor Vehicle Safety Standard	in	inches	mL	milliliters
FRP	fiberglass reinforced plastic	in³	cubic inches	mm	millimeters
FSA	field service authorization	Inc.	incorporated	mod.	module
FSM	fleet service manager	inH₂O	inches of water	mpg	miles per gallon
ft	feet	inHg	inches of mercury	mph	miles per hour
ft³	cubic feet	I/O	input/output	MSF	modular switch field
ft³/min	cubic feet per minute	IP	instrument panel	MSHA	Mining Safety and Health Administration
FTL	Freightliner	ISO	International Organization for Standardization	MVDA	Motor Vehicle Dealers Association
F.U.E.L.	fuel usage efficiency level	IVS	idle validation switch	n	negative (front axle wheel alignment specification)
g	grams	k	kilo (1000)	N	nitrogen
gal	gallons	kg	kilograms	N/A	not applicable
GAWR	gross axle weight rating	km	kilometers	N-cm	Newton-centimeters
GL	gear lubricant	km/h	kilometers per hour	NC	normally closed (terminal or switch)
GND	ground	kPa	kilopascals	NHTSA	National Highway Traffic Safety Administration
gpm	gallons per minute	kW	kilowatts	NIOSH	National Institute for Occupational Safety and Health
GPS	global positioning system	L	liters	NLGI	National Lubricating Grease Institute
GVWR	gross vehicle weight rating	lb	pounds	N-m	Newton-meters
HCOE	high cab over engine	LBCU	lightbar control unit	NO	normally open (terminal or switch)
HCU	hydraulic control unit	lbf-ft	pounds force feet	NOAT	Nitrited Organic Acid Technology
HD	heavy-duty	lbf-in	pounds force inches		
		LCD	liquid crystal display		
		LCOE	low cab over engine		
		LED	light-emitting diode		

List of Abbreviations

no.	number	PTP	powertrain protection	SPACE	seat pretensioner activation for crash survival enhancement
NPT	national pipe thread	pvc	polyvinyl chloride	SPG	special purpose grease
NPTF	national pipe thread fitting	PWM	pulse width modulation	SPN	suspect parameter number
NT	nylon tube or nylon tubing	pwr	power	sq in	square inches
NTSB	National Transportation Safety Board	qt	quarts	SRS	synchronous reference sensor
OAT	Organic Acid Technology	qty.	quantity	SRT	standard repair time
obs	obsolete	R & O	rust inhibitors and oxidants	SSD	side sensor display
OC	open circuit	R-12	refrigerant-12 (CFC)	SSID	smart switch identification
OCV	open circuit voltage	R-134a	refrigerant-134a (HFC)	SST	stainless steel
o.d.	outside diameter	RAM	random access memory	std.	standard
O.D.	overdrive	RC	reserve capacity	S/W	software
OEM	original equipment manufacturer	recirc.	recirculation	SW	switch
OSHA	Occupational Safety and Health Administration	Ref(s).	reference(s)	TAM	thermocouple amplifier module
oz	ounces	regen	regeneration	TBS	turbo boost sensor
ozf-in	ounces force inches	RFI	radio frequency interference	TCU	transmission control unit
p	positive (front axle wheel alignment specification)	RH	right-hand	TDC	top dead center
PACE	programmable electronically controlled engine	RH DR	right-hand drive	TDR	technician diagnostic routine
PAG	polyalkylene glycol (oil)	R/I	removal and installation	temp	temperature
parm	parameter	RMA	return material authorization	TIG	tungsten inert gas
PC	personal computer	ROM	read-only memory	TIR	total indicator reading
PCB	printed circuit board	rpm	revolutions per minute	TPMS	tire pressure monitoring system
PDC(s)	parts distribution center(s)	R/R	removal and replacement	TPS	thermal protection switch
PDM	power distribution module	RSG	road speed governor	TPS	throttle position sensor
PEC	power electronics carrier	RSM	regional service manager	TRS	timing reference sensor
PEEC	programmable electronic engine control	RTV	room temperature vulcanizing	TRS	timing reference sensor
PID	parameter identifier	RV	recreational vehicle	TSO	truck specification order
PLC	power line carrier	SA	source address	TSU	transmission shift unit
PLD	<i>Pumpe-Linie-Düse</i> (pump-line-nozzle)	SAE	Society of Automotive Engineers	U.D.	underdrive
p.m.	<i>post meridiem</i> (noon to midnight)	SB	service bulletin	UNC	unified national coarse
p/n	part number	SCA(s)	Supplemental Coolant Additive(s)	UNF	unified national fine
PRD	product requirements document	SCR	selective catalyst reduction	U.S.	United States
PSA	pressure-sensitive adhesive	SCU	system control unit (speedometer)	U.S.A.	United States of America
PSG	pressure sensor governor	SD	severe-duty	USC	United States customary (measures)
psi	pounds per square inch	SDU	step deployment unit	V	volts
psia	pounds per square inch, atmosphere	SEL	shutdown engine light	VCU	vehicle control unit
psig	pounds per square inch, gauge	SEM	switch expansion module	VDC	vehicle data computer
pt	pints	SEO	stop engine override	Vdc	volts, direct current
PTCM	pressure time control module	SHM	switch hub module	VIMS	vehicle information management system
PTO	power takeoff	SI	service information	VIN	vehicle identification number
		SI	<i>Système International</i>	VIP	vehicle instrumentation and protection (Kysor)
		SID	subsystem identifier	VIW	vehicle interface wiring (connector)
		SM	system malfunction	VOC	volatile organic compounds
		SMC	sheet molded compound		
		S/N	serial number		

List of Abbreviations

VOM	volt-ohmmeter
VRS	variable resistance sensor
VSG	variable speed governor
VSS	vehicle speed sensor
VSU	vehicle security unit
WB	wire braid
WI	work instructions
WIF	water-in-fuel
WOT	wide open throttle
-	minus or negative
+	plus or positive
±	plus-or-minus
>	greater than
<	less than
x	by (used in fastener size descriptions)
"	inches
°	degrees (of an angle)
°C	degrees Celsius (centigrade)
°F	degrees Fahrenheit
#	number
%	percent
&	and
©	copyright
™	trademark
®	registered trademark

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)

Vehicle Receipt

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 Daimler Trucks North America LLC *Warranty Manual* for details.

Vehicle Storage

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 Daimler Trucks North America LLC *Warranty Manual* for instructions on storage of new vehicles.

Pre-Delivery Information

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

Refer to Section 3 of the Daimler Trucks North America LLC *Warranty Manual* for details.

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

Hoses and Electrical Wiring Routing Standards

Cooling System

1. Cooling system hoses must clear all moving parts by a minimum of 1/4 inch (6 mm).
2. The 1-inch (25-mm) hose from the surge tank to the engine must be free of sumps and have allowance for engine torque.
3. Cooling system hoses should not be twisted or kinked.
4. Cooling system hoses must be routed at least six inches (152 mm) from a heat source if the heat source does not have a heat shield. If a heat shield is provided, the hose must be routed at least three inches (76 mm) from the heat source.

HVAC System

1. Cushion clamps are required to support all A/C lines. Butterfly or figure-8 clamps (two cushion clamps) may be used to prevent rubbing or chafing.
2. Tie straps may only be used to fasten together A/C lines that are parallel to each other.
3. Heater hoses that are protected with convoluted tubing may be fastened with tie straps. If not protected with convoluted tubing, only cushion clamps or butterfly clamps may be used for heater hoses.
4. A/C lines cannot be secured to air lines, fuel lines, or electrical wires.
5. HVAC hoses should be protected from damage by routing them away from hazards of heat, wheel splash (water, gravel, ice), human traffic, and moving parts of the vehicle.
6. HVAC hoses should be routed away from sharp points and edges (such as nuts, bolts, brackets, and frame rail edges), moveable parts, and sources of abrasion, cutting, pinching, or crushing.

NOTE: If hoses are covered with convoluted tubing, they may touch any of the above.

7. Hoses that are protected with convoluted tubing may come in contact with the bends on frame rails and filters.

8. HVAC hoses must be routed at least six inches (152 mm) from a heat source if the heat source does not have a heat shield. If a heat shield is provided, the hose must be routed at least three inches (76 mm) from the heat source.
9. HVAC hoses should be clamped every 12 to 18 inches (305 to 457 mm).
10. All HVAC hoses must be routed so that regularly serviced components, such as fuel filters, fuel/water separators, oil filters, air filters, belts, and fill and drain plugs, are readily accessible for adjustment or replacement without the need to relocate or remove the hoses.
11. All Conventional sleeper heater hoses must be protected with convoluted tubing when they pass through the crossmember, and at the lower frame rail flange.
12. Hose supports for Conventional sleeper heater hoses will be where the brackets are located.

Auxiliary Heater

No additional tie straps or tape are needed when convoluted tubing is installed where the auxiliary heater hose routes past the edge of the frame rail.

Engine Plumbing

1. On vehicles equipped with the Cummins M-11 engine and power steering, no additional tie straps or tape are needed if convoluted tubing is installed on the power steering hose where it routes under the frame rail.
2. The engine oil pressure line should not rub or chafe against the Teflon® discharge line.

Electrical Wiring

1. Wires that are bundled together should be fastened at 8- to 12-inch (203- to 305-mm) intervals. If anchor clamps are more than 12 inches (305 mm) apart, a tie strap must be used between the anchor clamps.
2. Bundles of wires that are located in an exposed area, such as under the cab or outside the frame rail, need to be fastened with heavy-duty cable ties.

Hoses and Electrical Wiring Routing Standards

3. Any wiring that will be exposed to water or heat must be covered with either loom or convoluted tubing. Loom or convoluted tubing need not butt up against Weather Pack® connectors.
4. Any wiring routed across the vehicle, on the engine crossmember, or across the rear of the engine, must be secured with a clamp or tie strap, and covered with either convoluted tubing or a loom.
5. Any wiring that may come into contact with sharp points and edges (such as nuts, bolts, brackets, and frame rail edges), moveable parts, and sources of abrasion, cutting, pinching, or crushing, must be protected by either a loom or convoluted tubing.
6. Unprotected breakouts (individual wires) of up to eight inches (203 mm) are acceptable as long as these wires are routed safely away from sharp points and edges, moveable parts, and sources of abrasion, cutting, pinching, or crushing.
7. Gray, flame-retardant convoluted tubing may be used to protect wiring in the cab or the chassis. Black nylon convoluted tubing may only be used in the chassis.
8. All wiring must be routed so that regularly serviced components, such as fuel filters, fuel/water separators, oil filters, air filters, belts, and fill and drain plugs, are readily accessible for adjustment or replacement without the need to relocate or remove any wiring.
9. In exposed locations, such as the road light harness near the headlights, loose loops of wire must be secured with tie straps.
10. All wiring should be routed a minimum of four inches (102 mm) from the exhaust. In situations where the wiring is less than four inches (102 mm) from the exhaust, a heat shield must be placed between the wiring and the exhaust.

Battery Cables

1. Battery cables must be routed along an unobstructed path from the starter to the battery box. The cables must **not** rub or chafe on brackets, tanks, air lines, or fuel lines.
2. Battery cables and electrical wiring cannot be tied or secured to fuel lines, discharge lines, or air lines.
3. Battery cables must have support brackets no more than 30 inches (762 mm) apart. Tie straps must be within six inches (152 mm) of both sides of the support brackets, and every 12 inches (305 mm) between the brackets.
4. Battery cables must have convoluted tubing from the frame bracket to the batteries, and from the frame bracket to the starter.

Fuel Lines

1. Fuel lines must not be clamped to A/C lines, battery cables, jumper cables, or any other electrical wiring.
2. Stand-off brackets or clamps may be used to prevent fuel lines from rubbing against the frame.
3. Fuel lines must be routed at least six inches (152 mm) from a heat source. If a heat shield is provided, the fuel line must be at least three inches (76 mm) from the heat source.
4. Fuel lines that are parallel may be fastened together. Fuel lines that cross or that rub on metal, plastic, or electrical parts, need to be separated with butterfly clamps.

Chassis Air Lines and Brake Hoses

1. Hoses may come in contact with each other if they are parallel, or if they are bundled together.
2. If the hoses lie on the curve or flat surface of a bracket or crossmember, they do not need convoluted tubing.
3. Brake hoses may be clamped at the top of the axle housing, and touch or lie against the axle housing in its path to the brake chamber as this assembly moves together.
4. Brake hoses must have slack between the last clamping point on the frame rail and the brake chamber to allow for full range of suspension travel.
5. Brake hoses should have butterfly clamps at breakout points.

Hoses and Electrical Wiring Routing Standards

6. Air lines and brake hoses that are bundled together should be fastened at 8- to 12-inch (203- to 305-mm) intervals. If anchor clamps are more than 12 inches (305 mm) apart, a tie strap must be used between the anchor clamps. Tie straps may be closer than 12 inches (305 mm) apart.
7. Hoses or lines that may come into contact with the sharp edge of a bracket or frame rail are to be protected by convoluted tubing.
8. Air lines and brake hoses that are parallel may be fastened together. Air lines and brake hoses that cross or that rub on metal, plastic, or electrical parts need to be separated with butterfly clamps.
9. Nylon or STX (wire braid) chassis air lines may be fastened together to prevent rubbing, as long as the lines are stationary.

VIN for Vehicles Built through April 30, 2000

IMPORTANT: See **Subject 060** for the vehicle identification numbering system for vehicles built May 1, 2000, or later.

Federal Motor Vehicle Safety Standard 115 specifies that all vehicles sold in the U.S. be assigned a 17-character Vehicle Identification Number (VIN). Using a combination of letters and numerals, the VIN defines the manufacturer, model, and major characteristics of the vehicle. See **Table 1** for the character positions of a typical Freightliner VIN, 1FUYSTEBXVPA99999.

The VIN can be found on the Vehicle Specification Decal (see the driver's manual for decal location) and stamped on the left frame rail over the front axle about 2 inches (50 mm) from the top of the web or on the top flange of the left frame rail at frame station 30.

NOTE: For Freightliner vehicles assembled and sold in Mexico, the VIN appears on a plate or label attached to the driver's door. Also, a data card placed in the glove box shows the Mexican

VIN as the "CHASSIS" number. The "CABIN" number is part of the Freightliner VIN, the last six digits of which are the Freightliner serial number.

IMPORTANT: A new VIN-code structure will be used for all vehicles built after April 30, 2000. Character positions 1 through 4 and 9 through 17 are nearly the same in both versions, but positions 5 through 8 have been assigned slightly different parameters. As a result, the build date of a vehicle must be determined before the VIN can be decoded.

For all vehicles, a check digit (9th character) is determined by assignment of weighted values to the other 16 characters. These weighted values are processed through a series of equations designed to check validity of the VIN and to detect VIN alteration.

NOTE: Always specify the VIN when ordering parts.

Seventeen-Character Vehicle Identification Number (VIN)										
Typical VIN	1 F U	Y	S	T E	B	X	V	P	A 9 9 9 9 9	
Character Position	1, 2, 3	4	5	6, 7	8	9	10	11	12 thru 17	
Decoding Table *	Table 2	Table 3	Table 4	Table 5	Table 6	—	Table 7	Table 8	—	
Code Description	Manufacturer, Make, Vehicle Type		Chassis, Front Axle Position, Brakes		Vehicle Model Series, Cab		Engine Model, Horsepower Range		Gross Vehicle Weight Rating (GVWR)	
	Check Digit		Vehicle Model Year		Plant of Manufacture		Production Number			

* For corresponding decoding information, see the applicable tables in this subject.

Table 1, Seventeen-Character Vehicle Identification Number (VIN)

VIN Positions 1, 2, and 3 (Manufacturer, Make, Vehicle Type)			
Code	Vehicle Manufacturer	Vehicle Make	Vehicle Type
1FU	Freightliner, U.S.A.	Freightliner	Truck-Tractor

VIN for Vehicles Built through April 30, 2000

VIN Positions 1, 2, and 3 (Manufacturer, Make, Vehicle Type)			
Code	Vehicle Manufacturer	Vehicle Make	Vehicle Type
1FV	Freightliner, U.S.A.	Freightliner	Incomplete Vehicle
2FU	Freightliner, Canada	Freightliner	Truck-Tractor
2FV	Freightliner, Canada	Freightliner	Incomplete Vehicle
3FE	M-B, Mexico (before April 1996)	Freightliner	Truck-Tractor
3FF	M-B, Mexico (before April 1996)	Freightliner	Incomplete Vehicle
3AK	M-B, Mexico (after April 1996)	Freightliner	Truck-Tractor
3AL	M-B, Mexico (after April 1996)	Freightliner	Incomplete Vehicle
AFV	M-B, South Africa	Freightliner	Truck
KFB	AIL, Israel	Freightliner	Truck
RSA	NAI, Saudi Arabia	Freightliner	Incomplete Vehicle
RSB	NAI, Saudi Arabia	Freightliner	Truck-Tractor

Table 2, VIN Positions 1, 2, and 3 (Manufacturer, Make, Vehicle Type)

VIN Position 4 (Chassis, Front Axle Position, Brakes)			
Code	Chassis	Front Axle Position	Brakes
A	4 x 2 Truck	Forward	Hydraulic
B	8 x 4 Truck-Tractor	Setback	Air
C	6 x 6 Truck-Tractor	Setback	Air
D	4 x 4 Truck	Setback	Hydraulic
E	4 x 4 Truck	Setback	Air
F	8 x 4 Truck	Forward	Air
G	8 x 4 Truck-Tractor	Forward	Air
H	4 x 2 Truck	Forward	Air
J	10 x 4 Truck	All	Air
K	4 x 2 Truck-Tractor	Forward	Air
L	6 x 2 Truck	Forward	Air
M	6 x 2 Truck-Tractor	Forward	Air
N	6 x 4 Truck	Forward	Air
P	6 x 4 Truck-Tractor	Forward	Air
R	10 x 6 Truck	Forward	Air
S	10 x 6 Truck-Tractor	Forward	Air
T	6 x 6 Truck	Setback	Air
U	8 x 6 Truck	All	Air
V	8 x 6 Truck-Tractor	All	Air
W	4 x 2 Truck-Tractor	Setback	Air

VIN Position 4 (Chassis, Front Axle Position, Brakes)			
Code	Chassis	Front Axle Position	Brakes
X	6 x 4 Truck	Setback	Air
Y	6 x 4 Truck-Tractor	Setback	Air
Z	6 x 2 Truck	Setback	Air
1	4 x 2 Truck *	Forward	Air/Hydraulic
	10 x 6 Truck †	Setback	Air
2	4 x 4 Truck	Setback	Air
3	4 x 2 Truck	Setback	Hydraulic
4	8 x 4 Truck	Setback	Air
5	6 x 2 Truck-Tractor	Setback	Air
6	4 x 2 Truck	Setback	Air
7	Glider	Setback	Air
8	Glider	Forward	Air
9	4 x 2 Truck	Setback	Air/Hydraulic
0	Glider	Setback	Air

* Starting August 1998.

† Through July 1998; included in code R starting August 1998.

Table 3, VIN Position 4 (Chassis, Front Axle Position, Brakes), January 18, 1988 through April 30, 2000

VIN for Vehicles Built through April 30, 2000

VIN Position 5 (Model Series, Cab)	
Code	Vehicle Model, Cab
A	FLA High COE
B	FLB High COE
C	120 Conventional XL
D	FLD120 Conventional, Highway
E	FL50 Short Conventional
F	FLD120SD Conventional, Construction
G	FL60 Short Conventional
H	FL70 Short Conventional
J	FL80 Short Conventional
L	112 Conv., Alum. Cab, Hwy., 48RR94MY * Argosy High COE
M	120 Conventional, Military
N	Century Class 112 Conventional
P	120 Conv., Alum. Cab, Hwy., 48RR94MY Columbia 120 Conventional
R	112 Conventional, Steel Cab, Hwy., RH Drive
S	Century Class 120 Conventional
T	High COE (through 88MY) FL112 Conventional
U	120 Conventional XL, 48RR94MY

VIN Position 5 (Model Series, Cab)	
Code	Vehicle Model, Cab
V	MB60 Short Conventional (to 95MY) Legacy FL112 (00MY)
W	FC80 Freightliner Cargo COE
X	MB70 Short Conventional (to 97MY) Legacy FLD120 (00MY)
Y	MB80 Short Conventional (through 98MY)
Z	112 Conventional, Steel Cab, Highway
1	FLC112 Conv., Steel Cab, Constr. (to 98MY)
2	FLC120 Conventional (to 91MY) FC60 Freightliner Cargo COE
3	FLD112 Conventional, Alum. Cab, Highway
4	Low COE, Aluminum Cab
5	MB50 Short Conventional
6	FLD112SD Conv., Alum. Cab, Construction
7	FLD120 Conventional, SilverAero (91MY) FC70 Freightliner Cargo COE
8	FL106 Short Conventional
9	RIV

* MY = Model Year

Table 4, VIN Position 5 (Model Series, Cab)

VIN Positions 6 and 7 (Engine Manufacturer, Model, Horsepower Range)			
Code	Engine Manufacturer	Engine Model	HP Range
AY	Cummins	NTC / N14	207–251
BD	Mercedes-Benz	MBE4000	353–407
BE	Mercedes-Benz	MBE4000	408–495
BX	Mercedes-Benz	MBE4000	288–352
BY	Cummins	NTC / N14	254–310
CX	Detroit Diesel	S-60, 11.1 L	331–402
CY	Cummins	N14	315–385
DY	Cummins	NTC / N14	389–475
DZ	Cummins	N14	476–580
EB	Caterpillar	C10 / 3176J	225–275
EC	Caterpillar	C10 / 3176J	276–335
ED	Caterpillar	C10 / 3176	336–407

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Vehicle Identification Numbering System

VIN for Vehicles Built through April 30, 2000

VIN Positions 6 and 7 (Engine Manufacturer, Model, Horsepower Range)			
Code	Engine Manufacturer	Engine Model	HP Range
F4	Cummins	B5.9 (propane)	185–224
FA	Cummins	6BT 5.9 (diesel) / ISB	185–224
FB	Cummins	6BT 5.9 (diesel) / ISB	225–275
FF	Cummins	6BT 5.9/ ISB	153–184
FH	Cummins	6BT 5.9–195G (natural gas)	185–224
FV	Cummins	6BT 5.9–195G (natural gas)	126–152
GA	Mercedes-Benz	OM 366LA	185–224
GB	Mercedes-Benz	OM 366LA	225–275
GF	Mercedes-Benz	OM 366LA	153–184
HB	Detroit Diesel	S–50	225–275
HC	Detroit Diesel	S–50	276–335
HD	Detroit Diesel	S–50	336–407
JA	Caterpillar	CFE / 3126 (diesel)	185–224
JB	Caterpillar	CFE / 3126 (diesel)	225–275
JC	Caterpillar	CFE / 3126 (diesel)	276–335
JF	Caterpillar	CFE / 3126 (diesel)	153–184
KY	Cummins	L10	225–275
LA	Cummins	6C 8.3 (diesel) / ISC	185–224
LB	Cummins	6C 8.3 (diesel) / ISC	225–275
LC	Cummins	6C 8.3 (diesel) / ISC	276–335
LD	Cummins	L10	336–407
LE	Cummins	ISC	336–407
LL	Cummins	C 8.3 (natural gas) / ISC	225–276
LY	Cummins	L10	276–330
MC	Cummins	M11 / ISM	276–335
MD	Cummins	M11 / ISM	336–407
ME	Cummins	M11 / ISM	408–495
MW	Cummins	ISM	496–605
NT	Cummins	4B 3.9–130 hp (diesel)	126–152
PY	Detroit Diesel	S-60, 11.1 L	275–330
RY	Caterpillar	3406	270–330
SE	Detroit Diesel	S-60, 12.7 L	408–495
SM	Detroit Diesel	S-60, 12.7 L	276–335
SY	Caterpillar	3406	333–407
SZ	Detroit Diesel	S-60, 12.7 L	496–605

Vehicle Identification Numbering System

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VIN for Vehicles Built through April 30, 2000

VIN Positions 6 and 7 (Engine Manufacturer, Model, Horsepower Range)			
Code	Engine Manufacturer	Engine Model	HP Range
TD	Detroit Diesel	S-55	336–407
TE	Detroit Diesel	S-55	408–495
TJ	Dodge	Magnum V8 (gasoline)	207–253
TR	Dodge	Magnum V10 (gasoline)	270–330
TY	Caterpillar	3408	383–467
UY	Caterpillar	3306	225–275
VY	Caterpillar	3406	225–269
WC	Caterpillar	CFE/3126	276–335
WD	Caterpillar	C12 / 3176L	336–407
WE	Caterpillar	C12 / 3176L	408–495
WY	Caterpillar	3306	276–335
XY	Caterpillar	3406	408–495
XZ	Caterpillar	3406	496–605
YY	Detroit Diesel	S-60, 11.1 L	225–274
ZY	Detroit Diesel	S-60, 12.7 L	333–407
1B	Detroit Diesel	6L–71	225–275
1C	Detroit Diesel	6L–71	276–335
2W	Detroit Diesel	S-60, 14.0L	496–605
3A	Mercedes-Benz	MB904	185–224
4Y	Detroit Diesel	6V–92	239–287
5Y	Detroit Diesel	6V–92	288–352
6A	Mercedes-Benz	MB906	185–224
6B	Mercedes-Benz	MB906	225–275
6C	Mercedes-Benz	MB906	276–335
6Y	Detroit Diesel	8V–92	365–446
7D	Cummins	ISX Signature	336–407
7E	Cummins	ISX Signature	408–495
7W	Cummins	ISX Signature	496–605
8Y	Detroit Diesel	8V–92	302–364
9Y	Detroit Diesel	8V–92	447–522
0Y	No Engine	—	—

Table 5, VIN Positions 6 and 7 (Engine Manufacturer, Model, Horsepower Range)