MERCURY

MERCURY

Service Manual

200/225/250/275/300
250 & 300 Pro
300 CCT
Verado FourStroke

Starting Model Year 2005
Starting Serial Number 0T980000 and Above

200/225/250/275/300
250 & 300 Pro
300 CCT
Verado FourStroke

90-8M0082470
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Notice to Users of This Manual

Throughout this publication, dangers, warnings, cautions, and notices (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully!

These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures.

⚠ DANGER
Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE
Indicates a situation which, if not avoided, could result in engine or major component failure.

IMPORTANT: Identifies information essential to the successful completion of the task.

NOTE: *Indicates information that helps in the understanding of a particular step or action.*

This manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein. We reserve the right to make changes to this manual without prior notification.

Alpha, Axius, Bravo One, Bravo Two, Bravo Three, Circle M with Waves Logo, K-planes, Mariner, MerCathode, MerCruiser, Mercury, Mercury with Waves Logo, Mercury Marine, Mercury Precision Parts, Mercury Propellers, Mercury Racing, MotorGuide, OptiMax, Quicksilver, SeaCore, Skyhook, SmartCraft, Sport-Jet, Verado, VesselView, Zero Effort, Zeus, and #1 On the Water are registered trademarks of Brunswick Corporation. Mercury Product Protection is a registered service mark of Brunswick Corporation.

It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury Marine Power Products, including the use of mechanics' common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

Refer to dealer service bulletins, operation maintenance and warranty manuals, and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

It should be kept in mind, while working on the product, that the electrical and ignition systems are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material into the cylinders which could cause extensive internal damage when the engine is started.

During any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for reuse, care should be taken to select a replacement that matches the original.

Replacement Parts

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

Cleanliness and Care of Product

A Mercury Marine Power Product is a combination of many machined, honed, polished, and lapped surfaces with tolerances measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. It should be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

Personnel should not work on or under an engine that is suspended. Engines should be attached to work stands, or lowered to ground as soon as possible.

Manual Outline

Important Information

Section 1A - Master Specifications

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200/225/250/275/300 Verado Master Specifications

General Specifications

Model Specifications	
Kilowatts (horsepower)	149 kw (200 HP) 168 kw (225 HP) 186 kw (250 HP) 205 kw (275 HP) 224 kw (300 HP)
Weight, except offshore models	
50.8 cm (20 in.)	293 kg (645 lb)
63.5 cm (25 in.)	299 kg (659 lb)
76.2 cm (30 in.)	307 kg (677 lb)
Weight, offshore models	
50.8 cm (20 in.)	299 kg (659 lb)
63.5 cm (25 in.)	305 kg (672 lb)
76.2 cm (30 in.)	313 kg (690 lb)
Displacement (all horsepower)	2.6L (158.5 cu in.)
RPM	
Idle	550 ± 50 RPM
WOT	5800–6400 RPM
Induction system	SmartCraft DTS® electronic throttle, intercooled supercharged aspiration with electronic boost pressure control
Fuel system	Computer controlled sequential multiport electronic fuel injection
Ignition system	SmartCraft propulsion control module (PCM) 03–08 digital inductive
Charging system	Regulated belt-driven 70 A alternator
Exhaust system	Through-the-propeller
Cooling system	Water-cooled - thermostat with pressure control
Lubrication system	
Integrated dry sump	7 Liter (7.4 US qt)
Oil type recommendation	NMMA FC-W Certified Synthetic Blend 25W-50 (preferred) or NMMA FC-W Certified Synthetic Blend 4-Stroke Outboard Oil 25W-40
Engine control system	SmartCraft PCM 03 digital throttle and shift (DTS)
Trim system	SmartCraft programmable
Maximum tilt range	73° (–6° to 67°)
Maximum trim range	20° (–6° to 14°)
Steering system	Electric - hydraulic power steering with integral hydraulic cylinder

Fuel System Specifications

Fuel System Specifications	
Model	Type of fuel
Models 200/225/250 (non-Pro) 149 kw (200 hp), 168 kw (225 hp), 186 kw (250 hp)	USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable.
	Outside USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable.
Models 250 Pro/275/300/300 Pro 186 kw (250 hp), 205 kw (275 hp), 224 kw (300 hp)	Automotive unleaded with a minimum pump posted octane rating of 92 (R+M)/2 Octane is required for best performance. Having a posted pump Octane Rating of 87 (R+M)/2 minimum is acceptable, however, performance losses may occur.
	Outside USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 96 RON is required for best performance. Having a posted pump Octane Rating of 90 RON minimum is acceptable, however, performance losses may occur.
Approximate fuel pressure at idle	279–289 kPa (40–42 psi)
Fuel filtration	
Fuel inlet water separator	2 microns
High pressure	20 microns

Ignition Specifications

Ignition Specifications	
Full throttle RPM range (all models)	5800–6400
Idle RPM (all models)	550
Ignition type	Digital inductive
Spark plug type	NGK ILFR6G or NGK ILFR6GE
Spark plug gap	0.8 mm (0.031 in.)
Spark plug hex size	16 mm
Spark plug torque	27.5 Nm (19 lb-ft)
Spark plug hole size	14 mm
Firing order	1-3-5-6-4-2
Ignition timing at idle	Not adjustable; PCM controlled (approximately 2° ATDC)
Ignition timing at WOT	Not adjustable; PCM controlled
PCM overspeed limiter	Activates at 6500 RPM

Charging and Starting Specifications

Charging and Starting Specifications	
Alternator output (regulated)	
Output at battery (at 1000 RPM)	37–44 A
Output at battery (at 3000 RPM)	53–69 A
Output at alternator (at 1000 RPM)	48–54 A
Output at alternator (at 3000 RPM)	65–72 A
Voltage set point	14.5 ± 0.25 V
Regulator current draw[1.]	
Ignition switch "OFF" (maximum)	1.0 mA
Ignition switch "ON"	350 mA
Starter draw (under load)	160 A
Starter draw (no load)	60 A
Minimum brush length	6.4 mm (0.25 in.)
Battery rating	
Required starting battery type	12 V absorbed glass mat (AGM)
USA and Canada (SAE) requirement	800 minimum marine cranking amps (MCA) with a minimum reserve capacity of 135 RC25 rating
International (EN) requirement	975 minimum cold cranking amps (CCA) with a minimum of 65 ampere hours (Ah) rating

1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Cylinder Head Specifications

Cylinder Head Specifications	
Maximum deck warp	0.075 mm (0.003 in.)
Number of valves	24
Number of valves per cylinder	4
Number of cams	2
Camshaft bearing journal (intake and exhaust)	28.94–28.96 mm (1.139–1.140 in.)
Camshaft bearing cap ID	29.000–29.021 mm (1.1417–1.1425 in.)
Camshaft lobe (S/N 1B517433 and below)	
Intake (minimum)	42.44 mm (1.6709 in.)
Exhaust (minimum)	43.49 mm (1.7122 in.)
Camshaft lobe (S/N 1B517434 and above)	
Intake (minimum)	43.49 mm (1.7122 in.)
Exhaust (minimum)	43.49 mm (1.7122 in.)
Valve lash clearance	
Intake	0.150–0.270 mm (0.0059–0.0106 in.)
Exhaust	0.350–0.470 mm (0.0137–0.0185 in.)
Valve seat angles	30°, 44.625–45°, 55°
Valve spring free length	48.77 mm (1.920 in.)
Valve spring installed height	34 mm (1.339 in.)
Measure load at installed height	222 ± 10 N (49.91 ± 2.25 lb-force)
Valve outside diameter	
Intake	31.85–32.15 mm (1.253–1.265 in.)
Exhaust	27.05–27.35 mm (1.065–1.077 in.)
Valve face width (intake and exhaust)	2.25 mm (0.0886 in.)
Valve margin thickness (minimum)	
Intake	0.424 mm (0.0167 in.)
Exhaust	0.420 mm (0.0165 in.)
Valve guide bore ID (intake and exhaust)	6.00–6.016 mm (0.2362–0.2368 in.)
Valve stem diameter	
Intake	5.96–5.98 mm (0.2346–0.2354 in.)
Exhaust	5.95–5.97 mm (0.2343–0.2350 in.)
Valve stem runout (maximum)	0.038 mm (0.0015 in.)
Valve stem to valve guide clearance	
Intake	0.020–0.050 mm (0.0008–0.0020 in.)
Exhaust	0.030–0.060 mm (0.0012–0.0024 in.)
Valve seat contact width	
Intake	1.4–1.6 mm (0.0551–0.0630 in.)
Exhaust	1.5–1.7 mm (0.0591–0.0669 in.)

Cylinder Block/Crankcase Specifications

Cylinder Block/Crankcase Specifications	
Number of cylinders	6
Displacement	2.6 liters (158.6 CID)
Compression ratio	8.25:1
Standard bore	82.0 mm (3.228 in.)
Stroke	82.0 mm (3.228 in.)
Cylinder bore maximum taper (service)	0.0762 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.0762 mm (0.003 in.)
Cylinder block main bearing	65.997–66.013 mm (2.5982–2.5989 in.)
Crankshaft main bearing journal	59.985–60.001 mm (2.3616–2.3622 in.)
Crankshaft pin journal	49.982–50.0 mm (1.9678–1.968 in.)
Crankshaft end play	0.08–0.19 mm (0.003–0.007 in.)
Crankshaft runout	0.05 mm (0.002 in.)
Crankshaft main bearing oil clearance (without expansion)	0.014–0.042 mm (0.0005–0.0016 in.)
Crankshaft pin bearing oil clearance (without expansion)	0.020–0.050 mm (0.0008–0.0019 in.)
Connecting rod wrist pin bore diameter	22.005–22.014 mm (0.8663–0.8666 in.)
Connecting rod crankshaft pin diameter	53.000–53.018 mm (2.0866–2.0873 in.)
Piston skirt standard diameter	81.975 mm (3.2273 in.)
Piston wrist pin bore diameter	22.004–22.011 mm (0.8662–0.8665 in.)
Wrist pin diameter	21.997–22.000 mm (0.8660–0.8661 in.)
Top ring groove width	1.25 mm (0.049 in.)
Middle ring groove width	1.25 mm (0.049 in.)
Oil ring groove width	2.05 mm (0.081 in.)
Top ring thickness	1.19 mm (0.047 in.)
Middle ring thickness	1.19 mm (0.047 in.)
Oil ring thickness	1.98 mm (0.078 in.)
Top ring side clearance	0.04–0.08 mm (0.001–0.003 in.)
Middle ring side clearance	0.04–0.08 mm (0.001–0.003 in.)
Oil ring side clearance	0.05–0.17 mm (0.002–0.006 in.)
Top ring end gap	0.27–0.42 mm (0.010–0.016 in.)
Middle ring end gap	0.42–0.62 mm (0.016–0.024 in.)
Oil ring end gap	0.2–0.7 mm (0.007–0.027 in.)

Power Trim Specifications

Power Trim Specifications	
Trim up circuit pressure, maximum	18,270–28,960 kPa (2650–4200 psi)
Trim down circuit pressure	1255–2765 kPa (182–401 psi)
System fluid	Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III)

Oil System Specifications

Engine capacity wet	7 L (7.4 US qt)
Engine capacity dry	8 L (8.4 US qt)
Oil filter part number (S/N 1B517433 and below)	883701K01
Oil filter part number (S/N 1B517434 and above)	877769KO1
Oil type recommendation	Mercury Racing 4-Stroke Oil or NMMA FC-W SAE 25W-50 Synthetic Blend (preferred) or NMMA FC-W SAE 25W-40 Synthetic Blend 4-Stroke Outboard Oil
S/N 1B517433 and below	
Oil pressure (minimum) at 550 RPM	70 kPa (10 psi)
Oil pressure (minimum) at 6000 RPM	220 kPa (32 psi)
S/N 1B517434 and above	
Oil pressure (minimum) at 550 RPM	35 kPa (5 psi)
Oil pressure (minimum) at 6000 RPM	200 kPa (29 psi)
IOM thermostat opening temperature	105 °C (221 °F)

Gear Housing Specifications (Standard Rotation)

Gear Housing Specifications (Standard Rotation)	
Gear ratio	
Model 200/225/250/275	1.85:1 (13/24 teeth)
Model 300	1.75:1 (12/21 teeth)
Gearcase capacity	970 ml (32.8 fl oz)
Gear lubricant type	High Performance Gear Lubricant
Pinion height	0.635 mm (0.025 in.)
Forward gear backlash	0.482–0.660 mm (0.019–0.026 in.)
Reverse gear backlash	1.27–1.47 mm (0.050–0.058 in.)
Water pressure at RPM	
at 550 RPM (Idle)	15.2 kPa (2.2 psi)
at 6000 RPM (WOT) warm water fast boat	60 kPa (8.7 psi)
at 6000 RPM (WOT) cold water fast boat	260 kPa (37.8 psi)
Gear housing pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)
Propeller shaft runout	0.23 mm (0.009 in.)

Gear Housing Specifications (Counter Rotation)

Gear Housing Specifications (Counter Rotation)	
Gear ratio	
Model 200/225/250/275	1.85:1 (13/24 teeth)
Model 300	1.75:1 (12/21 teeth)
Gearcase capacity	970 ml (32.8 fl oz)
Gear lubricant type	High Performance Gear Lubricant
Pinion height	0.635 mm (0.025 in.)
Forward gear backlash	0.482–0.660 mm (0.019–0.026 in.)
Reverse gear backlash	1.27–1.47 mm (0.050–0.058 in.)
Water pressure at RPM	
at 550 RPM (idle)	15.2 kPa (2.2 psi)
at 6000 RPM (WOT) warm water fast boat	60 kPa (8.7 psi)
at 6000 RPM (WOT) cold water fast boat	260 kPa (37.8 psi)
Gear housing pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)
Propeller shaft runout	0.23 mm (0.009 in.)

Gear Housing Specifications–5.44 in. Diameter Gearcase Torpedo

Gear Housing Specifications		
Gear ratio		
Model 225/250/300		1.85:1 (13/24 teeth)
Model 300 HD/350 SCi		1.75:1 (12/21 teeth)
Gear housing capacity	All models	850 ml (28.7 fl oz)
Propeller shaft runout	All models	0.23 mm (0.009 in.)
Pinion height	All models	0.635 mm (0.025 in.)
Front gear backlash (right-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.533 mm (0.021 in.)
	1.85:1 ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.584 mm (0.023 in.)
Front gear backlash (left-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.838 mm (0.033 in.)
	1.85:1 ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.914 mm (0.036 in.)
Rear gear backlash (right-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.864 mm (0.034 in.)
	1.85: ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.939 mm (0.037 in.)
Rear gear backlash (left-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.533 mm (0.021 in.)
	1.85: ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.584 mm (0.023 in.)
Water pressure at 550 RPM	All models	6.9–20.5 kPa (1–3 psi)

Gear Housing Specifications		
Water pressure at 6000 RPM (warm water)	All models	60 kPa (8.7 psi)
Water pressure at 6000 RPM (cold water)	All models	260 kPa (37.8 psi)
Leak test (for 5 minutes)	All models	103.4 kPa (15 psi)
Poppet valve open pressure	All models	27.6–62.0 kPa (4–9 psi)

Power Steering Specifications

Power Steering Specifications	
Fluid type	SAE 0W-30 Synthetic Power Steering Fluid
Capacity	Typical 1–2 liters (1–2 US qt)
Current draw	Shall not exceed 75 amps
Steering ratio (40 cc helm and single steering cylinder, lock to lock)	4.1 turns
Steering ratio (50 cc helm with dual steering cylinders, lock to lock)	6.5 turns

Propeller Chart

Mercury/Mariner 200 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 4.8 in. gearcase
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	27	4	Trophy Plus	Up to 953 kg (2100 lb)	Up to 6.4 m (21 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	Up to 953 kg (2100 lb)	Up to 6.4 m (21 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo 1	862–998 kg (1900–2200 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	862–998 kg (1900–2200 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	862–998 kg (1900–2200 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	907–1043 kg (2000–2300 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	907–1043 kg (2000–2300 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	907–1043 kg (2000–2300 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	953–1089 kg (2100–2400 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 48-831911A45 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	24	4	Trophy Plus	953–1089 kg (2100–2400 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	953–1089 kg (2100–2400 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47
14.62	23	4	Revolution 4	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	High Five	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	998–1134 kg (2200–2500 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	High Five	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1270–1451 kg (2800–3200 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1270–1451 kg (2800–3200 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	High Five	1270–1451 kg (2800–3200 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1270–1451 kg (2800–3200 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1406–1678 kg (3100–3700 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	High Five	1406–1678 kg (3100–3700 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-821154A46
14.25	17	4	VenSura	1406–1678 kg (3100–3700 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-825898A48 (RH) 48-825899A48 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.75	15	3	Mirage Plus	1633–1996 kg (3600–4400 lb)	6.7–7.9 m (22–26 ft)	61–76 km/h (38–47 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	1860–2631 kg (4100–5800 lb)	6.7–7.9 m (22–26 ft)	50–64 km/h (31–40 mph)	48-826072A46
16	12	3	Aluminum	2223–3085 kg (4900–6800 lb)	7.0–8.2 m (23–27 ft)	42–56 km/h (26–35 mph)	48-16436A45
16	11	3	Aluminum	2722 + kg (6000 + lb)	Workboat	1.6–47 km/h (1–29 mph)	48-78112A45 (RH) 48-78117A40 (LH)

Mercury/Mariner 225 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 4.8 in. gearcase
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 998 kg (2200 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 998 kg (2200 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	907–1043 kg (2000–2300 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	907–1043 kg (2000–2300 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	23	4	Revolution 4	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	1134–1270 kg (2500-2800 lb)	6.7–7.3 m (22–24 ft)	104–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1270–1451 kg (2800–3200 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1270–1451 kg (2800–3200 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-821154A46
14.25	17	4	VenSura	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	1860–2495 kg (4100–5500 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2268 + kg (5000 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-825072A46

Mercury/Mariner 225 (6 Cyl., FourStroke) with 5.44 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 5.44 in. gearcase with 25.4 mm (1.0 in.) diameter propeller shaft
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 998 kg (2200 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 998 kg (2200 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	907–1043 kg (2000–2300 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	907–1043 kg (2000–2300 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	953–1089 kg (2100–2400 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	998–1134 kg (2200–2500 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 84-831911A45 (LH)
13.75	24	4	Trophy Plus	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1089–1225 kg (2400–2700 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47
14.62	23	4	Revolution 4	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	1134–1270 kg (2500-2800 lb)	6.7–7.3 m (22–24 ft)	104–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.00	23	4	VenSura	1134–1270 kg (2500–2800 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1270–1451 kg (2800–3200 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1270–1451 kg (2800–3200 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1270–1451 kg (2800–3200 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	84-815758A46
14.00	19	4	VenSura	1406–1633 kg (3100–3600 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-821154A46
14.25	17	4	VenSura	1588–1860 kg (3500–4100 lb)	6.7–7.9 m (22–26 ft)	72–84 km/h (45–52 mph)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	1860–2495 kg (4100–5500 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2268 + kg (5000 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-826072A46

Mercury/Mariner 250 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 4.8 in. gearcase
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1134 kg (2500 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55 (RH) 48-831915A55 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	28	4	Trophy Plus	Up to 1134 kg (2500 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	998–1180 kg (2200–2600 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	998–1180 (2200–2600 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	1089–1225 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	1089–1225 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	1089–12250 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1180–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1180–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1180–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47
14.62	23	4	Revolution 4	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.25	21	5	HighFive	1406–1588 kg (3100–3500 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1406–1588 kg (3100–3500 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1769–2268 kg (3900–5000 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1769–2268 kg (3900–5000 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-851154A46
14.25	17	4	VenSura	1950–2268 kg (4300–5000 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	2087–2722 kg (4600–6000 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2495 + kg (5500 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-826072A46

Mercury/Mariner 250 Pro (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.)
- 4.8 in. gearcase
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1225 kg (2700 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55
13.75	28	4	Trophy Plus	Up to 1225 kg (2700 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	1179–1361 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45
13.75	26	4	Trophy Plus	1179–1361 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	26	3	Tempest Plus	1179–1361 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46
13.75	25	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1315–1497 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45
13.75	24	4	Trophy Plus	1315–1497 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1320–1500 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47
14.62	23	4	Revolution 4	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46
13.75	23	4	Trophy Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-13704A46
13.25	23	5	HighFive	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48
13.75	21	4	Trophy Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46
13.25	21	5	HighFive	1542–1769 kg (3400–3900 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1542–1769 kg (3400–3900 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48
14.62	19	3	Tempest Plus	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46
13.25	19	5	HighFive	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48
15.5	17	3	Mirage Plus	1950–2495 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	48-18278A46
13.5	17	5	HighFive	1950–2495 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	84-821154A46

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.25	17	4	VenSura	1950–2495 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	48-825898A48
15.75	15	3	Mirage Plus	2268–2948 kg (5000–6500 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46
16	13	3	Mirage Plus	2495 + kg (5500 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-826072A46

Mercury/Mariner 250 (6 Cyl., FourStroke) with 5.44 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 5.44 in. gearcase with 25.4 mm (1.0 in.) diameter propeller shaft
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1134 kg (2500 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 1134 kg (2500 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	998–1179 kg (2200–2600 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	998–1179 kg (2200–2600 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	1089–1225 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	1089–1225 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	1089–1225 kg (2400–2700 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1179–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1179–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1179–1361 kg (2600–3000 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	23	4	Revolution 4	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47
14.63	23	3	Mirage Plus	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	1225–1406 kg (2700–3100 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1406–1588 kg (3100–3500 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1406–1588 kg (3100–3500 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1406–1588 kg (3100–3500 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1542–1814 kg (3400–4000 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1769–2268 kg (3900–5000 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1769–2268 kg (3900–5000 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	48-821154A46
14.25	17	4	VenSura	1950–2268 kg (4300–5000 lb)	6.7–7.9 m (22–26 ft)	39–49 km/h (24–30 mph)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	2087–2722 kg (4600–6000 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2495 + kg (5500 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-826072A46

Mercury/Mariner 275 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 4.8 in. gearcase
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1225 kg (2700 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 1225 kg (2700 lb)	Up to 6.7 m (22 ft)	126–142 km/h (78–88 mph)	48-825948A47
13.75	27	4	Trophy Plus	1134–1270 kg (2500–2800 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825946A47
14.62	27	3	Tempest Plus	1134–1270 kg (2500–2800 lb)	Up to 6.7 m (22 ft)	121–137 km/h (75–85 mph)	48-825868A47
15.25	26	4	Bravo I	1180–1360.78 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	1180–1360.78 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825944A47
14.62	26	3	Tempest Plus	1180–1361 kg (2600–3000 lb)	6.4–7.0 m (21–23 ft)	116–130 km/h (72–81 mph)	48-825874A47
14.50	25	3	Mirage Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825942A47
14.62	25	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	6.4–7.0 m (21–23 ft)	111–126 km/h (69–78 mph)	48-825866A47
15.25	24	4	Bravo I	1315.4–1496.9 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1315.4–1496.9 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825940A47
14.62	24	3	Tempest Plus	1315.4–1496.9 kg (2900–3300 lb)	6.7–7.3 m (22–24 ft)	106–119 km/h (66–74 mph)	48-825872A47
14.62	23	4	Revolution 4	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114.23 km/h (63–71 mph)	48-825938A47
14.62	23	3	Tempest Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825864A47

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.63	23	3	Mirage Plus	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-815762A46
14.00	23	4	VenSura	1361–1542 kg (3000–3400 lb)	6.7–7.3 m (22–24 ft)	101–114 km/h (63–71 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825934A47
14.62	21	3	Tempest Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-825862A47
14.75	21	3	Mirage Plus	1542–1769 kg (3400–3900 lb)	6.7–7.3 m (22–24 ft)	92–103 km/h (57–64 mph)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1542–1769 kg (3400–3900 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-815760A46
14.00	21	4	VenSura	1542–1769 kg (3400–3900 lb)	6.4–7.3 m (21–24 ft)	92–103 km/h (57–64 mph)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825860A47
15.25	19	3	Mirage Plus	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1724–1996 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-815758A46
14.00	19	4	VenSura	1724–19961 kg (3800–4400 lb)	6.7–7.6 m (22–25 ft)	82–93 km/h (51–58 mph)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1950–2494.76 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1950–2495 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-821154A46
14.25	17	4	VenSura	1950–2494.76 kg (4300–5500 lb)	6.7–7.9 m (22–26 ft)	63–78.9 km/h (39–49 mph)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	2268–2948 kg (5000–6500 lb)	7.0–8.2 m (23–27 ft)	56–72 km/h (35–45 mph)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2722 + kg (6000 + lb)	7.6–9.1 m (25–30 ft)	40–61 km/h (25–38 mph)	48-826072A46

Mercury/Mariner 300 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 4.8 in. gearcase
- Gear reduction: 1.75:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	27	4	Trophy Plus	Up to 1361 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825946A47
14.62	27	3	Tempest Plus	Up to 1361 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825868A47
13.75	26	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825944A47
14.62	26	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825944A47
15.25	26	4	Bravo I	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-831914A45 (RH) 48-831913A45 (LH)
14.50	25	3	Mirage Plus	1270–1496.9 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1270–1496.9 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825942A47
14.62	25	3	Tempest Plus	1270–1496.9 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825866A47
14.62	25	4	Revolution 4	1270–1496.9 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-857032A46 (RH) 48-857033A46 (LH)
13.75	24	4	Trophy Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825940A47
14.62	24	3	Tempest Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825872A47
15.25	24	4	Bravo I	1361–1542 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	23	4	Trophy Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825938A47
14.62	23	3	Tempest Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825864A47
14.63	23	3	Mirage Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-13704A46 (RH) 48-13705A46 (LH)
14.62	23	4	Revolution 4	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.45	22	3	Enertia	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–112.7 km/h (62–70 mph)	48-899202A46
15.25	22	4	Bravo I	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–112.7 km/h (62–70 mph)	48-831909A45

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	21	3	Tempest Plus	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-825862A47
13.63	21	3	Enertia	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-899002A46 (RH) 48-899003A46 (LH)
14.62	21	4	Revolution 4	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-857028A46 (RH) 48-857029A46 (LH)
13.80	20	3	Enertia	1724–1950.45 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-899000A46
14.62	19	3	Tempest Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-825860A47
14.00	19	3	Enertia	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–974 km/h (53–60 mph)	48-898998A46 (RH) 48-898999A46 (LH)
15.25	19	5	Mirage Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-13700A46 (RH) 48-13701A46 (LH)
14.62	19	4	Revolution 4	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-857026A46 (RH) 48-857027A46 (LH)
14.22	18	3	Enertia	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	81–90 km/h (50–56 mph)	48-898996A46
15.38	18	3	Mirage Plus	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	81–90 km/h (50–56 mph)	48-889620A46 (RH) 48-889619A46 (LH)
14.45	17	3	Enertia	2087–2449.4 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-898993A46 (RH) 48-898994A44 (LH)
15.5	17	3	Mirage Plus	2087–2449.4 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-18278A46 (RH) 48-90159A46 (LH)
14.62	17	4	Revolution 4	2087–2449.4 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-857024A46 (RH) 48-857025A46 (LH)
14.72	16	3	Enertia	2223–2631 kg (4900–5800 lb)	7.3–8.5 m (24–28 ft)	69–81 km/h (43–50 mph)	48-898992A46
15.00	15	3	Enertia	2449.4–2948 kg (5400–6500 lb)	7.3–8.5 m (24–28 ft)	63–74 km/h (39–46 mph)	48-898990A46 (RH) 48-898991A46 (LH)
15.75	15	3	Mirage Plus	2449.4–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-19838A46 (RH) 48-19841A46 (LH)
14.62	15	4	Revolution 4	2449.4–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-857022A46

Mercury/Mariner Pro 300 (6 Cyl., FourStroke) with 4.8 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400

- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.)
- 4.8 in. gearcase
- Gear reduction: 1.75:1
- Right-hand rotation standard (left-hand rotation not available)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	27	4	Trophy Plus	Up to 1361 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825946A47
14.62	27	3	Tempest Plus	Up to 1361 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825868A47
13.75	26	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825944A47
14.62	26	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825874A47
15.25	26	4	Bravo I	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-831914A45
14.50	25	3	Mirage Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-13706A46
13.75	25	4	Trophy Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825942A47
14.62	25	3	Tempest Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825866A47
14.62	25	4	Revolution 4	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-857032A46
13.75	24	4	Trophy Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825940A47
14.62	24	3	Tempest Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825872A47
15.25	24	4	Bravo I	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-831912A45
13.75	23	4	Trophy Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825938A47
14.62	23	3	Tempest Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825864A47
14.63	23	3	Mirage Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-13704A46
14.62	23	4	Revolution 4	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-857030A46
13.45	22	3	Enertia	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–113 km/h (62–70 mph)	48-899202A46
15.25	22	4	Bravo I	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–113 km/h (62–70 mph)	48-831910A45
14.62	21	3	Tempest Plus	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-825862A47
13.63	21	3	Enertia	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-899002A46
14.62	21	4	Revolution 4	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-857028A46
13.80	20	3	Enertia	11724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-899000A46

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	19	3	Tempest Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-825860A47
14.00	19	3	Enertia	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-898998A46
15.25	19	3	Mirage Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-13700A46
14.62	19	4	Revolution 4	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-857026A46
14.22	18	3	Enertia	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-898996A46
15.38	18	3	Mirage Plus	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-889620A46
14.45	17	3	Enertia	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-898994A46
15.5	17	3	Mirage Plus	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-18278A46
14.62	17	4	Revolution 4	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-857024A46
14.72	16	3	Enertia	2223–2631 kg (4900–5800 lb)	7.3–8.5 m (24–28 ft)	69–80 km/h (43–50 mph)	48-898992A46
15.00	15	3	Enertia	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-898990A46
15.75	15	3	Mirage Plus	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-19838A46
14.62	15	4	Revolution 4	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-857022A46

Mercury/Mariner 300 (6 Cyl., FourStroke) with 5.44 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 5.44 in. gearcase with 25.4 mm (1.0 in.) diameter propeller shaft
- Gear reduction: 1.85:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.00	26	3	Fury	1315–1497 kg (2900–3300 lb)	5.8–6.7 m (19–22 ft)	113–129 km/h (70–80 mph)	48-8M8023160
14.62	26	3	Tempest Plus	1315–1497 kg (2900–3300 lb)	5.8–6.7 m (19–22 ft)	113–129 km/h (70–80 mph)	48-825874A47
15.25	26	4	Bravo I	1315–1497 kg (2900–3300 lb)	5.8–6.7 m (19–22 ft)	113–129 km/h (70–80 mph)	48-831914A45 (RH) 84-831913A45 (LH)
14.00	25	3	Fury	1315–1497 kg (2900–3300 lb)	5.8–6.7 m (19–22 ft)	108–122 km/h (67–76 mph)	84-8M8023140
14.50	25	3	Mirage Plus	1361–1588 kg (3000–3500 lb)	6.1–6.7 m (20–22 ft)	108–122 km/h (67–76 mph)	84-13706A46 (RH) 84-13707A46 (LH)
14.62	25	3	Tempest Plus	1361–1588 kg (3000–3500 lb)	6.1–6.7 m (20–22 ft)	108–122 km/h (67–76 mph)	48-825866A47
14.62	25	4	Revolution 4	1361–1588 kg (3000–3500 lb)	6.1–6.7 m (20–22 ft)	108–122 km/h (67–76 mph)	48-857032A46 (RH) 84-857033A46 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.00	24	3	Fury	1451–1678 kg (3200–3700 lb)	6.1–7.0 m (20–23 ft)	103–117 km/h (64–73 mph)	48-8M8023120
14.62	24	3	Tempest Plus	1451–1678 kg (3200–3700 lb)	6.1–7.0 m (20–23 ft)	103–117 km/h (64–73 mph)	48-825872A47
15.25	24	4	Bravo I	1451–1678 kg (3200–3700 lb)	6.1–7.0 m (20–23 ft)	103–117 km/h (64–73 mph)	48-831912A45 (RH) 84-831911A45 (LH)
14.62	23	3	Tempest Plus	1542–1724 kg (3400–3800 lb)	6.4–7.0 m (21–23 ft)	100–111 km/h (62–69 mph)	48-825864A47 (RH) 48-825865A47 (LH)
14.62	23	3	Mirage Plus	1542–1724 kg (3400–3800 lb)	6.4–7.0 m (21–23 ft)	100–111 km/h (62–69 mph)	48-13704A46 (RH) 48-13705A46 (LH)
14.62	23	4	Revolution 4	1542–1724 kg (3400–3800 lb)	6.4–7.0 m (21–23 ft)	100–111 km/h (62–69 mph)	48-857030A46 (RH) 48-857031A46 (LH)
14.00	23	4	VenSura	1542–1724 kg (3400–3800 lb)	6.4–7.0 m (21–23 ft)	100–111 km/h (62–69 mph)	48-825906A48 (RH) 48-825907A48 (LH)
13.45	22	3	Enertia	1633–1860 kg (3600–4100 lb)	6.4–7.0 m (21–23 ft)	95–106 km/h (59–66 mph)	48-899202A46
15.25	22	4	Bravo I	1633–1860 kg (3600–4100 lb)	6.4–7.0 m (21–23 ft)	95–106 km/h (59–66 mph)	48-831910A45 (RH) 48-831909A45 (LH)
14.62	21	3	Tempest Plus	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-825862A47 (RH) 48-825863A47 (LH)
13.63	21	3	Enertia	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-899002A46 (RH) 48-899003A46 (LH)
14.75	21	3	Mirage Plus	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-13702A46 (RH) 48-13703A46 (LH)
14.62	21	4	Revolution 4	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-857028A46 (RH) 48-857029A46 (LH)
14.00	21	4	VenSura	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-825902A48 (RH) 48-825903A48 (LH)
13.80	20	3	Enertia	1860–2087 kg (4100–4600 lb)	6.7–7.3 m (22–24 ft)	85–95 km/h (53–59 mph)	48-899000A46
14.62	19	3	Tempest Plus	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-825860A47 (RH) 48-825861A47 (LH)
14.00	19	3	Enertia	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-898998A46 (RH) 48-898999A46 (LH)
15.25	19	3	Mirage Plus	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-13700A46 (RH) 48-13701A46 (LH)
14.00	19	3	VenSura	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-825900A48 (RH) 48-825901A48 (LH)
14.62	19	4	Revolution 4	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-857026A46 (RH) 48-857027A46 (LH)
14.22	18	3	Enertia	2087–2449 kg (4600–5400 lb)	7.0–7.6 m (23–25 ft)	74–85 km/h (46–53 mph)	48-898996A46
15.38	18	3	Mirage Plus	2087–2449 kg (4600–5400 lb)	7.0–7.6 m (23–25 ft)	74–85 km/h (46–53 mph)	48-889620A46 (RH) 48-889619A46 (LH)
14.45	17	3	Enertia	2223–2631 kg (4900–5800 lb)	7.3–8.2 m (24–27 ft)	69–80 km/h (43–50 mph)	48-898994A46 (RH) 48-898995A46 (LH)
15.50	17	3	Mirage Plus	2223–2631 kg (4900–5800 lb)	7.3–8.2 m (24–27 ft)	69–80 km/h (43–50 mph)	48-18278A46 (RH) 48-90159A46 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	17	4	Revolution 4	2223–2631 kg (4900–5800 lb)	7.3–8.2 m (24–27 ft)	69–80 km/h (43–50 mph)	48-857024A46 (RH) 48-857025A46 (LH)
14.00	17	4	VenSura	2223–2631 kg (4900–5800 lb)	7.3–8.2 m (24–27 ft)	69–80 km/h (43–50 mph)	48-825898A48 (RH) 48-825899A48 (LH)
14.72	16	3	Enertia	2359–2948 kg (5200–6500 lb)	7.3–8.5 m (24–28 ft)	63–76 km/h (39–47 mph)	48-898992A46
15.00	15	3	Enertia	2540–3221 kg (5600–7100 lb)	7.6–8.8 m (25–29 ft)	58–71 km/h (36–44 mph)	48-898990A46 (RH) 48-898991A46 (LH)
15.75	15	3	Mirage Plus	2540–3221 kg (5600–7100 lb)	7.6–8.8 m (25–29 ft)	58–71 km/h (36–44 mph)	48-19838A46 (RH) 48-19841A46 (LH)
14.62	15	4	Revolution 4	2540–3221 kg (5600–7100 lb)	7.6–8.8 m (25–29 ft)	58–71 km/h (36–44 mph)	48-857022A46

Mercury/Mariner 300 HD (6 Cyl., FourStroke) with 5.44 in. Gearcase Torpedo

- Wide-open throttle RPM: 5800–6400
- Recommended transom height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- 5.44 in. gearcase with 31.75 mm (1.25 in.) diameter propeller shaft
- Gear reduction: 1.75:1
- Right-hand rotation (RH), left-hand rotation (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	27	4	Trophy Plus	Up to 1364 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825946A47
14.62	27	3	Tempest Plus	Up to 1364 kg (3000 lb)	Up to 6.4 m (21 ft)	126–142 km/h (78–88 mph)	48-825868A47
13.75	26	4	Trophy Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825944A47
14.62	26	3	Tempest Plus	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-825874A47
15.25	26	4	Bravo I	1225–1406 kg (2700–3100 lb)	5.8–6.7 m (19–22 ft)	121–137 km/h (75–85 mph)	48-831914A45 (RH) 48-831913A45 (LH)
14.50	25	3	Mirage Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825942A47
14.62	25	3	Tempest Plus	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-825866A47
14.62	25	4	Revolution 4	1270–1497 kg (2800–3300 lb)	6.1–6.7 m (20–22 ft)	114–130 km/h (71–81 mph)	48-857032A46 (RH) 48-857033A46 (LH)
13.75	24	4	Trophy Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825940A47
14.62	24	3	Tempest Plus	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-825872A47

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	24	4	Bravo I	1361–1588 kg (3000–3500 lb)	6.1–7.0 m (20–23 ft)	109–124 km/h (68–77 mph)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	23	4	Trophy Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825938A47
14.62	23	3	Tempest Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-825864A47
14.63	23	3	Mirage Plus	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-13704A46 (RH) 48-13705A46 (LH)
14.62	23	4	Revolution 4	1406–1633 kg (3100–3600 lb)	6.4–7.0 m (21–23 ft)	105–119 km/h (65–74 mph)	48-857030A46 (RH) 48-857031A46 (LH)
13.45	22	3	Enertia	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–113 km/h (62–70 mph)	48-899202A46
15.25	22	4	Bravo I	1496.9–1724 kg (3300–3800 lb)	6.4–7.0 m (21–23 ft)	100–113 km/h (62–70 mph)	48-831910A45 (RH) 48-831909A45 (LH)
14.62	21	3	Tempest Plus	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-825862A47
13.63	21	3	Enertia	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-899002A46 (RH) 48-899003A46 (LH)
14.62	21	4	Revolution 4	1633–1860 kg (3600–4100 lb)	6.7–7.3 m (22–24 ft)	95–106 km/h (59–66 mph)	48-857028A46 (RH) 48-857029A46 (LH)
13.80	20	3	Enertia	1724–1950 kg (3800–4300 lb)	6.7–7.3 m (22–24 ft)	90–101 km/h (56–63 mph)	48-899000A46
14.62	19	3	Tempest Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-825860A47
14.00	19	3	Enertia	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-898998A46 (RH) 48-898999A46 (LH)
15.25	19	3	Mirage Plus	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-13700A46 (RH) 48-13701A46 (LH)
14.62	19	4	Revolution 4	1814–2087 kg (4000–4600 lb)	7.0–7.6 m (23–25 ft)	85–97 km/h (53–60 mph)	48-857026A46 (RH) 48-857027A46 (LH)
14.22	18	3	Enertia	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-898996A46
15.38	18	3	Mirage Plus	1950–2223 kg (4300–4900 lb)	7.0–7.6 m (23–25 ft)	80–90 km/h (50–56 mph)	48-889620A46 (RH) 48-889619A46 (LH)

Diameter (in.)	Pitch (in.)	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.45	17	3	Enertia	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-898994A46 (RH) 48-898995A46 (LH)
15.5	17	3	Mirage Plus	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-18278A46 (RH) 48-90159A46 (LH)
14.62	17	4	Revolution 4	2087–2449 kg (4600–5400 lb)	7.3–8.2 m (24–27 ft)	74–85 km/h (46–53 mph)	48-857024A46 (RH) 48-857025A46 (LH)
14.72	16	3	Enertia	2223–2631 kg (4900–5800 lb)	7.3–8.5 m (24–28 ft)	69–80 km/h (43–50 mph)	48-898992A46
15.00	15	3	Enertia	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-898990A46 (RH) 48-898991A46 (LH)
15.75	15	3	Mirage Plus	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-19838A46 (RH) 48-19841A46 (LH)
14.62	15	4	Revolution 4	2449–2948 kg (5400–6500 lb)	7.6–8.8 m (25–29 ft)	63–74 km/h (39–46 mph)	48-857022A46

Notes:

Important Information

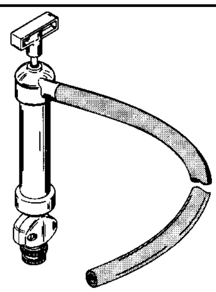
Section 1B - Maintenance

Table of Contents

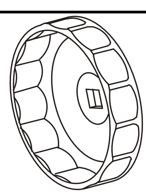
Lubricants, Sealants, Adhesives

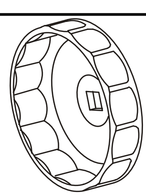
Tube Ref No.	Description	Where Used	Part No.
81	Anti-Seize Compound	Spark plug threads	92-898101385
94	Anti-Corrosion Grease	Propeller shaft splines	Obtain Locally
95	2-4-C with PTFE	Propeller shaft splines	92-802859A 1
114	Power Trim and Steering Fluid	Power trim system	92-858074K01
120	Corrosion Guard	External metal surfaces of the powerhead and powerhead components	92-802878 55
138	Synthetic Power Steering Fluid SAE 0W-30	Power steering system	92-858076K01
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Air filter element	92-858052K01

Special Tools

Crankcase Oil Pump	Obtain locally
 11591	Aids in the removal of engine oil without draining the crankcase.

Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates.

Oil Filter Wrench	91-889277
 5221	Aids in the removal of the oil filter. Use with 35-877769 series oil filters.

Oil Filter Wrench	91-802653Q02
 5221	Assists in the removal of the oil filter. Use with 35-889277 series oil filters

Outboard Care

To keep the outboard in the best operating condition, perform the periodic inspections and maintenance listed in the **Inspection and Maintenance Schedule**. Proper maintenance will ensure the safety of the operator, passengers, and retain the outboard dependability.

Record maintenance performed in the **Maintenance Log** located in the owner's manual. Save all maintenance work orders and receipts.

Selecting Replacement Parts For Your Outboard

We recommend using original Mercury Precision or Quicksilver replacement parts and Genuine Lubricants.

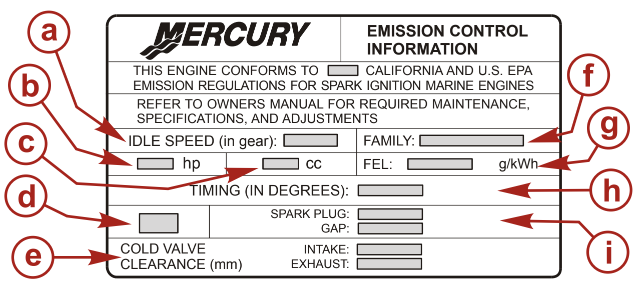
EPA Regulations

All new outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency, as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, wherever practicable, returned to the original intent of the design. **Maintenance, replacement, or repair of the emission control devices and systems may be performed by any marine spark ignition (SI) engine repair establishment or individual.**

EPA Emissions

Emission Certification Label

An emission certification label, showing emission levels and engine specifications directly related to emissions, is placed on the engine at time of manufacture.



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- **a -** Idle speed
- **b -** Engine horsepower
- **c -** Piston displacement
- **d -** Date of manufacture
- **e -** Valve clearance (if applicable)
- **f -** Family number
- **g -** Maximum emission output for the engine family
- **h -** Timing specification
- **i -** Recommended spark plug and gap

Owner Responsibility

The owner/operator is required to have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is not to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

Inspection and Maintenance Schedule

Before Each Use

- Check engine oil level.
- Check that lanyard stop switch stops the engine.
- Visually inspect the fuel system for deterioration or leaks.
- Check outboard for tightness on transom.
- Check steering system for binding or loose components.
- Visually check the power steering fittings and hoses for leaks or signs of damage. Check tie bar fasteners on multiple outboard installations for proper tightness.
- Check propeller blades for damage.

After Each Use

- Flush out the outboard cooling system if operating in salt or polluted water. See **Flushing the Cooling System**.
- Wash off all salt deposits and flush out the exhaust outlet of the propeller and gearcase with fresh water if operating in saltwater.

Every 100 Hours of Use or Once Yearly, Whichever Occurs First

- Change the engine oil and replace the oil filter. The oil should be changed more often when the engine is operated under adverse conditions such as extended trolling. See **Changing Engine Oil**.
- Inspect the thermostat visually for corrosion and/or a broken spring. Make sure the thermostat closes completely at room temperature.[1]
- Check the engine water separating fuel filter for contaminants. Clean or replace the filter. See **Fuel System**.
- Check the corrosion control anode. Check more frequently when used in saltwater. See **Corrosion Control Anode**.
- Drain and replace the gearcase lubricant. See **Gearcase Lubrication**.
- Check the power steering fluid. See **Checking Power Steering Fluid**.
- Inspect the battery. See **Battery Inspection**.
- Check the wiring and connectors.
- Check the tightness of bolts, nuts, and other fasteners.
- Saltwater usage. Remove and inspect the spark plugs for corrosion and replace the spark plugs as necessary. Apply a thin coating of Anti-Seize Compound only on the threads of the spark plugs prior to installation. See **Spark Plug Inspection and Replacement**.

Tube Ref No.	Description	Where Used	Part No.
81	Anti-Seize Compound	Spark plug threads	92-898101385

Every 300 Hours of Use or Three Years

IMPORTANT: The engine oil must be drained before removing the gearcase to avoid oil spillage. Perform the scheduled water pump replacement in combination with an engine oil change.

- Replace the water pump impeller. Replace the impeller more often if overheating occurs or if reduced water pressure is noted.[1]
- Check the power trim fluid. See **Checking Power Trim Fluid**.
- Replace the high-pressure in-line fuel filter.[1]
- Replace the spark plugs at the first 300 hours or third year. After that, inspect the spark plugs every 300 hours or three years. Replace the spark plugs as needed. See **Spark Plug Inspection and Replacement**.
- Replace the accessory drive belt. See **Accessory Drive Belt Inspection**.[1]

Before Periods of Storage

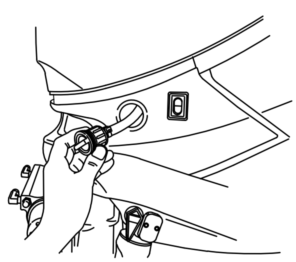
- Refer to **Storage Preparation**.

Flushing the Cooling System

Flush the internal water passages of the outboard with fresh water after each use in salt, polluted, or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

NOTE: The outboard can be tilted or in the vertical operating position during flushing.

1. With the engine turned off, place the outboard in either the operating position (vertical) or in a tilted position.
2. Disconnect the flush connector from the fitting on the bottom cowl.



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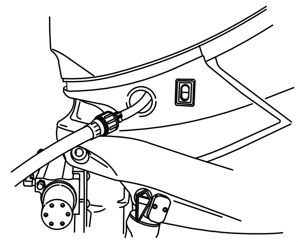
1. These items should be serviced by an authorized dealer.

3. Thread a water hose into the flush fitting.



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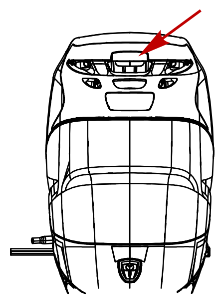
4. Turn on the water tap (1/2 maximum) and let the water flush through the cooling system for about 15 minutes.
5. When flushing is complete, turn off water and disconnect the water hose.
6. Install the flushing connector to the fitting on the bottom cowl. Tighten the connector securely.

Cowl Removal and Installation

Cowl Removal

IMPORTANT: Most maintenance points are accessible by removing the top cowl only.

1. Pull up on the top cowl lock latch.



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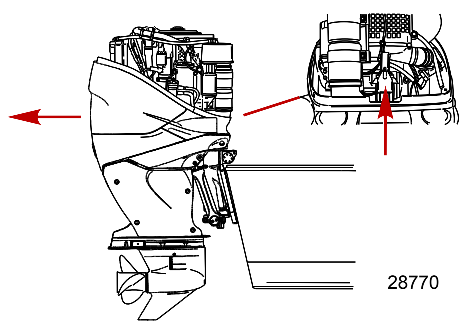
2. Pull top cowl forward and lift off.
3. Pull lower cowl release latch up.
4. Remove rear cowl towards aft of outboard.



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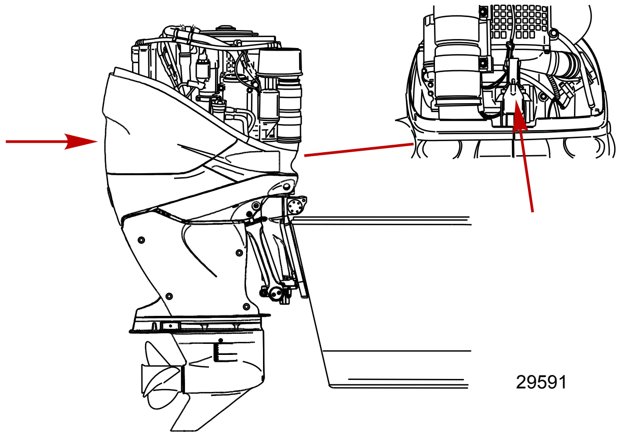
Cowl Installation

1. Position lower cowl from aft side of outboard. Make sure it fits properly in the rubber seal.

2. Lock cowl in place by pulling lower cowl latch down.



3. Place top cowl into position over engine, front first. Ensure cowl fits properly into the rubber seal.
4. The top cowl will lock into place when downward pressure is applied to the back side of cowl. Ensure cowl is securely fastened by pulling up on back of cowl.

Exterior Care

Cleaning Care for Top and Bottom Cowls

IMPORTANT: Wiping the plastic surface when it is dry will result in minor surface scratches. Always wet the surface before cleaning. Do not use detergents containing hydrochloric acid. Follow the cleaning and waxing procedure.

1. Before washing, rinse the cowls with clean water to remove the dirt and dust that may scratch the surface.
2. Wash the cowls with clean water and a mild nonabrasive soap. Use a soft, clean cloth when washing.
3. Dry thoroughly with a soft, clean cloth.
4. Wax the surface using a nonabrasive automotive polish designed for clear coat finishes. Remove the applied wax by hand using a soft, clean cloth.
5. To remove minor scratches, use Mercury Marine Cowl Finishing Compound P/N 92-859026K1.

Cleaning Care for the Powerhead in Saltwater Use

IMPORTANT: Do not allow lubricant or Corrosion Guard spray to come in contact with the alternator drive belt or the belt pulleys. The alternator drive belt could slip and be damaged if it becomes coated with any lubricant or Corrosion Guard spray.

1. If the outboard is operated in saltwater, remove the top cowl and flywheel cover.
2. Inspect the powerhead and powerhead components for salt buildup.
3. Wash off any salt buildup from the powerhead and powerhead components with fresh water.
4. Keep water spray out of the air filter/intake and alternator.
5. After washing, allow the powerhead and components to dry.
6. Apply Quicksilver or Mercury Precision Lubricants Corrosion Guard spray on the external metal surfaces of the powerhead and powerhead components. Do not allow the Corrosion Guard spray to come in contact with the alternator drive belt, belt pulleys, or the outboard motor mounts.

Tube Ref No.	Description	Where Used	Part No.
120	Corrosion Guard	External metal surfaces of the powerhead and powerhead components	92-802878 55

Battery Inspection

The battery should be inspected at periodic intervals to ensure proper engine starting capability.

IMPORTANT: Read the safety and maintenance instructions which accompany your battery.

1. Turn off the engine before servicing the battery.
2. Ensure the battery is secure against movement.
3. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
4. Ensure the battery is equipped with a nonconductive shield to prevent accidental shorting of battery terminals.

Verado Engine Battery Specifications

IMPORTANT: Verado engines require a 12-volt AGM (absorbed glass mat) marine starting battery that meets the minimum ratings.

For best performance, Mercury Marine does not recommend using the more common flooded (wet cell) or gel cell type lead acid batteries for starting Verado engines.

Each Verado engine must be equipped with its own starting battery.

If the boat application requires additional battery loads for boat accessories or marine electronics, it is recommended that an auxiliary battery, or batteries, be installed.

Choose a 12-volt AGM (absorbed glass mat) battery which meets the following ratings.

USA (SAE) Verado Starting Battery Rating	
Required Verado starting battery	12-volt AGM (absorbed glass mat) battery
Required MCA (marine cranking amps) and reserve capacity	800 minimum marine cranking amps with a minimum reserve capacity of 135 minutes RC25 rating

International (EN) Verado Starting Battery Rating	
Required Verado starting battery	12-volt AGM (absorbed glass mat) battery
Required CCA (cold cranking amps) and Ah (amp hour)	975 minimum cold cranking amps with a minimum of 65 amp hours

NOTE: Do not use an engine starting battery that does not meet the specified ratings. If a battery that does not meet the ratings is used, the electrical system may perform poorly.

IMPORTANT: Boating industry standards (BIA, ABYC, etc.), federal standards, and Coast Guard regulations must be adhered to when installing the battery. Ensure that battery cable installation meets the pull test requirements and that the positive battery terminal is properly insulated in accordance with regulations.
It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.

When connecting the engine battery, hex nuts must be used to secure the battery leads to the battery posts. Tighten the hex nuts to the specified torque.

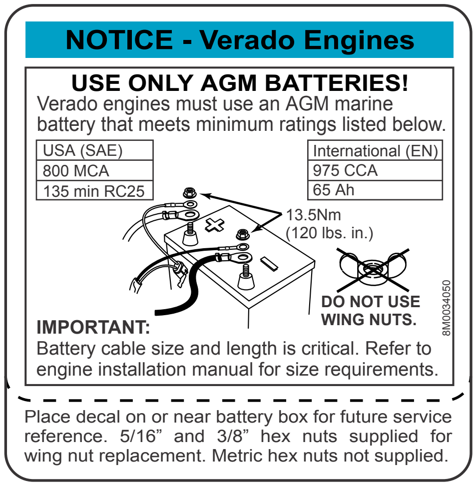
⚠ WARNING

Failure to properly secure the battery leads can result in a loss of power to the Digital Throttle and Shift (DTS) system, leading to serious injury or death due to loss of boat control. Secure the battery leads to the battery posts with hex nuts to avoid loose connections.

Description	Nm	lb-in.	lb-ft
Hex nuts	13.5	120	–

IMPORTANT: Battery cable size and length is critical. Refer to Battery Cable Size tables or engine installation manual for size requirements.

The decal needs to be placed on or near the battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut is supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



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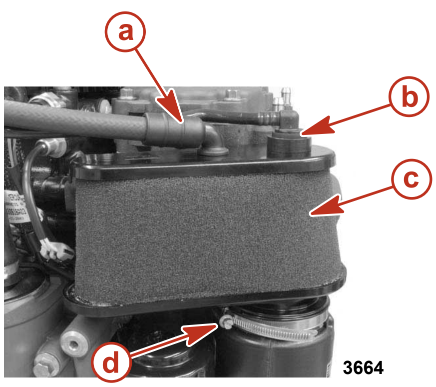
Air Filter

The air filter assembly is a serviceable item and can be cleaned with warm soap water, if required.

Air Filter Removal and Cleaning

1. Loosen air filter clamp screw.
2. Remove crankcase ventilation hose.



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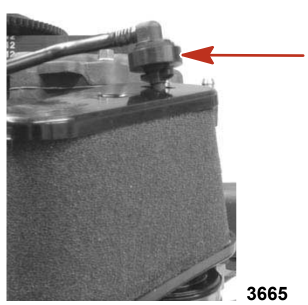
a - Crankcase ventilation hose
b - Fuel supply module (FSM) purge valve hose
c - Filter assembly
d - Clamp screw

3. Remove the air filter assembly and disconnect the fuel supply module (FSM) purge valve hose by rotating the air filter assembly and pulling on the hose.



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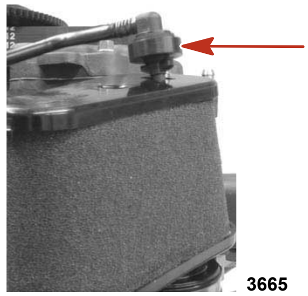
4. Wash the air filter assembly in warm soap water.
5. Dry the filter assembly with compressed air.
6. Apply Synthetic Blend 4-Stroke Outboard Oil 25W-40 on a rag or towel and lightly pad the air filter element. Wipe off the excess oil. The air filter element should be moist to the touch.

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Air filter element	92-858052K01

Air Filter Installation

1. Install the fuel supply module (FSM) purge valve hose to the air filter assembly.



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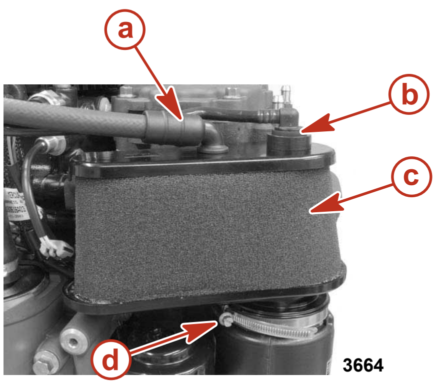
2. Install the crankcase ventilation hose.
3. Install the air filter assembly and tighten the clamp screw securely.



3664

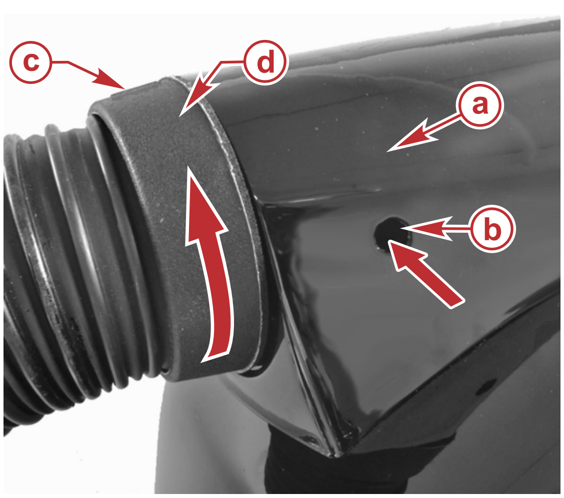
a - Crankcase ventilation hose
b - Fuel supply module (FSM) purge valve hose
c - Filter assembly
d - Clamp screw

Closed Compartment Technology

Cowl Removal and Installation

Air Duct Removal

1. Use a suitable tool to press the release button located on the port side of the air duct top cowl and rotate the quick release air hose adapter counterclockwise.



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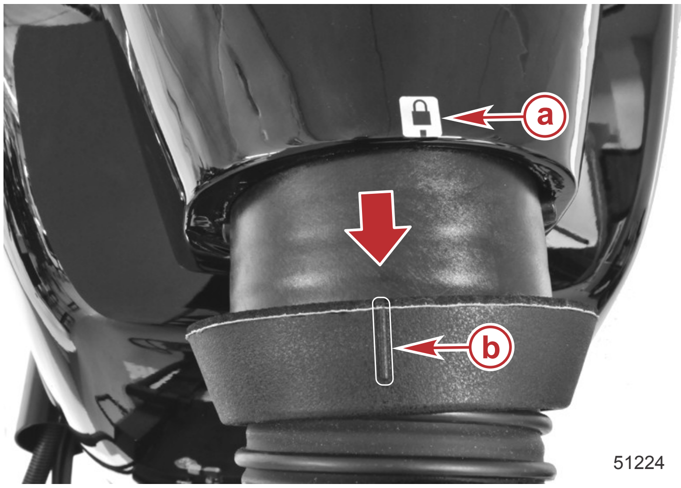
a - Air duct top cowl
b - Release button
c - Alignment mark
d - Quick release air hose adapter

2. Pull the quick release air hose adapter out of the air duct top cowl.

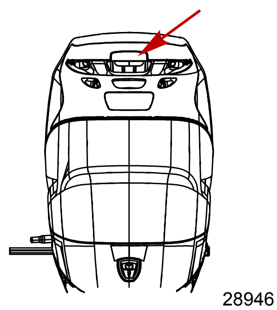


a - Lock position decal
b - Alignment mark

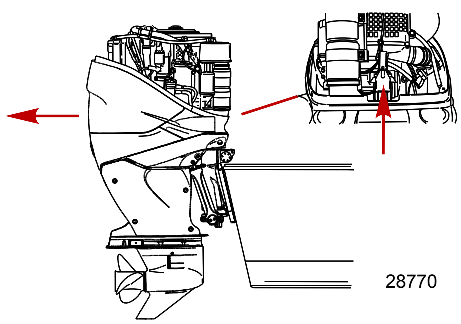
IMPORTANT: Most maintenance points are accessible by removing the top cowl only.

Cowl Removal

1. Pull up on the top cowl lock latch.



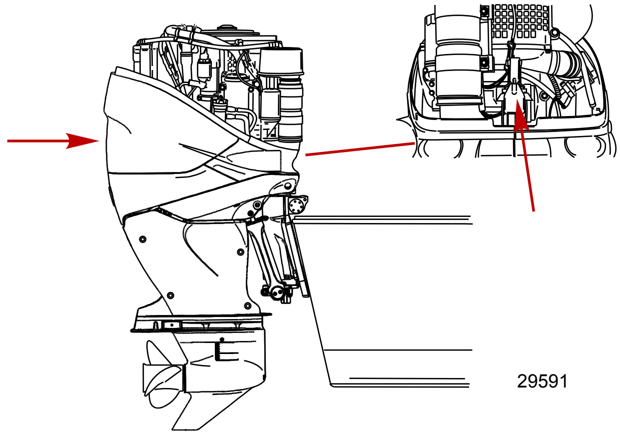
2. Pull top cowl forward and lift off.
3. Pull lower cowl release latch up.
4. Remove rear cowl towards aft of outboard.



Cowl Installation

1. Position lower cowl from aft side of outboard. Make sure it fits properly in the rubber seal.

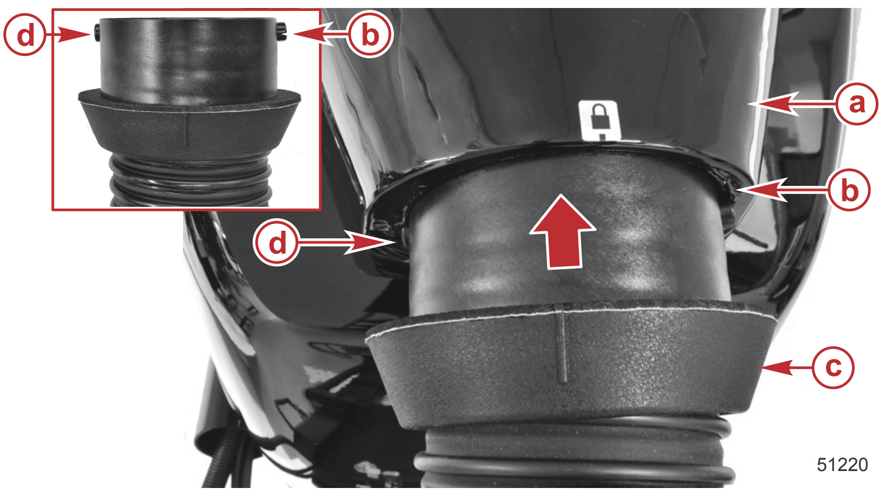
2. Lock cowl in place by pulling the lower cowl latch down.



3. Place top cowl into position over engine, front first. Ensure cowl fits properly into the rubber seal.
4. The top cowl will lock into place when downward pressure is applied to the back side of the cowl. Ensure the cowl is securely fastened by pulling up on the back of the cowl.

Air Duct Installation

1. Align the tab and release button on the quick release air hose adapter with the slots in the air duct top cowl.
2. Insert the quick release air hose adapter into the air duct top cowl.



a - Air duct top cowl
b - Release button
c - Quick release air hose adapter
d - Tab

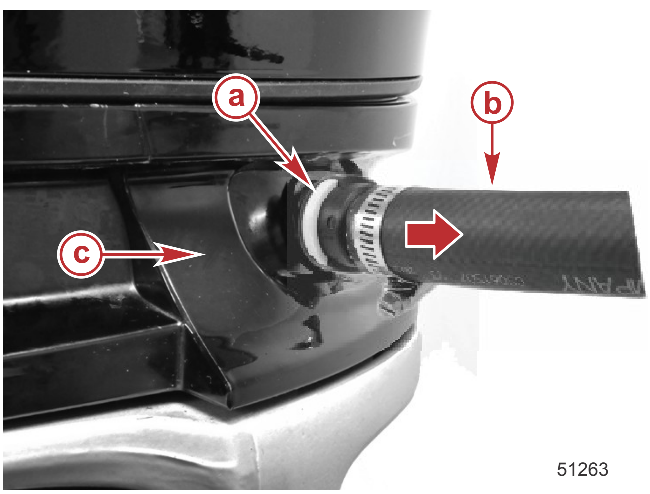
3. Rotate the quick release air hose adapter clockwise until the alignment mark aligns with the lock decal and the release button snaps into the hole in the air duct top cowl.

a - Alignment mark
b - Lock decal
c - Air duct top cowl
d - Release button

Idle Relief Hose Connection

Removal

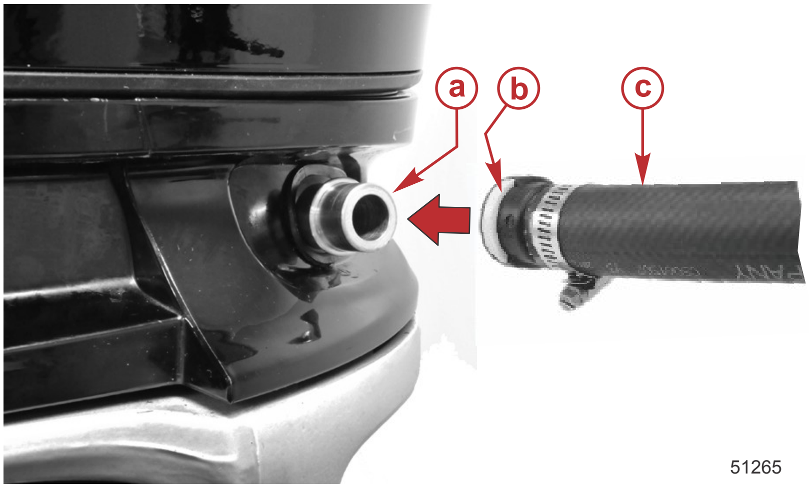
Push the release clip and pull the hose away from the lower cowl.



a - Release clip
b - Idle relief hose
c - Lower cowl

Installation

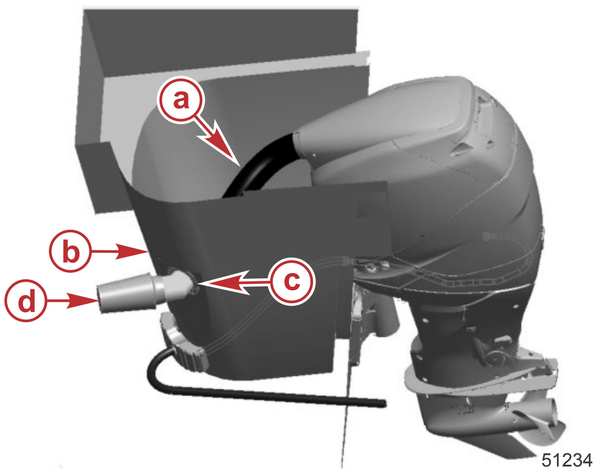
Push the coupler onto the brass fitting. The coupler will lock in place when fully seated.



a - Brass fitting
b - Release clip
c - Idle relief hose

Intake Air Filter

The engine intake air filter is externally mounted.

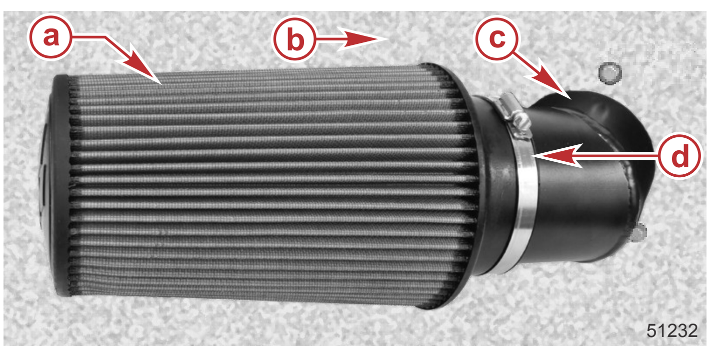


Port engine intake air component routing

a - Air duct
b - Engine well
c - Elbow
d - Filter

Air Filter Removal

1. Loosen the hose clamp securing the filter to the flange elbow.
2. Remove the filter.



a - Filter
b - Engine well
c - Elbow
d - Hose clamp

Air Filter Installation

1. Install the hose clamp onto the air filter inlet base.
2. Install the air filter onto the flange elbow.
3. Tighten the hose clamp.

K & N Air Filter Maintenance

Refer to the K & N Filter website for K & N air filter inspection and cleaning instructions.

Flushing the Cooling System

Flush the internal water passages of the outboard with fresh water after each use in salt, polluted, or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

These instructions are specific to the Verado flushing kit installed on Closed Compartment Technology (CCT) outboards.

Refer to the boat owner's manual for the location of the flushing hose connector.

NOTE: The outboard can be in either the vertical operating position or a tilted position during flushing.

IMPORTANT: Do not run the engine during the flushing procedure.

1. With the engine turned off, place the outboard in either the vertical operating position or in a tilted position.
2. Remove the plug from the flush fitting located at the end of the CCT flush hose (not the outboard flushing connector located on the cowl).
3. Thread a water hose into the flush fitting.
4. Turn on the water tap (½ maximum) and let the water flush through the cooling system for about 15 minutes.

   NOTE: During the flushing procedure it is normal for water to spray out of the flushing connector fitting on the bottom cowl.
5. When flushing is complete, turn off the water and disconnect the water hose.
6. Install the plug into the flush fitting.

Fuel System

⚠ WARNING
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

IMPORTANT: Use an approved container to collect and store fuel. Wipe up spilled fuel immediately. Material used to contain spilled fuel must be disposed of in an approved receptacle.

Before servicing any part of the fuel system:

1. Stop engine and disconnect the battery.
2. Perform fuel system service in a well-ventilated area.
3. Inspect any completed service work for sign of fuel leakage.

Fuel Line Inspection

Visually inspect the fuel line for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions are found, the fuel line must be replaced.

Water Separating Fuel Filter

NOTE: The warning system will turn on when water in the fuel filter reaches the full level.

This filter removes moisture and debris from the fuel. If the filter holder becomes filled with water, the water can be removed. If the filter becomes plugged with debris, replace the filter.

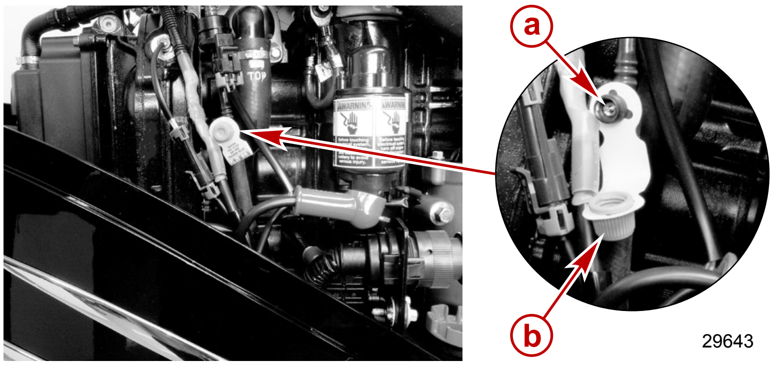
Refer to the **Inspection and Maintenance Schedule** for the proper maintenance interval.

Filter Removal

1. Turn the ignition key switch to "OFF" position.
2. Remove the cap from the fuel vapor purge relief valve.

⚠ CAUTION
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

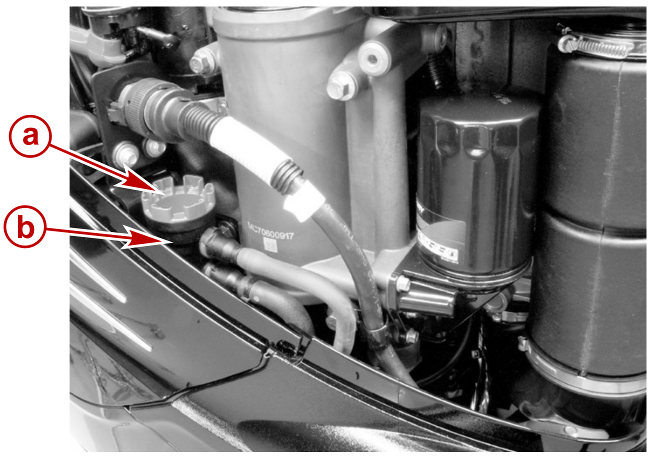
3. Place a rag or towel around the valve. Release the fuel pressure by pushing in on the valve stem.



29643

a - Fuel vapor purge relief valve
b - Cap

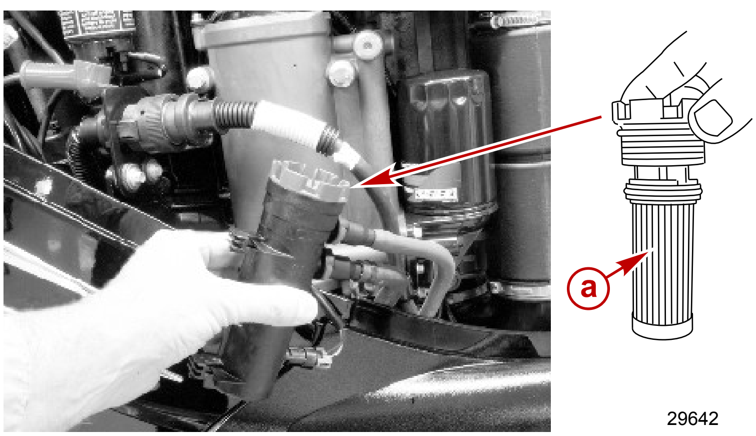
4. Slide the filter holder up to release it from the bracket. The hoses and wire harness can remain attached to the filter holder.



29644

a - Fuel filter
b - Filter holder

5. Use the fuel filter removal/installation tool or the shaft of a screwdriver between the lugs on the filter cap and unscrew the fuel filter.

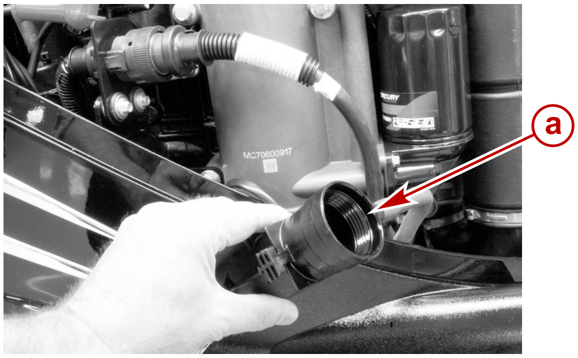


29642

a - Fuel filter

Filter Draining

Tip the filter holder to drain any fluid into an approved container.

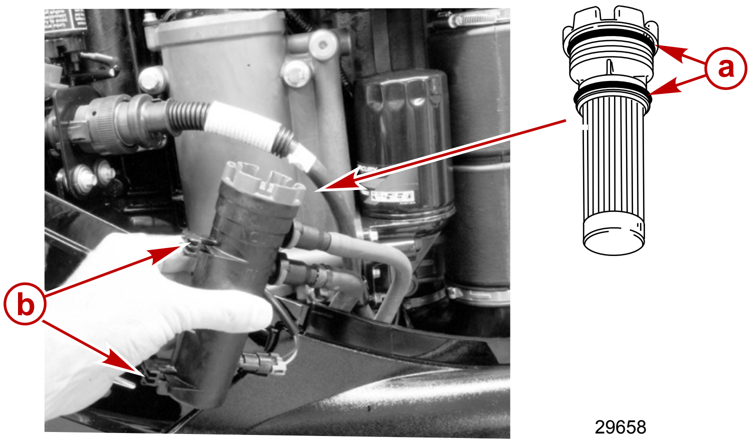


29648

a - Filter holder

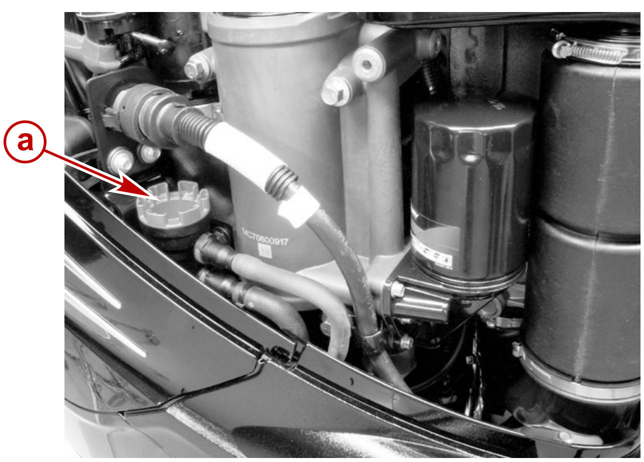
Filter Installation

1. Lubricate the O-ring seals with oil.
2. Install the filter and tighten securely.
3. Place the filter holder mounting tabs into the slots on the bracket and push down on the filter holder to slide the mounting tabs into the lock position.



29658

a - O-ring seals
b - Filter holder mounting tabs



29652

a - Fuel filter installed

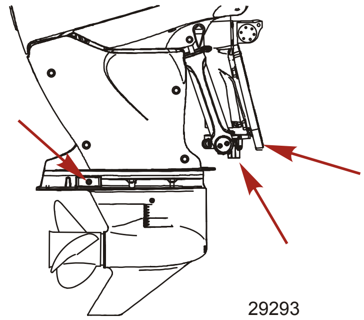
IMPORTANT: Visually inspect for fuel leakage from the filter while turning the ignition key to the run position, forcing fuel into the filter.

Corrosion Control Anode

The outboard has corrosion control anodes at different locations. An anode helps protect the outboard against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the outboard metals.

Each anode requires periodic inspection, especially in saltwater which will accelerate the erosion. To maintain this corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode, as this will reduce effectiveness of the anode.

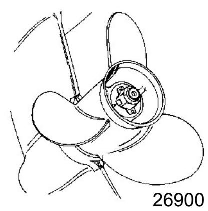
Two anodes are located on each side of the gearcase. Another anode is installed on the bottom of the pedestal. Two more anodes are located on the bottom of each power trim ram.



29293

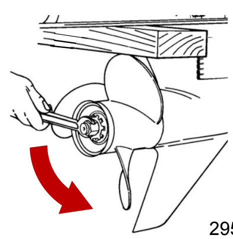
Propeller Replacement

1. Shift outboard to neutral position.
2. Straighten the bent tabs on the propeller nut retainer.



26900

3. Place a block of wood between gearcase and propeller to hold propeller and remove propeller nut.

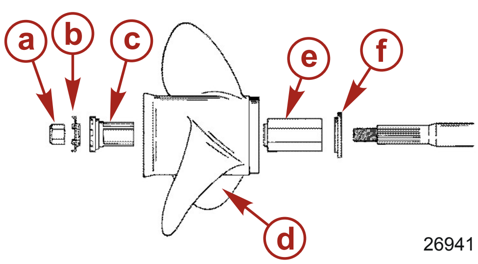


29592

4. Pull propeller straight off shaft. If propeller is seized to the shaft and cannot be removed, have the propeller removed by an authorized dealer.
5. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Mercury/ Quicksilver products:

Tube Ref No.	Description	Where Used	Part No.
94	Anti-Corrosion Grease	Propeller shaft splines	Obtain Locally
95	2-4-C with PTFE	Propeller shaft splines	92-802859A 1

6. **Flo-Torq II drive hub propellers** - Install forward thrust hub, replaceable drive sleeve, propeller, thrust hub, propeller nut retainer, and propeller nut onto the shaft.



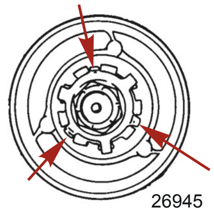
26941

a - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust hub

7. Place a block of wood between gearcase and propeller and torque to specifications.

Description	Nm	lb-in.	lb-ft
Propeller nut	75		55

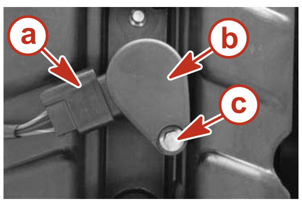
8. Secure propeller nut by bending three of the tabs into the thrust hub grooves.



26945

Spark Plug Inspection and Replacement

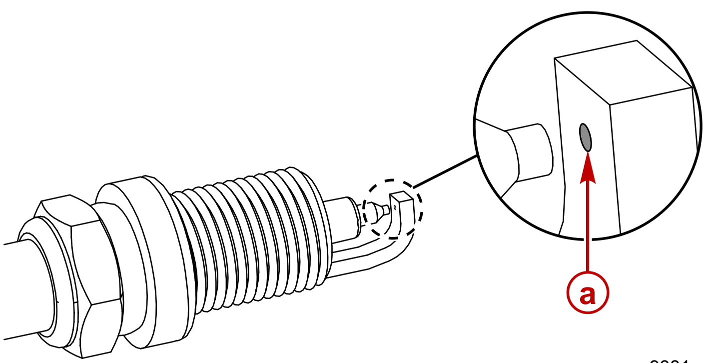
1. Remove top and rear cowlings. Refer to **Cowl Removal and Installation**.
2. Disconnect the six wiring harness connectors from pencil coil connections.
3. Remove mounting bolts, using a twisting motion, and pull pencil coils from spark plugs.



3658

a - Wiring harness connector
b - Pencil coil
c - Bolt

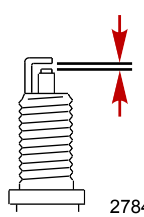
4. Remove the spark plugs. Replace the spark plug if the electrode is worn; the insulator is rough, cracked, broken, or blistered; or if the precious metal is not visible on the spark plug electrode.
IMPORTANT: The color of the plug may not accurately reflect its condition. To accurately diagnose a faulty plug, inspect the precious metal on the plug's electrode. If no precious metal is visible, replace the plug.



9381

a - Precious metal

5. Set the spark plug gap. Refer to **Specifications**.



27848

a. All of the spark plugs should have the gap checked and corrected as necessary before installation.
b. Measure the gap with a feeler gauge or pin gauge. Never use a wedge-type gap checking tool to inspect or to adjust the gap.
c. If an adjustment is necessary, do not pry or apply any force on the center electrode. This is critical with any type of spark plug that has a wear surface, such as platinum or iridium added to either the ground electrode or the center electrode.
d. When it is necessary to widen the gap, use a tool that only pulls back on the ground electrode without touching the center electrode, the porcelain, or the wear portion of the ground electrode.

e. When it is necessary to close the gap, gently tap the plug ground electrode on a hard surface.

6. Saltwater use - Apply a thin coating of Anti-Seize Compound only on threads of spark plugs.

Tube Ref No.	Description	Where Used	Part No.
81	Anti-Seize Compound	Spark plug threads	92-898101385

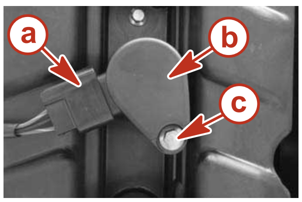
7. Before installing spark plugs, clean off any dirt on the spark plug seats. Install the plugs finger-tight and then tighten an additional 1/4 turn or tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plug	27	–	20

8. Push pencil coils into place over the spark plugs using a twisting motion.
9. Secure coils with retained bolts. Tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Bolts	8	71	–

10. Connect the six wiring harness connectors to pencil coil connections.



3658

a - Wiring harness connector
b - Pencil coil
c - Bolt

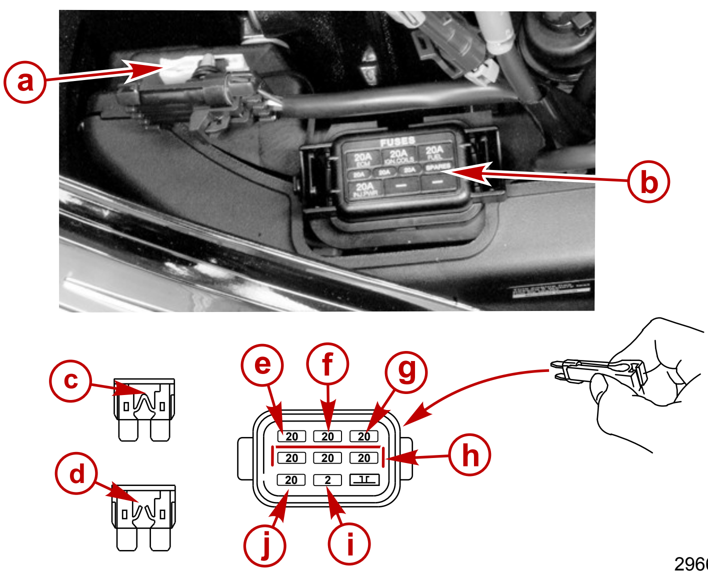
11. Install rear and top cowls.

Fuses

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

Remove the fuse puller from the holder.

Remove the cover from the fuse holder. Remove the suspected blown fuse and look at the silver band inside the fuse. If band is broken, replace the fuse. Replace the fuse with a new fuse with the same amp rating.



29663

a - Fuse puller
b - Fuse holder
c - Good fuse
d - Blown fuse
e - Engine control module and purge valve - 20 amp fuse "ECM"
f - Ignition coils - 20 amp fuse "IGN. COILS"
g - Fuel delivery - 20 amp fuse "FUEL"
h - Spare fuses (3)
i - Diagnostics terminal - 2 amp fuse (S/N 1B390143 and above)
j - Injector power and boost valve - 20 amp fuse "INJ. PWR."

DTS Wiring System

⚠ WARNING

Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control. To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system.

- Verify the harnesses are not routed near sharp edges, hot surfaces, or moving parts.
- Verify all unused connectors and receptacles are covered with a weather cap.
- Verify the harnesses are fastened along the routing path.

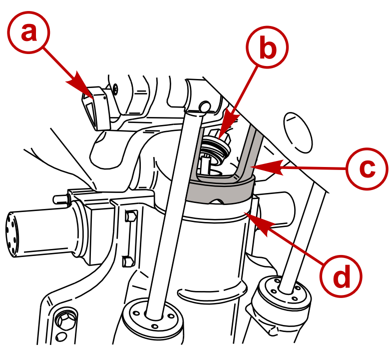
Accessory Drive Belt Inspection

Inspect the accessory drive belt and have it replaced by an authorized dealer if any of the following conditions are found.

- Cracks in the back of the belt or in the base of V grooves.
- Excessive wear at the roots of the grooves.
- Rubber portion swollen by oil.
- Belt surfaces roughened.
- Signs of wear on edges or outer surfaces of belt.

Checking Power Trim Fluid

1. Tilt outboard to the full up position.
2. Rotate the tilt support bracket down.
3. Lower outboard until tilt support bracket rests on pedestal.
4. Remove the power trim fill cap. The fill cap only requires 1/4 turn to remove.



29312

a - Tilt support lever
b - Power trim fill cap
c - Tilt support bracket
d - Pedestal

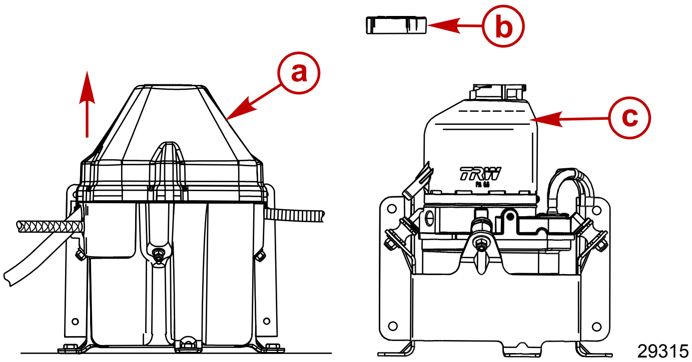
5. The fluid level should be approximately 25 mm (1 in.) from the top of the fill neck. Add Quicksilver or Mercury Precision Lubricants Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim system	92-858074K01

6. Install the power trim fill cap. Tighten fill cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.

Checking Power Steering Fluid

Remove power steering cover and fill cap to check fluid level. The fluid level should be slightly below the bottom of the fill hole. Use SAE 0W-30 synthetic power steering fluid, if needed.



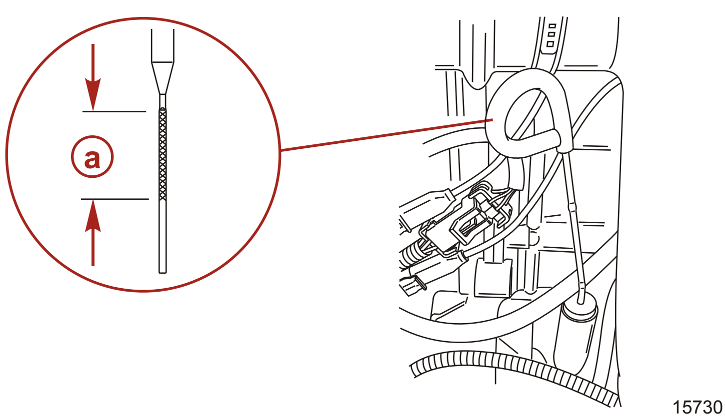
a - Power steering cover
b - Fill cap
c - Fill/full level

Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Power steering system	92-858076K01

Checking and Adding Engine Oil

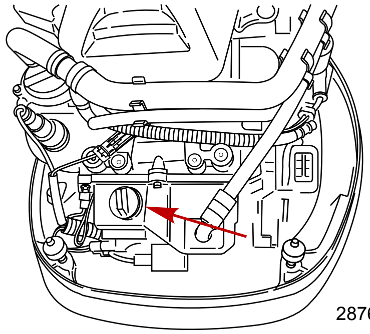
IMPORTANT: Do not overfill. Tilt outboard out/up past vertical for approximately one minute to allow trapped oil to drain back to the oil sump. Tilt outboard to vertical (not tilted) position when checking engine oil. For accurate readings, check oil only when engine is cold or after engine has not run for at least an hour.

1. Before starting (cold engine) tilt outboard out/up past vertical to allow trapped oil to drain back to the oil sump. Allow outboard to remain tilted for approximately one minute.
2. Remove the top cowl. Refer to **Cowl Removal and Installation**.
3. Tilt outboard to vertical operating position.
4. Pull out the dipstick. Wipe the dipstick end with a clean rag or towel and push it back in all the way.
5. Pull the dipstick back out again and observe the oil level. Oil should be in the operating range (cross hatched region).
   IMPORTANT: Do not try to fill the oil level to the top of the operating range (cross hatched region). Oil level is correct as long as it appears in the operating range (cross hatched region).



a - Oil level operating range

6. If the oil level is below the operating range (cross hatched region), remove the oil filler cap and add approximately 500 ml (16 oz) of specified outboard motor oil. Allow a few minutes for the added oil to drain to the oil sump and recheck the dipstick. Repeat the process until oil level is in the operating range (cross hatched region). Do not try to fill to the upper end of the operating range (cross hatched region).



28761

IMPORTANT: Inspect oil for signs of contamination. Oil contaminated with water will have a milky color to it; oil contaminated with fuel will have a strong fuel smell. If contaminated oil is noticed, have the engine checked by your dealer.

7. Push the dipstick back in all the way.
8. Reinstall the oil fill cap hand-tight.
9. Reinstall top cowl.

Changing Engine Oil

Engine Oil Capacity

Engine oil capacity is approximately 7.0 Liter (7.4 US qt).

Pump Method

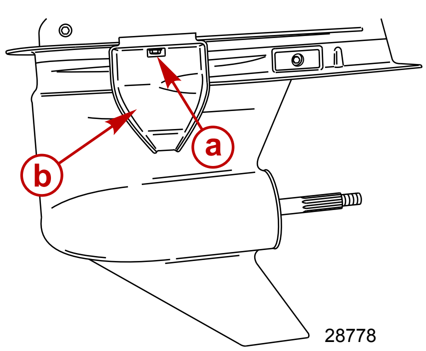
IMPORTANT: Tilt the outboard out/up past vertical for approximately one minute to allow any trapped oil to drain back to the oil sump.
IMPORTANT: To reduce or prevent oil spillage when removing the oil filter, make sure that the outboard is upright (not tilted) and the engine is cold or has not run for at least one hour.
IMPORTANT: The pump method is preferred to remove engine oil from XXL models. If the drain method is used, an oil drain funnel must be used to divert oil from the lower splash plate and into the container.

1. Tilt the outboard out/up past vertical for approximately one minute to allow any trapped oil to drain back to the oil sump.
2. Place the outboard in a vertical position.
3. Remove the dipstick and slide the adapter tube of the crankcase oil pump through the oil dipstick hole, to the bottom of the engine oil sump.
4. Pump out the engine oil into an appropriate container.

Crankcase Oil Pump	Obtain locally

Drain Method

1. Tilt the outboard out/up past vertical for approximately one minute to allow any trapped oil to drain back to the oil sump.
2. Place the outboard in a vertical position.
3. Place an appropriate container under the engine oil sump plug. The drain plug/seal washer is located beneath the splash plate on the port side of the outboard.
4. Loosen the drain plug/seal washer. Install the oil drain funnel over the drain plug/seal washer.



28778

a - Drain plug/seal washer
b - Oil drain funnel

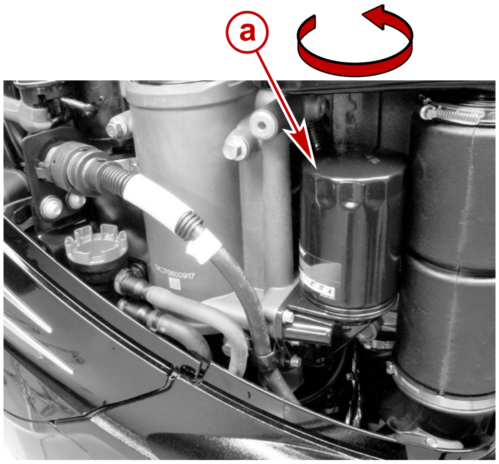
Oil Drain Funnel	91-892866A01

5. Remove drain plug/seal washer and drain the engine oil into a container.
6. Install the drain plug/seal washer.

Changing Oil Filter

IMPORTANT: To reduce or prevent oil spillage when removing the oil filter, ensure the outboard is upright (not tilted) and the engine is cold or has not run for at least one hour.

1. Remove the top cowl.
2. Place a rag or towel below the oil filter to absorb any spilled oil.
3. Unscrew the old filter by using an oil filter wrench tool and turning the filter counterclockwise.



a - Oil filter

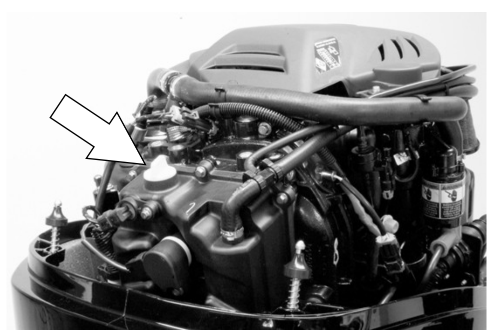
29662

Oil Filter Wrench	91-889277
Oil Filter Wrench	91-802653Q02

4. Clean the oil filter mounting base.
5. Apply a film of clean oil to the filter gasket. Do not use grease.
6. Screw the new filter on until the gasket contacts the base, then tighten the filter another 3/4 to 1 turn.

Oil Filling

1. Remove the oil fill cap and add the recommended oil to the midpoint of the operating range (midpoint of cross hatched region). Adding approximately 7 Liter (7.4 US qt) will bring the oil level to midpoint of the cross hatched region.



29681

2. Install the oil fill cap.
3. With the outboard in water or a cooling water flush hose connected, idle the engine for five minutes to check for leaks at the oil filter.
4. Stop the engine and check the oil level.

Gearcase Lubrication

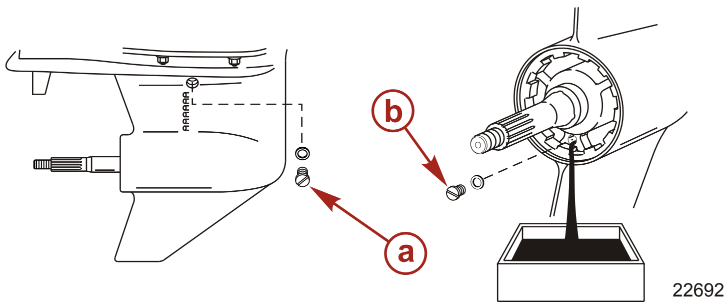
When adding or changing gearcase lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gearcase checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gearcase.

Examine the drained gearcase lubricant for metal particles. A small amount of metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

122 mm (4.8 in.) Diameter Gearcase

Draining Gearcase

1. Place outboard in a vertical operating position.
2. Remove propeller. Refer to **Propeller Replacement**.
3. Place drain pan below outboard.
4. Remove vent plug and fill/drain plug and drain lubricant.



a - Vent plug
b - Fill/drain plug

Gearcase Lubricant Capacity

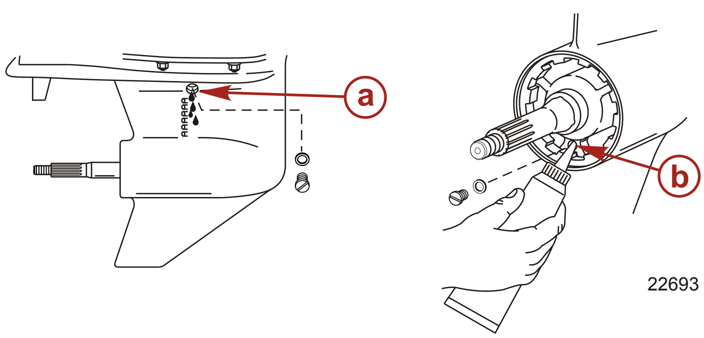
Gearcase lubricant capacity is approximately 970 ml (32.8 fl oz).

Gearcase Lubricant Recommendation

Mercury or Quicksilver High Performance Gear Lubricant.

Checking Lubricant Level and Refilling Gearcase

1. Place outboard in a vertical operating position.
2. Remove vent plug/sealing washer.
3. Remove fill/drain plug. Place lubricant tube into the fill hole and add lubricant until it appears at the vent hole.



a - Vent hole
b - Fill hole

IMPORTANT: Replace sealing washers if damaged.

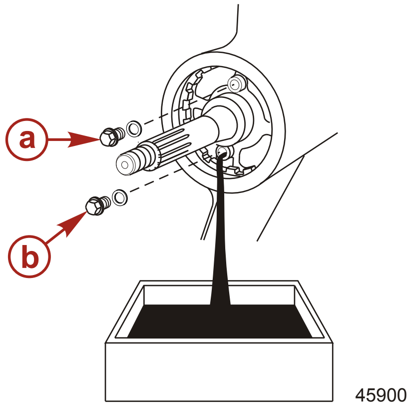
4. Stop adding lubricant. Install the vent plug and sealing washer before removing the lubricant tube.
5. Remove lubricant tube and reinstall cleaned fill/drain plug and sealing washer.

137 mm (5.4 in.) Diameter Gearcase

Draining Gearcase

1. Place outboard in a vertical operating position.
2. Remove propeller. Refer to **Propeller Replacement**.
3. Place drain pan below outboard.

4. Remove vent plug and fill/drain plug and drain lubricant.



a - Vent plug
b - Fill/drain plug

Gearcase Lubricant Capacity

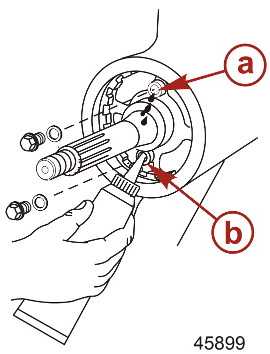
Gearcase lubricant capacity is approximately 850 ml (28.7 fl oz).

Gearcase Lubricant Recommendation

Mercury or Quicksilver High Performance Gear Lubricant.

Checking Lubricant Level and Refilling Gearcase

1. Place outboard in a vertical operating position.
2. Remove vent plug/sealing washer.
3. Remove fill/drain plug. Place lubricant tube into the fill hole and add lubricant until it appears at the vent hole.



a - Vent hole
b - Fill hole

IMPORTANT: Replace sealing washers if damaged.

4. Stop adding lubricant. Install the vent plug and sealing washer before removing the lubricant tube.
5. Remove lubricant tube and reinstall cleaned fill/drain plug and sealing washer.

Submerged Outboard

A submerged outboard will require service within a few hours by an authorized dealer once the outboard is recovered from the water. This immediate attention by a servicing dealer is necessary once the engine is exposed to the atmosphere to minimize internal corrosion damage to the engine.

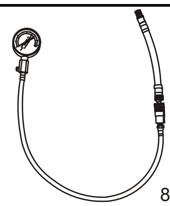
Notes:

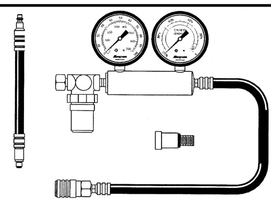
Important Information

Section 1C - General Information

Table of Contents

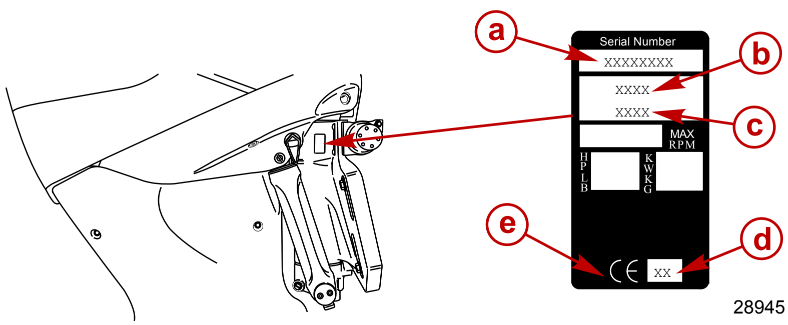
Special Tools

Compression Tester with Adapter	Snap-On EEPV303B
 8511	Checks cylinder compression. Use with M14 x 1.25 adapter.

Cylinder Leakage Tester	Snap-On EEPV309A
 11604	Aids in checking cylinder leakdown.

Serial Number Location

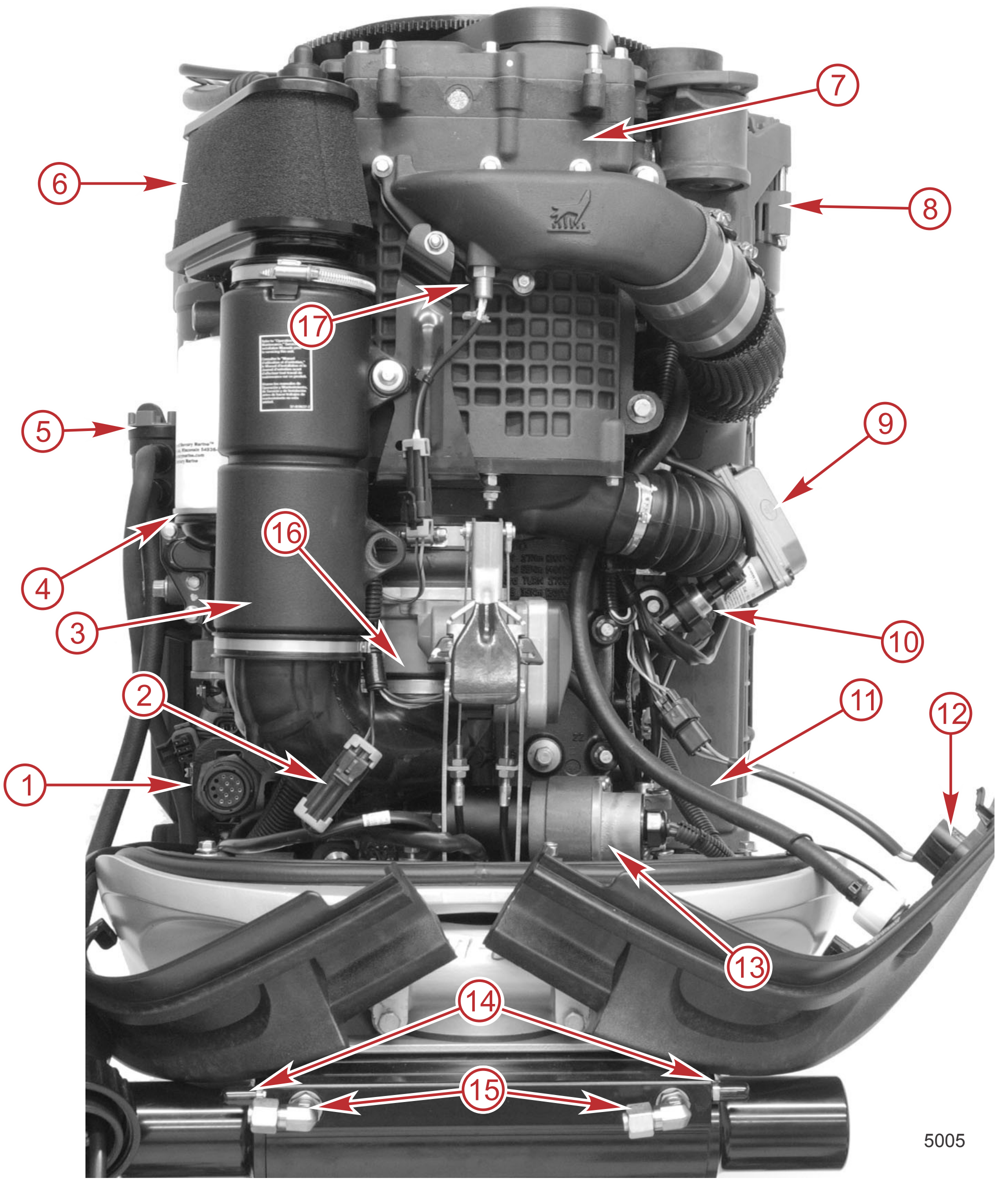
The serial number of the engine is located on the starboard side of the pedestal.



28945

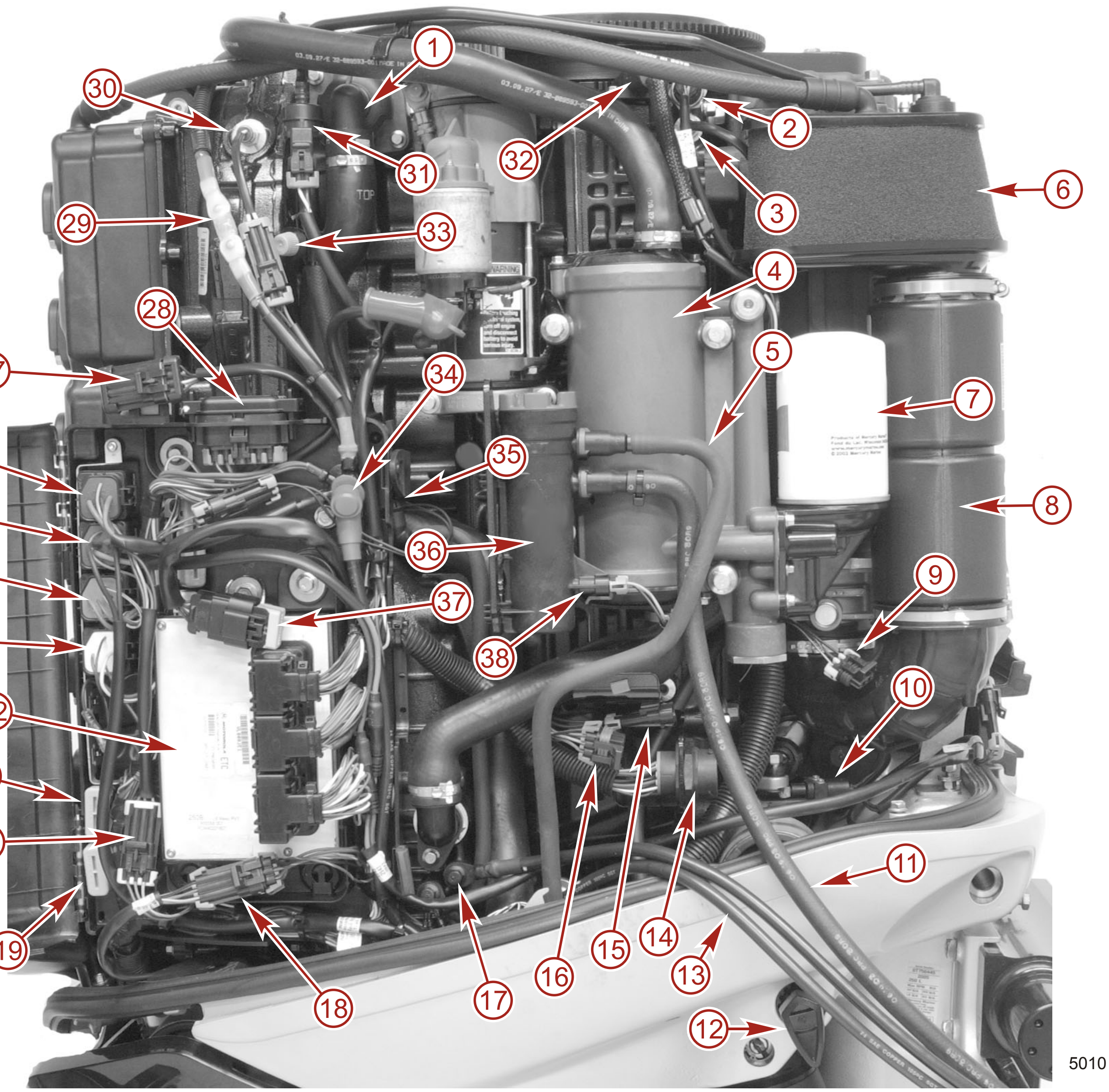
a - Serial number
b - Model year
c - Model designation
d - Year manufactured
e - Certified Europe Insignia (as applicable)

Powerhead Front View S/N 1B517433 and Below



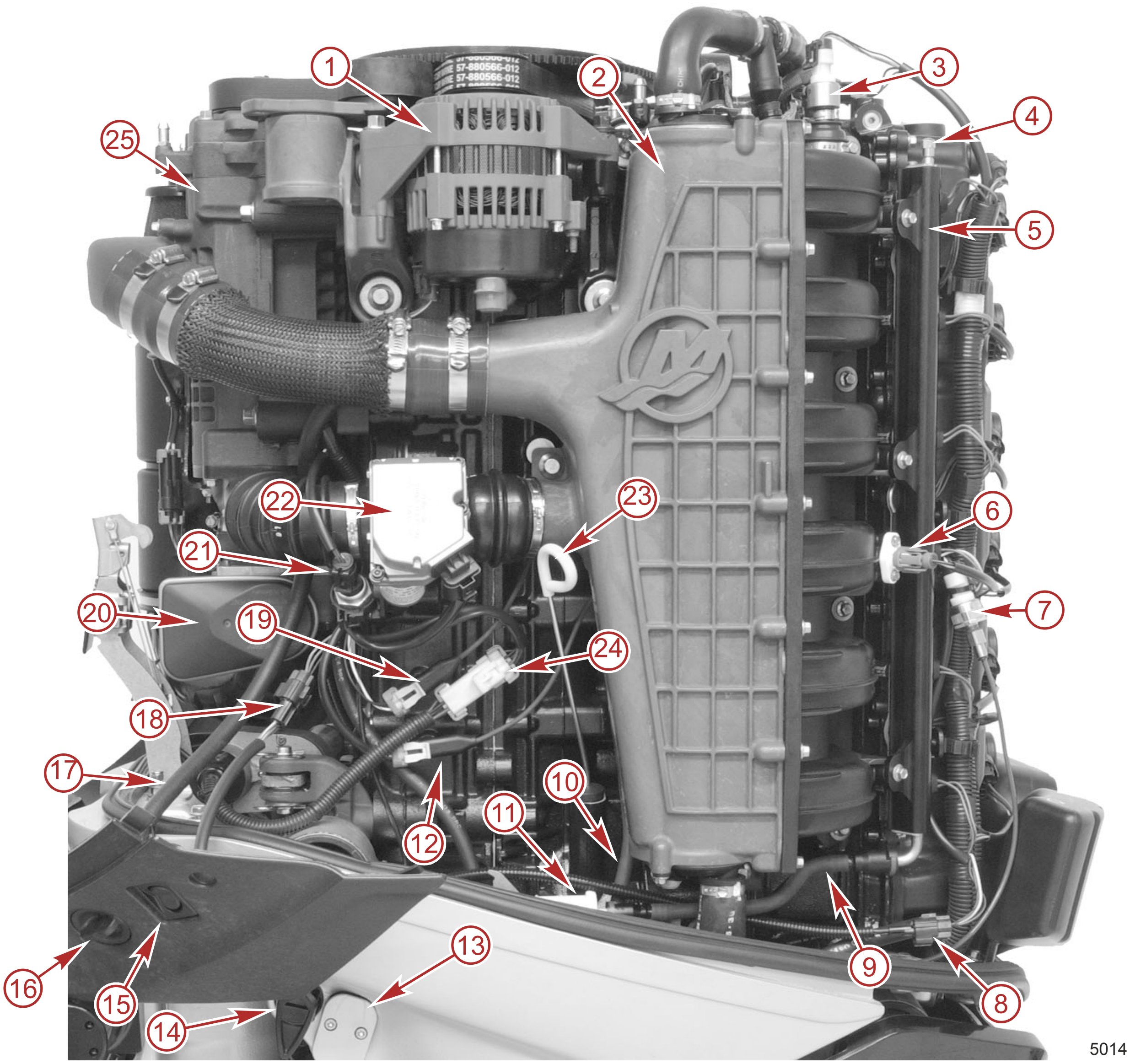
1 - 14 pin engine harness connector
2 - Shift position indicator harness
3 - Resonator
4 - Oil filter
5 - Water separating fuel filter (2 micron)
6 - Air filter
7 - Supercharger
8 - Alternator
9 - Electronic boost control (EBC) assembly
10 - Speedometer sensor
11 - Freshwater flush hose
12 - Cowl mounted tilt switch
13 - Electronic shift control (ESC) assembly
14 - Steering cylinder bleed port
15 - Steering cylinder hydraulic fittings
16 - Electronic throttle control (ETC) assembly
17 - Supercharger boost air temperature sensor

Powerhead Starboard View S/N 1B517433 and Below



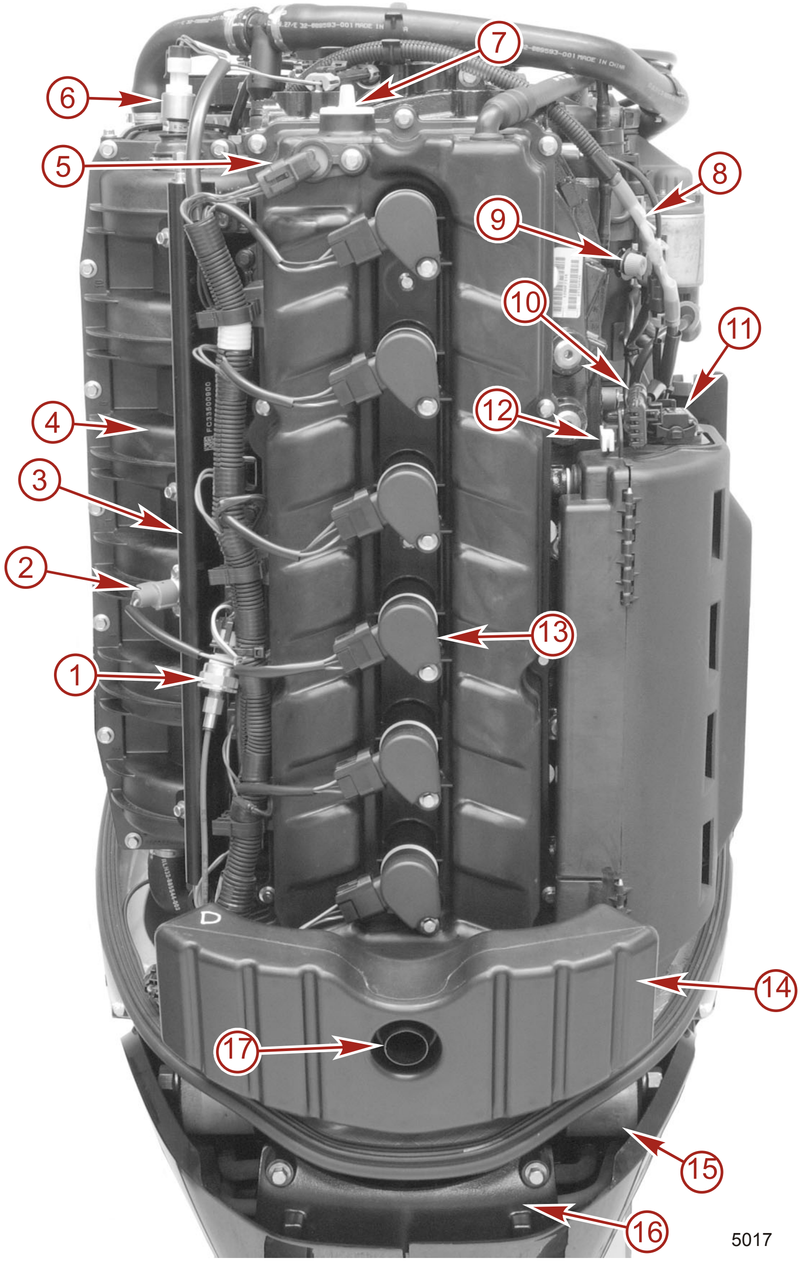
1 - Thermostat housing
2 - Oil pressure sensor
3 - Oil temperature sensor
4 - Integrated oil module (IOM)
5 - Fuel line to fuel supply module
6 - Air filter
7 - Oil filter
8 - Resonator
9 - Power steering signal harness connector
10 - Shift indicator switch
11 - Fuel line (fuel in)
12 - Tilt lock lever
13 - Battery positive cable
14 - 14 pin engine harness connector
15 - DTS power harness
16 - Boat sensor harness
17 - Battery ground cable
18 - Fuel supply module (FSM) harness connector
19 - Splicesaver (red/yellow)
20 - Trim wire harness connector
21 - Splicesaver (red/orange)
22 - PCM
23 - Starter relay
24 - Main power relay
25 - Trim down relay
26 - Trim up relay
27 - Diagnostic port (4 pin)
28 - Fuses
29 - Fusible link, 150 amp
30 - Cylinder head temperature sensor
31 - Vent canister purge valve (VCPV)
32 - Crank position sensor (CPS)
33 - FSM purge valve
34 - Hot stud (battery positive)
35 - Vent canister float switch (VCFS)
36 - Water separating fuel filter (2 micron)
37 - CAN terminating resistor
38 - Water in fuel sensor

Powerhead Port View S/N 1B517433 and Below



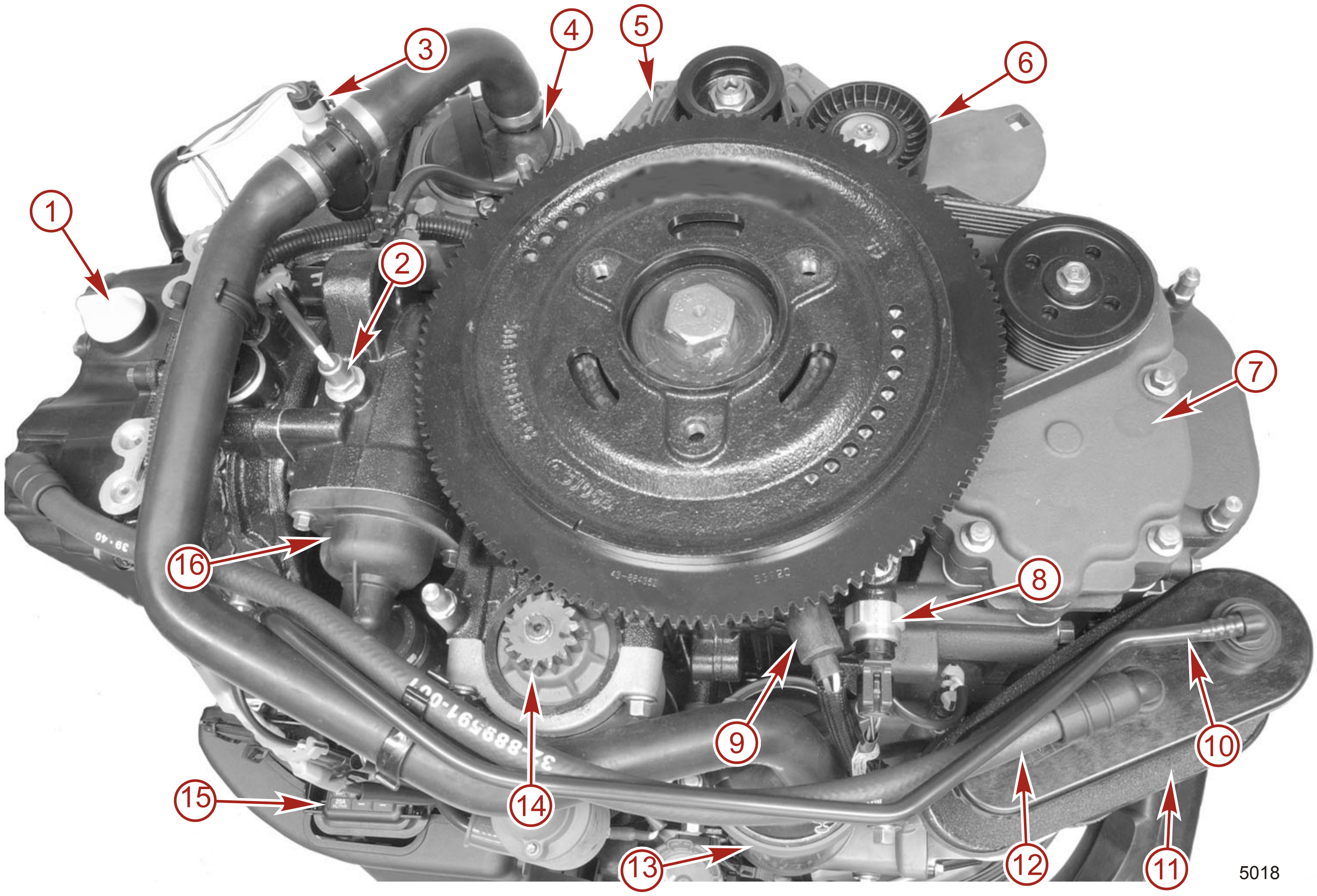
1 - Alternator
2 - Charge air cooler (CAC)
3 - Manifold absolute pressure (MAP) sensor
4 - Fuel pressure port
5 - Fuel rail
6 - Manifold air temperature (MAT) sensor
7 - Cylinder block water pressure sensor
8 - Trim position sensor harness connector
9 - Fuel inlet line to fuel rail
10 - MAP reference line to FSM
11 - High-pressure fuel hose fuel filter (20 micron)
12 - Lower knock sensor harness connector (with black sleeve)
13 - Trim position sensor
14 - Tilt lock lever
15 - Tilt switch
16 - Freshwater flush inlet
17 - Freshwater flush hose
18 - Tilt switch harness connector
19 - Upper knock sensor harness connector
20 - Electronic throttle control (ETC) assembly
21 - Speedometer sensor
22 - Electronic boost control (EBC)
23 - Oil dipstick
24 - Electronic shift control (ESC) harness connector
25 - Supercharger

Powerhead Aft View S/N 1B517433 and Below



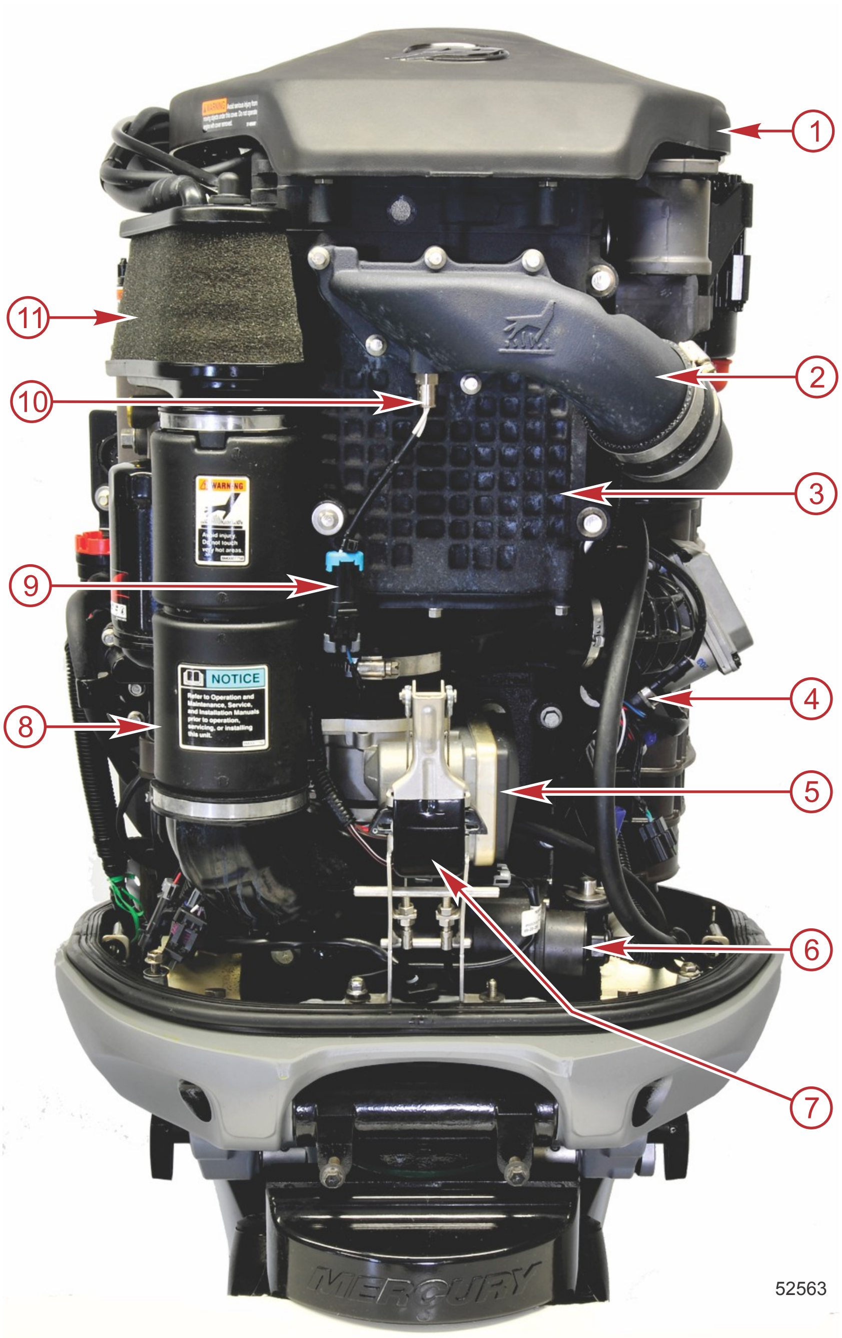
1 - Cylinder block water pressure sensor
2 - Manifold air temperature (MAT) sensor
3 - Fuel rail
4 - Intake manifold
5 - Cam position sensor
6 - Manifold absolute pressure (MAP) sensor
7 - Oil fill plug
8 - Fusible link, 150 amp
9 - FSM purge valve
10 - Diagnostic port (4 pin)
11 - Fuse holder
12 - Fuse puller
13 - Pencil coil (6)
14 - Plenum
15 - Rear motor mount
16 - FSM protection cover
17 - Exhaust relief

Powerhead Top View S/N 1B517433 and Below



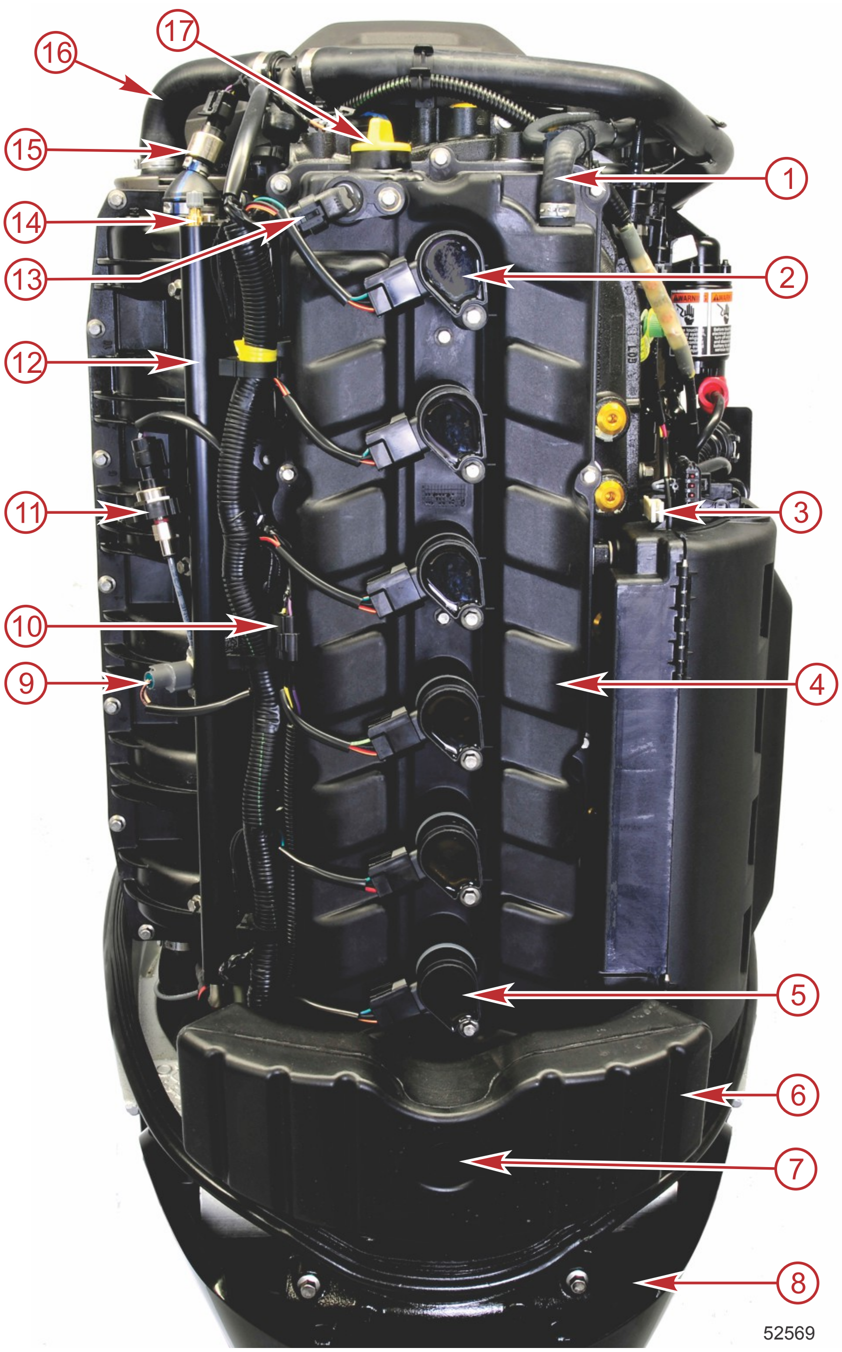
1 - Oil fill plug
2 - Cylinder block water temperature sensor
3 - Manifold absolute pressure (MAP) sensor
4 - Charge air cooler
5 - Alternator
6 - Belt tensioner
7 - Supercharger
8 - Oil pressure sensor
9 - Crank position sensor (CPS)
10 - Vent canister purge valve hose
11 - Air filter
12 - Breather hose
13 - Integrated oil module (IOM)
14 - Starter motor
15 - Fuse holder
16 - Thermostat housing

Powerhead Front View S/N 1B517434 and Above



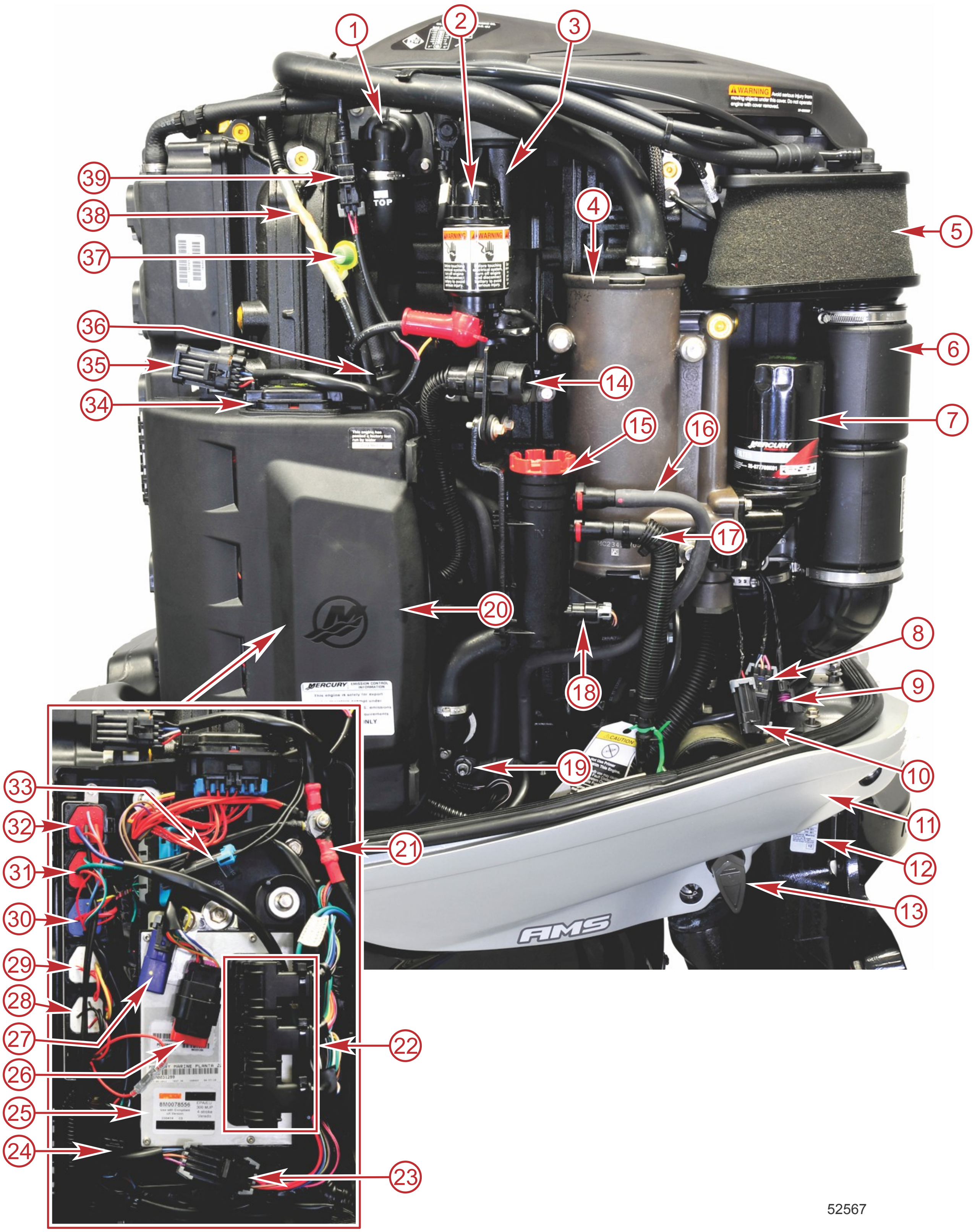
1 - Flywheel cover
2 - Supercharger outlet
3 - Supercharger
4 - Speedometer sensor
5 - Electronic throttle control (ETC) assembly
6 - Electronic shift control (ESC) assembly
7 - Cowl latch bracket assembly
8 - Resonator
9 - Supercharger boost air temperature sensor connector
10 - Supercharger boost air temperature sensor
11 - Air filter

Powerhead Aft View S/N 1B517434 and Above



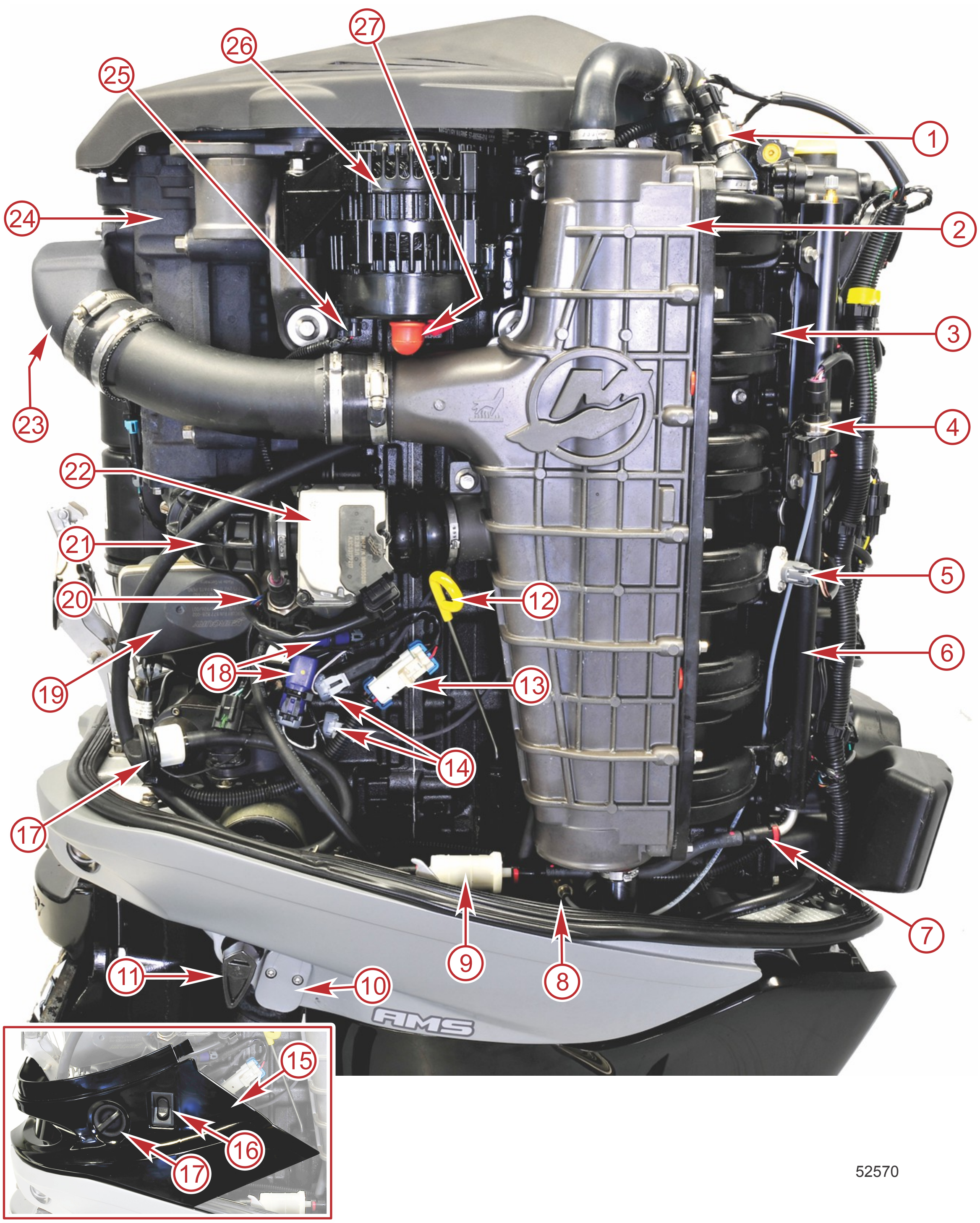
- **1 -** Camshaft cover vent hose
- **2 -** #1 pencil coil
- **3 -** Fuse puller
- **4 -** Camshaft cover
- **5 -** #6 pencil coil
- **6 -** Exhaust relief muffler
- **7 -** Exhaust relief outlet
- **8 -** FSM protection cover
- **9 -** Manifold air temperature (MAT) sensor
- **10 -** Trim position sensor harness connector
- **11 -** Cylinder block water pressure sensor
- **12 -** Fuel rail
- **13 -** Camshaft position sensor
- **14 -** Fuel pressure valve
- **15 -** Manifold absolute pressure (MAP) sensor
- **16 -** Hose
- **17 -** Oil fill plug

Powerhead Starboard View S/N 1B517434 and Above



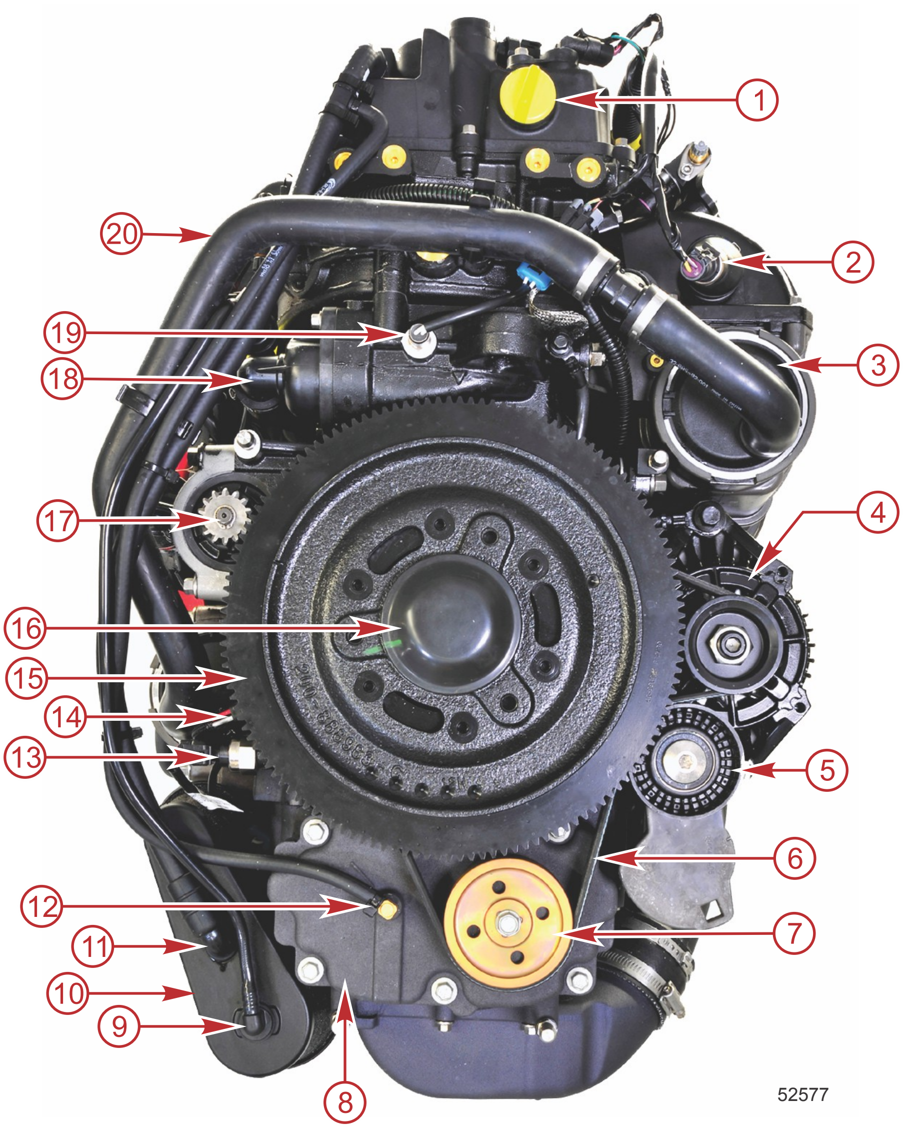
1 - Thermostat housing
2 - Starter solenoid
3 - Starter motor
4 - Integrated oil module (IOM)
5 - Air filter
6 - Resonator
7 - Oil filter
8 - DTS power harness
9 - Power steering signal harness connector
10 - Boat sensor harness
11 - Mount cradle
12 - Serial number location
13 - Tilt lock lever
14 - 14-pin engine harness connector
15 - Water separating fuel filter (2 micron)
16 - Fuel line to fuel supply module
17 - Fuel line (fuel in)
18 - Water-in-fuel (WIF) sensor
19 - Battery ground cable
20 - Electrical box cover
21 - Battery positive cable
22 - Engine harness connectors (3)
23 - Connector
24 - Trim wire harness connector
25 - Propulsion control module (PCM)
26 - CAN P (dark blue and white) and CAN H (green/orange and orange/green) terminating resistor
27 - CAN X terminator resistor
28 - High-pressure fuel pump relay (S/N 1B229689 and above)
29 - Starter relay
30 - Main power relay
31 - Trim down relay
32 - Trim up relay
33 - Vent canister float switch connector
34 - Fuses
35 - Diagnostic port (4 pin)
36 - Vent canister float switch (VCFS)
37 - FSM purge valve
38 - Fusible link, 150 amp
39 - Vent canister purge valve (VCPV)

Powerhead Port View S/N 1B517434 and Above



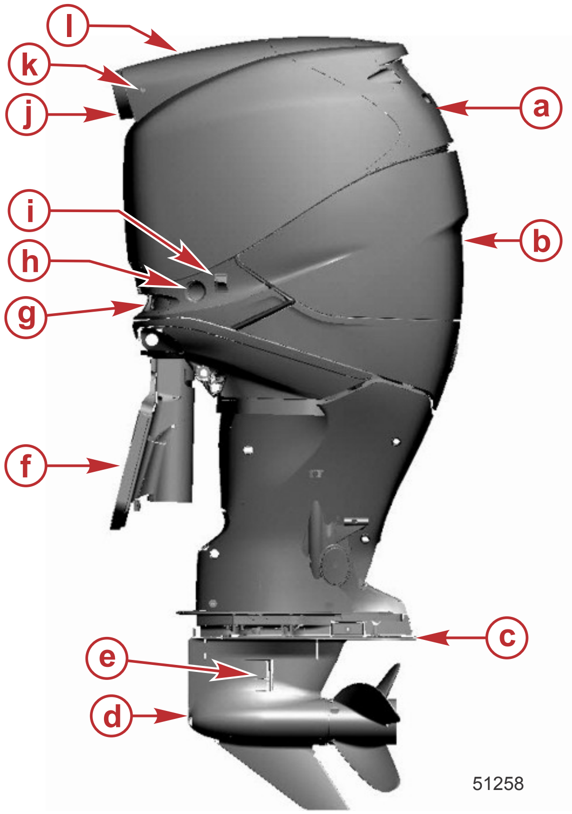
1 - Manifold absolute pressure (MAP) sensor
2 - Charge air cooler (CAC)
3 - Intake manifold
4 - Cylinder block water pressure sensor
5 - Manifold air temperature (MAT) sensor
6 - Fuel rail
7 - Fuel inlet line to fuel rail
8 - Cylinder block water pressure fitting
9 - High-pressure fuel hose fuel filter (20 micron)
10 - Trim position sensor
11 - Tilt lock lever
12 - Oil dipstick
13 - Electronic shift control (ESC) harness connector
14 - Upper and lower knock sensor connectors
15 - Port front cowl
16 - Tilt switch
17 - Fresh water flush inlet
18 - Upper and lower knock sensor resistors
19 - Electronic throttle control (ETC) assembly
20 - Speedometer sensor
21 - Elbow
22 - Electronic boost control (EBC)
23 - Supercharger outlet
24 - Supercharger
25 - Alternator sense harness connector
26 - Alternator
27 - Alternator output terminal

Powerhead Top View S/N 1B517434 and Above

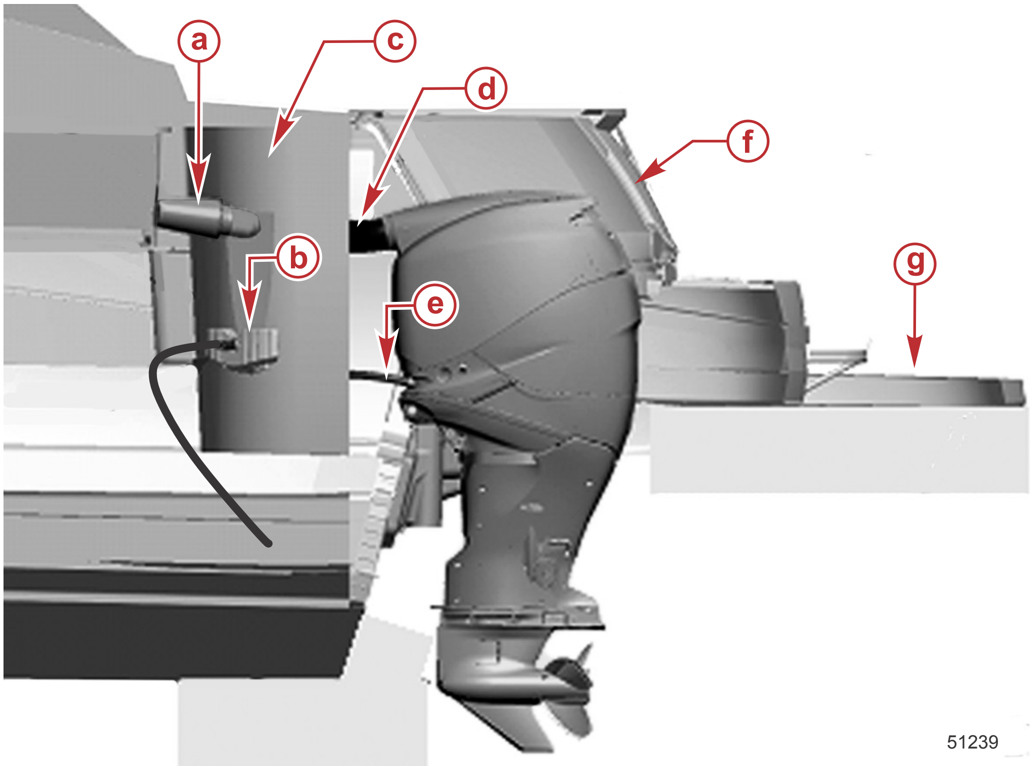


1 - Oil fill plug
2 - Manifold absolute pressure (MAP) sensor
3 - Charge air cooler
4 - Alternator
5 - Belt tensioner
6 - Accessory drive belt
7 - Supercharger pulley
8 - Supercharger
9 - Vent canister purge valve hose
10 - Air filter
11 - Crankcase ventilation hose
12 - Supercharger vent hose
13 - Oil pressure sensor
14 - Crankshaft position sensor (CPS)
15 - Flywheel
16 - Flywheel cap
17 - Starter motor
18 - Thermostat housing
19 - Cylinder block water temperature sensor
20 - Water cooler hose

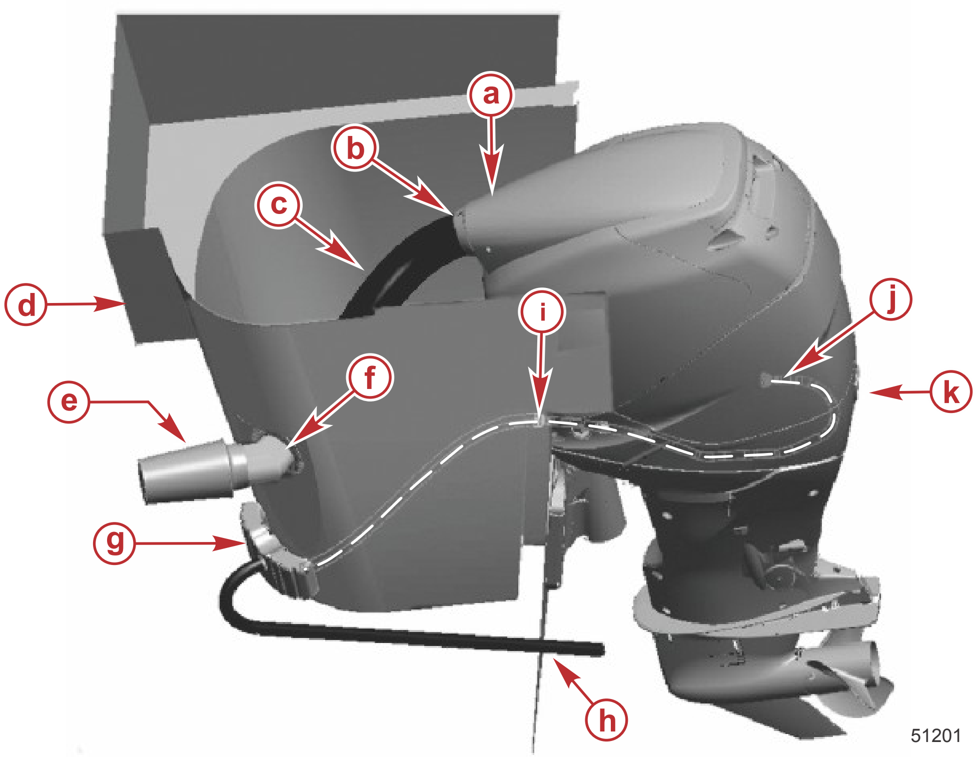
Verado CCT Configuration and Components



- a - Top cowl
- b - Rear cowl
- c - Anti-ventilation plate
- d - Gearcase
- e - Cooling water intake holes
- f - Mount pedestal
- g - Idle relief quick-connect fitting
- h - Engine flush
- i - Auxiliary tilt switch
- j - Quick release air hose adapter
- k - Release button
- l - Air duct top cowl



a - Air filter
b - Idle relief muffler
c - Engine well
d - Engine intake air hose
e - Idle relief hose
f - Engine hatch
g - Swim platform



a - Air duct top cowl
b - Quick release air hose adapter
c - Engine intake air hose
d - Engine well
e - Air filter
f - Elbow
g - Idle relief muffler
h - Idle relief hose
i - Quick-connect coupler
j - Idle relief hose
k - Grommet with plug

Conditions Affecting Performance

Weather

It is a known fact that weather conditions exert a profound effect on the power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

Corporations internationally have settled on adoption of I.S.O. (International Standards Organization) engine test standards, as set forth in I.S.O. 3046 standardizing the computation of horsepower from data obtained on the dynamometer. All values are corrected to the power that the engine will produce at sea level, at 30% relative humidity, at 25 °C (77 °F) temperature, and a barometric pressure of 29.61 inches of mercury.

Summer conditions of high temperature, low barometric pressure, and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds as much as 3 to 5 km/h (2 to 3 mph) in some cases. Nothing will regain this speed for the boater but cooler, dry weather.

Pointing out the consequences of weather effects, an engine running on a hot, humid day may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk day. The horsepower that any internal combustion engine produces depends upon the density of the air that it consumes. The density of air is dependent upon the ambient air temperature, the barometric pressure, and the humidity (water vapor) content.

Accompanying the effects of weather inspired loss of power is a second, but more subtle loss. Consider a boat rigged during cooler, less humid weather with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. Higher temperatures with high humidity weather will consequently decrease the available horsepower. The propeller, in effect, is too large for the atmospheric conditions and the engine operates at less than its recommended RPM.

The engine rated horsepower is a direct relation to the engines' RPM. An engine with too large a propeller will have a further loss of horsepower and subsequent decrease in boat speed. This secondary loss of RPM and boat speed can be regained by switching to a smaller pitch propeller that allows the engine to run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine have the proper propeller to allow it to operate at, or near, the top end of the recommended maximum RPM range at wide-open throttle with a normal boat load. Not only does this allow the engine to develop full power, but equally important, the engine will be operating in an RPM range that discourages damaging detonation. This enhances overall reliability and durability of the engine.

Weight Distribution (Passengers and Gear) Inside the Boat

Shifting weight to rear (stern):

- Generally increases speed and engine RPM
- Causes bow to bounce in choppy water
- Increases danger of following wave splashing into the boat when coming off plane
- At extremes, can cause the boat to porpoise

Shifting weight to front (bow):

- Improves ease of planing
- Improves rough water ride
- At extremes, can cause the boat to veer back and forth (bow steer)

Bottom of Boat

For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in fore and aft direction.

- **Hook:** Exists when bottom is concave in fore and aft direction when viewed from the side. When boat is planing, hook causes more lift on bottom near transom and allows bow to drop, thus greatly increasing wetted surface and reducing boat speed. Hook frequently is caused by supporting boat too far ahead of transom while hauling on a trailer or during storage.
- **Rocker:** The reverse of hook and much less common. Rocker exists if bottom is convex in fore and aft direction when viewed from the side, and boat has strong tendency to porpoise.
- **Surface roughness:** Moss, barnacles, etc., on boat or corrosion of outboard's gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.

Water Absorption

It is imperative that all through-the-hull fasteners be coated with a quality marine sealer at time of installation. Water intrusion into the transom core and/or inner hull will result in additional boat weight (reduced boat performance), hull decay, and eventual structural failure.

Cavitation

Cavitation occurs when water flow cannot follow the contour of a fast-moving underwater object, such as a gear housing or a propeller. Cavitation increases propeller speed while reducing boat speed. Cavitation can seriously erode the surface of the gear housing or the propeller. Common causes of cavitation are:

- Weeds or other debris snagged on the propeller
- Bent propeller blade
- Raised burrs or sharp edges on the propeller

Ventilation

Ventilation is caused by surface air or exhaust gases that are introduced around the propeller resulting in propeller speed-up and a reduction in boat speed. Air bubbles strike the propeller blade and cause erosion of the blade surface. If allowed to continue, eventual blade failure (breakage) will occur. Excessive ventilation is usually caused by:

- Drive unit trimmed out too far
- A missing propeller diffuser ring
- A damaged propeller or gear housing, which allows exhaust gases to escape between propeller and gear housing
- Drive unit installed too high on transom

Detonation

Detonation in a 4-cycle engine resembles the pinging heard in an automobile engine. It can be otherwise described as a tin-like rattling or plinking sound.

Detonation is the explosion of the unburned fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine. These shock waves often find or create a weakness: the dome of a piston, cylinder head or gasket, piston rings or piston ring lands, piston pin, and roller bearings.

A few of the most common causes of detonation in a marine 4-cycle application are as follows:

- Over-advanced ignition timing
- Use of low octane gasoline
- Propeller pitch too high: engine RPM below recommended maximum range
- Lean fuel mixture at, or near, wide-open throttle
- Spark plugs: heat range too hot, incorrect reach, cross-firing
- Deteriorated or inadequate engine cooling system
- Combustion chamber deposits: result in higher compression ratio

Detonation usually can be prevented if:

- The engine is correctly set up
- Regular maintenance is scheduled

Following Complete Engine Submersion

Engine Submerged While Running (Special Instructions)

When an engine is submerged while running, the possibility of internal engine damage is greatly increased. After the engine is recovered, remove the spark plugs. If the engine fails to turn over freely when turning the flywheel, the possibility of internal damage (bent connecting rod and/or bent crankshaft) exists. The powerhead must be disassembled for inspection.

Freshwater Submersion (Special Instructions)

1. Recover the engine as quickly as possible.
2. Place engine at full trim in.
3. Remove cowling.
4. Flush exterior of outboard with freshwater to remove mud, weeds, etc. Do not attempt to start the engine if sand has entered the powerhead. Disassemble powerhead, if necessary, to clean components.
5. Remove spark plugs and get as much water as possible out of the powerhead. Most of the water inside the combustion chambers, can be eliminated by rotating the flywheel while the engine is tilted in.
6. Remove the rubber boot from the ETC assembly. Drain water from the rubber boot.
7. Remove spark plugs and pour approximately one teaspoon of engine oil into each spark plug opening. Rotate flywheel to distribute oil in cylinders.
8. Change the engine oil. Run the outboard for a short time and check for the presence of water in the oil. If water is present, the oil will appear milky. Drain and replace the oil.

9. Dry all wiring and electrical components using compressed air.
10. Disassemble the engine starter motor and dry all the internal parts with compressed air. Be careful not to lose the brush springs.
11. Install spark plugs.
12. Attempt to start engine, using a fresh fuel source. If engine starts, it should be run for at least one hour to eliminate any water in engine. Run the outboard for a short time and check for the presence of water in the oil. If water is present, the oil will appear milky. Drain and replace the oil as previously mentioned.

    NOTE: The fuel system is closed to the ambient air at all times when the engine is not running.
13. If engine fails to start, determine if the cause is fuel, electrical, or mechanical. The engine should be run within two hours after recovery from the water, or serious internal damage will occur. If unable to start engine within two hours of recovery, disassemble the engine and clean all parts. Apply oil as soon as possible.

Saltwater Submersion (Special Instructions)

Due to the corrosive effect of saltwater on internal engine components, complete disassembly of the engine is necessary before any attempt is made to start the engine.

Fuel and Oil

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine, and damage caused thereby will not be covered under the limited warranty.

Mercury Marine engines will operate satisfactorily when using a major brand of unleaded gasoline meeting the following specifications:

Models 250 Pro, 300 Pro, and 300

USA and Canada - Having a posted pump Octane Rating of 92 (R+M)/2 Octane is required for best performance. Having a posted pump Octane Rating of 87 (R+M)/2 minimum is acceptable, however, performance losses may occur. Do not use leaded gasoline.

Outside USA and Canada - Having a posted pump Octane Rating of 96 RON is required for best performance. Having a posted pump Octane Rating of 90 RON minimum is acceptable, however, performance losses may occur. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Models 225 and 250

USA and Canada - Having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - Having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasolines (USA Only)

This type of gasoline is required in certain areas of the USA. The two types of oxygenates used in these fuels are alcohol (ethanol) or ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasolines Containing Alcohol**.

These reformulated gasolines are acceptable for use in your Mercury Marine engine.

Gasolines Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with methanol. Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury Marine engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boat's fuel system components (fuel tanks, fuel lines, and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

Fuel leakage is a fire or explosion hazard, which can cause serious injury or death. Periodically inspect all fuel system components for leaks, softening, hardening, swelling, or corrosion, particularly after storage. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury Marine engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Filling Fuel Tank

⚠ WARNING

Avoid serious injury or death from a gasoline fire or explosion. Use caution when filling fuel tanks. Always stop the engine and do not smoke or allow open flames or sparks in the area while filling fuel tanks.

Fill the fuel tanks outdoors away from heat, sparks, and open flames.

Remove the portable fuel tanks from the boat to fill them.

Always stop the engine before filling the tanks.

Do not completely fill the fuel tanks. Leave approximately 10% of the tank volume unfilled. Fuel will expand in volume as its temperature rises and can leak under pressure if the tank is completely filled.

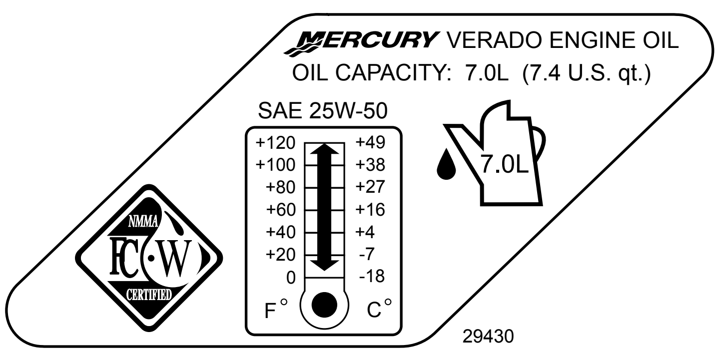
Portable Fuel Tank Placement in the Boat

Place the fuel tank in the boat so the vent is higher than the fuel level under normal boat operating conditions.

Engine Oil Recommendations

Mercury Verado NMMA FC-W Certified Synthetic Blend 25W-50 Multi-Viscosity 4-Stroke Outboard Oil is recommended for general, all-temperature use. As an optional choice, Mercury or Quicksilver NMMA FC-W Certified Synthetic 25W-40 Synthetic Blend 4-Stroke Engine Oil may be used. If the recommended Mercury or Quicksilver NMMA FC-W certified oils are not available, a major outboard manufacturers brand of NMMA FC-W Certified 4-Stroke Outboard Oil of similar viscosity may be used.

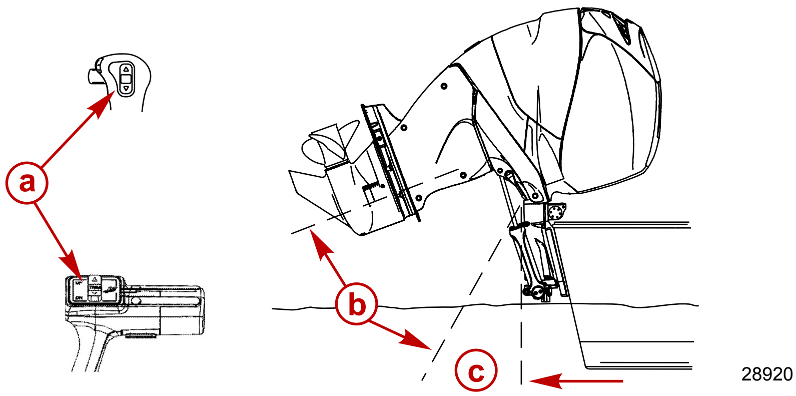
IMPORTANT: The use of nondetergent oils, multi-viscosity oils (other than Mercury or Quicksilver NMMA FC-W certified oil or a major brand NMMA FC-W certified oil), synthetic oils, low quality oils, or oils that contain solid additives are not recommended.



Power Trim System

Power Trim and Tilt

The outboard has a trim/tilt control called power trim. This enables the operator to easily adjust the position of the outboard by pressing the trim switch. Moving the outboard in closer to the boat transom is called trimming in or trimming down. Moving the outboard further away from the boat transom is called trimming out or trimming up. The term trim generally refers to the adjustment of the outboard within the first 20° range of travel. This is the range used while operating the boat on plane. The term tilt is generally used when referring to adjusting the outboard further up out of the water. With the engine not running and the key switch in the "ON" position, the outboard can be tilted out of the water. At low idle speed (2000 RPM and below), the outboard can also be tilted up past the trim range to permit shallow water operation.



a - Trim switch
b - Tilt range of travel
c - Trim range of travel

Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim the outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, this being an awareness of some potential control hazards.

Consider the following lists carefully:

1. Trimming in or down can:
    - Lower the bow.
    - Result in quicker planing off, especially with a heavy load or a stern heavy boat.
    - Generally improve the ride in choppy water.
    - In excess, can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or oversteering) if any turn is attempted, or if a significant wave is encountered.

⚠ WARNING

Operating the boat at high speeds with the outboard trimmed too far under can create excessive bow steer, resulting in the operator losing control of the boat. Install the trim limit pin in a position that prevents excessive trim under and operate the boat in a safe manner.

2. Trimming out or up can:
    - Lift the bow higher out of the water.
    - Generally increase top speed.
    - Increase clearance over submerged objects or a shallow bottom.
    - In excess, can cause boat porpoising (bouncing) or propeller ventilation.
    - Cause engine overheating if any cooling water intake holes are above the waterline.

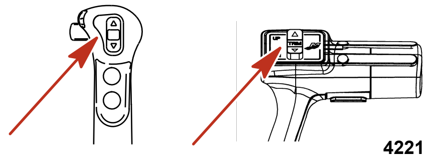
Tilting to Full Up Position

Tilt at Helm S/N 1B278999 and Below

IMPORTANT: Turning key to the "START" position while the engine is running will result in engine shutdown, while leaving the DTS system active. This will allow the use of the power trim/tilt from the remote control handle.

1. Shut off engine by:
    a. Turning the key to the "START" position, then releasing it to the "ON" position.
    b. Turning the key to the "OFF" position and returning it to the "ON" position.

2. Press the trim/tilt switch to the up position. The outboard will tilt up until the switch is released or it reaches its maximum tilt position.



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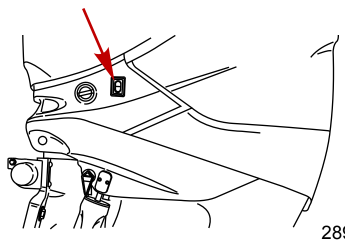
Tilt at Helm S/N 1B277000 and Above

NOTE: The trim/tilt switch will remain active for 15 minutes after the ignition key switch has been turned off.

1. If the ignition key switch has been turned off for over 15 minutes, turn it to the "ON" position.
2. Press the trim/tilt switch to the up position. The outboard will tilt up until the switch is released or it reaches its maximum tilt position.

Tilt at Engine

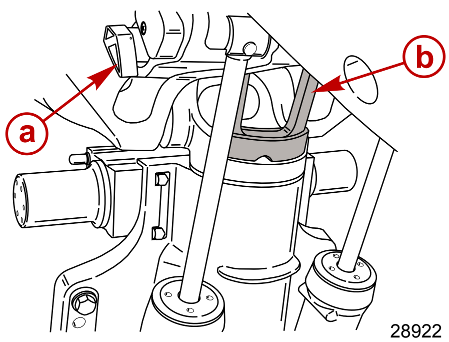
The cowl-mounted auxiliary tilt switch can be used to tilt the outboard with the key switch in the "OFF" position.



28927

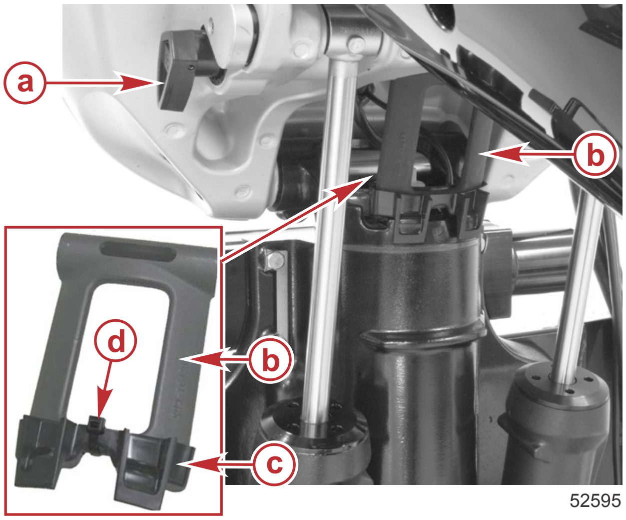
1. Rotate the tilt support lever down.
2. Lower the outboard until the tilt support bracket rests on the pedestal.
3. Disengage the tilt support bracket by raising the outboard up and rotating the tilt support lever up. Lower the outboard.

   NOTE: Outboards without a cable tie securing the pad to the bracket should replace their factory installed tilt bracket pad with an improved tilt bracket pad P/N 8M0075798 and a cable tie.



28922

a - Tilt support lever
b - Tilt support bracket/pad

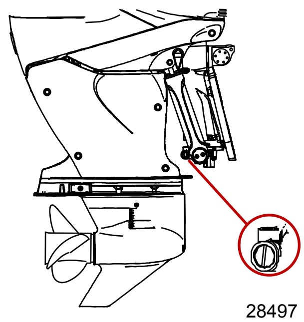


52595

a - Tilt support lever
b - Tilt support bracket
c - Tilt support pad (P/N 8M0075798)
d - Cable tie

Manual Tilting

If the outboard cannot be tilted using the power trim/tilt switch, the outboard can be manually tilted.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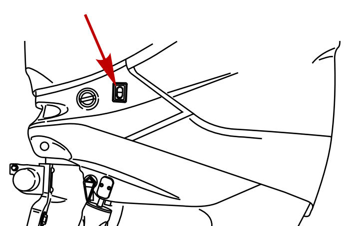
NOTE: The manual tilt release valve must be tightened before operating the outboard to prevent the outboard from tilting up during reverse operation.

Turn out the manual tilt release valve three turns counterclockwise. This allows manual tilting of the outboard. Tilt the outboard to the desired position and tighten the manual tilt release valve.

Auxiliary Tilt Switch

The auxiliary tilt switch can be used to tilt the outboard up or down using the power trim system.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Shallow Water Operation

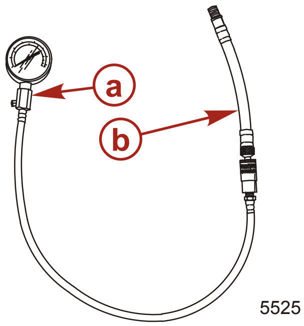
When operating your boat in shallow water, you can tilt the outboard beyond the maximum trim range to prevent hitting bottom.

1. Reduce engine speed below 2000 RPM.
2. Tilt outboard up. Make sure all the water intake holes stay submerged at all times.
3. Operate the engine at slow speed only. With the outboard tilted past 20° trim limit, the warning horn will sound and engine speed will be automatically limited to approximately 2000 RPM. The outboard must be tilted (trimmed) down below the maximum trim range to allow operation above 2000 RPM.

Compression Check

Engine compression should be checked with the engine block at operating temperatures, all spark plugs removed and using a fully charged battery.

1. Remove spark plugs.
2. Install compression gauge in spark plug hole.



a - Compression gauge
b - 14 mm adapter

Compression Tester with Adapter	Snap-On EEPV303B

3. Crank the engine over until the compression reading peaks on the gauge. Record the reading.
4. Check and record compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15%. A reading below 827.4 kPa (120 psi) may indicate a total engine wear problem. **The following example chart below, is not a representation of compression values specific to the engine that is actually tested. It is only an example.**

Compression Test Differences		
Condition	Maximum Reading	Minimum Reading
Good	1241 kPa (180 psi)	1062 kPa (154 psi)
Bad	1172 kPa (170 psi)	972.2 kPa (141 psi)

5. To find the maximum allowable minimum compression reading difference, use this formula; highest compression reading x 0.85 = the lowest allowable difference. 1241 kPa x 0.85 = 1054.85 kPa (180 x 0.85 = 153 psi).
6. Compression check is important because an engine with low or uneven compression can not be tuned successfully to give peak performance. It is essential therefore, that improper compression be corrected before proceeding with an engine tune-up.
7. A variance of more than 103.4 kPa (15 psi) indicates the need for a powerhead inspection/disassembly.

Cylinder Leakage Testing

Engine Firing Order	
Cylinder sequence	1 - 3 - 5 - 6 - 4 - 2

NOTE: Cylinder leakage testing, along with compression testing, can help the mechanic pinpoint the source of a mechanical failure by gauging the amount of leakage in an engine cylinder. Refer to the manufacturer's tester instructions for proper testing procedures.

NOTE: Spark plug hole is a 14 mm diameter. Use Snap-On Tool MT26J-200 adapter (or equivalent) with valve core removed.

Cylinder Leakage Tester	Snap-On EEPV309A

1. Remove the spark plugs from cylinders 2, 3, 4, 5, and 6.
2. Rotate the engine clockwise until resistance is felt.
3. Continue to rotate flywheel so the timing marks on the flywheel and cylinder block are in alignment. This will be the compression stroke for cylinder #1.
4. Remove the spark plug from cylinder #1.
5. Complete the cylinder leak down test on the #1 spark plug hole. Refer to the manufacturer's tester instructions for proper testing procedures.
6. After testing cylinder #1, install a dial indicator on the next firing order sequence cylinder.
7. Rotate the flywheel so the piston is at TDC.
8. Complete the cylinder leak down test.

9. Proceed with the succeeding firing order cylinder TDC and complete the cylinder leak down test.
10. Complete the procedure in sequence on the remain cylinders.

Analysis

Due to standard engine tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important only that cylinders have somewhat consistent reading between them. Differences of 15 to 30% indicate excessive leakage. Larger engines tend to have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, first check that the piston is at top dead center of its compression stroke. Leakage will naturally occur if the exhaust or intake valve is open.

To determine the cause of high percentage leaks, you must locate where the air is escaping from. Listen for air escaping through the intake, adjacent spark plug holes, exhaust pipe, and crankcase oil fill plug. Use the following table to aid in locating the source of cylinder leakage.

Air Escaping from	Possible Location
Air induction	Intake valve
Exhaust system	Exhaust valve
Oil fill plug	Piston/rings
Adjacent cylinder	Head gasket

Painting Procedures

⚠ WARNING

Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators.

Propellers

1. Sand the entire area to be painted with 3M 120 Regalite Polycut or coarse Scotch-Brite disc or belts.
2. Feather edges of all broken paint edges. Try not to sand through the primer.
3. Clean the surface to be painted using PPG Industries DX330 Wax and Grease Remover or equivalent (Xylene or M.E.K.).
4. If bare metal has been exposed, use Mercury/Quicksilver Light Gray Primer.
5. Allow a minimum of one hour dry time and no more than one week before applying the finish coat.
6. Apply the finish coat using Mercury/Quicksilver EDP Propeller Black.

Gear Housing

The following procedures should be used in refinishing gear housings. This procedure will provide the most durable paint system available in the field. The materials recommended are of high quality and approximate marine requirements. The following procedure will provide a repaint job that compares with a properly applied factory paint finish. It is recommended the listed materials be purchased from a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each material shown following is sufficient to refinish several gear housings.

1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth, and rinse with water.
2. Wash the gear housing with soap and water. Rinse with clean water.
3. Sand blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather edge all broken paint edges.
4. Clean gear housing thoroughly with DX-330 Wax and Grease Remover.
5. Spot repair surfaces where bare metal is exposed with DX-503 Alodine Treatment.
   IMPORTANT: Do not use aerosol spray paints as the paint will not properly adhere to the surface, nor will the coating be sufficiently thick to resist future paint blistering.
6. Mix Epoxy Chromate Primer DP-90LF with equal part catalyst DP-402LF per the manufacturer's instructions. Allow proper induction period for permeation of the epoxy primer and catalyst.
7. Allow a minimum of one hour drying time and no more than one week before the top coat application.
8. Use Ditzler Urethane DU9300 for Mercury Black, DU34334 for Mariner Grey, DU35466 for Force Charcoal, DU33414M for Sea Ray White, and DFHS 37372H for Verado Silver. Catalyze all five colors with Ditzler DU5 catalyst mixed 1:1 ratio. Reduce with solvents per Ditzler label.

⚠ WARNING

Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators.

NOTE: Apply one half to one mil even film thickness with a spray gun. Allow the paint to flash off for five minutes before applying the second even coat of one half to one mil film thickness. Urethane paint will dry to the touch in a matter of hours, but will remain sensitive to scratches and abrasions for a few days.

9. The type of spray gun used will determine the proper reduction ratio of the paint.
   IMPORTANT: Do not paint the sacrificial anode.
10. Cut out a cardboard plug for trim tab pocket to keep paint off of mating surface to maintain good continuity circuitry between trim tab and gear housing.

Decal Removal

1. Mark decal location before removal to assure proper alignment of new decal.
2. Carefully soften decal and decal adhesive with a heat gun or heat blower while removing old decal.
3. Clean decal contact area with a 1:1 mixture of isopropyl alcohol and water.
4. Thoroughly dry decal contact area and check for a completely cleaned surface.

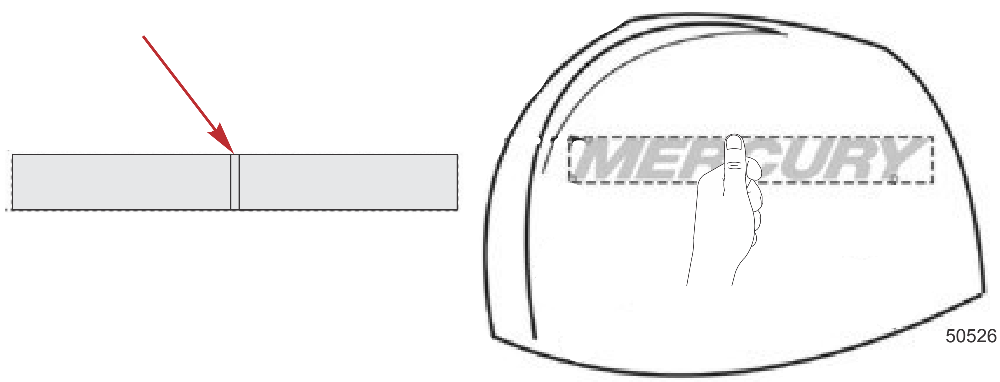
Decal Application

Application Tips

1. Ensure that the surrounding work area and the surface are properly cleaned to avoid contamination.
2. Ensure that the surface and the ambient air temperature is within the specified range.
3. Ensure that your hands are clean and dry.
4. Ensure that the paper liner on the decal does not become wet. A wet paper liner is very difficult to remove.
5. Use the recommended plastic applicator. The applicator should be new and must not be damaged.
   a. If the decal has a premask, use the squeegee only.
   b. If the decal does not have a premask, use a low friction sleeve or felt squeegee to prevent scratching or damaging the decal and cowl.
6. Use firm pressure on the squeegee with overlapping strokes.
7. Remove the premask and application tape at a 180° angle to the decal.
8. Puncture the air bubbles with an air release tool or straight pin. Do not use a knife or razor blade.
9. Immediately squeegee the entire decal after removing the premask tape.

Applying the Decal

1. Ensure that your hands are clean and dry.
2. Remove the center paper liner strip from decal if applicable.
3. Align the decal according to the reference placement drawing and apply light pressure on the center strip location.



4. Align the decal and secure one side of the decal with your hand.
5. Lightly hinge the decal in half to expose the liner tape and remove the liner paper.
6. Apply a little tension to the decal and squeegee the entire decal from the center towards the outside edge with overlapping strokes.

7. Lightly hinge the other half of the decal to expose the liner tape and remove the liner paper.
8. Apply a little tension to the decal and squeegee the entire decal from the center towards the outside edge with overlapping strokes. Be sure to overlap the outside edge of the decal with the squeegee.
9. Inspect the decal closely for entrapped air bubbles. Use the squeegee to push the air bubble to the outside edge.
10. Remove the premask liner from the decal beginning at one corner and carefully pull the premask liner off and onto itself at a 180° angle.
    IMPORTANT: When the premask is removed from the decal, the pulling force loosens the adhesive at the edges of the decal. It is imperative to squeegee the entire decal with special attention to the edges of the decal.

50338

11. Do not allow the premask to remain on the decal for more than 24 hours after installation.
12. Squeegee the complete decal including all edges after the premask liner has been removed.

Entrapped Air Removal

The micro-comply adhesive has a unique pattern to the adhesive that allows entrapped air to escape through very small channels for a faster, easier installation. Always work from the center of the decal towards the edge. If the channels are closed off, use an air release tool or straight pin to aid in removing the bubble. Puncture one end of the bubble and use your thumb to push the entrapped air towards the puncture site. Do not use a knife or razor blade to puncture the decal.

Final Decal Squeegee

It is recommended to use a Meguiar's Supreme Shine Microfiber Towel for the final decal squeegee. With a firm hand pressure, work the decal from the center out to the edge. Ensure to pay attention to the edge of the decal during this final decal squeegee.

IMPORTANT: It is imperative to squeegee the entire decal with special attention to the edges of the decal.
IMPORTANT: Do not allow the new decal to have direct sunlight contact for a minimum of 24 hours.

Cleaning and Maintenance

IMPORTANT: Never use petroleum products or strong household cleaning chemicals to clean the outside surface of the cowls. Using petroleum products or strong household cleaning chemicals will cause damage to the decal and may damage the cowl.
IMPORTANT: Pressure wash and scrub brush with caution. Always use a wide spray pattern, low-pressure, and an angle less than 60° to the surface when using a pressure washer. Low angle water streams can lift the decal from the surface.

General Cleaning Instruction

- Rinse the surface well with lukewarm water to remove dirt.
- Use a soft cloth or sponge to gently wash the surface with a mild dishwashing soap with lukewarm water.
- Do not scrub, use a brush, or a squeegee.
- Rinse the surface thoroughly.
- Use a clean, soft, lint-free cloth to dry and prevent water spotting.

Shipping of Hazardous Material (HazMat) and Engine/Components Containing Hazardous Material

Outboard Service Bulletin 2008-07

There are a number of United States regulations regarding the shipment of hazardous material. These regulations apply not only to shipments within the United States, but to import and export shipments as well. It is important to comply with all of these regulations. This bulletin is intended to provide you with some basic information about some of these regulations, and provide you with information about resources from which you can obtain additional information. It is also intended to draw your attention to the importance of proper packaging, labeling, and shipping of hazardous material; as well as any engine or engine component that contains hazardous material like gasoline or other fluids such as crankcase oil, gearcase oil, and hydraulic fluid. There are also requirements for training personnel that deal with the shipment of hazardous material. This bulletin is intended to draw your attention to some of the shipping regulations that we are aware of that might apply to your business, it is not a complete review of all of the laws and regulations that apply to the shipment of hazardous materials. Please do not treat it as such.

NOTE: You, as the shipper of record, are responsible for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials.

Overview of Regulations

The Hazardous Materials Regulations (HMR) specify requirements for the safe transportation of hazardous materials in commerce by rail car, aircraft, vessel, and motor vehicle. These comprehensive regulations govern transportation-related activities. In general, the HMR prescribe requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials. The HMR are enforced by Pipeline Hazardous Material Safety Administration (PHMSA), Department of Transportation (DOT), Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and the United States Coast Guard (USCG).

Overview of Training Requirements

Current U.S. Department of Transportation (DOT) regulations require initial training (and recurrent training) of all employees who perform work functions covered by the Hazardous Materials Regulations. Any employee who works in a shipping, receiving, or material handling area; or who may be involved in preparing or transporting hazardous materials, is required to have training. Hazardous materials transportation training is available from ShipMate, Inc. The training modules on CD-ROM or online contain an interactive training program which satisfies the DOT requirement for general awareness, general safety, and HazMat security training. A comprehensive exam is offered and Certificates of Completion are generated upon successful completion of the program. The CD-ROM and online Web-Based Training may be purchased from ShipMate, Inc. This also includes an electronic version of the 49 CFR Hazardous Materials Regulations, the current Emergency Response Guidebook, and full access to ShipMate's technical staff to assist you in properly preparing hazardous materials for transport. ShipMate, Inc. may be reached at 1-310-370-3600 or on the web at http://www.shipmate.com.

*NOTE: The DOT training program does **NOT** include a test of any type and contains a lot of material which is not relevant (e.g. cargo tanks). In addition, you would have to purchase the 49 CFR and the Emergency Response Guidebook separately. Further, the DOT program provides no support – technical or otherwise. For further information, view the DOT website at http://www.dot.gov.*

Shipping of Complete Engines and Major Assemblies

Complete engines cannot be transported without going through additional preparation first. Electronic fuel injection (EFI) and direct fuel injection (DFI) engines must have the fuel system drained of fuel, not run dry because of possible damage to electric fuel pumps. Carbureted engines must be completely run dry and have stalled due to lack of fuel. All engines must have any remaining fluids/oils drained (including engine and gearcase oil) and hydraulic fluids (including power trim fluid) and disconnected fluid pipes that previously contained fluid must be sealed with leakproof caps that are positively retained. Major assemblies such as gearcases, dressed powerheads, or other components containing any fluids must be also drained prior to shipping.

More Information on Hazardous Material

More information on hazardous material, regulations, packaging, training, etc. can be found by going to the ShipMate website: http://www.shipmate.com or by calling:

ShipMate Inc.	
Telephone	+ 1 (310) 370-3600
Fax	+ 1 (310) 370-5700
E-mail	shipmate@shipmate.com

Important Information

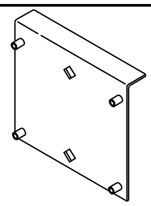
Section 1D - Outboard Motor Installation

Table of Contents

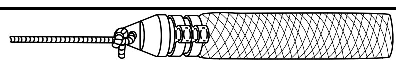
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal battery cable connections	92- 25711 3
94	Anti-Corrosion Grease	Propeller shaft splines	Obtain Locally
95	2-4-C with PTFE	Propeller shaft splines	92-802859A 1

Special Tools

Transom Drilling Fixture	91- 98234A 2
 5489	Aids in engine installation by acting as a template for engine mounting holes.

Flywheel Puller/Lifting Ring	91-895343T02
 14869	Flywheel Puller/Lifting Ring

Data Cable Puller	888462A 1
 4618	Attaches to end of DTS data harness to aid in pulling harness through boat. Prevents damage to DTS data harness.

Notice to Installer

This Product Requires Electronic Calibration Before Use.

Installation of this product will require electronic calibration. This calibration must not be attempted by anyone other than the Original Equipment Manufacturer (OEM) or a Mercury technician trained in Digital Throttle and Shift systems (DTS) at an authorized Mercury dealership. Improper installation and calibration of the DTS product will result in a system which is inoperable or unsafe for use.

Avoiding Loss of Throttle and Shift Control

⚠ WARNING

Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control. To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system.

Fuel System Requirements

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine, and any damage caused will not be covered under the Limited Warranty.

Mercury Marine engines will operate satisfactorily when using a major brand of unleaded gasoline meeting the following specifications:

Models 250 Pro, 275, 300 Pro, and 300

USA and Canada - Having a posted pump Octane Rating of 92 (R+M)/2 Octane is required for best performance. Having a posted pump Octane Rating of 87 (R+M)/2 minimum is acceptable, however, performance losses may occur. Do not use leaded gasoline.

Outside USA and Canada - Having a posted pump Octane Rating of 96 RON is required for best performance. Having a posted pump Octane Rating of 90 RON minimum is acceptable, however, performance losses may occur. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Models 225 and 250

USA and Canada - Having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - Having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasolines (USA Only)

This type of gasoline is required in certain areas of the USA. The two types of oxygenates used in these fuels are alcohol (ethanol) or ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasolines Containing Alcohol**.

These reformulated gasolines are acceptable for use in your Mercury Marine engine.

Gasolines Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with methanol. Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury Marine engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boat's fuel system components (fuel tanks, fuel lines, and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through rubber fuel lines
- Starting and operating difficulties

⚠ WARNING
Fuel leakage is a fire or explosion hazard, which can cause serious injury or death. Periodically inspect all fuel system components for leaks, softening, hardening, swelling, or corrosion, particularly after storage. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury Marine engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Accessory Electric Fuel Pump/Fuel Line Primer Bulb

IMPORTANT: Do not install an accessory electric fuel pump or a fuel line primer bulb into the fuel system of this engine.

Avoiding Fuel Flow Restriction

IMPORTANT: Adding components to the fuel supply system (filters, valves, fittings, etc.) may restrict the fuel flow. This may cause engine stalling at low speed, and/or a lean fuel condition at high RPM that could cause engine damage.

Low Permeation Fuel Hose Requirement

Required for outboards manufactured for sale, sold, or offered for sale in the United States.

- The Environmental Protection Agency (EPA) requires that any outboard manufactured after January 1, 2009, must use low permeation fuel hose for the primary fuel hose connecting the fuel tank to the outboard.
- Low permeation hose is USCG Type B1-15 or Type A1-15, defined as not exceeding 15/gm²/24 h with CE 10 fuel at 23 °C as specified in SAE J 1527 - marine fuel hose.

EPA Pressurized Portable Fuel Tank Requirements

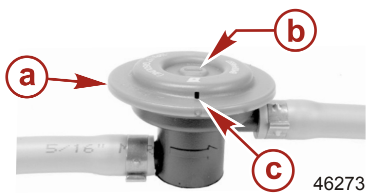
The Environmental Protection Agency (EPA) requires portable fuel systems that are produced after January 1, 2011, for use with outboard engines to remain fully sealed (pressurized) up to 34.4 kPa (5.0 psi). These tanks may contain the following:

- An air inlet that opens to allow air to enter as the fuel is drawn out of the tank.
- An air outlet that opens (vents) to the atmosphere if pressure exceeds 34.4 kPa (5.0 psi).

Fuel Demand Valve (FDV) Requirement

Whenever a pressurized fuel tank is used, a fuel demand valve is required to be installed in the fuel hose between the fuel tank and primer bulb. The fuel demand valve prevents pressurized fuel from entering the engine and causing a fuel system overflow or possible fuel spillage.

The fuel demand valve has a manual release. The manual release can be used (pushed in) to open (bypass) the valve in case of a fuel blockage in the valve.



46273

a - Fuel demand valve - installed in the fuel hose between the fuel tank and primer bulb
b - Manual release
c - Vent/water drain holes

Mercury Marine's Pressurized Portable Fuel Tank

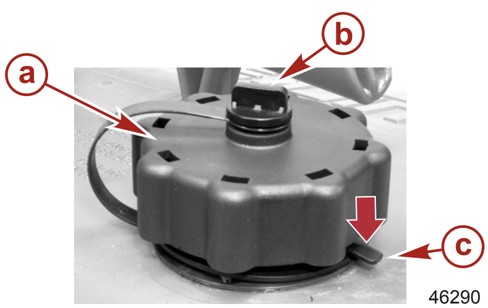
Mercury Marine has created a new portable pressurized fuel tank that meets the preceding EPA requirements. These fuel tanks are available as an accessory or are provided with certain portable outboard models.

Special Features of the Portable Fuel Tank

- The fuel tank has a two-way valve which allows air to enter the tank as the fuel is drawn to the engine, and also opens to vent to the atmosphere if internal pressure in the tank exceeds 34.4 kPa (5.0 psi). A hissing noise may be heard as the tank vents to the atmosphere. This is normal.
- The fuel tank includes a fuel demand valve that prevents pressurized fuel from entering the engine and causing a fuel system overflow or possible fuel spillage.
- When installing the fuel tank cap, turn the cap to the right until you hear a click. This signals that the fuel cap is fully seated. A built-in device prevents overtightening.
- The fuel tank has a manual vent screw which should be closed for transportation and open for operation and cap removal.

Since sealed fuel tanks are not vented, they will expand and contract as the fuel expands and contracts during heating and cooling cycles of the outside air. This is normal.

Removing the Fuel Cap



46290

a - Fuel cap
b - Manual vent screw
c - Tab lock

IMPORTANT: Contents may be under pressure. Rotate the fuel cap 1/4 turn to relieve pressure before opening.

1. Open the manual vent screw on top of the fuel cap.
2. Turn the fuel cap until it contacts the tab lock.
3. Press down on the tab lock. Rotate the fuel cap 1/4 turn to relieve the pressure.
4. Press down on the tab lock again and remove the cap.

Directions for Using the Pressurized Portable Fuel Tank

1. When installing the fuel tank cap, turn the cap to the right until you hear a click. This signals that the fuel cap is fully seated. A built-in device prevents overtightening.
2. Open the manual vent screw on top of the cap for operation and cap removal. Close the manual vent screw for transportation.
3. For fuel hoses that have quick disconnects, disconnect the fuel line from the engine or fuel tank when not in use.
4. Follow **Filling Fuel Tank** instructions for fueling.

Fuel Tanks

Portable Fuel Tank

Select a suitable location in the boat within the engine fuel line length limitations and secure the tank in place.

Permanent Fuel Tank

Permanent fuel tanks should be installed in accordance with industry and federal safety standards, which include recommendations applicable to grounding, anti-siphon protection, ventilation, etc.

Filling the Fuel System

NOTE: For initial start of a new engine, or for an engine that ran out of fuel or was drained of fuel, the fuel system should be filled as follows:
Turn the ignition key switch to the "ON" position for approximately one minute. This operates the fuel lift pump. Turn the ignition key switch back to the "OFF" position and then return the ignition key switch to the "ON" position again for an additional minute. Turn the ignition key switch back to the "OFF" position. The filling of the fuel system is complete.

Boat Horsepower Capacity

⚠ WARNING

Exceeding the boat's maximum horsepower rating can cause serious injury or death. Overpowering the boat can affect boat control and flotation characteristics or break the transom. Do not install an engine that exceeds the boat's maximum power rating.

Do not overpower or overload your boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.

U.S. COAST GUARD CAPACITY	
MAXIMUM HORSEPOWER	XXX
MAXIMUM PERSON CAPACITY (POUNDS)	XXX
MAXIMUM WEIGHT CAPACITY	XXX

26777

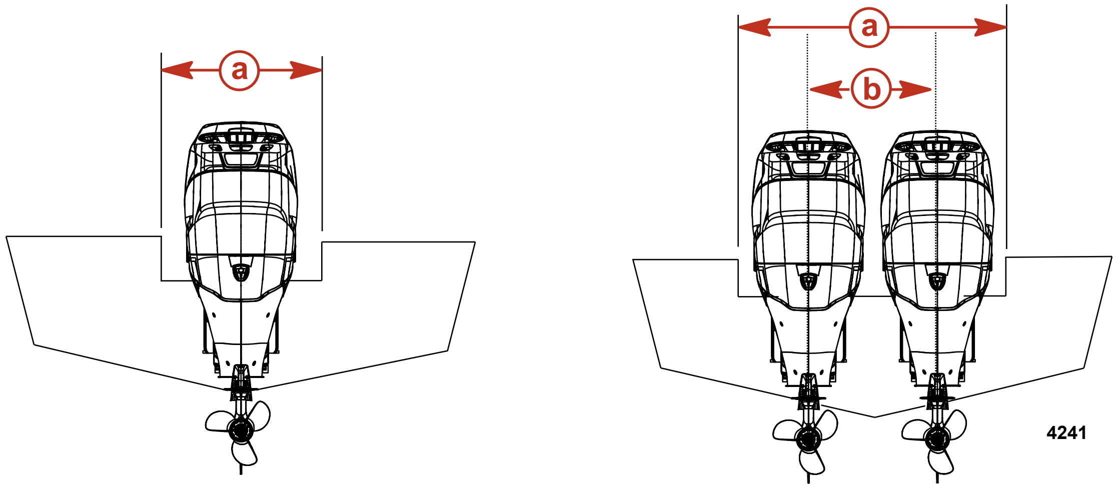
Selecting Accessories for Your Outboard

Genuine Mercury Precision or Quicksilver Accessories have been specifically designed and tested for this outboard.

Some accessories not manufactured or sold by Mercury Marine are not designed to be safely used with this outboard or outboard operating system. Acquire and read the installation, operation, and maintenance manuals for all selected accessories.

Installing Outboard on the Transom

Installation Specifications

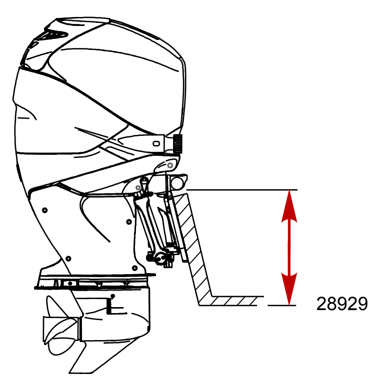


a - Minimum transom opening
b - Engine centerline for dual engine - 66.0 cm (26 in.)

Minimum Transom Opening	
Single engine	99.0 cm (39 in.)
Dual engine	165.0 cm (65 in.)

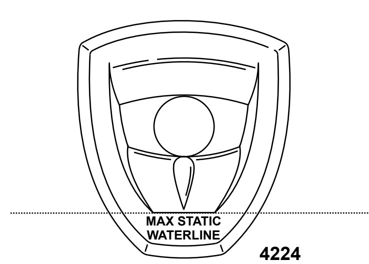
Maximum Outboard Mounting Height

The mounting height of the outboard must not exceed 63.5 cm (25 in.) for L models, 76.2 cm (30 in.) for XL models, and 88.9 cm (35 in.) for XXL models. Mounting the outboard higher may cause damage to the gearcase components.



Maximum Static Waterline

The static waterline, with boat at rest, must be below the "MAX STATIC WATERLINE" mark on the idle relief grommet (located at the rear of the outboard) when the outboard is fully tilted in/down. If waterline is above "MAX STATIC WATERLINE" mark, adjust boat load forward or increase (raise) outboard mounting height to correctly place mark above waterline.

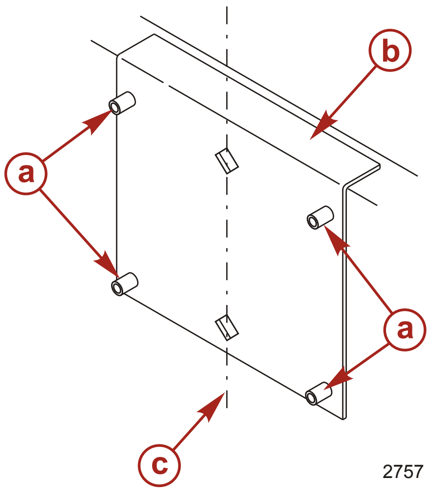


Drilling Outboard Mounting Holes

IMPORTANT: Before drilling any mounting holes, carefully read Determining Recommended Outboard Mounting Height. There is a19 mm (0.75 in.) difference between the outboard mounting holes in the transom brackets.

⚠ WARNING
Improper installation of an outboard can result in serious injury or death. Do not allow the upper outboard mounting bolts to be closer than 25 mm (1 in.) from the top of the boat transom, not including any shims used to increase transom mouting height. Never install the upper mounting bolts through these shims.

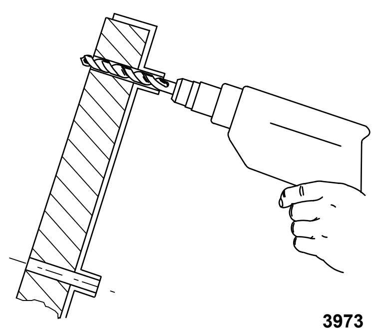
1. Mark four mounting holes on the transom using the transom drilling fixture.



a - Drill guide holes
b - Transom drilling fixture - not included
c - Transom centerline

Transom Drilling Fixture	91- 98234A 2

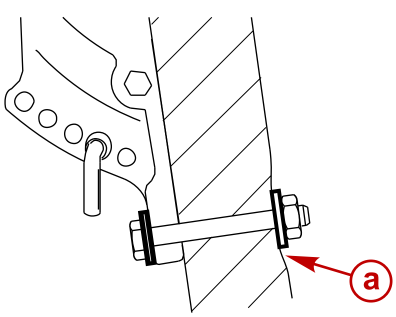
2. Place masking tape directly onto the boat where the mounting holes will be drilled to help keep the fiberglass from chipping.

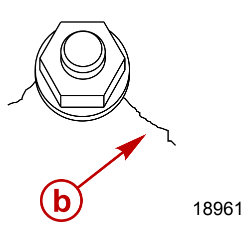


3. Using the drill guide holes on the transom drilling fixture, drill four 13 mm (17/32 in.) holes perpendicular to and through the transom.

Checking Boat Transom Construction

IMPORTANT: Determine the strength of the boat transom. The outboard mounting locknuts and bolts should be able to hold 75 Nm (55 lb-ft) of torque without the boat transom yielding or cracking. If the boat transom yields or cracks under this torque, the construction of the transom may not be adequate. The boat transom must be strengthened or the load carrying area increased.

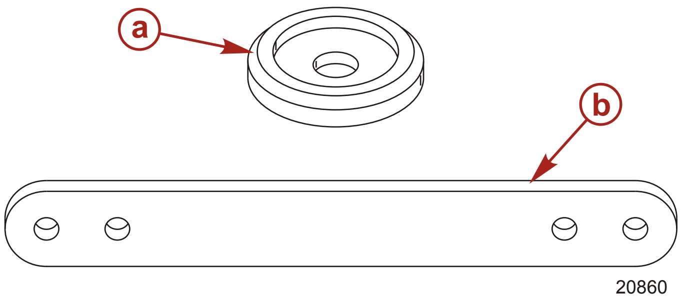




a - Transom yielding under bolt torque
b - Transom cracking under bolt torque

When first determining transom strength, use a dial torque wrench. If the bolt or nut continues to turn without the torque reading on the dial increasing, it is an indication that the transom is yielding. The load area can be increased by using a larger transom washer or a transom reinforcement plate.

NOTE: The inside holes on the transom reinforcement plate are for the lower transom bolts and the outside holes are for the upper transom bolts.



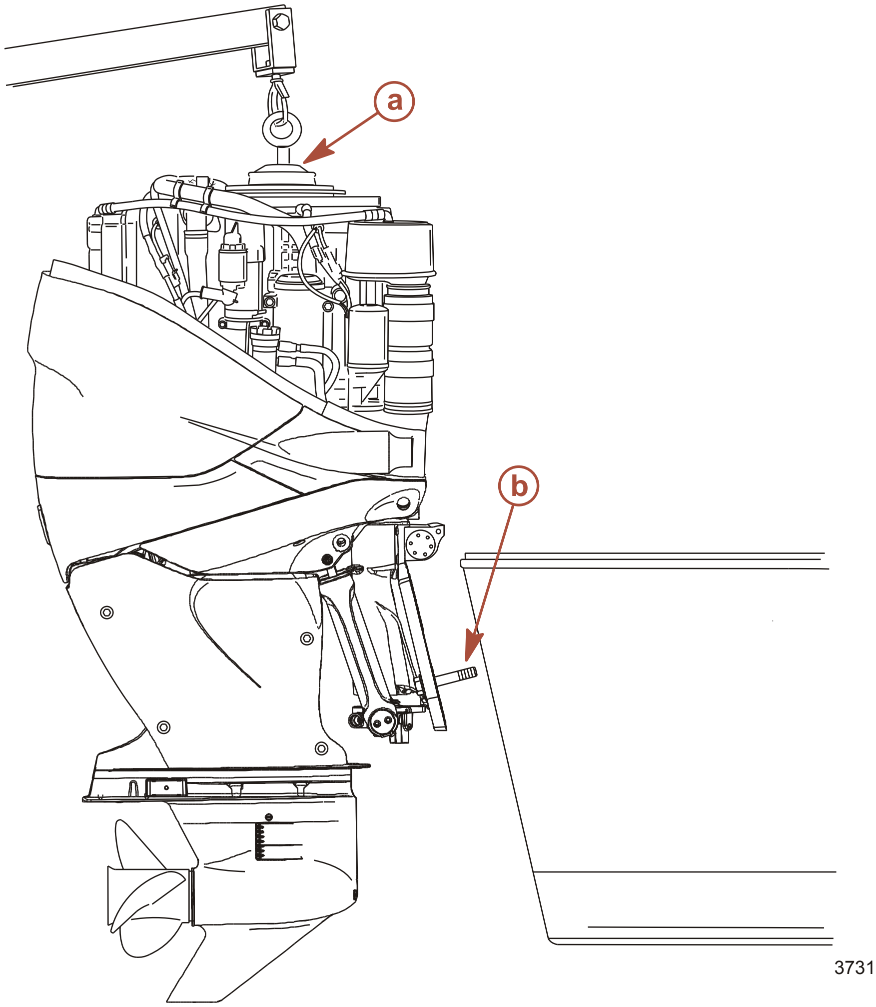
a - Large transom washer
b - Transom reinforcement plate

Description	Part Number
Large transom washer	67-896392
Transom reinforcement plate	67-896305001

Lifting Outboard

1. Remove top cowl and engine flywheel cover.
2. Install lifting ring/flywheel puller to flywheel. Tighten bolts securely.
3. Lift engine using engine lift with a minimum capacity of 450 kg (1000 lb.).
4. Avoid interference by placing the lower mounting bolts into the lower mounting slots before placing outboard against the transom.

5. Refer to **Determining Recommended Outboard Mounting Height**, and install outboard to the nearest recommended mounting height.

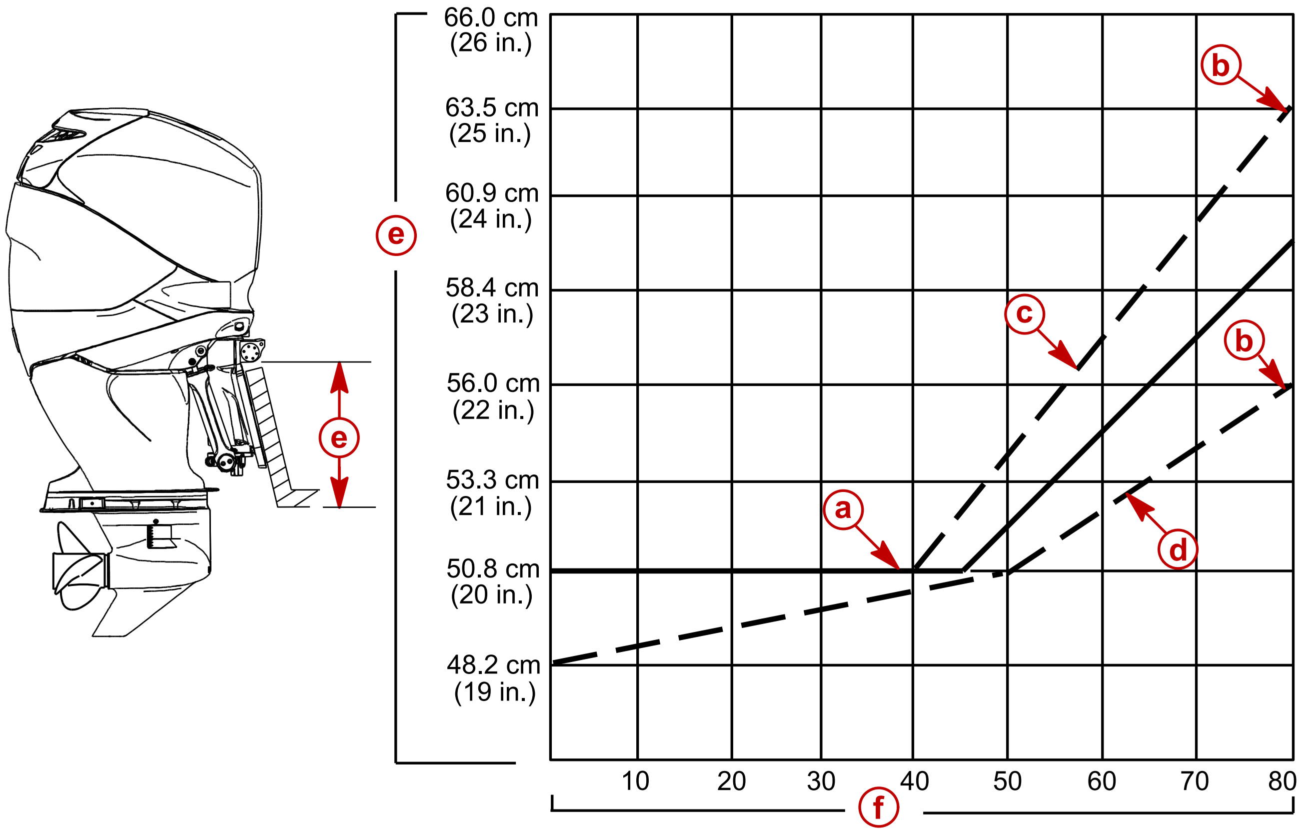


a - Lifting eye
b - Mounting bolts

Flywheel Puller/Lifting Ring	91-895343T02

6. Fasten outboard with mounting hardware provided. Refer to **Fastening Outboard**.

Determining Recommended Outboard Mounting Height



Add 12.7 cm (5 in.) for XL models and 25.4 cm (10 in.) for XXL models to listed outboard mounting height.

a - The solid line is recommended to determine the outboard mounting height

b - The broken lines represent the extremes of known successful outboard mounting height dimensions

c - The line may be preferred to determine outboard mounting height dimension, if maximum speed is the only objective

d - The line may be preferred to determine outboard mounting height dimension for dual outboard installation

e - Outboard mounting height (height from a point on the pedestal 48 mm [1-7/8 in.] above center of top mounting hole to the bottom of the boat transom). For heights over 56.0 cm (22 in.), a propeller designed for surfacing operation is usually preferred.

f - Maximum boat speed (mph) anticipated

NOTICE
• The static waterline, with boat at rest, must be below the "MAX STATIC WATERLINE" mark on the idle relief grommet (located at the rear of the outboard), when the outboard is fully tilted in/down. If waterline is above "MAX STATIC WATERLINE" mark, adjust boat load forward or increase (raise) outboard mounting height to correctly place mark above waterline.
• The mounting height of the outboard must not exceed 63.5 cm (25 in.)for L models, 76.2 cm (30 in.)for XL models, and 88.9 cm (35 in.) for XXL models. Mounting the outboard higher may cause damage to the gearcase components.

Increasing the mounting height will usually:

- Increase top speed
- Increase boat stability
- Cause propeller to break loose during planing or turning

Mercury Marine Validated Engine Mounting Hardware

IMPORTANT: Mercury Marine provides validated fasteners and installation instructions, including torque specifications, with all of our outboards so they can be properly secured to boat transoms. Improper installation of the outboard can cause performance and reliability issues that can lead to safety concerns. Follow all of the instructions relating to the outboard installation. DO NOT mount any other accessory onto the boat with the fasteners provided with the outboard. For example, do not mount a tow sport bars or boarding ladders onto the boat using the mounting hardware included with the outboard. Installing other products onto the boat that utilize the outboard mounting hardware will compromise the ability of that hardware to properly and safely secure the outboard to the transom.

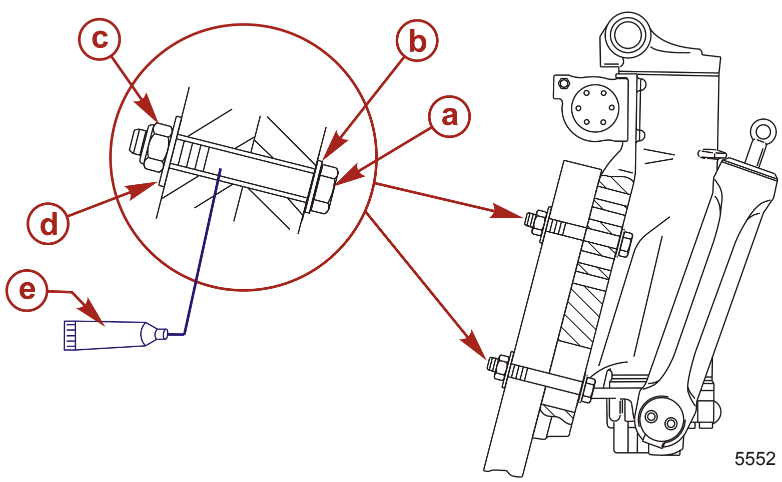
Outboards that require validated mounting hardware will have the following decal on the transom clamp.

51965

Fastening Outboard

1. Place lower mounting bolts into mounting slots before placing outboard on transom.
2. Refer to **Determining Recommended Outboard Mounting Height**, and install outboard to the nearest recommended mounting height.
3. Fasten the outboard with the stainless steel transom bolts, nylon insert locknuts, and flat washers as shown. Tighten the locknuts or transom bolts to the specified torque.

   NOTE: For more accurate torque, whenever possible, tighten the mounting locknuts rather than the mounting bolts.



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a - Transom bolts (1/2 x 20) (4)
b - Flat washers - outer (4)
c - Nylon insert locknuts (4)
d - Flat washers - inner (4)
e - Marine sealer - apply to shank of bolts, not threads

Description	Nm	lb. in.	lb. ft.
Outboard mounting bolts and locknuts	75		55

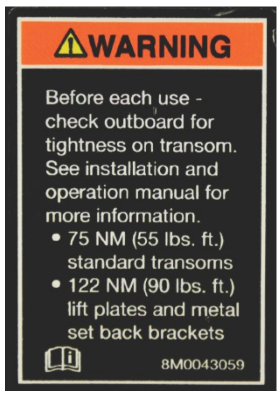
Outboard Transom Mounting Hardware - Supplied with Outboard		
Part Number	Part Name	Description
10-67755003	Transom bolt	1/2 x 20 x 5.50 in. long (3.25 in. thread)
11-826711-17	Nylon insert locknut	1/2 x 20
12-28421	Washer - inner	0.516 in. ID x 1.50 in. OD

Outboard Transom Mounting Hardware - Supplied with Outboard		
Part Number	Part Name	Description
12-895062	Washer - outer	0.551 in. ID x 1.06 in. OD

Available Transom Mounting Bolts		
Part Number	Part Name	Description
10-67755005	Transom bolt	1/2-20 x 2.50 in. long (1.25 in. thread)
10-67755006	Transom bolt	1/2-20 x 3.50 in. long (1.25 in. thread)
10-814259	Transom bolt	1/2-20 x 4.00 in. long (2.25 in. thread)
10-67755-1	Transom bolt	1/2-20 x 4.50 in. long (2.25 in. thread)
10-67755-003	Transom bolt	1/2-20 x 5.50 in. long (3.25 in. thread)
10-67755-2	Transom bolt	1/2-20 x 6.50 in. long (2.75 in. thread)

Check the Fasteners

A decal on the transom bracket reminds the owner to check the fasteners securing the outboard to the transom before each use.



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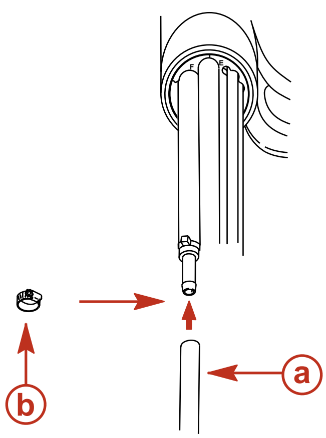
Decal on the transom bracket

Fuel Hose Connection

Fuel Hose Size

IMPORTANT: Fuel line inside diameter (I.D.) must be 10 mm (3/8 in.) with separate fuel line/fuel tank pickup for each engine.

Fasten remote fuel hose to fitting with hose clamp.



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a - Remote fuel hose
b - Hose clamp

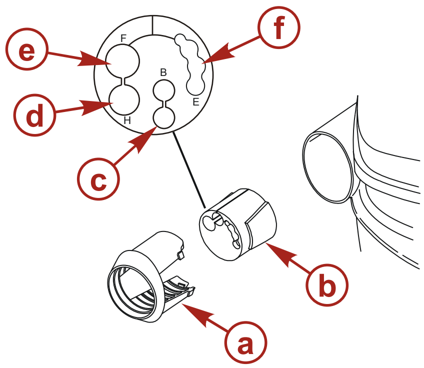
Wiring and Installation

Routing Connections Through the Cowl

IMPORTANT: Ensure that sufficient excess exists in the wiring harness and battery cables routed between the cowl fitting and the engine attachment point to relieve stress and prevent hoses from being kinked or pinched. Ensure that excess exists in all hoses and cables in full left and right turns and full tilt position.

NOTE: Mercury Marine suggests routing the wiring, cables, and fuel hose through a rigging hose or flexible sleeve from the engine to the boat's gunnel or motor well. Follow the installation instructions included with the rigging hose or flexible sleeve kit.

1. Pull out the grommet fitting and rubber grommet from the front cowl opening. Route the wiring harnesses, battery cables, and fuel hose through the correct openings in the rubber grommet as shown.



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- a - Grommet fitting
- b - Rubber grommet
- c - Battery cables
- d - Data harness
- e - Fuel hose
- f - DTS power harness, vessel sensor harness, power steering pump harness

2. Insert rubber grommet into grommet fitting and secure grommet fitting in front cowl opening.

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Installation Guidelines for DTS System Components

⚠ WARNING

Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control. To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system.

Data Harness

⚠ WARNING

Prevent serious injury or death from a loss of boat control. Pulling on or flexing connectors can loosen terminals and cause open or intermittent electrical connections, which will interrupt control of throttle and shifting. Do not pull on cable connectors when pulling cables through the boat. Do not allow cables to flex at connection points. Fasten all electrical harnesses within 25 cm (10 in.) of any connection.

Connectors

IMPORTANT: Connectors should never have to be forced into the receptacle. Ensure that connectors are free of any lubricant or dielectric grease before installation. When the connector is properly aligned, it will only take a small amount of pressure to insert it into the receptacle. Rotate the locking collar to secure the electrical connection.

NOTE: Connect only one data harness of the required length between the engine and helm. If a data harness is too short, do not connect multiple harnesses together to make up the required length. For installations requiring a data harness length longer than 12.2 m (40 ft), contact Mercury Marine for more information.

DTS Wiring Guidelines

⚠ WARNING
Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control. To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system.

- Never attempt to connect, network, tie into, switch, and/or sink source voltage or current from the DTS wiring harnesses.
- Never attempt to connect any type of communication or navigation equipment into the DTS wiring harnessing other than at the designated connection point.
- Boat accessory equipment being installed must be connected to an appropriate power source such as a fuse panel or junction box.
- Never attempt to tap directly into any of the DTS electrical wiring harnesses for a source of power.

Wiring Guidelines for Electrical Boat Accessories

⚠ WARNING
Excessive voltage drop may compromise the DTS system, leading to serious injury or death from loss of throttle and shift control. Do not wire any electrical accessory into the 12-volt ignition key switch circuits of the DTS system.

IMPORTANT: Do not connect boat accessories to 12-volt or ignition key switch DTS circuits. Use a separate switched 12-volt source for wiring boat accessories.

The DTS system requires a consistent 12-volt power source. Splicing or connecting accessories to the 12-volt or ignition key switch DTS circuits (purple, purple/white, or red wires) could blow a fuse or overload circuits, causing intermittent or complete loss of operation.

Harness Installation Guidelines

- Locate a routing path for the harness connections so they reach their installation points.
- Inspect the routing path to ensure surfaces are free of any sharp edges or burrs that could cut the harness.
- Fasten and support the harness with clamps or cable ties along the routing path. A clamp or cable tie must be used within 25.4 cm (10 in.) of any connection in a DTS system.
- Ensure that all connections are tight and seal all unused connectors with weather caps.

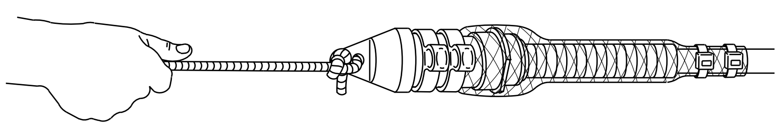
Data Harness Pulling Procedure

IMPORTANT: Do not route data harness near engine ignition components (coils, spark plug leads, and spark plugs), high power VHF coax, or radios. An electrical field generated from these components could cause interference with data transmission.

IMPORTANT: Do not route data harness near sharp edges, hot surfaces, or moving parts. Fasten cables away from any sharp edges, fasteners, or objects that could wear into the harness.

IMPORTANT: Avoid sharp bends in the data harness. Minimum bend radius should be 7.6 cm (3 in.) for the final wiring installation.

1. Inspect the routing path to ensure surfaces are free of any sharp edges or burrs that could cut the harness.
2. Install cable pulling tool to data harness.
3. Secure pulling tool with two cable ties.
   IMPORTANT: The cable ties must be tight to prevent any slipping during installation.



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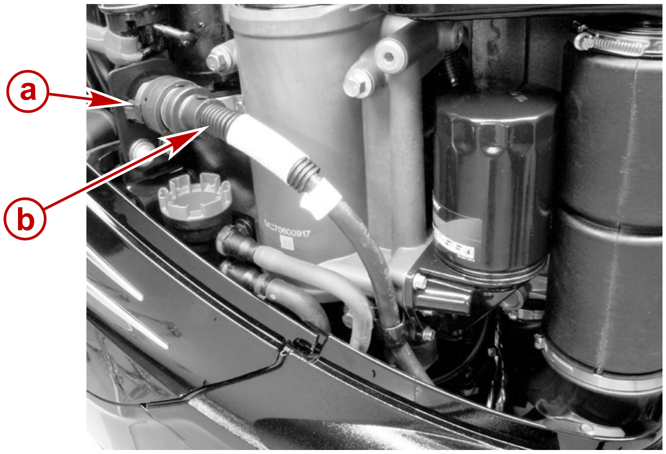
Data Cable Puller	888462A 1

IMPORTANT: Carefully inspect data harness pins to ensure that all pins are securely fastened to data harness connector end following installation.

NOTE: Data harness should be secured with mounting clips or cable ties along the routing path.

Data Harness Connection to the Engine

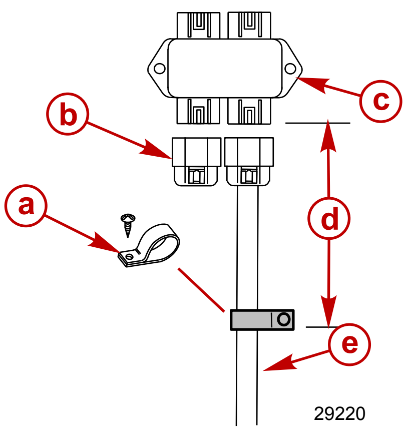
Route the data harness through the front cowl opening. Connect the data harness to the 14 pin connector.



a - 14 pin connector
b - Data harness

Junction Box (If Equipped)

- Although the junction box connections are watertight, it is recommended the junction box be mounted in an area that stays relatively dry.
- Mount in an area where the wiring connection will not get stepped on or disturbed.
- Mount in an area that is accessible for troubleshooting and servicing the system.
- Ensure the DTS command module harness will reach all the connection points.
- Fasten all junction box connections within 25.4 cm (10 in.) of the junction box.
- Seal all unused connections with weather caps.



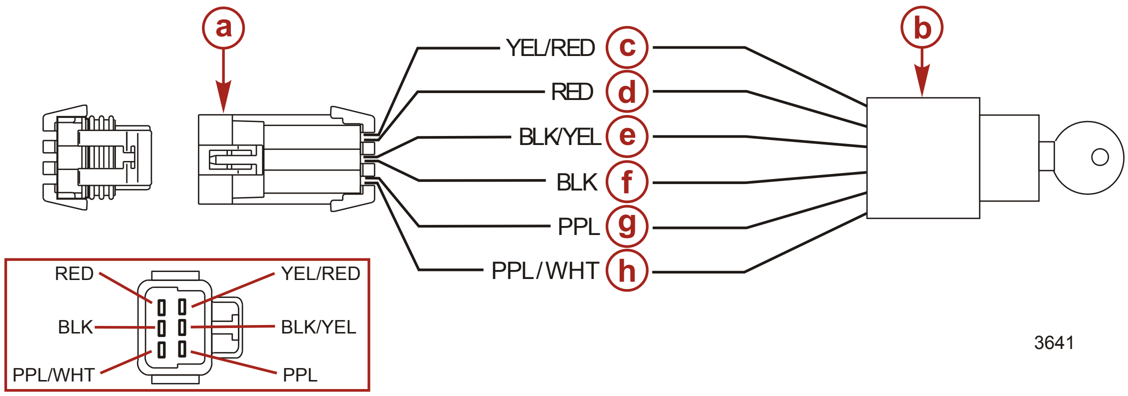
a - Clamp
b - Weather cap (859318T 2)
c - Junction box
d - 25.4 cm (10 in.)
e - DTS command module harness

Wiring Instructions for Non-Mercury Marine Ignition Key Switch

⚠ CAUTION
Ignition switches not sold by Mercury Marine can exceed acceptable current flow and voltage drop specifications, causing the engine to start unexpectedly. Only install switches sold through Mercury Marine.

IMPORTANT: We recommend only the use of Mercury Marine brand SmartCraft and DTS accessories. Mercury Marine designs and manufactures these accessories specifically for use on our SmartCraft or DTS systems, with each of these accessories passing through an extensive product qualification process. It is impossible to test our systems with all accessories manufactured and sold by other entities. If a boatbuilder or dealer chooses to disregard this recommendation, any non-Mercury Marine components connected to a SmartCraft or DTS system must adhere to all specifications provided. Documentation exhibiting compliance with these specifications must be submitted and approved by Mercury Marine before releasing the finished product for sale. Damage caused by the use of accessories or parts not manufactured or sold by Mercury Marine is not covered under warranty.

- The ignition key switch must comply with Mercury specifications for key switches and controller input switches (897741-S or 897791-S). Switches that do not meet these specifications could leak current.
- Switches must contain an emergency stop circuit.



a - Connector - Packard Metripack 150 Series sealed (6 pin)
b - Ignition key switch
c - Crank
d - +12 volts
e - Lanyard stop
f - Ground
g - Run
h - Accessory

Wiring Accessories

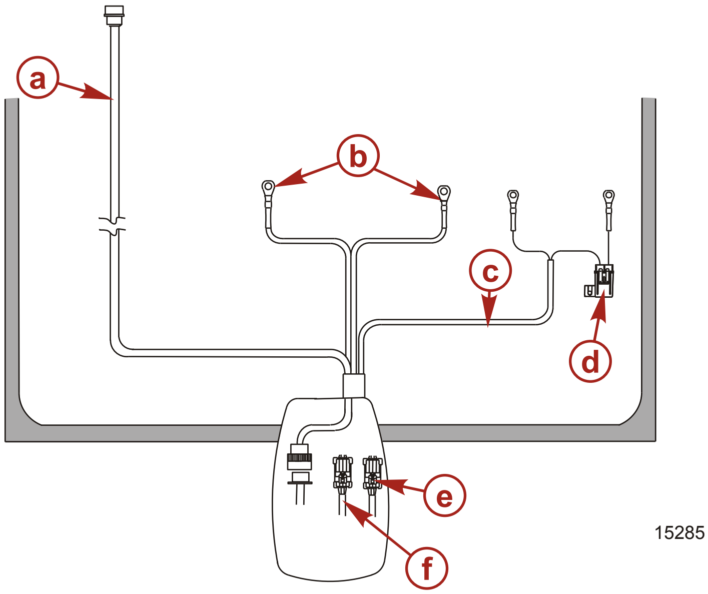
NOTE: Refer to ***Mercury Precision Parts Accessories Guide****.*

System Wiring Reference Points

Features

- **DTS power harness** - Requires connection to the engine starting battery. Provides 12 V power to the DTS system. If starting battery is located at the helm, a DTS accessory power harness kit is required to minimize voltage drop. Use cable ties to secure power harness leads to battery cables, beginning within 15 cm (6 in.) of battery posts and continuing along the entire length of the harness.
- **Battery cables** - Connect to the engine starting battery.
- **Vessel sensor harness plug** - The vessel sensor harness connects between the plug on the engine and the main fuel tank sensor, auxiliary fuel tank, remote oil tank sensor (2 stroke models), and the paddle wheel speed/temperature sensor, if equipped.
- **Power steering pump harness plug** - The power steering pump harness connects between the plug on the engine and the power steering pump, if equipped.

- **14 pin data harness** - Connects between the command module harness at the helm and the engine.

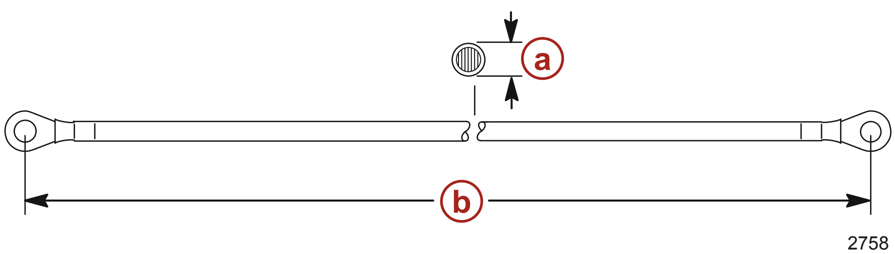


a - 14-pin data harness
b - Battery cables
c - DTS power harness
d - 5-amp fuse
e - Power steering pump harness plug
f - Vessel sensor harness plug

Battery Cable Size for Outboard DTS Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

NOTE: If longer battery cables are required, the wire gauge size must increase. See the following chart for correct wire gauge size.



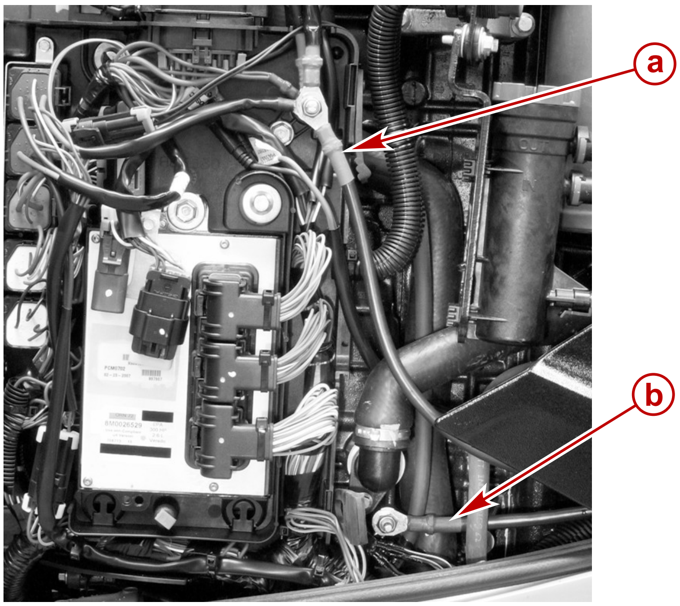
a - Wire gauge size
b - Battery cable length

Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)	Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)
	Verado and OptiMax DTS Engines		Verado and OptiMax DTS Engines
2.4 m (8 ft)	-	**7.6 m (25 ft)**	1
2.7 m (9 ft)	-	**7.9 m (26 ft)**	1/0
3.0 m (10 ft)	-	**8.2 m (27 ft)**	1/0
3.4 m (11 ft)	-	**8.5 m (28 ft)**	1/0
3.7 m (12 ft)	4	**8.8 m (29 ft)**	1/0
4.0 m (13 ft)	2	**9.1 m (30 ft)**	1/0
4.3 m (14 ft)	2	**9.4 m (31 ft)**	1/0
4.6 m (15 ft)	2	**9.8 m (32 ft)**	1/0
4.9 m (16 ft)	2	**10.1 m (33 ft)**	2/0
5.2 m (17 ft)	2	**10.4 m (34 ft)**	2/0
5.5 m (18 ft)	2	**10.7 m (35 ft)**	2/0
5.8 m (19 ft)	2	**11.0 m (36 ft)**	2/0
6.1 m (20 ft)	2	**11.3 m (37 ft)**	2/0
6.4 m (21 ft)	1	**11.6 m (38 ft)**	2/0
6.7 m (22 ft)	1	**11.9 m (39 ft)**	2/0

Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)	Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)
	Verado and OptiMax DTS Engines		Verado and OptiMax DTS Engines
7.0 m (23 ft)	1	**12.2 m (40 ft)**	2/0
7.3 m (24 ft)	1		

Battery Cable Connections to the Engine

1. Remove the cowling and open the cover on the electrical box.
2. Route the battery cables through the front cowl opening.
3. Fasten the negative battery cable to the ground stud on the side of the engine and positive battery cable to the stud in the electrical box. Position the positive battery cable on the stud in the direction as shown. Tighten the hex nuts to the specified torque.
4. Seal the cable connections with Liquid Neoprene.
5. Close the cover and secure it with the two fastening straps.



a - Positive battery cable
b - Negative battery cable

29951

Description	Nm	lb. in.	lb. ft.
Battery cable hex nuts	17	150	

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal battery cable connections	92- 25711 3

Battery Information

WARNING

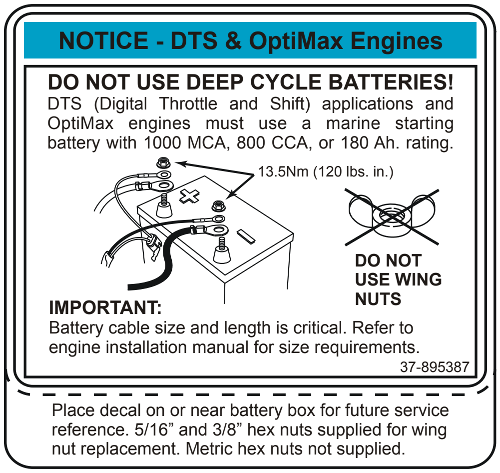
Failure to properly secure the battery leads can result in a loss of power to the Digital Throttle and Shift (DTS) system, leading to serious injury or death due to loss of boat control. Secure the battery leads to the battery posts with hex nuts to avoid loose connections.

- Do not use deep-cycle batteries. Engines must use a marine starting battery with 1000 MCA, 800 CCA, or 180 Ah.
- When connecting the engine battery, hex nuts must be used to secure battery leads to battery posts. Torque nuts to specification.

Description	Nm	lb-in.	lb-ft
Hex nuts	13.5	120	–

IMPORTANT: Battery cable size and length is critical. Refer to engine installation manual for size requirements.

The decal needs to be placed on or near the battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut is supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



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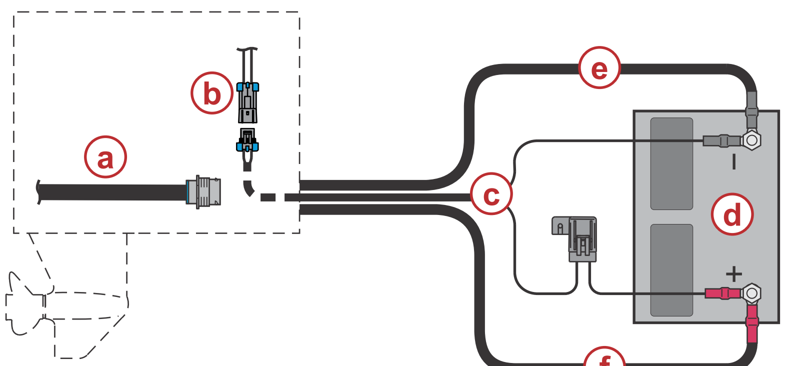
Connecting Battery Cables and DTS Power Harness

> **⚠ CAUTION**
>
> The DTS power harness connection may be pulled off the battery, resulting in a possible loss of electrical power and loss of throttle and shift control. To avoid the possibility of serious injury or death from a loss of boat control, fasten the DTS power harness to one of the battery cables near the battery with cable tie.

NOTE: Do not extend the lead length of the DTS power harness.

1. Install the DTS power harness directly to the starting battery.

   *NOTE: The DTS power harness is provided with the 20 in. L models. For XL and XXL models, refer to the **Mercury Precision Parts Accessories Guide** for the required DTS power harness kit.*

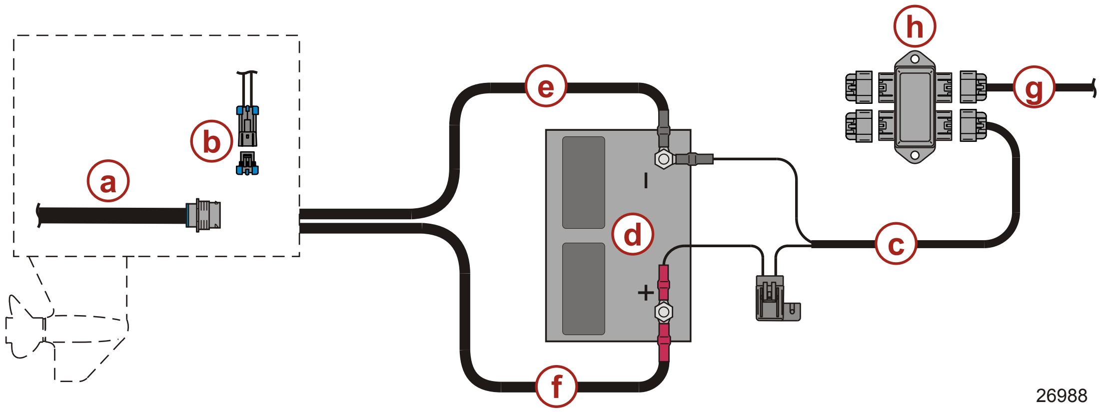


26984

Battery located at the stern

- a - 14 pin DTS data harness
- b - 2 pin DTS power harness connector
- c - DTS power harness
- d - Battery
- e - Negative engine battery cable
- f - Positive engine battery cable

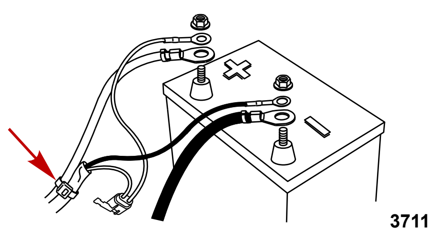
NOTE: For batteries located at the helm, refer to the ***Mercury Precision Parts Accessories Guide*** *for an optional DTS power harness connection kit.*



Battery located at the helm

- a - 14 pin DTS data harness
- b - 2 pin DTS power harness connector - weather cap
- c - Helm DTS power harness (optional)
- d - Battery
- e - Negative engine battery cable
- f - Positive engine battery cable
- g - DTS command module harness
- h - Junction box

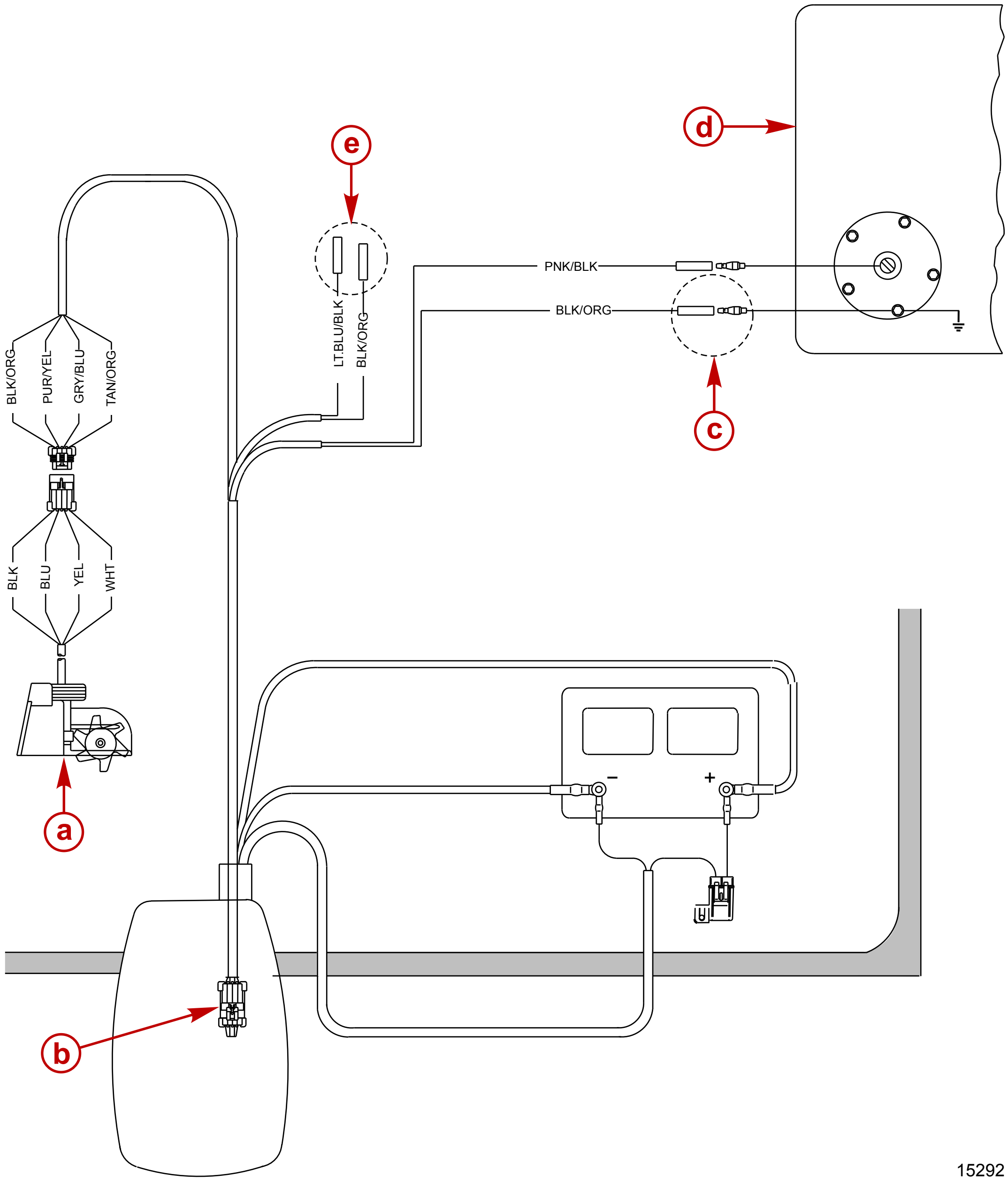
2. Fasten the DTS power harness to one of the battery cables with a cable tie.



Connecting Fuel Tank and Speed Sensor

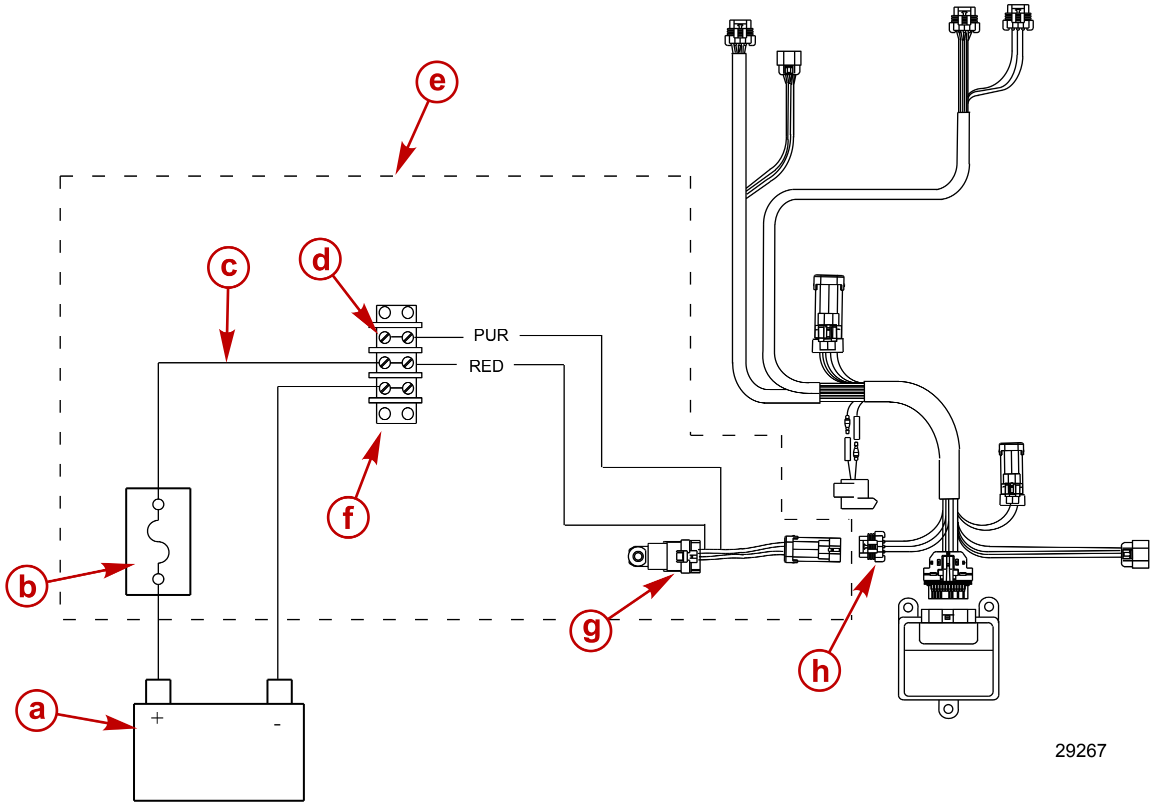
IMPORTANT: Do not connect the BLK/ORG wire (if equipped) to the fuel tank sensor when there is an engine battery ground strap connected to the fuel tank or sender assembly. If not used, plug the unused open bullet connector with a rubber plug. Metal fuel tanks must be grounded to hull or battery ground in accordance to Coast Guard regulations.

If fuel tank is plastic and fuel sensor mounting plate is not connected to battery ground, connect BLK/ORG wire (if equipped) to fuel sender mounting plate.



- a - Paddle wheel kit
- b - Vessel harness
- c - Black/orange wire connection, if equipped
- d - Fuel tank
- e - To second fuel tank

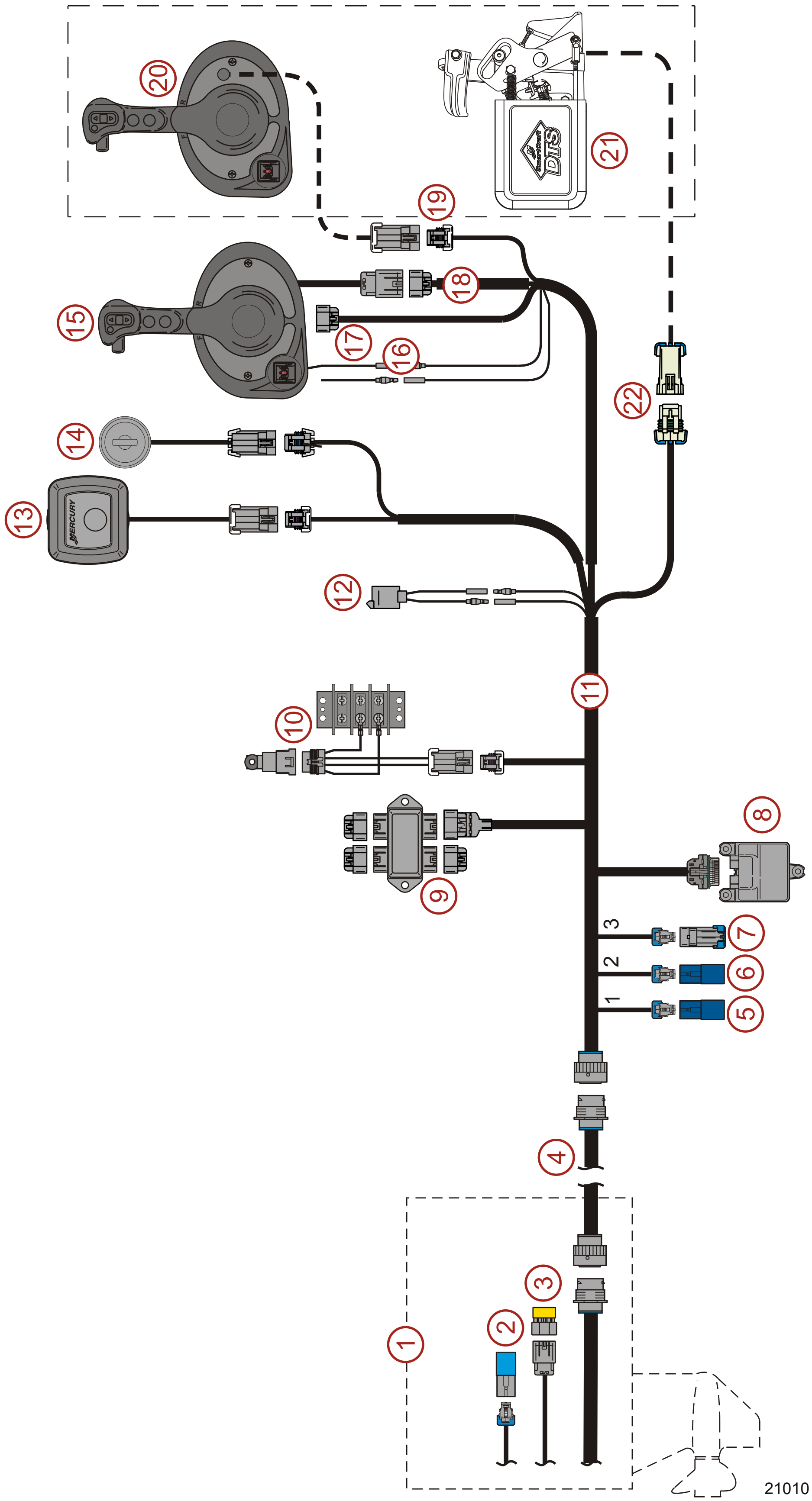
Switched 12 V Accessory Connection



a - Battery
b - Fuse - 40 amp
c - Power harness with 40-amp fuse
d - Switched 12 V
e - Complete kit
f - Terminal block
g - Accessory power relay
h - DTS command module harness

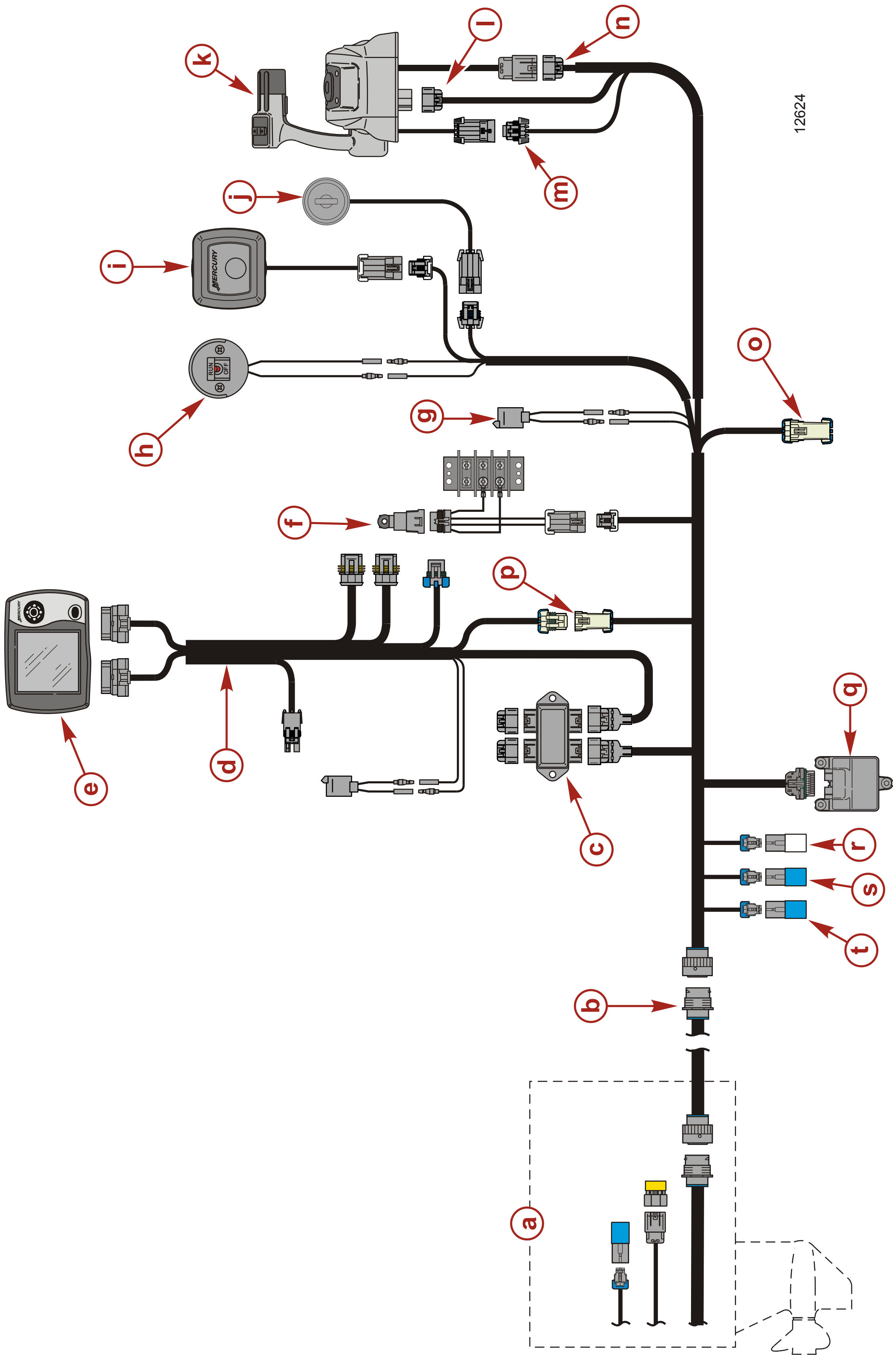
Notes:

DTS Single-Engine Single-Helm with Panel Control



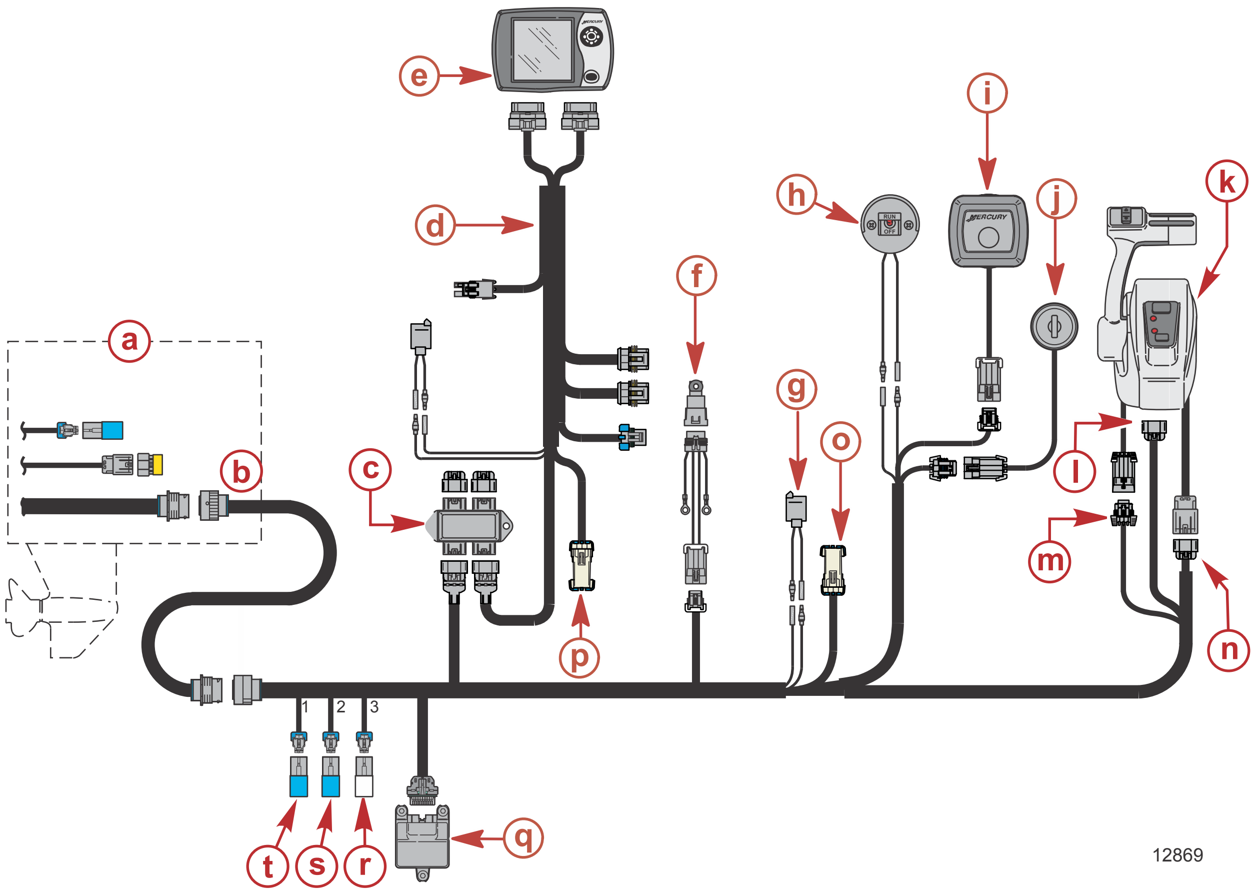
1 - Engine
2 - Engine CAN 2 connector (brown and yellow) - blue terminator resistor
3 - Engine CAN 1 connector (blue and white) - yellow terminator resistor
4 - 14-pin data harness
5 - CAN 1 connector (blue and white) - blue terminator resistor
6 - CAN 2 connector (brown and yellow) - blue terminator resistor
7 - CAN 3 connector (orange and green) - weather cap
8 - Command module
9 - Junction box
10 - Switched power relay
11 - Command module harness
12 - Warning horn
13 - Start/stop switch (optional)
14 - Ignition key switch
15 - Panel mount control
16 - Lanyard stop switch bullet connectors
17 - Lever 1 connector
18 - Handle connector
19 - Foot throttle on/off switch connector
20 - Panel mount control with foot throttle on/off switch (optional)
21 - Foot throttle (optional)
22 - Foot throttle connector

DTS Single-Console Mount Control Wiring - Single Helm



- a - Engine
- b - 14-pin data harness
- c - Junction box
- d - System View harness
- e - System View
- f - Switched power relay
- g - Warning horn
- h - Lanyard stop switch
- i - Start/stop switch (optional)
- j - Ignition key switch
- k - Single console control
- l - Lever 1 connector
- m - Handle connector
- n - Trackpad connector
- o - Foot throttle connector
- p - System View/trackpad connector
- q - Command module
- r - CAN 3 (orange and green) (weather cap)
- s - CAN 2 (brown and yellow) (terminator)
- t - CAN 1 (blue and white) (terminator)

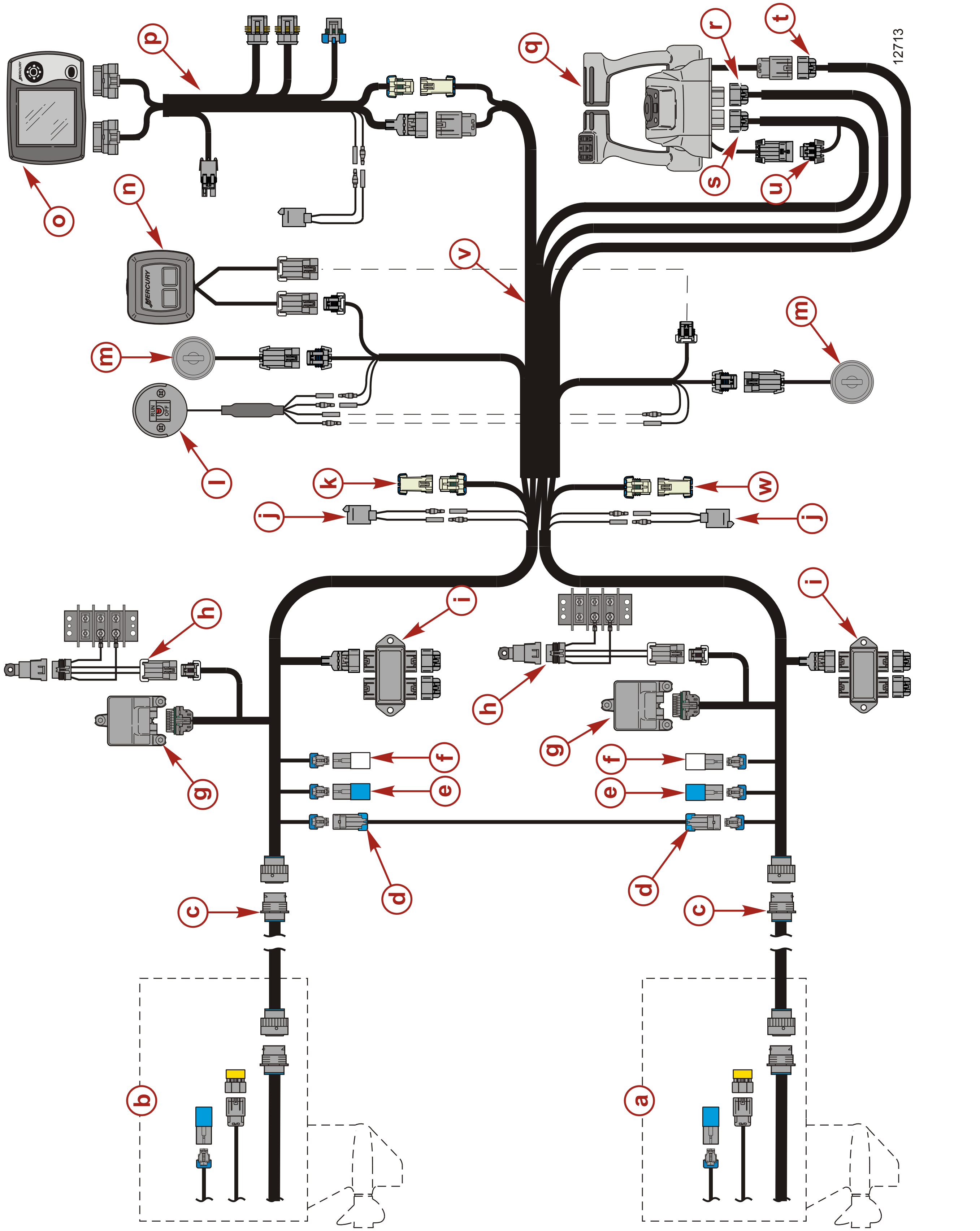
DTS Slim Binnacle Single-Console Mount Control Wiring - Single Helm



- **a -** Engine
- **b -** 14-pin data harness
- **c -** Junction box
- **d -** System View harness
- **e -** System View
- **f -** Switched power relay
- **g -** Warning horn
- **h -** Lanyard stop switch
- **i -** Start/stop switch (optional)
- **j -** Ignition key switch
- **k -** Slim binnacle single console control
- **l -** Lever 1 connector
- **m -** Handle connector
- **n -** Start/stop panel connector
- **o -** Foot throttle connector
- **p -** System View/trackpad connector
- **q -** Command module
- **r -** CAN 3 (orange and green) (weather cap)
- **s -** CAN 2 (brown and yellow) (terminator)
- **t -** CAN 1 (blue and white) (terminator)

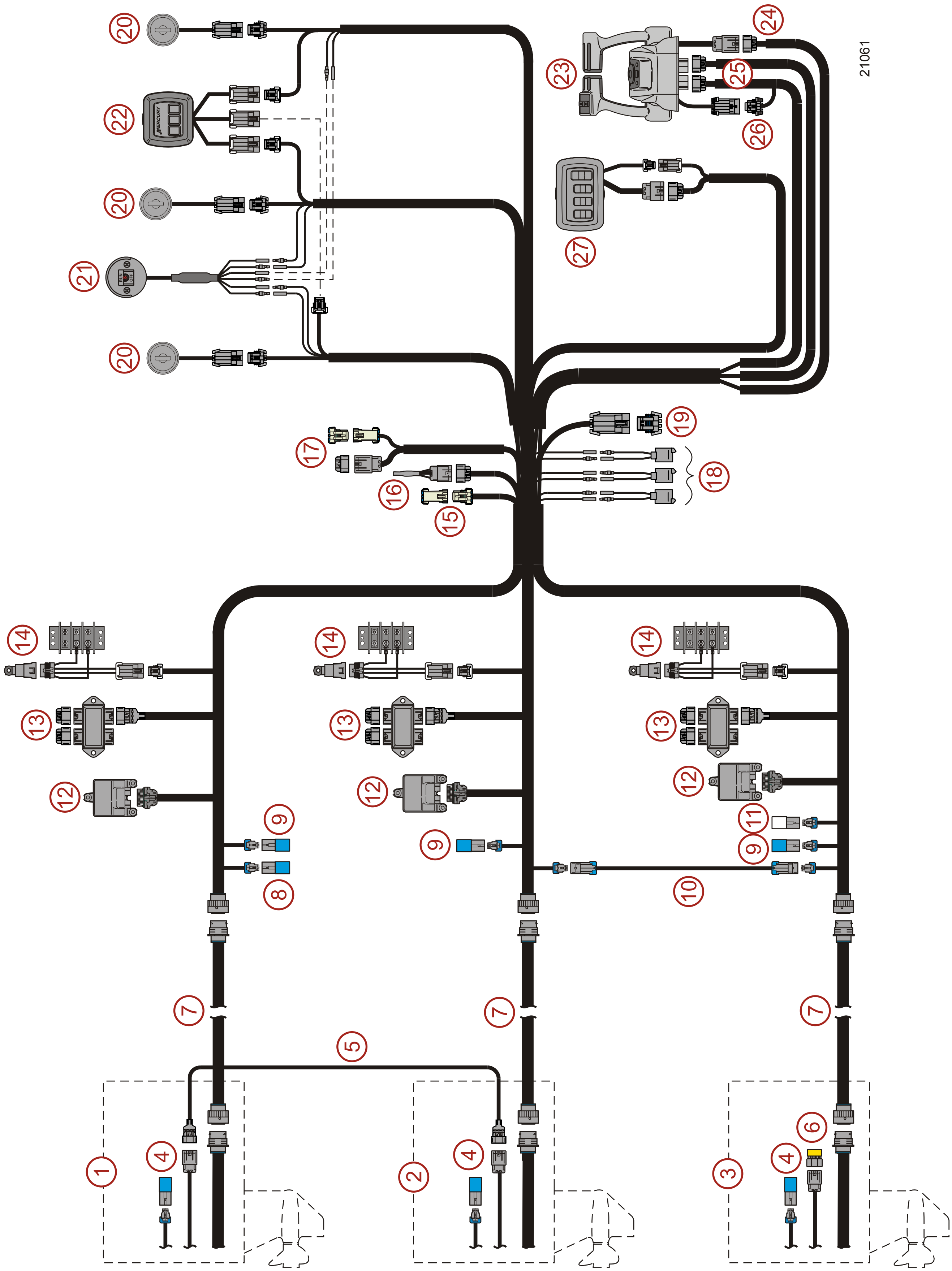
Notes:

DTS Dual-Console Mount Control Wiring - Single Helm



- a - Starboard engine
- b - Port engine
- c - 14-pin data harness
- d - CAN 1 link harness
- e - CAN 2 (brown and yellow) (terminator)
- f - CAN 3 (orange and green) (weather cap)
- g - Command module
- h - Accessory power relay
- i - Junction box
- j - Warning horn
- k - Lever 3 connector
- l - Lanyard stop switch
- m - Ignition key switch
- n - Start/stop switch (optional)
- o - System View
- p - System View harness
- q - Dual console control
- r - Lever 1 connector
- s - Lever 2 connector
- t - Trackpad connector
- u - Trim connector
- v - Command module harness
- w - Lever 4 connector

DTS Triple-Engine, Single-Helm with Shadow Mode Control



1 - Port engine
2 - Starboard inner engine
3 - Starboard outer engine
4 - Engine CAN 2 connector (brown and yellow) - blue terminator resistor
5 - 10-pin CAN link harness
6 - Engine CAN 1 connector (blue and white) - yellow terminator resistor
7 - 14 pin data harness
8 - CAN 1 connector (blue and white) - blue terminator resistor
9 - CAN 2 connector (brown and yellow) - blue terminator resistor
10 - CAN 1 link harness - 2-pin
11 - CAN 3 connector (orange and green) - weather cap
12 - Command module
13 - Junction box
14 - Accessory power relay
15 - For future use
16 - Resistor pack (#93)
17 - Gauge connectors
18 - Warning horns
19 - Quad engine command module harness adapter
20 - Ignition key switch
21 - Lanyard stop switch
22 - Start/stop switch
23 - Shadow mode control
24 - Trackpad connector
25 - Lever 1 and lever 2 connectors
26 - Handle trim connector
27 - Dash mounted trim switch

System Wiring Installation Checklist

Data Cable

- [ ] Verify the data harness is not routed near sharp edges, hot surfaces, or moving parts.
- [ ] Verify data harness is not routed near ignition components (coils, spark plug leads, and spark plugs), high power VHF coax, or radios.

Junction Box (if equipped)

- [ ] Verify the data harness is not routed near sharp edges, hot surfaces, or moving parts.
- [ ] Ensure the harness connections are fastened within 25.4 cm (10 in.) of the junction box.
- [ ] Verify that all unused receptacles are covered with a weather cap.

Non-Mercury Marine Supplied Ignition Key Switch

- [ ] If a non-Mercury Marine ignition key is used, verify that it passes the ingress protection testing per IEC IP66 specification minimum. Ignition switches must pass this specification.

Electronic Remote Control

- [ ] Ensure electronic remote control (ERC) connections are completed following ERC installation instructions prior to engine operation.

DTS Command Module Harness

- [ ] Verify that all connectors are properly inserted and locked in their receptacle (remote control, key switch, command module, lanyard stop switch, and junction box, if equipped).
- [ ] Verify that while moving the remote control handle (full forward and full reverse) the harness has unobstructed movement (moves freely).
- [ ] Verify that the lanyard stop switch is wired into the system correctly.
- [ ] Verify that the harness is fastened along the routing path.
- [ ] Verify that all unused connectors have weather caps to prevent corrosion.

Battery

- ☐ Verify that wing nuts have been replaced with hex nuts, provided.
- ☐ Verify that all engine battery cables are connected to the correct terminals.
- ☐ Verify that the DTS power harness leads are connected to the starting battery and secured with locknuts.
- ☐ Ensure the 5 amp fuse for the DTS power harness is accessible.

Lanyard Stop Switch

- ☐ Verify that the switch is installed.
- ☐ Verify that the switch is connected to the DTS command module harness.

Propeller Installation

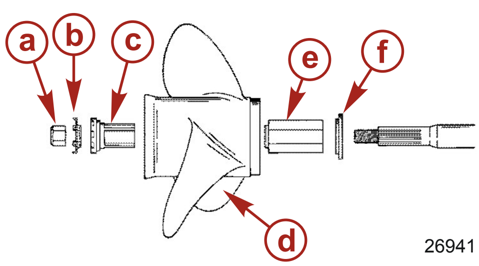
⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Mercury/ Quicksilver products:

Tube Ref No.	Description	Where Used	Part No.
94	Anti-Corrosion Grease	Propeller shaft splines	Obtain Locally
95	2-4-C with PTFE	Propeller shaft splines	92-802859A 1

2. **Flo-torq II drive propellers** - Install forward thrust hub, replaceable drive sleeve, propeller, thrust hub, propeller nut retainer, and propeller nut onto the shaft.



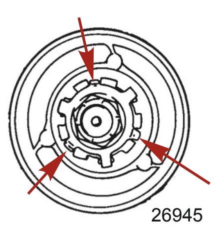
26941

a - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust hub

3. Place a block of wood between gearcase and propeller and torque nut to specification.

Description	Nm	lb-in.	lb-ft
Nut	75		55

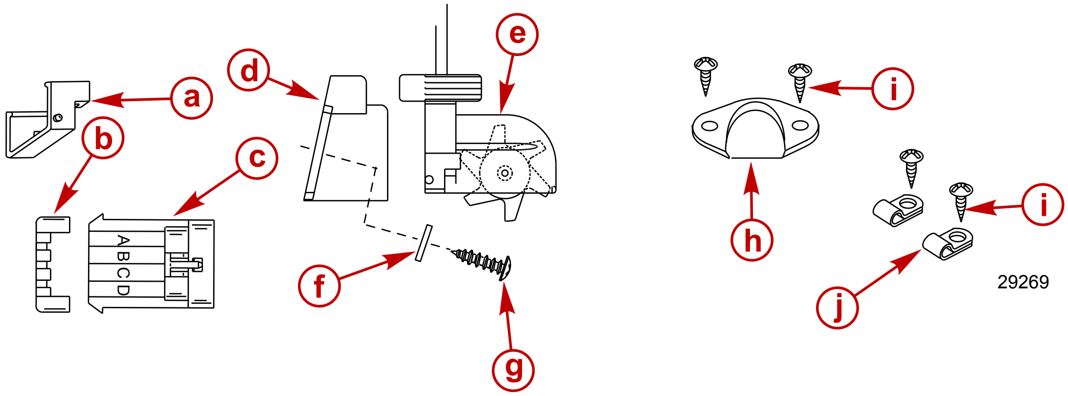
4. Secure propeller nut by bending three of the tabs into the thrust hub grooves.



26945

Paddle Wheel Speed Sensor Installation (if Equipped)

Parts Provided



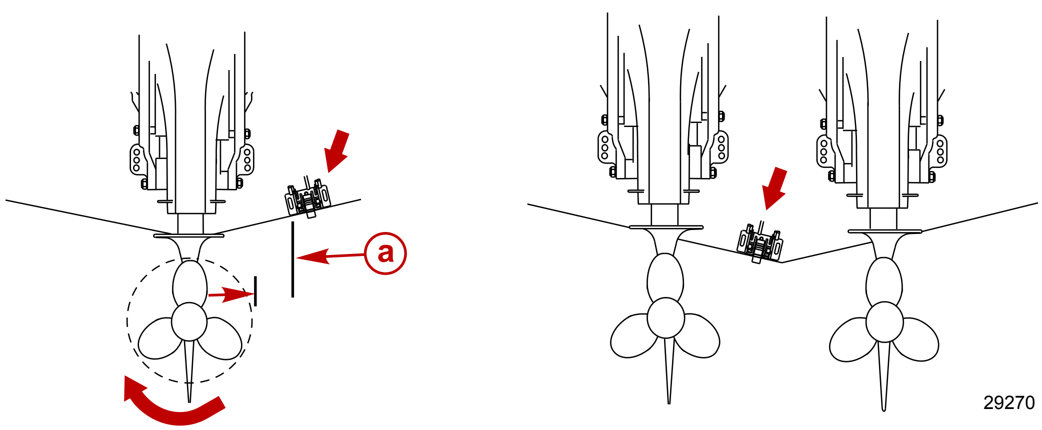
- a - Spare pin yoke
- b - Wire retainer
- c - Connector
- d - Bracket
- e - Paddle wheel
- f - Flat washer (2)
- g - #10 screw - 19 mm (3/4 in.) (4)
- h - Cable cap
- i - #6 screw - 12 mm (1/2 in.) (4)
- j - Clamp (2)

Selecting Location

Single engine installation - Mount paddle wheel on the transom where the propeller blade is rotating downward. Usually the right (starboard) side to minimize cavitation. If feasible, mount at least 50 mm (2 in.) beyond the swing radius of the propeller.

Dual engine installation - Mount the paddle wheel between the engines as close to the centerline (keel) of the boat as possible. On slower, heavier displacement boats, however, positioning it farther from the keel is acceptable.

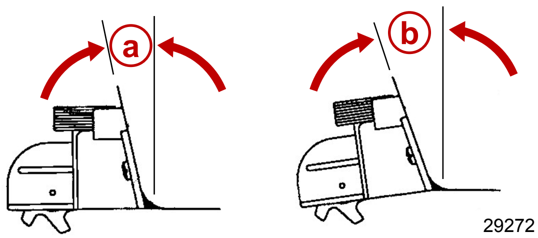
NOTE: Do not mount the paddle wheel directly behind any strakes, ribs, intakes, or outlets for livewells or any protrusion that may cause turbulence or cavitation.



- a - 50 mm (2 in.)

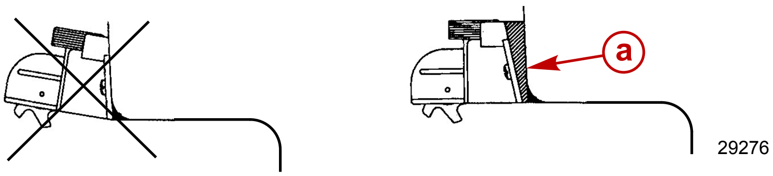
Transom Angle Requirements

Standard 13° to 20° transoms - No special adjustment required.



a - 13° transom angle
b - 20° transom angle

Stepped or undercut transom with 3 angles - A small shim of tapered plastic, metal, or wood must be fabricated and installed, as shown. Mount the paddle wheel on the step for best performance.



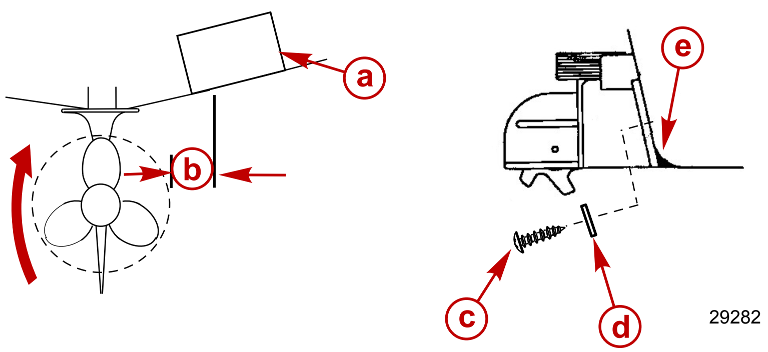
a - Shim

Installing Bracket

1. Cut out the template. At the location selected, tape the template to the transom. Make sure the black dotted line on the template is aligned with the transom bottom edge, as shown.

   NOTE: The mounting template provided is located on the last page of this manual.
2. Using a #28 or 9/64 in. bit, drill two 22 mm (7/8 in.) deep holes where indicated on the template. To prevent drilling too deeply, wrap masking tape around the drill bit 22 mm (7/8 in.) from the point end of drill bit.

   NOTE: In fiberglass hulls, first chamfer the gelcoat using a 6 mm (1/4 in.) drill; drilling about 1.5 mm (1/16 in.) deep to prevent surface cracks.
3. To prevent water seepage into the transom, apply a marine sealer (such as RTV) to the two #10 screws provided. Using the washer provided, attach and tighten the bracket to the hull making sure the bracket is flush with the underside of the hull.
4. Fill any gap between the housing and the transom with a caulking material, as shown. Using a putty knife, smooth the surface to ensure proper water flow.



a - Template
b - 50 mm (2 in.)
c - #10 screw
d - Flat washer (2)
e - Caulking

Routing the Cable

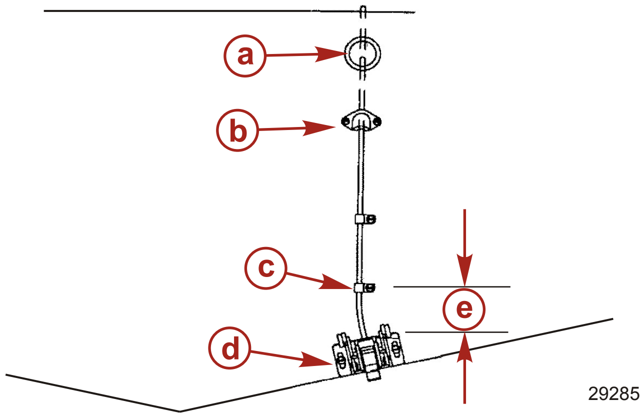
Drilling Hole Through Transom (optional)

1. Select a transom location for the hole above the waterline that does not interfere with other cables and controls.
2. Drill a 15 mm (5/8 in.) diameter hole.
3. Route the cable through the drilled hole. Seal the transom hole with silicone (RTV) or a comparable marine sealer after the cable has been routed through.

   NOTE: The hole for the first clamp should be 25 mm (1 in.) above the paddle wheel. The hole for the second clamp should be positioned halfway between the first clamp and the cap covering the transom hole drilled for the cable.
4. Using a 2.8 mm (7/64 in.) bit, drill holes for the clamps and cap approximately 13 mm (1/2 in.) deep.
5. Apply silicone sealer (RTV) or a comparable marine sealer to the screw threads, install the cable clamps, and feed the cable through the cable cap.

Without Drilling Hole Through Transom (optional)

Route the cable over the transom or through a drain hole that is above the waterline.

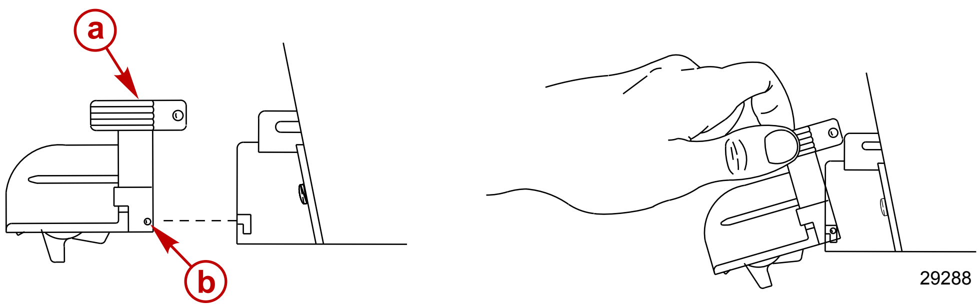


a - Splash well drain hole
b - Cable cap
c - Cable clamp
d - Paddle wheel assembly
e - Distance between first cable clamp and top of paddle wheel - 25.4 mm (1.0 in.)

Installing and Removing the Paddle Wheel

Installation - Slide the pins into the slots in the bracket and snap the tabs into place.

Removal - Squeeze open (unlock) the tabs and pull on the paddle wheel.

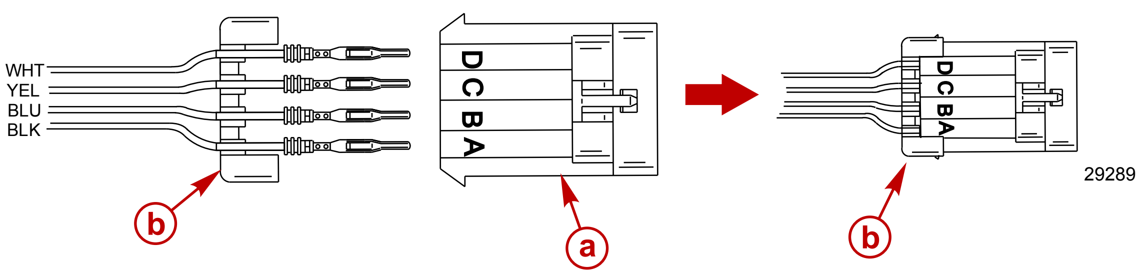


a - Tabs
b - Pins

Wiring Connections

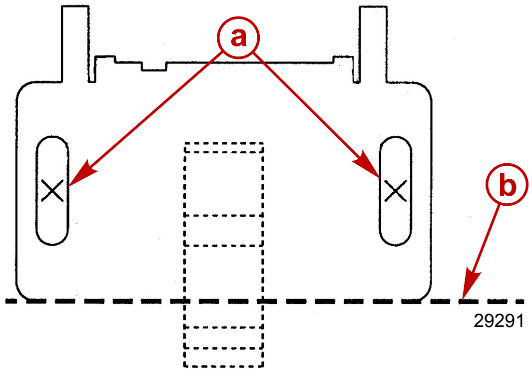
IMPORTANT: Before making wire connections, make sure wires are routed through the transom.

NOTE: Wires can only be pushed into the connector one way. Align the wire terminal with the tabs inside the connector. Have the wiring routed through the transom. Push each wire terminal into its respective location in the connector. Push wire in until they snap into place. Secure wires into connector with the wire retainer.



a - Connector
b - Wire retainer

Template - Paddle Wheel Speed Sensor



a - Drill holes here
b - Align dotted line with the transom bottom edge and fold under

Important Information

Section 1E - Storage

1
E

Table of Contents

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1
119	Storage Seal Rust Inhibitor	Spark plug holes	92-858081K03
120	Corrosion Guard	External metal surfaces	92-802878 55
124	Fuel System Treatment and Stabilizer	Fuel tank	92-8M0047932

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out of season storage or prolonged storage (two months or longer).

> ***NOTICE***
>
> **Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.**

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

IMPORTANT: This outboard is equipped with a closed fuel system when the engine is not running. With this closed system, fuel within the engine's fuel system, other than the fuel tank, will remain stable during normal storage periods without the addition of fuel treatment stabilizers.

Fill the fuel tank and engine fuel system with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with the following instructions.

- Portable fuel tank - Pour the required amount of Fuel System Treatment and Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
- Permanently installed fuel tank - Pour the required amount of Fuel System Treatment and Stabilizer (follow instructions on container) into a separate container and mix with approximately one liter (one quart) of gasoline. Pour this mixture into fuel tank.

Tube Ref No.	Description	Where Used	Part No.
124	Fuel System Treatment and Stabilizer	Fuel tank	92-8M0047932

Protecting External Outboard Components

- Touch up any paint nicks. See your dealer for touch-up paint.
- Spray Quicksilver or Mercury Precision Lubricants Corrosion Guard on external metal surfaces (except corrosion control anodes).

Tube Ref No.	Description	Where Used	Part No.
120	Corrosion Guard	External metal surfaces	92-802878 55

Protecting Internal Engine Components

IMPORTANT: Refer to Section 1B Maintenance - Spark Plug Inspection and Replacement for correct procedure for removing spark plugs.

- Change the engine oil and filter.
- Disconnect the fuel pumps from the engine harness connection.
- Remove pencil coils and spark plugs.
- Spray approximately 30 ml (1 fl oz) of Storage Seal Rust Inhibitor into each spark plug hole.

Tube Ref No.	Description	Where Used	Part No.
119	Storage Seal Rust Inhibitor	Spark plug holes	92-858081K03

- Actuate the key/push button start switch to crank the engine through one start cycle, which will distribute the storage seal throughout the cylinders.
- Connect the fuel pumps to the engine harness connection.
- Install the spark plugs and pencil coils.

Gearcase

- Drain and refill the gearcase lubricant.

Positioning Outboard for Storage

Store outboard in an upright (vertical) position to allow water to drain out of the outboard.

> *NOTICE*
>
> **Storing the outboard in a tilted position can damage the outboard. Water trapped in the cooling passages or rain water collected in the propeller exhaust outlet in the gearcase can freeze. Store the outboard in the full down position.**

Battery Storage

- Follow the battery manufacturer's instructions for storage and charging.
- Remove the battery from the boat and check water level. Charge if necessary.
- Store the battery in a cool, dry place.
- Periodically check the water level and charge the battery during storage.

Winter Storage of Batteries

Battery companies are not responsible for battery damage, either in winter storage or in dealer stock, if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate, and dirt from the top surface by running water over top of the battery. Be sure, however, the vent caps are tight beforehand and blow off all excess water thoroughly with compressed air. Check water level, making sure the plates are covered.
2. When adding distilled water to the battery, be extremely careful not to fill more than 4.8 mm (3/16 in.) above perforated baffles inside the battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling the battery will cause the electrolyte to overflow (if filled beyond 4.8 mm [3/16 in.] above baffles).
3. Grease terminal bolts with 2-4-C with PTFE and store the battery in a cool-dry place. Remove the battery from storage every 30–45 days, check the water level, and put on charge for 5 or 6 amps. Do not fast charge.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1

4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.
5. Repeat preceding charging procedure every 30–45 days, as long as the battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place the battery back in service, remove excess grease from the terminals (a small amount is desirable on terminals at all times), recharge again, as necessary, and reinstall the battery.

Notes:

Electrical System

Section 2A - Ignition

2
A

Table of Contents

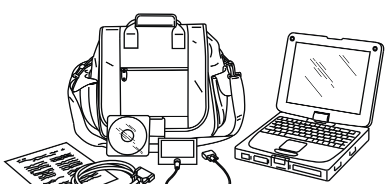
Ignition Specifications

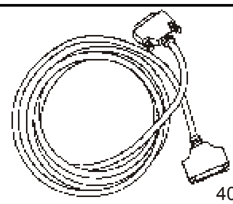
Ignition Specifications	
Full throttle RPM range (all models)	5800–6400
Idle RPM (all models)	550
Ignition type	Digital inductive
Spark plug type	NGK ILFR6G or NGK ILFR6GE
Spark plug gap	0.8 mm (0.031 in.)
Spark plug hex size	16 mm
Spark plug torque	27.5 Nm (19 lb-ft)
Spark plug hole size	14 mm
Firing order	1-3-5-6-4-2
Ignition timing at idle	Not adjustable; PCM controlled (approximately 2° ATDC)
Ignition timing at WOT	Not adjustable; PCM controlled
PCM overspeed limiter	Activates at 6500 RPM

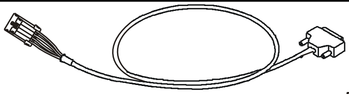
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All ring terminal connections	92- 25711 3
136	Lubriplate SPO 255	Camshaft position sensor O-ring	Obtain Locally

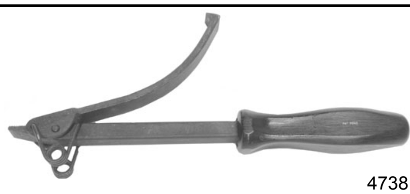
Special Tools

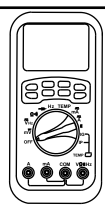
Computer Diagnostic System (CDS)	Purchase from SPX*
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: USA and Canada SPX Corporation 28635 Mound Rd. Warren, MI 48092 800-345-2233 (option 2 then 2 again) oetech@servicesolutions.spx.com or EMEA 0049 6182 959 403 technical-support@spx.com Australia 61 3 9544 6222 techsupport-aus@servicesolutions.spx.com Mexico 52 55 25 95 16 30 (option 9) tecnico@spx.com Brazil 0800-762-1003 (option 9) tecnico@spx.com *CDS G3 must be purchased from Mercury Marine

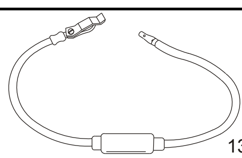
Extension Cable	84-825003A 1
 4012	Data link extension harness (3.05 m [10 ft.]) between the adapter harness and the Digital Diagnostic Terminal or Computer Diagnostic System (CDS).

Adapter Harness	84-822560A13
 5826	Data link harness between engine and computer diagnostic system (CDS).

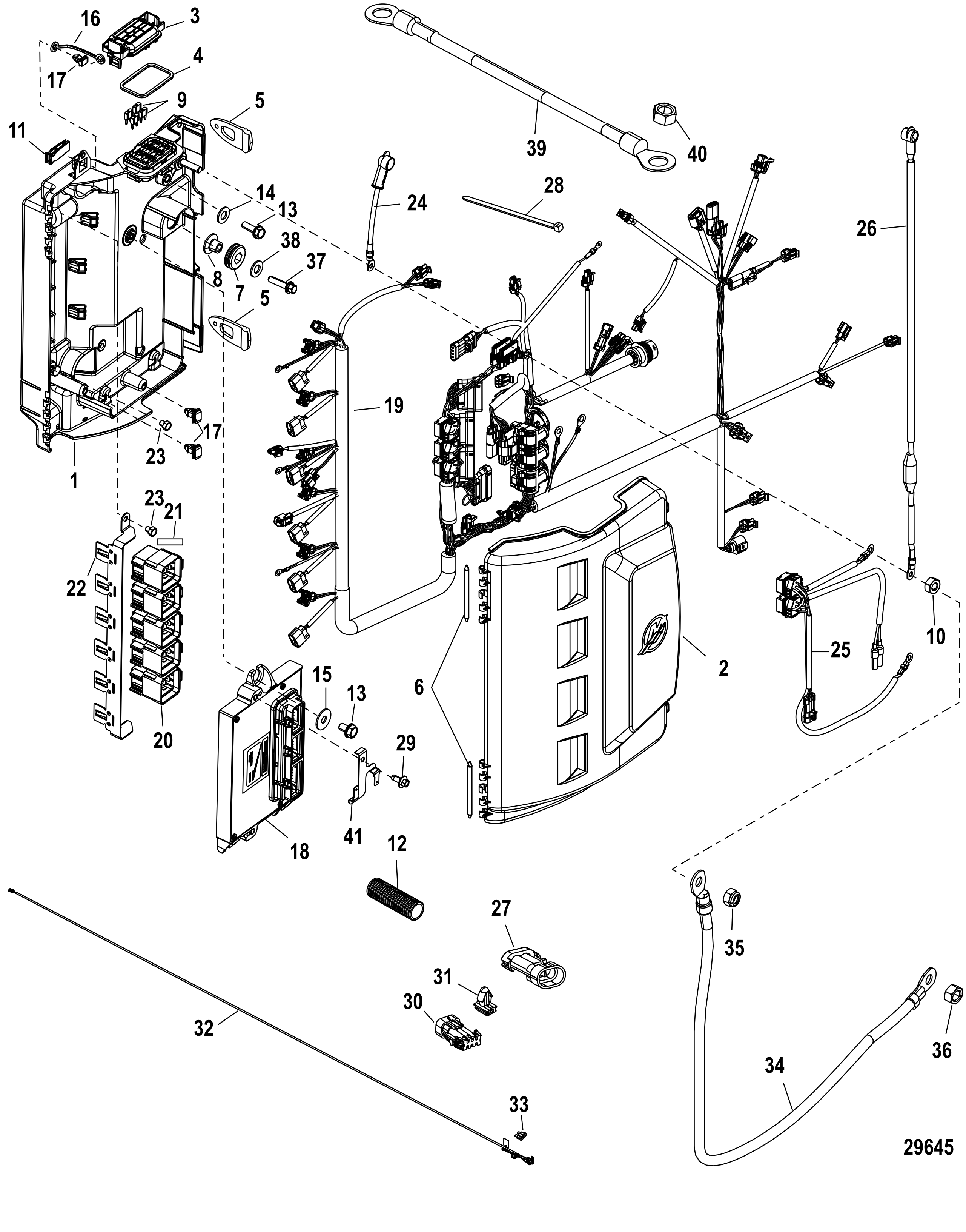
Flywheel Puller/Lifting Ring	91-895343T02
 14869	Removes flywheel from engine and for lifting powerhead/engine

Flywheel Holding Tool	91- 52344
 4738	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler

DMT 2004 Digital Multimeter	91-892647A01
 **4516**	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Spark Gap Tester	91- 63998A 1
 13488	Provides a visual indication of spark/coil efficiency.

Electrical Components (200–300 HP In-line FourStroke)

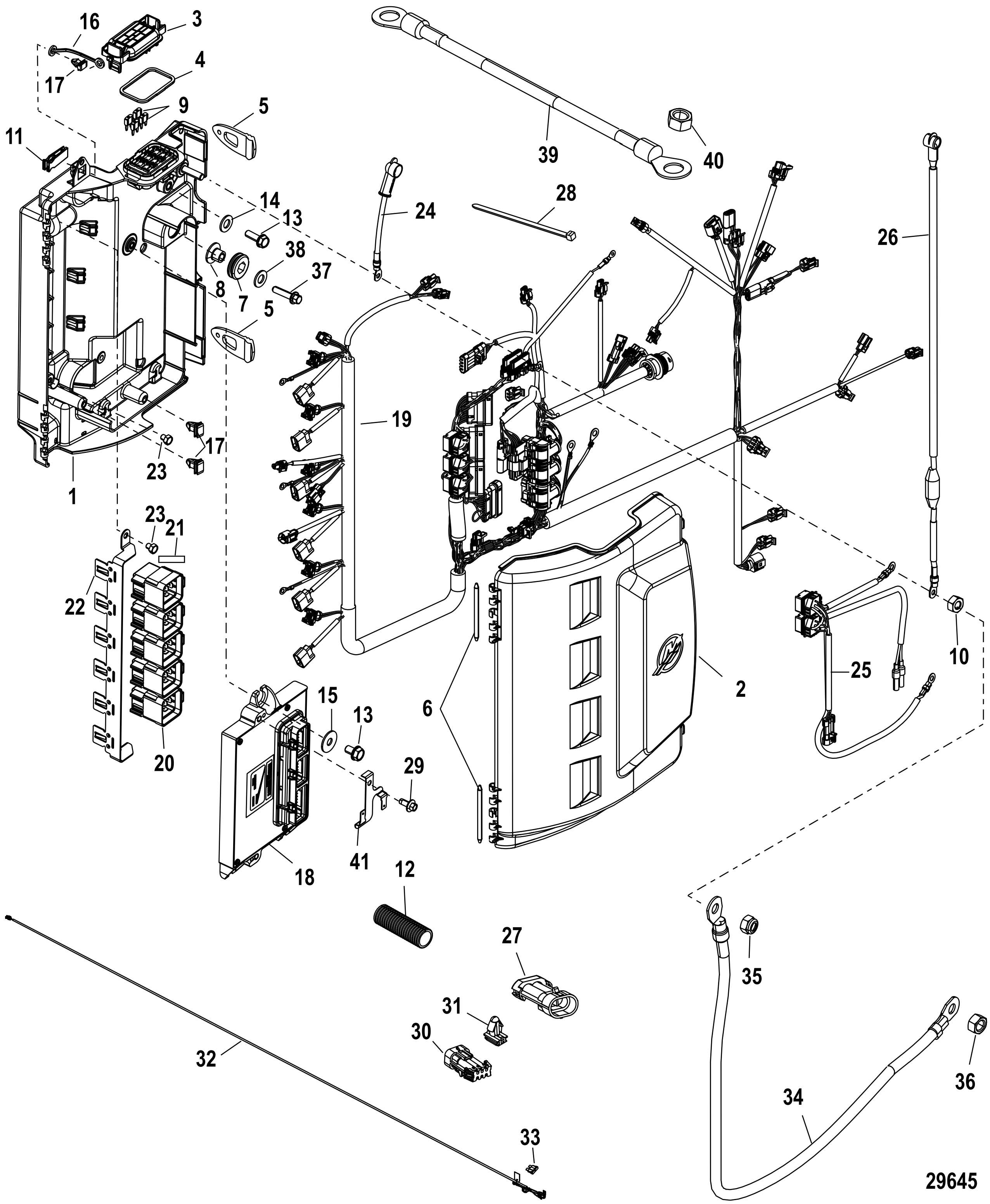


Electrical Components (200–300 HP In-line FourStroke)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Electrical box base			
2	1	Fuse box cover			
3	1	Fuse cover			
4	1	Seal			
5	2	Strap			
6	2	Hinge pin			
7	1	Grommet			
8	1	Bushing			
9	7	Mini fuse (20 amp) (yellow)			
10	1	Nut (M8)	17	150	
11	1	Fuse extractor			
12	1	Conduit			
13	2	Screw (M8 x 13)	9	80	
14	1	Washer (0.33 x 0.56 x 0.06)			
15	1	Washer (0.344 x 1.0 x 0.063)			
16	1	Cover strap			
17	5	Clip			
18	1	PCM			
19	1	Engine harness assembly			
20	5	Relay			
21	4	Decal			
22	1	Bracket			
23	2	Screw (M5 x 6)	4.5	40	
24	1	Starter cable (21.6 cm [8.5 in.])			
25	1	Trim harness assembly			
26	1	Fuse harness assembly			
27	1	Weather cap connector assembly (2 pin male)			
28	6	Cable tie (29.8 cm [11.75 in.])			
	AR	Cable tie (20.3 cm [8 in.])			
29	1	Screw (M6 x 14)	6	53	
30	1	Weather cap connector assembly (6 pin)			
31	1	Clip			
32	1	Command module power harness			
33	1	Fuse (5 amp) (tan)			
34	1	Positive battery cable			
35	5	Nut (M8)	17	150	12.5
36	1	Positive battery cable nut (3/8-16)	13.5	120	
37	1	Screw (M8 x 35)	24		17.5
38	1	Washer (0.344 x 1.0 x 0.063)			
39	1	Negative battery cable			

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
40	1	Negative battery cable nut (5/16-18)	13.5	120	
41	1	Bracket			

Electrical Components (200–300 HP In-line FourStroke)



Troubleshooting without a Computer Diagnostic System (CDS)

Troubleshooting without the computer diagnostic system (CDS) is limited to checking resistance on some of the sensors.

Typical failures usually do not involve the PCM. Connectors, set-up, or mechanical wear are most likely at fault.

- Verify the ignition coils are securely installed (pushed in) into the spark plugs.
- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.

IMPORTANT: Disconnecting a sensor while the engine is running may result in a fault recording in the PCM Fault History. Use the CDS to view the PCM fault history when troubleshooting/repair is completed.

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the PCM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires, or pins pushed back into the connector. Verify the connectors are properly seated.
- Inspect the harness for damage: pinched or cut wires and chafing.
- Secure the grounds and all connections involving ring terminals. Apply Liquid Neoprene to all ring terminal connections.

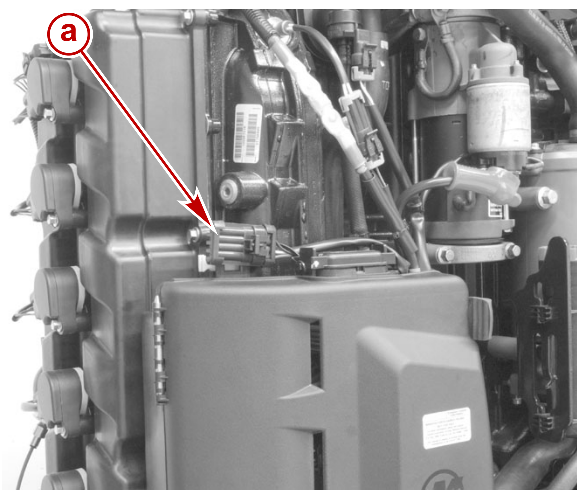
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All ring terminal connections	92- 25711 3

- Inspect the fuel pump harness connector for corrosion, loose wires, or pins pushed back into connector.
- Check the fuel pump pressure.

Troubleshooting with the Computer Diagnostic System (CDS)

The computer diagnostic system (CDS) is designed to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

Attach the diagnostic cable to the PCM diagnostic connector. This will enable the technician to monitor sensors, PCM data values, and the real time status of the switches. Use the 3 m (10 ft) extension cable between the CDS diagnostic connector and the PCM adapter to monitor the engine system while at the helm.



5483

a - Diagnostic terminal connector

The PCM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time, and then can be played back to review the recorded information.

Refer to the computer diagnostic system reference manual for complete diagnostic procedures.

Computer Diagnostic System (CDS)	Purchase from SPX*
Extension Cable	84-825003A 1
Adapter Harness	84-822560A13

Troubleshooting Guide

1. Engine Cranks, but Will Not Start	
Cause	**Action**
1.0 Weak battery or bad starter motor, battery voltage drops below 11 volts while cranking (PCM cuts out below 8 volts) (fuel pump requires 9 volts)	Replace/recharge battery Inspect condition of starter motor Check condition of battery terminals and cables
1.1 No fuel	Key-on engine to verify that fuel pump runs for 5 seconds and then turns off. If no fuel is available, fuel pump will run for as long as 180 seconds before shutting off. ***NOTE:*** *Running fuel pump for up to 180 seconds due to lack of fuel will damage fuel pump.*
1.2 Low fuel pressure	Measure fuel pressure (valve on top of fuel rail) Fuel pressure should be 281–345 kPa (41–50 psi)
1.3 Flywheel key sheared or flywheel key not installed	Remove flywheel and inspect
1.4 Blown fuse	Inspect 20 amp fuse in fuse holder and replace if blown
1.5 Main power relay not functioning	Listen for relay to click when the key switch is turned on. If relay does not click, inspect harness and connector pins for damage.
1.6 Spark plugs[1.]	Remove fuel pump fuse Remove spark plugs from each cylinder Install Spark Gap Tester 91-63988A1 to each ignition coil Crank engine or use the computer diagnostic system (CDS) output load test for each ignition coil and observe spark. If no spark is present, replace appropriate ignition coil. If spark is present, replace spark plugs.
1.7 PCM not functioning	Fuel injection system: Listen for injector ticking when cranking or connect spare injector to each respective harness Ignition system: Install spark gap tool between ignition coil and engine ground. Check for purple/white colored spark while cranking engine. Check for battery voltage (red/yellow lead) at ignition coils Check for blown 20 amp fuse Check for battery voltage to fuse from main power relay (purple lead) Check for shorted stop wire (black/yellow lead) Power supply: Inspect and clean remote control male and female harness connector Defective PCM
1.8 Crank position sensor not functioning	Check that magnet is not missing from end of sensor Perform ohm resistance check of sensor (300 to 350 ohms between red and white leads) Defective crank position sensor

2. Engine Will Not Crank	
Cause	**Action**
2.0 Defective PCM	Use the computer diagnostic system (CDS) to determine proper functioning of the electronic throttle control (ETC)
2.1 Defective main power relay	Use CDS to determine proper functioning of main power relay
2.2 Main power relay fuse blown	Check for blown 20 amp fuse
2.3 Lanyard stop switch in wrong position	Reset lanyard stop switch

1. Spark jumping the gap from all cylinders at the same time in the spark gap tool may cause interference in the PCM. The interference may cause the absence of spark on some cylinders and a false diagnosis of a no spark condition. Crank the engine over with only one spark plug wire connected to spark gap tool at a time or use the CDS to fire one cylinder at a time.

3. Engine Cranks, Starts, and Stalls	
Cause	Action
3.0 Low fuel pressure in fuel rail	See 1.2
3.1 Abnormally high friction in engine	Check for scuffed piston or other sources of high friction
3.2 Air in fuel system/lines	Crank and start engine several times to purge
3.3 Defective electronic throttle control	Use computer diagnostic system (CDS) to determine proper functioning of electronic throttle control (ETC) Replace ETC
3.4 Remote control to engine harness connection is poor	Clean and inspect male and female connections
3.5 Flywheel misaligned during installation	Flywheel key sheared or missing

4. Engine Idle is Rough	
Cause	Action
4.1 Fouled spark	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel ***NOTE:*** *If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston.*
4.2 Failed fuel injector	Refer to specifications for ohm test
4.3 Bad ignition coil/weak spark	Refer to specifications for ohm test
4.4 Flywheel misaligned during installation	Flywheel key sheared or missing
4.5 Engine not running on all cylinders	Inspect for mechanical damage

5. Engine Idles Fast (RPM Above 700) or Surges	
Cause	Action
5.1 Defective electronic throttle control	Use computer diagnostic system (CDS) to determine proper functioning of the electronic throttle control (ETC) Replace ETC

6. Engine Runs Rough (RPM Below 3000)	
Cause	Action
6.1 Fouled spark plug	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel ***NOTE:*** *If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston.*
6.2 Low fuel pressure in fuel rail	Measure fuel pressure (valve on top of fuel rail) Fuel pressure should be 281–345 kPa (41–50 psi)
6.3 Defective electronic throttle control	Use computer diagnostic system (CDS) to determine proper functioning of the electronic throttle control (ETC) Replace ETC
6.4 Bad ignition coil/weak spark	Refer to specifications for ohm test
6.5 Fuel system module float fails in conjunction with failure of vent canister switch	Excess fuel will enter air intake. Use CDS to determine proper function of vent canister switch.
6.6 Engine not running on all cylinders	Inspect for mechanical damage

7. Engine Runs Rough (RPM Above 3000)	
Cause	Action
7.1 Fouled spark plug	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel *NOTE: If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston.*
7.2 Defective electronic throttle control	Use computer diagnostic system (CDS) to determine proper functioning of the electronic throttle control (ETC) Replace ETC
7.3 Low fuel pressure in fuel rail	Measure fuel pressure (valve on top of fuel rail) Fuel pressure should be 281–345 kPa (41–50 psi)
7.4 Speed reduction	Refer to SmartCraft gauges for low oil, engine overheat, or sensor/actuator out of range. CDS will help identify proper functioning of sensors/actuator.
7.5 Defective crank position sensor	Refer to CDS for fault identification

8. Speed Reduction (RPM Reduced to Idle)	
Cause	Action
8.1 Engine communication/remote control failure	Refer to computer diagnostic system (CDS) for fault identification
8.2 Sensor/actuator is out of range	Refer to CDS for fault identification
8.3 Low oil pressure	Check oil dipstick for proper oil level
8.4 Engine overheat	Check engine cooling system for proper functioning

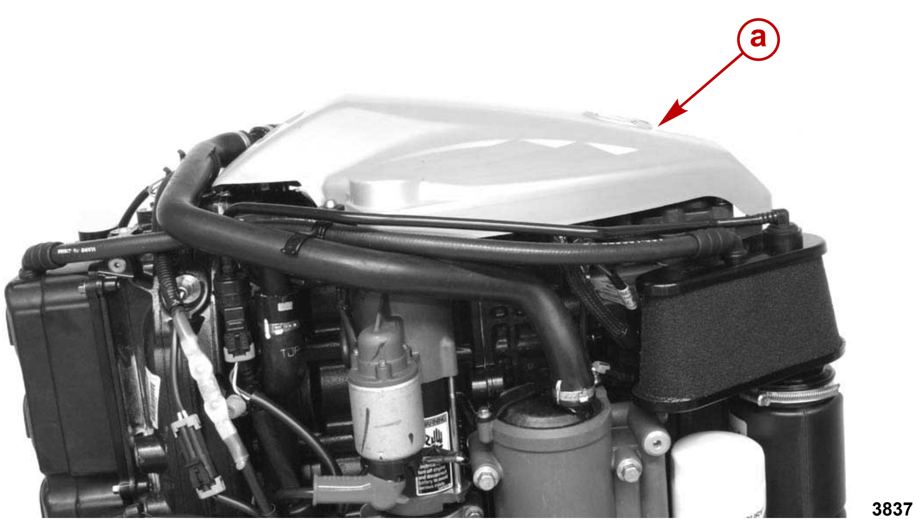
9. Speed Reduction (RPM Reduced to 75%)	
Cause	Action
9.1 Sensor/actuator is out of range	Refer to computer diagnostic system (CDS) for fault identification
9.2 Low oil pressure	Check oil dipstick for proper oil level
9.3 Engine overheat	Check engine cooling system for proper functioning

Ignition Components

Flywheel Cover

The purpose of the flywheel cover is to provide basic protection against accidental contact with the flywheel, starter motor pinion gear and alternator/supercharger drive belt while the engine is running.

Removal of the flywheel cover provides access to the flywheel, alternator/supercharger drive belt, starter motor pinion gear, cylinder block water temperature sensor, cylinder block water pressure sensor, crankshaft position sensor, oil temperature sensor and oil pressure sensor.



a - Flywheel cover

The flywheel cover is secured to the engine by four rubber grommets pressed over four locating pins on the cylinder block. To remove cover, lift cover off of locating pins. To reinstall cover, align flywheel cover grommets with locating pins and push down until cover seats against locating pins.

Flywheel

The flywheel is weighted and balanced to improve engine running characteristics. The flywheel is secured to the crankshaft by a bolt (M20 x 68) (30 mm socket) and washer. The flywheel has two ring gears. The top ring gear is used with the starter motor to start the engine. The lower ring gear has 54 teeth with six teeth missing at specific locations. As the lower ring gear passes the crankshaft position sensor, an electrical pulse is generated and sent to the propulsion control module (PCM). The frequency of these pulses in conjunction with the missing tooth locations on the ring gear provides crankshaft location information to the PCM. The PCM will use this information to regulate ignition and fuel injector timing.

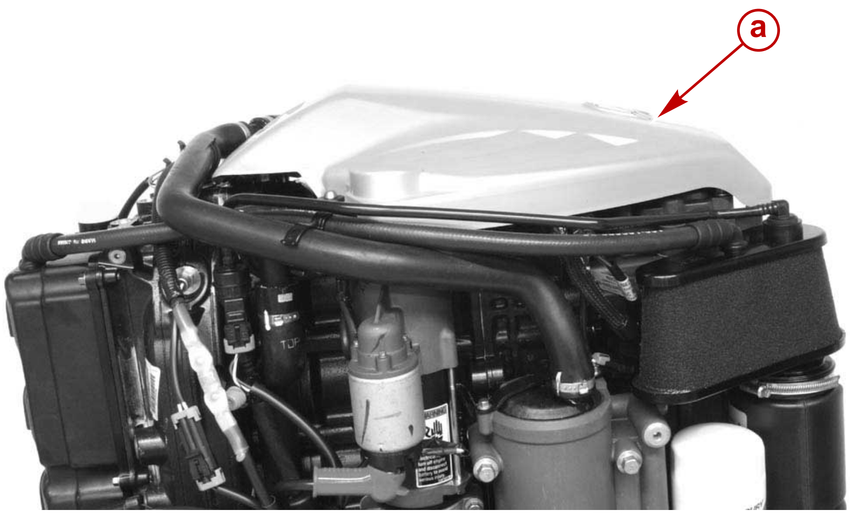
Flywheel Removal

The flywheel has three threaded holes which are used with the flywheel puller/lifting ring to remove the flywheel. These three holes can also be used with the flywheel puller/lifting ring to remove or install the complete outboard on a boat.

Flywheel Puller/Lifting Ring	91-895343T02

IMPORTANT: Striking or heating the flywheel to ease removal will damage the flywheel. Do not strike or heat the flywheel.

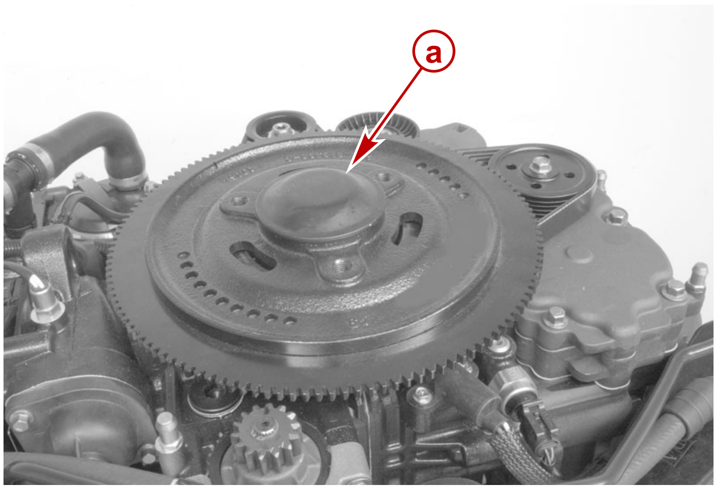
1. Remove the flywheel cover.



3837

a - Flywheel cover

2. Remove the flywheel bolt cap from the flywheel.



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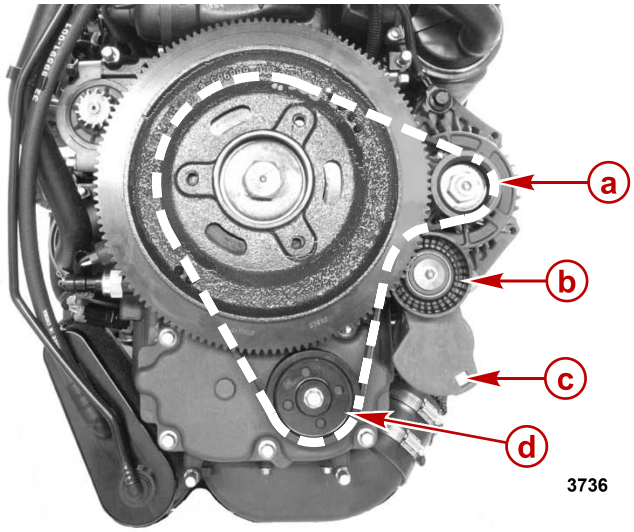
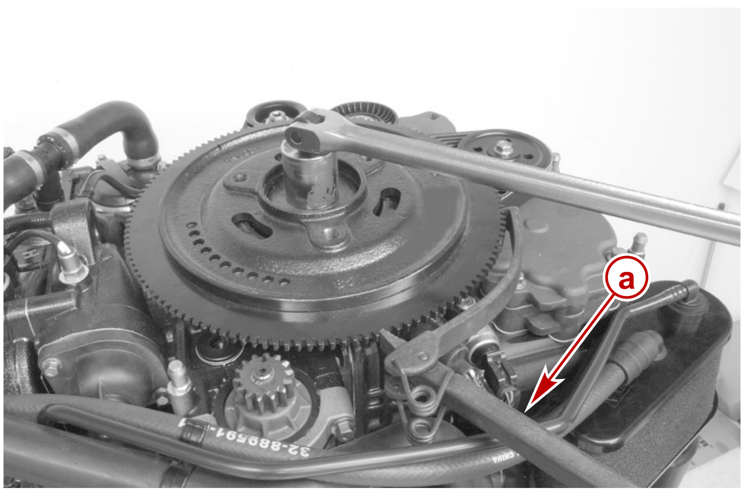
a - Cap

3. Use a breaker bar to release the alternator/supercharger belt tension and remove the belt from the flywheel.



a - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger

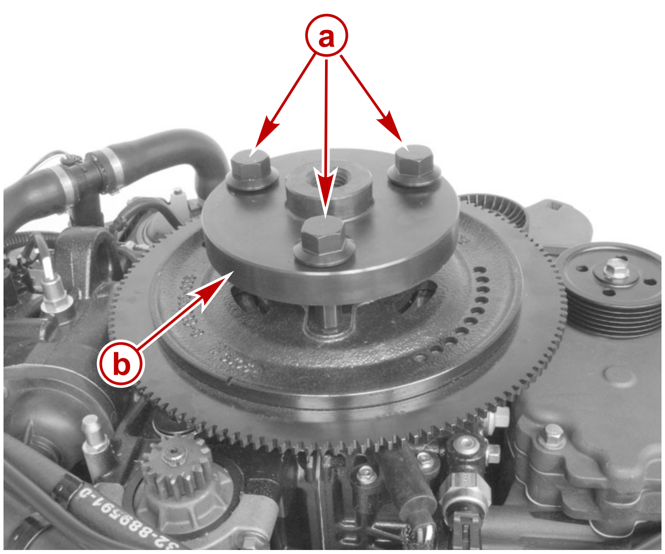
4. Hold the flywheel with a flywheel holding tool. Loosen the flywheel bolt four turns out from a light seat.



a - Flywheel holding tool

Flywheel Holding Tool	91- 52344

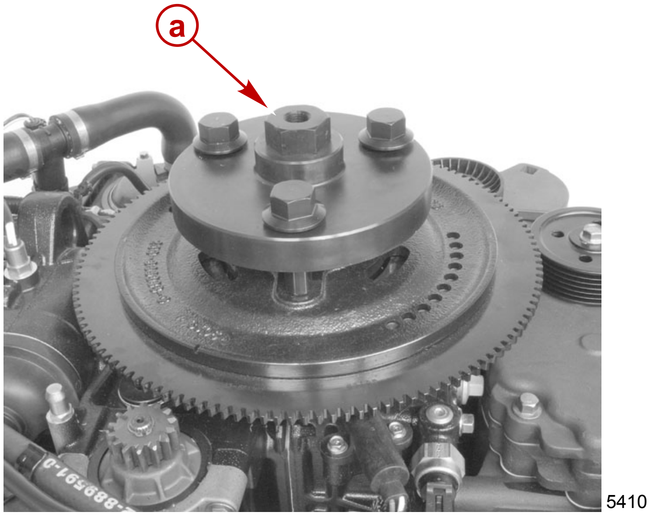
5. Install the flywheel puller base to the flywheel with three bolts.



a - Puller base
b - Bolts

Flywheel Puller/Lifting Ring	91-895343T02

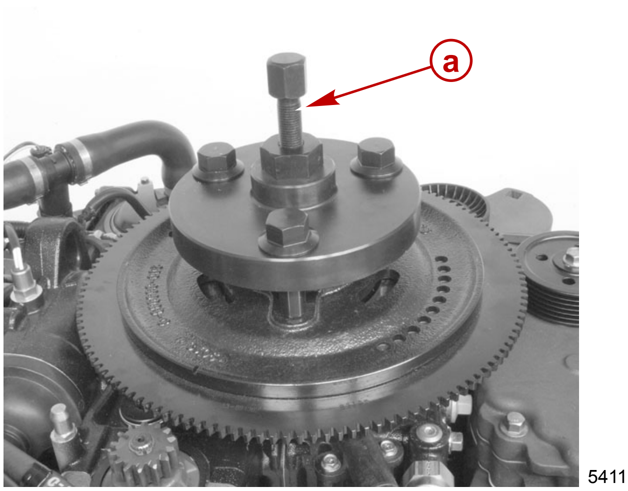
6. Thread the flywheel puller adapter into the puller base until it bottoms out.



a - Puller adapter

Flywheel Puller/Lifting Ring	91-895343T02

7. Thread the flywheel puller bolt into the flywheel puller adapter.



a - Puller bolt

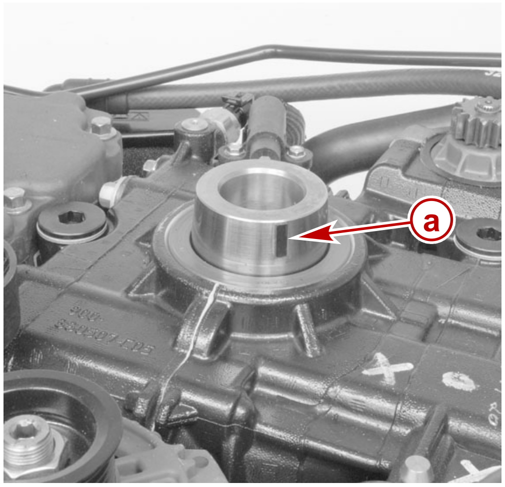
Flywheel Puller/Lifting Ring	91-895343T02

8. Tighten the flywheel puller bolt until the flywheel becomes loose and remove the flywheel.

Flywheel Installation

IMPORTANT: Clean flywheel/crankshaft taper with solvent and assemble dry.

1. Install the flywheel key in the crankshaft.



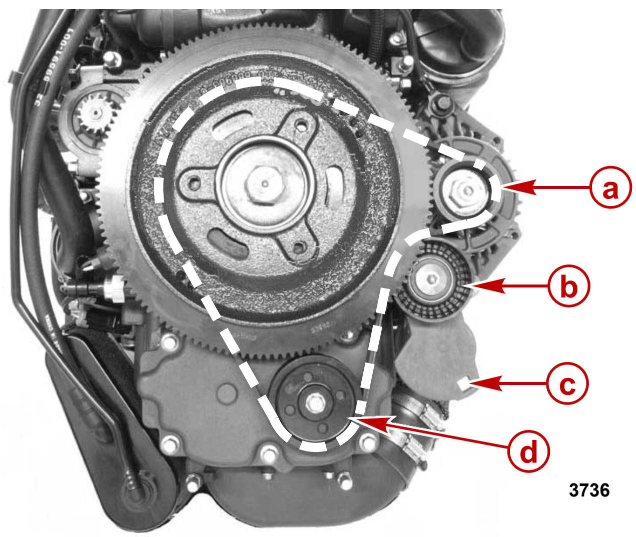
a - Flywheel key

2. Align the flywheel with the key and install the flywheel onto the crankshaft.
3. Secure the flywheel with a bolt and washer. Use a flywheel holding tool to hold the flywheel and tighten the bolt to specification.

Flywheel Holding Tool	91- 52344

Description		Nm	lb. in.	lb. ft.
Flywheel bolt	**First**	60		44
	Final	180		133

4. Using a breaker bar in the tensioner release slot, reinstall the alternator/supercharger belt.



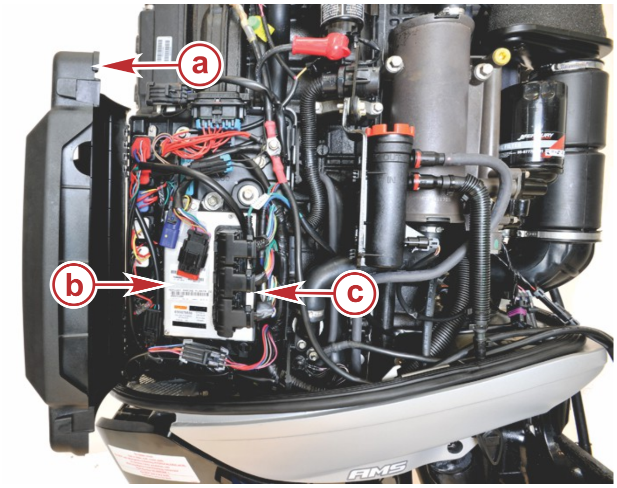
a - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger

5. Install the flywheel cover.

Propulsion Control Module (PCM)

The propulsion control module requires 8 VDC minimum to operate. If the PCM should fail, the engine will stop running.

The inputs to the PCM can be monitored and tested by using the computer diagnostic system available from the SPX Corporation in Warren, Michigan.



52631

- **a -** Electrical box cover
- **b -** Propulsion control module (PCM)
- **c -** Engine harness connectors (3)

Computer Diagnostic System (CDS)	Purchase from SPX*

The PCM controls the following functions:

- Electronic shift control
- Electronic throttle control
- Electronic boost control
- Main power relay
- Fuel injectors
- Ignition coils
- Power steering
- Vent canister purge valve
- Trim up
- Trim down
- Start relay
- Lift fuel pump
- Diagnostics
- Engine Guardian
- Tachometer link (analog tachometer output or link gauge driver)

The PCM operates in four modes: power off, stall, crank, and run. The PCM also provides for a smooth throttle response between varying throttle positions and engine loads. A warm-up mode is integrated with the run mode and disengaged after the engine accumulates a given amount of power.

Power off mode - With the key switch "OFF," the PCM function does not exist. 12 VDC power is available from the battery at the starter battery terminal, fuses, positive cable terminal in the electrical box, and at the alternator.

Stall mode - With the key switch in the "RUN" position, the PCM is energized. The PCM powers the main power relay, the fuel pump relay for five seconds, and provides 5 VDC power to the sensors. The PCM records barometric pressure from the MAP sensor, intake air temperature from the manifold intake air temperature (MAT) sensor, and coolant temperature from the coolant temperature sensors. The PCM will use this information to establish a warm-up strategy that will control fuel delivery and engine speed during warm-up and idle.

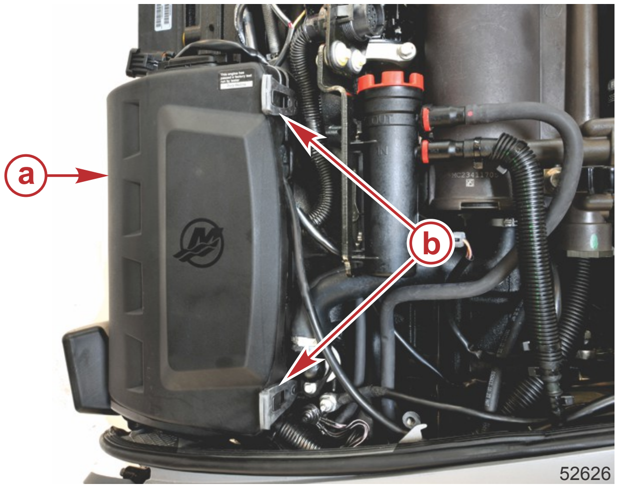
Crank mode - When the key switch is turned to the "START" position, the starter relay and the starter solenoid will be energized and battery power will turn the starter motor. With the engine rotating, a pulse will be generated at the crankshaft sensor which provides the PCM engine speed information. The PCM will then supply power to the fuel pump and ignition coils through the main power relay and the fuel pump relay.

Run mode - At approximately 500 RPM, the PCM will transition to the run mode.

- The warm-up strategy will continue to adjust engine speed with the fuel injector pulse width and engine spark advance until the engine accumulates a given amount of power.
- The camshaft position sensor provides cylinder compression phasing information to the PCM for sequential fuel injection.
- The manifold air temperature (MAT), throttle position, and manifold absolute pressure (MAP) are monitored to determine proper spark timing, boost control, and the fuel needs necessary to develop the amount of power asked for by the operator.

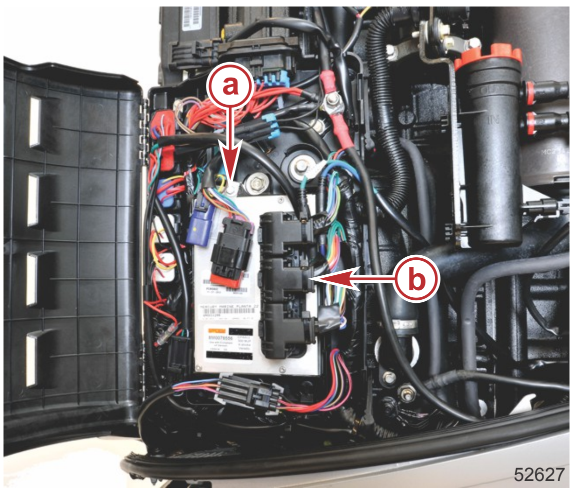
PCM Removal

1. Release the straps securing the electrical box cover.



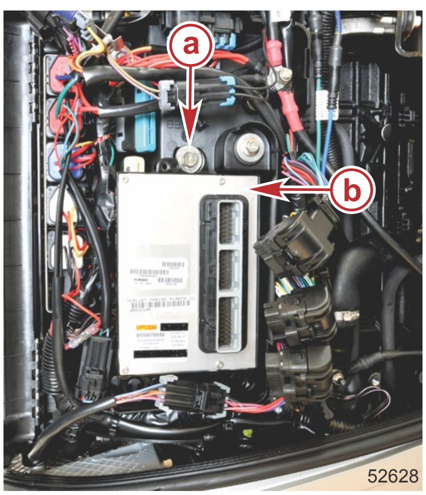
a - Electrical box cover
b - Straps

2. Remove the screw securing the clip holding the two terminator connectors.
3. Disconnect the three engine harness connectors.



a - Screw securing terminator clip
b - Engine harness connectors

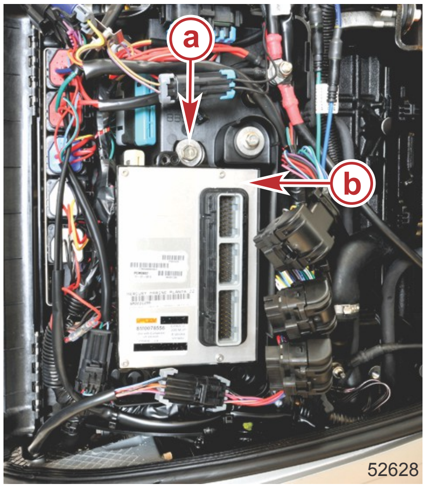
4. Remove the screw securing the PCM and remove the PCM.



a - PCM attaching screw
b - PCM

PCM Installation

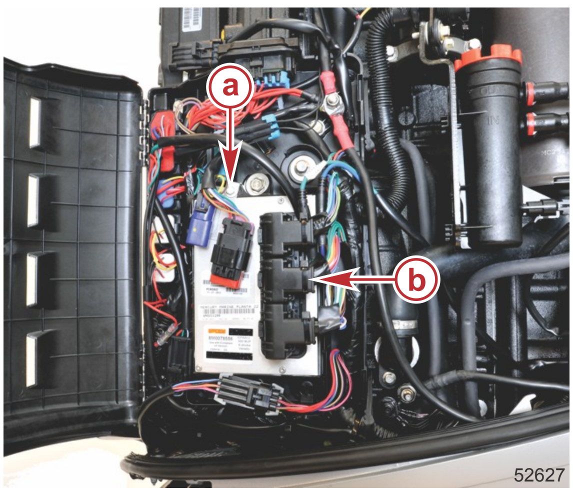
1. Install the PCM into the electrical box and secure the PCM with a screw. Tighten the screw to the specified torque.



a - PCM attaching screw (M8 x 13)
b - PCM

Description	Nm	lb-in.	lb-ft
PCM attaching screw (M8 x 13)	9	80	–

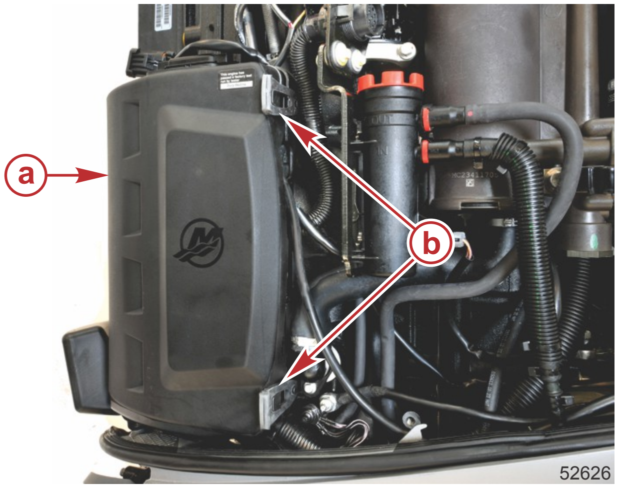
2. Secure the terminator clip to the PCM with a screw. Tighten the screw to the specified torque.
3. Connect the three engine harness connectors to the PCM.



a - Screw (M6 x 14) securing terminator clip
b - Engine harness connectors

Description	Nm	lb-in.	lb-ft
Screw (M6 x 14)	6	53	–

4. Close the electrical box cover and secure the cover with two straps.



a - Electrical box cover
b - Straps

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

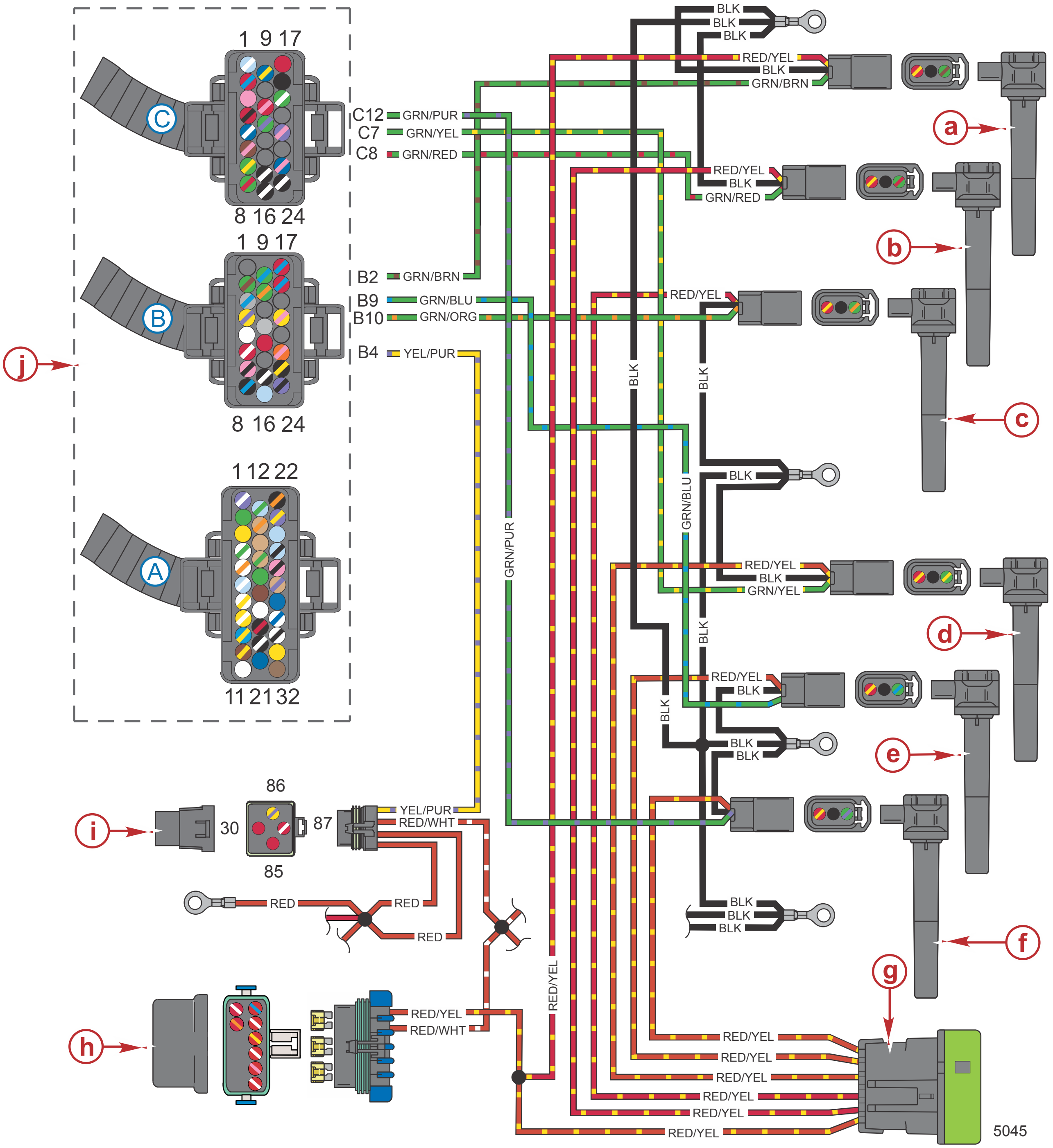
Ignition Pencil Coil

The engine ignition system utilizes six ignition coils, one for each cylinder. The ignition coils are inductive type coils with each coil having its own integrated driver. Battery voltage is present at each coil (red/yellow lead) whenever the main power relay is activated. Each coil is triggered by a 5 VDC digital pulse from the propulsion control module (PCM). Each ignition coil is capable of producing a 40,000 volt spark.

NOTE: Beginning with serial number 1B753729, the coils use a black epoxy potting material and the plastic cover was removed.

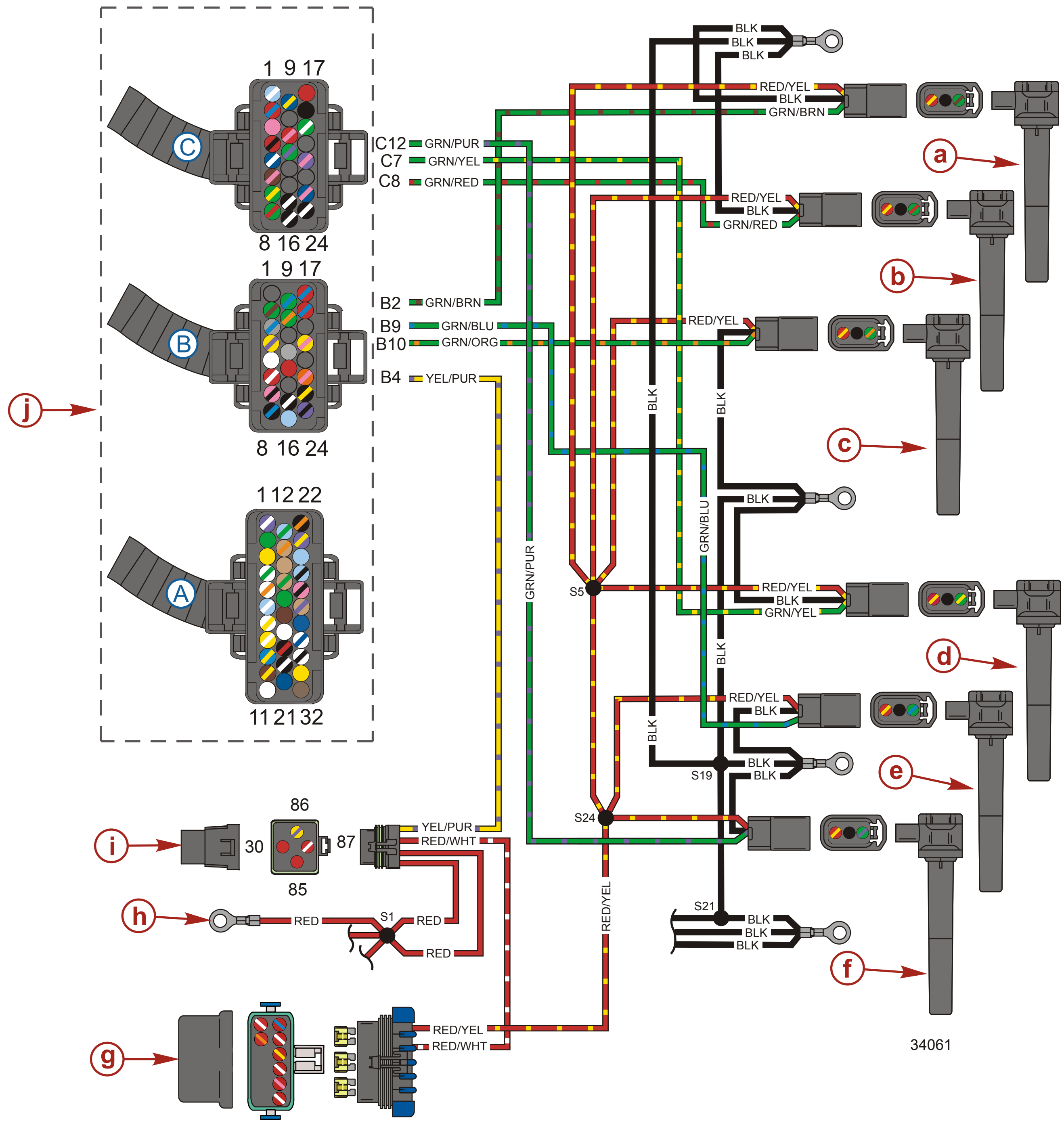
a - Ignition coil #1 (6–1 for each cylinder)

Ignition Coil Test (S/N 1B229688 and Below)



- a - Cylinder #1 ignition coil
- b - Cylinder #2 ignition coil
- c - Cylinder #3 ignition coil
- d - Cylinder #4 ignition coil
- e - Cylinder #5 ignition coil
- f - Cylinder #6 ignition coil
- g - Terminal junction
- h - Fuse holder
- i - Main power relay
- j - Propulsion control module (PCM)

Ignition Coil Test (S/N 1B229689 and Above)



- a - Cylinder #1 ignition coil
- b - Cylinder #2 ignition coil
- c - Cylinder #3 ignition coil
- d - Cylinder #4 ignition coil
- e - Cylinder #5 ignition coil
- f - Cylinder #6 ignition coil
- g - Fuse holder
- h - Positive connection terminal
- i - Main power relay
- j - Propulsion control module (PCM)

⚠ WARNING

High voltage is present any time the key is turned on, especially when starting or operating the engine. Do not touch ignition components or metal test probes and stay clear of spark plug leads when performing live tests.

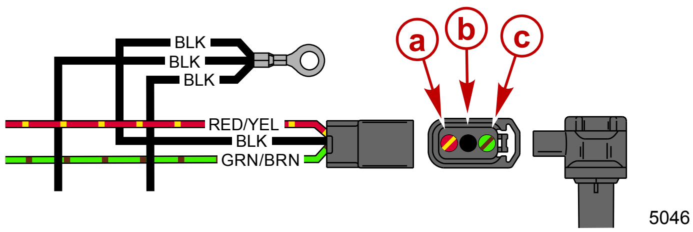
Condition: With the key switch in the "RUN" position and the engine "OFF," power (battery voltage) is only available (red/yellow lead) for three seconds when no crankshaft position sensor (CPS) signal is being received by the propulsion control module (PCM).

1. Disconnect the connector from the coil being tested.
2. Perform a visual inspection of the pins at the coil and the wires coming to the connector. Look for broken, bent, and corroded pins at the coil and loose, broken, or corroded wires at the connector.

   NOTE: Shake or move the harness and connector when performing the following tests. If the voltmeter readings vary during the tests, inspect for a broken, loose, or corroded wire. Repair the problem wire and retest the circuit as follows.
3. Connect a voltmeter across the red/yellow and the black wires at the connector.

   NOTE: The main power relay must be on for 12 VDC (battery voltage) to be present at the red/yellow wire. If voltage is not present, the main power relay may be defective or the 20 amp fuse in the fuse holder is blown.
4. The voltmeter must read 12 VDC (battery voltage). If not, connect the voltmeter across the red/yellow wire and the engine ground. If the voltmeter indicates 12 VDC (battery voltage), there is an open in the ground circuit.

   NOTE: All coil ground wires are spliced together and connected to a common engine ground. The most likely failure would be at the connector or in-between the connector and the engine ground.



a - +12 volt (red/yellow)
b - Ground (black)
c - Output from PCM (5 volt digital pulse)

5. If the voltmeter does not indicate 12 VDC (battery voltage), there is an open circuit between the splice point and the connector (red/yellow lead).

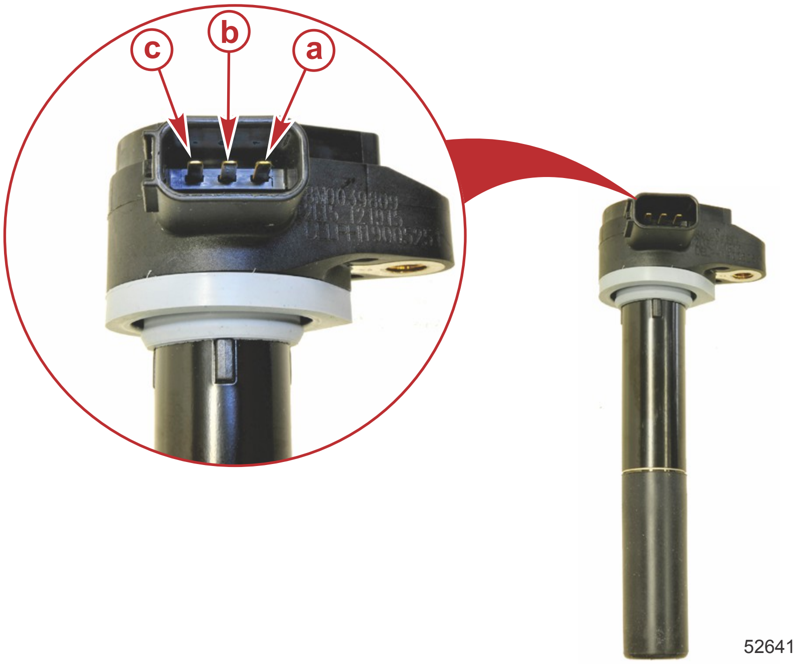
   NOTE: All 12 VDC power wires for the coils are spliced together. Unless all the coils have failed, the most likely failure would be at the splice point, the connector, or in-between the connector and the splice point.
6. Check the input wire (5 VDC) for continuity between the connector and the PCM. Repair if needed.
7. Remove the coil and install a spark tester between the high voltage tower and ground to see if there is a strong blue spark. If the spark is weak or is not blue in color, replace the coil and retest.

Ignition Coil Ohm Test

NOTE: Perform the coil ohm tests using a DMT 2004 or equivalent ohmmeter.

DMT 2004 Digital Multimeter	91-892647A01

NOTE: Some meter brands may require the test lead polarity to be reversed in order to obtain correct ohm specifications.



a - Red/yellow
b - Black
c - Green/stripe

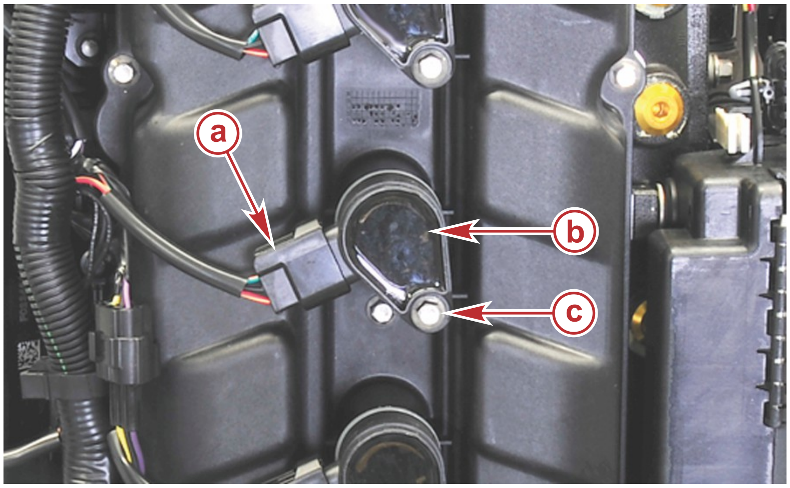
Ignition Coil Ohm Test					
Red Ohmmeter Lead		**Black Ohmmeter Lead**			
		Electronic Spark Trigger	**Ground**	**Battery +**	**Secondary**
Terminal	**Wire Color**	Green with stripe	Black	Red/yellow	Spring/output
Electronic spark trigger	Green with stripe	N/A	4.3–5.3 kΩ (switching circuit)	2–4 MΩ (power circuit)	Infinite (O.L.)
Ground	Black	4.3–5.3 kΩ (switching circuit)	N/A	2–4 MΩ (power circuit)	Infinite (O.L.)
Battery +	Red/yellow	Infinite (O.L.)	Infinite (O.L.)	N/A	Infinite (O.L.)
Secondary	Spring/output	Infinite (O.L.)	Infinite (O.L.)	Infinite (O.L.)	N/A

IMPORTANT: After performing the ignition pencil coil wiring and ignition coil ohm tests as outlined, if no problems are found, proceed to Ignition Pencil Coil Troubleshooting.

Ignition Coil Removal

1. Disconnect the electrical harness from the coil.

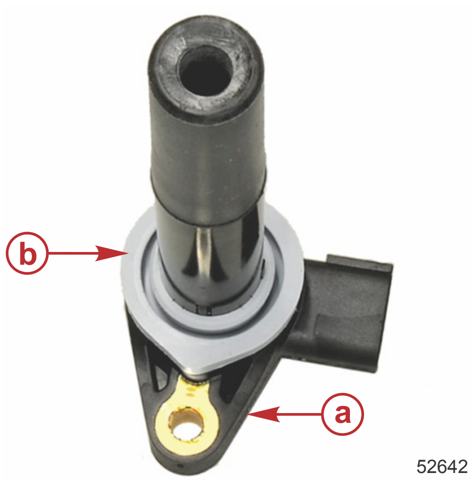
2. Remove the screw securing the coil.



52635

a - Electrical harness
b - Ignition coil
c - Ignition coil screw (M6 x 16)

3. Inspect the coil sealing ring for cuts or abrasion. If the sealing ring is damaged, replace the ring.

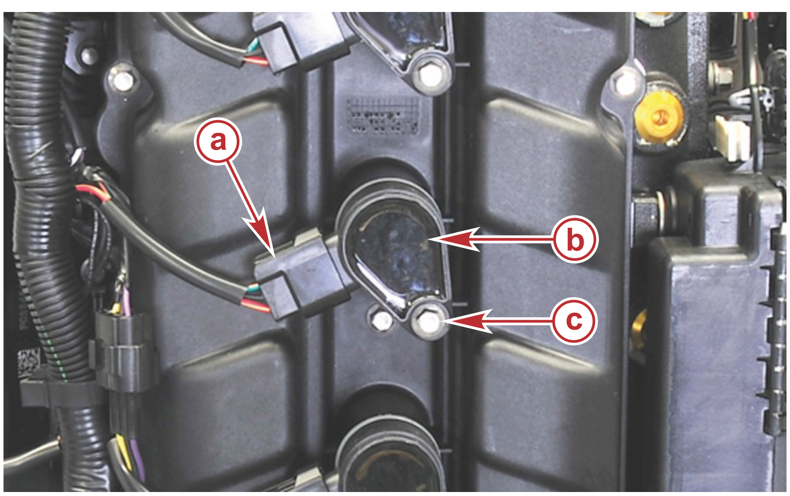


52642

a - Ignition coil
b - Sealing ring

Ignition Coil Installation

1. Insert the ignition coil into the spark plug access hole in the cylinder head. Secure the ignition coil with the screw. Tighten the screw to the specified torque.
2. Reconnect the electrical harness to the ignition coil.



52635

a - Electrical harness
b - Ignition coil
c - Ignition coil screw (M6 x 16)

Description	Nm	lb-in.	lb-ft
Ignition coil screw (M6 x 16)	8	71	–

Ignition Pencil Coil Troubleshooting

⚠ WARNING

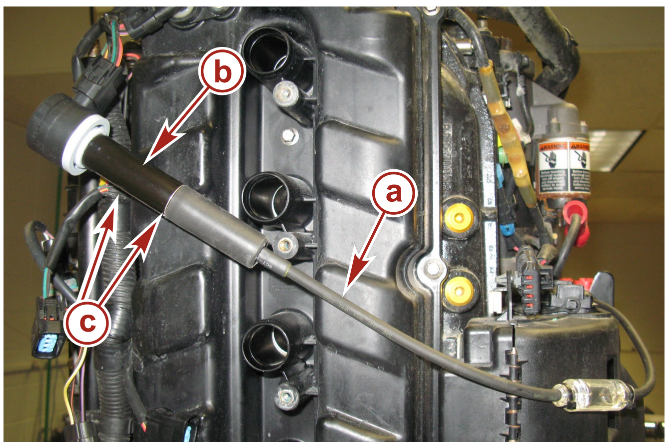
Prior to performing these ignition pencil coil tests, disconnect the fuel supply module (FSM) wiring harness to disable the fuel pumps. Failure to do so could result in a fire hazard.

⚠ WARNING

High voltage is present during these ignition pencil coil tests. Do not touch testing or ignition components and stay clear of the ignition coils when performing these tests.

IMPORTANT: Perform ignition pencil coil wiring and ignition coil ohm tests as outlined in the outboard service manual. If no problems are found, proceed to the following steps.

1. Disconnect the fuel supply module wiring harness to disable the fuel pumps.
2. Remove the pencil coils and spark plugs from each cylinder. Keep track of the cylinder location of each coil.
3. Reconnect the wiring harness connector to the pencil coil being tested.
4. Use spark gap tester. Adjust the spark gap between the pins to 11 mm (7/16 in.).
5. Install the spark gap tester between the pencil coil spark plug contact spring and engine ground (starter motor mounting bolt shown).



49402

a - Spark gap tester
b - Ignition pencil coil cylinder #1
c - Coil tube seams

Spark Gap Tester	91- 63998A 1

Troubleshooting without the Computer Diagnostic System (CDS)

1. Use the starter motor to spin the engine over.
2. A good coil will produce a strong blue spark across the spark plug gap.
3. While the coil is firing, carefully observe the seams of the coil tube for leakage (arcing). Replace the coil if arcing is observed.

Troubleshooting with the Computer Diagnostic System (CDS)

1. Connect the CDS to the outboard.
2. Proceed to the **Active Diagnostics** screen and run the **Ignition** (plugs out of the cylinder) test.
3. A good coil will produce a strong blue spark across the spark plug gap.
4. While the coil is firing, carefully observe the seams of the coil tube for leakage (arcing). Replace the coil if arcing is observed.

Computer Diagnostic System (CDS)	Purchase from SPX*

Good Ignition Pencil Coils

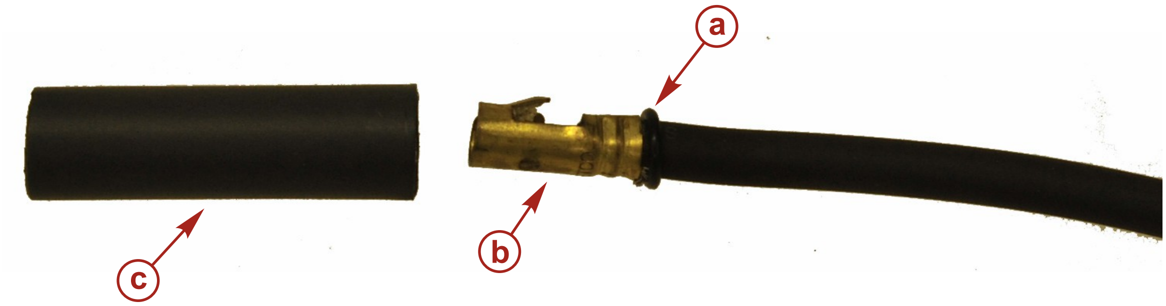
Pencil coils that produce a strong blue spark across the 11 mm (7/16 in.) spark gap and do not show signs of leakage (arcing) at the coil tube seams should not be replaced.

Service Tip

The spark gap tester can be modified (described below) to work with pencil coils. Installing the O-ring with shrink tubing will provide a friction fit to hold the spark gap tester into the pencil coil spark plug boot.

Spark Gap Tester	91- 63998A 1

1. Install an O-ring over the spark plug connector end of the spark gap tester. The O-ring size should be approximately 6 mm (0.24 in.) inside diameter with a 1.6 mm (0.063 in.) cross section, such as P/N 25-806232.
2. The O-ring should be positioned over the test lead just past the spark plug connector.



49403

- **a -** O-ring
- **b -** Spark plug connector
- **c -** Heat shrink tubing

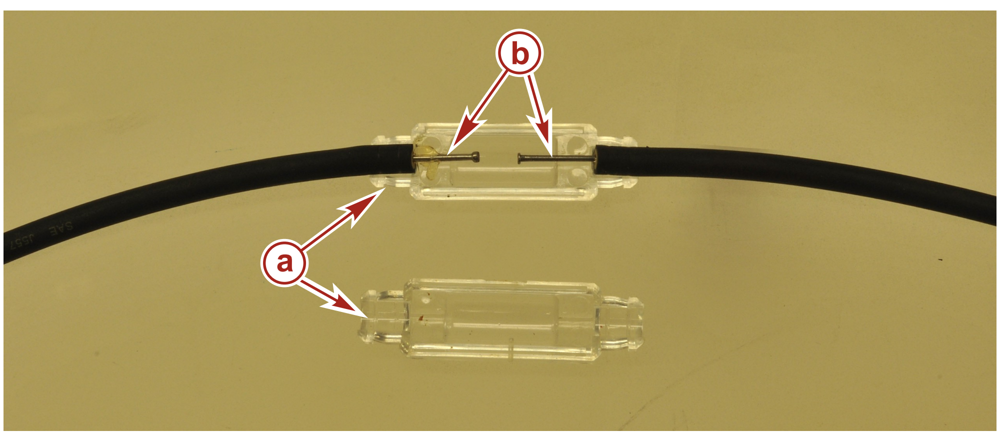
IMPORTANT: Positioning the tubing over the hooks of the spark plug connector will protect the inner rubber spark plug boot of the pencil coil during spark gap tester removal.

3. Install a 40 mm (1.5 in.) piece of heat shrink tubing over the test lead so that it covers both the hooks of the spark plug connector and the O-ring.
4. Heat tubing to secure the assembly in place.

Spark Gap Tester Adjustment

Should the spark gap require adjustment, proceed as follows:

1. Remove the cable ties from both ends of the spark chamber.
2. Split the spark chamber and adjust (push/pull) the spark gap pins to obtain a gap of 11 mm (7/16 in.).
3. Reassemble the spark chamber and secure the assembly with two cable ties.

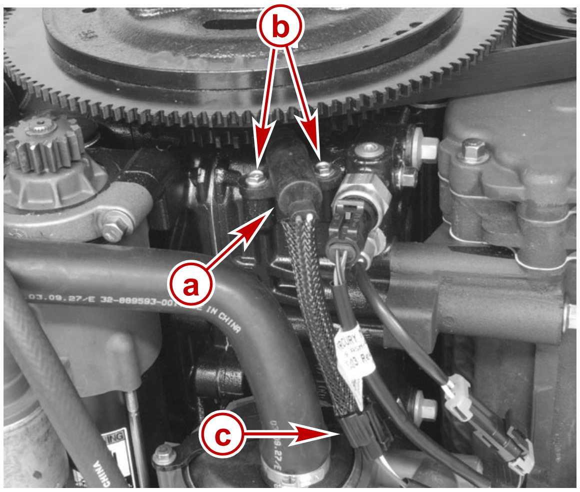


49405

- **a -** Spark chamber
- **b -** Spark gap pins

Crankshaft Position Sensor (CPS)

The CPS is located at the top of the cylinder block, next to the flywheel. The sensor contains a magnet which is positioned next to the flywheel's lower ring gear. This ring gear has 54 teeth with six gaps (or missing teeth) at specific locations. The close proximity of the CPS magnet to the 54 teeth allows a magnetic field to be created each time a tooth passes the sensor. This field collapses and creates a AC voltage pulse. This AC pulse is sent to the propulsion control module (PCM). The timing and frequency of these pulses allows the PCM to regulate ignition and fuel injector timing. If the CPS fails, the engine will run rough or stop running.



5522

a - CPS
b - Attaching screws
c - Harness connector

Crankshaft Position Sensor Test

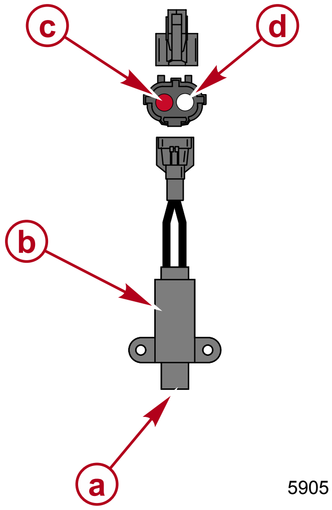
NOTE: It is recommended that the flywheel cover and flywheel be removed to gain access to the CPS.

1. Perform a visual inspection of the sensor. The tip of the sensor must be flush across the end; if not, replace the sensor.
2. The tip of the sensor must be clean. There should be no metal debris (ring gear filings) attached to the sensor tip.

   NOTE: There is a magnet mounted in the sensor's tip. If the magnet is missing, the sensor will not operate properly.
3. Inspect the flywheel timing wheel for:
   - Excessive corrosion
   - The teeth should have square edges
   - There should only be one missing tooth on either side of the two tooth, three tooth, or four tooth groups
4. Replace the flywheel if it does not meet inspection requirements.
5. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
6. Disconnect the connector from the sensor. Measure the resistance across the sensor pins. Replace the sensor if out of specification.

Crankshaft Position Sensor	
Resistance	300–350 ohms

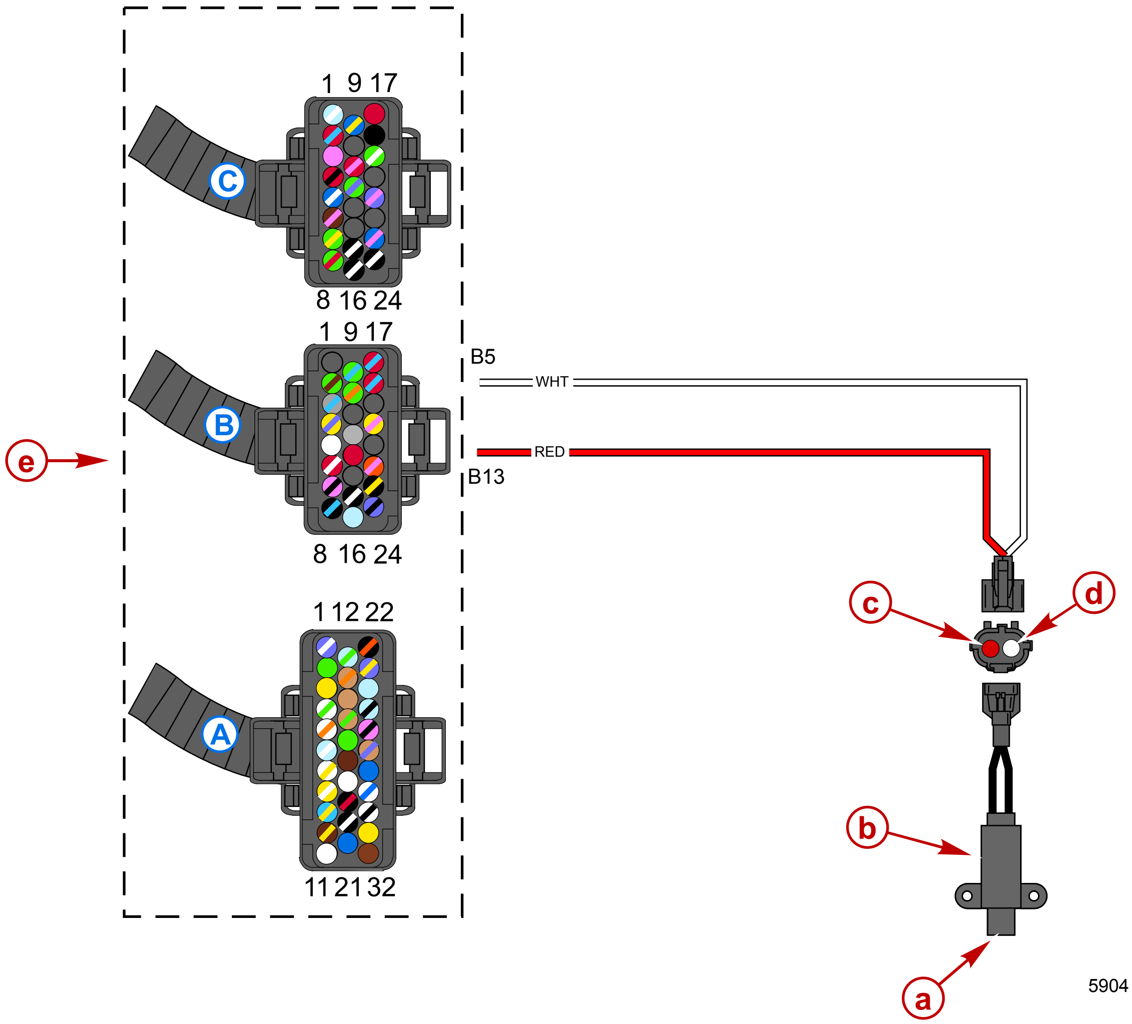
NOTE: If an engine problem occurs above 3000 RPM (runs rough, no high RPM), an ohm test of the CPS may be good, but the sensor can still be defective.



a - Magnet
b - CPS
c - Pin 1 (red)
d - Pin 2 (white)

7. Reconnect the harness to the sensor. Disconnect the B connector from the PCM and measure the resistance across pins 5 and 13. Resistance must be within specification. If not, repair the wiring between the PCM and the sensor.

Crankshaft Position Sensor	
Resistance	300–350 ohms



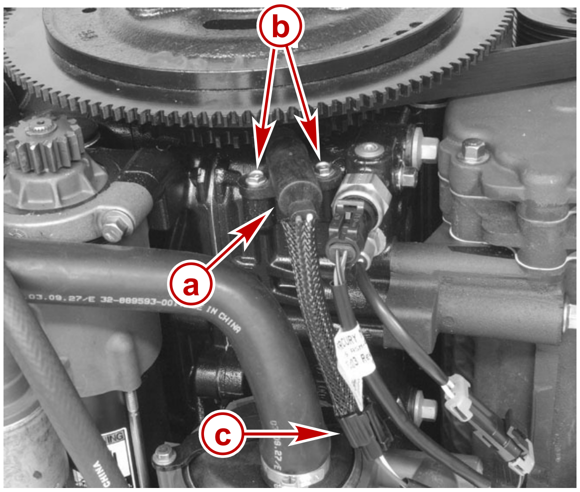
a - Magnet
b - CPS
c - Pin 1 (red)
d - Pin 2 (white)
e - PCM

8. If the tests in the preceding steps are satisfactory, replace the PCM.

Crankshaft Position Sensor Removal

1. Remove the flywheel cover and flywheel.
2. Disconnect the sensor harness connector.

3. Remove the two screws securing the sensor and remove the sensor.



5522

a - CPS
b - Attaching screws
c - Harness connector

Crankshaft Position Sensor Installation

1. Position the sensor on the engine and secure the sensor with two screws. Torque the screws to specification.
2. Connect the sensor harness to the sensor.

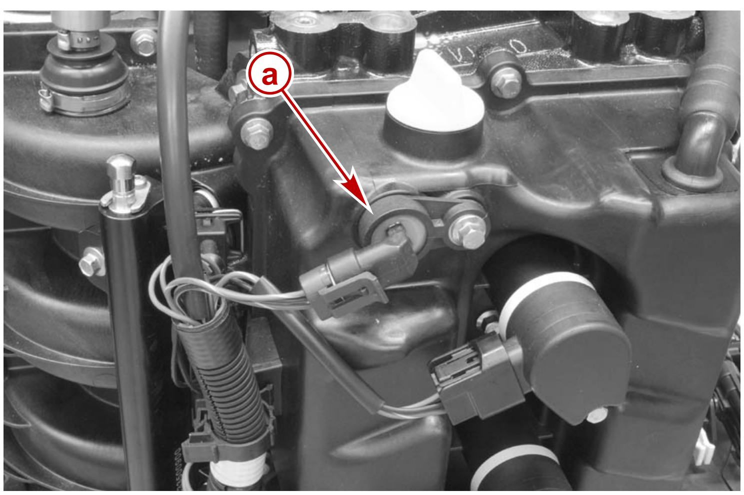
Description	Nm	lb. in.	lb. ft.
Screw (M5 x 16)	5	45	

Camshaft Position Sensor

The camshaft position sensor is located at the top of the valve cover. It supplies the PCM with timing and RPM information. When the camshaft position sensor is functioning, the PCM controls the fuel injection in a sequential, multi-port timing strategy. When the camshaft position sensor has failed, the PCM controls the fuel injection in a batch fire strategy. The engine may not start as quickly and the Guardian System will limit power to 75%. The PCM will generate and store a failure code when the camshaft position sensor fails.

A sequential firing strategy means that the fuel injectors fire once per engine cycle (every two crankshaft revolutions). The fuel injection event is complete just before the intake valve closes and the coils fire only once per engine cycle. Sequential is ideal for emissions, driveability transients, and slight horsepower advantages.

Batch fire strategy means that the fuel injectors fire every revolution (1/2 the fuel needed per revolution/per cycle) and the coils also fire every revolution (wasted spark). This strategy does not consider the phase of the engine; i.e. whether a particular cylinder is on a compression or exhaust stroke. Batch fire engines do not require a camshaft position sensor and are less expensive to build.



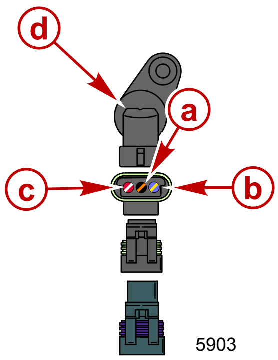
5540

a - Camshaft position sensor

Camshaft Position Sensor Test

The camshaft position sensor output to the PCM will change from +5 volts to 0 volts each time the number 1 or number 6 cylinder reaches top dead center. This voltage change can be monitored by the computer diagnostic system (CDS). If the voltage change is not occurring, shake or move the harness by hand. If the voltage readings vary, look for a broken, loose, or corroded wire.

1. Disconnect the connector from the sensor.
2. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
3. If the wiring appears serviceable, perform an ohmmeter check on the sensor. The normal resistance for the cam sensor at 21 °C (70 °F):
   - Between pins A and B is 23.2 MΩ
   - Between pins B and C is 23.2 MΩ

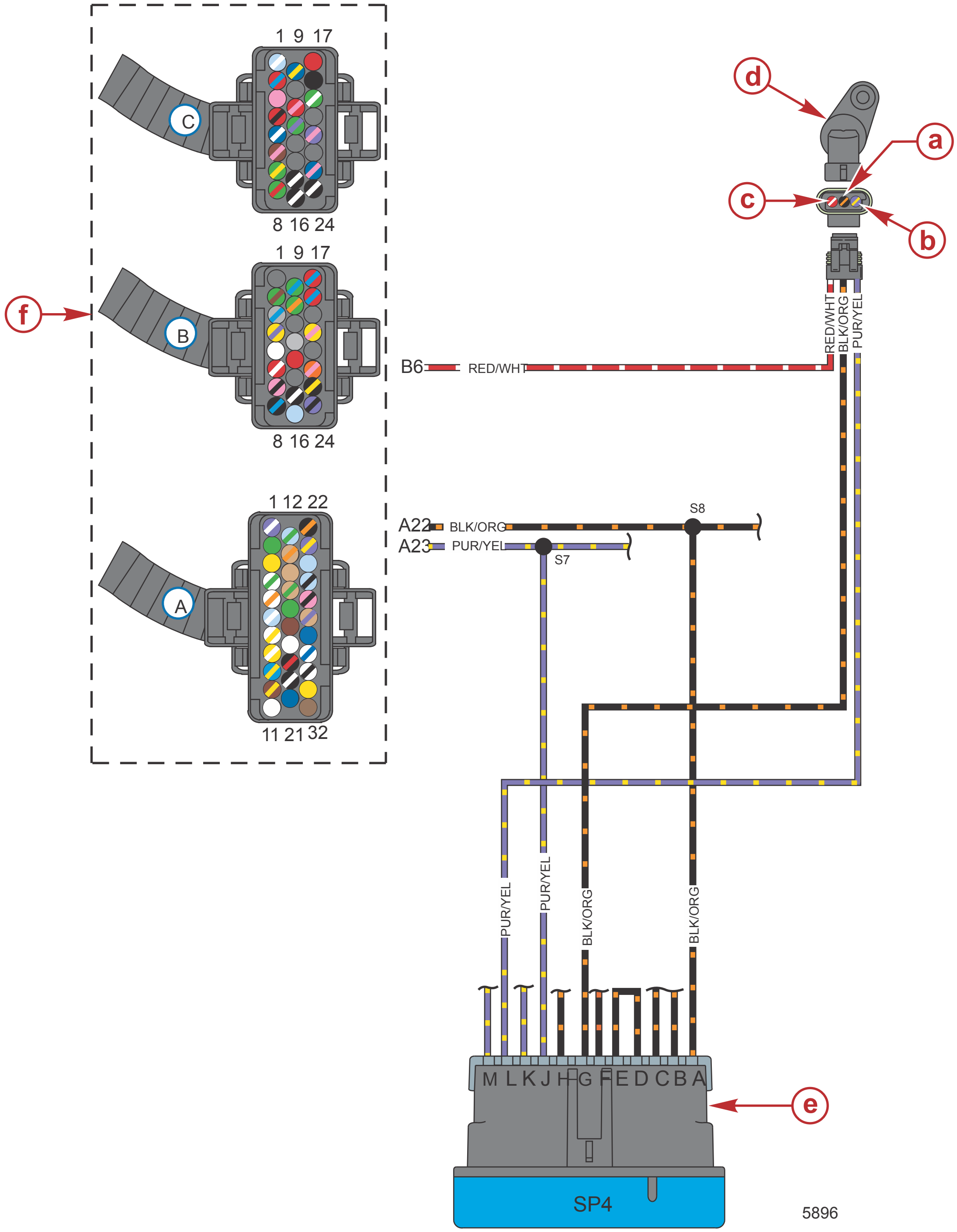


5903

a - Pin B (black/orange)
b - Pin C (purple/yellow)
c - Pin A (red/white)
d - Camshaft position sensor

4. If the ohmmeter check of the camshaft position sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector B pin 6 to red/white pin of sensor connector is less than 1 ohm.
   - PCM connector A pin 22 to black/orange pin of sensor connector is less than 1 ohm.
   - PCM connector A pin 23 to purple/yellow pin of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or in between the connector and the splice point.

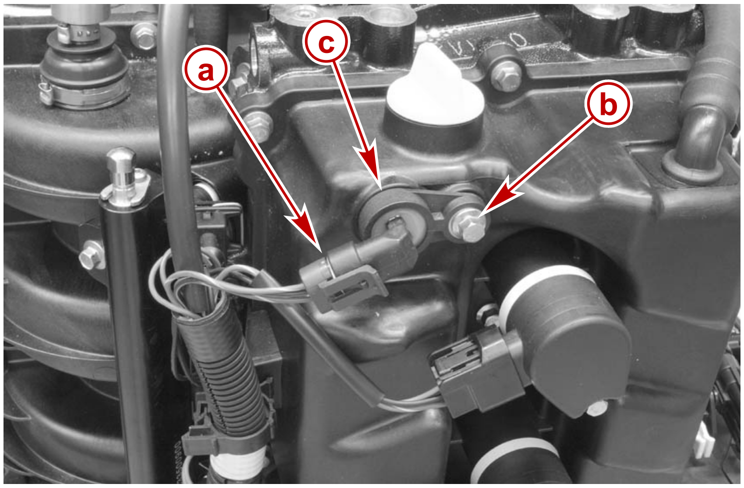


a - Pin B (black/orange)
b - Pin C (purple/yellow)
c - Pin A (red/white)
d - Camshaft position sensor
e - Splice saver SP4
f - PCM

5. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Camshaft Position Sensor Removal

1. Disconnect the sensor harness from the sensor.
2. Remove the screw securing the camshaft sensor and remove the sensor.

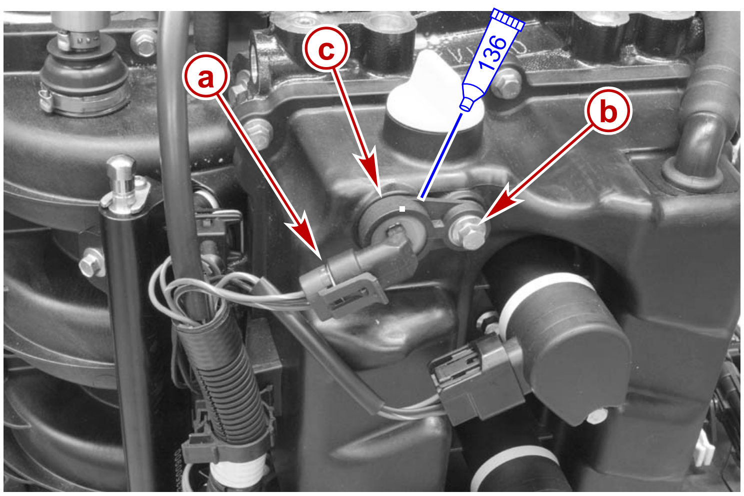


4569

a - Harness connector
b - Sensor attaching screw
c - Camshaft position sensor

Camshaft Position Sensor Installation

1. Apply Lubriplate SPO 255 to the sensor O-ring.
2. Install the sensor into the valve cover.
3. Secure the sensor with the screw. Tighten the screw to specification.
4. Connect the harness to the sensor.



5879

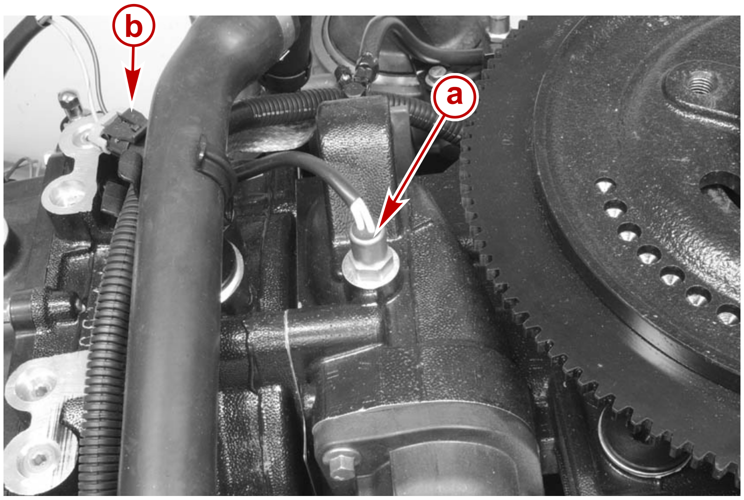
a - Harness connector
b - Screw
c - Camshaft position sensor

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Camshaft position sensor O-ring	Obtain Locally

Description	Nm	lb. in.	lb. ft.
Screw (M6 x 16)	8	70	

Cylinder Block Temperature Sensor

The cylinder block temperature sensor is located at the top of the cylinder block, aft of the flywheel. It is a thermistor immersed in the engine coolant path. It supplies the PCM with engine temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the cylinder block. Low coolant temperature produces high resistance. High coolant temperature causes low resistance. The normal resistance value for the sensor at 21 °C (70 °F) is 11.3 kΩ.



4574

a - Temperature sensor
b - Harness connector

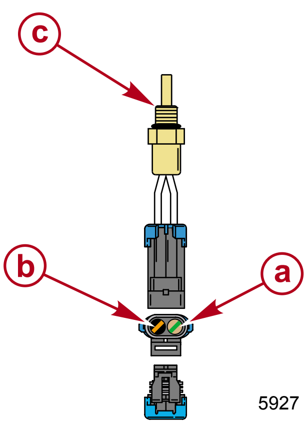
Cylinder Block Temperature Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the cylinder block temperature sensor by providing a numerical readout of the block temperature before and after the engine is started. With the engine not running, the cylinder block temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in cylinder block temperature to approximately 60–70 °C (140–158 °F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine cylinder block temperature.

1. With the engine running and the CDS connected to the engine, if the cylinder block temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



5927

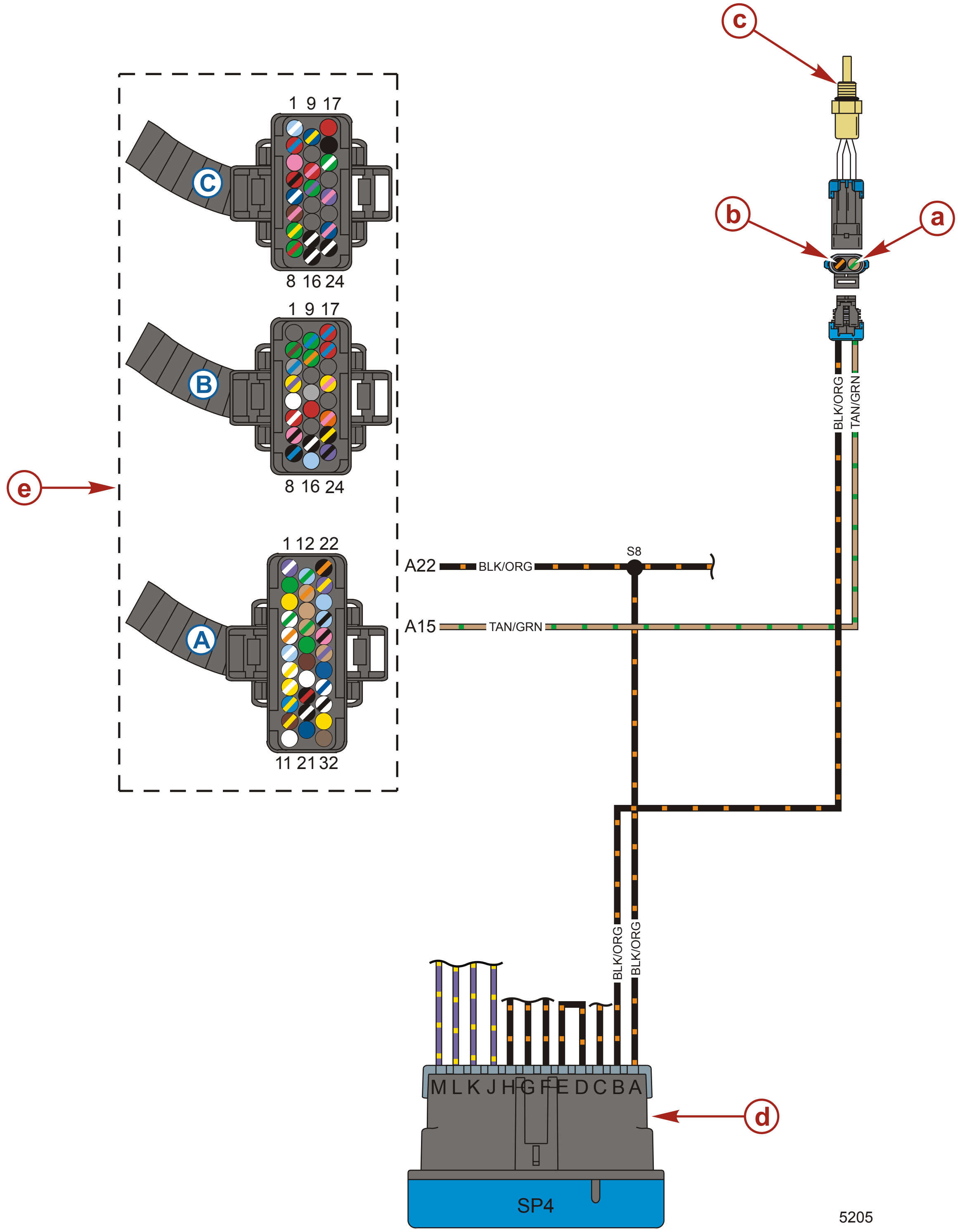
a - Pin A (tan/green)
b - Pin B (black/orange)
c - Cylinder block temperature sensor

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Block Temperature Sensor Ohm Test				
Degree centigrade	–10	21	38	65
Degree fahrenheit	14	70	100	149
kΩ	20 kΩ	11.3 kΩ	5.7 kΩ	2.1 kΩ

5. If the ohmmeter check of the cylinder block temperature sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 15 to tan/green pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



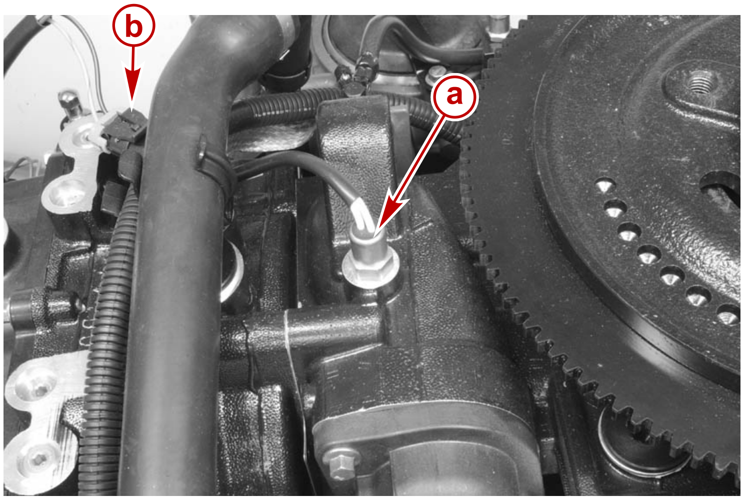
- **a -** Pin A (tan/green)
- **b -** Pin B (black/orange)
- **c -** Cylinder block temperature sensor
- **d -** Splice saver SP4
- **e -** PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Cylinder Block Temperature Sensor Removal

1. Remove the flywheel cover.
2. Disconnect the sensor harness connector.
3. Remove the sensor from the cylinder block.



4574

a - Temperature sensor
b - Harness connector

Cylinder Block Temperature Sensor Installation

1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Install the sensor with the O-ring into the cylinder block. Tighten the sensor to the specified torque.

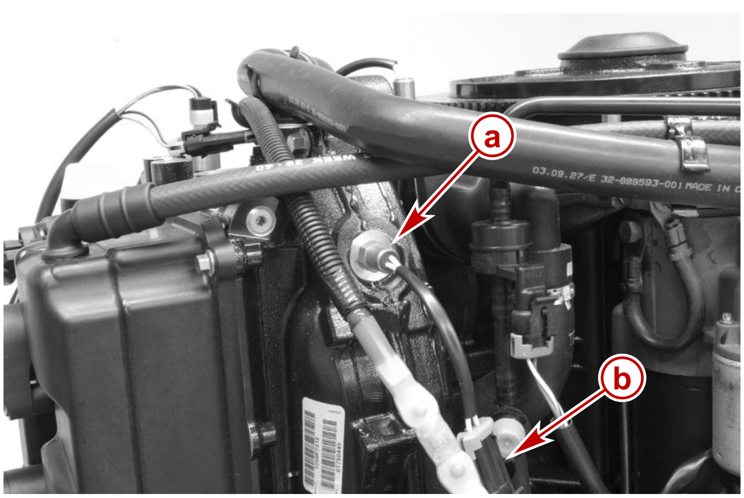
Description	Nm	lb-in.	lb-ft
Temperature sensor	15	133	–

3. Connect the sensor harness to the sensor.
4. Install the flywheel cover.

Cylinder Head Coolant Temperature Sensor

***NOTE:** Engines with S/N 1B517433 and below have a cylinder head coolant temperature sensor. Engines with S/N 1B517434 and above do not have a cylinder head coolant temperature sensor.*

The cylinder head coolant temperature sensor is a thermistor immersed in the engine coolant stream. It is located on the starboard side of the head near the top of the head. It supplies the PCM with temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the head. Low coolant temperature produces high resistance. High coolant temperature causes low resistance. The normal resistance value for the sensor at 21 °C (70 °F) is 11.3 kΩ.



4575

S/N 1B517433 and below
a - Cylinder head coolant temperature sensor
b - Harness connector

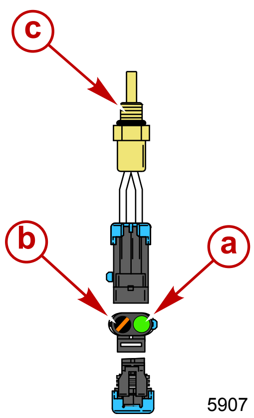
Cylinder Head Coolant Temperature Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the cylinder head coolant temperature sensor by providing a numerical readout of the head temperature before and after the engine is started. With the engine not running, cylinder head temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in head temperature to approximately 40–50 °C (104–122 °F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine block temperature.

1. With the engine running and the CDS connected to the engine, if the cylinder head coolant temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

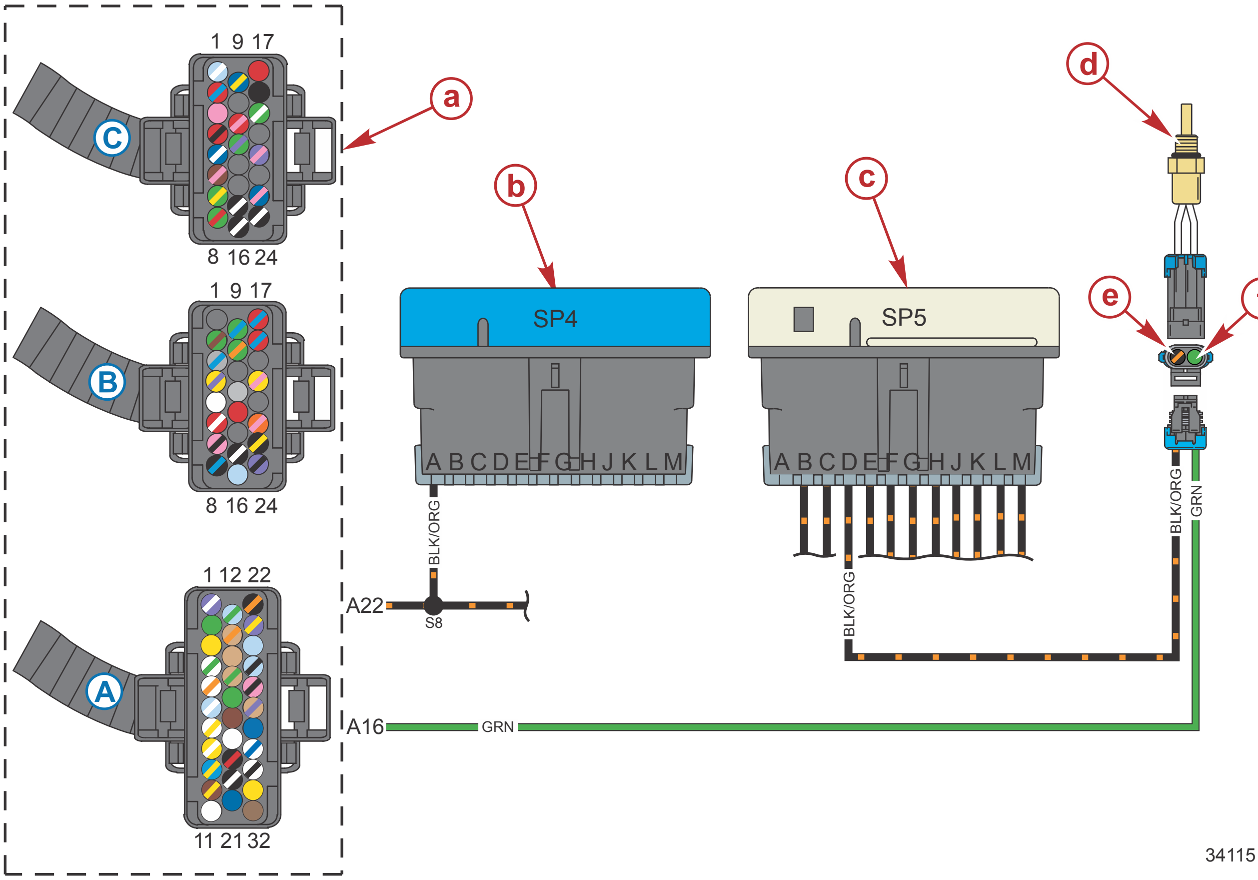


a - Pin A (green)
b - Pin B (black/orange)
c - Cylinder head coolant temperature sensor

Cylinder Head Coolant Temperature Sensor Ohm Test					
Degree centigrade	–10	21	38	65	95
Degree fahrenheit	14	70	100	149	203
KΩ	20 kΩ	11.3 kΩ	5.7 kΩ	2.1 kΩ	800 Ω

5. If the ohmmeter check of the cylinder head coolant temperature sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 16 to green pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



a - PCM
b - Splice saver SP4
c - Splice saver SP5
d - Cylinder head coolant temperature sensor
e - Pin B (black/orange)
f - Pin A (green)

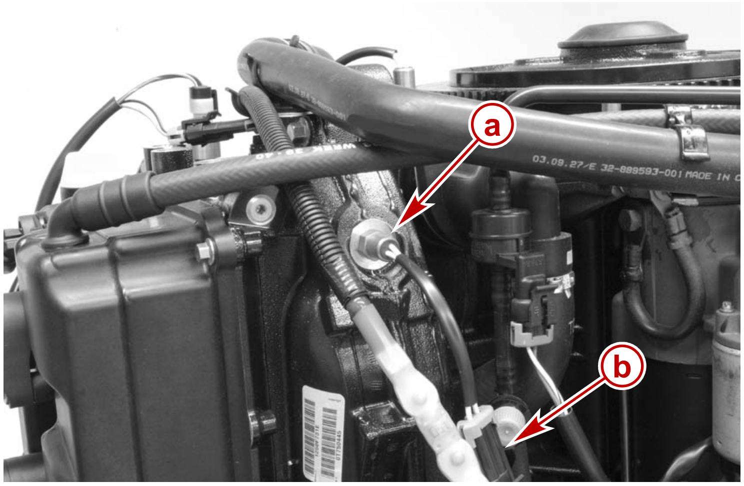
6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Cylinder Head Coolant Temperature Sensor Removal

1. Disconnect the sensor harness connector.

2. Remove the sensor from the cylinder block.



4575

S/N 1B517433 and below

- a - Cylinder head coolant temperature sensor
- b - Harness connector

Cylinder Head Coolant Temperature Sensor Installation

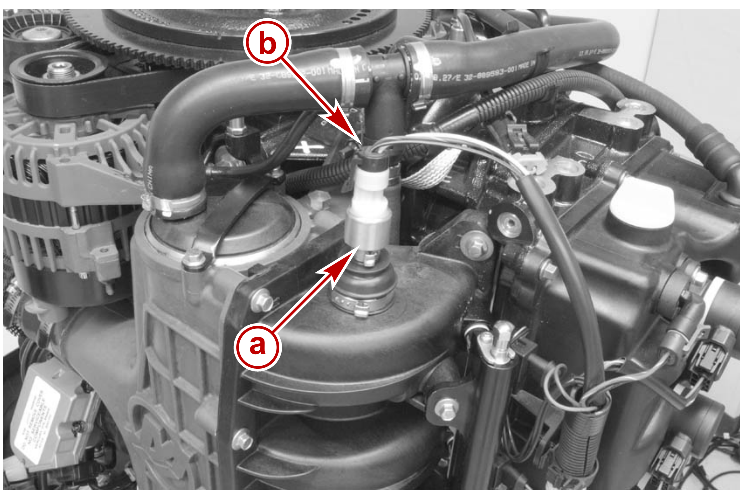
1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Install the sensor with the O-ring into the cylinder block. Tighten the sensor to the specified torque.

Description	Nm	lb-in.	lb-ft
Temperature sensor	15	133	–

3. Connect the sensor harness to the sensor.

Manifold Absolute Pressure (MAP) Sensor

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure. It is located at the top of the intake manifold. When the key is turned "ON," the MAP sensor reads the ambient atmospheric pressure. This information is used by the PCM as an indication of altitude and is referred to as BARO. The manifold absolute pressure will change as a result of engine load and speed changes.



4576

- a - MAP sensor
- b - Harness connector

Manifold Absolute Pressure Sensor Test

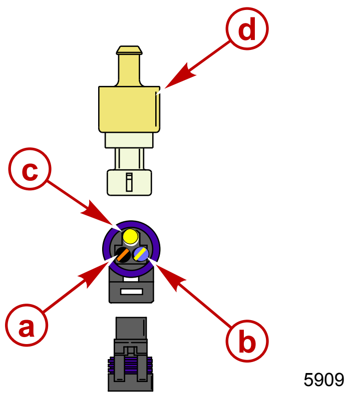
The computer diagnostic system (CDS) will determine the proper functioning of the MAP sensor by providing a numerical readout of the sensor after the engine is started.

Manifold Absolute Pressure Sensor Readings	
At idle	35–48 kPa (5–7 psi)
At wide-open throttle	195–200 kPa (28–29 psi)

1. With the engine running and the CDS connected to the engine, if the MAP sensor does not appear to be indicating a pressure change, shake or move the sensor harness and connector. If the pressure begins to change, look for broken, loose, or corroded wires.

Computer Diagnostic System (CDS)	Purchase from SPX*

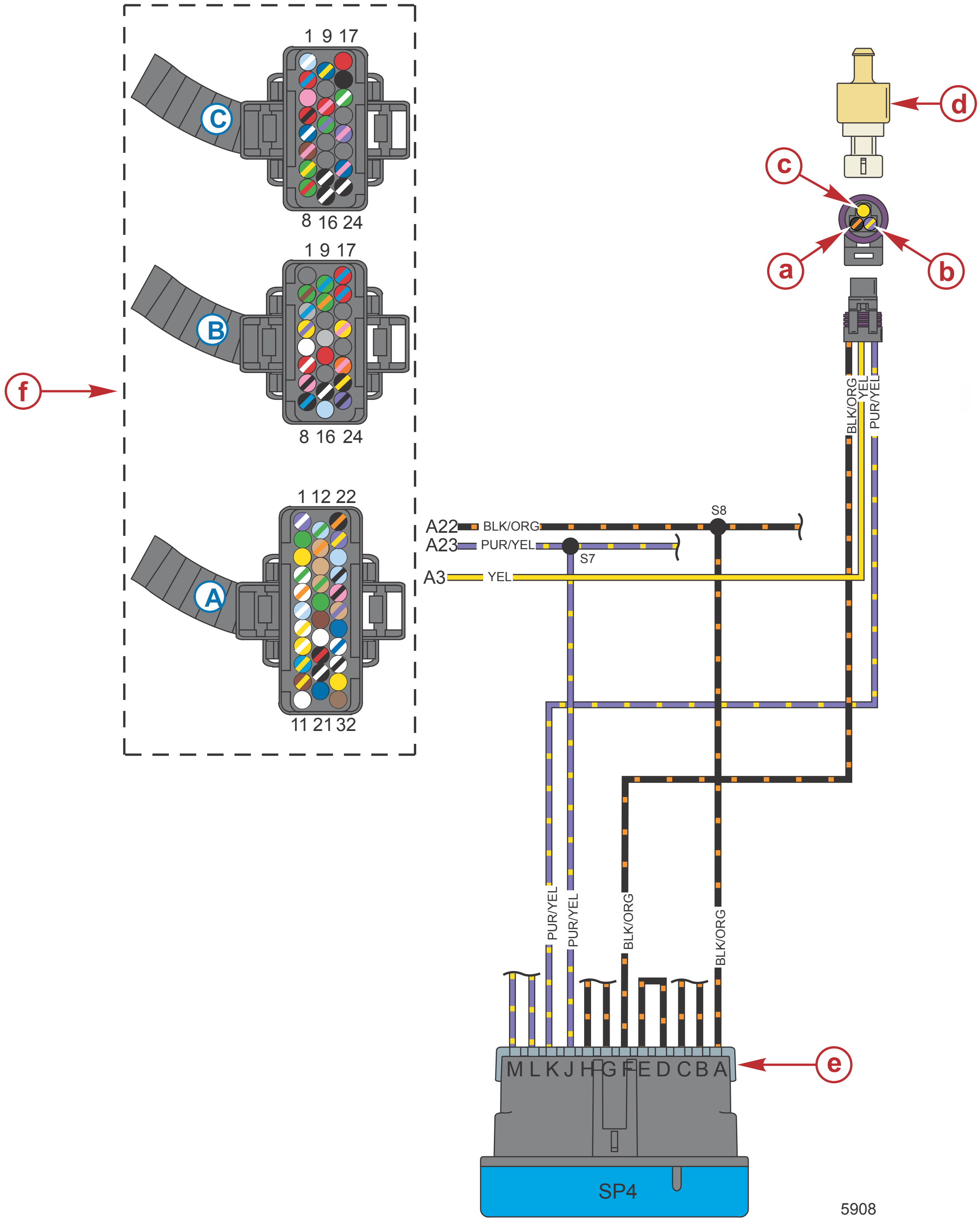
2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
4. An ohmmeter check of the MAP sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B, and C. The normal resistance values for the MAP sensor at 21 °C (70 °F) are:
   - Between pin A and pin B is 100–135 kΩ.
   - Between pin A and pin C is 240–305 kΩ.



a - Pin A (black/orange)
b - Pin B (purple/yellow)
c - Pin C (yellow)
d - MAP sensor

5. If the ohmmeter check of the MAP sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin A of sensor connector is less than 1 ohm.
   - PCM connector A pin 3 to yellow pin C of sensor connector is less than 1 ohm.
   - PCM connector A pin 23 to purple/yellow pin B of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



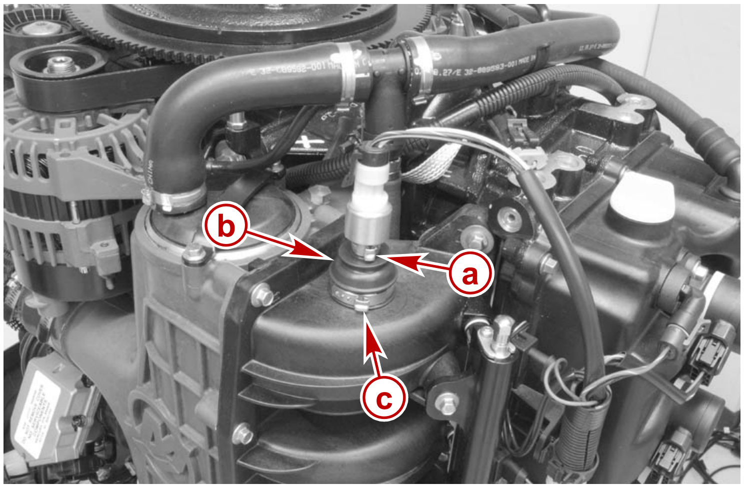
a - Pin A (black/orange)
b - Pin B (purple/yellow)
c - Pin C (yellow)
d - MAP sensor
e - Splice saver SP4
f - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Manifold Absolute Pressure Sensor Removal

1. Disconnect the sensor harness connector.
2. Remove the attaching clamp and remove the sensor from the adapter boot.
3. Inspect the adapter boot for cuts, cracks, or abrasions. Replace the boot as required.



5628

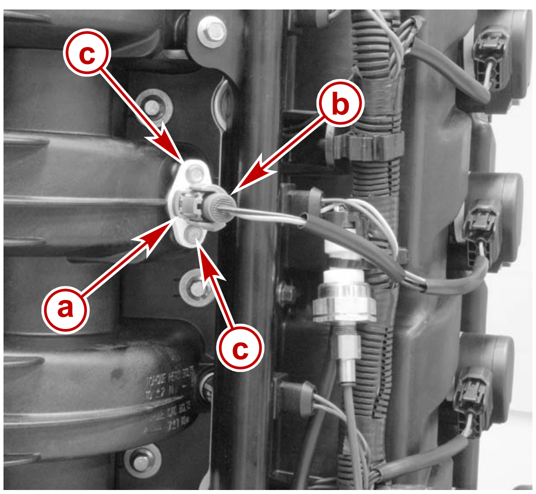
- a - Clamp 15.7 mm diameter
- b - Adapter boot
- c - Clamp 36.1 mm diameter

Manifold Absolute Pressure Sensor Installation

1. Install the sensor into the adapter boot. Secure the sensor with a new 15.7 mm diameter clamp.
2. Connect the sensor harness to the sensor.

Manifold Intake Air Temperature (MAT) Sensor

The manifold intake air temperature sensor is a thermistor that sends a signal voltage to the PCM. It is located in the middle of the intake manifold close to the fuel rail. It informs the PCM of the air temperature inside the intake manifold. The PCM adjusts the fuel injection duration needed to run the engine at optimum efficiency according to the MAT information. When intake air is cold, the sensor resistance is high. As the air temperature rises, resistance lowers.



4577

- a - MAT sensor
- b - Harness connector
- c - Screws (M4 x 16)

Manifold Intake Air Temperature Sensor Test

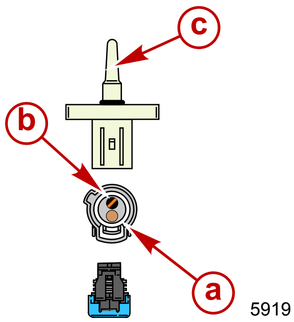
The computer diagnostic system (CDS) will determine the proper functioning of the MAT sensor by providing a numerical readout of the sensor temperature before and after the engine is started. With the engine not running, intake air temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in air intake temperature. Outside air temperature will directly affect the engine manifold air intake temperature.

Manifold Intake Air Temperature Sensor Resistance	
At 21 °C (70 °F)	2.26 kΩ ± 5%

1. With the engine running and the CDS connected to the engine, if the MAT sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



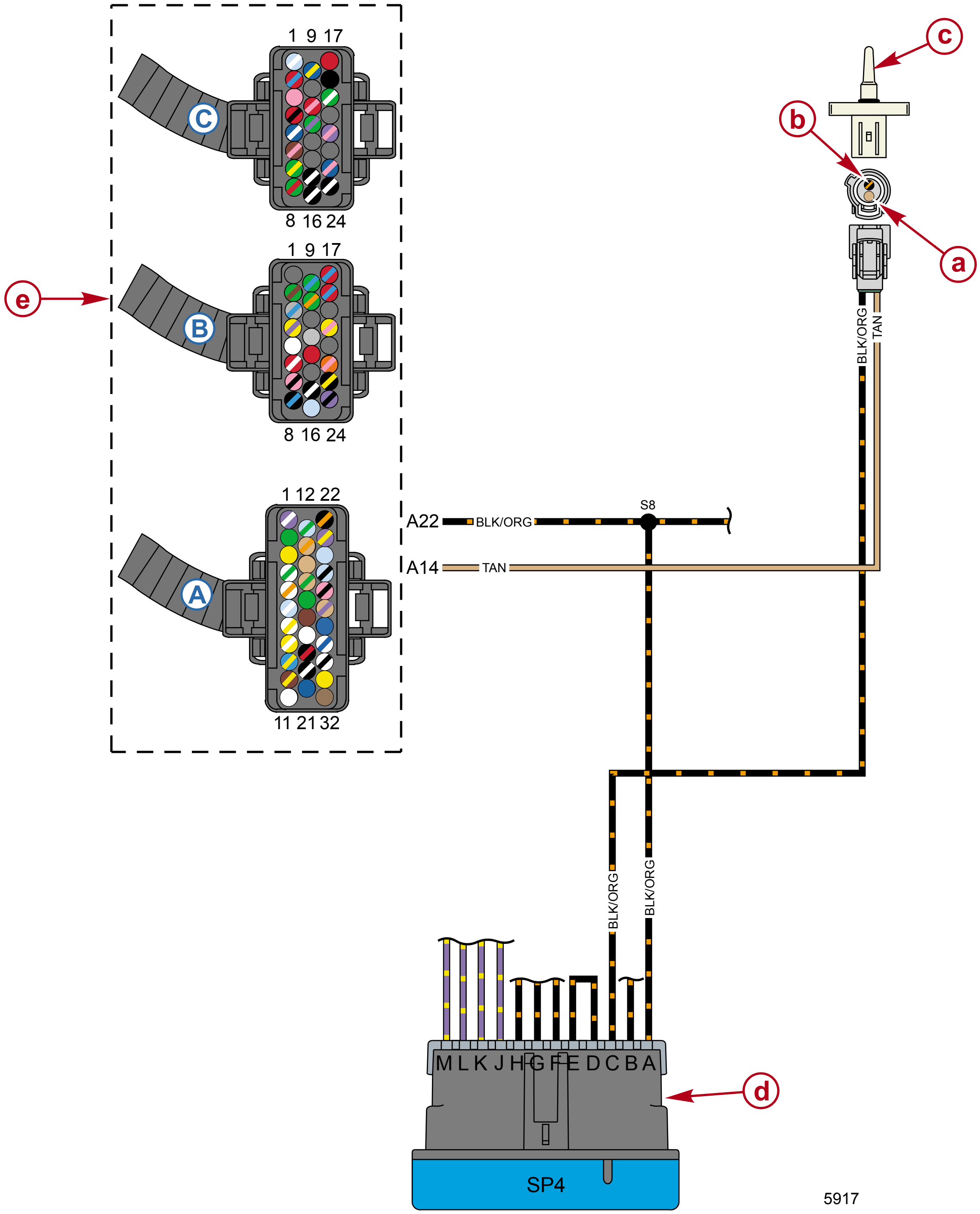
a - Pin A (tan)
b - Pin B (black/orange)
c - MAT sensor

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Manifold Intake Air Temperature Sensor Ohm Test				
Degree centigrade	–8	20	40	60
Degree fahrenheit	18	68	104	140
KΩ	9.82 kΩ ± 5%	2.57 kΩ ± 5%	1.13 kΩ ± 5%	0.54 kΩ ± 5%

5. If the ohmmeter check of the MAT sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 14 to tan pin A of sensor connector is less than 1 ohm.

NOTE: *All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.*



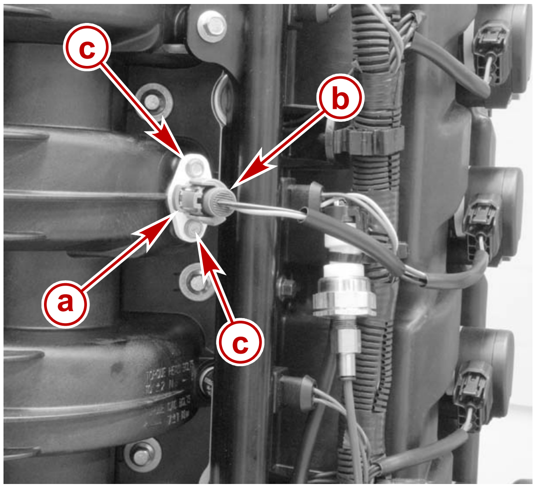
a - Pin A (tan)
b - Pin B (black/orange)
c - MAT sensor
d - Splice saver SP4
e - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Manifold Intake Air Temperature Sensor Removal

1. Disconnect the sensor harness connector.
2. Remove the two screws securing the sensor and remove the sensor.



4577

a - MAT sensor
b - Harness connector
c - Screws (M4 x 16)

Manifold Intake Air Temperature Sensor Installation

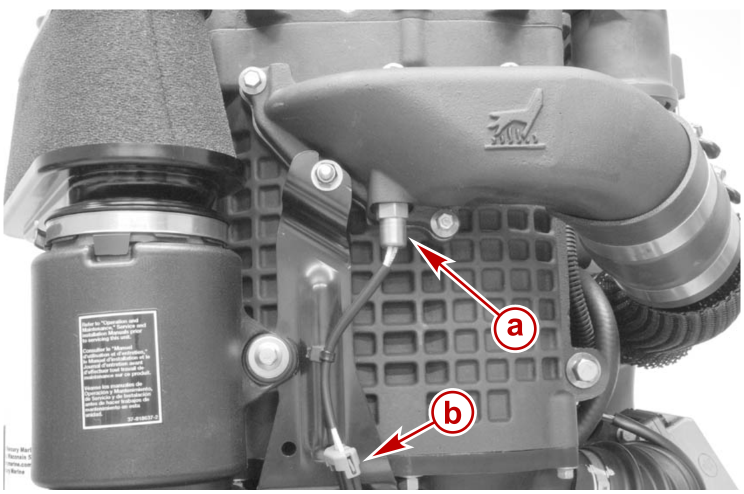
1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Install the sensor with the O-ring into the cylinder block. Tighten the sensor screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Sensor screw (M4 x 16)	1.7	15	–

3. Connect the sensor harness to the sensor.

Supercharger Outlet Temperature Sensor

The supercharger outlet temperature sensor is a thermistor immersed in the boost pressure outlet stream. It is located in the front of the engine, at the base of the outlet duct. Low air temperature produces high resistance. High air temperature causes low resistance. The PCM will reduce engine RPM and warn the helm of the high temperature.



4579

a - Supercharger outlet temperature sensor
b - Harness connector

Supercharger Outlet Temperature Sensor Test

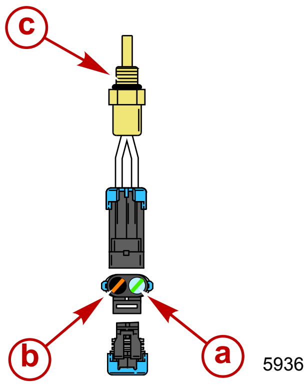
The computer diagnostic system (CDS) will determine the proper functioning of the supercharger outlet temperature sensor by providing a numerical readout of the sensor temperature before and after the engine is started. With the engine not running, the sensor temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in temperature.

Supercharger Outlet Temperature Sensor Resistance	
At 21 °C (70 °F)	11.3 kΩ

1. With the engine running and the CDS connected to the engine, if the sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



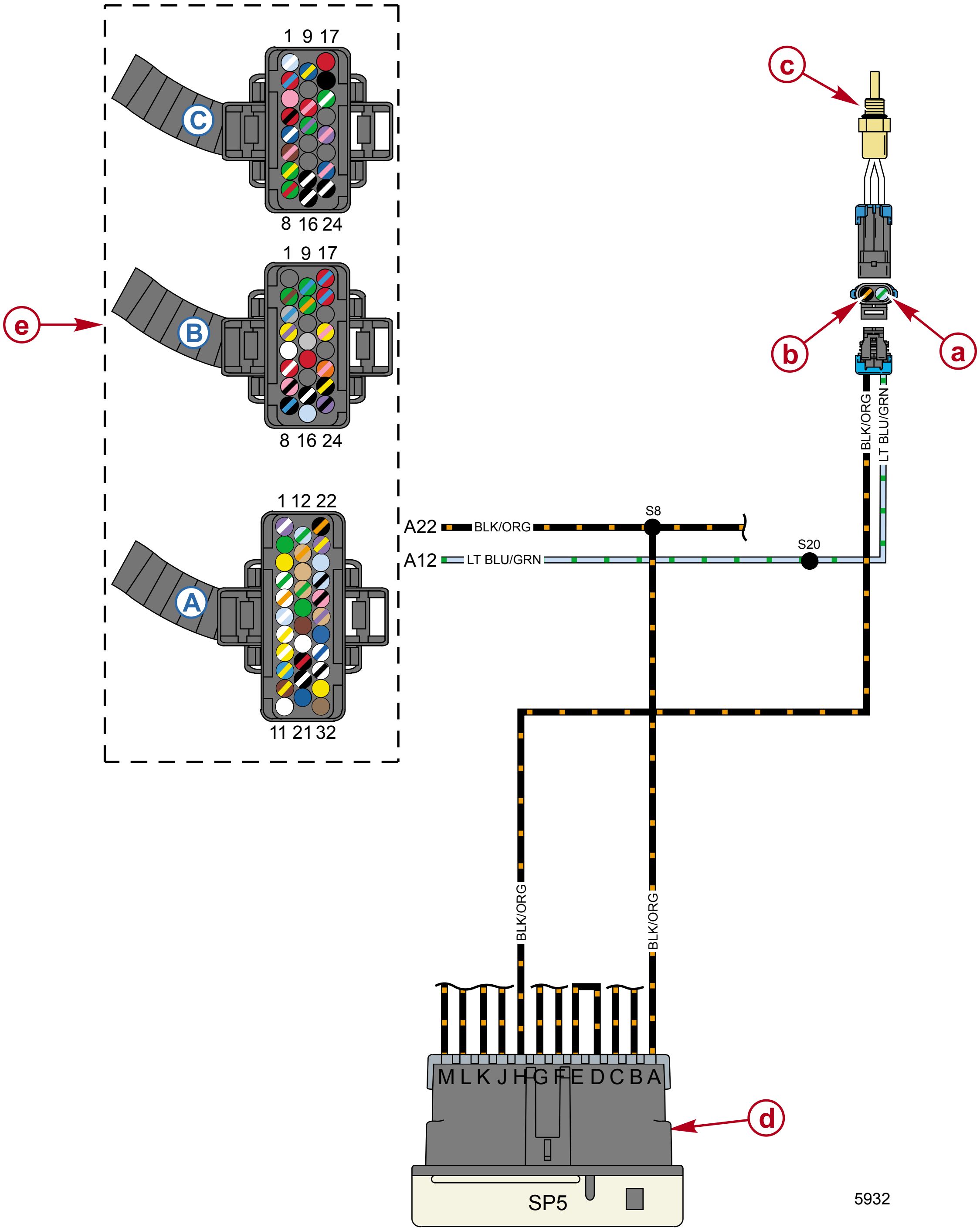
a - Pin A (light blue/green)
b - Pin B (black/orange)
c - Supercharger outlet temperature sensor

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Supercharger Outlet Temperature Sensor Ohmmeter Test					
Degree centigrade	10	21	38	65	160
Degree fahrenheit	48	70	100	149	320
KΩ	17.63 kΩ	10.90 kΩ	5.05 kΩ	2.01 kΩ	174 Ω

5. If the ohmmeter check of the sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 12 to light blue/green pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



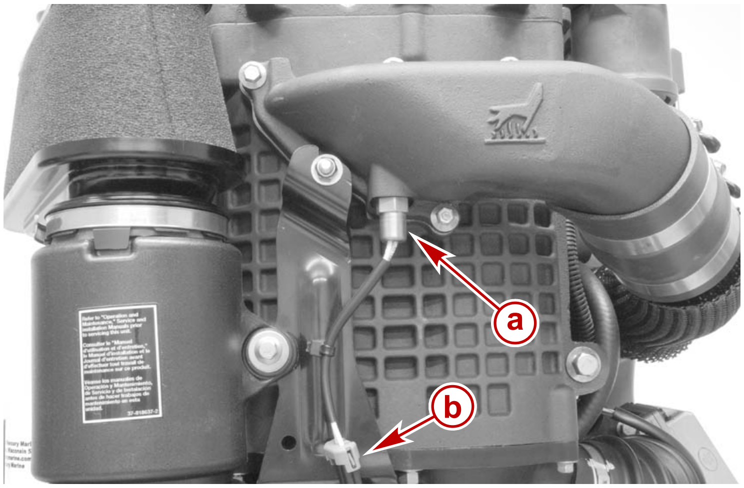
a - Pin A (light blue/green)
b - Pin B (black/orange)
c - Supercharger outlet temperature sensor
d - Splice saver SP5
e - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Supercharger Outlet Temperature Sensor Removal

1. Disconnect the sensor harness connector.
2. Remove the sensor from the outlet duct.



4579

a - Supercharger outlet temperature sensor
b - Harness connector

Supercharger Outlet Temperature Sensor Installation

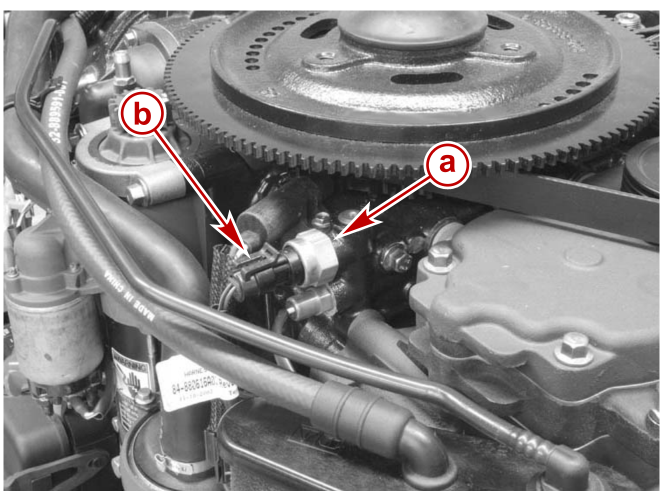
1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Install the sensor with the O-ring into the outlet duct. Tighten the sensor to the specified torque.

Description	Nm	lb-in.	lb-ft
Temperature sensor	15	133	–

3. Connect the sensor harness to the sensor.

Oil Pressure Sensor

The oil pressure sensor measures cylinder block oil pressure. It is located beside the CPS on the starboard side of the engine. In the event of low oil pressure, the PCM will limit engine power based on the amount of oil pressure available at a specific engine RPM.



5772

a - Oil pressure sensor
b - Harness connector

Oil Pressure Sensor Test

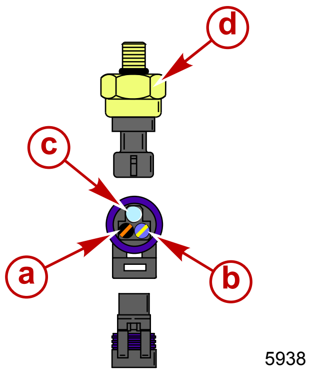
The computer diagnostic system (CDS) will determine the proper functioning of the oil pressure sensor by providing a numerical readout of the sensor after the engine is started.

Oil Pressure Sensor	
At idle	48–69 kPa (7–10 psi)
At wide-open throttle	448–655 kPa (65–95 psi)

1. With the engine running and the CDS connected to the engine, if the oil pressure sensor does not appear to be indicating a pressure change, shake or move the sensor harness and connector. If the pressure begins to change, look for broken, loose, or corroded wires.

Computer Diagnostic System (CDS)	Purchase from SPX*

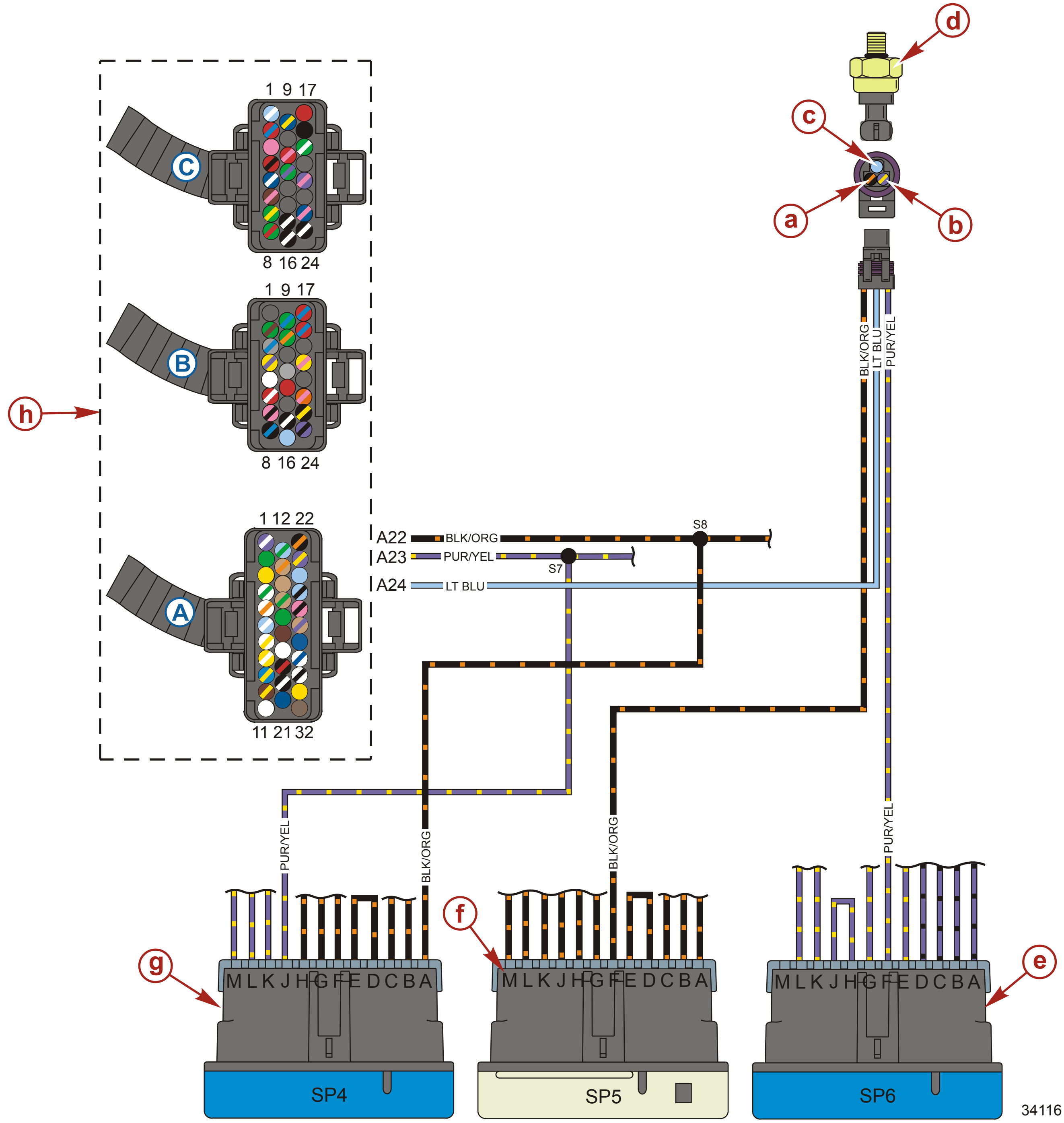
2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



a - Pin A (black/orange)
b - Pin B (purple/yellow)
c - Pin C (light blue)
d - Oil pressure sensor

4. An ohmmeter check of the oil pressure sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B, and C. The normal resistance values for the oil pressure sensor at 21 °C (70 °F) are:
   - Between pin A and pin B is 100–135 kΩ.
   - Between pin A and pin C is 240–305 kΩ.
5. If the ohmmeter check of the oil pressure sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin A of sensor connector is less than 1 ohm.
   - PCM connector A pin 23 to purple/yellow pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 24 to light blue pin C of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.

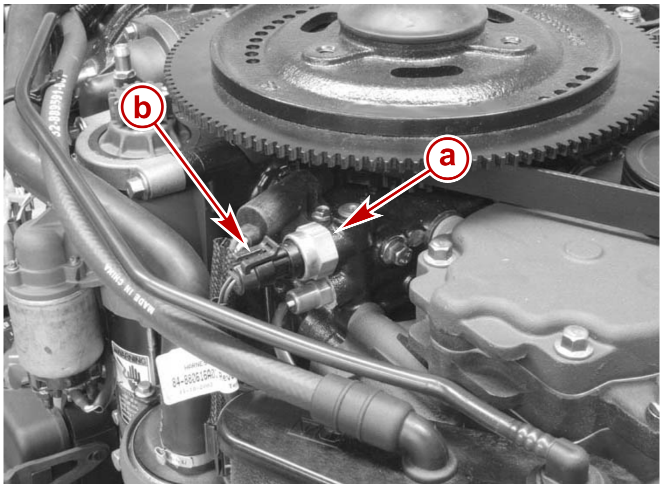


- a - Pin A (black/orange)
- b - Pin B (purple/yellow)
- c - Pin C (light blue)
- d - Oil pressure sensor
- e - Splice saver SP6
- f - Splice saver SP5
- g - Splice saver SP4
- h - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Oil Pressure Sensor Removal

1. Disconnect the sensor harness connector.
2. Remove the sensor from the cylinder block.



5772

a - Oil pressure sensor
b - Harness connector

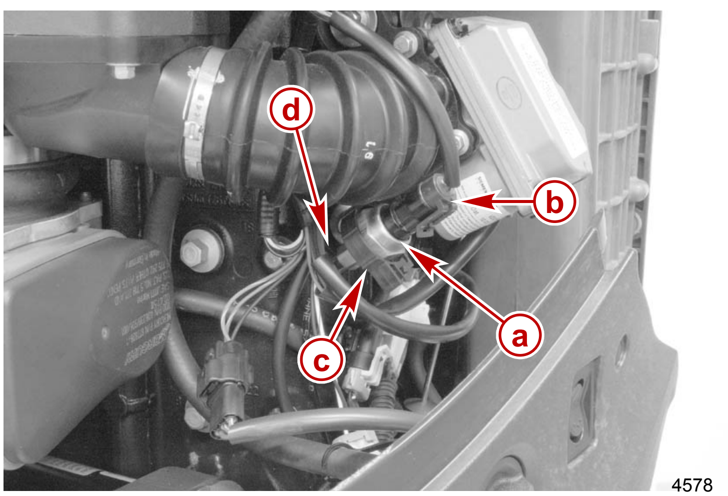
Oil Pressure Sensor Installation

1. Install the sensor into the cylinder block. Tighten the sensor to the specified torque.
2. Connect the sensor harness to the sensor.

Description	Nm	lb-in.	lb-ft
Oil pressure sensor	15	133	–

Pitot Pressure Sensor

The pitot pressure sensor measures the force of the water at the front of the gearcase. The sensor converts this pressure to a voltage which is sent to the PCM. The PCM uses this voltage signal to determine boat speed. The pitot pressure sensor is located beneath the electronic boost control front tube on the port side of the engine.



4578

a - Pitot pressure sensor
b - Harness connector
c - Sensor retainer
d - Sensor water tube

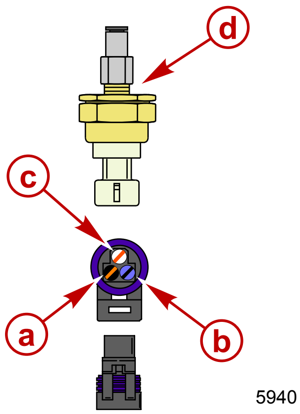
Pitot Pressure Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the pitot pressure sensor by providing a numerical readout of the sensor after the engine is started and the boat is moving forward through the water.

1. With the engine running and the boat moving forward and the CDS connected to the engine, if the pitot pressure sensor does not appear to be indicating a speed change, shake or move the sensor harness and connector. If the speed begins to change, look for broken, loose, or corroded wires.

Computer Diagnostic System (CDS)	Purchase from SPX*

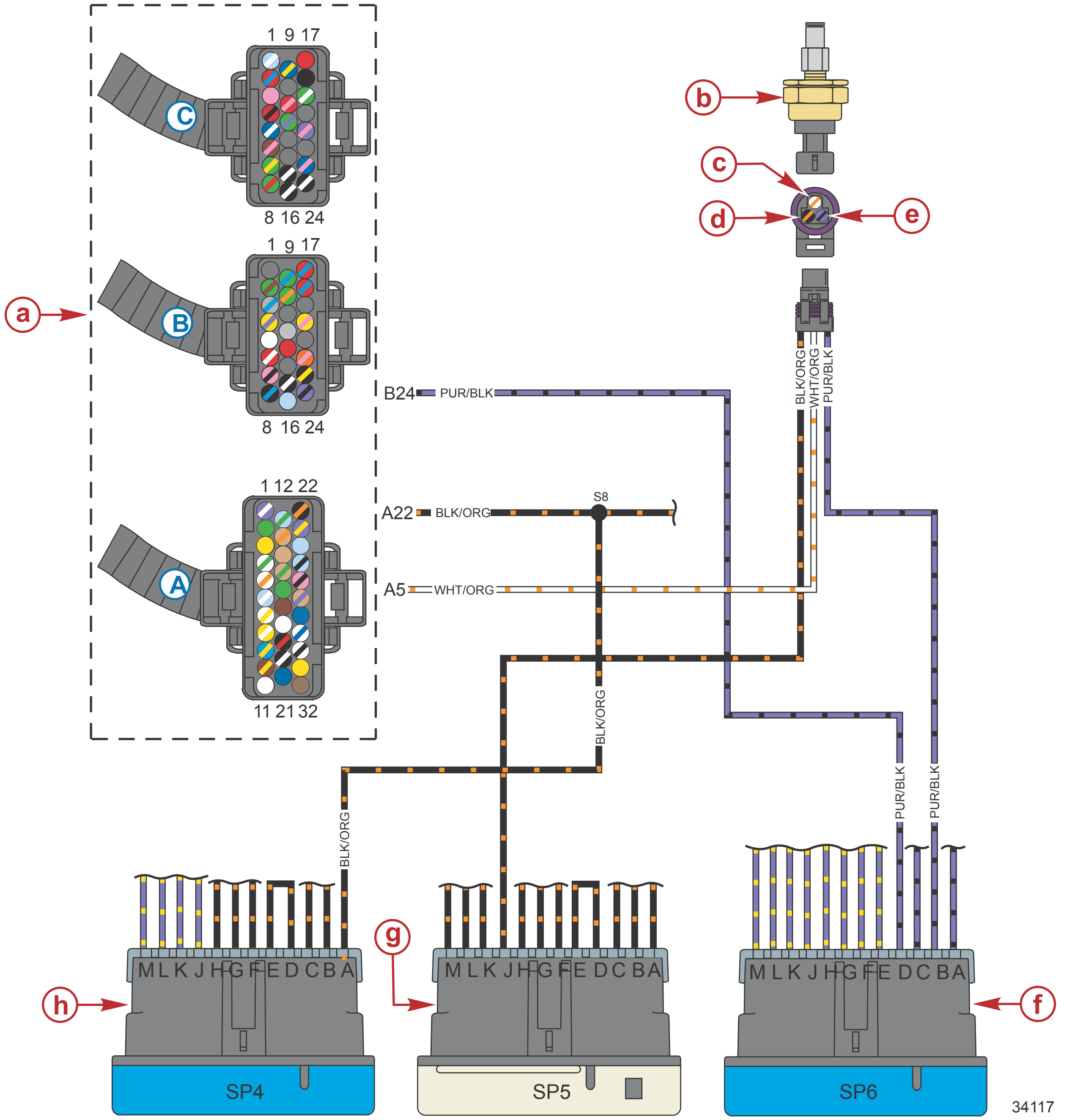
2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



a - Pin A (black/orange)
b - Pin B (purple/black)
c - Pin C (white/orange)
d - Pitot pressure sensor

4. An ohmmeter check of the pitot pressure sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B, and C. The normal resistance values for the pitot sensor at 21 °C (70 °F) are:
   - Between pin A and pin B is 100–135 kΩ.
   - Between pin A and pin C is 240–305 kΩ.
5. If the ohmmeter check of the pitot pressure sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin A of sensor connector is less than 1 ohm.
   - PCM connector B pin 24 to purple/black pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 5 to white/orange pin C of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



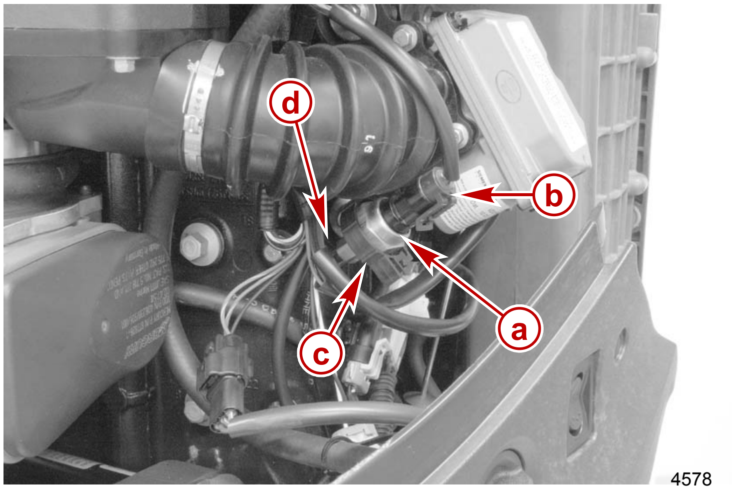
- **a -** PCM
- **b -** Pitot pressure sensor
- **c -** Pin C (white/orange)
- **d -** Pin A (black/orange)
- **e -** Pin B (purple/black)
- **f -** Splice saver SP6
- **g -** Splice saver SP5
- **h -** Splice saver SP4

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Pitot Pressure Sensor Removal

1. Disconnect the sensor harness connector.
2. Disconnect the sensor water tube.
3. Unlock the sensor retainer and remove the sensor.



4578

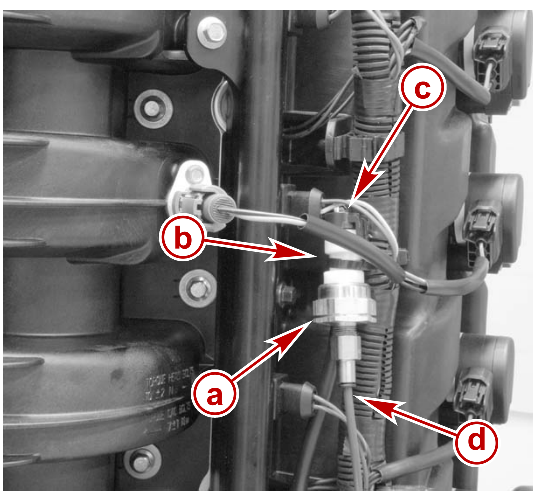
a - Pitot pressure sensor
b - Harness connector
c - Sensor retainer
d - Sensor water tube

Pitot Pressure Sensor Installation

1. Secure the sensor with the retainer.
2. Connect the sensor harness to the sensor.
3. Reconnect the sensor water tube.

Block Water Pressure Sensor

The block water pressure sensor measures the amount of coolant supplied by the water pump to the cylinder block. The sensor converts this pressure to a voltage which is sent to the PCM. The PCM will limit engine power if the coolant supply (water pressure) is insufficient at a given RPM. The water pressure sensor is located on the aft side of the engine and is secured to the fuel injector harness with a cable tie.



5850

a - Block water pressure sensor
b - Cable tie
c - Harness connector
d - Sensor coolant tube

Block Water Pressure Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the water pressure sensor by providing a numerical readout of the sensor after the engine is started and engine RPM is varied.

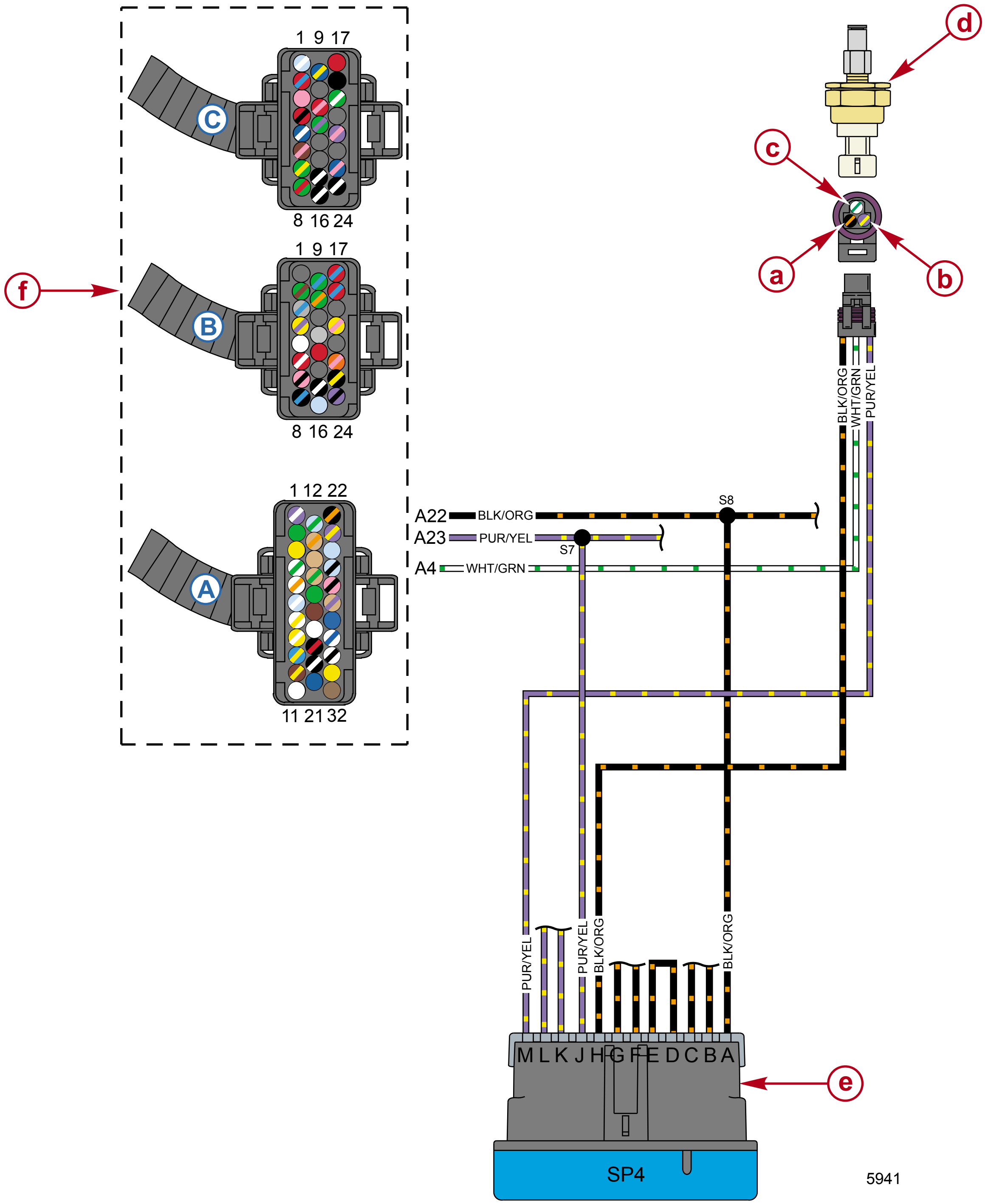
1. With the engine running and the CDS connected to the engine, if the water pressure sensor does not appear to be indicating a pressure change when engine RPM is varied, shake or move the sensor harness and connector. If the pressure begins to change, look for broken, loose, or corroded wires.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
4. Perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:
   - PCM connector A pin 22 to black/orange pin A of sensor connector is less than 1 ohm.
   - PCM connector A pin 23 to purple/yellow pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 4 to white/green pin C of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



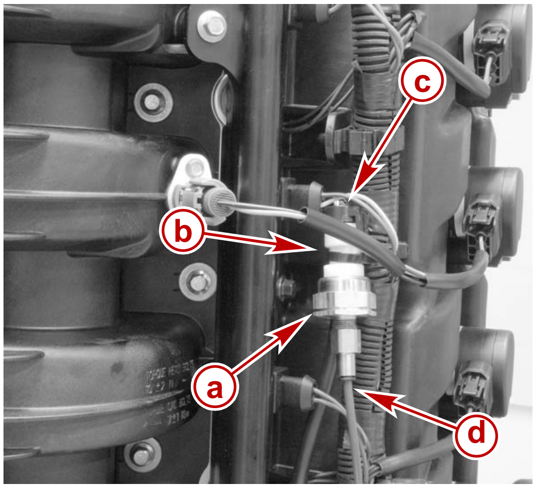
- **a -** Pin A (black/orange)
- **b -** Pin B (purple/yellow)
- **c -** Pin C (white/green)
- **d -** Block pressure sensor
- **e -** Splice saver SP4
- **f -** PCM

5. If the wiring is serviceable, the PCM can be tested using the computer diagnostic system with the pinpoint guided diagnostic instructions. If the PCM is serviceable, replace the sensor.

Computer Diagnostic System (CDS)	Purchase from SPX*

Block Water Pressure Sensor Removal

1. Disconnect the sensor harness connector.
2. Remove the water pressure sensor coolant tube.
3. Cut the cable tie securing the sensor and remove the sensor.



5850

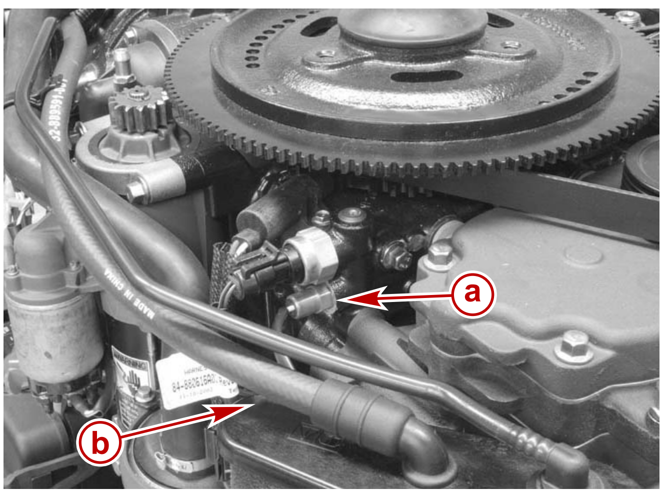
a - Block water pressure sensor
b - Cable tie
c - Harness connector
d - Coolant tube

Block Water Pressure Sensor Installation

1. Connect the sensor harness.
2. Install the coolant tube to the sensor.
3. Secure the sensor to the fuel injector wiring harness with a cable tie.

Oil Temperature Sensor

The oil temperature sensor is located at the top of the cylinder block, below the oil pressure sensor. It is a thermistor immersed in the engine oil passage way. It supplies the PCM with engine oil temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the oil temperature in the cylinder block. Low oil temperature produces high resistance. High oil temperature causes low resistance. The normal resistance value for the sensor at 21 °C (70 °F) is 11.3 kΩ.



5851

a - Oil temperature sensor
b - Harness connection (not shown)

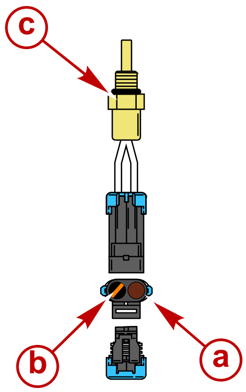
Oil Temperature Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the oil temperature sensor by providing a numerical readout of the oil temperature before and after the engine is started. With the engine not running, oil temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in oil temperature to approximately 75–110 °C (167–230 °F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine oil temperature.

1. With the engine running and the CDS connected to the engine, if the oil temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Purchase from SPX*

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.



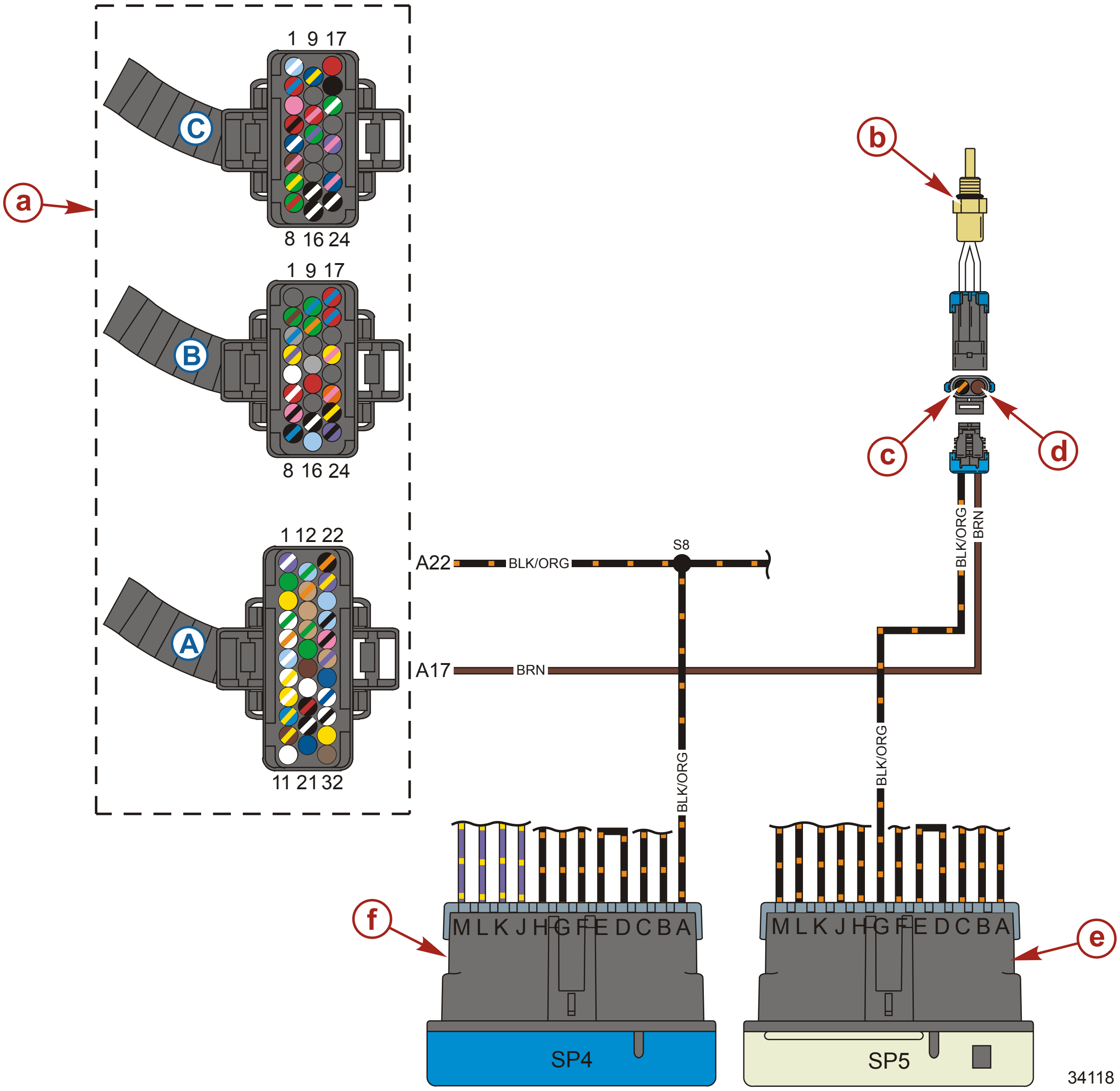
a - Pin A (brown)
b - Pin B (black/orange)
c - Oil temperature sensor

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.
5. If the ohmmeter check of the oil temperature sensor indicates that the sensor is serviceable, perform an ohmmeter check of the sensor wiring between the sensor connector and the PCM as follows:

Oil Temperature Sensor Ohmmeter Test					
Degree centigrade	–10	21	38	65	95
Degree fahrenheit	14	70	100	149	203
kΩ	20 kΩ	11.3 kΩ	5.7 kΩ	2.1 kΩ	800 Ω

- PCM connector A pin 22 to black/orange pin B of sensor connector is less than 1 ohm.
- PCM connector A pin 17 to brown pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connected to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or between the connector and the splice point.



a - PCM
b - Oil temperature sensor
c - Pin B (black/orange)
d - Pin A (brown)
e - Splice saver SP5
f - Splice saver SP4

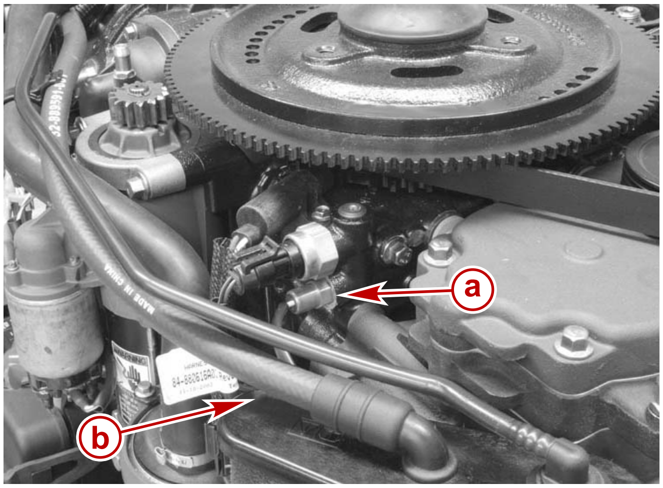
6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the computer diagnostic system.

Computer Diagnostic System (CDS)	Purchase from SPX*

Oil Temperature Sensor Removal

1. Disconnect the sensor harness connector.

2. Remove the sensor from the cylinder block.



5851

a - Oil temperature sensor
b - Harness connection (not shown)

Oil Temperature Sensor Installation

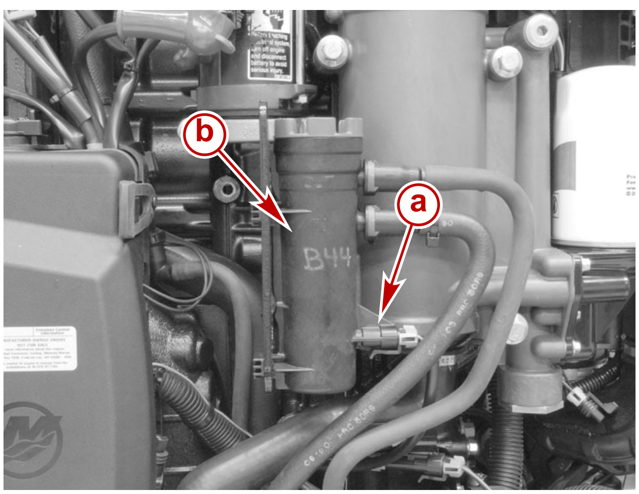
1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Install the sensor with the O-ring into the cylinder block. Tighten the sensor to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil temperature sensor	15	133	–

3. Connect the sensor harness to the sensor.

Water in Fuel (WIF) Sensor

The water in fuel sensor is located in the lower portion of the engine fuel filter which is mounted on the starboard side of the engine. The sensor is a normally open switch which when exposed to water completes a circuit and activates a warning horn.

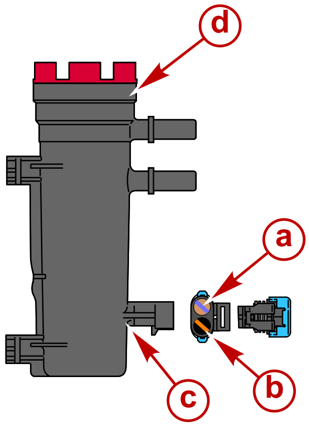


5892

a - Water in fuel sensor
b - Fuel filter assembly

Water in Fuel Sensor Test

1. If the water in fuel warning horn activates, remove the fuel filter assembly from the engine and pour the contents into a clear container. If no water is present, disconnect the water in fuel sensor harness and perform a continuity check between the two sensor pins. There should be no continuity. If there is continuity, the sensor is defective and the fuel filter assembly must be replaced.

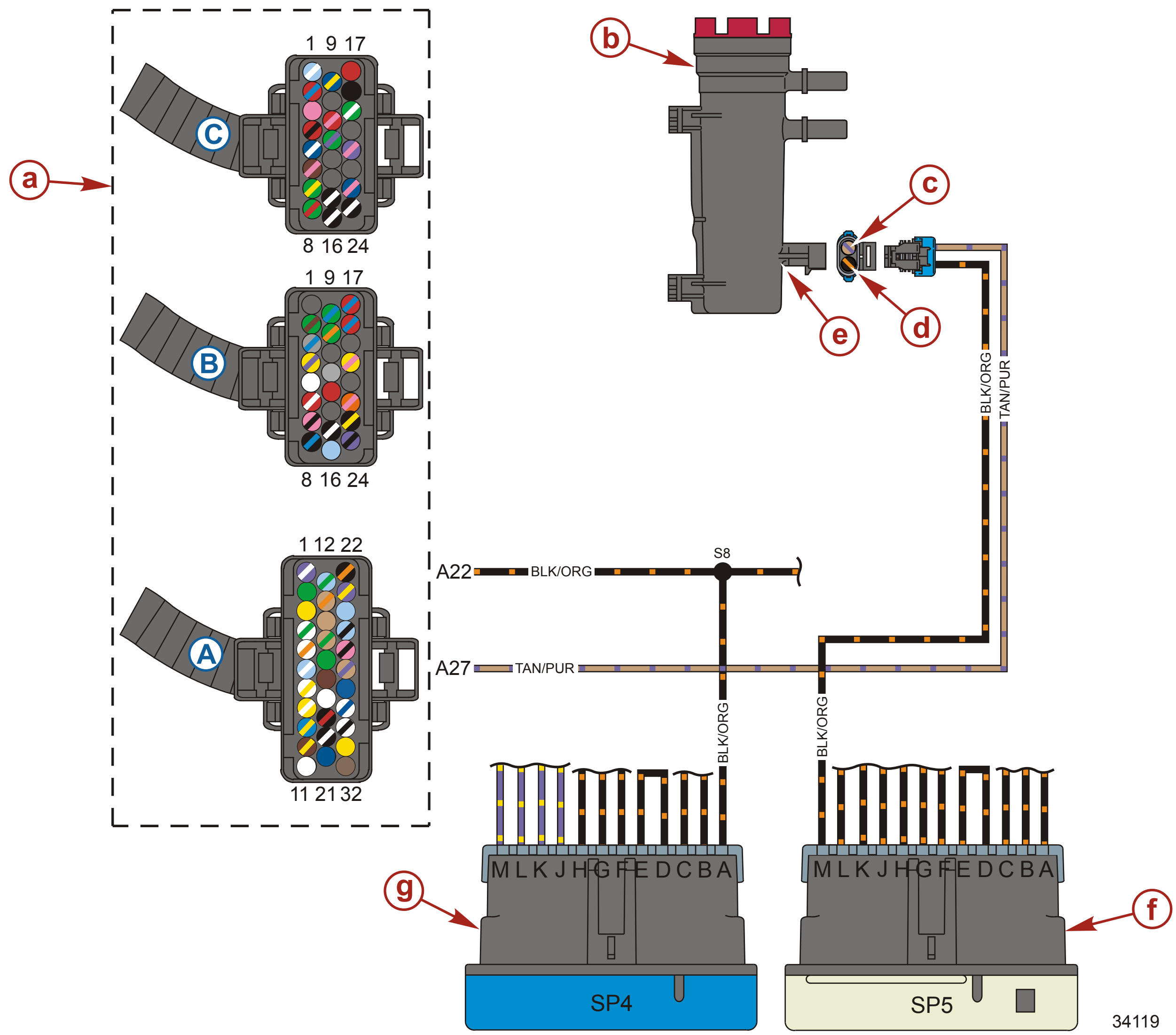


5986

a - Pin A (tan/purple)
b - Pin B (black/orange)
c - Water in fuel sensor
d - Fuel filter

2. If the sensor is serviceable, perform a continuity check on the sensor harness between the sensor connector and the PCM. Check for shorts to ground.
   - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
   - PCM connector A pin 27 to pin A of sensor connector is less than 1 ohm. There should be no shorts to ground.

All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or in between the connector and the splice point.



a - PCM
b - Fuel filter
c - Pin A (tan/purple)
d - Pin B (black/orange)
e - Water in fuel sensor
f - Splice saver SP5
g - Splice saver SP4

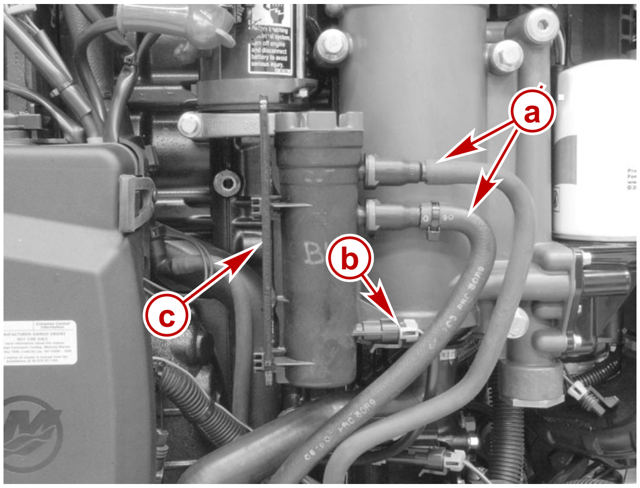
If the sensor harness is serviceable, replace the PCM.

Water in Fuel Sensor Removal

NOTE: *The water in fuel sensor is not replaceable as an individual component. It must be replaced as part of the fuel filter assembly.*

1. Disconnect sensor harness.
2. Remove two fuel hoses from fuel filter.

3. Slide fuel filter assembly up and out of the retaining bracket.



5895

a - Fuel hoses
b - Harness connector
c - Retaining bracket

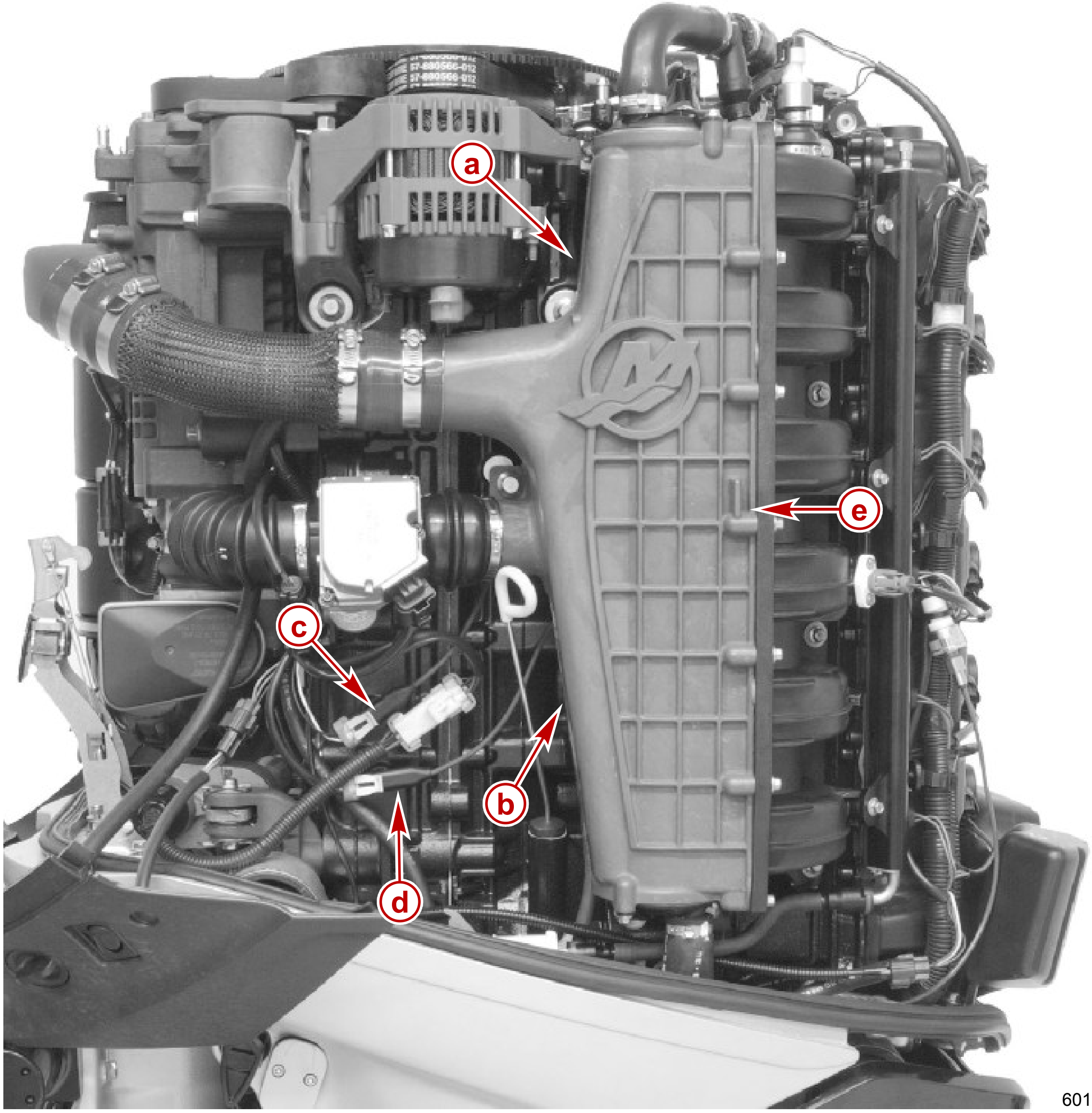
Water in Fuel Sensor Installation

1. Slide fuel filter assembly into retaining bracket.
2. Reconnect fuel hoses.
3. Reconnect sensor harness.

Knock Sensor

There are two knock sensors located on the port side of the engine behind the charge cooler/intake manifold. The knock sensors are piezoelectric transducers with a 1–2 mv per Gforce output signal. When detonation occurs in a cylinder, a vibration is generated in the cylinder block which activates the knock sensors to produce their output signal to the PCM. The PCM will reduce timing and/or increase fuel into the cylinders until the detonation stops.

IMPORTANT: The knock sensor harness connections must not be interchanged with one another. The PCM is calibrated to receive detonation information from a specific location. Switching harness connections between knock sensors may allow certain levels of detonation to occur unimpeded by the PCM, resulting in engine damage.



6010

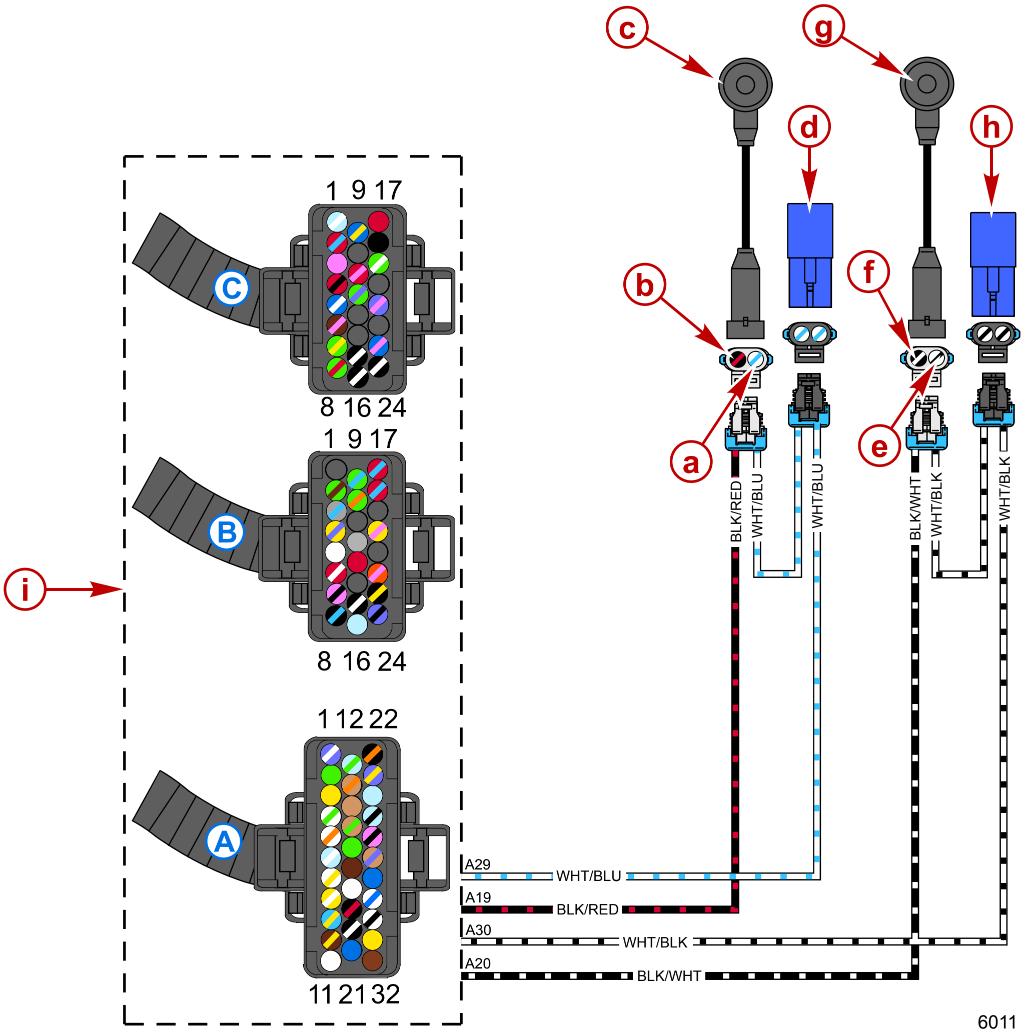
- a - Upper knock sensor (hidden behind charge cooler/intake manifold)
- b - Lower knock sensor (hidden behind charge cooler/intake manifold)
- c - Upper knock sensor connector (white/blue wire)
- d - Lower knock sensor connector (white/black wire)
- e - Charge cooler/intake manifold

Knock Sensor Test

There is no practical field test for this device. Check connector for bent, broken, or corroded pins. Perform continuity check between knock sensor connectors and PCM. Consult the PCM fault codes. If the PCM indicates a fault, test the connector and wire connections.

- PCM connector A pin 29 to pin A (white/blue) of upper knock sensor connector is 20 kΩ (± 10%).
- PCM connector A pin 19 to pin B (black/red) of upper knock sensor connector is less than 1 ohm.
- PCM connector A pin 30 to pin E (white/black) of lower knock sensor is 20 kΩ (± 10%).

- PCM connector A pin 20 to pin F (black/white) of lower knock sensor connector is less than 1 ohm.



a - Pin A (white/blue) (upper knock sensor connector)
b - Pin B (black/red) (upper knock sensor connector)
c - Upper knock sensor
d - Resistor (upper knock sensor)
e - Pin A (white/black) (lower knock sensor connector)
f - Pin B (black/white) (lower knock sensor connector)
g - Lower knock sensor
h - Resistor (lower knock sensor)
i - PCM

Knock Sensor Removal

1. Refer to **Section 4A** for charge cooler/intake manifold removal procedures.
2. Disconnect the knock sensor harness connectors.
3. Remove the screw and washer securing the knock sensor and remove the sensor.

Knock Sensor Installation

1. Secure the knock sensor with a screw and washer. Tighten the screw to specification.

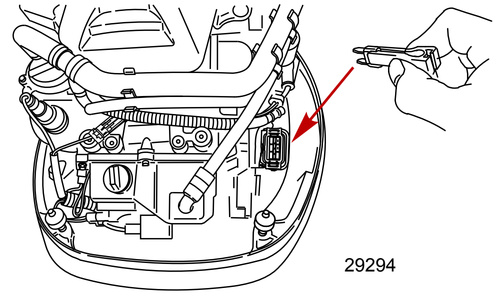
Description	Nm	lb. in.	lb. ft.
Screw (M10 x 35)	20		15

2. Reconnect the sensor harness to the sensor.
3. Refer to **Section 4A** for the installation procedures for the charge cooler/intake manifold.

Fuses

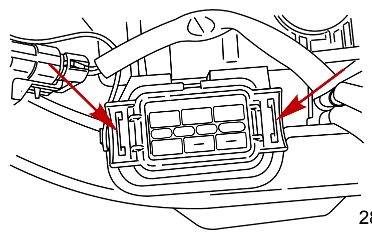
The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

1. Remove the top cowl. Locate the fuse holder on the starboard side of the engine.

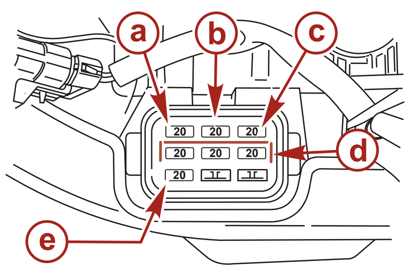


29294

2. Remove the plastic cover from the fuse holder.
3. Remove the fuse puller from the fuse holder.
4. Remove the suspected blown fuse to determine if the silver colored band is broken.
5. Replace the fuse with a new fuse of the same amperage rating.



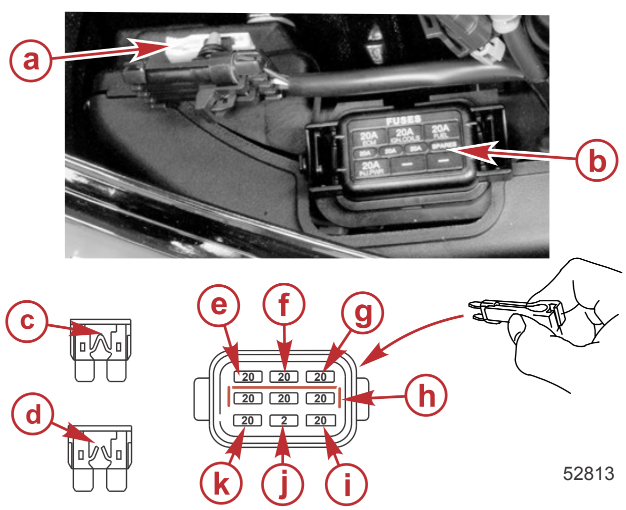
28767



28776

S/N 1B390142 and below

a - Electronic control module and purge valve - 20-amp fuse "ECM"
b - Ignition coils - 20-amp fuse "IGN. COILS"
c - Fuel delivery - 20-amp fuse "FUEL"
d - Spare fuses - 20-amp fuse
e - Injector power and boost valve - 20-amp fuse "INJ. PWR."



52813

S/N 1B390143 and above

a - Fuse puller
b - Fuse holder
c - Good fuse
d - Blown fuse
e - Electronic control module and purge valve - 20-amp fuse "ECM"
f - Ignition coils - 20-amp fuse "IGN. COILS"
g - Fuel delivery - 20-amp fuse "FUEL"
h - Spare fuses (3) - 20-amp fuse
i - Thrust vector module (TVM) – 20-amp fuse (for Mercury Joystick Piloting models only)
j - Diagnostics terminal - 2-amp fuse
k - Injector power and boost valve - 20-amp fuse "INJ. PWR."

Notes:

Electrical System

Section 2B - Charging and Starting System

2
B

Table of Contents

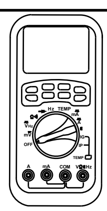
Charging and Starting Specifications

Charging and Starting Specifications	
Alternator output (regulated)	
Output at battery (at 1000 RPM)	37–44 A
Output at battery (at 3000 RPM)	53–69 A
Output at alternator (at 1000 RPM)	48–54 A
Output at alternator (at 3000 RPM)	65–72 A
Voltage set point	14.5 ± 0.25 V
Regulator current draw[1]	
Ignition switch "OFF" (maximum)	1.0 mA
Ignition switch "ON"	350 mA
Starter draw (under load)	160 A
Starter draw (no load)	60 A
Minimum brush length	6.4 mm (0.25 in.)
Battery rating	
Required starting battery type	12 V absorbed glass mat (AGM)
USA and Canada (SAE) requirement	800 minimum marine cranking amps (MCA) with a minimum reserve capacity of 135 RC25 rating
International (EN) requirement	975 minimum cold cranking amps (CCA) with a minimum of 65 ampere hours (Ah) rating

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter motor threads and cable ends	92- 25711 3
		Alternator cable ends	
		Starter bolt; ground wire eyelet	
		Starter exciter wire terminal; battery starter cable	
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1
120	Corrosion Guard	Battery terminals	92-802878 55

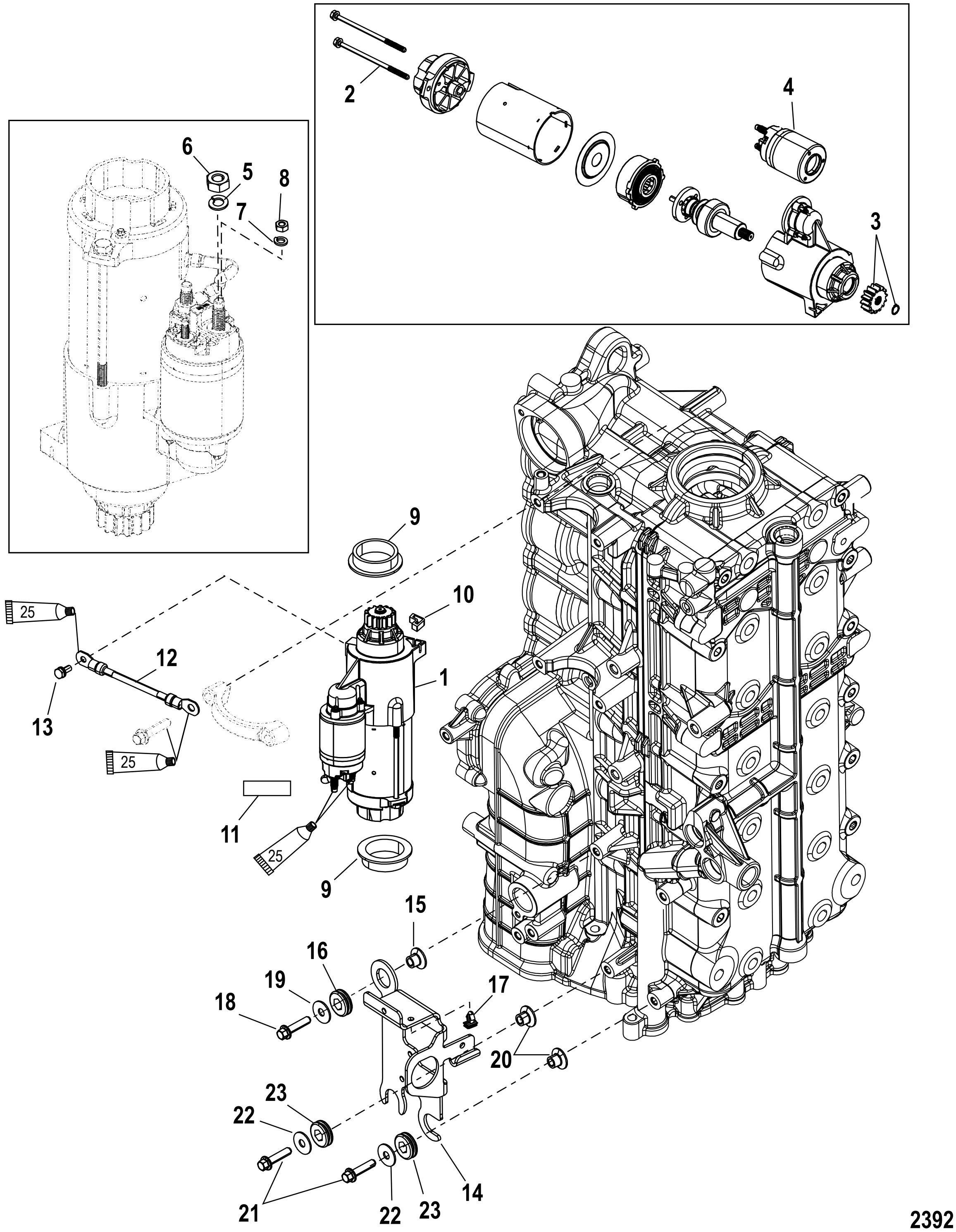
Special Tools

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments

1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Notes:

Starter Motor Components (S/N 1B517433 and Below)

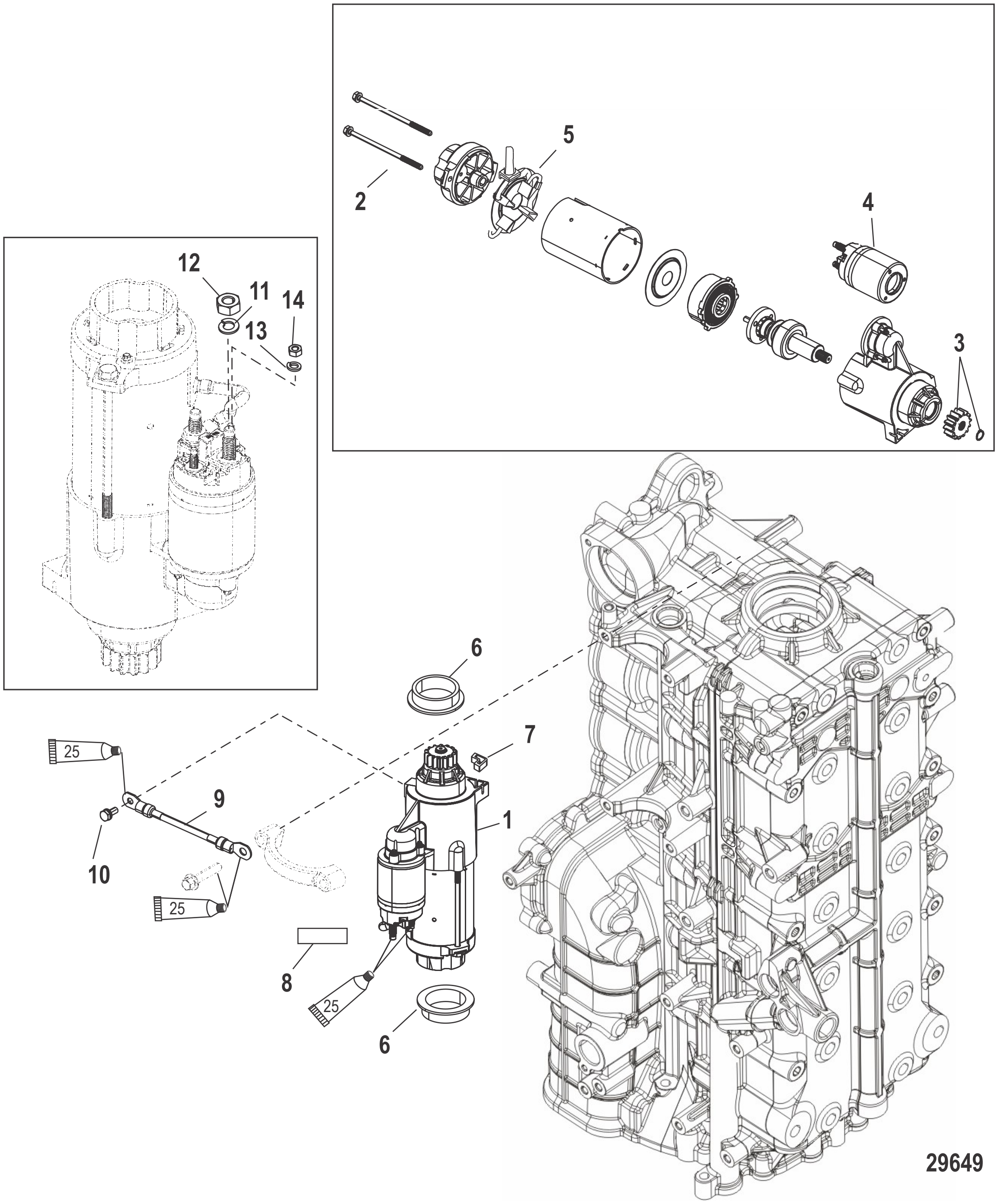


Starter Motor Components (S/N 1B517433 and Below)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Starter motor assembly			
2	2	Bolt	12.5	110	
3	1	Gear kit			
4	1	Solenoid			
5	1	Lockwasher			
6	1	Nut (M8)	9	80	
7	1	Lockwasher			
8	1	Nut (M5)	2.5	22	
9	2	Collar			
10	1	Stop			
11	1	High voltage warning decal			
12	1	Cable			
13	1	Screw and lockwasher (0.250-20 x 0.625)	9	80	
14	1	Bracket			
15	1	Bushing			
16	1	Grommet			
17	1	Clip			
18	1	Screw (M8 x 35)	24		17.7
19	1	Washer			
20	2	Bushing			
21	2	Screw (M8 x 35)	24		17.7
22	2	Washer			
23	2	Grommet			

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter motor threads and cable ends	92- 25711 3

Starter Motor Components (S/N 1B517434 and Above)

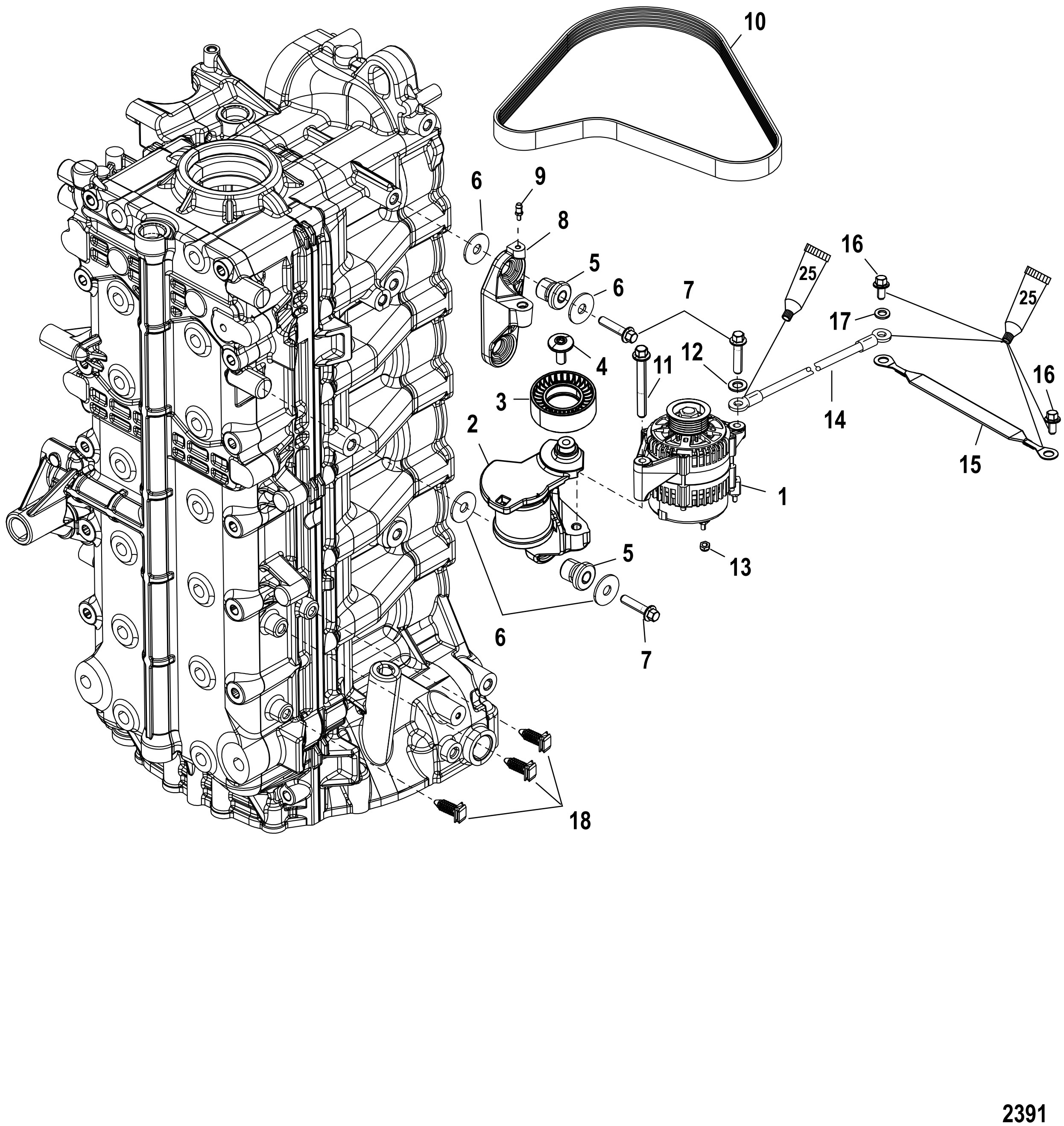


Starter Motor Components (S/N 1B517434 and Above)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Starter motor assembly			
2	2	Bolt	12.5	110	–
3	1	Gear kit			
4	1	Solenoid			
5	1	Brush set			
6	2	Collar			
7	1	Stop			
8	1	High voltage warning decal			
9	1	Cable assembly (black) (15.2 cm [6.0 in.])			
10	1	Screw and lockwasher (0.250-20 x 0.625)	9	80	–
11	1	Lockwasher (0.312)			
12	1	Nut (M8)	9	80	–
13	1	Lockwasher (M5)			
14	1	Nut (M5 x 0.8)	2.5	22	–

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter motor threads and cable ends	92- 25711 3

Alternator and Belt Tensioner



Alternator and Belt Tensioner

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Alternator (70 amp)			
2	1	Belt tensioner			
3	1	Pulley			
4	1	Screw	26		19
5	4	Bushing			
6	8	Washer (0.406 x 1.250 x 0.089)			
7	5	Screw (M10 x 45)	47.5		35
8	1	Bracket			
9	1	Pin	8	71	
10	1	Drive belt			
11	1	Screw (M10 x 85)	47.5		35
12	1	Washer			
13	1	Nut (M6)	7	62	
14	2	Cable			
15	1	Cable (braided)			
16	2	Screw (M6 x 16)	8	71	
17	1	Washer (0.281 x 0.50 x 0.06)			
18	3	Clip			

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Alternator cable ends	92- 25711 3

Battery Cable Test

This test is used to determine if there is excessive resistance in the battery's positive or negative cables, or if the cable is sized properly to carry the necessary current needed to crank the engine at the proper RPM.

IMPORTANT: This test must be performed while the key switch is in the "START" position. Ignore any voltage readings taken without the circuit under load.

⚠ WARNING

Moving parts can cause serious injury or death. Wear eye protection and keep hands, hair, and clothing away from moving parts when performing tests or checking adjustments on an operating engine.

1. Perform a load test on the battery following the instructions supplied with the load tester. Ensure that the battery is brought to a full charge after being tested.
2. With the key switch in the "START" position, measure the voltage across the battery posts - not the cable clamps. Record the voltage reading. If the voltage is less than 10 VDC, replace the battery.

   NOTE: The voltage reading in step 2 is the base voltage. The base voltage reading will be compared to the voltage readings obtained in the following steps.
3. With the key switch in the "START" position, measure the voltage from the battery positive post - not the cable clamp - to the starter post where the battery positive cable is connected. Record the voltage reading.
4. If the voltage reading in step 3 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.
5. With the key switch in the "START" position, measure the voltage from the starter positive terminal to the battery negative post - not the cable clamp. Record the voltage reading.
6. If the difference between the voltage readings taken in step 2 and step 5 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.

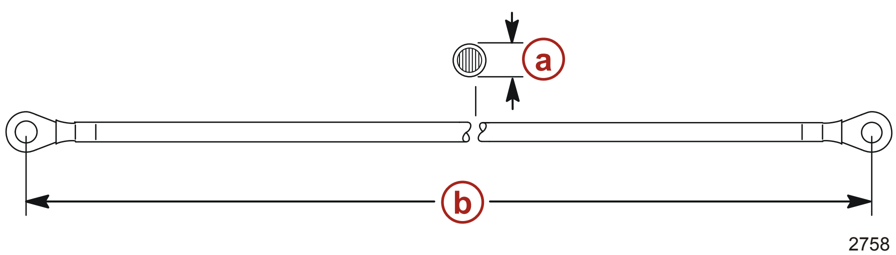
Resistance in the cables can cause a voltage drop and limit current to the starter. If corrosion is present, or if the starter is worn, there may not be enough amperage to turn the starter motor.

NOTE: If the voltage at the starter is less than 11 VDC, the engine may not start.

Battery Cable Size for Outboard DTS Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

NOTE: If longer battery cables are required, the wire gauge size must increase. See the following chart for correct wire gauge size.



a - Wire gauge size
b - Battery cable length

Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)	Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)
	Verado and OptiMax DTS Engines		Verado and OptiMax DTS Engines
2.4 m (8 ft)	-	**7.6 m (25 ft)**	1
2.7 m (9 ft)	-	**7.9 m (26 ft)**	1/0
3.0 m (10 ft)	-	**8.2 m (27 ft)**	1/0
3.4 m (11 ft)	-	**8.5 m (28 ft)**	1/0
3.7 m (12 ft)	4	**8.8 m (29 ft)**	1/0
4.0 m (13 ft)	2	**9.1 m (30 ft)**	1/0
4.3 m (14 ft)	2	**9.4 m (31 ft)**	1/0

Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)	Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)
	Verado and OptiMax DTS Engines		Verado and OptiMax DTS Engines
4.6 m (15 ft)	2	**9.8 m (32 ft)**	1/0
4.9 m (16 ft)	2	**10.1 m (33 ft)**	2/0
5.2 m (17 ft)	2	**10.4 m (34 ft)**	2/0
5.5 m (18 ft)	2	**10.7 m (35 ft)**	2/0
5.8 m (19 ft)	2	**11.0 m (36 ft)**	2/0
6.1 m (20 ft)	2	**11.3 m (37 ft)**	2/0
6.4 m (21 ft)	1	**11.6 m (38 ft)**	2/0
6.7 m (22 ft)	1	**11.9 m (39 ft)**	2/0
7.0 m (23 ft)	1	**12.2 m (40 ft)**	2/0
7.3 m (24 ft)	1		

Replacement Parts

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

IMPORTANT: Deep-cycle batteries are not suitable for use as engine starting batteries or for use as accessory batteries that are connected to high output engine charging systems. Deep-cycle battery life may be shortened by high output engine charging systems. Refer to individual battery manufacturer instructions for specific battery charging procedures and applications.

Battery Information

Battery Cable Connections

1. Apply Corrosion Guard to the battery terminal connections to prevent corrosion.

Tube Ref No.	Description	Where Used	Part No.
120	Corrosion Guard	Battery terminals	92-802878 55

IMPORTANT: Locking hex nuts are required on battery posts. If the battery is equipped with wing nuts, remove the wing nuts and install hex nuts. Do not use wing nuts on battery post connections.

2. Tighten the battery terminal nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Battery terminal nuts	13.5	120	–

IMPORTANT: Local laws may require that both battery terminals are covered.

3. Use an insulating sleeve on positive terminal connections to prevent accidental shorts.
4. Additional requirements for positive cranking cables:
   a. One positive cable union (connection at bulkhead or splice) is allowed between the battery and the battery switch.
   b. One positive cable union (connection at bulkhead or splice) is allowed between the battery switch and the engine cranking battery connection.
5. Additional requirements for negative cranking cables:
   a. One negative cable union (connection at the bulkhead or splice) is allowed between the engine ground connection and main vessel DC ground bus.
   b. Bulkhead connections or splicing between the main vessel DC ground bus and the engine cranking battery must not be used.

6. When stacking multiple battery cable connections, observe the following:
   a. There can be a maximum of four connections per battery post/connection point.
   b. Do not use washers between ring terminals on battery post/connections.
   c. Ensure that the highest current carrying conductor is in direct contact with the largest surface area of the battery post conducting surface.
   d. Terminals should be grouped by size. Install largest to smallest ring terminal size.

Battery Specifications

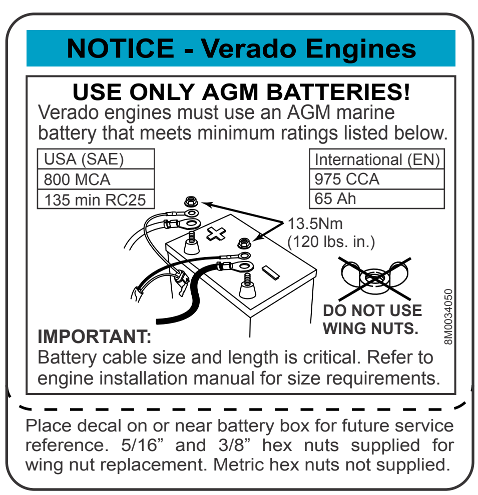
IMPORTANT: Battery manufacturers may rate and test their batteries to different standards. MCA, CCA, Ah, and Reserve Capacity (RC) are the ratings recognized by Mercury Marine. Manufacturers that use standards different than these, such as equivalent MCA, do not meet Mercury Marine battery requirements.

The specifications for each individual cranking battery are as follows.

SAE (North America) Ratings	EN (International) Ratings	Battery Type
Minimum 800 MCA (~ 650 CCA) and minimum RC25 rating of 135 min	Minimum 975 CCA and minimum 65 Ah	AGM (starting or deep cycle)

1. There must be a minimum of one cranking battery per engine.
2. Multiple main propulsion engines must not crank from the same power source except through an emergency-use-only parallel circuit.
3. The association between an engine and its cranking battery must be easily identifiable by orientation or labeling.
4. The engine battery must have minimum 5/16 in. stud provisions that are integral to the battery or affixed to an existing SAE/BCI terminal.

   NOTE: Mercury cables are designed for 5/16 in. (negative) and 3/8 in. (positive) connections.
5. SAE/BCI terminals are not required.
6. Batteries must meet or exceed requirements specific to engine type:
   a. North America (SAE rating) both MCA and RC25
   b. International (EN rating) both CCA and Ah
7. Dissimilar type and model/size batteries must not be combined. Batteries in permanently parallel configurations must be of exactly the same make, model, and size.
8. Temporary crossover (parallel starting) of dissimilar type batteries (AGM, flooded, or gel) should only be performed during an emergency. (For example, when a cranking battery is dead and the corresponding engine will not start.) To be approved, connections between dissimilar type batteries must have:
   a. Continuous diode-type isolation
   b. Momentary mechanical contacts or momentary electrical contacts, such as an automatic charging relay (ACR) or voltage sensing relay (VSR) device
9. The decal shown following must be placed on or near the battery box for future service reference.



33871

Battery Precautions

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

When charging batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through holes in the vent plugs and may form an explosive atmosphere around the battery if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion, which may shatter the battery.

The following precautions should be observed to prevent an explosion:

1. Do not smoke near batteries being charged or which have been charged very recently.
2. Do not break live circuits at terminals of batteries, because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. Do not reverse polarity of battery terminal to cable connections.

Charging a Discharged Battery

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

The following basic rules apply to any battery charging situation:

1. Any battery may be charged at any rate (in amperes), or as long as spewing of electrolyte (from violent gassing) does not occur, and for as long as electrolyte temperature does not exceed 52 °C (125 °F). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 52 °C (125 °F), charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2 hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260–1.275, corrected for electrolyte temperature with electrolyte level at 4.8 mm (3/16 in.) over plate, unless electrolyte loss has occurred (from age or overfilling), in which case, specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check the battery voltage while cranking the engine with an electric starting motor at ambient air temperature of 23.8 °C (75 °F), place the red (+) lead of the tester on the positive (+) battery terminal and the black (–) lead of the tester on the negative (–) battery terminal. If the voltage drops below 10-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage, either in winter storage or in dealer stock, if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate, and dirt from the top surface by running water over top of the battery. Be sure, however, the vent caps are tight beforehand and blow off all excess water thoroughly with compressed air. Check water level, making sure the plates are covered.
2. When adding distilled water to the battery, be extremely careful not to fill more than 4.8 mm (3/16 in.) above perforated baffles inside the battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling the battery will cause the electrolyte to overflow (if filled beyond 4.8 mm [3/16 in.] above baffles).
3. Grease terminal bolts with 2-4-C with PTFE and store the battery in a cool-dry place. Remove the battery from storage every 30–45 days, check the water level, and put on charge for 5 or 6 amps. Do not fast charge.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1

4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.

5. Repeat preceding charging procedure every 30–45 days, as long as the battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place the battery back in service, remove excess grease from the terminals (a small amount is desirable on terminals at all times), recharge again, as necessary, and reinstall the battery.

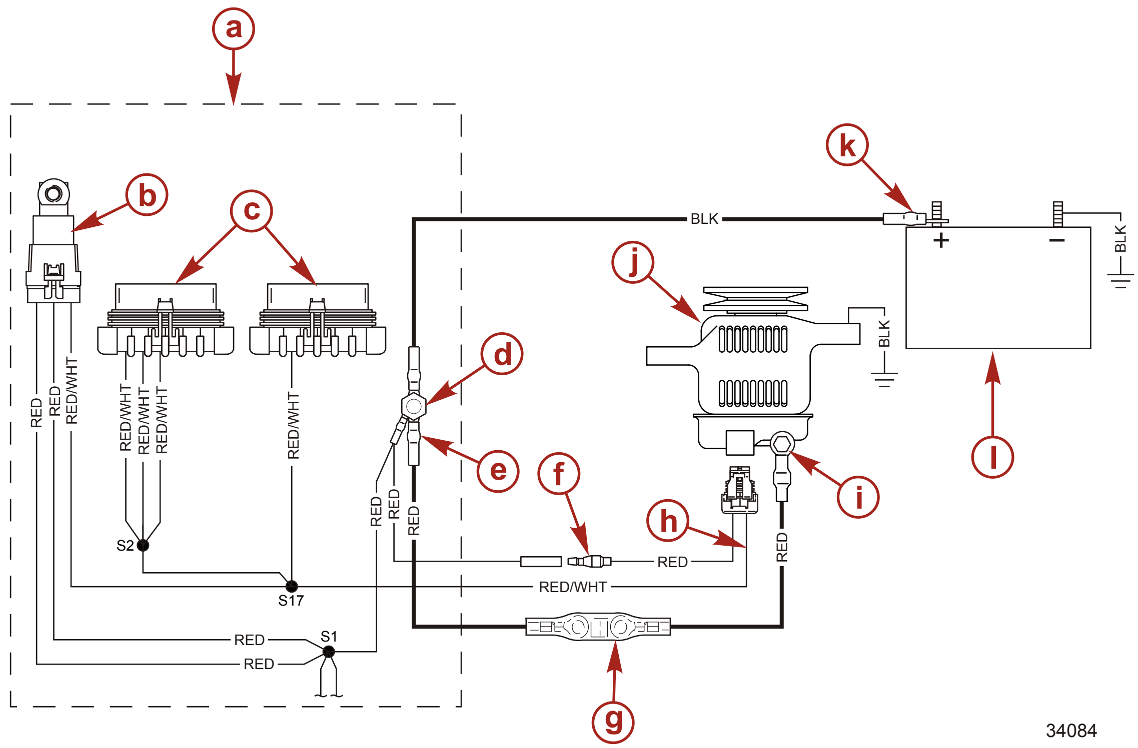
Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Alternator System

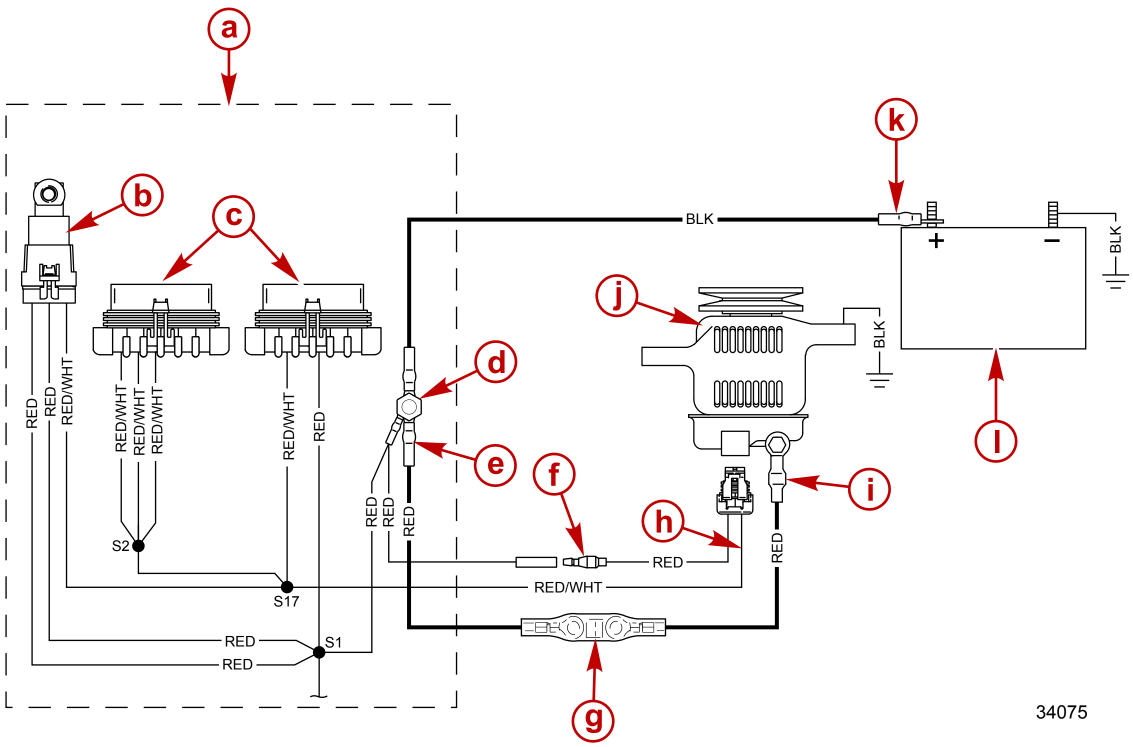
System Components

The charging system consists of the alternator, battery, 150 amp fusible link, main power relay, and wiring that connects these components.



S/N 1B229688 and below

- a - Electrical box
- b - Main power relay
- c - Fuse holder
- d - Positive cable terminal
- e - Black cable with red sleeve
- f - Alternator sense lead
- g - 150 amp fusible link
- h - Alternator excitation lead
- i - Alternator output lead (black with red sleeve)
- j - 70 amp alternator
- k - Positive battery lead (black with red sleeve)
- l - 12 VDC battery



S/N 1B229689 and above

- **a -** Electrical box
- **b -** Main power relay
- **c -** Fuse holder
- **d -** Positive cable terminal
- **e -** Black cable with red sleeve
- **f -** Alternator sense lead
- **g -** 150 amp fusible link
- **h -** Alternator excitation lead
- **i -** Alternator output lead (black with red sleeve)
- **j -** 70 amp alternator
- **k -** Positive battery lead (black with red sleeve)
- **l -** 12 VDC battery

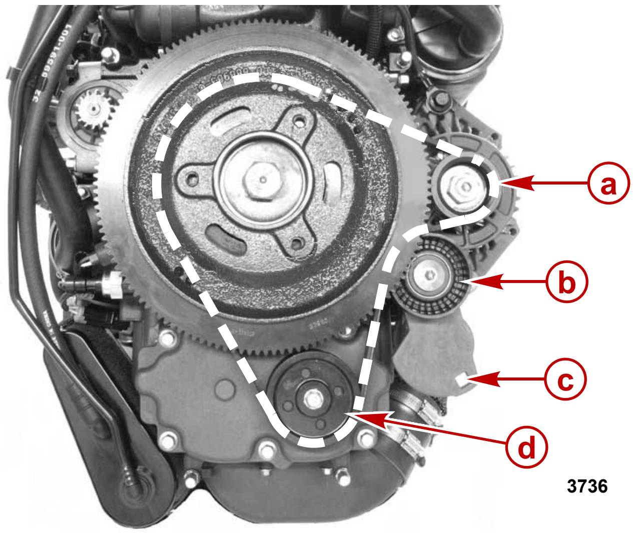
Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead, regulator harness, or battery cables when the alternator is being driven by the engine.
4. Always remove the negative (–) battery cable from the battery before working on the alternator system.
5. When installing the battery, be sure to connect the negative (–) (grounded) battery cable to the negative (–) battery terminal and the positive (+) battery cable to the positive (+) battery terminal. Connecting the battery cables to the battery in reverse will result in blowing the 150 amp fusible link in the output lead of the alternator. The alternator will not be able to charge the battery and the battery will be quickly discharged if the engine is run.
6. When using a charger or booster battery, connect it in parallel with the existing battery (positive to positive; negative to negative).

Alternator and Supercharger Belt Tension Adjustment

Correct alternator and supercharger belt tension is maintained by a belt tensioner assembly.



a - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger pulley

Alternator Description

The alternator employs a rotor that is supported in two end frames by ball bearings and is driven at 2.8 times engine speed. The rotor contains a field winding enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes which make continuous sliding contact with the slip rings. The current flowing through the field winding creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

The three phase stator is mounted directly over the rotor pole pieces and between the two end frames. It consists of three windings wound 120 degrees electrically out of phase on the inside of a laminated core.

The rectifier bridge contains six diodes which allows current to flow from the ground, through the stator, and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge changes the alternating current to direct current which is present at the output terminal. The diode trio is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage for properly charging the battery. Current output of the alternator does not require regulation and is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator is not required. The rectifier diodes prevent the battery from discharging back through the stator.

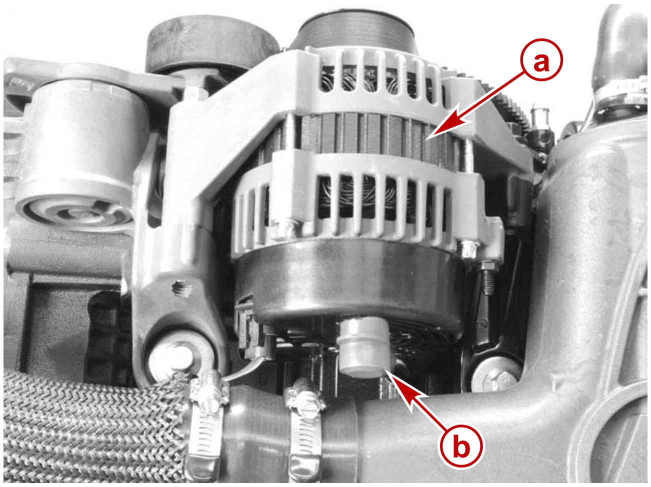
A small amount of current is supplied by the excitation circuit in the regulator to the rotor field to initially start the alternator charging. Once the alternator begins to produce output, field current is supplied solely by the diode trio.

The alternator is equipped with two fans which induce air flow through the alternator to remove heat created by the rectifier and stator.

Diagnosis of Alternator System on Engine

1. If the problem is an undercharged battery, verify condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
   IMPORTANT: Red output lead from alternator must be tight. A darkened red sleeve indicates lead was loose and becoming hot. Verify output lead attaching nut is torqued to specification.

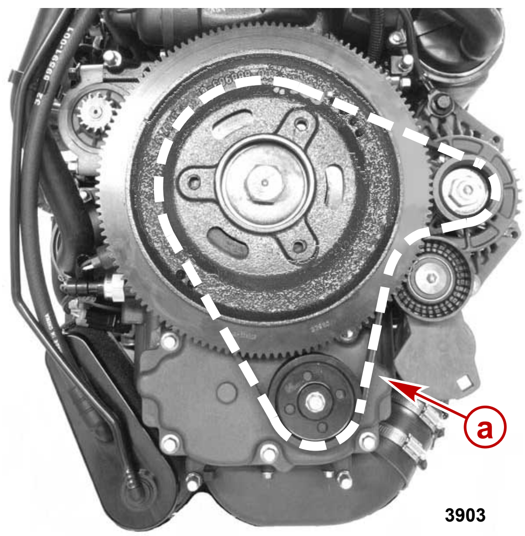
Description	Nm	lb. in.	lb. ft.
Nut	7	62	



3888

a - Alternator
b - Red sleeved output lead (under red boot)

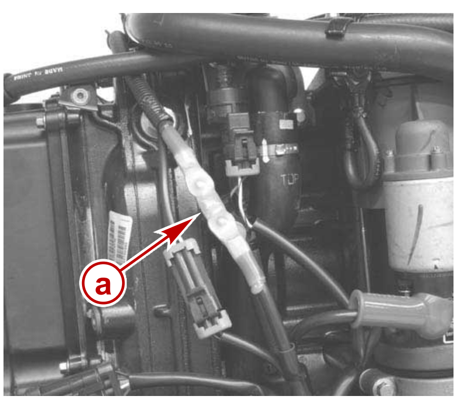
4. Check alternator drive belt for excessive wear, cracks, glazed surfaces, and fraying. Replace if necessary. Check belt tension.



3903

a - Alternator/supercharger drive belt

5. Inspect 150 amp fusible link located in alternator red sleeved output lead. If link is blown, check battery leads for reversal and replace alternator red sleeved output lead.



3905

a - 150 amp fusible link

Alternator System Circuitry Test

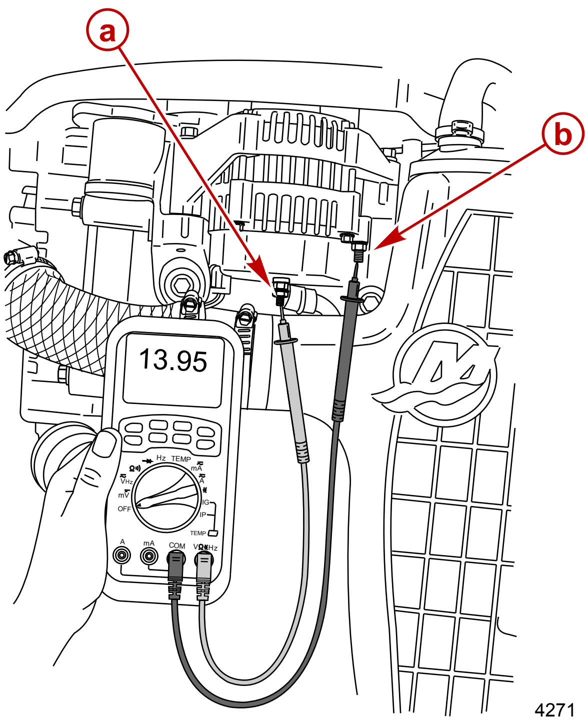
Perform the following tests with a DMT 2004 digital multimeter to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

DMT 2004 Digital Multimeter	91-892647A01

1. Check the belt condition and tension.
2. Check the wire connections at the alternator for tightness and absence of corrosion.
3. Check the wire connections at the battery for tightness and absence of corrosion.
4. Check the battery condition. The battery should be fully charged.

Output Circuit

1. Connect the DMT positive (+) lead to the battery positive (+) post.
2. Connect the DMT negative (–) lead to the battery negative (–) post.
3. Supply cooling water to the engine.
4. Start the engine and increase engine speed to approximately 1300 RPM.
5. Observe the voltage reading.
6. If the reading is between 13.5 and 14.8 volts, switch the DMT to the AC volt position. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
7. If the reading is below 13.5 volts:
    a. Connect the positive (+) DMT lead to the alternator output post.
    b. Connect the negative (–) DMT lead to the ground post on the alternator.
    c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, inspect the wiring harness for loose connections, corrosion, breaks, or shorts. Repair or replace harness as required.
8. If the reading is above 15 volts at the battery, the alternator is overcharging and must be replaced.

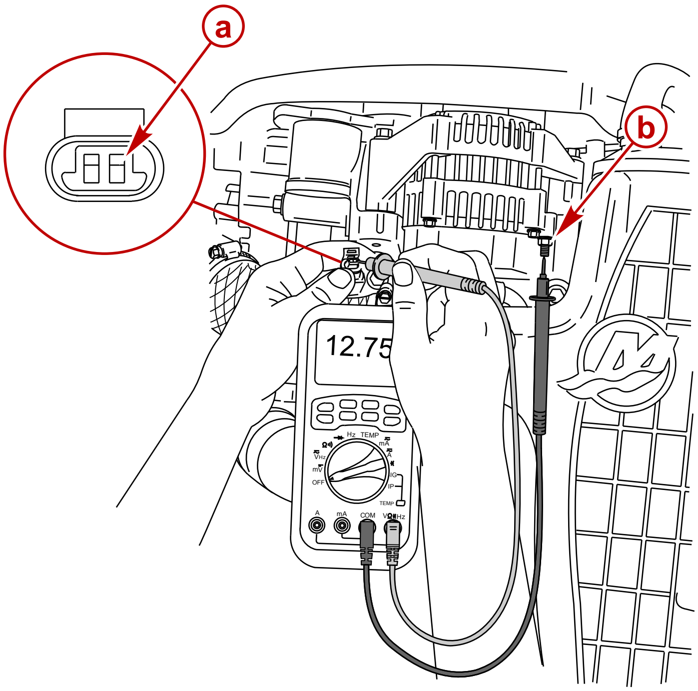


a - Alternator output post
b - Alternator ground post

Sensing Circuit

1. Unplug the red and red/white connector from the alternator.
2. Connect the positive (+) DMT lead to the red pin and the negative (–) DMT lead to the alternator ground post.

3. The DMT should indicate the battery voltage. If battery voltage is not present, check the red lead for loose or dirty connections or damaged wiring.



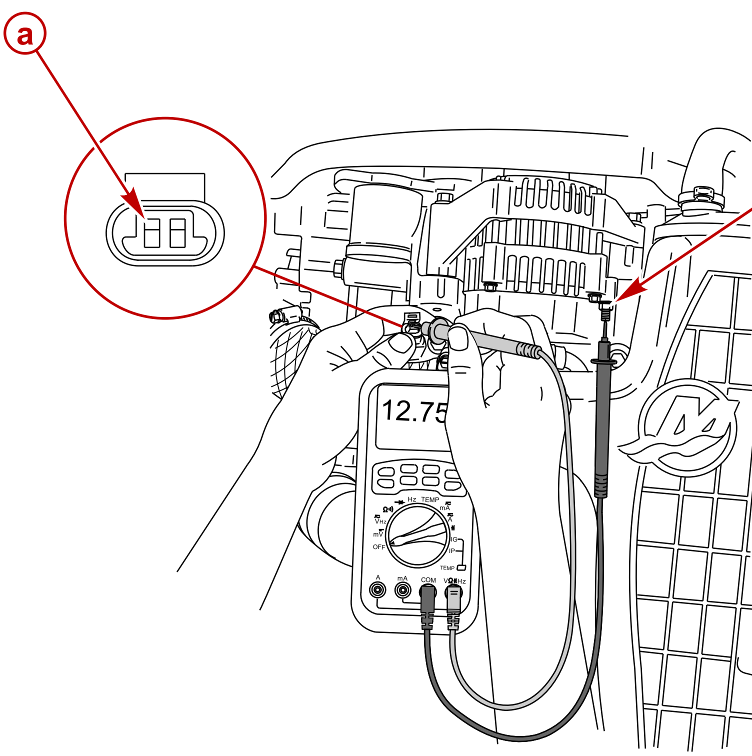
4273

a - Sensing circuit red lead
b - Alternator ground post

Excitation Circuit

NOTE: The ignition key must be in the "ON" position (engine not running). Battery voltage will be present at the red/white pin for approximately five seconds before the main power relay times out due to the engine not running. After the main power relay times out, no voltage will be present.

1. Unplug the red and red/white connector from the alternator.
2. Connect the positive (+) DMT lead to the red/white pin and the negative (–) DMT lead to the alternator ground post.
3. The DMT should indicate the battery voltage. If battery voltage is not present, check the red/white lead for loose or dirty connections or damaged wiring.



4272

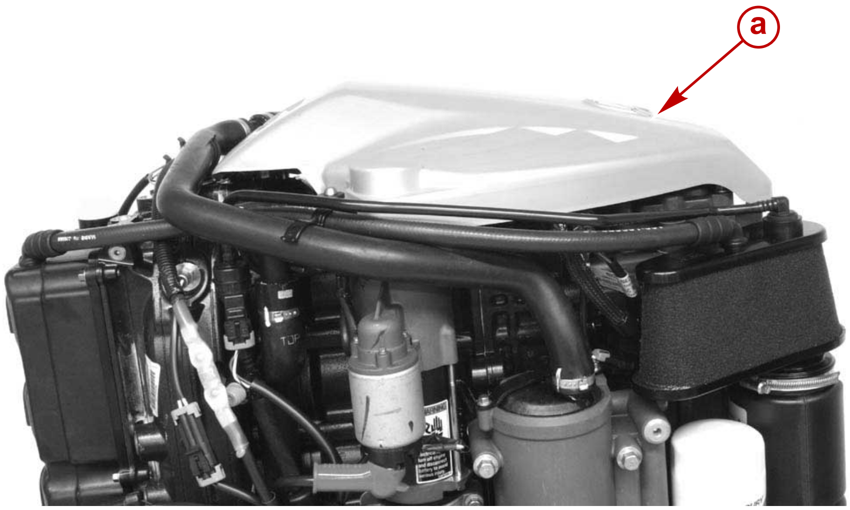
a - Excitation circuit red/white lead
b - Alternator ground post

Alternator Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

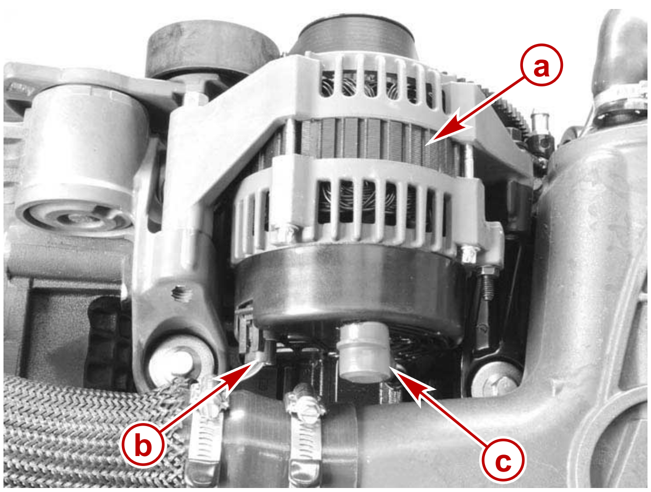
1. Disconnect battery leads from battery.
2. Remove flywheel cover.



3837

a - Flywheel cover

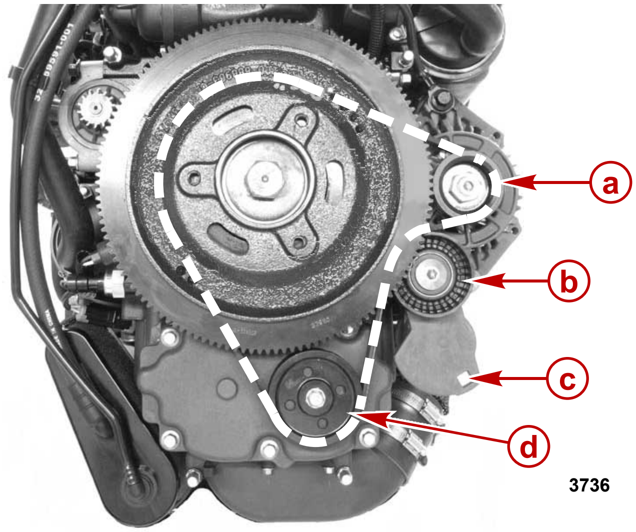
3. Disconnect output lead and sense harness connector from alternator.



3881

a - Alternator
b - Sense harness connector
c - Output lead

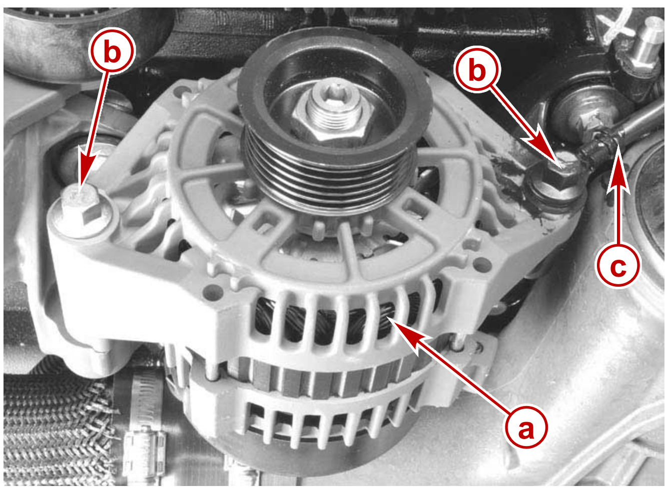
4. Use a breaker bar to release belt tension and remove alternator/supercharger belt.



3736

a - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger pulley

5. Remove 2 screws securing alternator.

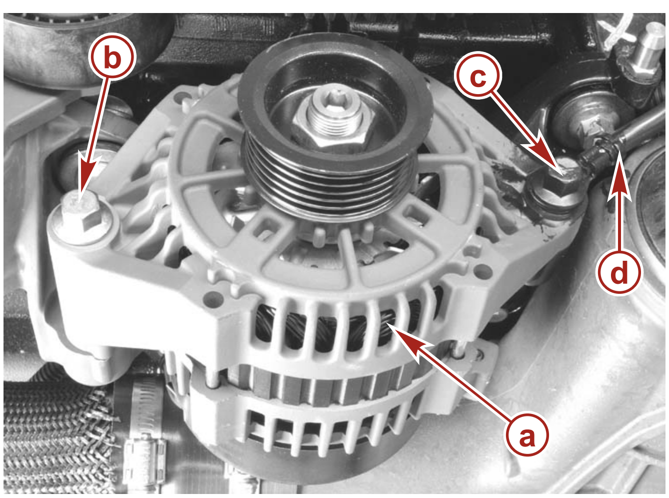


3882

a - Alternator
b - Screws
c - Ground lead

Alternator Installation

1. Install the ground lead eyelet through the M8 x 45 alternator mounting screw.
2. Install the M10 x 85 alternator mounting screw.
3. Tighten the alternator mounting screws to the specified torque.

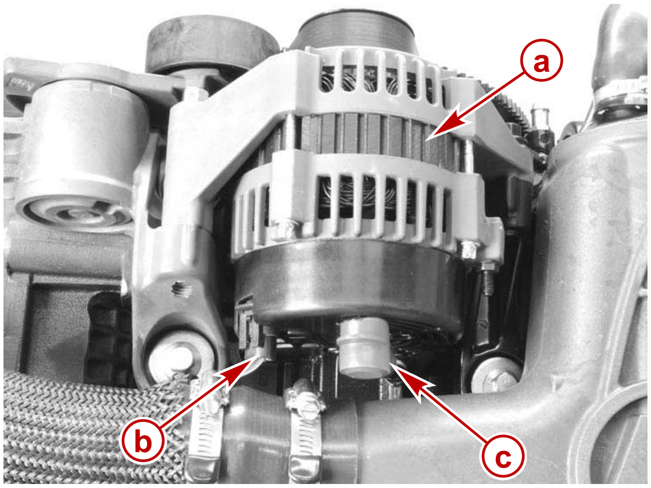


5770

a - Alternator
b - Alternator mounting screw (M10 x 85)
c - Alternator mounting screw (M8 x 45)
d - Ground lead

Description	Nm	lb. in.	lb. ft.
Screw (M10 x 85)	47.5		35
Screw (M8 x 45)	47.5		35

4. Connect the sense harness to the alternator.
5. Secure the output lead to the alternator with a nut. Tighten the nut to specification.

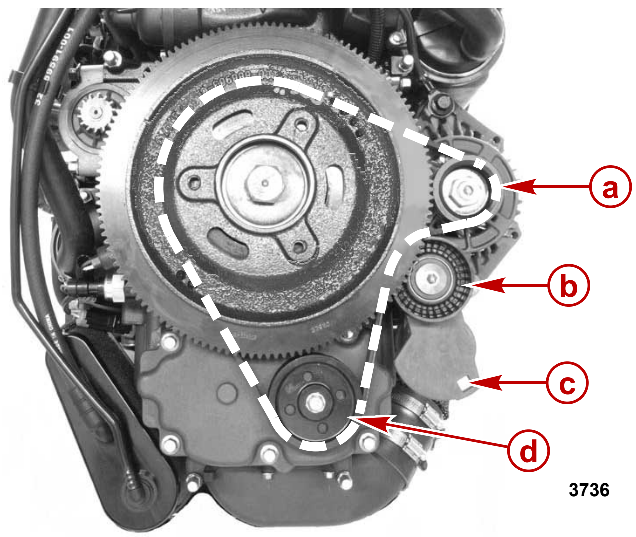


3881

a - Alternator
b - Sense harness connector
c - Output lead

Description	Nm	lb. in.	lb. ft.
Output lead nut	7	62	

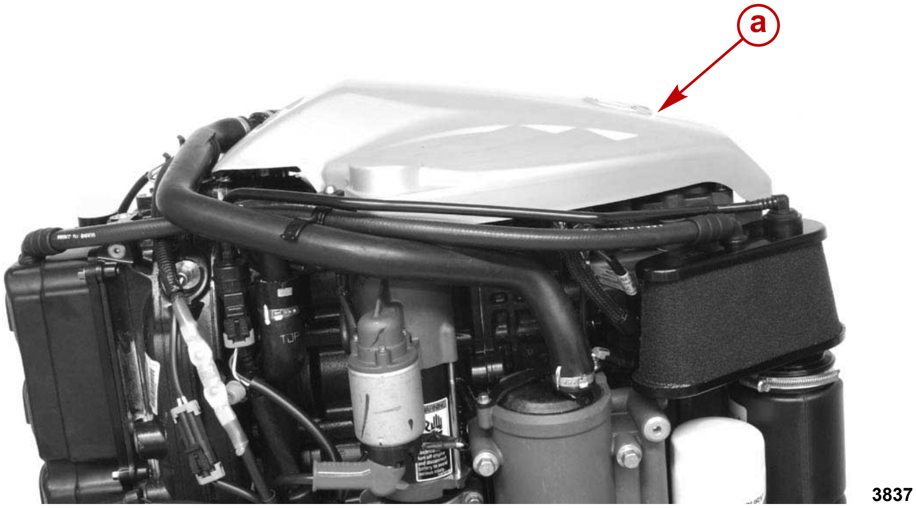
6. Reinstall the alternator/supercharger belt. Use a breaker bar to release the belt tensioner to ease installation.



3736

a - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger pulley

7. Reinstall the flywheel cover.



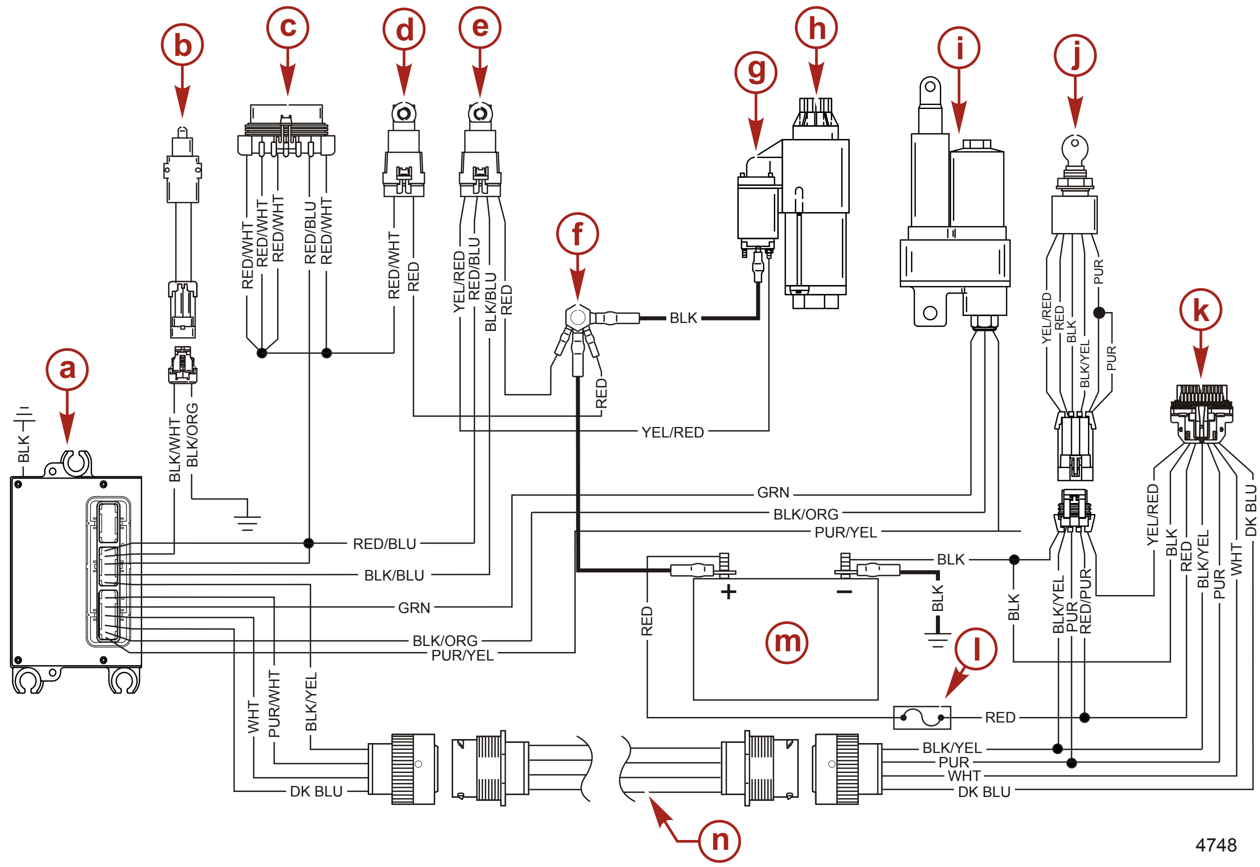
a - Flywheel cover

Starter System

Starter Motor Amperes Draw

Starter Motor (part number 50-892339)	
No Load Ampere Draw	60 amperes
Normal Ampere Draw	160 amperes

Starter System Components

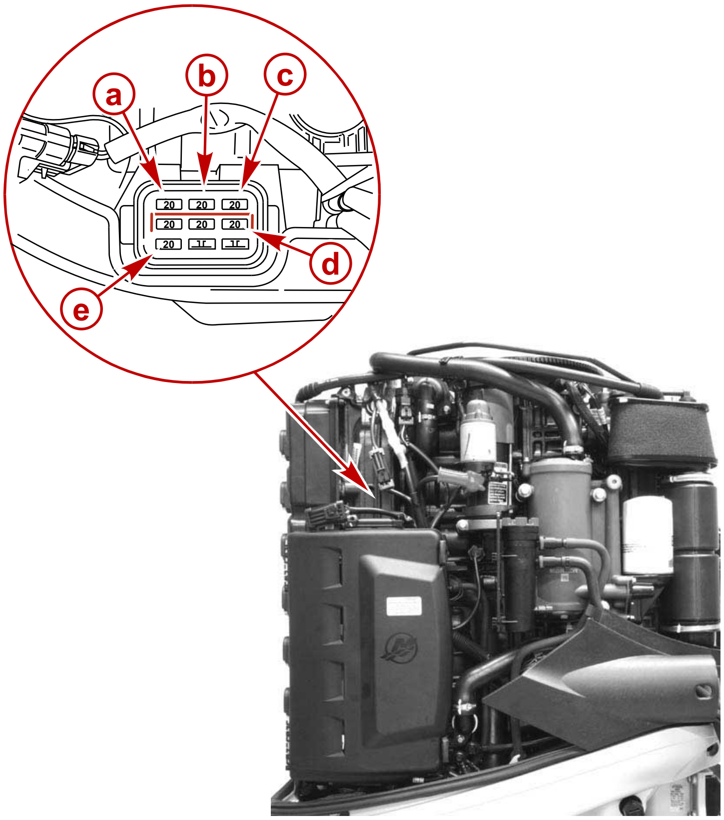


a - Propulsion control module (PCM)
b - Neutral start switch
c - Fuse holder
d - Start relay
e - Main power relay
f - Positive cable terminal
g - Starter solenoid
h - Starter motor
i - Shift actuator
j - Ignition switch
k - Command module
l - 5 Ampere fuse (digital power and shift)
m - 12 VDC Battery
n - Control area network (CAN) harness

Starting System Test

Fuse Inspection

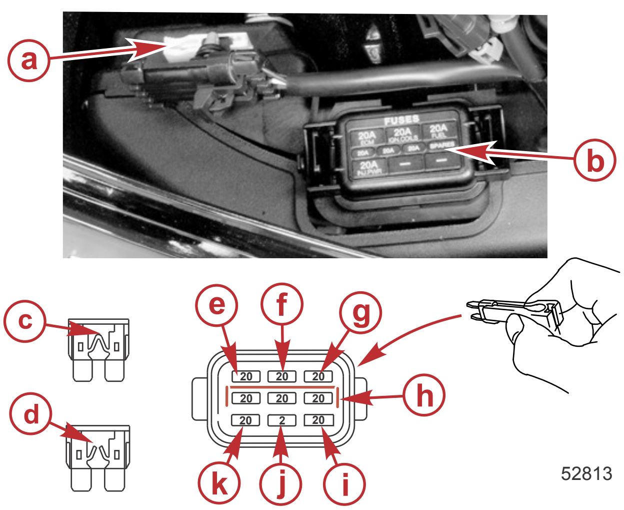
1. Inspect the 20-amp fuses in the fuse holder. These fuses protect the PCM, start relay, and associated wiring.



4794

S/N 1B390142 and below

- a - Electronic control module and purge valve - 20-amp fuse "ECM"
- b - Ignition coils - 20-amp fuse "IGN. COILS"
- c - Fuel delivery - 20-amp fuse "FUEL"
- d - Spare fuses - 20-amp fuse
- e - Injector power and boost valve - 20-amp fuse "INJ. PWR."



52813

S/N 1B390143 and above

- a - Fuse puller
- b - Fuse holder
- c - Good fuse
- d - Blown fuse
- e - Electronic control module and purge valve - 20-amp fuse "ECM"
- f - Ignition coils - 20-amp fuse "IGN. COILS"
- g - Fuel delivery - 20-amp fuse "FUEL"
- h - Spare fuses (3) - 20-amp fuse
- i - Thrust vector module (TVM) – 20-amp fuse (for Mercury Joystick Piloting models only)
- j - Diagnostics terminal - 2-amp fuse
- k - Injector power and boost valve - 20-amp fuse "INJ. PWR."

2. Inspect the 5-amp DTS fuse located on the engine starting battery. This fuse protects the CAN harness and key switch related wiring.

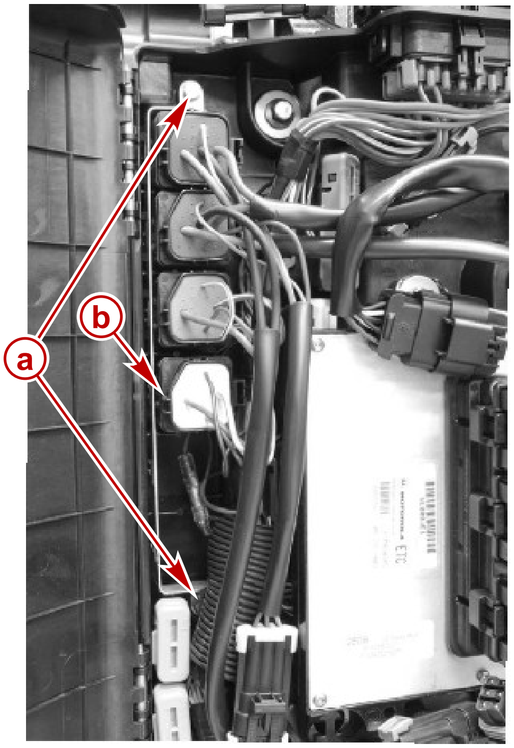
Battery and Wire Connections

1. The battery must deliver a minimum of 11 VDC to the starter. Perform a load test on the battery following the instructions supplied with the load tester.
2. Inspect all power and ground connections at the battery, starter solenoid, starter relay, starter motor, and the engine wiring harness connector for tightness and corrosion. Clean or repair as necessary.

3. Disconnect the engine wiring harness connector and check for continuity between pins **C** (purple) and **B** (red/purple) going through-the-hull wiring with the key switch in the "START" position. If the circuit is interrupted, investigate the hull wiring for the possible cause: key switch or lanyard switch, and repair as needed. If the circuit is complete, proceed to the next step.

Starter Relay

1. Remove the push-on relay terminal connector from the starter relay.

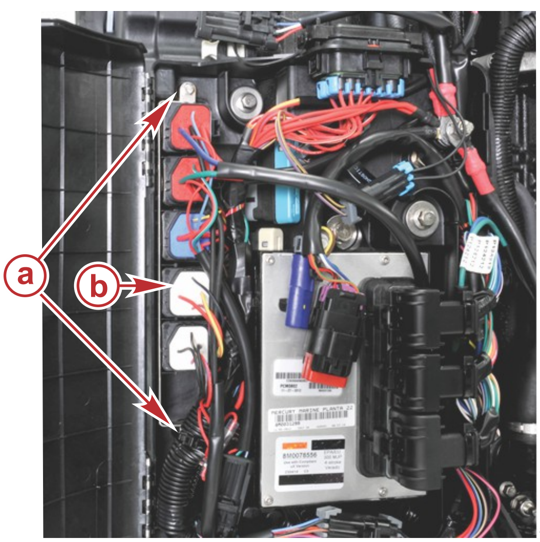


4304

S/N 1B229697 and below

a - Relay retainer screws

b - Starter relay



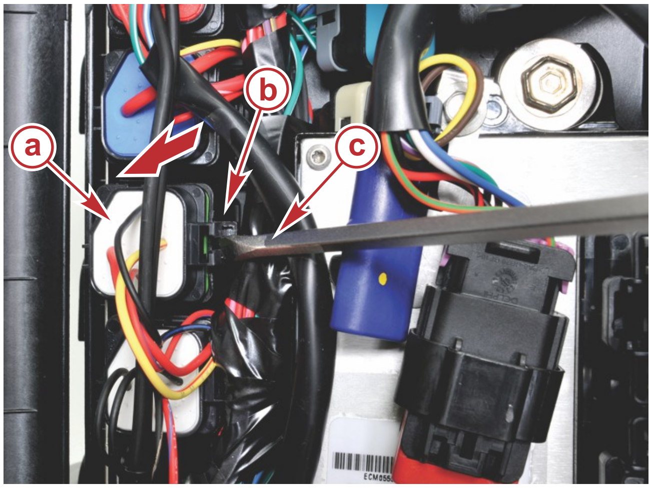
52688

S/N 1B22698 and above

a - Relay retainer screws

b - Starter relay

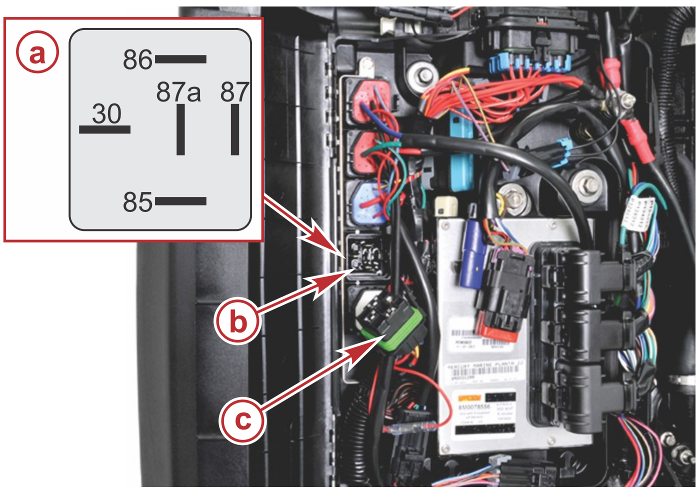
NOTE: *To remove the relay terminal connector, insert a flat blade screwdriver in the relay lock tab. Gently twist the blade and pry the relay terminal connector loose. Pull the relay terminal connector out. Do not pull with the wires.*



52678

a - Relay terminal connector
b - Lock tab
c - Flat blade screwdriver

2. Measure the resistance between relay terminal 85 (red/blue lead) and terminal 86 (black/blue lead).



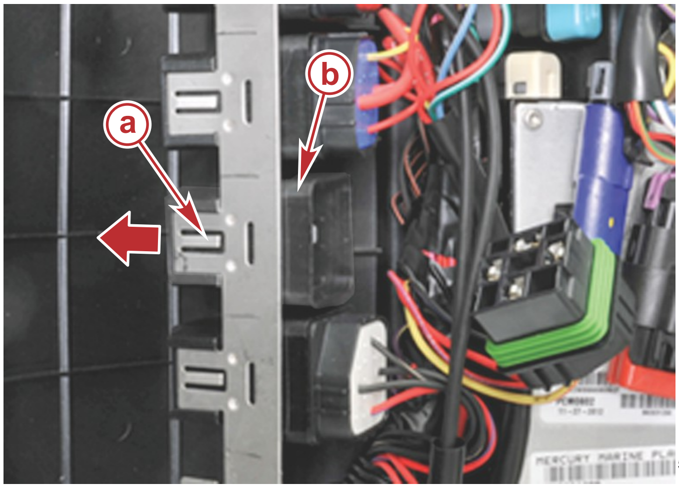
52679

a - Relay contacts
b - Starter relay
c - Starter relay terminal connector

Meter Test Leads		Meter Scale	Reading (Retainer)
Red	**Black**		
85	86	Full continuity (R x 1)	80–100 Ω

3. Replace the relay if resistance is not within specification.
    a. Remove the two retainer screws.

b. Remove the relay from the bracket. Pry the tab on the relay retainer up slightly and push the relay out.



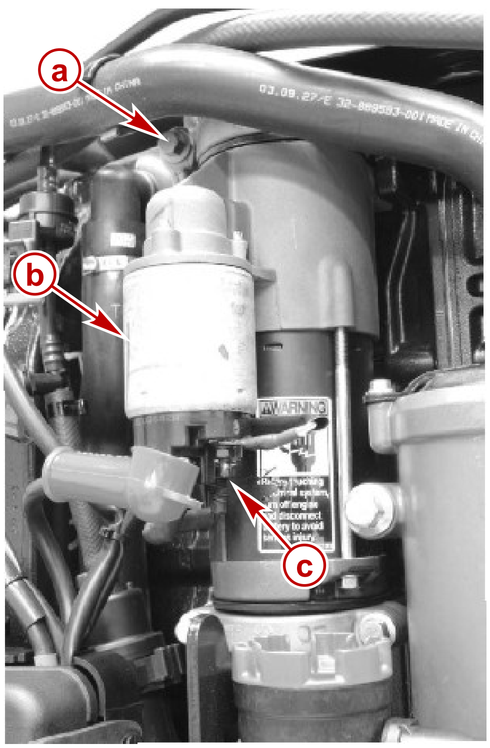
52689

a - Retainer tab
b - Relay

c. Install the new relay onto the bracket.
d. Attach the bracket with the two M5 x 6 retainer screws.
e. Install the relay terminal connector.

Starter Solenoid and Starter

1. With the key switch in the "START" position, the starter drive should engage the engine flywheel. If not, measure the resistance between the yellow/red terminal on the starter solenoid and engine ground. If resistance is not within specification, the starter solenoid is defective and must be replaced.

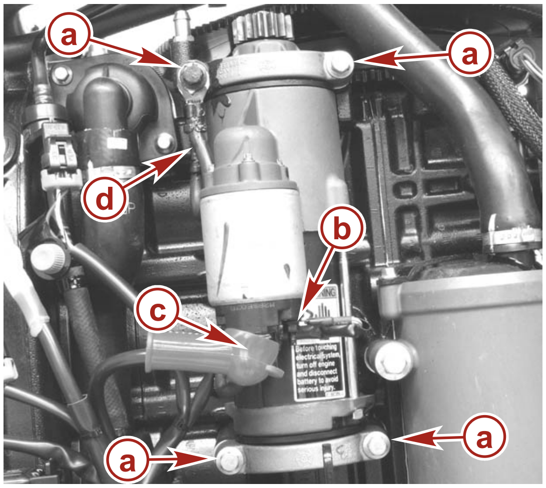


4305

a - Ground screw
b - Starter solenoid
c - Yellow/red terminal

Starter Solenoid	
Resistance (R x 1)	0.4–0.8 Ω

2. If the starter drive audibly engages the engine flywheel, but the starter does not rotate, remove the starter and test the no load amperage draw. If the amperage draw is not within the specification, replace the starter and/or starter solenoid assembly.



3839

a - Starter retaining screws
b - Yellow/red lead
c - Black/red sleeved lead
d - Starter ground lead

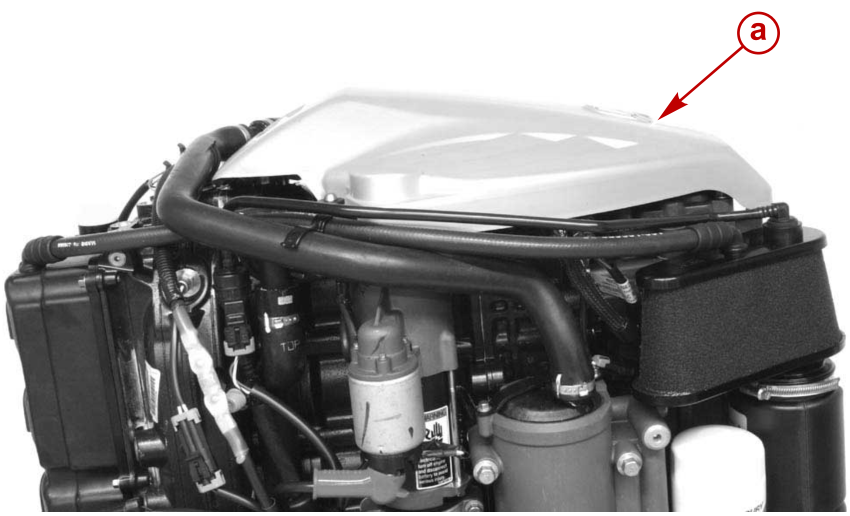
Starter	
No load amperage draw	60–90 A

Starter Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

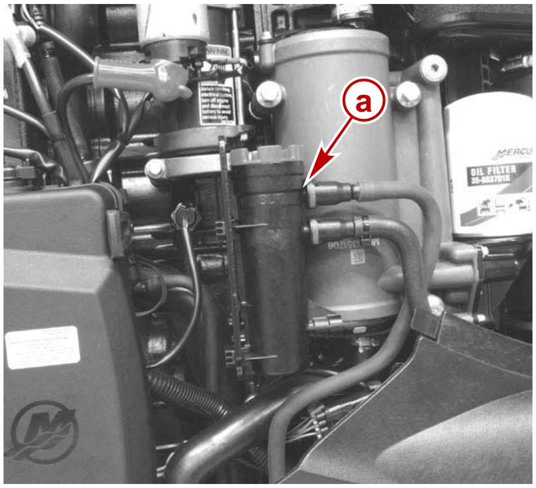
1. Remove flywheel cover.



3837

a - Flywheel cover

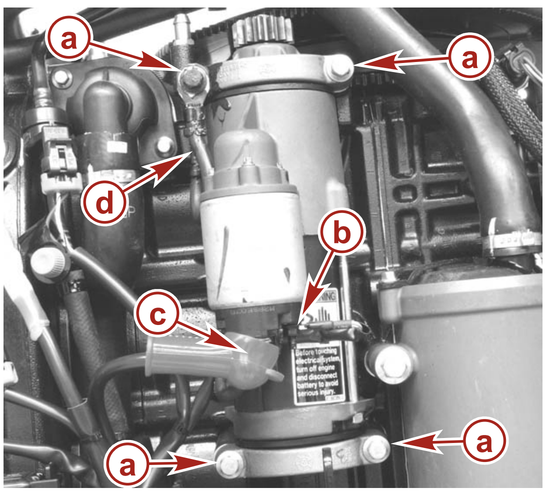
2. Slide fuel/water separator filter up and out of retaining bracket.



3838

a - Fuel/water separator filter

3. Remove yellow/red exciter lead from starter solenoid.
4. Remove black/red sleeved battery lead from starter solenoid.
5. Remove starter retaining screws.

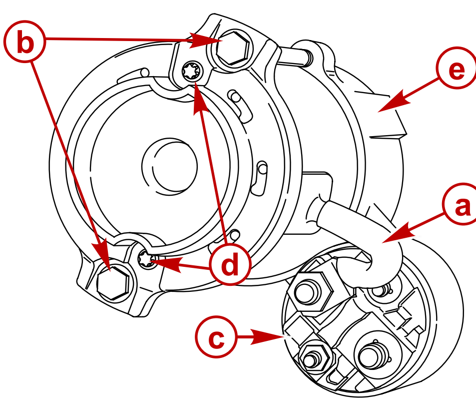


3839

a - Starter retaining screws
b - Yellow/red lead
c - Black/red sleeved lead
d - Starter ground lead

Starter Disassembly

1. Remove brush lead from solenoid and thru-bolts from end frame.

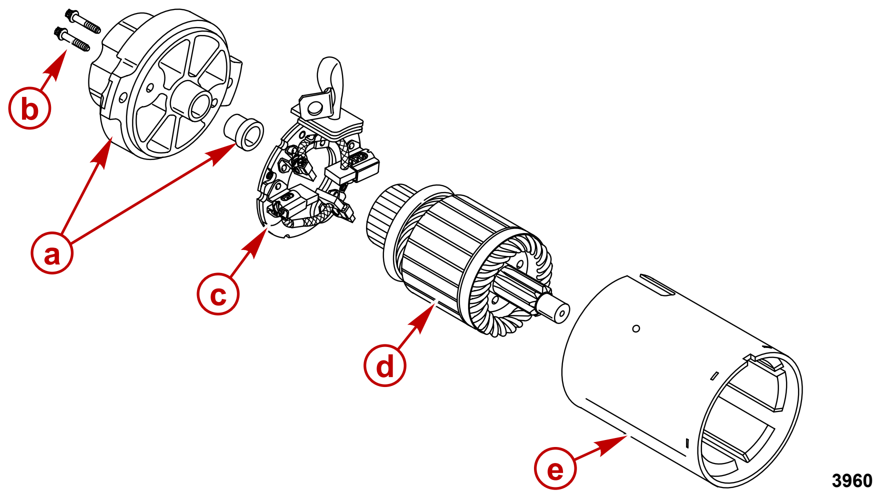


3959

a - Brush lead
b - Thru-bolts
c - Starter solenoid
d - Brush plate screws
e - End frame

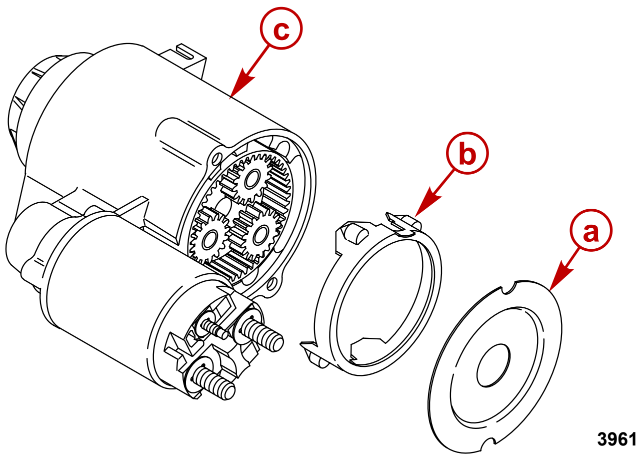
2. Remove armature and field frame from drive housing.

NOTE: Permanent magnets inside field frame will be holding armature in place.



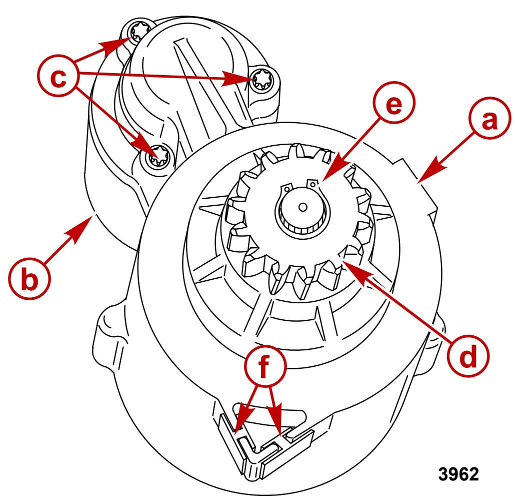
a - End frame and bearing
b - Screws (2) (Internal Torx - Snap On E6 Socket)
c - Brush holder
d - Armature
e - Field frame

3. Remove shield and cushion from drive housing.



a - Shield
b - Cushion
c - Drive housing

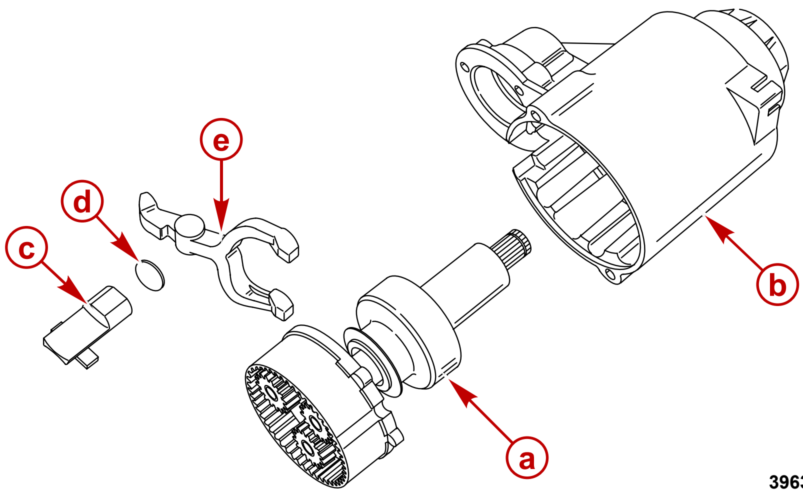
4. Remove 3 screws retaining starter solenoid. Remove solenoid from drive housing.
5. Remove snap ring and pinion gear from starter shaft.



a - Drive housing
b - Starter solenoid
c - Screws (3) (Internal Torx - Snap On E6 Socket)
d - Pinion gear
e - Snap ring
f - Bumpers

6. Remove planetary gear and clutch assembly from drive housing.

7. Remove solenoid arm, metal disc and plug from drive housing.

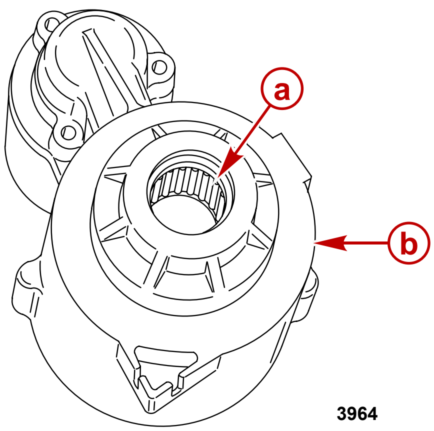


3963

a - Planetary gear and clutch assembly
b - Drive housing
c - Plug
d - Metal disc
e - Solenoid arm

8. Inspect drive housing needle bearing for roughness. If bearing is worn or damaged, bearing can be removed by using an appropriate mandrel to drive/press bearing from drive housing.

   NOTE: If bearing has spun in drive housing bore, drive housing must be replaced.



3964

a - Needle bearing
b - Drive housing

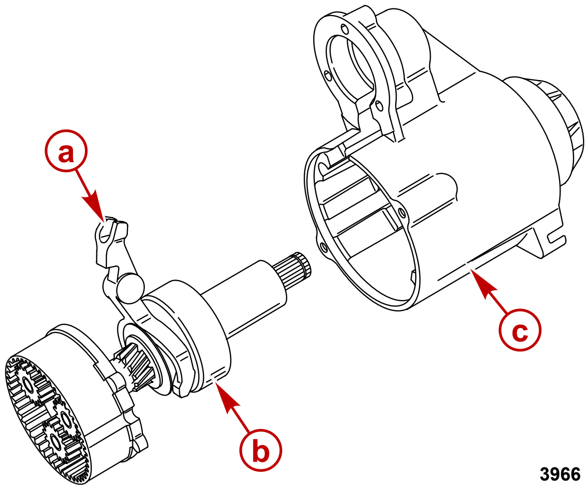
Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive clutch. Solvent will damage insulation and wash the lubricant out of the clutch drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Inspect pinion teeth for wear.
3. Inspect spring for tension and drive collar for wear.
4. Check that bearings roll freely. If any roughness is felt, replace bearing.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Starter Reassembly

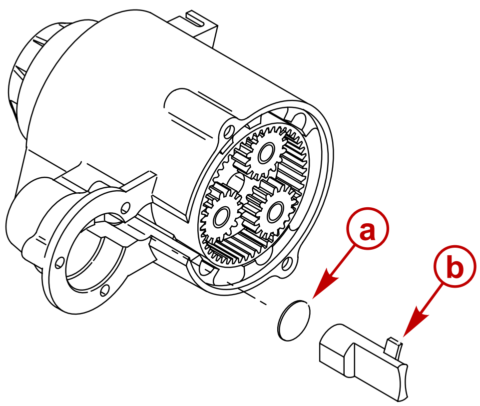
1. Install solenoid arm with planetary gear and clutch assembly into drive housing.



3966

a - Solenoid arm
b - Planetary gear and clutch assembly
c - Drive housing

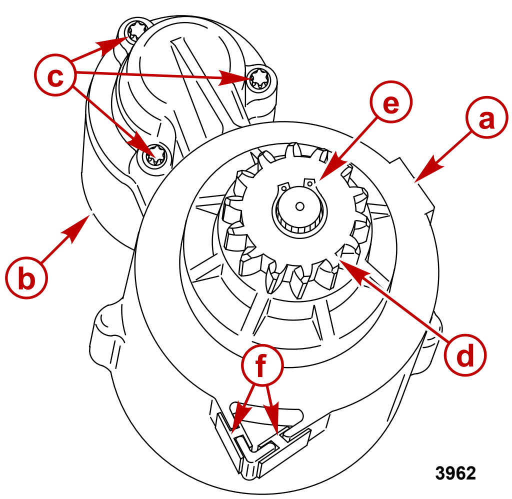
2. Install metal disc and plug into drive housing.



3967

a - Metal disc
b - Plug

3. Attach arm to starter solenoid. Install starter solenoid in drive housing and secure with 3 screws. Tighten solenoid mounting screws to specified torque.
4. Install drive gear and secure with snap ring.
5. Reinstall rubber bumper on housing.

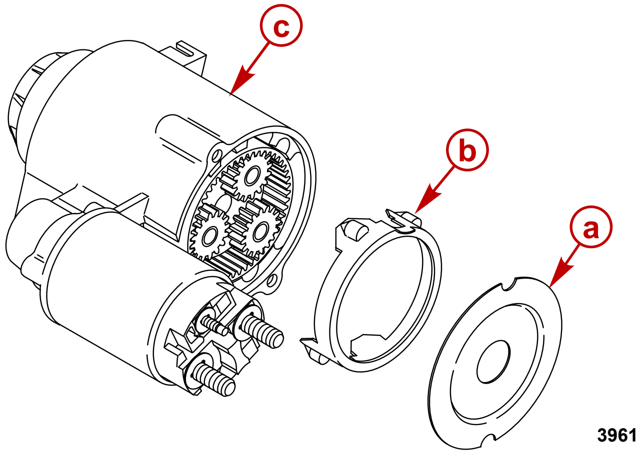


3962

a - Drive housing
b - Starter solenoid
c - Screws (3) (Internal Torx - Snap On E6 Socket)
d - Pinion gear
e - Snap ring
f - Bumpers

Description	Nm	lb. in.	lb. ft.
Solenoid mounting screws (3) internal torx	4.5	40	

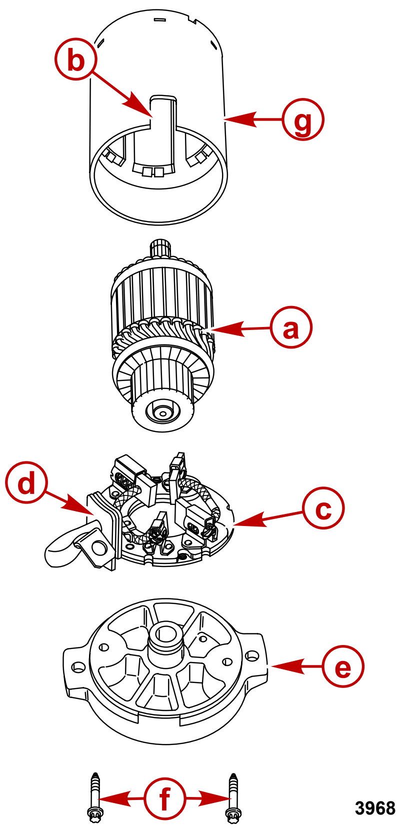
6. Install cushion and shield in drive housing.



a - Shield
b - Cushion
c - Drive housing

7. Install field frame over armature.
8. While holding brushes back, slide brush plate onto armature while aligning brush lead grommet with slot in frame.
9. Secure end plate to brush assembly with 2 screws. Tighten screws to specified torque.

NOTE: Prior to installing field frame assembly into drive housing, align slot in field frame with plug in drive housing.

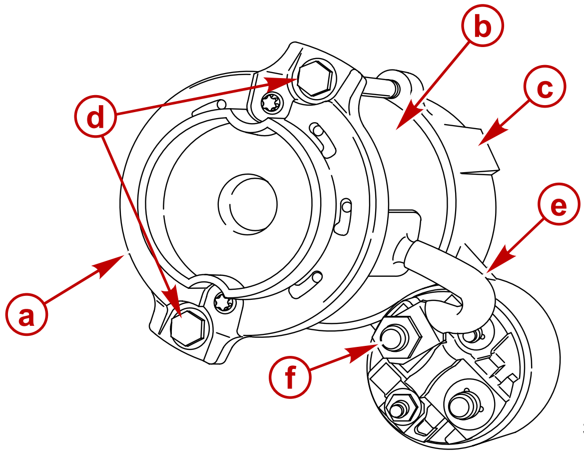


a - Armature
b - Field frame grommet slot
c - Brush plate
d - Brush lead grommet
e - End plate
f - End plate screws
g - Field frame plug slot

Description	Nm	lb. in.	lb. ft.
End plate screws	3.4	30	

10. Install field frame and end frame in drive housing.

11. Install thru-bolts and brush lead. Tighten thru-bolts and brush nut to specified torque.



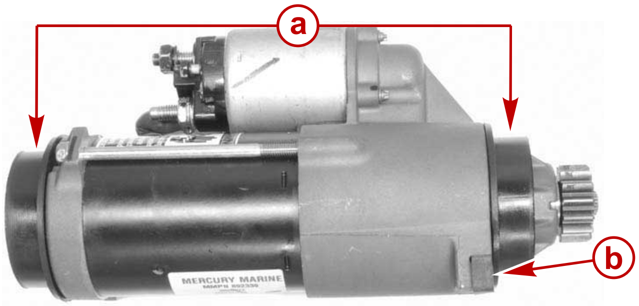
3969

- a - End frame
- b - Field frame
- c - Drive housing
- d - Thru-bolts
- e - Brush lead
- f - Brush nut

Description	Nm	lb. in.	lb. ft.
Thru-bolts	12.5	110	
Brush nut	6	55	

Starter Installation

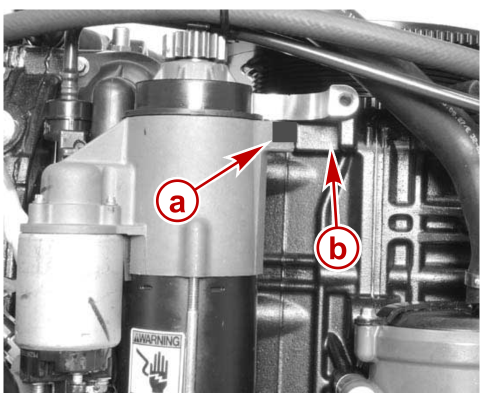
1. Ensure the bottom and top collars are on the starter end caps.
2. Ensure the starter stop is on the upper end cap.



3955

- a - Starter collar
- b - Starter stop

3. Place the starter onto the cylinder block starter mounting boss with the starter stop facing starter stop boss.

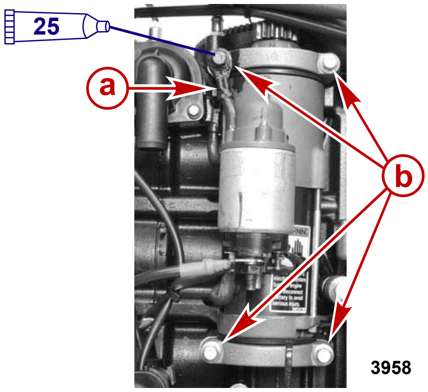


3956

- a - Starter stop
- b - Starter stop boss

4. Insert a starter bolt through the starter ground eyelet.
5. Secure the starter to the cylinder block with the starter retainers and starter bolts. Tighten the starter bolts to the specified torque.

6. Cover the bolt and starter ground wire eyelet with liquid neoprene.



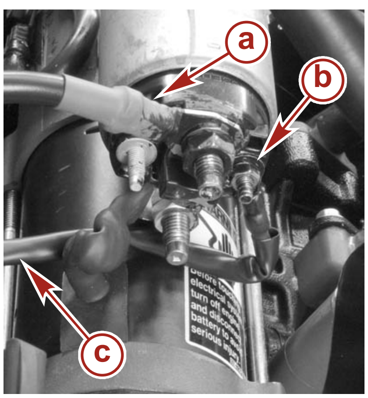
3958

a - Starter ground wire
b - Starter bolt

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter bolt; ground wire eyelet	92- 25711 3

Description	Nm	lb. in.	lb. ft.
Starter bolt (M8 x 40)	17	150	

7. Guide the starter yellow/red exciter wire behind the solenoid and connect the exciter wire to the solenoid exciter wire terminal. Tighten the exciter wire terminal nut to the specified torque.
8. Connect the battery black/red sleeved starter cable to the starter solenoid terminal. Tighten the battery starter cable nut to the specified torque.
9. Cover the starter exciter wire terminal and battery starter cable with liquid neoprene.



3965

a - Battery starter cable
b - Solenoid exciter wire terminal
c - Starter exciter wire

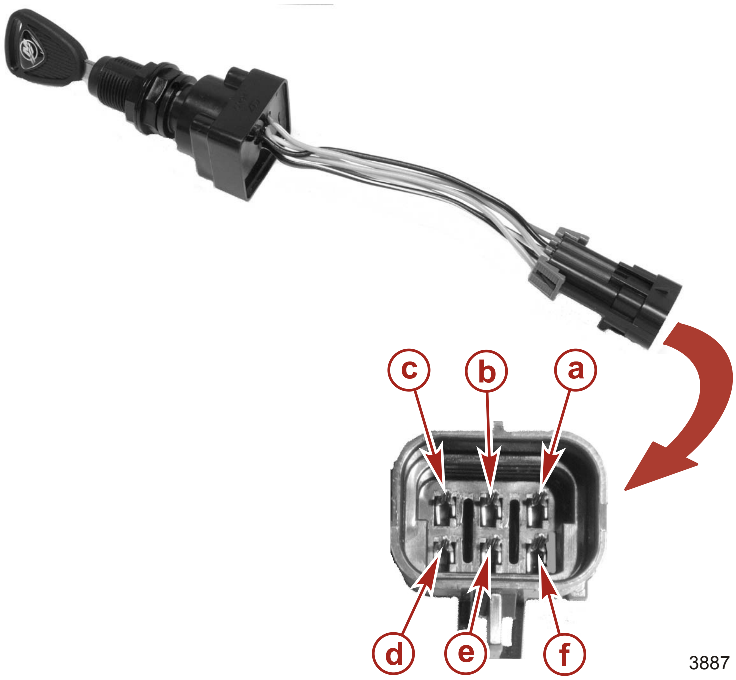
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter exciter wire terminal; battery starter cable	92- 25711 3

Description	Nm	lb. in.	lb. ft.
Exciter Wire Terminal Nut	2.5	22	
Battery Starter Cable Nut	9	80	

Key Switch Test (Four Position)

1. Disconnect the key switch from the command module harness.
2. Set ohmmeter on R x 1 scale for the following tests.

3. If meter readings are other than specified in the following tests, verify that the switch and not the wiring is faulty. If the wiring checks OK, replace the switch.



3887

a - Pin A - Red
b - Pin B - Black
c - Pin C - Purple/white
d - Pin D - Purple
e - Pin E - Black/yellow
f - Pin F - Yellow/red

Key Position	Continuity should be indicated at the following points:	
Off	B	E
Accessories	A	C
Run	A	D
Start	A	F
	F	D
	A	D

Electrical System

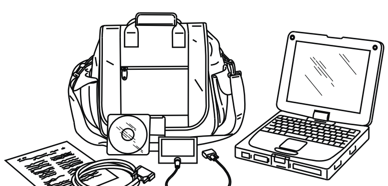
Section 2C - Timing, Synchronizing, and Adjusting

Table of Contents

Ignition Specifications

Ignition Specifications	
Full throttle RPM range (all models)	5800–6400
Idle RPM (all models)	550
Ignition type	Digital inductive
Spark plug type	NGK ILFR6G or NGK ILFR6GE
Spark plug gap	0.8 mm (0.031 in.)
Spark plug hex size	16 mm
Spark plug torque	27.5 Nm (19 lb-ft)
Spark plug hole size	14 mm
Firing order	1-3-5-6-4-2
Ignition timing at idle	Not adjustable; PCM controlled (approximately 2° ATDC)
Ignition timing at WOT	Not adjustable; PCM controlled
PCM overspeed limiter	Activates at 6500 RPM

Special Tools

Computer Diagnostic System (CDS)	Purchase from SPX*
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: USA and Canada SPX Corporation 28635 Mound Rd. Warren, MI 48092 800-345-2233 (option 2 then 2 again) oetech@servicesolutions.spx.com or EMEA 0049 6182 959 403 technical-support@spx.com Australia 61 3 9544 6222 techsupport-aus@servicesolutions.spx.com Mexico 52 55 25 95 16 30 (option 9) tecnico@spx.com Brazil 0800-762-1003 (option 9) tecnico@spx.com *CDS G3 must be purchased from Mercury Marine

Idle Timing Adjustment (All Models)

Idle timing is not adjustable. Idle timing is controlled by the propulsion control module (PCM). Idle timing can be monitored with the computer diagnostic system (CDS) through the PCM.

Computer Diagnostic System (CDS)	Purchase from SPX*

Maximum Timing Adjustment (All Models)

Maximum timing is not adjustable. Maximum timing is controlled by the propulsion control module (PCM). Maximum timing can be monitored with the computer diagnostic system (CDS) through the PCM.

Computer Diagnostic System (CDS)	Purchase from SPX*

Idle Speed Adjustment (All Models)

Engine idle speed is not adjustable. The parameters affecting idle speed can be checked and monitored by the computer diagnostic system (CDS).

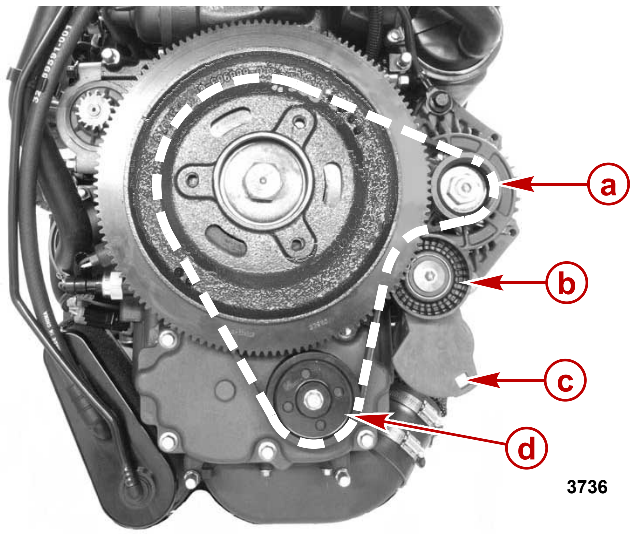
Computer Diagnostic System (CDS)	Purchase from SPX*

Throttle Adjustment (All Models)

All throttle inputs are relayed electronically from the helm to the engine. There are no mechanical linkages or adjustments to be made or checked.

Alternator and Supercharger Belt Tension Adjustment (All Models)

Correct alternator and supercharger belt tension is maintained by a belt tensioner assembly.



a - Alternator
b - Belt tensioner pulley
c - Tensioner release slot
d - Supercharger pulley

Notes:

Electrical System

Section 2D - Digital Throttle and Shift

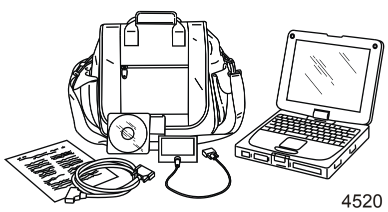
2
D

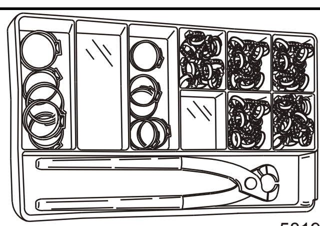
Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Pivot pin	92-802859A 1

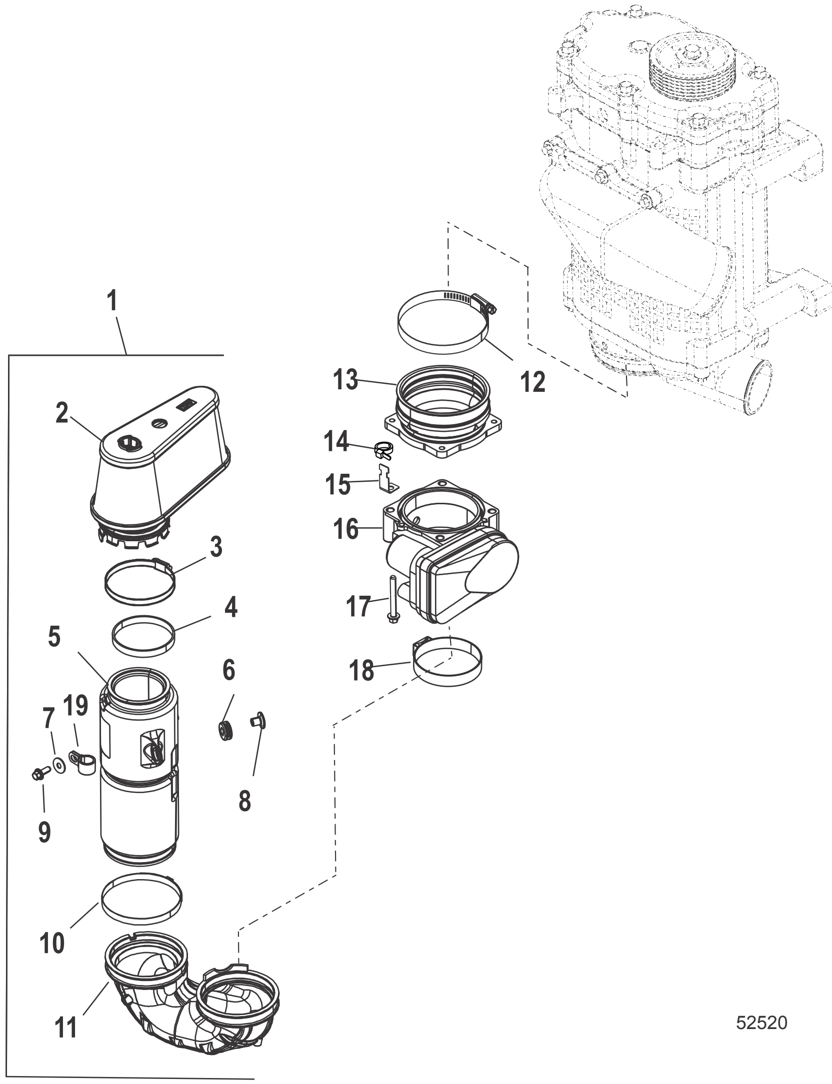
Special Tools

Computer Diagnostic System (CDS)	Purchase from SPX*
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: USA and Canada SPX Corporation 28635 Mound Rd. Warren, MI 48092 800-345-2233 (option 2 then 2 again) oetech@servicesolutions.spx.com or EMEA 0049 6182 959 403 technical-support@spx.com Australia 61 3 9544 6222 techsupport-aus@servicesolutions.spx.com Mexico 52 55 25 95 16 30 (option 9) tecnico@spx.com Brazil 0800-762-1003 (option 9) tecnico@spx.com *CDS G3 must be purchased from Mercury Marine

Hose Clamp Tool Kit	91-803146A2
 5819	Aids in the installation of high pressure (Oetiker ®) hose clamps.

Notes:

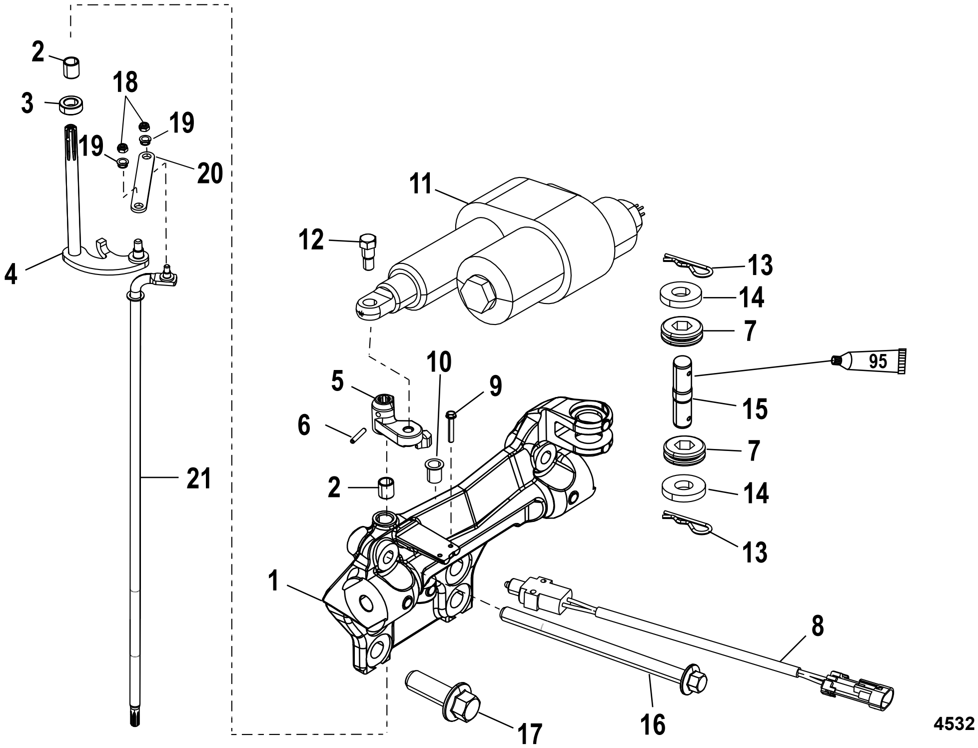
Electronic Throttle Control (ETC) Components



Electronic Throttle Control (ETC) Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Air intake assembly			
2	1	Filter			
3	1	Clamp			
4	1	Gasket			
5	2	Resonator			
6	2	Grommet			
7	1	Washer			
8	4	Bushing			
9	2	Screw (M6 x 25)	7.4	66	–
10	1	Clamp (96.5)			
11	1	Rubber boot			
12	1	Clamp	6.2	55	–
13	1	Isolator			
14	1	Cable tie			
15	1	Bracket			
16	1	Electronic throttle control assembly			
17	1	Screw (M6 x 50)	11	97	–
18	1	Clamp (96.5)			
19	1	Fuel hose clip (use where applicable)			

Electronic Shift Control (ESC) Components



Electronic Shift Control (ESC) Components

Ref. No.	Qty.	Description		Torque		
				Nm	lb. in.	lb. ft.
1	1	Bracket				
2	2	Bushing				
3	1	Spacer				
4	1	Bell crank shift shaft				
5	1	Upper bell crank				
6	1	Roll pin (0.125 x 0.75)				
7	2	Grommet				
8	1	Switch				
9	2	Screw (M3 x 20)		2.2	20	
10	1	Bushing				
11	1	Shift actuator				
12	1	Screw		20	177	
13	2	Cotter pin				
14	2	Washer				
15	1	Pivot pin				
16	2	Screw (M10 x 155)	First torque	40		29.5
			Final torque	Plus additional 45° turn		
17	4	Screw (M14)		185		136.5
18	2	Nut (M6)		6	53	
19	2	Bushing				
20	1	Shift shaft link				
21	1	Shift shaft				

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Pivot pin	92-802859A 1

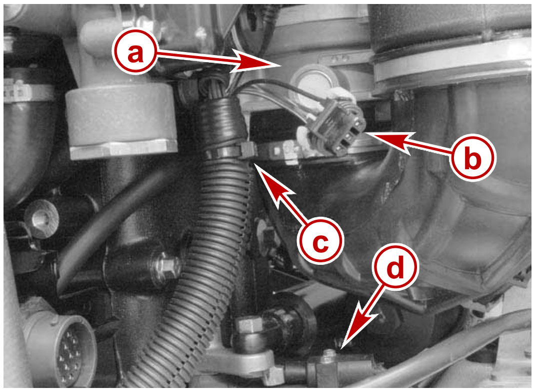
Electronic Throttle Control (ETC)

The ETC consists of a single bore cylindrical valve with a DC electric motor to control the position of the throttle valve. A positive spring force returns the throttle valve to a defined position when no electrical signal is connected to the DC motor. Idle airflow is controlled by the throttle valve; there is no additional idle air control system in the ETC. The ETC contains two throttle position sensors operating in opposite directions of one another to provide a position feedback signal. As the voltage increases in one, it decreases on the other. However, the PCM processes the signals from both throttle position sensors so that the computer diagnostic system (CDS) display will show both TPS's increasing and decreasing together.

Computer Diagnostic System (CDS)	Purchase from SPX*

Electronic Throttle Control (ETC) Removal

1. Remove the starboard front cowl.
2. Remove the cable tie securing the engine harness to the ETC.



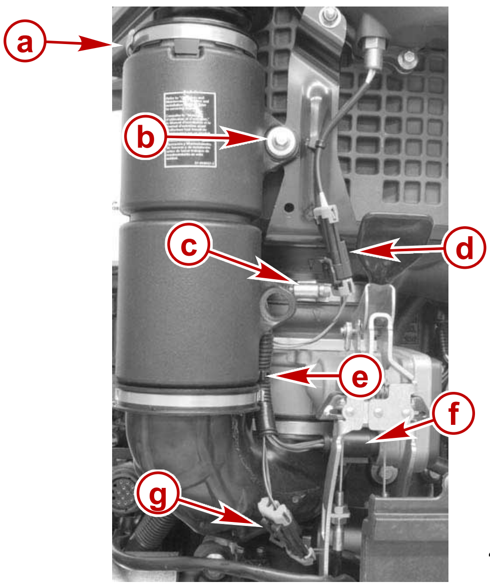
4599

- a - ETC
- b - Power steering harness
- c - Cable tie
- d - Shift indicator switch

3. Loosen the hose clamp securing the air filter to the resonator.
4. Remove the air filter.

NOTE: On early models, the resonator was attached to a support bracket and the boost air temperature sensor harness is secured to the same bracket. On later models, the resonator is attached to a boss on the supercharger and the boost air temperature sensor harness is secured to an eyelet on the resonator.

5. Remove the bolt securing the resonator to the support bracket.
6. Remove the cable tie securing the engine harness to the ETC.
7. Disconnect the boost air temperature sensor harness.
8. Disconnect the ETC engine harness from the ETC.
9. Disconnect the shift position indicator harness.
10. Loosen the hose clamp securing the ETC to the supercharger.



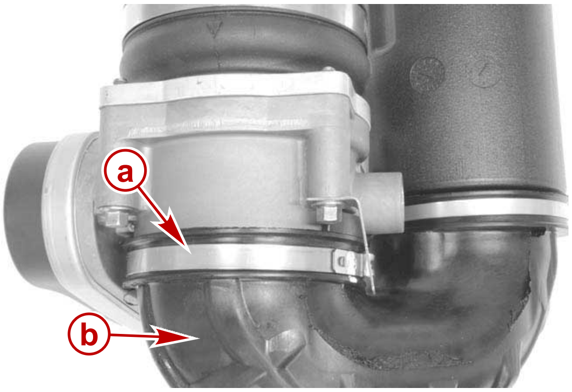
4600

- a - Hose clamp securing air filter to resonator
- b - Bolt securing resonator to support bracket
- c - Hose clamp securing ETC to supercharger
- d - Boost air temperature sensor harness
- e - Cable tie securing the engine harness to the ETC
- f - ETC engine harness connector
- g - Shift position indicator harness

11. Push down on the ETC to remove the ETC from the supercharger.

Electronic Throttle Control (ETC) Disassembly

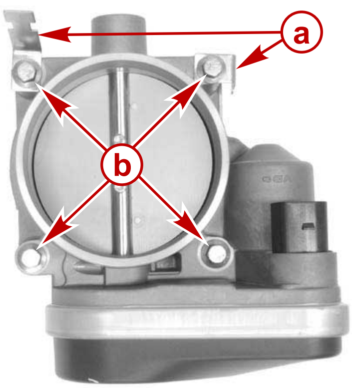
1. Remove the hose clamp securing resonator boot to the ETC.



4601

a - Hose clamp
b - Resonator boot

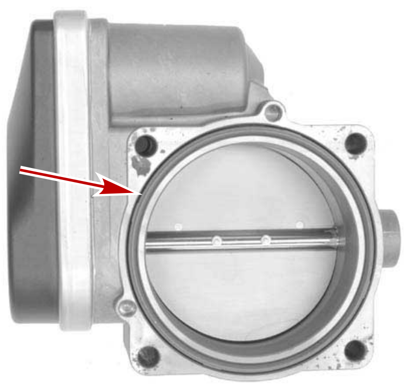
2. Remove the resonator boot.
3. Remove the four screws securing the isolator to the ETC. Do not lose the two harness support brackets.



4602

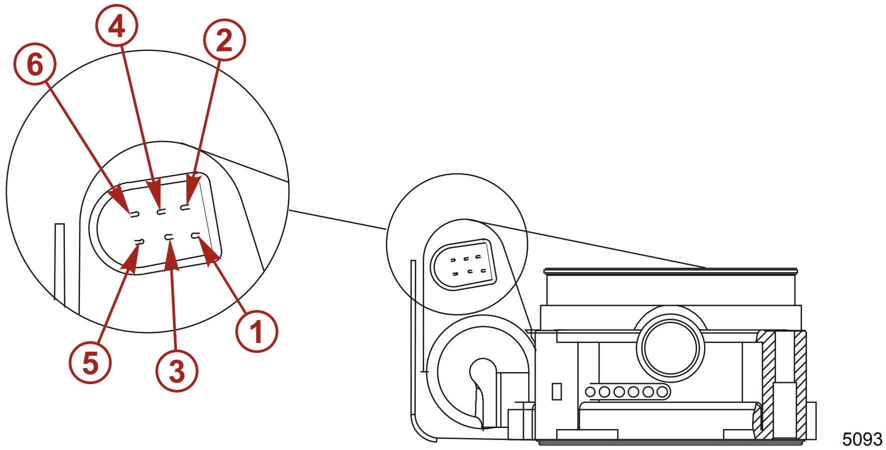
a - Harness support brackets
b - Screws securing isolator to ETC

4. Remove isolator seal and inspect for damage.



4603

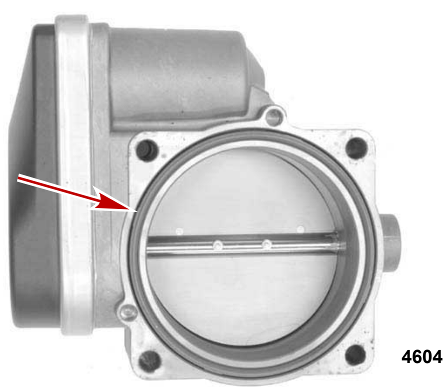
Electronic Throttle Control (ETC) Harness Connection Pin-Out



Pin Number	Assignment
1	TPI 1 voltage
2	Transducer reference power
3	Motor driver
4	TPI 2 voltage
5	Motor driver
6	Transducer ground

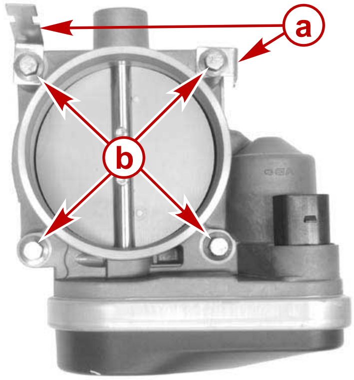
Electronic Throttle Control (ETC) Reassembly

1. Install seal onto the ETC.



2. Install the isolator onto the ETC.
3. Install the 4 isolator mounting screws. Ensure the harness support brackets are installed as shown.

4. Tighten the ETC screws to the specified torque.

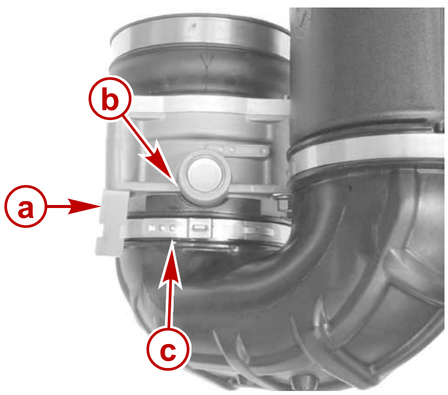


4602

a - Harness support brackets
b - Screws securing isolator to ETC

Description	Nm	lb. in.	lb. ft.
Isolator screw (M6 x 50)	11	97	

5. Install a 96.5 diameter hose clamp onto the resonator boot.
6. Install the resonator boot onto the ETC. Ensure the resonator boot is in proper alignment with the ETC throttle shaft and crimp hose clamp.



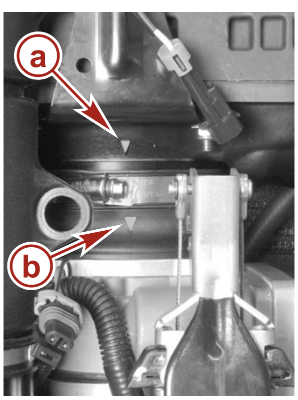
4605

a - Harness support bracket
b - Resonator boot alignment
c - 96.5 diameter hose clamp

Hose Clamp Tool Kit	91-803146A2

Electronic Throttle Control (ETC) Installation

1. Install a hose clamp onto the isolator.
2. Install the ETC assembly onto the supercharger.
3. Align the arrows on the supercharger and the ETC boot.



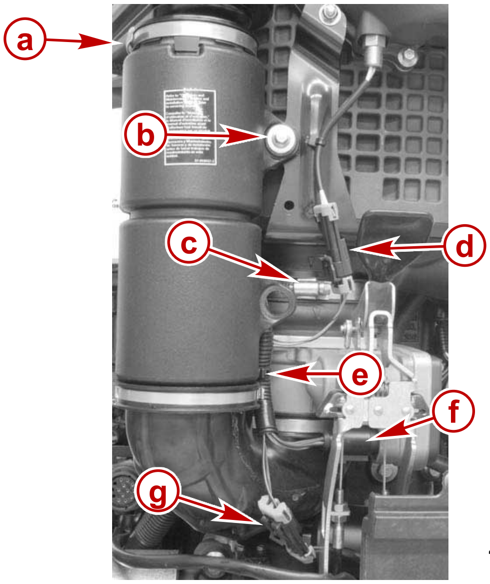
5584

a - Arrow on supercharger
b - Arrow on ETC boot

4. Tighten the hose clamp to the specified torque.
5. Connect the boost air temperature sensor harness (blue/black, black/orange).
6. Connect the ETC harness.
7. Connect the shift indicator harness to the shift indicator (black/white, black/orange).

NOTE: On early models, the resonator was attached to a support bracket and the boost air temperature sensor harness is secured to the same bracket. On later models, the resonator is attached to a boss on the supercharger and the boost air temperature sensor harness is secured to an eyelet on the resonator.

8. Secure the resonator to the resonator support bracket. Tighten the bolt to the specified torque.
9. Secure the air filter to the resonator.

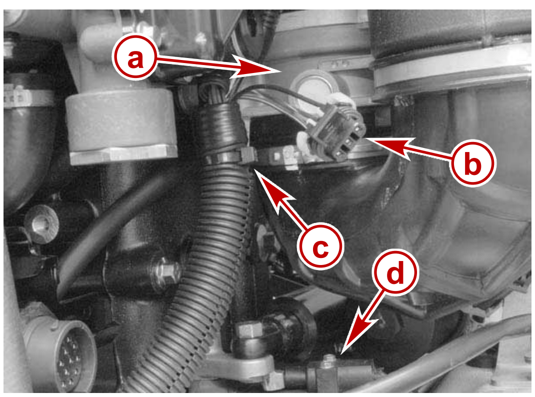


4600

a - Hose clamp securing air filter to resonator
b - Bolt securing resonator to support bracket
c - Hose clamp securing ETC to supercharger
d - Boost air temperature sensor harness
e - Cable tie securing the engine harness to the ETC
f - ETC engine harness connector
g - Shift position indicator harness

Description	Nm	lb. in.	lb. ft.
Bolt securing resonator (M6 x 25)	7.4	66	
Hose clamp securing ETC to supercharger	6.2	55	

10. Cable tie the engine harness to the harness support brackets that are mounted to the ETC.

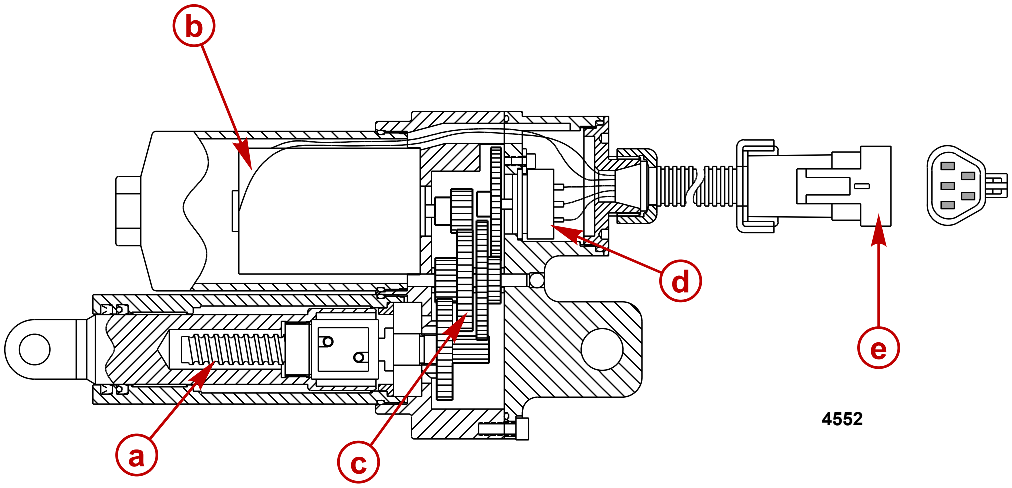


4599

a - ETC
b - Power steering harness
c - Cable tie
d - Shift indicator switch

11. Install starboard front cowl.

Electronic Shift Control (ESC)

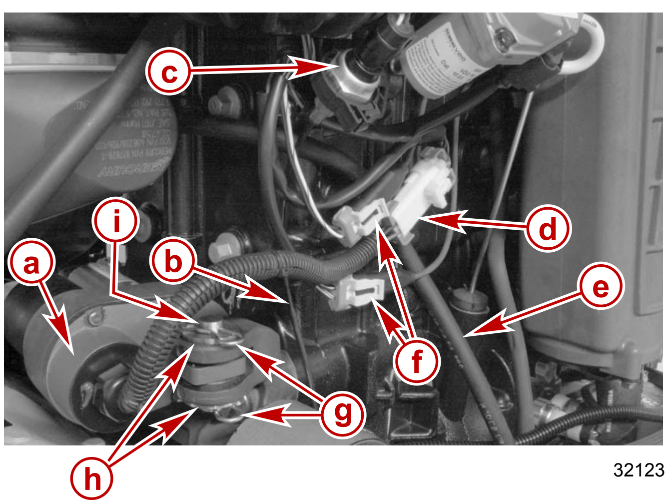


a - Ball screw assembly
b - Actuator motor
c - Reduction gears
d - Potentiometer
e - Harness connection

The ESC/shift actuator is used to shift the engine gearcase into forward, neutral, and reverse gears without mechanical cables from the shift/throttle controls. The 12 VDC actuator motor rotates a ball screw assembly through reduction gears in the actuator. The screw shaft then extends or retracts the actuator shaft while at the same time the gear set rotates a potentiometer in the actuator. The potentiometer receives a reference voltage (5.0 volts) from the PCM and its signal confirms the position of the actuator shaft.

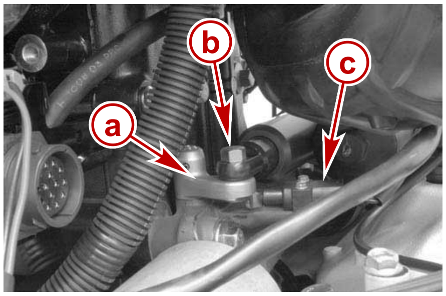
Electronic Shift Control (ESC) Removal

1. Slide the shift actuator harness connector aft to remove the connector from the mounting bracket.
2. Disconnect the electrical harness.
3. Remove the bottom cotter pin securing the pivot pin assembly.
4. Push the pivot pin up and remove the pin. Retain the cotter pins, pivot pin, and washers for reassembly.



a - Shift actuator
b - Speedometer hose
c - Speedometer sensor
d - Shift actuator harness connector
e - Tell-tale hose
f - Knock sensor harness connector
g - Cotter pin (2)
h - Washer (2)
i - Pivot pin

5. Remove the shift actuator bolt from the upper bell crank. Remove the shift actuator.



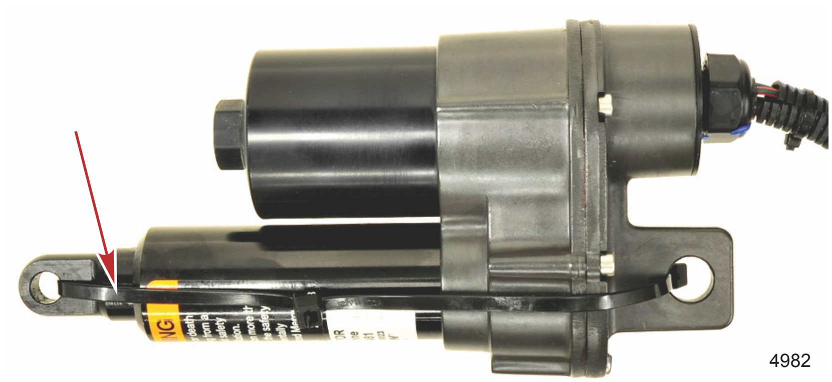
3596

a - Upper bell crank
b - Shift actuator bolt
c - Shift indicator switch

6. Remove the electronic shift control assembly.

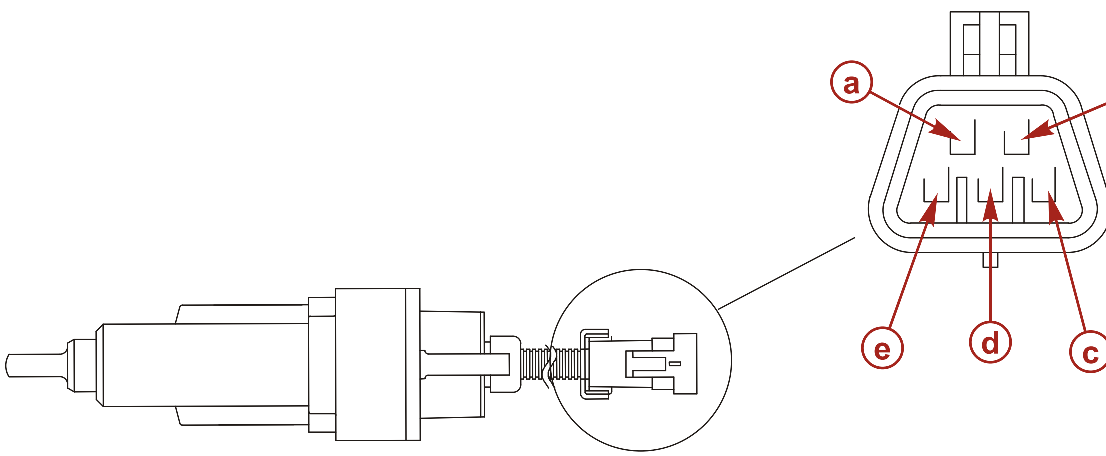
⚠ WARNING

To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through the electronic shift control piston to ensure that the piston does not rotate from the original factory position. Remove cable ties just prior to installation. Do not rotate the piston more than 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.



4982

Electronic Shift Control (ESC) Harness Connection Pin-Out

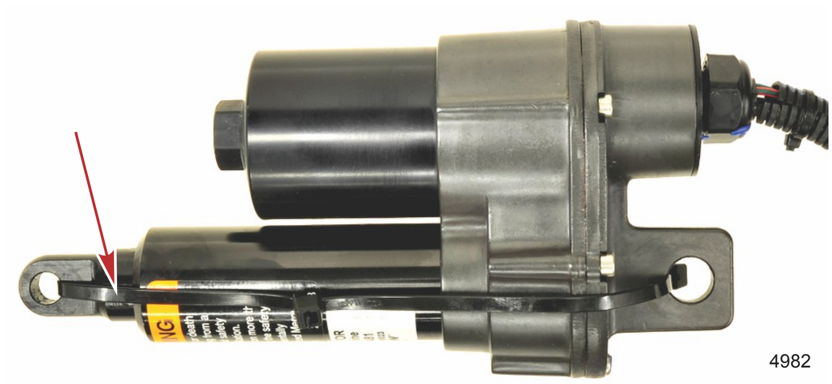


5094

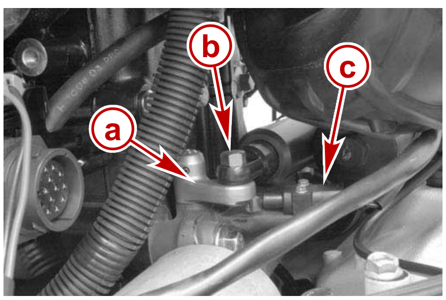
a - Transducer ground
b - Shift position input
c - Transducer reference power
d - Motor driver
e - Motor driver

Electronic Shift Control (ESC) Installation

> **⚠ WARNING**
>
> To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through the electronic shift control piston to ensure that the piston does not rotate from the original factory position. Remove cable ties just prior to installation. Do not rotate the piston more than 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.


4982

1. Remove the cable tie prior to installation.
2. Install the electronic shift control assembly.
3. Install the shift actuator bolt and torque to specification.

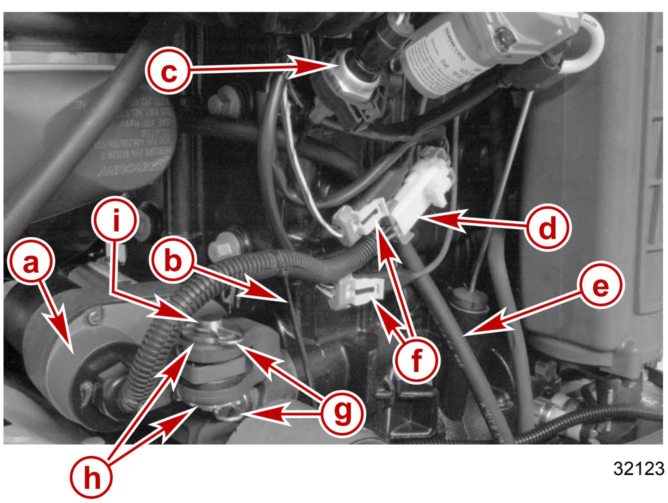


3596

- a - Upper bell crank
- b - Shift actuator bolt
- c - Shift indicator switch

Description	Nm	lb. in.	lb. ft.
Shift actuator bolt	20	177	

4. Install the pivot pin. Secure the pivot pin in place with the two washers and cotter pins that were retained.
5. Connect the electrical harness.
6. Slide the harness connector forward to connect to the mounting bracket.



32123

- a - Shift actuator
- b - Speedometer hose
- c - Speedometer sensor
- d - Shift actuator harness connector
- e - Tell-tale hose
- f - Knock sensor harness connector (2)
- g - Cotter pin (2)
- h - Washer (2)
- i - Pivot pin

Notes:

Fuel System

Section 3A - Fuel System Operation

Table of Contents

3
A

Air Induction System

Induction System Key Components

- Air filter
- Intake attenuator
- Electronic throttle control (ETC)
- Supercharger
- Charge air cooler (CAC)
- Intake manifold
- Electronic boost control (EBC)

Air Flow

Fresh air enters the cowling and is drawn into the air filter, where small airborne debris is filtered out. Air passing through the filter enters the intake attenuator, where the throttle noise of the engine is baffled for quiet operation. The air volume entering the engine is controlled by the electronic throttle control (ETC).

The ETC, with the assistance of the propulsion control module (PCM), meters the amount of air entering the engine. The ETC is operated with an electric motor. The position of the ETC blade is monitored with two throttle position sensors (TPS). The ETC also performs operations similar to an idle air control (IAC) valve. Should the ETC fail, the ETC blade is spring-loaded to return to an off idle setting of about 1200 RPM, in gear. After passing the ETC, the air enters the supercharger.

The supercharger is belt-driven from crankshaft rotation. As the air passes the ETC, it enters at the bottom of the supercharger, where two close-tolerance internal rotors (one male, one female) rotate in opposite directions to compress and accelerate the air towards the exit port of the supercharger. The compressed and accelerated air has potentially risen in temperature beyond 80 °C (176 °F) and must be cooled before entering the combustion chamber. The supercharged air pressure can increase 101 kPa (14.7 psi) above ambient barometric pressure during maximum boost. The supercharged air enters the charge air cooler (CAC).

The CAC is water-cooled. Supercharged air passing through the CAC is chilled and increases in density. This chilled, dense air travels through the intake manifold and enters the combustion chamber when the intake valves open.

The intake manifold runners allow the air to flow smoothly into the combustion chamber. Each runner has a single fuel injector controlled by the PCM. The fuel injector is unique and has two pintels or nozzles. The two-nozzle design allows for a better atomization of the fuel with the supercharged air. The nozzles spray the fuel directly at the intake valves. Any excess air is returned to the bottom of the supercharger intake. The amount of air returned is controlled by the electronic boost control (EBC) valve.

The EBC uses an electric motor that operates the boost control valve, and is controlled by the PCM. This valve is spring-loaded to the open position. The open position allows the excess air to be returned to the bottom of the supercharger. There is no demand for supercharged air at idle. During hard acceleration, the PCM monitors the throttle position sensor (TPS), manifold absolute pressure (MAP) sensor, manifold air temperature (MAT) sensor, and engine RPM to determine the amount of valve closure needed to supply supercharged air to the engine. Tampering with the EBC will generate an error and will not develop the engine's rated horsepower.

Fuel Injection System

The Verado fuel injection system is a multiport, sequential fuel injection system. Fuel is injected into the cylinder head one cylinder at a time, timed to coincide with each cylinder's intake stroke. This type of injection gives the Verado a significant fuel efficiency and performance advantage over synchronous (batch timed) fuel injection engines.

The fuel delivery system, in conjunction with the ignition, is controlled by the propulsion control module (PCM). The PCM requires input information from multiple sensors to maintain optimum fuel injection volume (pulse width); fuel injection timing, manifold absolute pressure (MAP), and throttle position sensor (TPS) input. The PCM converts the input signals from the various input sensors and sends digital instructions for the throttle, fuel injection timing/volume, positions the electronic boost control (EBC) valve, and controls the spark timing.

The PCM also controls the modulation of the fuel lift pump in the fuel supply module (FSM). The modulation of the fuel lift pump is dependent on the demands of the engine and the subsequent amount of fuel consumption. The fuel lift pump is activated through the fuel pump ground circuit inside the PCM. While the engine is in operation, the PCM calculates the volume of fuel used at any RPM and engine load, and cycles the fuel lift pump according to the calculated fuel consumption. The fuel lift pump should never be at 100% duty cycle (constantly on). The fuel lift pump will always be an on/off cycle. The fuel lift pump will become disabled in the event of a FSM overflow. The PCM recognizes the FSM overflow with the activation of the vent canister switch (VCS).

Fuel pressure changes with engine power demands. When the engine power demand changes, the manifold absolute pressure (MAP) changes. The demands of the engine are monitored by the PCM through the MAP sensor and the throttle position sensor. Fuel pressure will change in conjunction with the manifold absolute pressure change. A tube on the intake manifold is connected to the fuel pressure regulator inside the fuel supply module (FSM). The manifold pressure changes will push or pull the fuel pressure regulator diaphragm, changing the amount of fuel pressure in the fuel rail. Any excess pressure is released into the FSM.

Fuel injection volume is initially charted in the PCM when the system is activated by turning the key to the "ON" position. The PCM reads the MAP sensor in the intake manifold to determine the ambient barometric pressure. The PCM then looks at the cylinder block temperature and manifold air temperature. The barometric pressure, cylinder block temperature, and manifold air temperature readings are the base for all fueling strategies at start-up. Fuel strategy changes constantly during engine operation.

A supercharger is used to boost the air volume and power output. Supercharged air increases in temperature and must be cooled by passing through the charge air cooler (CAC) to increase the air density. The chilled, dense air is forced into the combustion chamber. The amount of boost required for the engine to operate at maximum horsepower capacity is controlled by the PCM. The PCM closes the electronic boost control (EBC) valve to increase the amount of air forced into the combustion chamber. The amount of EBC valve closure is dependent on the demands of the engine based on the throttle position, MAP, MAT, and engine RPM.

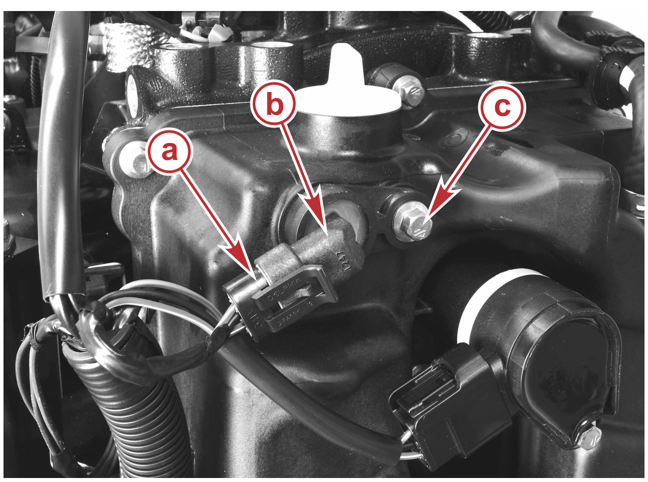
The fuel is water-cooled inside the fuel supply module (FSM). While the engine is running, water is pumped up to the powerhead by the water pump located in the lower unit. Water is pumped up to the engine via a water tube, then passes through the adapter plate main water galley where it enters the powerhead and is distributed to different locations. The water tube for cooling the fuel is connected to a preformed hose passing through the adapter plate, where it connects to a preformed hose attached to the fuel supply module (FSM). The water enters the FSM and passes through a coiled metal tube and exits outside the FSM. The metal tube is completely submerged in fuel while the engine is in operation.

The electronic throttle control (ETC) is modulated by the PCM. The PCM converts digital position signals at the helm and positions the ETC throttle plate accordingly. The ETC has two throttle position sensors (TPS). This redundancy ensures the accuracy of the throttle plate position. The ETC also acts as an idle air controller (IAC), increasing or decreasing the ETC plate opening, based on the engine temperature.

Powerhead Sensors

Camshaft Position Sensor

The camshaft position sensor is located at the top of the valve cover. It supplies the PCM with fuel injection timing and RPM information. When the camshaft position sensor is functioning, the PCM controls the fuel injection in a multiport timing strategy. When the camshaft position sensor has failed, the PCM controls the fuel injection in a synchronous (batch timed) method. The PCM will generate and store a failure code when the camshaft position sensor fails.

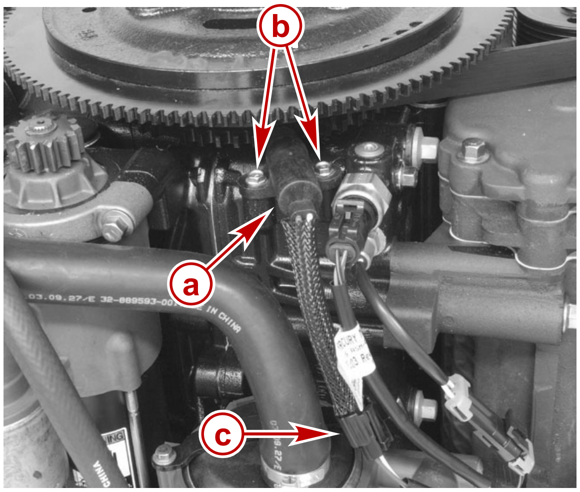


52828

- a - Harness connector
- b - Camshaft position sensor
- c - Attaching screw

Crankshaft Position Sensor (CPS)

The CPS is located at the top of the cylinder block, next to the flywheel. It supplies the PCM with timing and RPM information. If a failure occurs in the circuit, the engine will run rough or stop running. The PCM will generate and store a failure code.

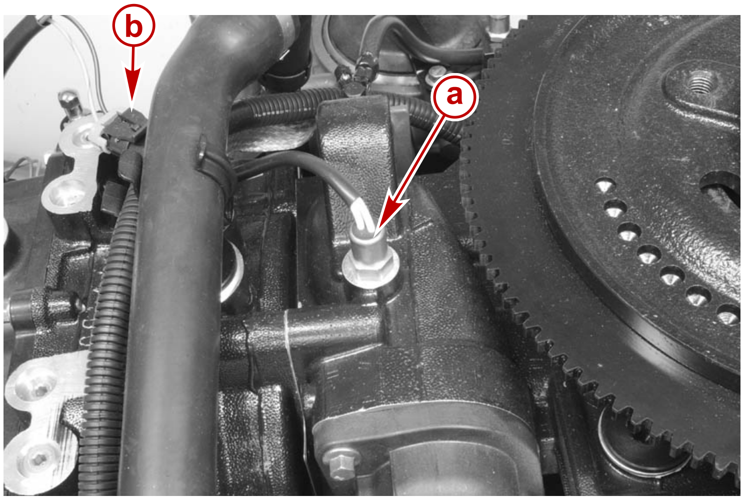


5522

a - Crankshaft position sensor
b - Retaining screw
c - Harness connector

Cylinder Block Temperature Sensor

The cylinder block temperature sensor is located at the top of the cylinder block, aft of the flywheel. It is a thermistor immersed in the engine coolant path. It supplies the PCM with engine temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the cylinder block.



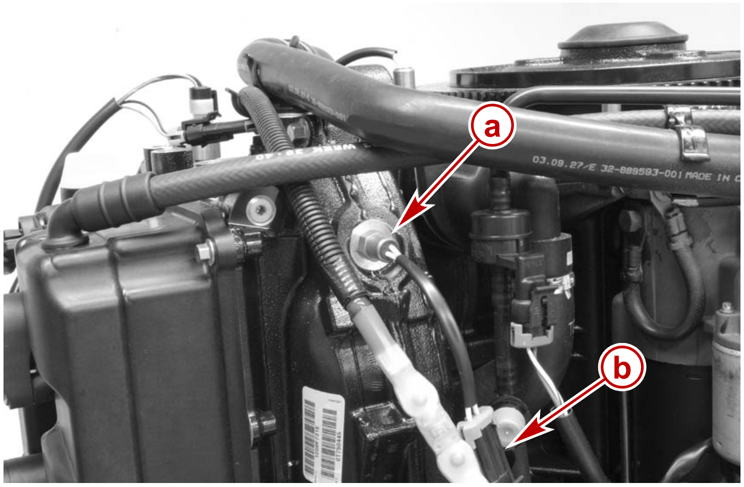
4574

a - Temperature sensor
b - Harness connector

Cylinder Head Coolant Temperature Sensor

***NOTE:** Engines with S/N 1B517433 and below have a cylinder head coolant temperature sensor. Engines with S/N 1B517434 and above do not have a cylinder head coolant temperature sensor.*

The cylinder head coolant temperature sensor is a thermistor immersed in the engine coolant stream. It is located on the starboard side of the head near the top of the head. It supplies the PCM with temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the head.

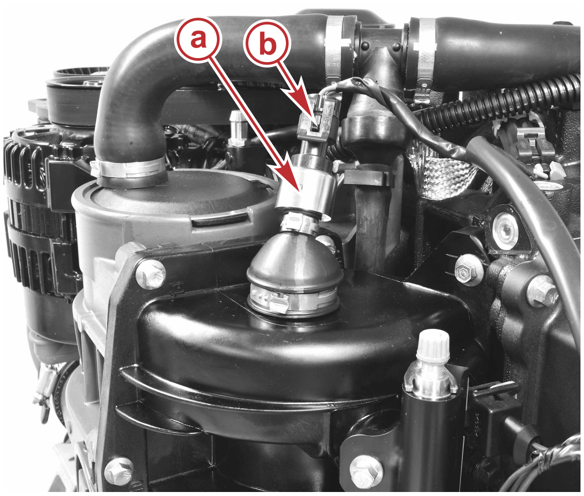


4575

- a - Cylinder head coolant temperature sensor (S/N 1B517433 and below)
- b - Harness connector

Manifold Absolute Pressure (MAP) Sensor

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure. It is located at the top of the intake manifold. When the key is turned "ON," the MAP sensor reads the ambient atmospheric pressure. This information is used by the PCM as an indication of altitude and is referred to as BARO.

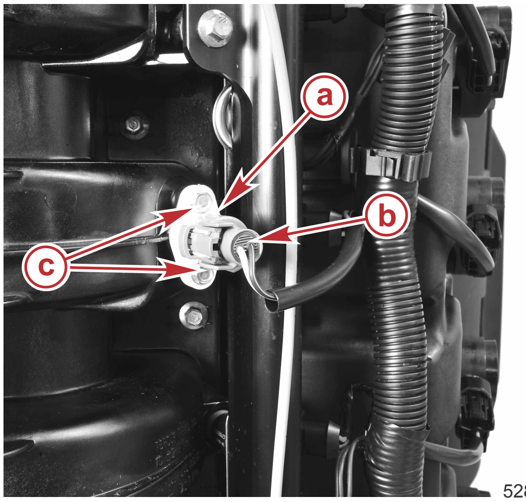


52529

- a - MAP sensor
- b - Harness connector

Manifold Air Temperature (MAT) Sensor

The manifold air temperature (MAT) sensor is a thermistor that sends a signal voltage to the PCM. It is located in the middle of the intake manifold close to the fuel rail. It informs the PCM of the air temperature inside the intake manifold. The PCM adjusts the fuel injection duration needed to run the engine at optimum efficiency according to the MAT information.

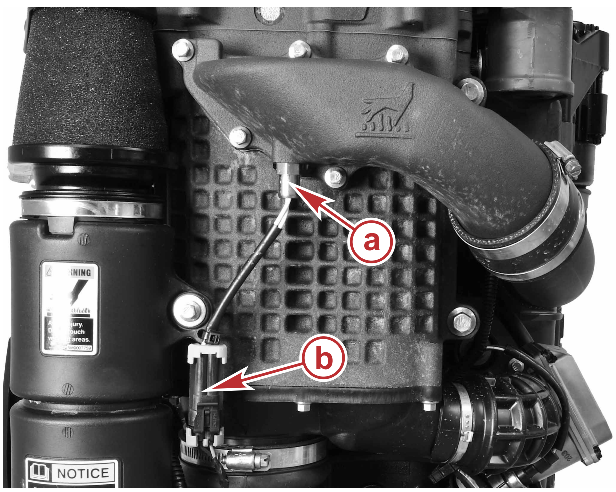


52830

- a - MAT sensor
- b - Harness connector
- c - Screws (M4 x 16)

Supercharger Outlet Temperature Sensor

The supercharger outlet temperature sensor is a thermistor immersed in the boost pressure stream. It is located in the front of the engine, at the base of the return duct. Low air temperature produces high resistance. High air temperature causes low resistance. The PCM will reduce engine RPM and warn the helm of the high temperature.



52831

- a - Supercharger outlet temperature sensor
- b - Harness connector

Fuel System

Fuel System Description

The components of the fuel system are:

- Main power relay (MPR)
- High-pressure fuel pump control relay
- Water-in-fuel (WIF) sensor
- Propulsion control module (PCM)
- Fuel supply module (FSM)
- Fuel float switch
- Vent canister float switch (VCFS)
- Vent canister purge valve (VCPV)
- Fuel lift pump
- High-pressure fuel pump

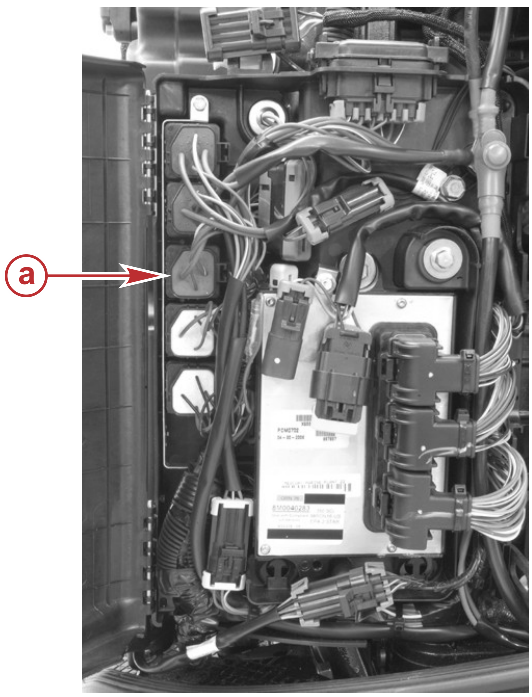
- Fuel pressure regulator
- Fuel cooler
- Fuel injector
- Fuel rail pressure damper
- Supercharger

IMPORTANT: No external electric fuel pump is allowed by the US Coast Guard. The system does not require an external primer bulb. Using an external primer bulb will cause a warning horn to sound and cause a flooding condition.

Main Power Relay (MPR)

The main power relay (MPR) is located inside the electrical box on the starboard side of the engine. The MPR will remain active for approximately three minutes, or until the fuel supply module (FSM) is full, the first time the system is powered up. The MPR is controlled by the PCM. After the first system power up, the MPR is active for approximately two seconds after the key is turned on. The PCM deactivates the MPR unless one or more various sensors, or solenoid activation, signals the PCM to initiate the MPR. The main power relay supplies 12 volts to the power trim, power steering, fuel lift pump, high-pressure fuel pump, ignition pencil coils, fuel injectors, electronic shift control (ESC), electronic throttle control (ETC), electronic boost control (EBC), and the alternator. The MPR is activated by:

- Power trim
- Power steering
- Moving the control handle
- Starting the engine

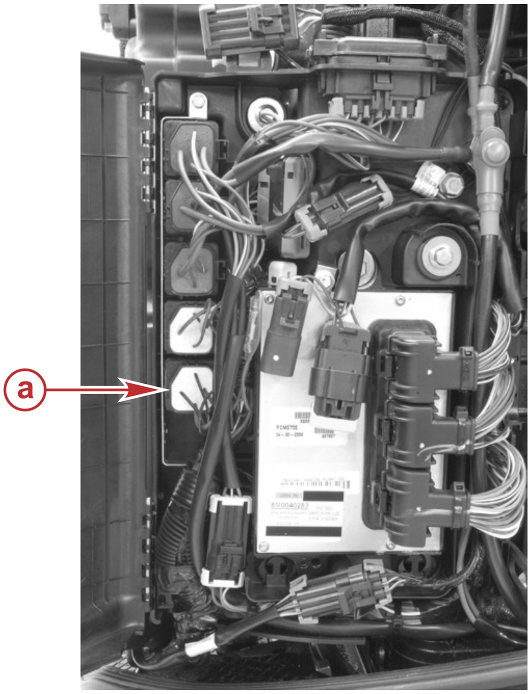


41655

a - Main power relay (MPR)

High-Pressure Fuel Pump Control Relay

The engine wire harness has a fifth relay for high-pressure fuel pump control, located next to the PCM. The incorporation of the high-pressure fuel pump control relay eliminates the possibility of pump damage when the key switch is turned to the "ON" position and the FSM is empty of fuel. The high-pressure fuel pump operation is controlled by the PCM. The PCM completes the ground connection of the high-pressure fuel pump through the high-pressure fuel pump control relay. The power for the high-pressure fuel pump is through the main power relay. A 20-amp fuse is in line with the power wire to the high-pressure fuel pump. The high-pressure fuel pump programmed logic limits the initial fuel pump use at key "ON" for five seconds. After the initial five seconds, the high-pressure fuel pump will not be active until engine RPM is recognized by the PCM.



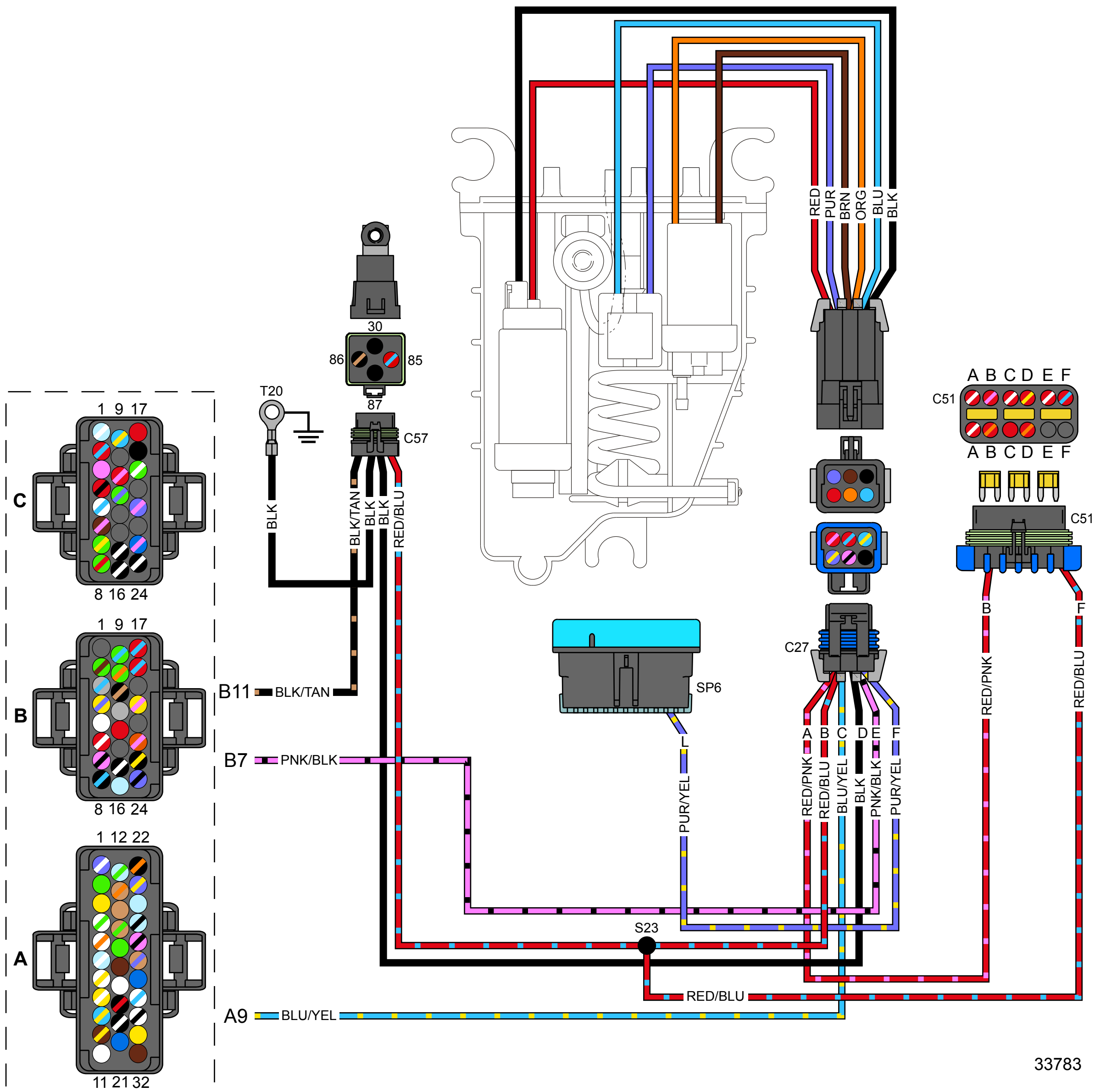
41656

a - High-pressure fuel pump control relay

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Fuel Pump Relay Circuit



Propulsion Control Module (PCM)

The PCM needs a minimum of 9 volts to operate. If the PCM fails, the engine will stop running.

The inputs to the PCM can be monitored and tested by the computer diagnostic system (CDS).

The PCM performs the following functions:

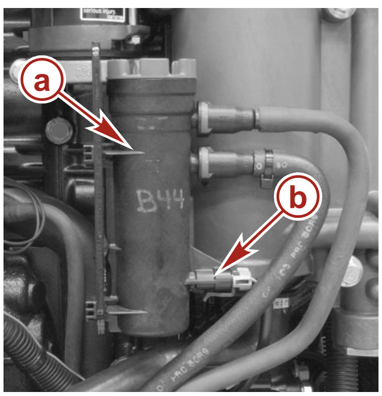
- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure, manifold air temperature, and cylinder block coolant temperature.
- Directly controls the ground circuit to: fuel injectors, ignition coil driver, electronic throttle control (ETC) motor drive, electronic boost control (EBC) motor drive, electronic shift control (ESC) motor drive, main power relay (MPR) activation, power steering pump, vent canister purge valve (VCPV), trim up, trim down, fuel lift pump, diagnostics, Engine Guardian, and tachometer link (analog tachometer output or link gauge driver).
- Indirectly controls the positive circuit to: fuel injectors, ignition coils, ETC motor drive, EBC motor drive, ESC motor drive, MPR activation, VCPV, and high-pressure fuel pump.

The PCM controls the ignition timing, fuel injection timing, fuel injection volume, activation of the fuel pumps, activation of the power steering pump, and throttle and shift; while maintaining the optimal air-fuel ratio and the amount of manifold boost in all operating conditions. The PCM converts the signals from the input sensors and sends electrical voltage instructions to each part of the fuel management system, power steering pump motor, throttle/shift controls, and ignition system. The PCM records all operations of the engine.

52832

Water-in-Fuel (WIF) Sensor

The water-in-fuel (WIF) sensor is located in the fuel filter housing on the starboard side of the engine. The sensor has two probes that are highly conductive when water is present in the fuel filter housing. Water in the fuel completes a 5 volt negative reference to the PCM. When water is detected in the fuel, the PCM will generate an error code and activate a warning horn to alert the operator. If SmartCraft gauges are installed, the PCM will flash a visual warning to the operator.



5911

a - Fuel filter housing
b - Water-in-fuel sensor

Fuel Supply Module (FSM)

The fuel supply module (FSM) contains the fuel lift pump, high-pressure fuel pump, fuel level float switch, fuel pressure regulator, and a fuel cooler. The FSM is mounted aft and outside of the driveshaft housing, directly below the lower adapter plate. There is no needle and seat controlling the amount of fuel entering the FSM. The filling of the FSM is controlled by the fuel level float switch inside the FSM. After the FSM is recognized as full, the PCM modulates the fuel lift pump to maintain the fuel level in the FSM.

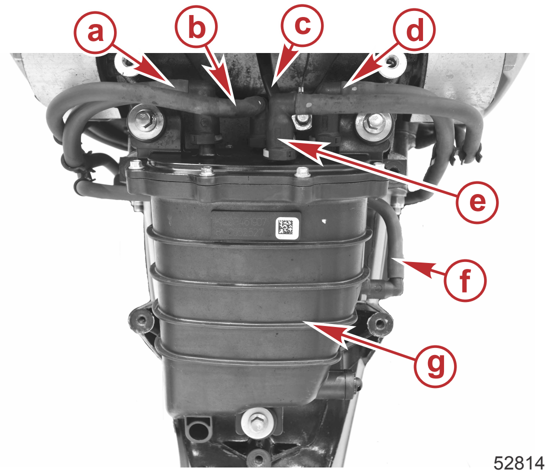
The FSM holds 500–600 ml (16.9–20.3 oz) when full. Using a specific gravity value of 0.74 for fuel, the 550 ml (18.6 oz) in a full FSM equals 408 grams of fuel. Using a PCM calibration setting of 60 grams of fuel mass (fuel consumed by engine) to turn on the lift pump, the mass of fuel in the FSM would range from 408 grams when full, to 348 grams at the low level when the lift pump would be turned on to refill. Maintaining this higher fuel level in the FSM helps isolate the float switch from vibration. Verado outboards with S/N 1B812284 and below, and have not had the PCM reflashed to a 60-gram calibration, use a PCM calibration setting of 150 grams of fuel mass consumed by the engine to turn on the lift pump. The fuel level in the FSM ranges from 408 grams when full, to 258 grams at the low level when the lift pump would be turned on to refill the FSM.

When the engine is keyed up, the PCM looks at the state of the FSM float switch and the vent canister float switch (VCFS). If the VCFS is high/open, the lift pump will not turn on. If the FSM float switch is high/open, the lift pump will not turn on. If both the FSM and VCFS are low/closed, the lift pump will turn on until the FSM float switch is high/open or the pump times out.

With the engine running, after the lift pump fills the FSM and the FSM float switch is high/open, the fuel mass counter will reset to "0" and begin counting grams of fuel consumed by the engine based on fuel per cycle (FPC) calculations in the PCM. When the fuel mass counter reaches 60 grams of fuel consumed, the lift pump is turned on to fill the FSM. Verado outboards with S/N 1B812284 and below have a PCM calibration setting of 150 grams of fuel mass; when the fuel mass counter reaches 150 grams of fuel consumed, the lift pump is turned on to fill the FSM.

Both the FSM float switch and the VCFS are normally low/closed. The only time the VCFS would go high/open is if there is fuel in the vent line or the switch failed to the open position. The lift pump will not run with the VCFS in the high/open state.

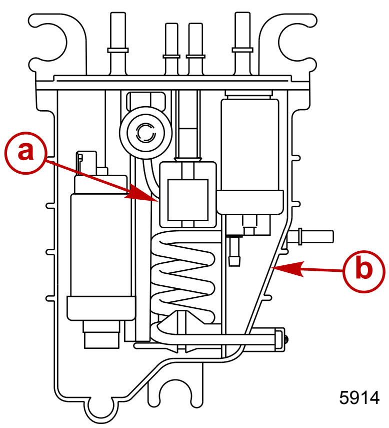
The FSM float switch controls the upper fuel level in the FSM and the lower fuel level is determined by a preset fuel mass value in the calibration.



- a - High-pressure fuel outlet hose (10 mm red tab)
- b - Manifold reference hose (8 mm white tab)
- c - FSM harness
- d - Input fuel hose (10 mm red tab)
- e - Vent canister hose (9 mm blue tab)
- f - Fuel cooler hose (8 mm blue tab)
- g - Fuel supply module (FSM)

Fuel Float Switch

The fuel float switch is a reed type switch sending an open or closed (off or on) signal to the PCM. The float has a magnet in it. As the fuel level increases in the FSM, the float will rise, causing the magnet to open the reed switch and send the off signal to the PCM. The switch contains anti-rotation ribs to reduce the effects of vibration on the float, and can be visually identified by red wires on the switch.



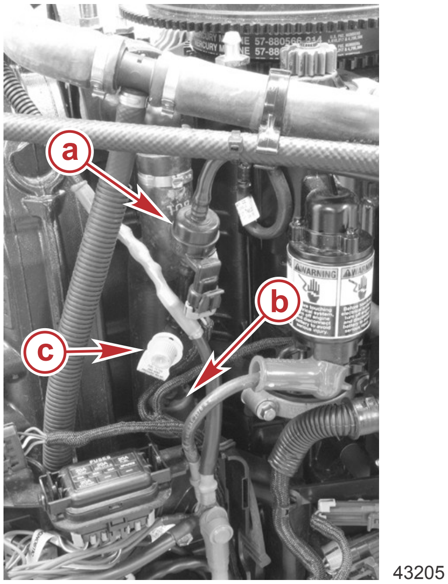
- a - Fuel float switch
- b - Fuel supply module

Vent Canister Purge Valve (VCPV)

The vent canister purge valve (VCPV) is closed when the engine is not running. This prevents the FSM fuel vapors from building up in the engine and cowl. When the engine is running, the PCM completes the ground circuit of the purge valve, opening the valve to allow fuel vapors from the FSM to be vented into the air filter. This allows the fuel vapors to be burned in the combustion chamber. The VCPV is modulated off and on by the PCM.

Vent Canister Float Switch (VCFS)

The vent canister float switch (VCFS) is located on the starboard side of the powerhead, aft of the starter. The VCFS sends an on/off signal to the PCM. The VCFS is normally closed, completing a 5 volt reference from the PCM. The VCFS will open during a fuel supply module overflow condition. An open VCFS will cause the PCM to close the VCPV.

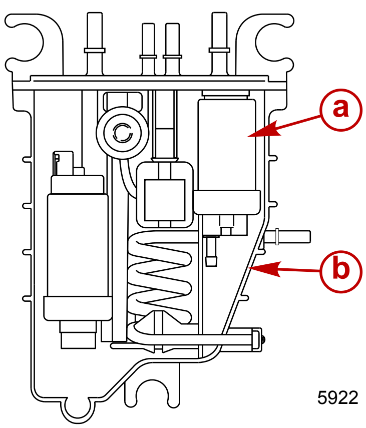


a - VCPV
b - VCFS
c - Fuel supply module pressure relief valve

Fuel Lift Pump

Fuel is pulled from the fuel tank by the fuel lift pump located inside the FSM. The fuel lift pump is activated with 12 volts through the main power relay when the key is turned to the "ON" position. The grounding of the fuel lift pump is completed in the PCM. The PCM circuit grounding of the fuel lift pump is dependent upon three conditions:

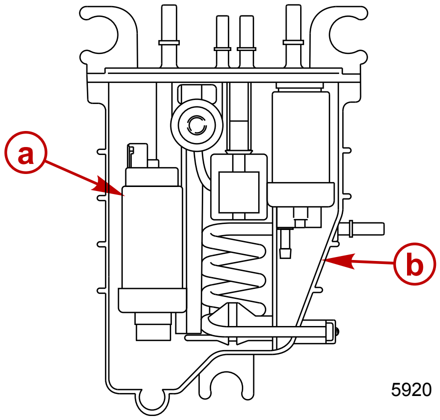
- **Condition one**: If there is no change in the fuel float switch signal during the first time an engine is put into service.
- **Condition two**: After a predetermined programmed time limit, the PCM will open the grounding circuit.
- **Condition three**: When the fuel float switch and the vent canister float switch are closed, the PCM grounds the return electrical lead, completing the circuit of the fuel lift pump.



a - Fuel lift pump
b - Fuel supply module

High Pressure Fuel Pump

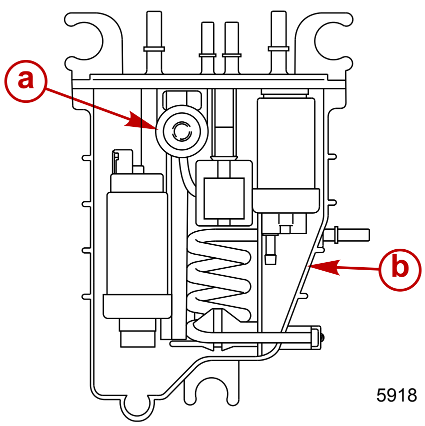
The high-pressure fuel pump is active when the PCM energizes the main power relay. The PCM does not have logic to detect the high-pressure fuel pump operation. In the event of a high-pressure fuel pump failure, no fault will be generated and the engine will not run. The high-pressure fuel pump sends the fuel through a 20 micron fuel filter into the bottom of the fuel rail. There is an internal regulation of the high-pressure pump of 689.5 kPa (100 psi). The fuel rail pressure is controlled by a fuel pressure regulator.



a - High-pressure fuel pump
b - Fuel supply module

Fuel Pressure Regulator

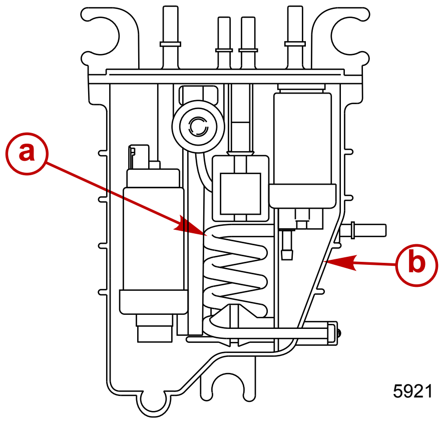
The fuel pressure regulator, located inside the fuel supply module (FSM), controls the amount of fuel pressure required for the engine to run efficiently. The fuel pressure regulator changes the pressurization of the fuel, depending on the demands of the engine. The air pressure changes in the intake manifold to a higher or lower pressure during RPM changes. These manifold air pressure changes are linked to the fuel pressure regulator. The changes which take place at the fuel pressure regulator are managed by a hose that is connected to the intake manifold integrated air/fuel module. The air pressure change that is positive or negative on the fuel pressure regulator diaphragm, increases or decreases the amount of fuel that is dumped back into the FSM.



a - Fuel pressure regulator
b - Fuel supply module

Fuel Cooler

The fuel cooler receives its supply of water from the filtered water outlet on the upper adapter plate. The filtered water outlet removes large debris from the water supply. The water is then directed with a preformed hose down to the FSM fuel cooler inlet. The fuel cooler is a metal line with several wound coils to help cool the fuel. After the water has passed through the fuel cooler, it is dumped immediately outside of the FSM.

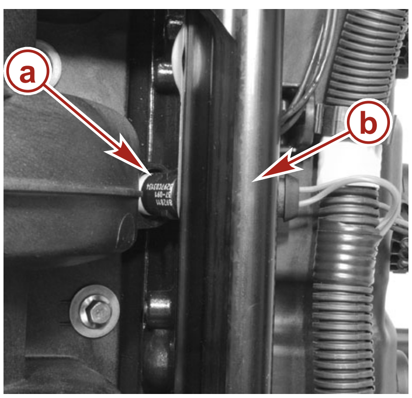


5921

a - Fuel cooler
b - Fuel supply module

Fuel Injector

The fuel injector is an electrically operated spring-loaded solenoid which delivers a metered amount of fuel into the intake manifold runner just ahead of the intake valve. The fuel injector is electrically charged when the key switch is set to the "RUN" position. The PCM controls the injection by completing the ground circuit and lifting the solenoid, which allows high-pressure fuel to flow. The PCM then opens the ground circuit, allowing the spring to close the injector and stop the fuel flow. The fuel injector is not serviceable and is not common with any other engine. There are two separate streams of fuel aimed at the intake valves for better atomization of the fuel. An injector filter is located on the fuel inlet side of the injector. The filter is not replaceable, but can be cleaned of debris. The fuel rail contains six fuel injectors.



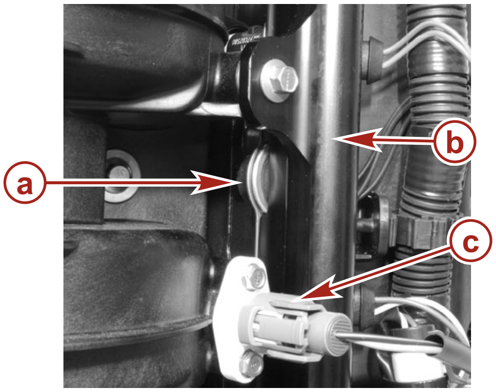
5925

a - Fuel injector
b - Fuel rail

Fuel Rail Pressure Damper

The fuel rail pressure damper is located on the fuel rail assembly. It's designed to reduce fuel pressure changes caused by pulses generated by the fuel injectors opening and closing. The fuel rail pressure damper contains a spring on the dry side of the diaphragm. This spring positions the diaphragm against the diaphragm seat when the engine is not running and there is no fuel pressure present.

When the fuel pressure reaches normal operating range, the fuel pressure will compress the spring and the diaphragm will move slightly away from the normal position. Any fuel pressure spikes will be equalized with the pressure of the spring pushing on the diaphragm, which helps maintain a constant pressure within the fuel system.



5924

a - Fuel rail pressure damper
b - Fuel rail
c - Manifold intake air temperature (MAT) sensor

Supercharger

Description

The supercharger is a crankshaft belt-driven positive displacement true air compressor. It delivers increased air density and pressures up to one atmosphere (101.35 kPa [14.7 psi]) of boost to the intake manifold. The added density and pressure increases the horsepower. It is located on the front of the engine.

The supercharger is belt-driven off of the crankshaft. The horsepower lost to drive the supercharger is minimal and is outweighed by the supercharger horsepower gains at full load. A bypass, called an electronic boost control valve, diverts air from the intake manifold back into the supercharger during idle speeds. Little or no boost is present during idle speeds.

When air is compressed, its ambient temperature rises and loses density. A cooler air intake charge results in more available horsepower due to the increase of air density. The charge air cooler located inside the intake manifold minimizes the heat added to the charged air by transferring the heat to coolant water before the charge reaches the combustion chamber.

Compression Sequence

1. **Inlet phase** - The supercharger has two helix rotors that spin counter to each other. The helix rotors do not contact each other. As the lobes on the rotors mesh at the inlet ports, air is captured and moved toward the discharge ports.
2. **Compression phase** - As captured air cells are moved toward the discharge ports, the space between the lobes progressively decreases, resulting in compression and an increase in the air temperature.
3. **Discharge phase** - The compressed air cells are moved to the discharge port and pass through the intercooler in the intake manifold. The bypass valve will close when there is a demand for boost. The bypass valve is controlled by the PCM.

52834

Notes:

Fuel System

Section 3B - Troubleshooting and Diagnostics

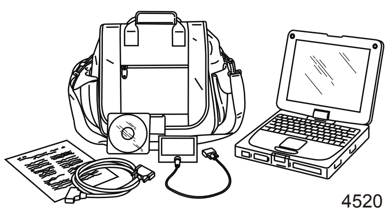
Table of Contents

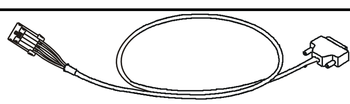
3
B

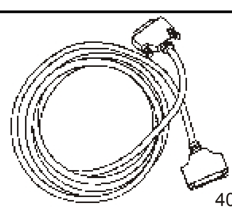
Lubricant, Sealant, Adhesives

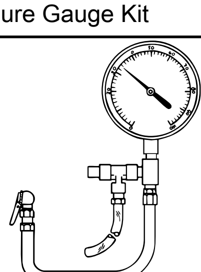
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Ground and ring terminal connections	92- 25711 3

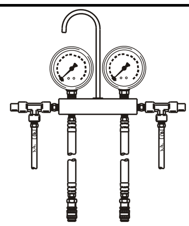
Special Tools

Computer Diagnostic System (CDS)	Purchase from SPX*
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: USA and Canada SPX Corporation 28635 Mound Rd. Warren, MI 48092 800-345-2233 (option 2 then 2 again) oetech@servicesolutions.spx.com or EMEA 0049 6182 959 403 technical-support@spx.com Australia 61 3 9544 6222 techsupport-aus@servicesolutions.spx.com Mexico 52 55 25 95 16 30 (option 9) tecnico@spx.com Brazil 0800-762-1003 (option 9) tecnico@spx.com *CDS G3 must be purchased from Mercury Marine

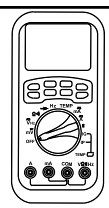
Adapter Harness	84-822560A13
 5826	Data link harness between engine and computer diagnostic system (CDS).

Extension Cable	84-825003A 1
 4012	Data link extension harness (3.05 m [10 ft.]) between the adapter harness and the Digital Diagnostic Terminal or Computer Diagnostic System (CDS).

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with computer diagnostic system (CDS)

DMT 2004 Digital Multimeter	91-892647A01
 **4516**	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments

Electrical Component Troubleshooting and Diagnostics

Using the Computer Diagnostic System (CDS)

The propulsion control module (PCM) is designed to prevent an overrich running condition in the event of a sensor failure. Therefore, disconnecting a sensor for troubleshooting purposes may have no noticeable effect.

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a fault in the PCM "Fault History." Use the CDS to view and clear the fault history when the troubleshooting/repair is completed.

The CDS has been developed specifically to help technicians diagnose and repair Mercury Marine two and four cycle engines.

Computer Diagnostic System (CDS)	Purchase from SPX*

Attach the diagnostic cable to the PCM diagnostic connector and plug in the software. You will be able to monitor sensors and PCM data values including status switches. The CDS software can help diagnose intermittent engine problems, and will record the state of the engine sensors and switches for a period of time, which can be played back to review the recorded information.

Adapter Harness	84-822560A13
Extension Cable	84-825003A 1

When using the CDS for troubleshooting, follow the CDS-driven menu for complete diagnostic troubleshooting procedures.

Troubleshooting without CDS

Troubleshooting without the CDS is limited to checking resistance on some of the sensors.

Typical failures do not involve the PCM, they usually involve the connectors, set-up, and mechanical wear.

- The engine may not run at or above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil, or is isolated to a particular cylinder.

  NOTE: *PCM's are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil or fuel injector can be performed using the CDS.*
- Any sensor or connection can be disconnected and connected while the engine is operating, without damaging the PCM. Disconnecting the crankshaft position sensor (CPS) will stop the engine.

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a fault in the PCM Fault History. Use the CDS to view and clear the fault history when troubleshooting/repair is completed.

Computer Diagnostic System (CDS)	Purchase from SPX*

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the PCM.
- If the problem is speed related or intermittent, it is typically a connector or contact related. Inspect the connectors for corrosion, loose wires, or loose pins. Secure the connector seating. Remove any residual dielectric compound from the connectors.
- Inspect the harness for obvious damage, pinched wires, broken insulation, exposed wires, and chafing.
- Ensure that all ground connections are clean and secured. Secure any connections using ring terminals. Coat grounds and ring terminals with Liquid Neoprene.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Ground and ring terminal connections	92- 25711 3

- Check the fuel pump connections and the fuel pump pressure.

Guardian Protection System

The Guardian Protection System monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

IMPORTANT: The Guardian Protection System cannot guarantee protection against powerhead damage when adverse operating conditions are encountered. The Guardian Protection System is designed to 1) warn the boat operator that the engine is operating under adverse conditions and 2) reduce power by limiting maximum RPM in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Fuel Component Troubleshooting and Diagnostics

Anti-Siphon Valves

Anti-siphon valves can be helpful from a safety standpoint, however, they can clog with debris, may be restrictive, or have too heavy a spring. The pressure drop across these valves can create operational problems and/or powerhead damage by restricting fuel to the fuel lift pump, and the high-pressure fuel pump. Some symptoms of restricted (lean) fuel flow, possibly caused by use of an anti-siphon valve, are:

- Severe fuel rail pressure fluctuation
- Loss of fuel pump pressure
- High-speed surging
- Outboard cuts out or hesitates upon acceleration
- Outboard runs rough
- Outboard quits and cannot be restarted
- Outboard will not start
- Vapor lock

Anti-siphon valves are typically installed between the fuel tank outlet and the engine fuel inlet. Use an alternative fuel supply, such as a remote tank, to determine if bad fuel or a malfunctioning anti-siphon valve is causing the problem.

If it is found that the anti-siphon valve is the cause of the problem, replace the anti-siphon valve with one that has a lighter spring tension, or replace it with a solenoid-operated fuel shutoff valve.

Referencing Fuel Pressure Readings

The fuel rail pressure reading will vary if the intake manifold is under vacuum during idle, or under pressure, when the demands on the engine are higher. This change from vacuum to pressure, and the subsequent changes of the fuel pressure reading, is maintained by a reference hose connection at the intake manifold to the fuel pressure regulator inside the fuel supply module (FSM).

During slow throttle advancement to WOT, the propulsion control module (PCM) determines that the demands of the engine are light based on the manifold absolute pressure (MAP) reading, throttle position, and engine RPM, and will not close the boost control valve. The manifold remains in a vacuum state. During fast throttle advancement to WOT, the PCM determines that the demands of the engine are high based on the MAP reading change, the throttle position, and engine RPM in relation to the throttle position. In this situation, the PCM closes the boost control valve to change the manifold from a vacuum state to a pressurized state.

When the manifold is in a pressurized state, air is forced into the combustion chamber as the intake valves open. More fuel is needed to have a correct stoichiometric air to fuel ratio (14.7:1). The additional air pressure is transferred to the fuel pressure regulator via the reference line. This reference line, connected to the fuel pressure regulator inside the fuel supply module (FSM), applies the additional pressure from the manifold to the fuel pressure regulator diaphragm. The additional pressure on the fuel pressure regulator diaphragm changes the pressure needed to unseat the fuel pressure regulator, increasing the amount of fuel pressure in the fuel rail.

The fuel pressure regulator is factory set to open at 350 ± 32 kPa (50.76 ± 4.64 psi). Fuel pressure is less than regulator set pressure when there is a vacuum in the engine's intake manifold (less than barometric pressure), and is more than regulator set pressure when there is boost pressure in the engine's intake manifold (higher than barometric pressure).

Fuel Pressure Calculations, Engine Running

When calculating the fuel pressure at different points in the engine's RPM range, a simple formula can be used to determine what the approximate fuel pressure should be: **(MAP – Baro) + regulator set point**.

The following examples are with an ambient barometric pressure of 101 kPa (14.65 psi).

If the intake manifold absolute pressure is below the barometric pressure (vacuum), and the CDS displays 32 kPa (4.64 psi), the formula appears as:

- **kPa**: 32 – 101 = –69 + 350 = 281. The calculated fuel pressure reading is 281 kPa.
- **psi**: 4.64 – 14.65 = –10.01 + 50.76 = 40.75. The calculated fuel pressure reading is 40.75 psi.

If the intake manifold absolute pressure is above the barometric pressure (boost) and the CDS displays 191 kPa (27.70 psi), the formula appears as:

- **kPa**: 191 – 101 = 90 + 350 = 440. The calculated fuel pressure reading is 440 kPa.
- **psi**: 27.70 – 14.65 = 13.05 + 50.76 = 63.81. The calculated fuel pressure reading is 63.81 psi.

Fuel Lift Pump

The fuel lift pump can be tested with the CDS.

Computer Diagnostic System (CDS)	Purchase from SPX*

The fuel lift pump is pulse width modulated (PWM) by the ground side of the pump through the PCM. The positive side is powered through the main power relay (MPR). The fuel lift pump PWM is dependent on the vent canister switch (VCS) and the fuel supply module (FSM) float level switch state.

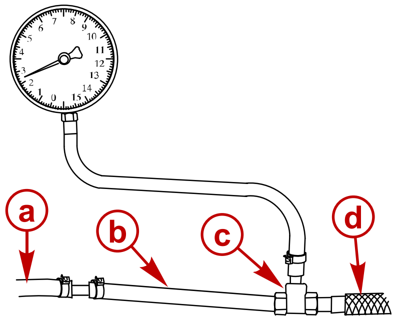
There are four possible dependencies for the PWM.

- FSM low, VCS low: Key on, engine not cranking—The fuel lift pump runs until the FSM is full, or until the lift pump times out, which is 25 seconds. Key on, engine cranking—The fuel lift pump runs until the FSM is full, or until the lift pump times out, which is 180 seconds in this situation. If the fuel lift pump times out, a "Lift Pump Time Out" fault will be set and the fuel lift pump will be turned off.
- FSM high, VCS low: The fuel lift pump is turned off. No fault will be set.
- FSM low, VCS high: The fuel lift pump is turned off, the vent canister purge valve (VCPV) is closed, and a "Vent Switch High" fault is set. Possible cause is a faulty fuel float level switch or fuel in the line between the VCS and the VCPV, which can be eliminated by opening the purge vent Schader valve (under the green cap).
- FSM high, VCS high: The fuel lift pump is turned off, VCPV is closed, and a "Vent Switch High" fault is set.
    - If the PCM does not see a fuel lift pump (open circuit), a "Fuel Pump CKT" fault will be set.
    - If the FSM fuel float switch sticks in the up position (FSM full, lift pump turned off), no fault is set and the engine will run out of fuel.

Testing Fuel Lift Pump Vacuum

1. Separate the engine fuel line and the boat fuel line.
2. Install a T-fitting on the boat fuel line.
3. Install a clear fuel line on the opposite side of the T-fitting.
4. Connect the clear fuel line to the engine fuel line.
5. Install a fuel vacuum gauge (obtain locally) on the T-fitting.
6. Clamp all fuel line connections securely to prevent vacuum leaks.
7. Start the engine.
8. Observe the clear fuel line for air bubbles.

9. The vacuum gauge reading should be within the listed specification when the pump is active.



4439

a - Engine fuel line
b - Clear fuel line
c - T-fitting
d - Boat fuel line

Fuel Lift Pump Vacuum Specification	
Sea level (maximum)	10.16 kPa (3.0 in. Hg)

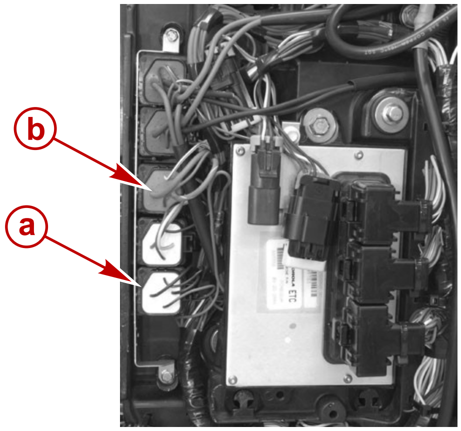
High-Pressure Fuel Pump

High-Pressure Fuel Pump	
Fuel pressure, engine not running	350 ± 32 kPa (50.7 ± 4.6 psi)
Fuel pressure, engine running	Pressure dependent on manifold vacuum/pressure

The high-pressure fuel pump can be tested for operation electrically with the CDS.

Computer Diagnostic System (CDS)	Purchase from SPX*

The engine wiring harness has a relay located next to the PCM to control the high-pressure fuel pump. The incorporation of the high-pressure fuel pump control relay eliminates the possibility of pump damage when the key switch is turned to the "ON" position and the FSM is empty of fuel. The high-pressure fuel pump operation is controlled by the PCM. The PCM completes the ground connection of the high-pressure fuel pump through the high-pressure fuel pump control relay. The power for the high-pressure fuel pump is through the main power relay. A 20-amp fuse is in line with the power wire to the high-pressure fuel pump. The high-pressure fuel pump program logic limits the initial fuel pump use at key "ON" for five seconds. After the initial five seconds, the high-pressure fuel pump will not be active until the engine RPM is recognized by the PCM.



33382

a - High-pressure fuel pump relay
b - Main power relay

The logic in the PCM cannot determine if the high-pressure fuel pump is functioning. No fault will be set if the high-pressure fuel pump fails, and the engine will not run.

1. Connect a fuel pressure gauge to the fuel rail Schrader valve.

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

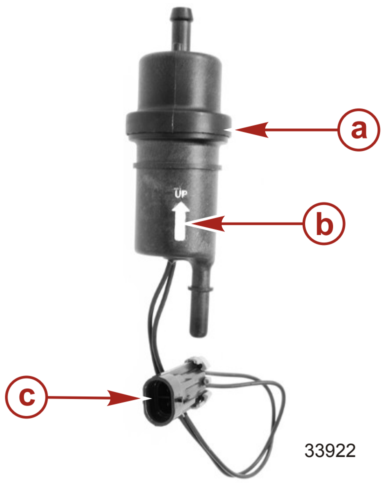
2. With the CDS, operate the fuel pump load test.
3. The fuel pressure gauge should read 350 ± 32 kPa (50.7 ± 4.6 psi) when the pump is running and the engine is not running.

4. If there is little or no pressure reading on the gauge, ensure that the FSM has enough fuel to supply the high-pressure fuel pump.

Vent Canister Float Switch (VCFS)

The vent canister float switch (VCFS) is controlled by the PCM. The PCM supplies 5 volts to the VCFS. The VCFS is normally closed or low when the FSM is empty of fuel. The VCFS can be checked with an ohmmeter while it is still mounted on the engine or with the CDS.

To test the vent canister float switch, disconnect the VCFS harness connector. Use an ohmmeter to check for continuity between the two harness connector pins. With the VCFS in the vertical position (arrow pointing up), the ohmmeter should indicate continuity. Rotate the VCFS 180° (arrow pointing down). There should be no continuity between the two harness connector pins. If the VCFS does not meet the test specifications, replace the VCFS.



a - Vent canister float switch
b - Arrow pointing up
c - Harness connector pins

DMT 2004 Digital Multimeter	91-892647A01
Computer Diagnostic System (CDS)	Purchase from SPX*

- If the VCFS sticks open or high, a "Vent Switch High" fault will be set.
- The vent canister purge valve (VCPV) will close, the lift pump will be turned off, and the engine will run out of fuel.
- The PCM will not turn on the fuel lift pump when the VCFS fault is open or high.
- The VCFS must be closed before the PCM will turn the lift pump on.
- If the VCFS sticks closed or low, and the FSM fuel level switch is functioning correctly, the engine will operate without faults or driveability issues.
- If the FSM should overflow (a primer bulb or an electric primer pump will cause an overflow, a faulty fuel float level switch may cause an overflow) and the VCFS sticks closed, a rich condition from unmetered fuel entering the air induction system at the air cleaner may cause the engine to operate less than optimal.

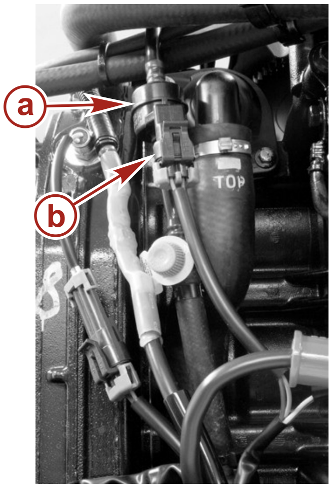
Vent Canister Purge Valve (VCPV)

The VCPV is powered by battery voltage through the main power relay (MPR). The ground is pulse width modulated (PWM) by the PCM. The PWM is based on engine RPM. The higher the RPM, the faster the VCPV opens and closes as the engine is able to burn more FSM fumes at higher RPM.

The VCPV is normally closed. During initial start up, the VCPV remains closed until the engine RPM is stable. The VCPV is then modulated (cycles open and closed) by the PCM.

- If the VCPV fails electrically or becomes unplugged while the engine is running, the valve will close. Since the VCPV is normally closed, the PCM has no logic to detect this failure.
- If the VCPV fails to mechanically open, the PCM has no logic to detect this failure and no fault will be set. If the VCPV fails and the FSM overflows with fuel, the engine could have driveability issues due to unmetered fuel entering the air intake filter.

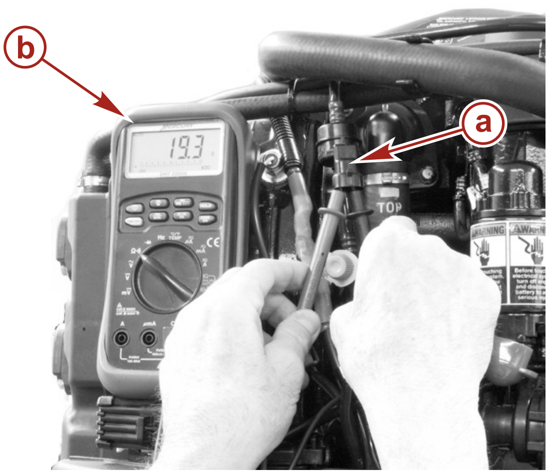
To test the vent canister purge valve (VCPV), disconnect the harness connector.



33867

- **a -** Vent canister purge valve (VCPV)
- **b -** Harness connector

Use an ohmmeter to measure the resistance between the two terminal pins in the VCPV connector. Resistance should be between 18–24 ohms at 20 °C (68 °F). If the resistance does not meet specification, replace the VCPV.

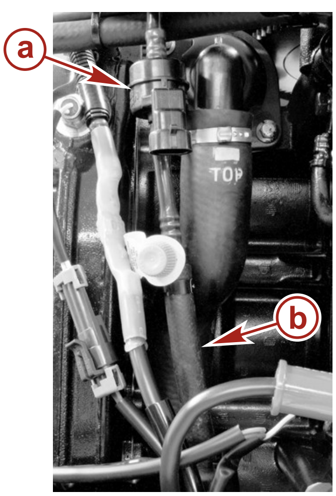


33868

- **a -** VCPV connector
- **b -** Ohmmeter

DMT 2004 Digital Multimeter	91-892647A01

Remove the VCPV inlet hose. Apply 34.5 kPa (5 psi) air pressure to the VCPV. The VCPV should hold this pressure for a minimum of 5–10 seconds without leakage. If the VCPV does not hold the pressure as specified, replace the VCPV.



33869

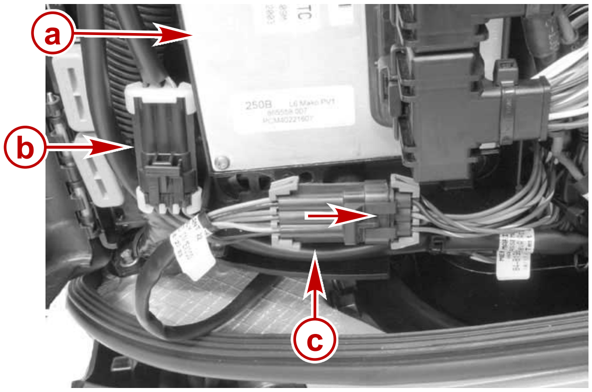
- **a -** Vent canister purge valve (VCPV)
- **b -** VCPV inlet hose

Fuel Supply Module (FSM)

The FSM fuel lift pump and fuel pressure pump can be tested with the CDS.

Computer Diagnostic System (CDS)	Purchase from SPX*

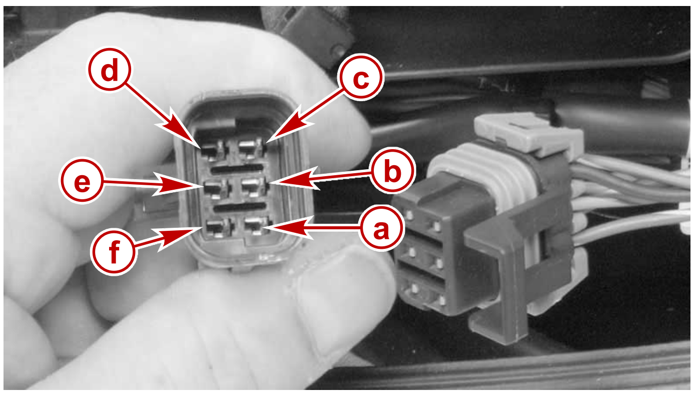
The FSM harness connector is inside the electrical box. Push the FSM harness connector towards the front of the engine to disengage the harness clip. Disconnect the FSM harness from the engine harness.



4935

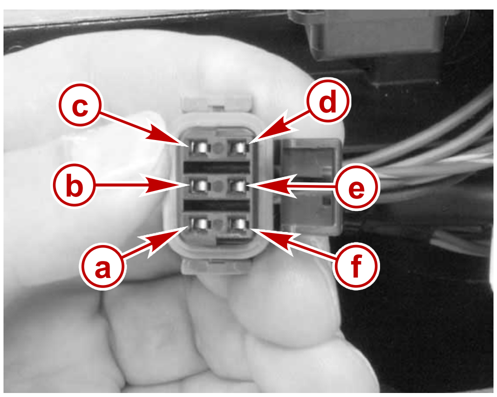
a - PCM
b - Trim motor wire harness connector
c - FSM harness connector

The following graphics show the FSM wire color - pin location and its purpose.



4937

a - Pin A, red wire, positive to high-pressure pump
b - Pin B, orange wire, positive to lift pump
c - Pin C, blue wire, ground to fuel float level switch
d - Pin D, black wire, ground to high-pressure pump
e - Pin E, brown wire, ground to lift pump
f - Pin F, purple wire, positive 5 volt to fuel float level switch



4938

a - Pin A, red/pink wire, positive to high-pressure pump
b - Pin B, red/blue wire, positive to lift pump
c - Pin C, blue/yellow wire, fuel float level switch ground inside PCM
d - Pin D, black wire, ground to high-pressure pump
e - Pin E, pink/black wire, lift pump ground inside PCM
f - Pin F, purple/yellow wire, positive 5 volt to fuel float level switch from PCM

Fuel Supply Module (FSM) Troubleshooting

CDS-FSM Based Fuel System Parameters

Key on, Engine off, Cranking, Starting

Every time the key switch is turned "ON," the PCM checks the FSM float switch and vent float switch status. If they are both "low," the PCM will turn the lift pump on for the amount of time listed, or until either switch reads "high."

Model	Seconds
Model year 2005	180 seconds
Model year 2006 and newer	25 seconds (early 2006 calibrations were 45 seconds)

***NOTE:** For model year 2005 only, a "Lift Pump Timeout" fault will be set if the FSM is not full after 180 seconds.*

If the engine is cranked or started before the FSM is full, the PCM uses the following time listed until either switch reads "high." If the FSM does not fill in the following time listed, a "Lift Pump Timeout" fault will be set.

Model	Seconds
135–350 Verado L4 and L6 SC	180 seconds

Engine Running

If the status of both switches are "low," the PCM will turn on the lift pump after the specific amount of fuel is consumed. Refer to the following chart for fuel consumption information. If the FSM does not fill in time, a "Lift Pump Timeout" fault will be set.

Model	Grams Consumed
135–350 Verado L4 and L6	150 grams—Serial Number 1B812284 and below
135–350 Verado L4 and L6	60 grams—Serial Number 1B812285 and above

Miscellaneous Information

- If a "Lift Pump Timeout" fault is set, the lift pump will be disabled and the engine will run out of fuel.
- A full FSM holds approximately 450 grams (600 ml) of fuel.
- Reprogramming model year 2006 and newer engines will upgrade the fuel system parameters.

CDS Displayed Data

CDS Data Item	Description (what it displays)
Lift Pump On Time	Counter (seconds of lift pump run time)
Calculated Fuel Mass	Counter (grams of fuel consumed) (displayed in CDS V8.xx)
Calculated Fuel Pressure	Pressure that should be present at the rail (± 4.64) (not actual pressure)
FSM Level Switch	Status (high or low), high = no continuity, low = continuity
Vent Switch	Status (high or low), high = no continuity, low = continuity
Vent Canister Purge Valve	Status (closed or open)
	Duty cycle (% on time)

NOTE: Model year 2005 Verado will only display calculated fuel pressure on the CDS.

Computer Diagnostic System (CDS)	Purchase from SPX*

Lift Pump On Time—This line item displays the amount of time the PCM is signaling the lift pump to run, in seconds. Maximum lift pump on time will typically be 5–10 seconds with the engine running at any load. If the lift pump on time exceeds 15–20 seconds to refill the FSM while the engine is running, the fuel system is restricted. Check for dirty filters, pinched lines, and stuck anti-siphon valves.

Calculated Fuel Mass—This line item displays the amount of fuel consumed in grams. When the engine is in the run state, the PCM calculates the fuel consumed to determine when to turn the lift pump on. On a Verado engine, serial number 1B812283 and below, the PCM will not cycle the lift pump until it has counted 150 grams of fuel used. On a Verado engine, serial number 1B812284 and above, the PCM will not cycle the lift pump until it has counted 60 grams of fuel used. When this calculated fuel mass has been consumed, and both float switches are low, the PCM will excite the lift pump to supply fuel to the FSM. The lift pump will continue to run until either switch turns to "high" or until the lift pump timeout threshold is reached.

Calculated Fuel Pressure—The actual fuel rail pressure should measure close to this calculated pressure. This line item displays a calculated fuel pressure value of what the fuel rail pressure should be. Fuel pressure is dynamically controlled based on intake manifold absolute pressure. A Verado engine can vary in actual fuel pressure from approximately 275.79–413.68 kPa (40–60 psi). This calculated fuel pressure provides a technician with the information needed to determine if the engine's mechanical fuel rail pressure is within specification.

FSM Level Switch—This line item displays the state of the FSM float switch. A float switch will read "high" when the FSM is full (opens the 5 volt signal going back to the PCM) and "low" when the FSM is not full (closes the 5 volt signal going back to the PCM). The PCM will only activate the lift pump based on the float switch and vent switch position. Both need to read "low" for the lift pump to activate during the key "ON" sequence. This will ensure that the FSM is full before starting.

Vent Switch—This line item displays the state of the vent switch. The vent switch should always read "low." If the vent switch reads "high," there is fuel in the vent system or the vent switch circuit has failed to open (faulty switch or circuit). If the vent switch circuit reads "high," the PCM will output fault #220 (vent float switch high). This fault will trigger the PCM to shutdown the lift pump and close the vent canister purge valve (VCPV).

NOTE: If fuel is present at the vent float switch, the vent Schrader valve must be pressed while tapping on the vent canister. This allows the trapped fuel to drain back into the FSM.

Vent Canister Purge Valve—This valve is displayed with two line items of information. One line item will display "open" or "closed" and the other will display in duty cycle (percent on time). With the key "ON" and the engine off, the VCPV should show closed and 0% duty cycle. With the engine running, the VCPV will normally show open with a duty cycle percentage varying from approximately 15% to 80%, depending on the demand on the engine.

Fuel Pressure Troubleshooting Chart

Engine State	Condition	Corrective Action
Key "ON"	Fuel pressure is less than 350 ± 32 kPa (50.76 ± 4.64 psi)	Check CDS data items for the "FSM Level Switch" position. • If "LOW," the "Lift Pump On Time" seconds should be counting and the lift pump should be running. The lift pump will continue to run until the "FSM Level Switch" reaches the "HIGH" position or until the lift pump timeout limit is reached. To verify the lift pump is running, connect a vacuum gauge between the FSM and fuel filter. Lift pump vacuum should not exceed 3.0 in. Hg (10.16 kPa). • If "HIGH," the lift pump will not run and the PCM believes the FSM is full of fuel. Listen for the high-pressure pump to run at key "ON." If the pump is running, the FSM float switch is likely stuck in the "HIGH" position. When this happens no faults will be set.
	Fuel pressure is 350 ± 32 kPa (50.76 ± 4.64 psi), but does not drop in pressure when started	The fuel pressure regulator changes the pressurization of the fuel, depending on the manifold pressure. Once the engine is started, the manifold pressure will drop and the fuel pressure will drop. The regulator in the FSM has a reference hose connected to it and the other end is connected to the FSM cover. From the cover, it is then connected to the intake manifold. Inspect the hose from the FSM to the intake manifold. If OK, remove the FSM cover and inspect the line from the cover to the regulator. If the line inside the FSM were to split, or become disconnected, fuel will be drawn into the intake causing the engine to run rich.
	Fuel pressure at the rail is higher than the calculated fuel pressure on the CDS	Remove the FSM cover and then remove the fuel pressure regulator from the cover. Inspect the screen on the backside of the regulator for debris. If clean, replace the regulator.
Running	Fuel pressure is fluctuating and the engine is starting to die	Check CDS data items for the "FSM Level Switch" position. • If "LOW," check the "Calculated Fuel Mass" and see if it is exceeding the number of grams of fuel used. If the number is higher than the specification for that model, the "Lift Pump On Time" should be counting and the lift pump should be running. If the seconds are exceeding 15–20 seconds before the "FSM Level Switch" reaches "HIGH," check the lift pump vacuum to verify it is not exceeding 3.0 in. Hg (10.16 kPa). A higher reading would indicate a restriction in the fuel system and a lower reading could indicate a possible lift pump failure. • If "HIGH," the lift pump will not run and the PCM believes the FSM is full of fuel. If the float is stuck in the "HIGH" position, the engine will run out of fuel. When this happens, no faults will be set. Check the "Calculated Fuel Mass" to see if it exceeds the grams consumed for the specific engine model. If so, the float switch is likely sticking in the "HIGH" position.

Computer Diagnostic System (CDS)	Purchase from SPX*

FSM Related CDS Engine Faults

Fault Number	Fault Name	Warning Type	Fault Description	Possible Root Cause
207	Lift Pump Timeout	Critical[1.]	FSM did not fill in the specified time. Reference CDS-FSM Based Fuel System Parameters.	• Fuel filter is restricted • Fuel restriction in boat • Weak lift pump
208	Lift Pump Output	Critical[1.]	Insufficient current draw at the lift pump.	• Lift pump failure • Lift pump circuit open
220	Vent Float Switch High	Critical[1.]	Vent switch is in the open position.	• Fuel is in the vent canister due to a failed FSM float switch or a pressurized fuel system. • Vent switch failure • Vent switch circuit open
221	Lift Pump Float Switch High	Critical[1.]	FSM float switch is in the low position and the vent float switch is in the high position.	• FSM float switch or circuit has failed and has caused fuel to flow into the vent canister. • Vent switch has failed to open and at the same time the FSM float switch is in the closed position.

Barometric Pressure Chart

Absolute Vacuum	One Atmosphere (Barometric Pressure at Sea Level)	Two Atmosphere (Barometric Pressure at Sea Level)
0 kPa	101.325 kPa	202.65 kPa
0 psi	14.696 psi	29.392 psi
0 in. Hg	29.92 in. Hg	59.84 in. Hg
Below Barometric Pressure (Vacuum)		Above Barometric Pressure (Boost)
-101.325 kPa	0 kPa	101.325 kpa
-14.696 psi	0 psi	14.696 psi

IMPORTANT: Always use the same units (kPa/psi/in.Hg) to understand pressure differences. Scan tools may give different units than other gauges.

The higher in altitude, the less atmospheric pressure there is (if weather conditions do not change), about 3.386 kPa (0.491 psi or 1 in. Hg) per 1,000 feet of elevation change.

Barometric pressure readings are recorded in the PCM using the MAP sensor after the key is turned on, but before the engine starts to crank over. After the engine is running, the PCM no longer knows what the barometric pressure reading is. This information is only used to calculate crank fueling. If the barometric pressure does change, the PCM will adjust fuel delivery because the overall intake manifold pressure will change. The PCM does compensate for barometric pressure changes indirectly (weather or altitude).

NOTE: A two atmosphere MAP sensor is needed for supercharged engines.

Manifold Absolute Pressure in Relationship to Fuel Pressure (psi) Calculations

NOTE: Fuel pressure formula = (MAP - Baro) + regulator set point

Barometric Pressure = 14.65 Regulator Set Point = 50.76 and Regulator Tolerance = ± 4.64				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
4.50	-10.15	40.61	45.25	35.97
4.70	-9.95	40.81	45.45	36.17
4.90	-9.75	41.01	45.65	36.37

1. Continous 6 second beep: Depending on the condition, the Engine Guardian system may engage and protect the engine by limiting the power.

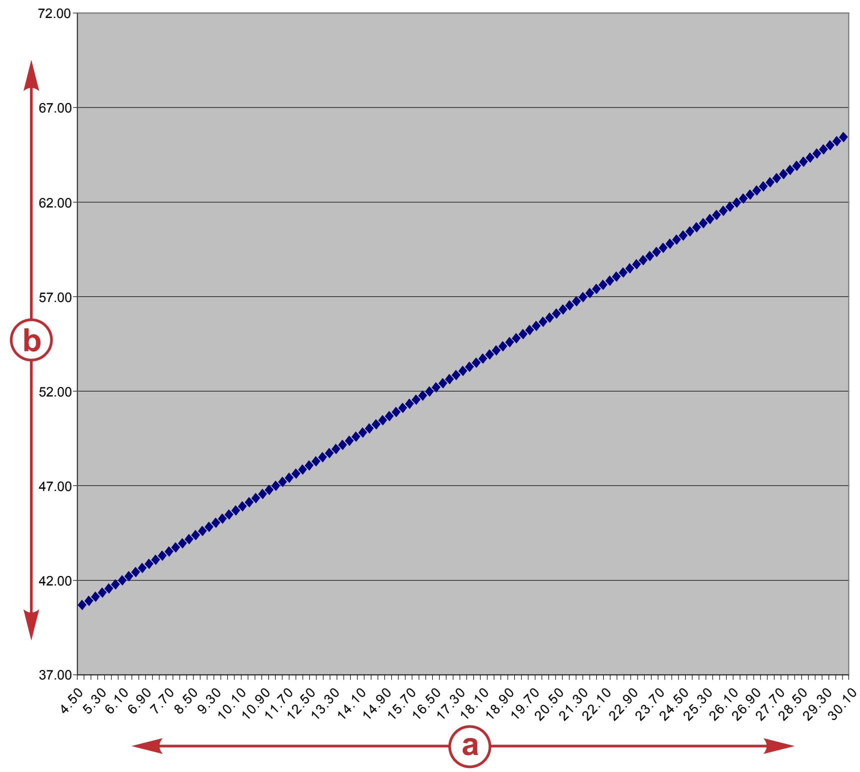
Barometric Pressure = 14.65 Regulator Set Point = 50.76 and Regulator Tolerance = ± 4.64				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
5.10	-9.55	41.21	45.85	36.57
5.30	-9.35	41.41	46.05	36.77
5.50	-9.15	41.61	46.25	36.97
5.70	-8.95	41.81	46.45	37.17
5.90	-8.75	42.01	46.65	37.37
6.10	-8.55	42.21	46.85	37.57
6.30	-8.35	42.41	47.05	37.77
6.50	-8.15	42.61	47.25	37.97
6.70	-7.95	42.81	47.45	38.17
6.90	-7.75	43.01	47.65	38.37
7.10	-7.55	43.21	47.85	38.57
7.30	-7.35	43.41	48.05	38.77
7.50	-7.15	43.61	48.25	38.97
7.70	-6.95	43.81	48.45	39.17
7.90	-6.75	44.01	48.65	39.37
8.10	-6.55	44.21	48.85	39.57
8.30	-6.35	44.41	49.05	39.77
8.50	-6.15	44.61	49.25	39.97
8.70	-5.95	44.81	49.45	40.17
8.90	-5.75	45.01	49.65	40.37
9.10	-5.55	45.21	49.85	40.57
9.30	-5.35	45.41	50.05	40.77
9.50	-5.15	45.61	50.25	40.97
9.70	-4.95	45.81	50.45	41.17
9.90	-4.75	46.01	50.65	41.37
10.10	-4.55	46.21	50.85	41.57
10.30	-4.35	46.41	51.05	41.77
10.50	-4.15	46.61	51.25	41.97
10.70	-3.95	46.81	51.45	42.17
10.90	-3.75	47.01	51.65	42.37
11.10	-3.55	47.21	51.85	42.57
11.30	-3.35	47.41	52.05	42.77
11.50	-3.15	47.61	52.25	42.97
11.70	-2.95	47.81	52.45	43.17
11.90	-2.75	48.01	52.65	43.37
12.10	-2.55	48.21	52.85	43.57
12.30	-2.35	48.41	53.05	43.77
12.50	-2.15	48.61	53.25	43.97
12.70	-1.95	48.81	53.45	44.17
12.90	-1.75	49.01	53.65	44.37
13.10	-1.55	49.21	53.85	44.57
13.30	-1.35	49.41	54.05	44.77

Barometric Pressure = 14.65 Regulator Set Point = 50.76 and Regulator Tolerance = ± 4.64				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
13.50	-1.15	49.61	54.25	44.97
13.70	-0.95	49.81	54.45	45.17
13.90	-0.75	50.01	54.65	45.37
14.10	-0.55	50.21	54.85	45.57
14.30	-0.35	50.41	55.05	45.77
14.50	-0.15	50.61	55.25	45.97
14.70	0.05	50.81	55.45	46.17
14.90	0.25	51.01	55.65	46.37
15.10	0.45	51.21	55.85	46.57
15.30	0.65	51.41	56.05	46.77
15.50	0.85	51.61	56.25	46.97
15.70	1.05	51.81	56.45	47.17
15.90	1.25	52.01	56.65	47.37
16.10	1.45	52.21	56.85	47.57
16.30	1.65	52.41	57.05	47.77
16.50	1.85	52.61	57.25	47.97
16.70	2.05	52.81	57.45	48.17
16.90	2.25	53.01	57.65	48.37
17.10	2.45	53.21	57.85	48.57
17.30	2.65	53.41	58.05	48.77
17.50	2.85	53.61	58.25	48.97
17.70	3.05	53.81	58.45	49.17
17.90	3.25	54.01	58.65	49.37
18.10	3.45	54.21	58.85	49.57
18.30	3.65	54.41	59.05	49.77
18.50	3.85	54.61	59.25	49.97
18.70	4.05	54.81	59.45	50.17
18.90	4.25	55.01	59.65	50.37
19.10	4.45	55.21	59.85	50.57
19.30	4.65	55.41	60.05	50.77
19.50	4.85	55.61	60.25	50.97
19.70	5.05	55.81	60.45	51.17
19.90	5.25	56.01	60.65	51.37
20.10	5.45	56.21	60.85	51.57
20.30	5.65	56.41	61.05	51.77
20.50	5.85	56.61	61.25	51.97
20.70	6.05	56.81	61.45	52.17
20.90	6.25	57.01	61.65	52.37
21.10	6.45	57.21	61.85	52.57
21.30	6.65	57.41	62.05	52.77
21.50	6.85	57.61	62.25	52.97
21.70	7.05	57.81	62.45	53.17

Barometric Pressure = 14.65 Regulator Set Point = 50.76 and Regulator Tolerance = ± 4.64				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
21.90	7.25	58.01	62.65	53.37
22.10	7.45	58.21	62.85	53.57
22.30	7.65	58.41	63.05	53.77
22.50	7.85	58.61	63.25	53.97
22.70	8.05	58.81	63.45	54.17
22.90	8.25	59.01	63.65	54.37
23.10	8.45	59.21	63.85	54.57
23.30	8.65	59.41	64.05	54.77
23.50	8.85	59.61	64.25	54.97
23.70	9.05	59.81	64.45	55.17
23.90	9.25	60.01	64.65	55.37
24.10	9.45	60.21	64.85	55.57
24.30	9.65	60.41	65.05	55.77
24.50	9.85	60.61	65.25	55.97
24.70	10.05	60.81	65.45	56.17
24.90	10.25	61.01	65.65	56.37
25.10	10.45	61.21	65.85	56.57
25.30	10.65	61.41	66.05	56.77
25.50	10.85	61.61	66.25	56.97
25.70	11.05	61.81	66.45	57.17
25.90	11.25	62.01	66.65	57.37
26.10	11.45	62.21	66.85	57.57
26.30	11.65	62.41	67.05	57.77
26.50	11.85	62.61	67.25	57.97
26.70	12.05	62.81	67.45	58.17
26.90	12.25	63.01	67.65	58.37
27.10	12.45	63.21	67.85	58.57
27.30	12.65	63.41	68.05	58.77
27.50	12.85	63.61	68.25	58.97
27.70	13.05	63.81	68.45	59.17
27.90	13.25	64.01	68.65	59.37
28.10	13.45	64.21	68.85	59.57
28.30	13.65	64.41	69.05	59.77
28.50	13.85	64.61	69.25	59.97
28.70	14.05	64.81	69.45	60.17
28.90	14.25	65.01	69.65	60.37
29.10	14.45	65.21	69.85	60.57
29.30	14.65	65.41	70.05	60.77
29.50	14.85	65.61	70.25	60.97
29.70	15.05	65.81	70.45	61.17
29.90	15.25	66.01	70.65	61.37

Barometric Pressure = 14.65 Regulator Set Point = 50.76 and Regulator Tolerance = ± 4.64				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
30.10	15.45	66.21	70.85	61.57

Manifold Absolute Pressure vs. Fuel Pressure Graph (psi)



52856

a - Manifold absolute pressure (psi)
b - Fuel pressure at rail (psi)

Manifold Absolute Pressure in Relationship to Fuel Pressure (kPa) Calculations

NOTE: Fuel pressure formula = (MAP - Baro) + regulator set point

Barometric Pressure = 101 Regulator Set Point = 350 and Regulator Tolerance = ± 32				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
30	-71	279	311	247
31	-70	280	312	248
32	-69	281	313	249
33	-68	282	314	250
34	-67	283	315	251
35	-66	284	316	252
36	-65	285	317	253
37	-64	286	318	254
38	-63	287	319	255
39	-62	288	320	256
40	-61	289	321	257
41	-60	290	322	258
42	-59	291	323	259
43	-58	292	324	260
44	-57	293	325	261
45	-56	294	326	262

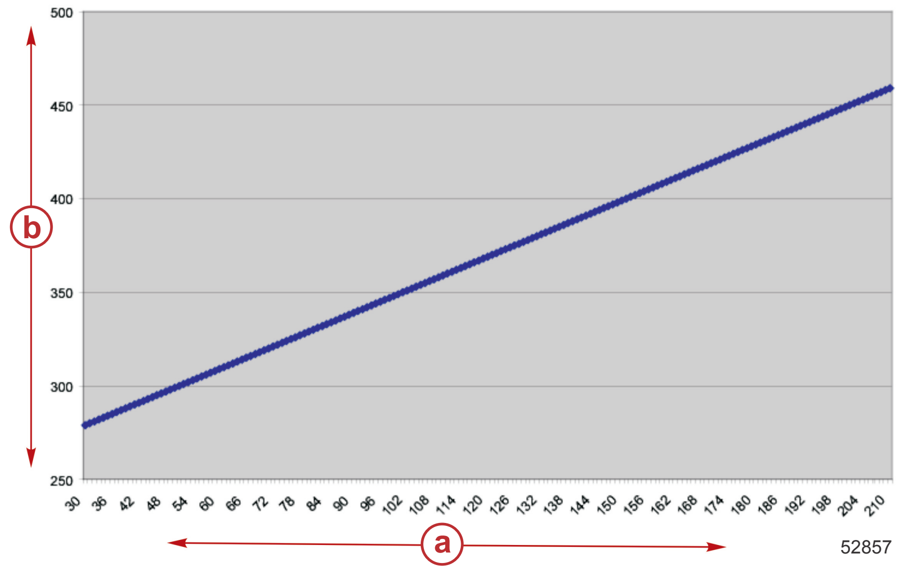
Barometric Pressure = 101 Regulator Set Point = 350 and Regulator Tolerance = ± 32				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
46	-55	295	327	263
47	-54	296	328	264
48	-53	297	329	265
49	-52	298	330	266
50	-51	299	331	267
51	-50	300	332	268
52	-49	301	333	269
53	-48	302	334	270
54	-47	303	335	271
55	-46	304	336	272
56	-45	305	337	273
57	-44	306	338	274
58	-43	307	339	275
59	-42	308	340	276
60	-41	309	341	277
61	-40	310	342	278
62	-39	311	343	279
63	-38	312	344	280
64	-37	313	345	281
65	-36	314	346	282
66	-35	315	347	283
67	-34	316	348	284
68	-33	317	349	285
69	-32	318	350	286
70	-31	319	351	287
71	-30	320	352	288
72	-29	321	353	289
73	-28	322	354	290
74	-27	323	355	291
75	-26	324	356	292
76	-25	325	357	293
77	-24	326	358	294
78	-23	327	359	295
79	-22	328	360	296
80	-21	329	361	297
81	-20	330	362	298
82	-19	331	363	299
83	-18	332	364	300
84	-17	333	365	301
85	-16	334	366	302
86	-15	335	367	303
87	-14	336	368	304

Barometric Pressure = 101 Regulator Set Point = 350 and Regulator Tolerance = ± 32				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
88	-13	337	369	305
89	-12	338	370	306
90	-11	339	371	307
91	-10	340	372	308
92	-9	341	373	309
93	-8	342	374	310
94	-7	343	375	311
95	-6	344	376	312
96	-5	345	377	313
97	-4	346	378	314
98	-3	347	379	315
99	-2	348	380	316
100	-1	349	381	317
101	0	350	382	318
102	1	351	383	319
103	2	352	384	320
104	3	353	385	321
105	4	354	386	322
106	5	355	387	323
107	6	356	388	324
108	7	357	389	325
109	8	358	390	326
110	9	359	391	327
111	10	360	392	328
112	11	361	393	329
113	12	362	394	330
114	13	363	395	331
115	14	364	396	332
116	15	365	397	333
117	16	366	398	334
118	17	367	399	335
119	18	368	400	336
120	19	369	401	337
121	20	370	402	338
122	21	371	403	339
123	22	372	404	340
124	23	373	405	341
125	24	374	406	342
126	25	375	407	343
127	26	376	408	344
128	27	377	409	345
129	28	378	410	346

Barometric Pressure = 101 Regulator Set Point = 350 and Regulator Tolerance = ± 32				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
130	29	379	411	347
131	30	380	412	348
132	31	381	413	349
133	32	382	414	350
134	33	383	415	351
135	34	384	416	352
136	35	385	417	353
137	36	386	418	354
138	37	387	419	355
139	38	388	420	356
140	39	389	421	357
141	40	390	422	358
142	41	391	423	359
143	42	392	424	360
144	43	393	425	361
145	44	394	426	362
146	45	395	427	363
147	46	396	428	364
148	47	397	429	365
149	48	398	430	366
150	49	399	431	367
151	50	400	432	368
152	51	401	433	369
153	52	402	434	370
154	53	403	435	371
155	54	404	436	372
156	55	405	437	373
157	56	406	438	374
158	57	407	439	375
159	58	408	440	376
160	59	409	441	377
161	60	410	442	378
162	61	411	443	379
163	62	412	444	380
164	63	413	445	381
165	64	414	446	382
166	65	415	447	383
167	66	416	448	384
168	67	417	449	385
169	68	418	450	386
170	69	419	451	387
171	70	420	452	388

Barometric Pressure = 101 Regulator Set Point = 350 and Regulator Tolerance = ± 32				
MAP	Gauge Pressure	Fuel Pressure	High Tolerance	Low Tolerance
172	71	421	453	389
173	72	422	454	390
174	73	423	455	391
175	74	424	456	392
176	75	425	457	393
177	76	426	458	394
178	77	427	459	395
179	78	428	460	396
180	79	429	461	397
181	80	430	462	398
182	81	431	463	399
183	82	432	464	400
184	83	433	465	401
185	84	434	466	402
186	85	435	467	403
187	86	436	468	404
188	87	437	469	405
189	88	438	470	406
190	89	439	471	407
191	90	440	472	408
192	91	441	473	409
193	92	442	474	410
194	93	443	475	411
195	94	444	476	412
196	95	445	477	413
197	96	446	478	414
198	97	447	479	415
199	98	448	480	416
200	99	449	481	417
201	100	450	482	418
202	101	451	483	419
203	102	452	484	420
204	103	453	485	421
205	104	454	486	422
206	105	455	487	423
207	106	456	488	424
208	107	457	489	425
209	108	458	490	426
210	109	459	491	427

Manifold Absolute Pressure vs. Fuel Pressure Graph (kPa)



a - Manifold absolute pressure (kPa)
b - Fuel pressure at rail (kPa)

Electronic Throttle Control (ETC)

The ETC is controlled through the PCM. The PCM receives information from the helm, based on the position of the throttle control handle/pedal. This information is sent to the PCM and the PCM activates the ETC motor to open or close the throttle valve. The two throttle valve position sensors in the ETC are also monitored by the PCM.

The ETC functions as an idle air control (IAC) valve. During hard deceleration, the ETC will remain open slightly until the engine RPM has stabilized, to eliminate engine stalling.

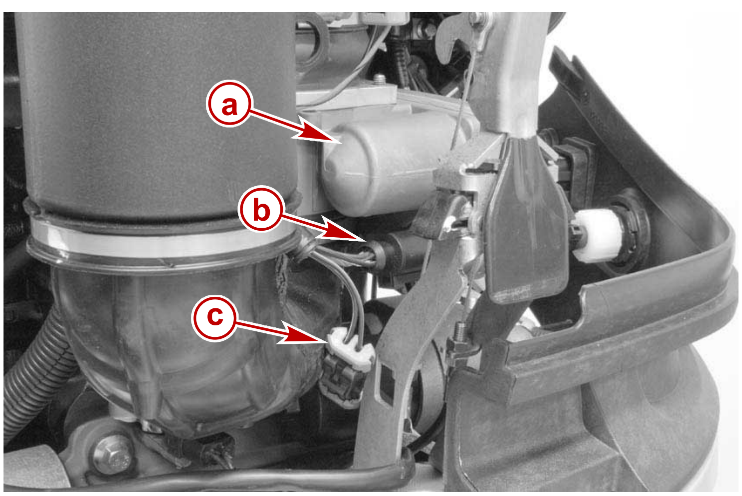
A built-in fail-safe is designed into the ETC. The ETC is spring-loaded to an off idle position to maintain engine RPM at approximately 1200 RPM in gear.

The ETC can be tested with the CDS.

Computer Diagnostic System (CDS)	Purchase from SPX*

The following step will assist you in determining if the failure is electrical or mechanical.

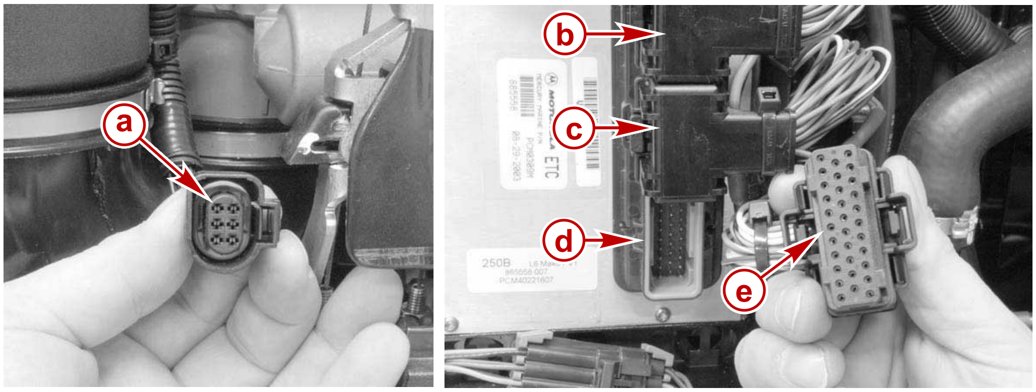
1. Remove the starboard front cowl.
2. Remove the harness connector at the ETC.



a - ETC
b - ETC harness connection
c - Shift indicator harness connection

3. Remove engine harness connector A1 at the PCM.

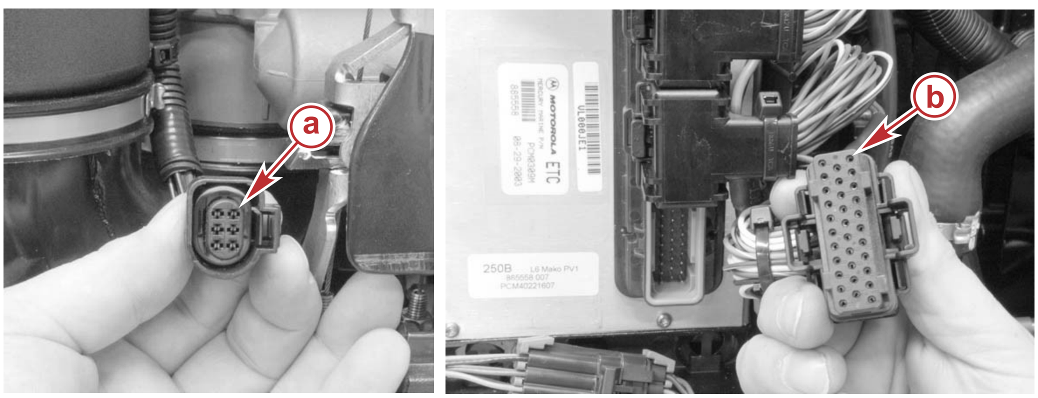
4. Check for continuity between pin 1 on the ETC harness connector and pin 6 on engine harness connector A1.



4587

- **a -** ETC harness connector pin 1
- **b -** C1 engine harness connector
- **c -** B1 engine harness connector
- **d -** A1 engine harness connector
- **e -** A1 engine harness connector pin 6

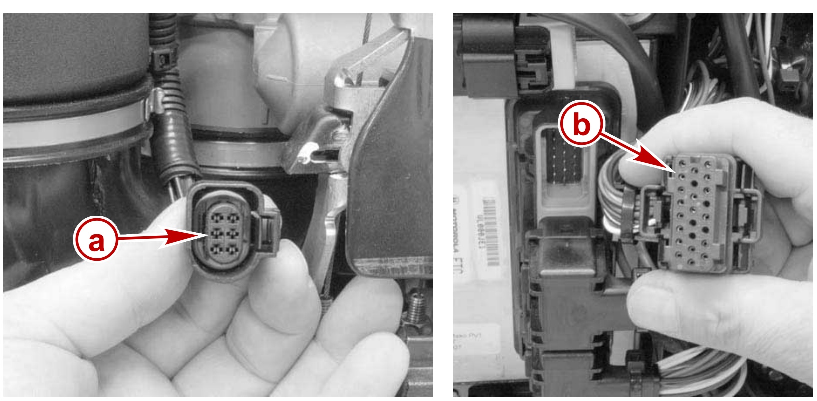
5. If no continuity is found, or there is high resistance, the engine harness must be replaced.
6. Check for continuity between pin 2 on the ETC harness connector and pin 23 on engine harness connector A1.
7. If no continuity is found, or there is high resistance, check the vent canister float switch (VCFS). The VCFS is normally closed.
8. If the VCFS is closed and no continuity or high resistance is found, the engine harness must be replaced.



52855

- **a -** ETC harness connector pin 2
- **b -** A1 engine harness connector pin 23

9. Remove engine harness connector C1 (top) at the PCM.
10. Check for continuity between pin 3 on the ETC harness connector and pin 2 on engine harness connector C1.

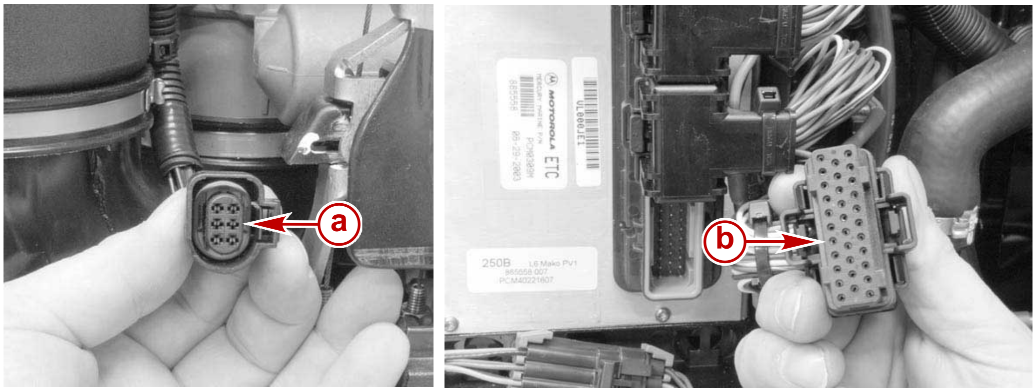


4589

- **a -** ETC harness connector pin 3
- **b -** C1 engine harness connector pin 2

11. If no continuity is found, or there is high resistance, the engine harness must be replaced.

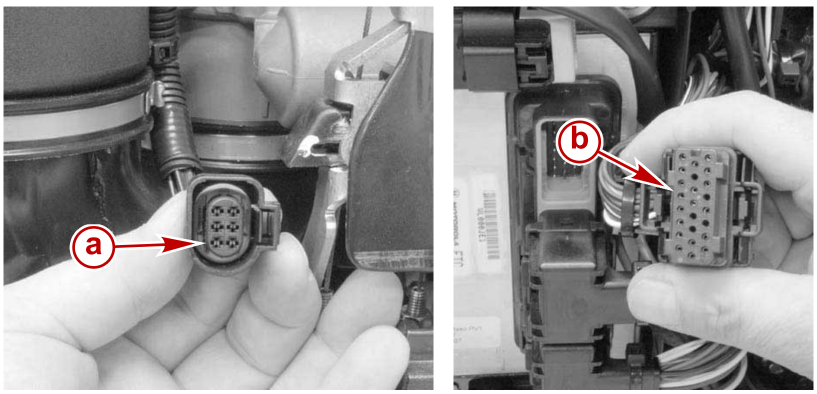
12. Check for continuity between pin 4 on the ETC harness connector and pin 7 on engine harness connector A1.



4591

a - ETC harness connector pin 4
b - A1 engine harness connector pin 7

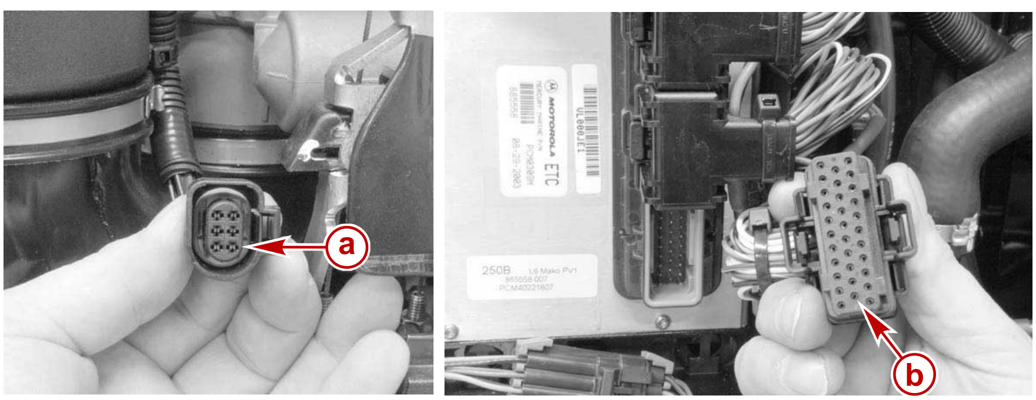
13. If no continuity is found, or there is high resistance, the engine harness must be replaced.
14. Check for continuity between pin 5 on the ETC harness connector and pin 4 on engine harness connector C1.



4592

a - ETC harness connector pin 5
b - C1 engine harness connector pin 4

15. If no continuity is found, or there is high resistance, the engine harness must be replaced.
16. Check for continuity between pin 6 on the ETC harness connector and pin 22 on engine harness connector A1. This connection is a positive 5 volt reference circuit from the PCM.



4593

a - ETC harness connector pin 6
b - A1 engine harness connector pin 22

17. If no continuity is found, there are multiple connections throughout the engine harness for this 5 volt reference circuit. Refer to the wire diagrams in the **Color Diagrams Set** to trace the wire harness.
18. If the pin continuity checks are good, the failure is mechanical.

Refer to **Section 2D** - **Electronic Throttle Control Assembly** for the removal and replacement of the ETC.

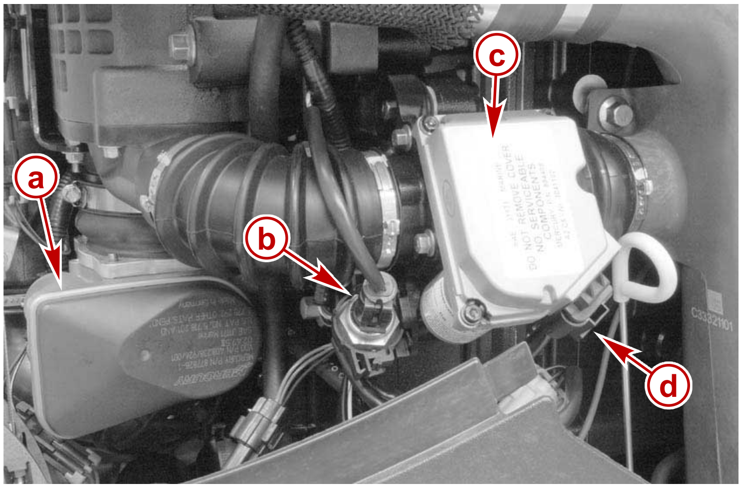
Electronic Boost Control (EBC)

The EBC is controlled through the PCM. The PCM receives data from several sensors to help determine the amount of boost needed for the engine to perform efficiently. The PCM activates the EBC valve motor to close or open. The EBC valve is normally open.

The EBC can be tested with the CDS.

The following steps will assist you in determining if the failure is electrical or mechanical.

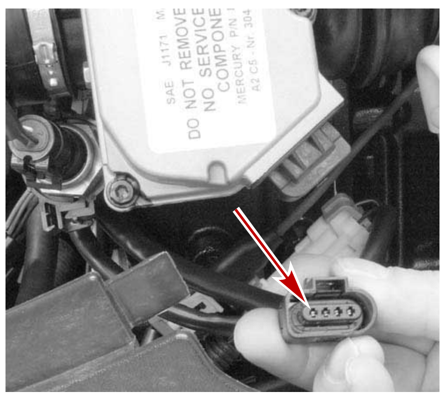
1. Remove the harness connector at the EBC.



4557

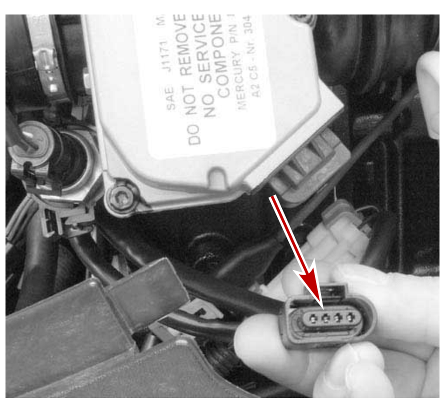
a - ETC
b - Speedometer sensor
c - EBC
d - EBC harness connector

2. Check for continuity between pin 1 and the engine ground.



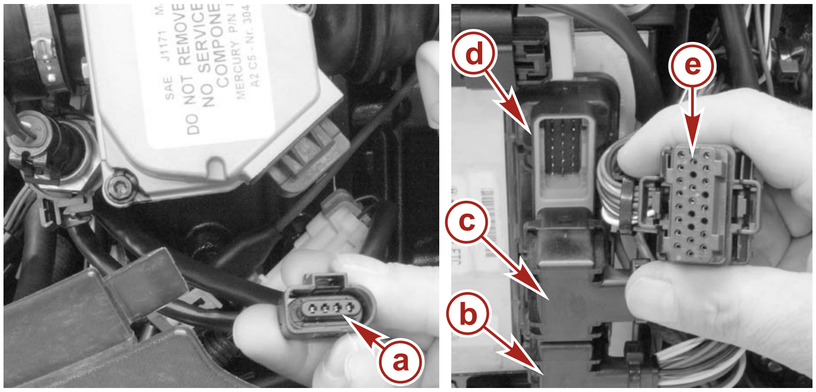
4558

3. If continuity is not found, or high resistance is present, the engine harness must be checked to determine if the harness is at fault or there is a poor ground connection to the cylinder block. Refer to the wire diagrams in the **Color Diagrams Set** to trace the wire harness and check the ground locations.
4. Connect the positive voltmeter lead to pin 2 and the negative voltmeter lead to a known good engine ground.
5. Turn the ignition key on. The main power relay (MPR) should be on (fuel pump will activate). Battery voltage should be at pin 2.



4560

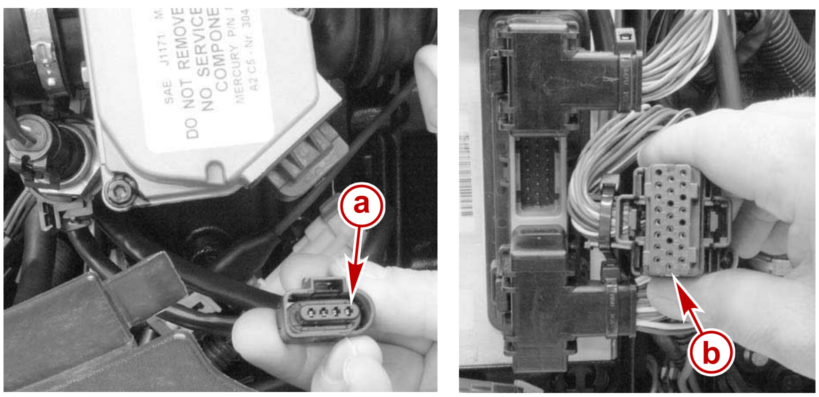
6. If you have no voltage and the MPR did not activate, check the MPR fuse.
7. If the MPR activated and there is no battery voltage, a continuity test of the engine wire harness must be completed to determine the location of the open connection. Refer to the wire diagrams in the **Color Diagrams Set** to trace the wire harness to the MPR.
8. Disconnect engine harness C1 (top) at the PCM.
9. Check for continuity between pin 3 at the EBC and pin 9 at the C1 engine harness connector. An open circuit indicates a repair or replacement of the engine harness is required.



4582

- **a -** EBC harness connector pin 3
- **b -** A1 engine harness connector
- **c -** B1 engine harness connector
- **d -** C1 engine harness connector
- **e -** C1 engine harness connector pin 9

10. Connect the C1 engine harness to the PCM.
11. Disconnect engine harness B1 (center) at the PCM.
12. Check the continuity between pin 4 at the EBC and pin 16 at the B1 engine harness connector. An open circuit indicates a repair or replacement of the engine harness is required.



4584

- **a -** EBC harness connector pin 4
- **b -** B1 engine harness connector pin 16

13. Connect the B1 engine harness connector to the PCM. If no problems were found with the wire harness, replace the electronic boost control assembly.

Notes:

Fuel System

Section 3C - Service Procedures

Table of Contents

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C

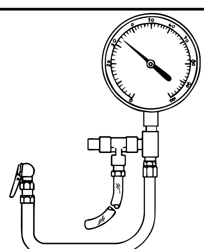
Fuel System Specifications

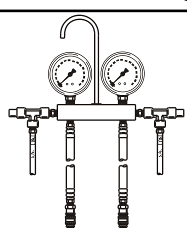
Fuel System Specifications	
Model	Type of fuel
Models 200/225/250 (non-Pro) 149 kw (200 hp), 168 kw (225 hp), 186 kw (250 hp)	USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable.
	Outside USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable.
Models 250 Pro/275/300/300 Pro 186 kw (250 hp), 205 kw (275 hp), 224 kw (300 hp)	Automotive unleaded with a minimum pump posted octane rating of 92 (R+M)/2 Octane is required for best performance. Having a posted pump Octane Rating of 87 (R+M)/2 minimum is acceptable, however, performance losses may occur.
	Outside USA and Canada: Automotive unleaded with a minimum pump posted octane rating of 96 RON is required for best performance. Having a posted pump Octane Rating of 90 RON minimum is acceptable, however, performance losses may occur.
Approximate fuel pressure at idle	279–289 kPa (40–42 psi)
Fuel filtration	
Fuel inlet water separator	2 microns
High pressure	20 microns

Lubricant, Sealant, Adhesives

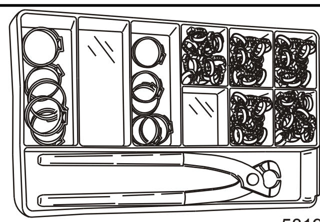
Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	FSM mounting screw threads	92-809821
		FSM shroud mounting screw threads	
136	Lubriplate SPO 255	Fuel injector O-rings	Obtain Locally
		Fuel injector O-ring, damper O-ring	

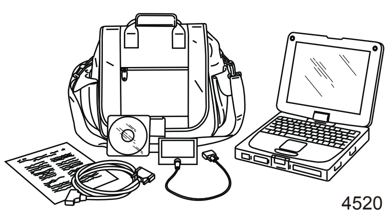
Special Tools

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

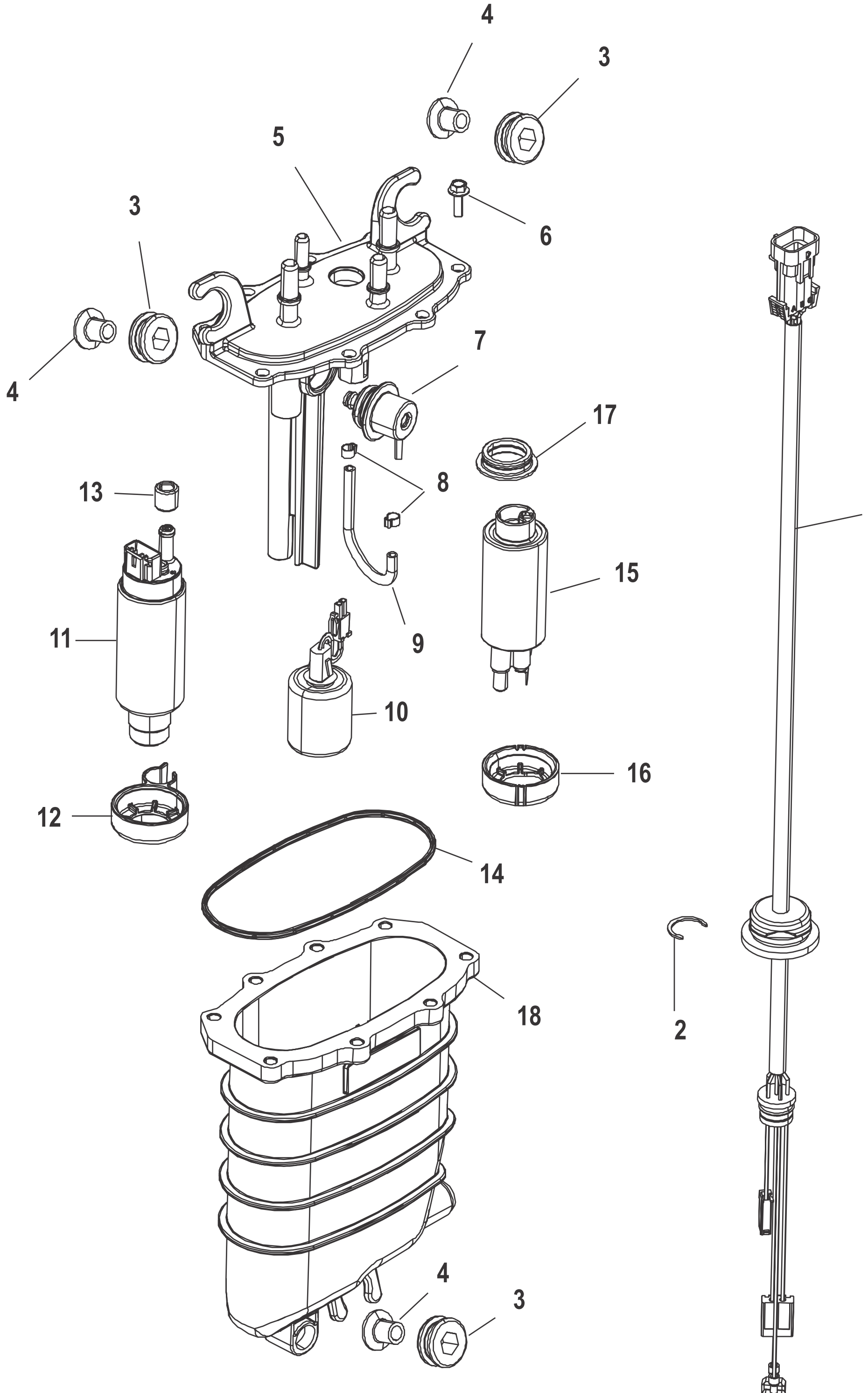
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously.

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS).

Hose Clamp Tool Kit	91-803146A04
 5819	Aids in the installation of high pressure (Oetiker Â®) hose clamps

Computer Diagnostic System (CDS)	Purchase from SPX*
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: USA and Canada SPX Corporation 28635 Mound Rd. Warren, MI 48092 800-345-2233 (option 2 then 2 again) oetech@servicesolutions.spx.com or EMEA 0049 6182 959 403 technical-support@spx.com Australia 61 3 9544 6222 techsupport-aus@servicesolutions.spx.com Mexico 52 55 25 95 16 30 (option 9) tecnico@spx.com Brazil 0800-762-1003 (option 9) tecnico@spx.com *CDS G3 must be purchased from Mercury Marine

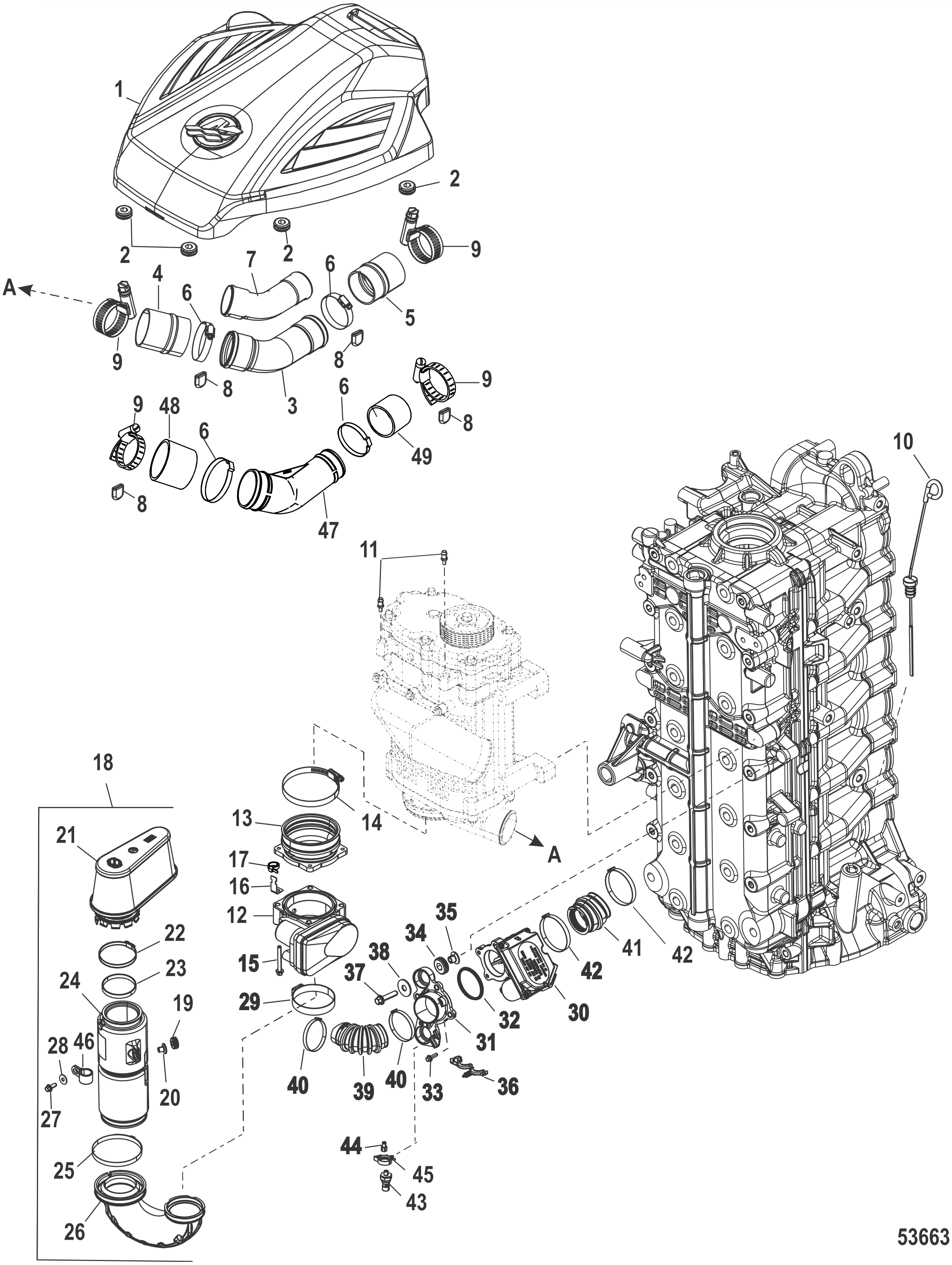
Fuel Supply Module Components



Fuel Supply Module Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Harness			
2	1	Clip			
3	3	Grommet			
4	3	Bushing			
5	1	Cover			
6	8	Screw	5	44	–
7	1	Regulator with O-ring			
8	2	Clamp			
9	1	Hose			
10	1	Float			
11	1	High-pressure fuel pump			
12	1	Seal			
13	1	Seal			
14	1	Seal			
15	1	Lift fuel pump			
16	1	Isolator			
17	1	Seal			
18	1	Housing			

Induction Components

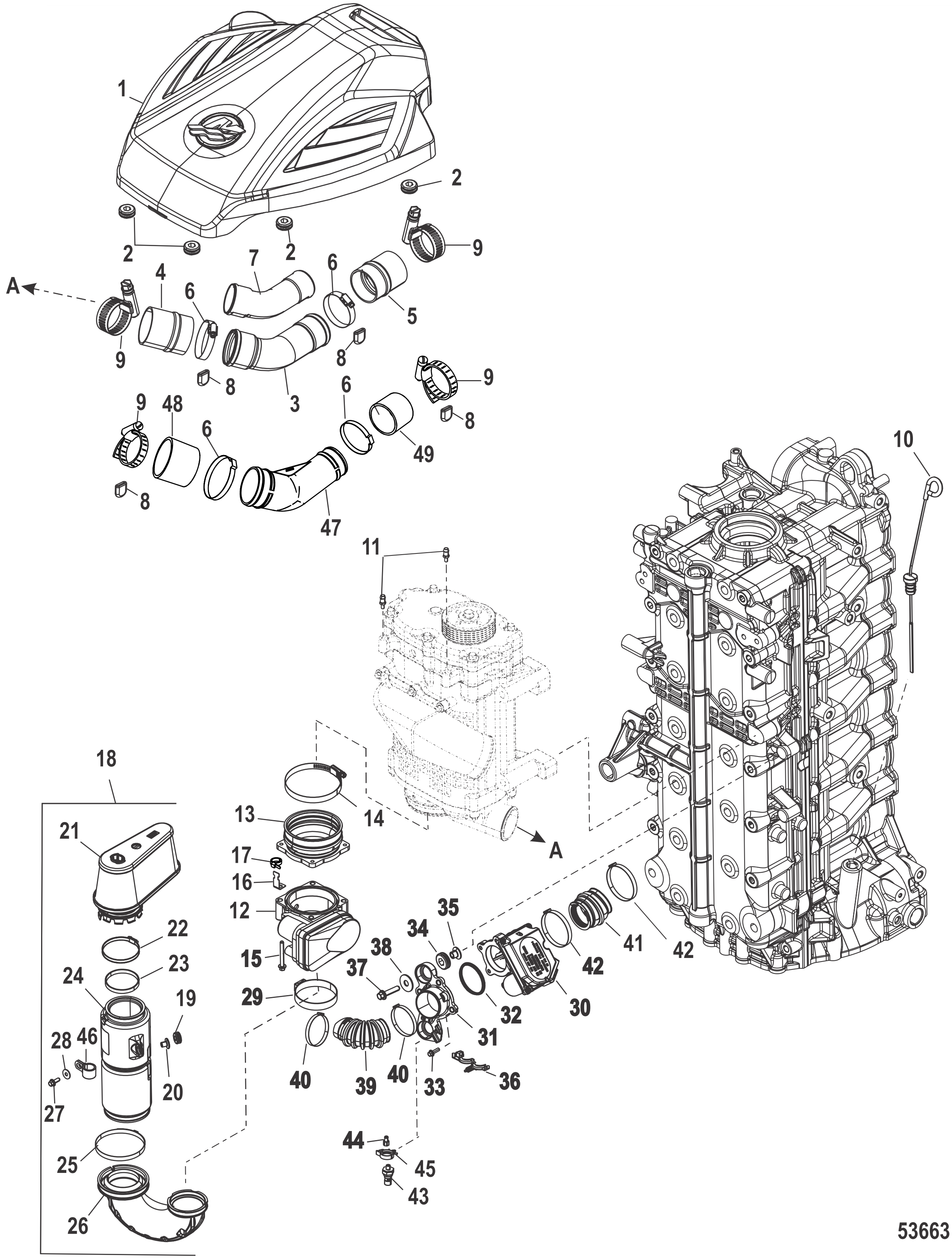


Induction Components

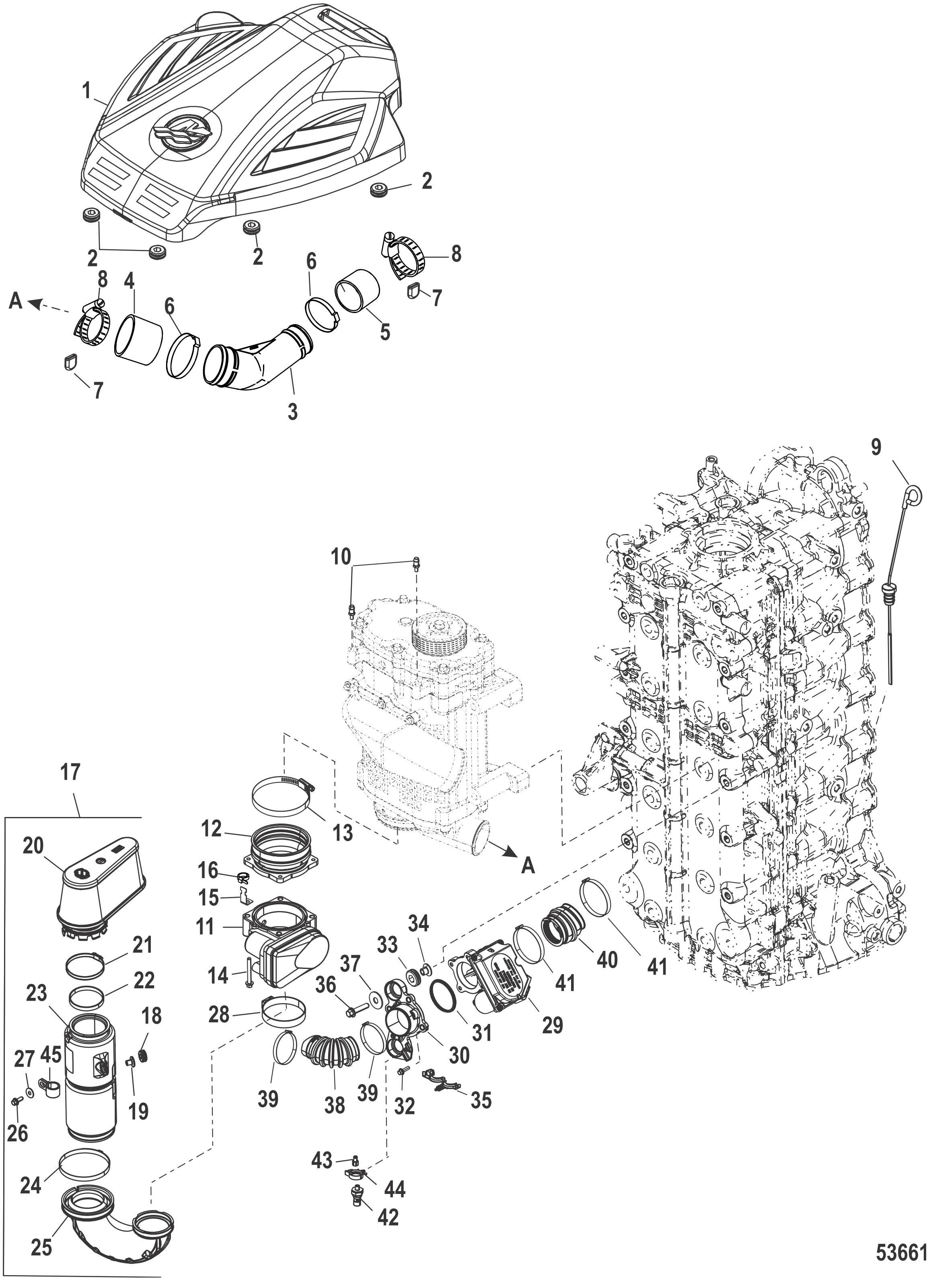
Ref. No.	Qty.	Description	Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Flywheel cover			
2	4	Grommet			
3	1	Tube assembly, **Design I**			
4	1	Hose 65 mm (2.56 in.) ID, **Design I**			
5	1	Hose 60 mm (2.36 in.) ID, **Design I**			
6	2	Clamp, **Design I**	6.2	55	–
		Clamp, **Design II**			
7	1	Hose sleeve, **Design I**			
8	2	Cover, **Design I**			
	2	Cover, **Design II**			
9	2	Clamp, **Design I**	6.2	55	–
	2	Clamp, **Design II**			
10	1	Oil dipstick			
11	2	Pin	8	71	
12	1	Electronic throttle control (ETC) assembly			
13	1	Isolator			
14	1	Worm gear clamp	6.2	55	–
15	4	Screw (M6 x 50)	11	97	–
16	2	Bracket			
17	2	Cable tie (8 in.)			
18	1	Air intake assembly			
19	1	Grommet			
20	1	Bushing			
21	1	Air filter			
22	1	Clamp			
23	1	Gasket			
24	1	Resonator			
25	1	Clamp (96.5 mm)			
26	1	Inlet duct			
27	1	Screw (M6 x 25)	7.4	66	–
28	1	Washer (0.265 x 0.750 x 0.048)			
29	1	Clamp (96.5 mm)			
30	1	Electronic boost control (EBC) assembly			
31	1	Boost valve mounting plate			
32	1	O-ring			
33	4	Screw (M6 x 20)	10	89	–
34	2	Grommet			
35	2	Bushing			
36	1	Clip			
37	2	Screw (M8 x 35)	24	–	17.7

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
38	2	Washer (0.344 x 1.00 x 0.063)			
39	1	Front hose			
40	2	Front electronic boost control clamp (57.5 mm)			
41	1	Rear tube			
42	2	Rear electronic boost control clamp (62.0 mm)			
43	1	Pitot sensor assembly			
44	1	Fitting			
45	1	Clip (0.865)			
46	1	Fuel hose clip			
47	1	Tube assembly, **Design II**			
48	1	Hose, **Design II**			
49	1	Hose, **Design II**			

Induction Components



Induction Components—Closed Compartment Technology

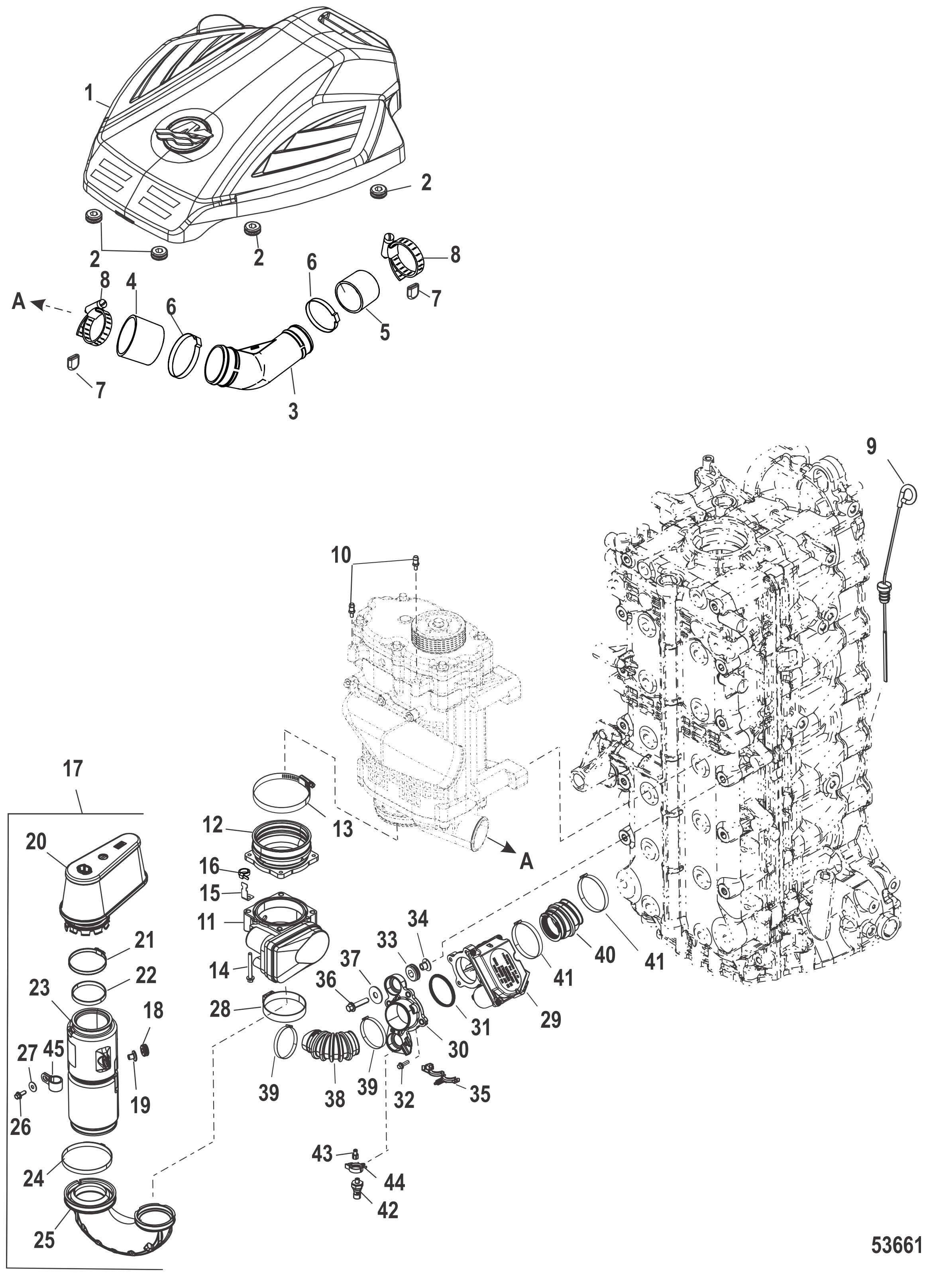


Induction Components—Closed Compartment Technology

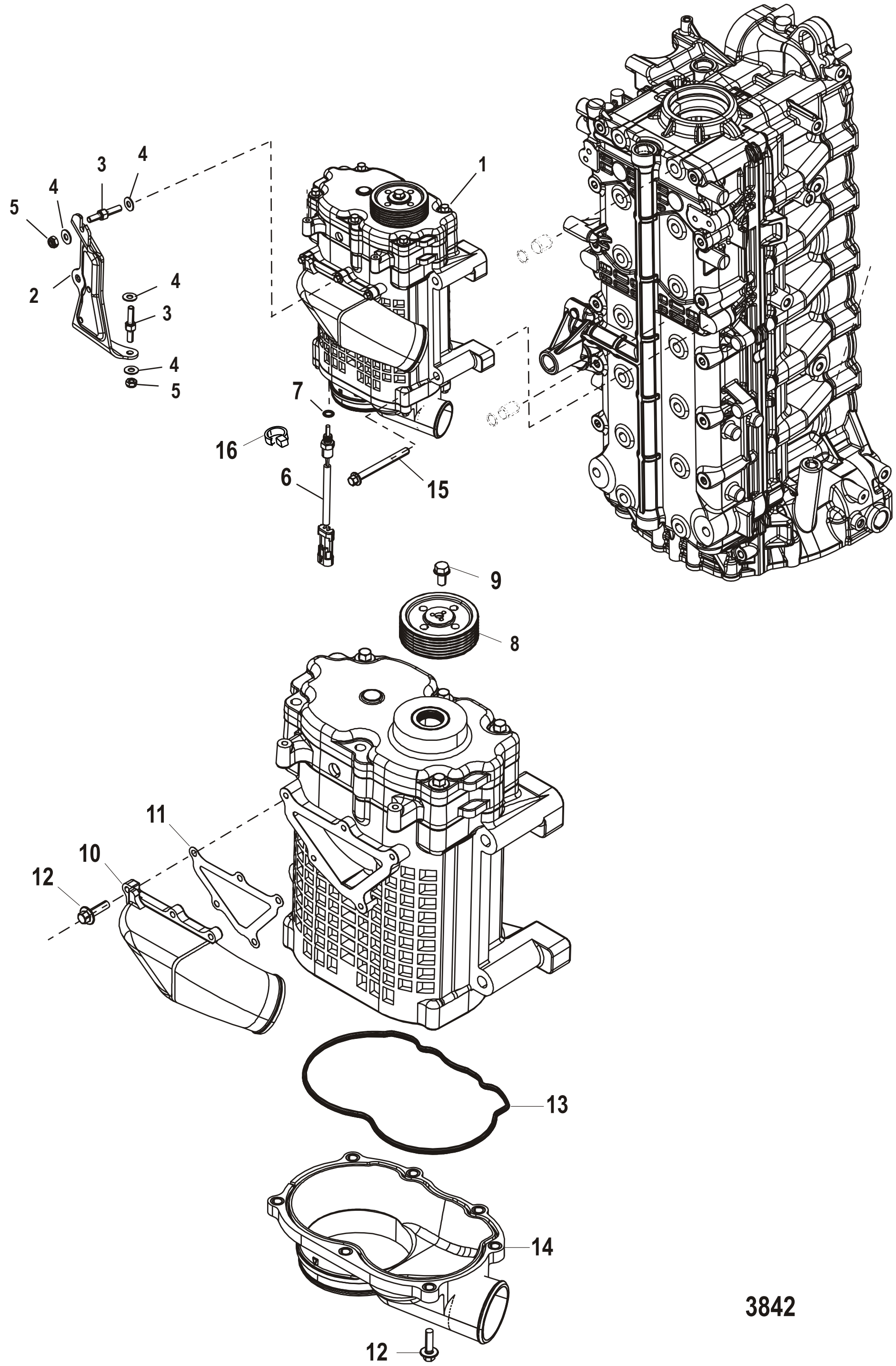
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Flywheel cover			
2	4	Grommet			
3	1	Tube assembly			
4	1	Hose 65 mm (2.56 in.) ID			
5	1	Hose 60 mm (2.36 in.) ID			
6	2	Clamp	6.2	55	–
7	2	Cover			
8	2	Clamp	6.2	55	–
9	1	Oil dipstick			
10	2	Pin	8	71	–
11	1	Electronic throttle control (ETC) assembly			
12	1	Isolator			
13	1	Worm gear clamp	6.2	55	–
14	4	Screw (M6 x 50)	11	97	–
15	2	Bracket			
16	2	Cable tie (8 in.)			
17	1	Air intake assembly			
18	1	Grommet			
19	1	Bushing			
20	1	Air filter			
21	1	Clamp			
22	1	Gasket			
23	1	Resonator			
24	1	Clamp (96.5 mm)			
25	1	Inlet duct			
26	1	Screw (M6 x 25)	7.4	66	–
27	1	Washer (0.265 x 0.750 x 0.048)			
28	1	Clamp (96.5 mm)			
29	1	Electronic boost control (EBC) assembly			
30	1	Boost valve mounting plate			
31	1	O-ring			
32	4	Screw (M6 x 20)	10	89	–
33	2	Grommet			
34	2	Bushing			
35	1	Clip			
36	2	Screw (M8 x 35)	24	–	17.7
37	2	Washer (0.344 x 1.00 x 0.063)			
38	1	Front hose			
39	2	Front electronic boost control clamp (57.5 mm)			
40	1	Rear tube			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	2	Rear electronic boost control clamp (62.0 mm)			
42	1	Pitot sensor assembly			
43	1	Fitting			
44	1	Clip (0.865)			
45	1	Fuel hose clip			

Induction Components—Closed Compartment Technology



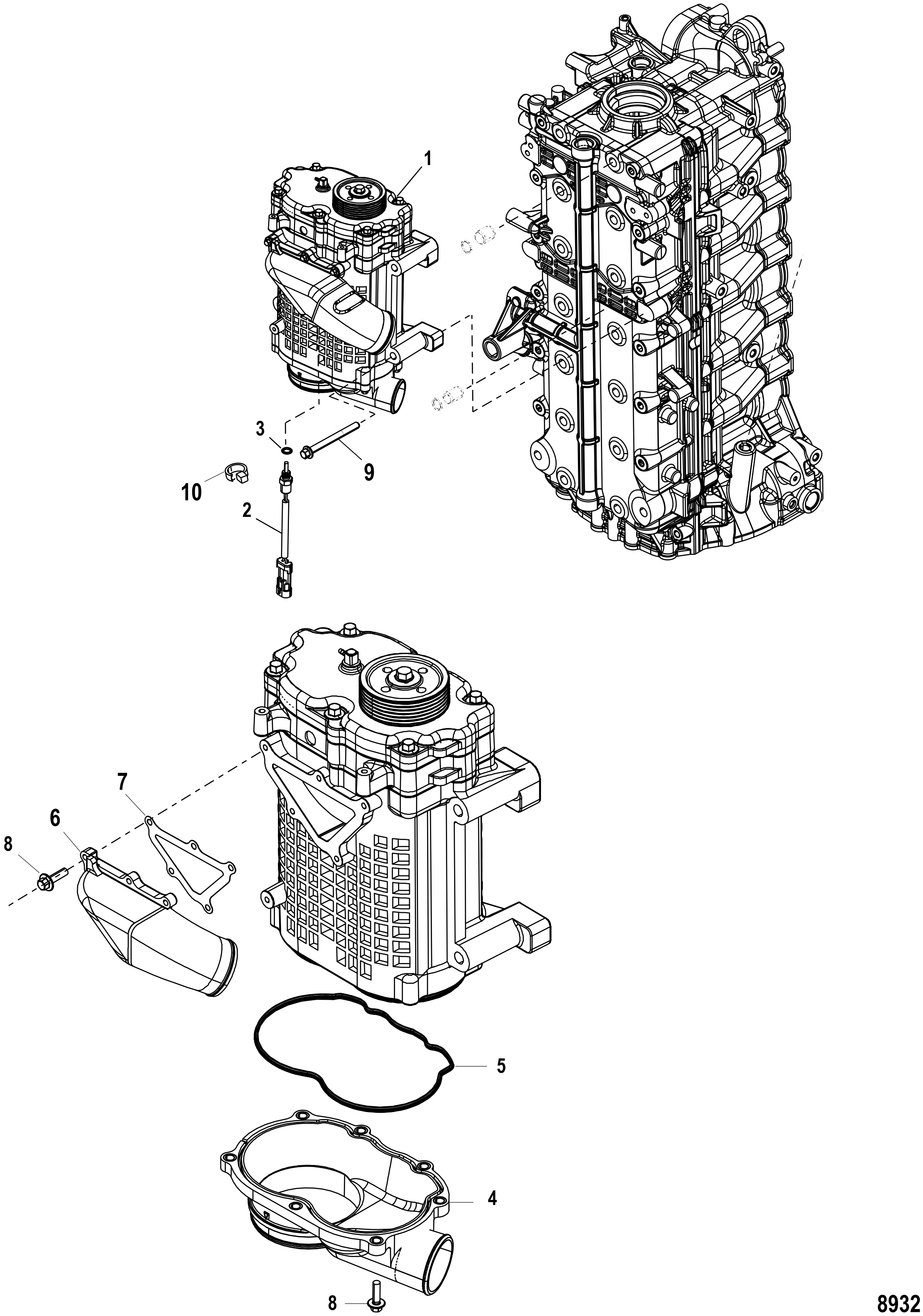
Supercharger S/N 1B226999 and Below



Supercharger S/N 1B226999 and Below

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Supercharger				
2	1	Bracket				
3	3	Shoulder stud		8	71	–
4	5	Washer				
5	5	Nut (M6)		8	71	–
6	4	Temperature sensor		15	133	–
7	1	O-ring				
8	4	Pulley				
9	1	Screw		36	–	26.6
10	1	Outlet duct				
11	1	Gasket				
12	5	Bolt		8	71	–
13	1	Seal				
14	1	Inlet duct				
15	4	Screw (M10 x 105)	First torque	15	133	–
			Final torque	43	–	32
16	1	Cable tie (4 in.)				

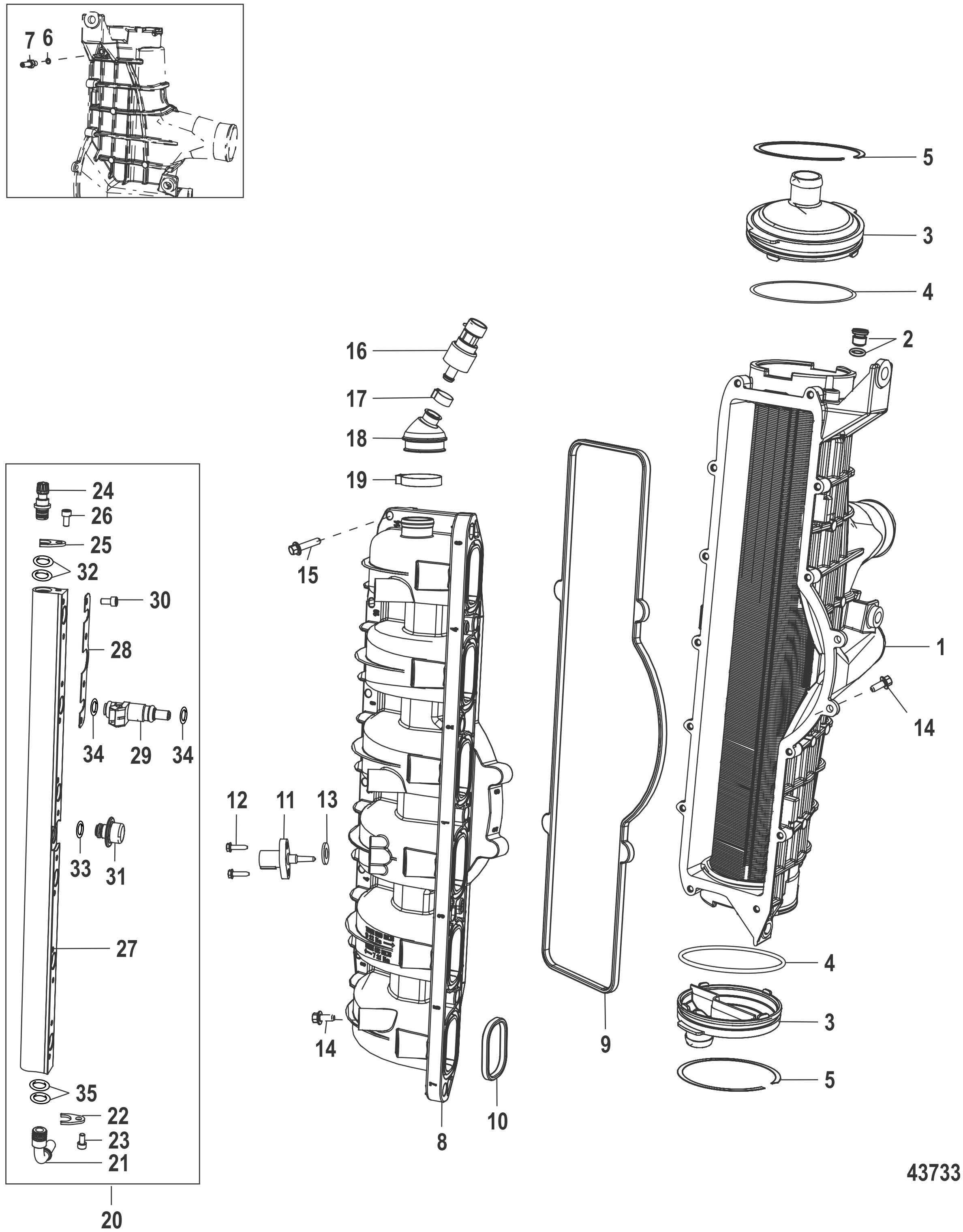
Supercharger S/N 1B227000 and Above



Supercharger S/N 1B227000 and Above

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Supercharger				
2	1	Temperature sensor		15	133	–
3	1	O-ring				
4	1	Inlet duct				
5	1	Seal				
6	1	Outlet duct				
7	1	Gasket				
8	9	Bolt		8	71	–
9	4	Screw (M10 x 105)	First torque	15	133	–
			Final torque	43	–	32
10	1	Cable tie (4 in.)				

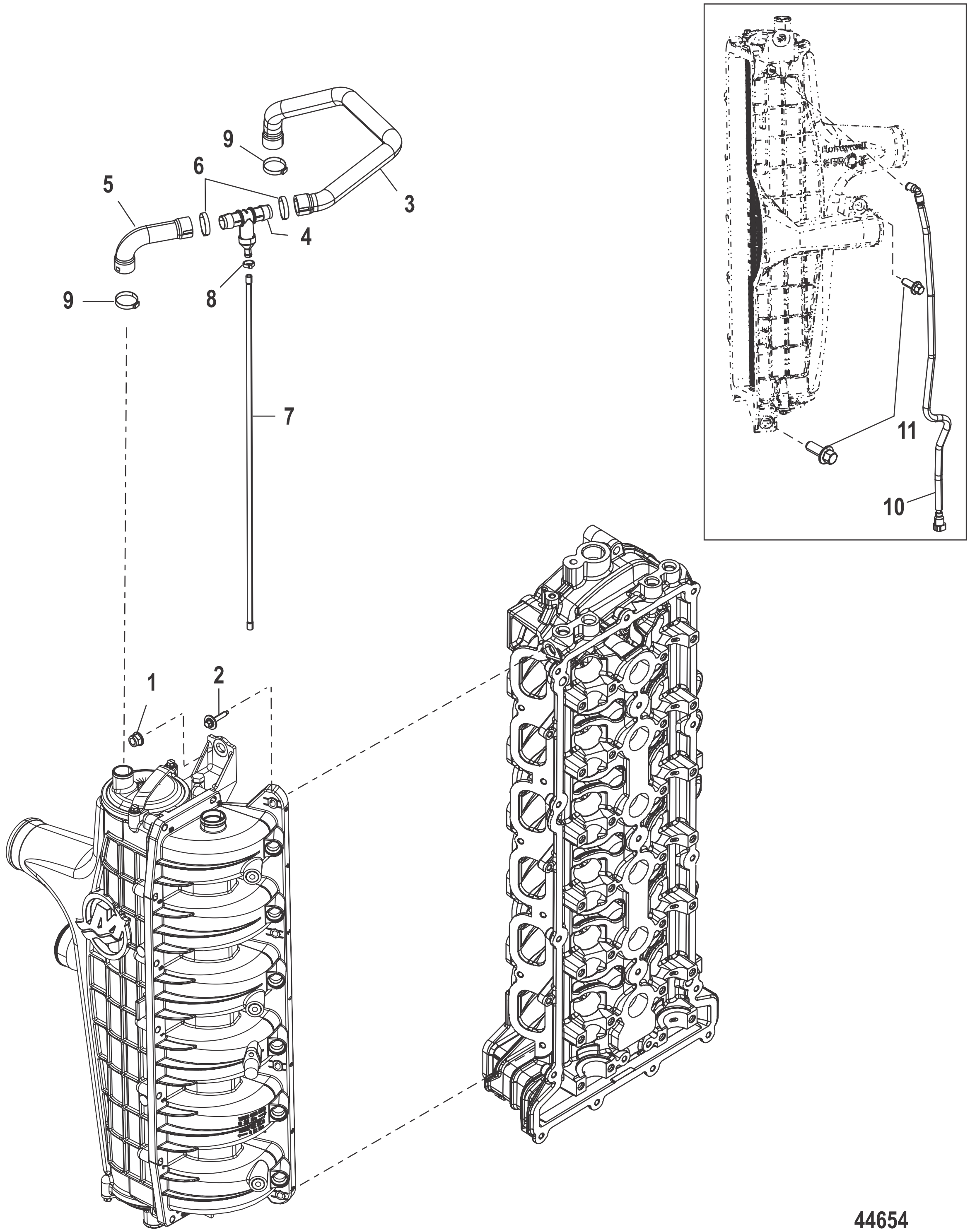
Charge Air Cooler—Intake Manifold



Charge Air Cooler—Intake Manifold

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Charge air cooler (CAC) assembly			
2	1	Plug with O-ring			
3	2	End cap assembly			
4	2	O-ring			
5	2	Retaining ring			
6	1	O-ring			
7	1	Fitting			
8	1	Intake manifold			
9	1	Seal			
10	6	Intake manifold-to-cylinder head seal			
11	1	Air temperature sensor			
12	2	Screw (M4 x 16)	2	18	–
13	1	O-ring			
14	2	Screw (M4 x 16) manifold-to-CAC, stainless steel	2	18	–
	3	Screw (M4 x 16) fuel rail-to-manifold, stainless steel			
15	13	Screw (M6 x 25) manifold-to-CAC, stainless steel	7	62	–
16	1	Manifold absolute pressure (MAP) sensor			
17	1	MAP sensor-to-boot clamp (15.7 mm)			
18	1	MAP sensor boot			
19	1	Clamp (36.1 mm)			
20	1	Fuel rail assembly			
21	1	Fuel inlet tube			
22	1	Retaining bracket			
23	1	Screw (M5 x 10)	7	62	–
24	1	Schrader valve			
25	1	Retaining bracket			
26	1	Screw (M5 x 10)	7	62	–
27	1	Fuel rail			
28	3	Bracket			
29	6	Fuel injector			
30	12	Screw (M5 x 10)	7	62	–
31	1	Damper			
32	2	O-ring			
33	1	O-ring			
34	6	O-ring			
35	2	O-ring			

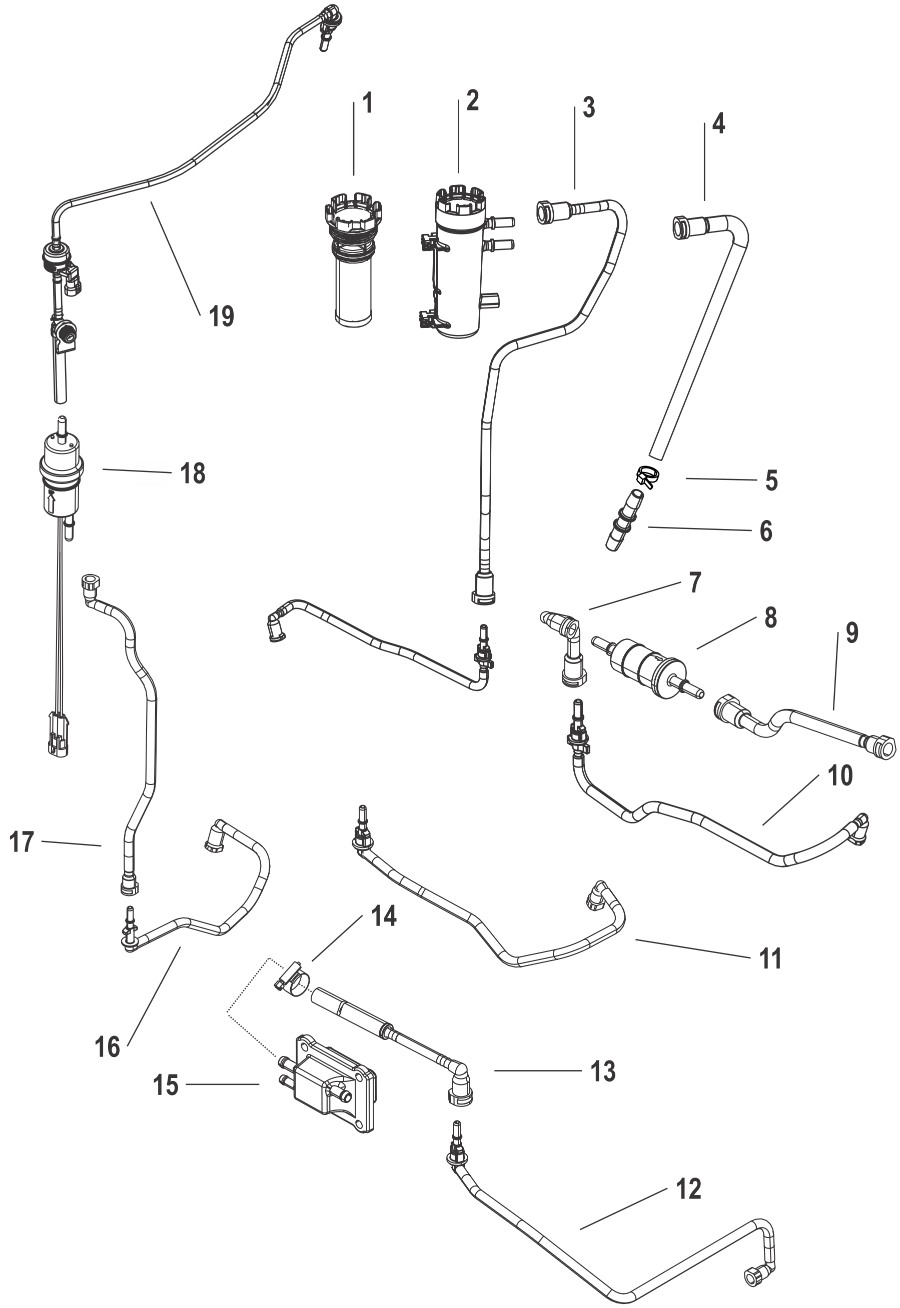
Charge Air Cooler—Intake Manifold Hose Routing



Charge Air Cooler—Intake Manifold Hose Routing

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Nut (M10)	32.5	–	24
2	7	Screw	9	80	–
3	1	Hose			
4	1	Flush fitting			
5	1	Hose			
6	2	Clamp (34.6 mm)			
7	1	Hose			
8	1	Cable tie (11.75 in.)			
9	2	Clamp (34.6 mm)			
10	1	Manifold reference upper hose			
11	2	Screw (M10 x 30)	32.5	–	24

Fuel Lines



Fuel Lines

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Fuel filter			
2	1	Filter housing			
3	1	Fuel-to-lift pump hose			
4	1	Fuel inlet hose			
5	1	Cable tie (8 in.)			
6	1	Connector			
7	1	High-pressure 20-micron filter hose			
8	1	20-micron filter			
9	1	Filter-to-fuel rail hose			
10	1	Fuel supply module (FSM) high-pressure-to-fuel filter hose			
11	1	Manifold reference hose			
12	1	Water-to-FSM hose (lower)			
13	1	Water-to-FSM hose (upper)			
14	1	Clamp			
15	1	Water manifold housing			
16	1	Vent hose (lower)			
17	1	Vent hose (upper)			
18	1	Vent canister			
19	1	Vent canister purge valve (VCPV) assembly			

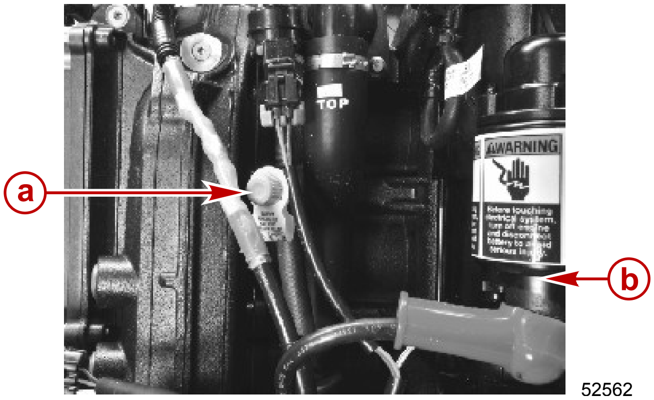
Fuel Supply Module (FSM) Removal/Installation

Fuel Supply Module (FSM) Removal

1. Starting with the negative (–) lead, disconnect the battery cables from the battery.
2. Remove the top cowl, rear cowl, front starboard cowl, and the driveshaft housing chaps. Refer to **Cowl Removal and Installation** in **Section 1B** - **Maintenance**.

⚠ CAUTION
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

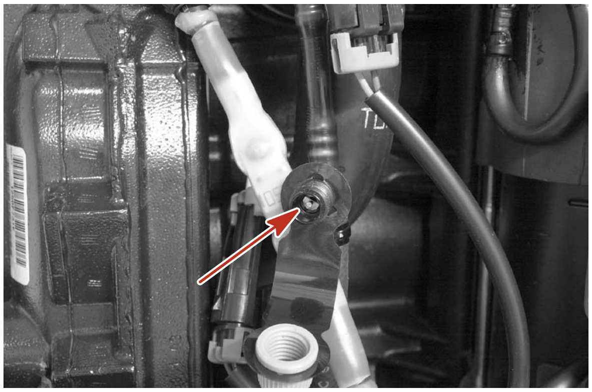
3. Remove the cap to access the pressure relief valve for the FSM.



52562

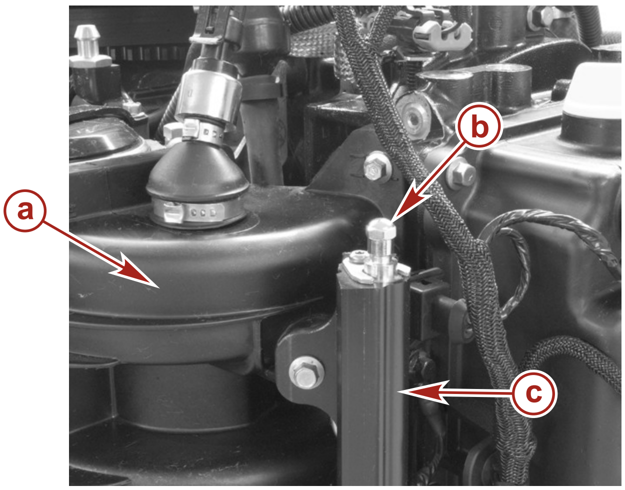
a - FSM pressure relief valve
b - Starter solenoid

4. Place a rag over the valve, then press in on the center of the valve to relieve any pressure inside the FSM.



3472

5. Attach a fuel pressure gauge to the fuel pressure relief valve on the fuel rail. Relieve the fuel pressure into an appropriate container and dispose of the fuel in an appropriate manner.

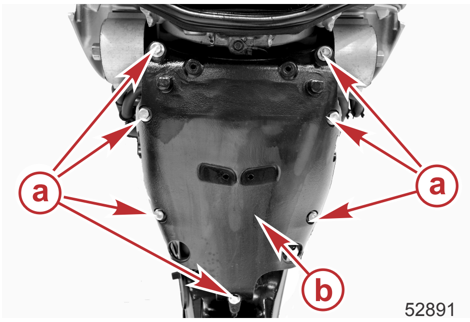


41765

a - Intake manifold
b - Fuel pressure relief valve
c - Fuel rail

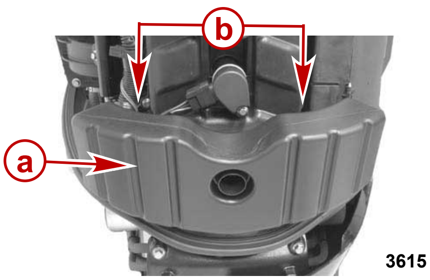
Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

6. Remove the seven screws securing the FSM shroud to the driveshaft housing.



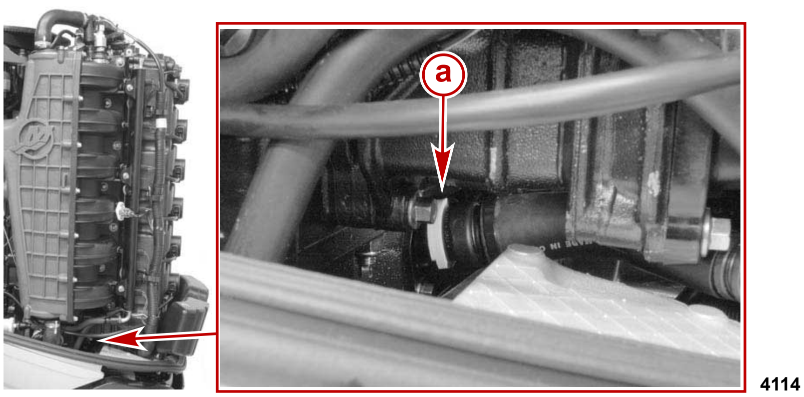
a - Screws (7)
b - FSM shroud

7. Remove the two screws holding the exhaust plenum to the mount cradle.



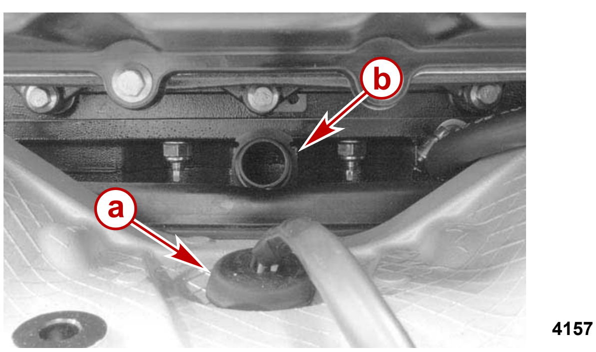
a - Exhaust plenum
b - Screws (2) (hidden by the exhaust plenum)

8. Disconnect the exhaust plenum tube by pushing in the release clip.



a - Release clip

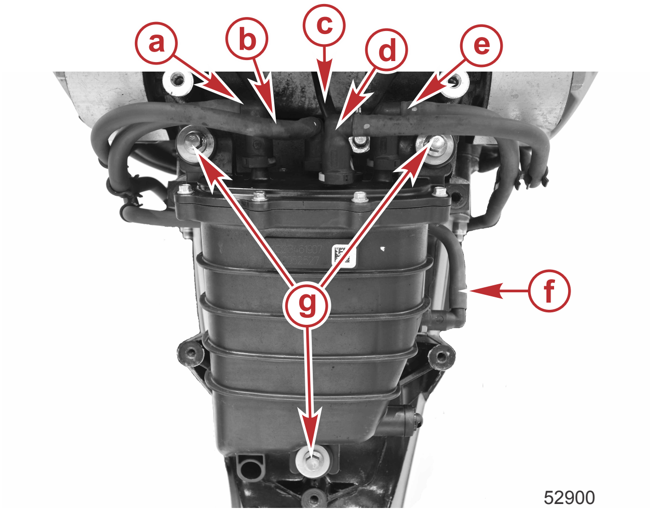
9. Push the FSM harness grommet through the mount cradle.



a - FSM harness grommet
b - Exhaust relief tube

10. Disconnect the fuel cooler line.
11. Disconnect the vent canister line.
12. Disconnect the input fuel line. Capture any fuel leaking from the fuel line.
13. Disconnect the high-pressure fuel outlet line. Capture any fuel leaking from the fuel line.
14. Disconnect the manifold reference line.

15. Remove the screws securing the FSM to the driveshaft housing.

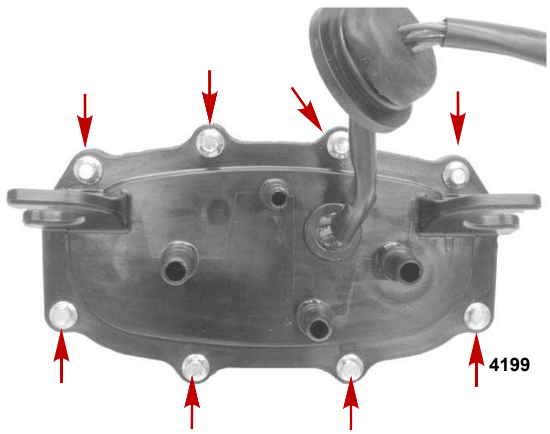


a - High-pressure fuel outlet line (10 mm red tab)
b - Manifold reference line (8 mm white tab)
c - FSM wire harness
d - Vent canister line (0.375 in. blue tab)
e - Input fuel line (10 mm red tab)
f - Fuel cooler line (8 mm blue tab)
g - Mounting screws

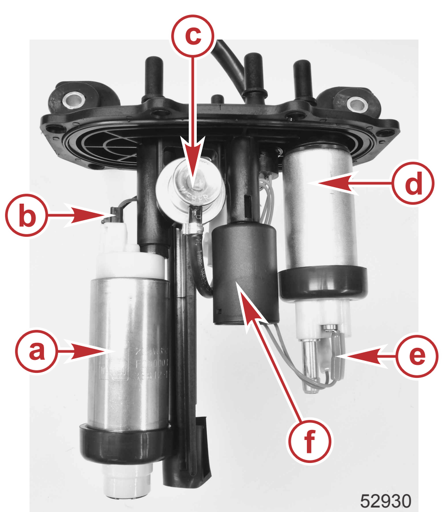
Fuel Supply Module (FSM) Disassembly and Inspection

FSM Disassembly

1. Remove the screws securing the FSM cover to the FSM housing. Remove the FSM cover.

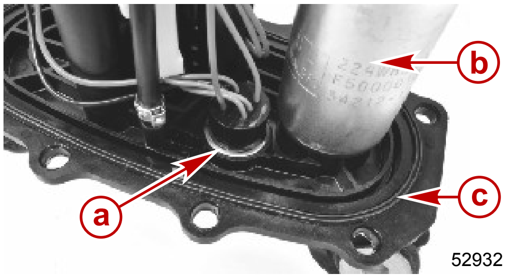


2. Disconnect the fuel lift pump connectors, high-pressure fuel pump connector, and float switch connector from the FSM wire harness.



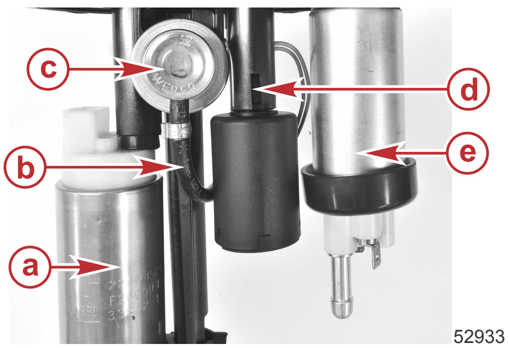
a - High-pressure fuel pump
b - Harness connector
c - Fuel pressure regulator
d - Lift pump
e - Lift pump connector with orange wire
f - Float switch (connector hidden from view)

3. Remove the clip securing the FSM wire harness to the FSM cover. Remove the FSM wire harness from the FSM cover.



a - FSM wire harness clip
b - Fuel lift pump
c - FSM cover gasket

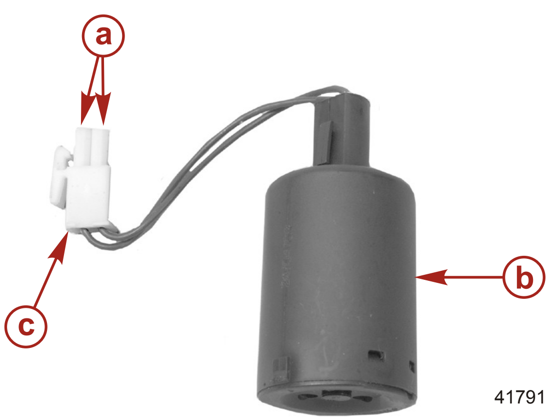
4. Push on the tabs to remove the float switch.
5. Pull on the high-pressure fuel pump to remove the pump from the FSM cover.
6. Pull the fuel lift pump to remove the pump from the FSM cover.
7. Remove the manifold reference hose from the fuel pressure regulator.
8. Pull the fuel pressure regulator off the FSM cover.



a - High-pressure fuel pump
b - Manifold reference hose
c - Fuel pressure regulator
d - Float switch tab
e - Fuel lift pump

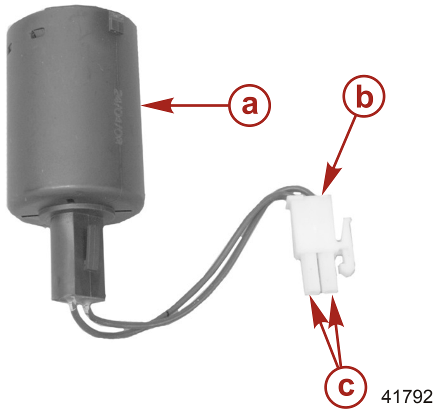
FSM Inspection

1. Visually check the float switch to ensure that fuel has not leaked into the float.
2. Inspect the FSM cover gasket for cuts or damage. Remove the FSM cover gasket if it is being replaced.
3. Check that the manifold reference hose is not cracked, broken, or detached from the fuel pressure regulator.
4. Connect an ohmmeter to the float switch wires.
5. With the float switch in a normal operating position (wires facing up) there should be continuity. Replace the float switch if no continuity is found.



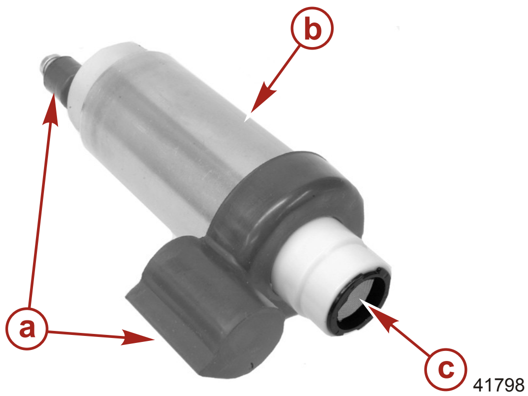
a - Connector terminals
b - Float switch (normal operating position)
c - Float switch harness connector

6. Invert the float switch (wires facing down). There should be no continuity. Replace the float switch if there is continuity.



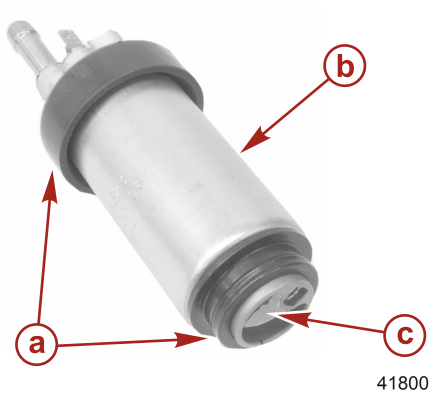
a - Float switch inverted
b - Float switch harness connector
c - Connector terminals

7. Remove the grommets on the high-pressure fuel pump. Inspect the fuel filter screen for debris and clean as required.



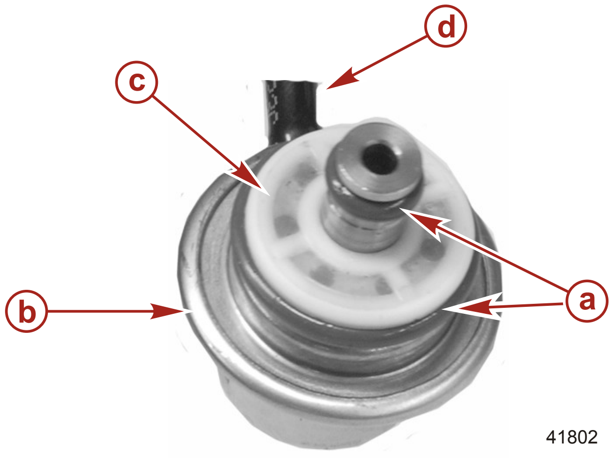
a - Grommets
b - High-pressure fuel pump
c - Fuel filter screen

8. Remove the grommets on the fuel lift pump. Inspect the screen for debris and clean as required.



a - Grommets
b - Fuel lift pump
c - Fuel filter screen

9. Visually inspect the fuel pressure regulator. Replace the fuel pressure regulator if debris is found on the fuel pressure regulator screen.

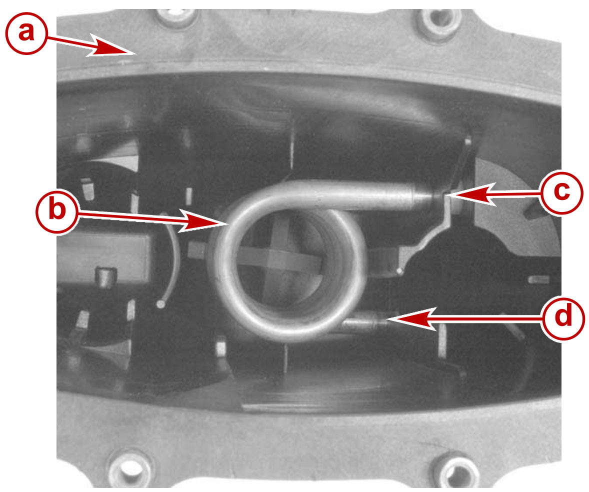


41802

- a - O-rings
- b - Fuel pressure regulator
- c - Fuel filter screen
- d - Manifold reference hose

10. Inspect the fuel cooling coil inside of the FSM housing for damage.

    NOTE: *If damage to the cooling coil is severe enough to cause a water flow restriction, or if the coil is suspected of leaking water into the FSM, the FSM housing must be replaced.*

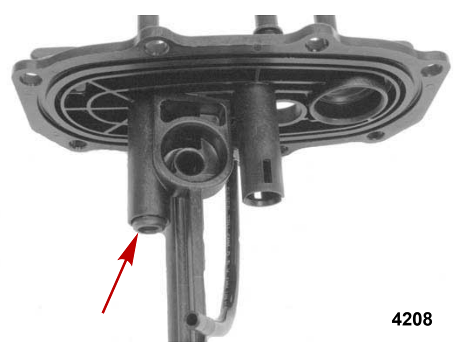


4213

- a - FSM housing
- b - Fuel cooler
- c - Fuel cooler water inlet
- d - Fuel cooler water outlet

Fuel Supply Module (FSM) Assembly

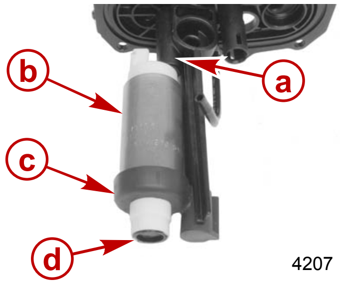
1. Insert the small grommet into the FSM cover.



4208

2. Install the high-pressure fuel pump.

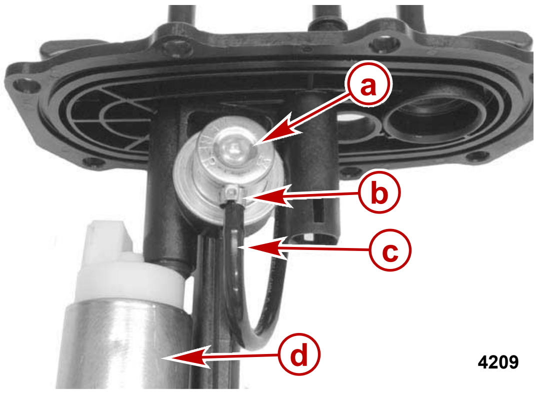
3. Ensure that the filter on the high-pressure fuel pump is clear of debris.



a - Grommet in FSM cover
b - High-pressure fuel pump
c - Isolator
d - Filter

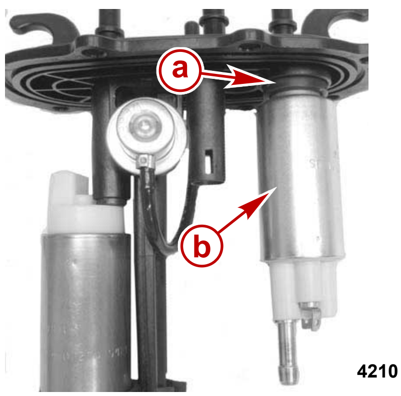
4. Install the fuel pressure regulator onto the FSM cover. Secure the manifold reference hose to the fuel pressure regulator.

NOTE: The fuel pressure regulator O-rings cannot be purchased separately.



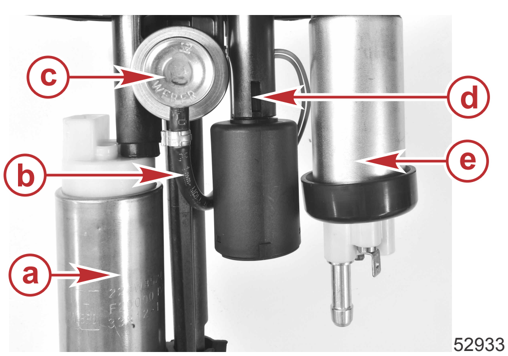
a - Fuel pressure regulator
b - Fuel pressure regulator hose clamp (6.5 mm)
c - Manifold reference hose
d - High-pressure fuel pump

5. Insert the lift pump grommet into the FSM cover.
6. Insert the fuel lift pump into the grommet. Ensure that the fuel lift pump is fully seated into the grommet.



a - Fuel lift pump grommet
b - Fuel lift pump

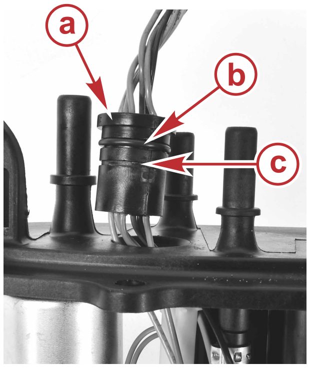
7. Guide the float switch wires into the slot on the FSM cover.
8. Align the float switch tabs with the FSM retaining holes.
9. Push the float switch completely into the FSM cover.



a - High-pressure fuel pump
b - Manifold reference hose
c - Fuel pressure regulator
d - Float switch tab
e - Fuel lift pump

10. Ensure that the O-ring on the FSM harness grommet is not damaged.
11. Guide the FSM harness connectors through the FSM cover.

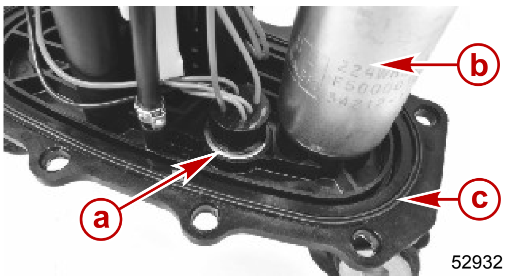
12. Push the FSM harness grommet into the FSM cover until it bottoms out.



52938

- a - FSM harness grommet
- b - O-ring
- c - Recess for retaining ring

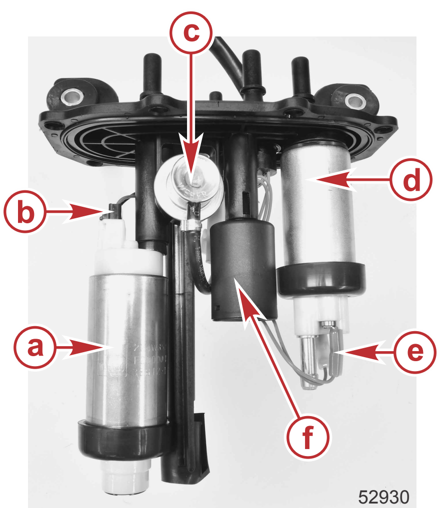
13. Install the FSM harness grommet retaining ring.



52932

- a - FSM harness grommet retaining ring
- b - Fuel lift pump
- c - FSM cover gasket

14. Connect the high-pressure fuel pump harness.
15. Connect the fuel lift pump harness.
16. Connect the float switch harness.

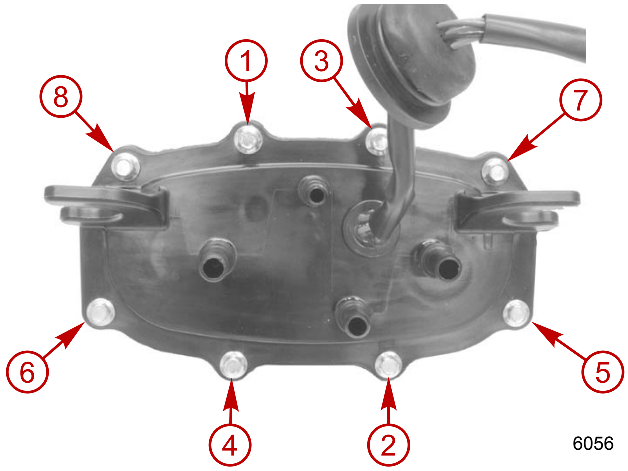


52930

- a - High-pressure fuel pump
- b - Harness connector
- c - Fuel pressure regulator
- d - Lift pump
- e - Lift pump connector with orange wire
- f - Float switch (connector hidden from view)

17. Install the FSM cover gasket if it was removed.
18. Install the FSM cover to the FSM housing.

19. Secure the FSM cover to the FSM housing. Tighten the FSM cover screws in sequence to the specified torque.



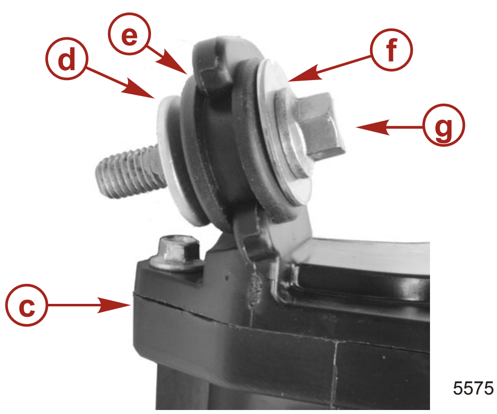
Description	Nm	lb-in.	lb-ft
FSM cover screw	5	44	–

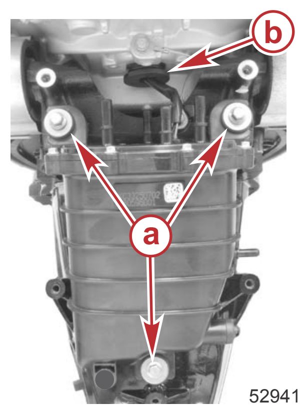
Fuel Supply Module (FSM) Installation

1. Install the rubber grommets onto the FSM.
2. Insert the bushings from the rear of the FSM into the rubber grommets.
3. Install the washers onto the FSM mounting screws.
4. Insert the FSM screw/washer into each bushing.
5. Apply Loctite 242 Threadlocker to the FSM mounting screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	FSM mounting screw threads	92-809821

6. Install the FSM onto the driveshaft housing. Tighten the mounting screws to the specified torque.
7. Guide the FSM wire harness through the cradle mount hole.
8. Push the FSM wire harness grommet into the cradle mount hole.



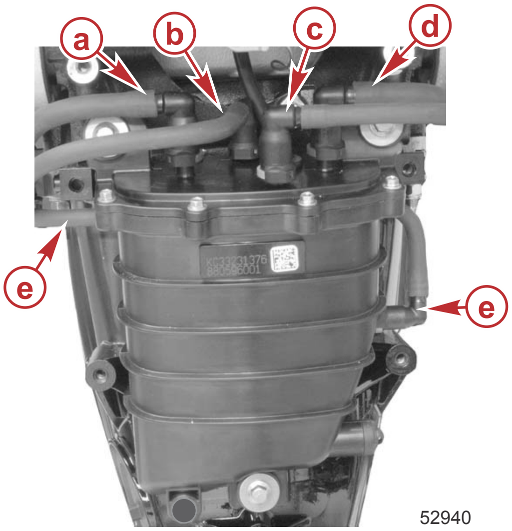


a - FSM mounting screws
b - FSM wire harness grommet
c - Fuel supply module
d - Bushing (3)
e - Grommet (3)
f - Washer (3)
g - Mounting screw (M8 x 35) (3)

Description	Nm	lb-in.	lb-ft
FSM mounting screws (M8 x 35)	24	–	17.7

9. Connect the fuel outlet line, manifold reference line, input fuel line, vent canister line, and the fuel cooler line.

NOTE: The fuel lines at the FSM are preformed and only fit onto the correct FSM port.

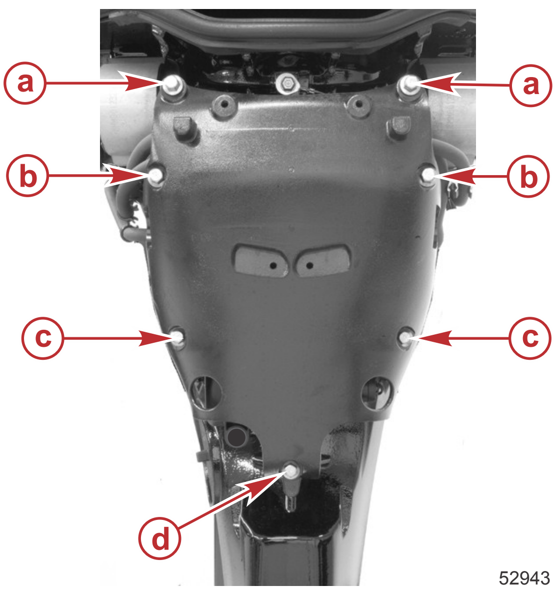


- a - High-pressure fuel outlet line (10 mm red tab)
- b - Manifold reference line (8 mm white tab)
- c - Vent canister line (0.375 in. blue tab)
- d - Input fuel line (10 mm red tab)
- e - Fuel cooler line (8 mm blue tab)

10. Apply Loctite 242 Threadlocker to the seven FSM shroud mounting screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	FSM shroud mounting screw threads	92-809821

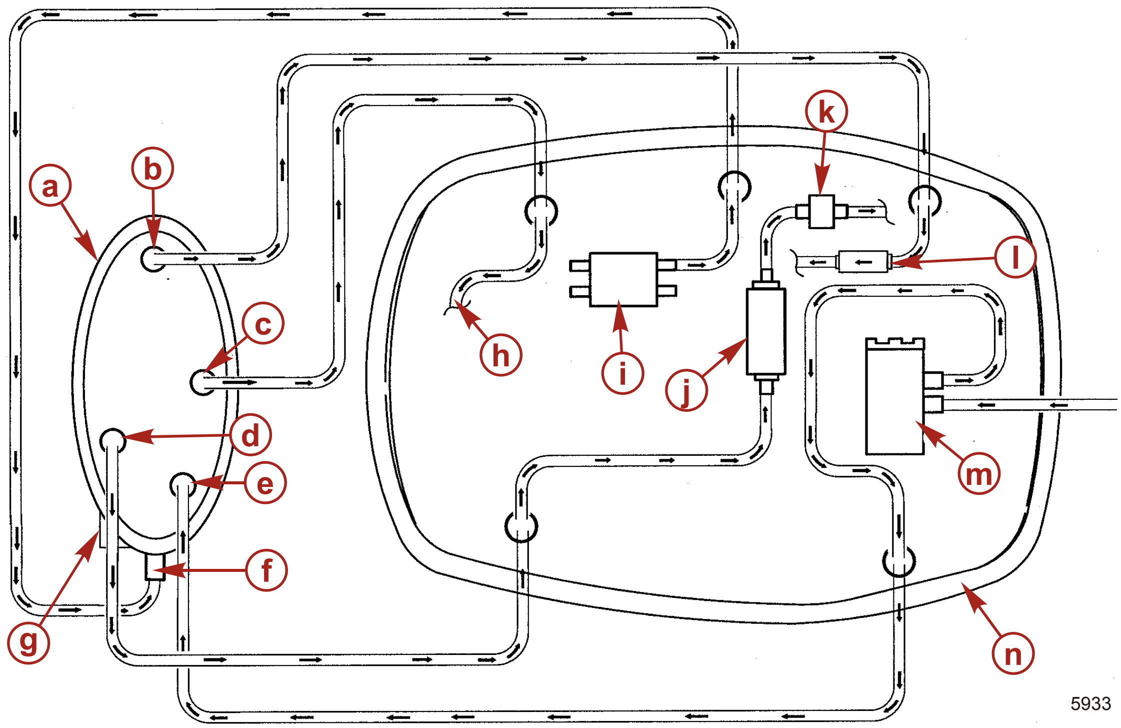
11. Install the FSM shroud. Tighten the FSM shroud mounting screws to the specified torque.



- a - Screw (M8 x 75) (2)
- b - Screw (M8 x 120) (2)
- c - Screw (M8 x 50) (2)
- d - Screw (M8 x 40) (1)

Description	Nm	lb-in.	lb-ft
FSM shroud mounting screws (M8 x 40, M8 x 50, M8 x 75, M8 x 120)	24	–	17.7

Fuel Supply Module (FSM) Hose Routing Diagram



- **a -** Fuel supply module (FSM)
- **b -** Fuel out
- **c -** Manifold reference
- **d -** To vent canister switch/vent canister purge valve
- **e -** Fuel in
- **f -** Water in
- **g -** Water out
- **h -** Manifold reference-to-intake manifold
- **i -** Water manifold
- **j -** Vent canister switch
- **k -** Vent canister purge valve
- **l -** 20-micron fuel filter
- **m -** 2-micron fuel filter/water separator
- **n -** Adapter plate

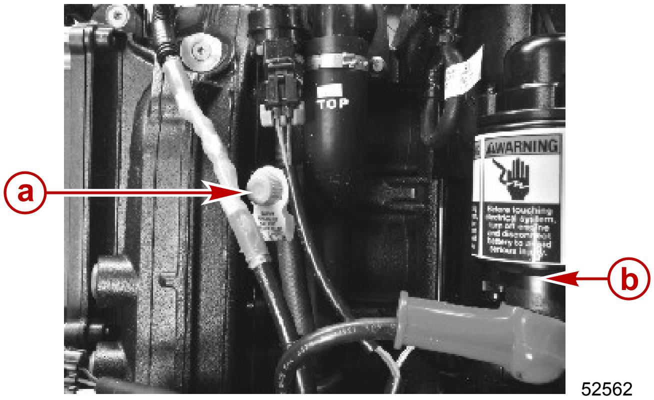
Charge Air Cooler (CAC) - Intake Manifold Removal/Installation

Charge Air Cooler (CAC) Removal

⚠ CAUTION
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

1. Starting with the negative (–) lead, disconnect the battery cables from their terminals.

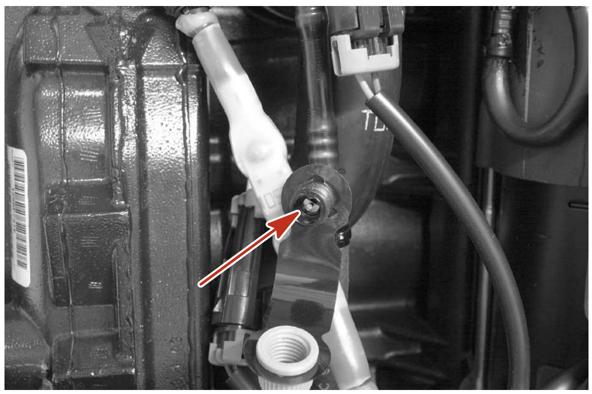
2. Remove the cap to access the FSM pressure relief valve for the fuel supply module (FSM).



52562

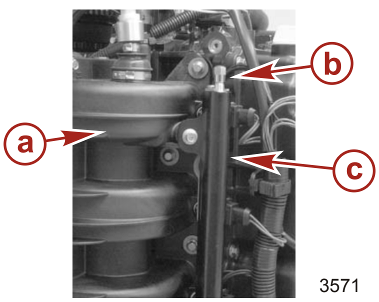
a - FSM pressure relief valve
b - Starter solenoid

3. Place a rag over the valve, then press on the center of the valve to relieve any pressure inside the FSM.



3472

4. Connect a fuel pressure gauge to the fuel pressure relief valve on the fuel rail. Relieve the fuel pressure into an appropriate container and dispose of the fuel in an appropriate manner.



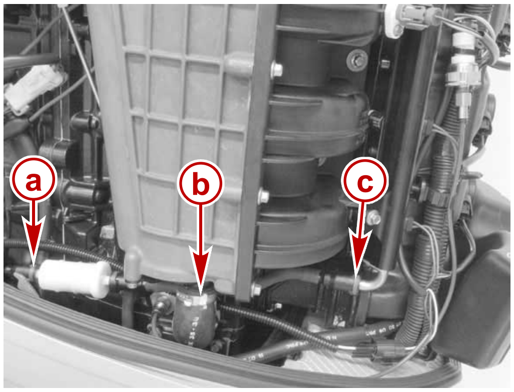
3571

a - Intake manifold
b - Fuel pressure valve
c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

5. Push in on the fuel line retaining clips and remove both of the fuel lines at the fuel filter. Drain the lines into an appropriate container and dispose of the fuel in an appropriate manner.
6. Disconnect the fuel line at the fuel rail inlet.
7. Remove the fuel filter and fuel line.

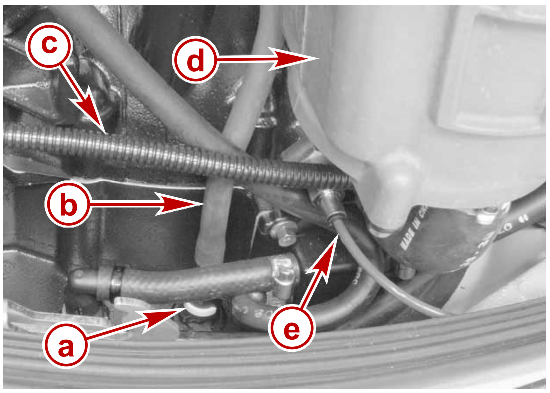
8. Remove the hose clamp at the bottom of the charge air cooler (CAC).



4225

- a - Fuel inlet at the fuel filter
- b - Hose clamp
- c - Fuel line at the fuel rail inlet

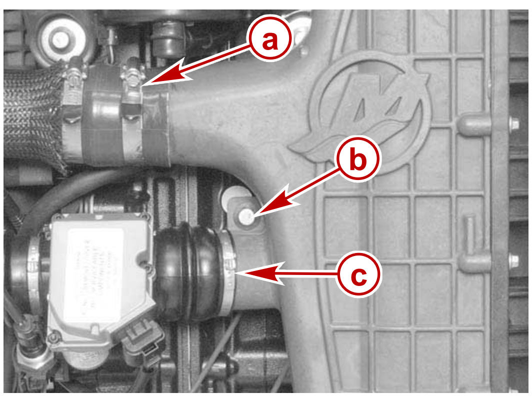
9. Disconnect the manifold absolute pressure (MAP) sensor reference hose from the adapter plate.



3614

- a - MAP sensor reference hose clip
- b - MAP sensor reference hose
- c - Trim position sensor wire harness
- d - Charge air cooler
- e - Water pressure line

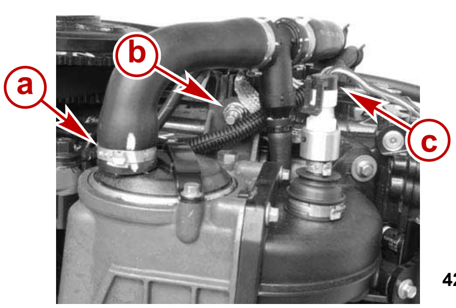
10. Loosen the hose clamp at the CAC intake port.
11. Remove the front manifold screw.
12. Remove the hose clamp at the manifold port for the electronic boost control (EBC).



4226

- a - Hose clamp at the CAC intake
- b - Front manifold screw
- c - Hose clamp at the manifold port for the EBC

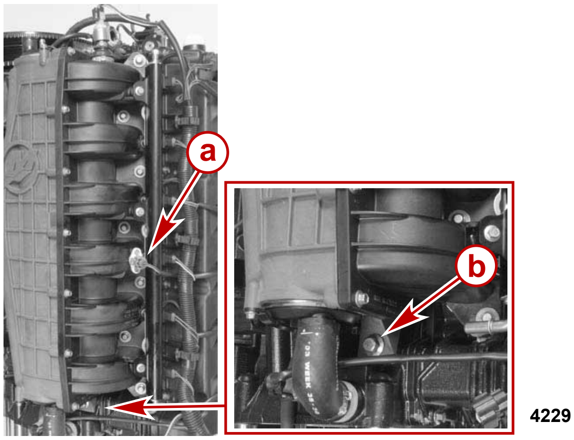
13. Remove the hose clamp on the upper CAC hose.
14. Remove the hose from the CAC.
15. Remove the nut securing the CAC/intake manifold assembly to the cylinder head.
16. Disconnect the MAP sensor harness.



4228

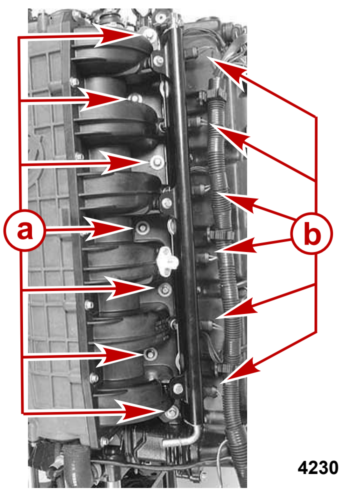
- a - Hose clamp
- b - Nut
- c - MAP sensor harness

17. Disconnect the manifold air temperature (MAT) sensor harness connector.
18. Remove the lower screw securing the charge air cooler/intake manifold to the cylinder block.



a - MAT sensor harness
b - Lower screw

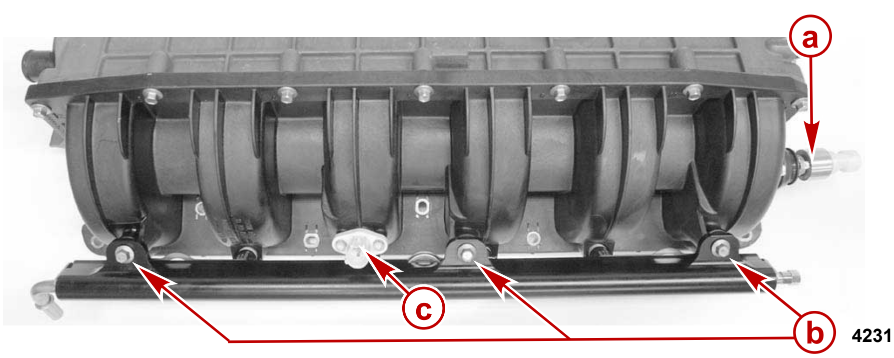
19. Disconnect the fuel injector harness connectors from the fuel injectors.
20. Remove the seven screws securing the CAC/intake manifold to the cylinder head.
21. Remove the CAC/intake manifold.



a - Screws (7)
b - Fuel injector harness connectors

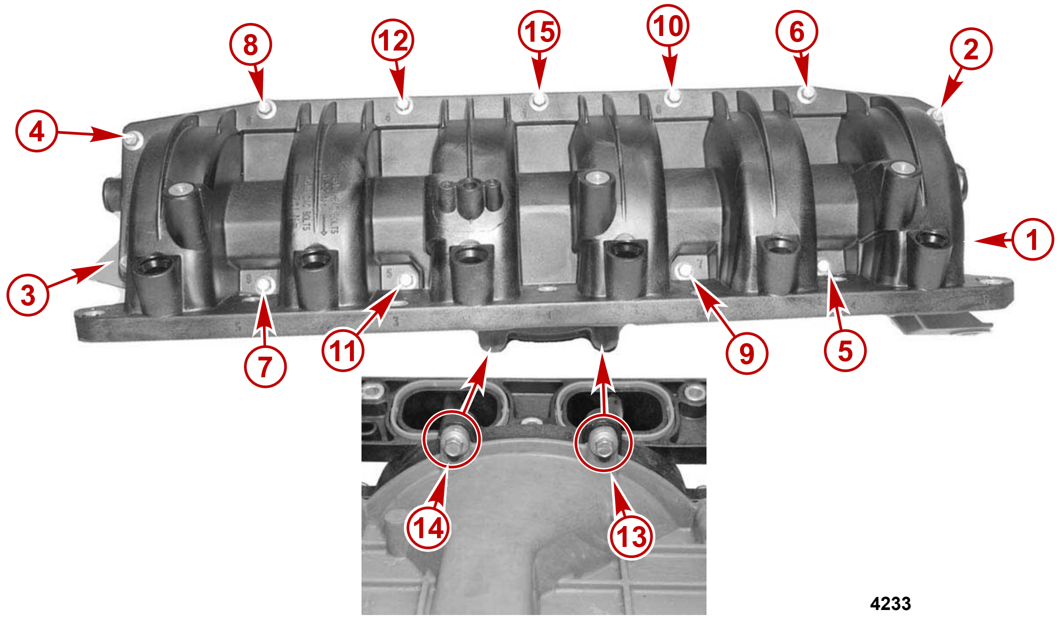
Charge Air Cooler (CAC)—Intake Manifold Disassembly

1. Remove the fuel rail screws. Remove the fuel rail.
2. Remove the MAT sensor screws. Remove the MAT sensor.
3. Remove the MAP sensor.



a - MAP sensor
b - Fuel rail screws
c - MAT sensor

4. Remove the screws securing the intake manifold to the CAC in the sequence shown.



4233

5. Separate the CAC from the intake manifold.

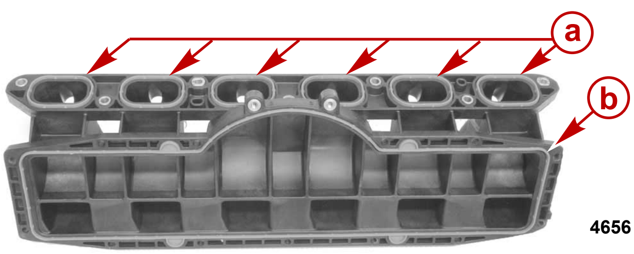
Cleaning/Inspection

NOTE: The charge air cooler is a nonserviceable component and must be replaced as an assembly if suspected of leaking or is severely fouled.

4251

Charge Air Cooler (CAC)—Intake Manifold Assembly

1. Install new seals onto the intake manifold.

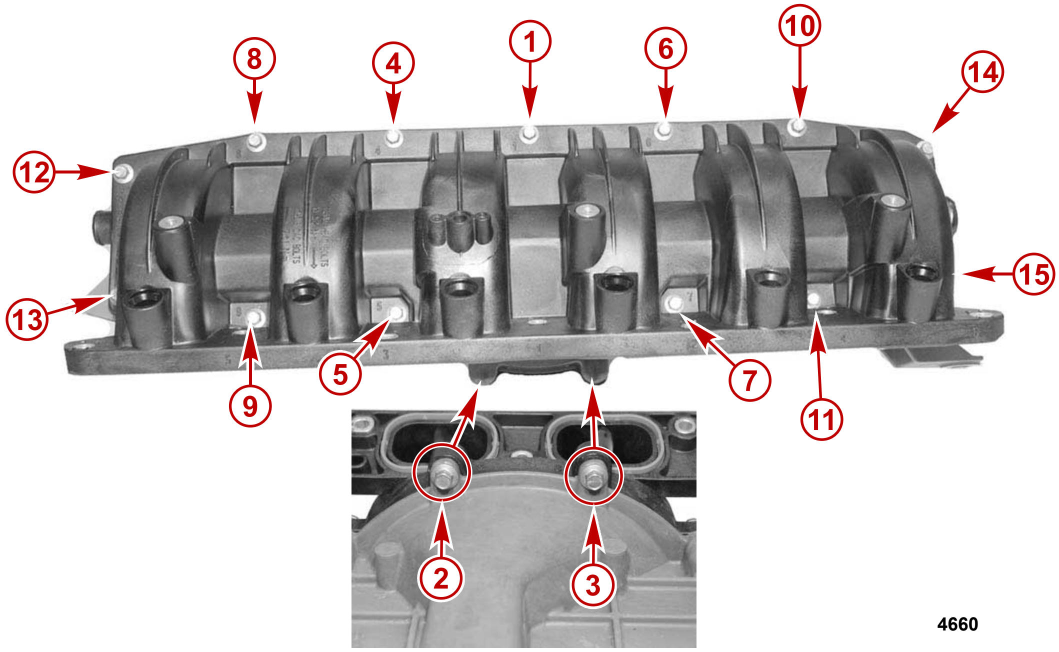


4656

a - Manifold port seals
b - Manifold seal

2. Place the intake manifold onto the CAC.
3. Install all intake manifold screws.

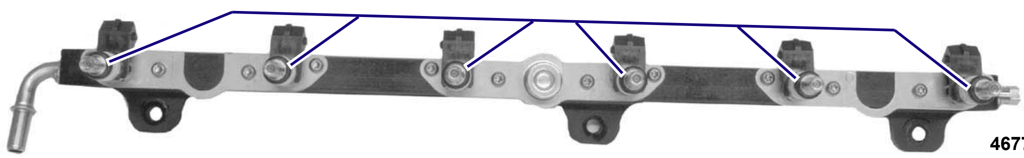
4. Tighten the intake manifold screws in the sequence shown to the specified torque.



4660

Description	Nm	lb-in.	lb-ft
Intake manifold screws (M6 x 15, M6 x 25)	7	62	–

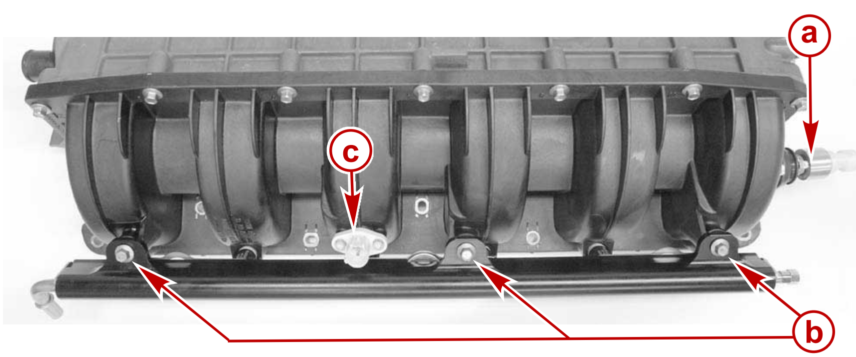
5. Apply Lubriplate SPO 255 to the O-ring on each fuel injector.



4677

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Fuel injector O-rings	Obtain Locally

6. Install the fuel rail assembly. Tighten the fuel rail screws to the specified torque.
7. Install the manifold air temperature (MAT) sensor. Tighten the MAT sensor screws to the specified torque.
8. Install the manifold absolute pressure (MAP) sensor. Secure the sensor with a hose clamp.
9. Crimp the hose clamp with a hose clamp tool.



4668

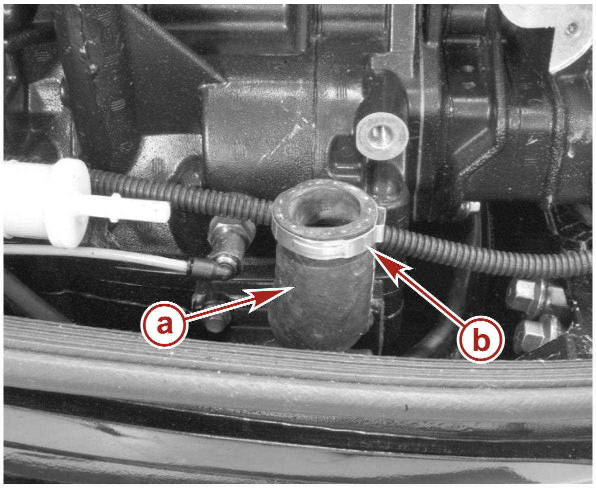
a - MAP sensor
b - Fuel rail screws (M6 x 15)
c - MAT sensor

Description	Nm	lb-in.	lb-ft
Fuel rail screws (M6 x 15)	6	53	–
MAT sensor screws (M4 x 6)	2	18	–

Hose Clamp Tool Kit	91-803146A04

Charge Air Cooler (CAC) Installation

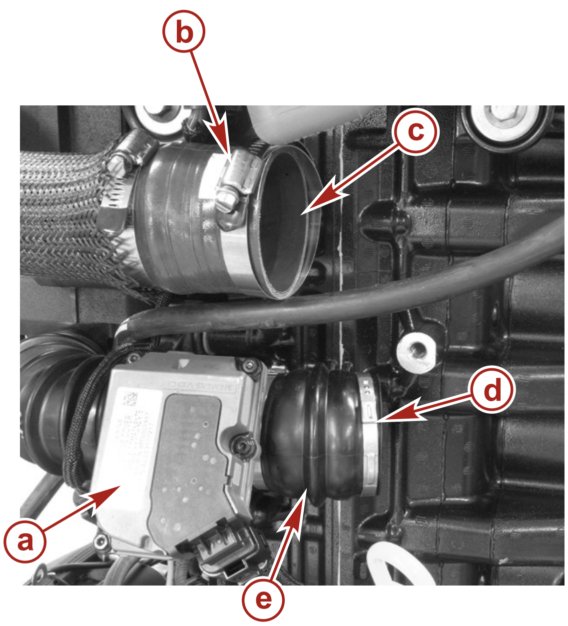
1. Install a 34.6 mm diameter hose clamp loosely onto the lower CAC water hose.



41915

a - Lower CAC water hose
b - Hose clamp (34.6 mm)

2. Install a 62.0 mm diameter hose clamp loosely onto the rear electronic boost control (EBC) hose.
3. Install a screw-type hose clamp loosely onto the CAC inlet tube hose.

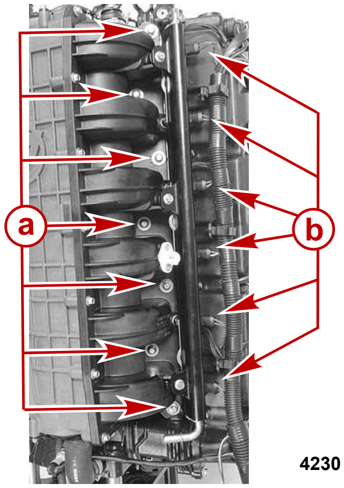


41920

a - EBC
b - Screw-type hose clamp
c - CAC inlet tube hose
d - 62.0 mm hose clamp
e - Rear EBC hose

4. Insert the CAC lower water inlet into the lower CAC hose.
5. Carefully align the CAC inlet tube hose and EBC rear tube with the CAC.
6. Push the CAC onto the CAC inlet tube hose and the rear EBC hose. The CAC should align with the upper CAC mounting stud.
7. Install all the CAC mounting screws and nut.
8. Connect the fuel injector harness connectors to the fuel injectors.

9. Tighten the CAC manifold screws to the specified torque.

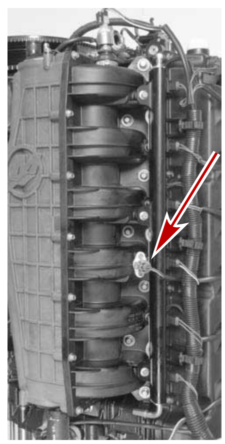


4230

a - Charge air cooler manifold screws
b - Fuel injector harness connectors

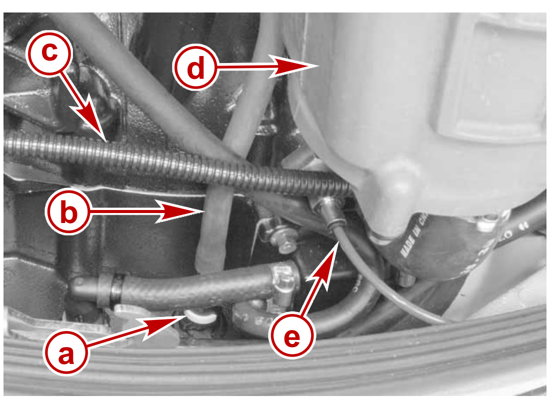
Description	Nm	lb-in.	lb-ft
Charge air cooler manifold screw	10	89	–

10. Connect the MAT sensor harness connector to the MAT sensor.



4687

11. Install the MAP sensor reference hose.

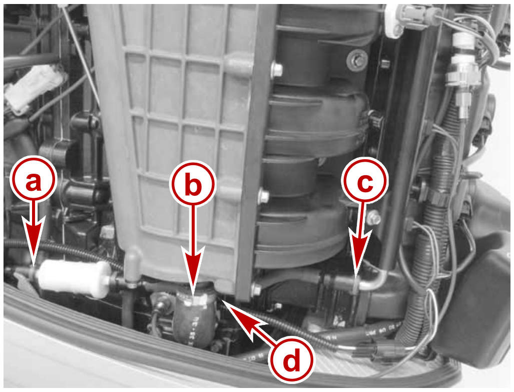


3614

a - MAP sensor reference hose clip
b - MAP sensor reference hose
c - Trim position sensor wire harness
d - Charge air cooler
e - Water pressure line

12. Tighten the lower manifold screw to the specified torque.
13. Install the fuel line and fuel filter.

14. Crimp the lower hose clamp with a hose clamp tool.



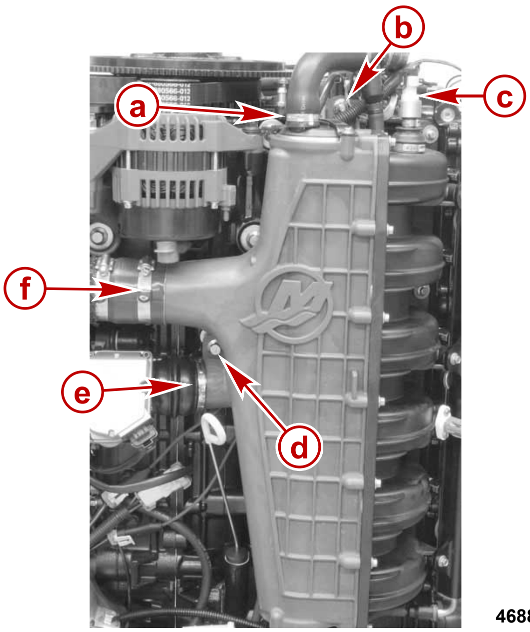
4686

a - Fuel inlet at fuel filter
b - 34.6 mm diameter lower charge air cooler water hose clamp
c - Fuel line at the fuel rail inlet
d - Lower manifold screw (hidden) (M10 x 30)

Description	Nm	lb-in.	lb-ft
Screw (M10 x 30)	32.5	–	24

Hose Clamp Tool Kit	91-803146A04

15. Install a 34.6 mm diameter hose clamp on the upper CAC hose. Install the hose onto the upper CAC outlet. Crimp the hose to the CAC with a hose clamp tool.
16. Tighten the upper mounting nut to the specified torque.
17. Connect the MAP sensor harness connector to the MAP sensor.
18. Tighten the front charge air cooler screw to the specified torque.
19. Crimp the 62.0 mm hose clamp on the rear EBC tube with a hose clamp tool.
20. Tighten the hose clamp on the CAC inlet to the specified torque.



4688

a - 34.6 mm diameter hose clamp
b - Upper mounting nut
c - MAP sensor harness
d - Front charge air cooler screw (M10 x 30)
e - 62.0 mm diameter hose clamp
f - Hose clamp on CAC inlet

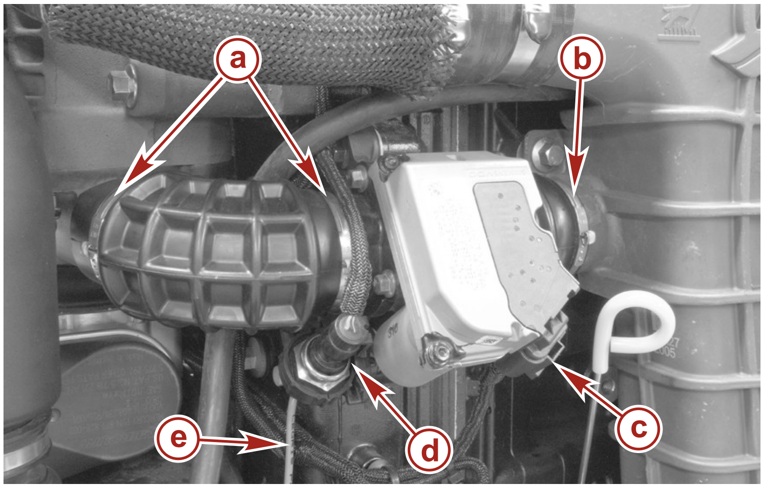
Description	Nm	lb-in.	lb-ft
Upper mounting nut	32.5	–	24
Screw (M10 x 30)	32.5	–	24
Hose clamp on charge air cooler inlet	6	53	–

Hose Clamp Tool Kit	91-803146A04

Electronic Boost Control (EBC) Removal/Installation

Electronic Boost Control (EBC) Removal and Disassembly

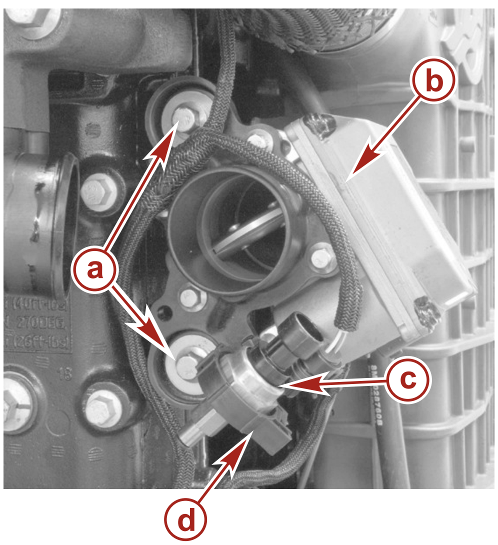
1. Remove the two hose clamps securing the front tube.
2. Remove the hose clamp securing the rear tube to the charge air cooler.
3. Disconnect the EBC engine harness connector.
4. Disconnect the pitot sensor harness connector.
5. Disconnect the pitot sensor hose.
6. Remove the front tube.



41941

a - Hose clamps securing the front tube
b - Hose clamp securing the rear tube
c - EBC engine harness connector
d - Pitot sensor harness connector
e - Pitot sensor hose

7. Remove the two screws securing the EBC mounting bracket to the cylinder block.

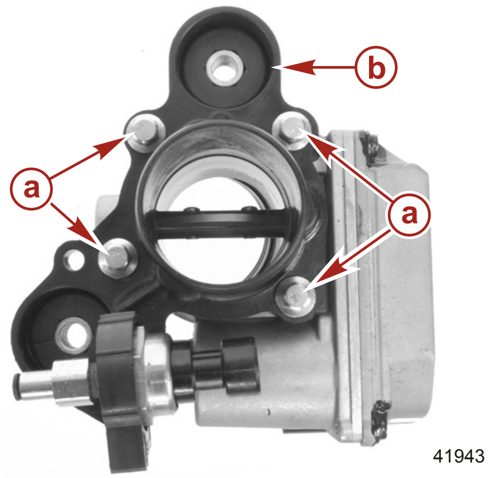


41942

a - Screws (2)
b - EBC assembly
c - Pitot sensor
d - Sensor retaining clip

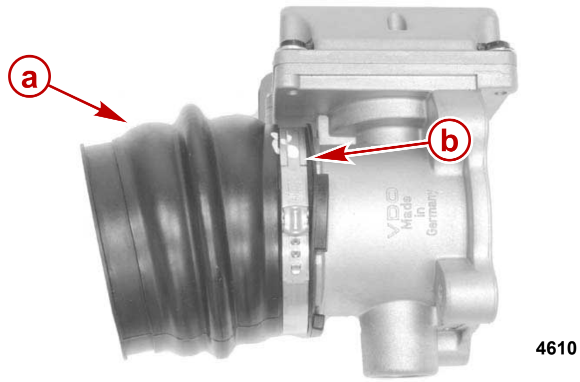
8. Pull the EBC assembly off the charge air cooler.

9. Remove the four screws securing the EBC mounting bracket to the EBC.



a - Screws (4)
b - EBC mounting bracket

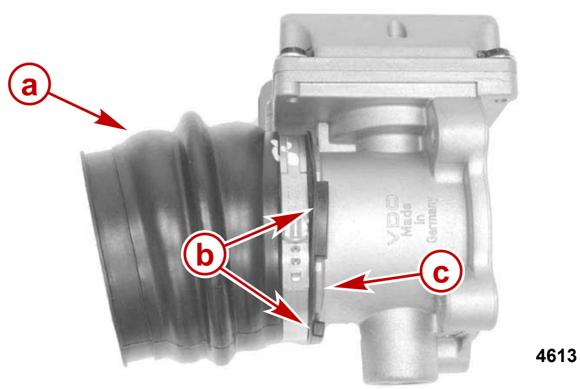
10. Remove the hose clamp securing the rear hose to the EBC.



a - Rear hose
b - Hose clamp

Electronic Boost Control (EBC) Assembly

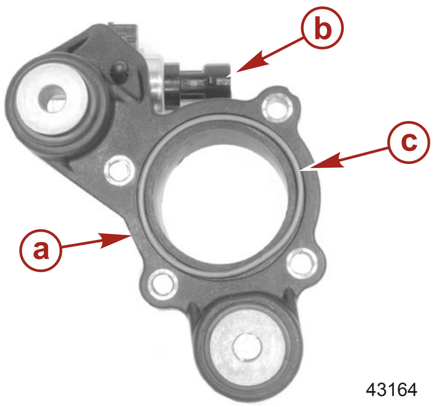
1. Place a 62.0 mm diameter hose clamp onto the end of the rear hose that has a molded alignment key.
2. Install the rear tube onto the EBC. Ensure that the tube molded key is in proper alignment with the cast key on the EBC.
3. Crimp the hose clamp with a hose clamp tool.



a - Rear hose
b - Tube molded key
c - Cast key on EBC

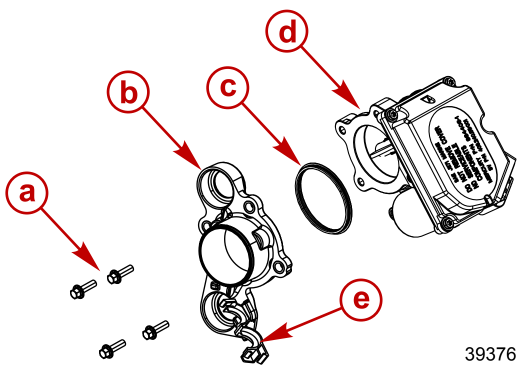
Hose Clamp Tool Kit	91-803146A04

4. Install a new O-ring onto the EBC mounting bracket.



- a - EBC mounting bracket
- b - Pitot sensor
- c - O-ring

5. Install the EBC mounting bracket onto the EBC.
6. Secure the EBC mounting bracket to the EBC. Ensure that the pitot sensor retaining clip is mounted in the correct location. Tighten the EBC mounting bracket screws to the specified torque.

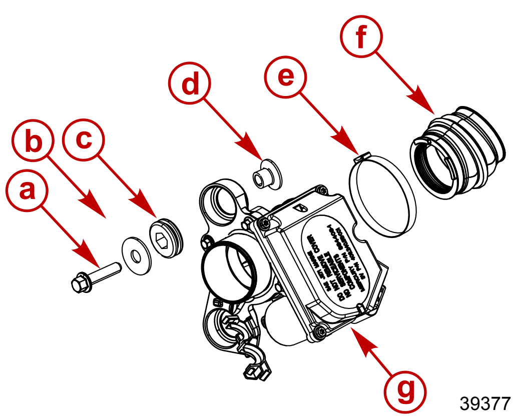


- a - Mounting bracket screws (4)
- b - EBC mounting bracked
- c - O-ring
- d - EBC
- e - Pitot sensor retaining clip

Description	Nm	lb-in.	lb-ft
Mounting bracket screws (4) (M6 x 20)	10	89	–

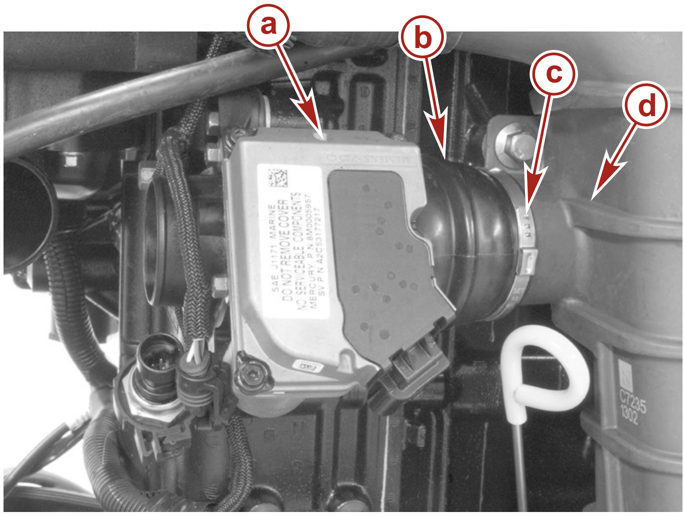
Electronic Boost Control (EBC) Installation

1. Install two grommets and bushings onto the EBC mounting bracket.
2. Install a 62.0 mm diameter hose clamp on the rear tube.



- a - Mounting screw
- b - Washer
- c - Grommet
- d - Bushing
- e - Hose clamp (62.0 mm)
- f - Rear tube
- g - EBC

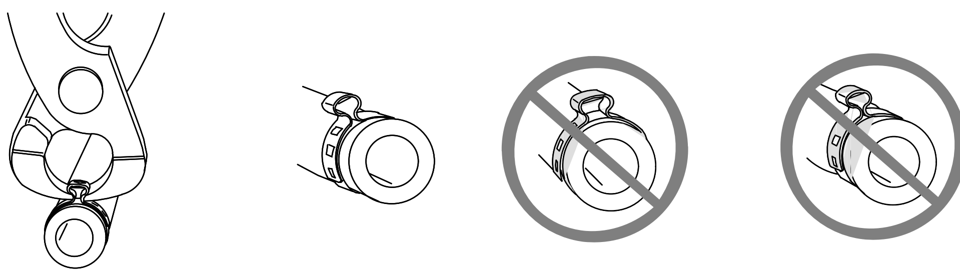
3. Install the EBC assembly onto the charge air cooler. Do not crimp the rear tube hose clamp.



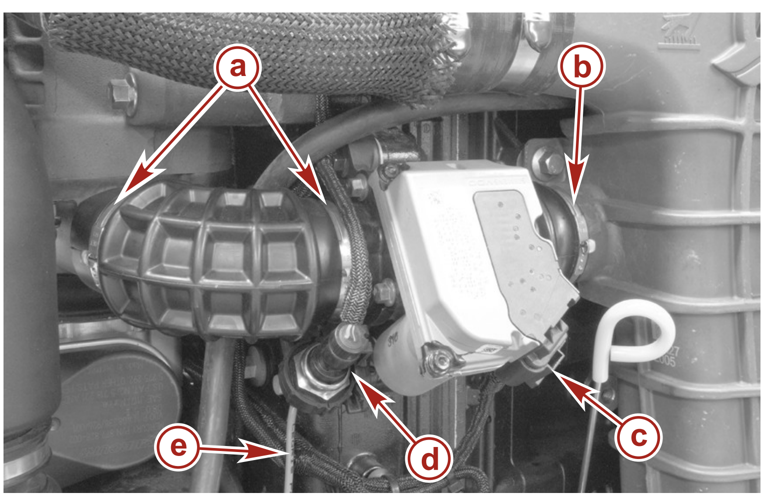
41947

- a - EBC
- b - Rear tube
- c - Hose clamp (62.0 mm)
- d - Charge air cooler

4. Install two 57.5 mm diameter hose clamps onto the front tube, one at each end.
5. Install the front tube onto the supercharger and the EBC mounting bracket at the same time. Ensure that the tube does not fold over when installing the front tube.
6. Align the EBC mounting bracket screw holes with the cylinder block. Install the EBC mounting bracket screws with washers. Tighten the screws to the specified torque.
7. Install the pitot sensor hose into the pitot sensor.
8. Connect the pitot sensor harness connector to the pitot sensor.
9. Connect the EBC harness connector to the EBC.
10. Crimp the front and rear tube hose clamps with a hose clamp tool.
    IMPORTANT: Use tool 91-803146T or Snap-On equivalent YA3080 to crimp the full circle hose clamp. Using a different tool could result in a crimp that is too loose or too tight. Do not use a screw-type hose clamp as it may damage the hose.



3924



41941

- a - Hose clamps securing the front tube
- b - Hose clamp securing the rear tube
- c - EBC engine harness connector
- d - Pitot sensor harness connector
- e - Pitot sensor hose

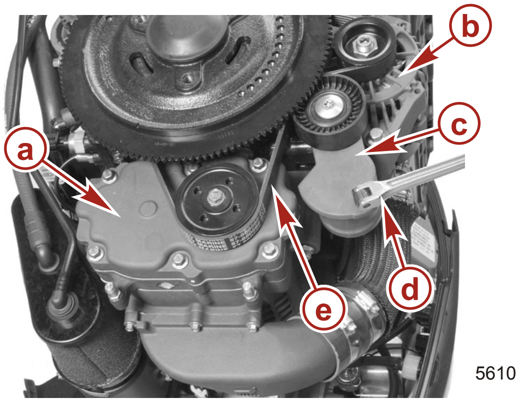
Description	Nm	lb-in.	lb-ft
EBC mounting bracket screw (M8 x 35)	24	–	17.7

Hose Clamp Tool Kit	91-803146A04

Supercharger Removal/Installation

Supercharger Removal

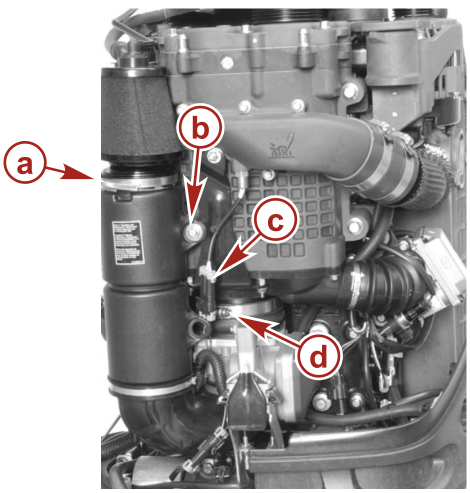
1. Remove the top cowl and flywheel cover.
2. Install a 3/8 in. drive breaker bar into the supercharger/alternator belt tensioner.
3. Release the belt tension and remove the belt from the alternator and supercharger.



5610

a - Supercharger
b - Alternator
c - Tensioner
d - Breaker bar
e - Belt

4. Disconnect the supercharger air temperature sensor harness connector.
5. Loosen the air cleaner hose clamp.
6. Remove the resonator support screw.
7. Loosen the hose clamp securing the electronic throttle control (ETC) to the supercharger.
8. Push the ETC/resonator assembly down and off the supercharger inlet.



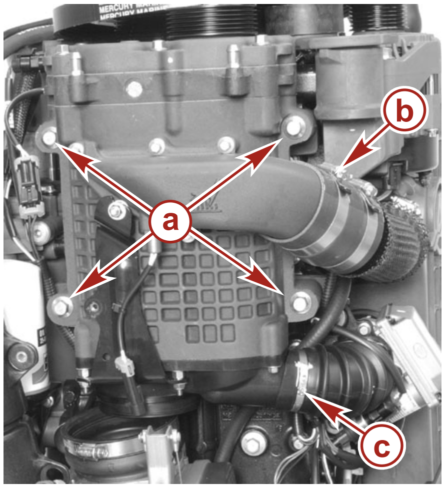
5612

a - Air cleaner hose clamp
b - Resonator support screw
c - Sensor harness
d - Hose clamp securing the ETC isolator to the supercharger

9. Loosen the hose clamp securing the supercharger outlet to the charge air cooler (CAC).
10. Remove the hose clamp securing the bypass boot to the supercharger.
11. Cut the cable tie and remove the vent hose from the top of the supercharger.

    NOTE: *Engines with S/N 1B226999 and below are not equipped with a supercharger vent hose.*
12. Remove the four screws securing the supercharger to the cylinder block.
    IMPORTANT: Use care when removing the supercharger. Once the screws are removed, the supercharger can fall off of the oil supply dowels.
13. Remove the supercharger from the cylinder block and hoses.

NOTE: Engines with S/N 1B227000 and above are not equipped with a resonator support bracket.



a - Screws (4)
b - Hose clamp securing supercharger outlet to CAC
c - Hose clamp securing bypass boot to supercharger

Supercharger Disassembly/Assembly

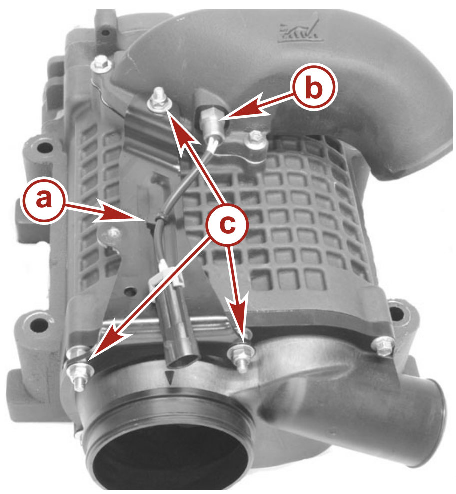
Disassembly

NOTE: The supercharger is a nonserviceable component and must be replaced as an assembly if it is damaged.

1. Cut the cable tie securing the supercharger air temperature sensor to the resonator support bracket.

   NOTE: Engines with S/N 1B227000 and above are not equipped with a resonator support bracket.

2. Remove the supercharger air temperature sensor.
3. Remove the three nuts and washers securing the resonator support bracket to the supercharger.



a - Cable tie
b - Supercharger air temperature sensor
c - Three nuts securing resonator support bracket to supercharger (S/N 1B226999 and below)

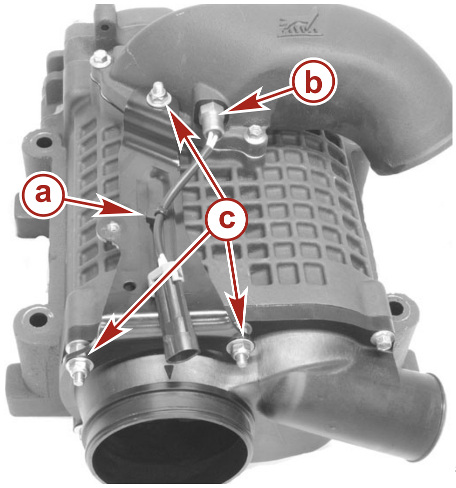
Assembly

1. Install a new O-ring onto the supercharger air temperature sensor.
2. Install the supercharger air temperature sensor onto the supercharger and tighten it to the specified torque.
3. Install the resonator support bracket to the supercharger with three nuts and washers. Tighten the three nuts to the specified torque.

   NOTE: Engines with S/N 1B227000 and above are not equipped with a resonator support bracket.

4. Secure the supercharger air temperature sensor harness to the supercharger with a cable tie.

NOTE: *For engines with S/N 1B227000 and above, secure the supercharger air temperature sensor harness to the air intake resonator with a cable tie.*



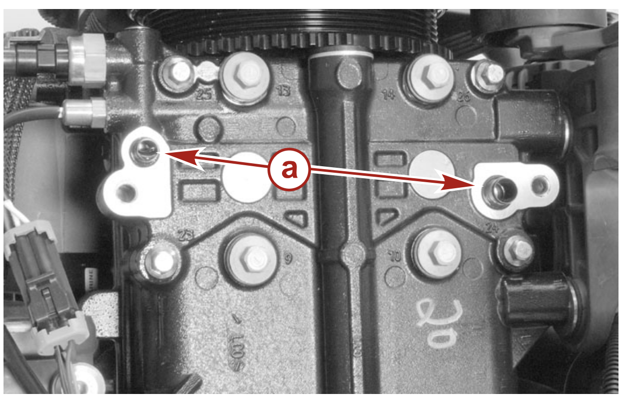
5615

- a - Cable tie
- b - Supercharger air temperature sensor
- c - Three nuts securing resonator support bracket to supercharger (S/N 1B226999 and below)

Description	Nm	lb-in.	lb-ft
Supercharger air temperature sensor	15	133	–
Resonator support bracket nuts (S/N 1B226999 and below)	8	71	–

Supercharger Installation

1. Install new O-rings onto the supercharger dowels.

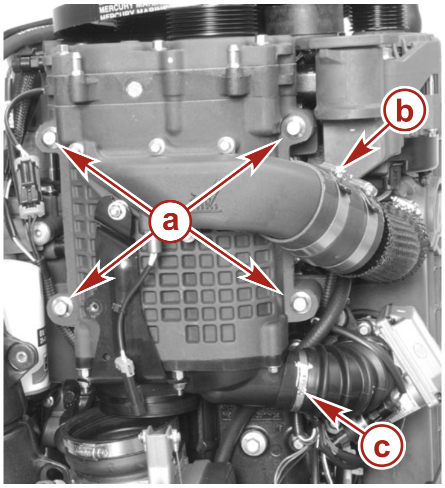


5617

- a - Supercharger dowel O-ring

2. Install a 57.5 mm diameter hose clamp onto the rear electronic boost control (EBC) tube.
3. Ensure that a hose clamp is installed on the supercharger outlet tube.
4. Install the supercharger onto the rear EBC tube and supercharger outlet tube.
5. Place the supercharger onto the supercharger dowels.
6. Secure the supercharger to the cylinder block with four screws.
7. Tighten the four screws in two steps.
8. Secure the 57.5 mm rear EBC hose clamp with a hose clamp tool.

9. Tighten the supercharger outlet tube hose clamp to the specific torque.



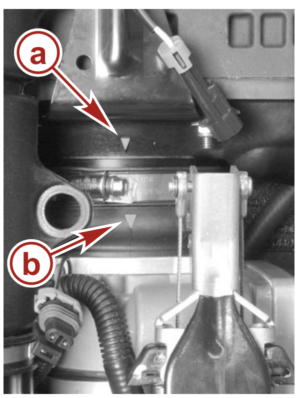
5614

a - Screws (M10 x 105) (4)
b - Supercharger outlet tube hose clamp
c - Hose clamp securing bypass boot to the supercharger

Description		Nm	lb-in.	lb-ft
Screws (M10 x 105)	**First**	15	133	–
	Final	43	–	32
Supercharger outlet tube hose clamp		6	53	–

Hose Clamp Tool Kit	91-803146A04

10. Ensure that a hose clamp is installed on the ETC isolator.
11. Install the electronic throttle control (ETC) assembly onto the supercharger.
12. Align the arrows on the supercharger and the ETC boot.



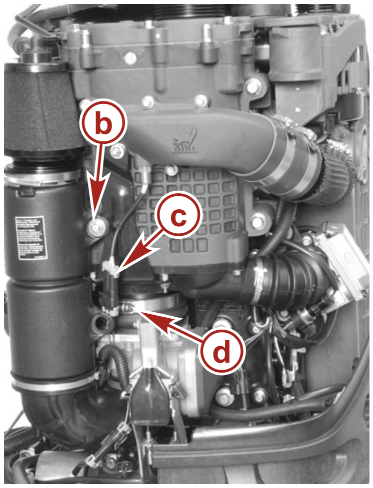
5584

a - Arrow on supercharger
b - Arrow on ETC boot

13. Tighten the ETC isolator hose clamp to the specified torque.
14. Connect the supercharger air temperature sensor harness.
15. Secure the resonator to the resonator support bracket. Tighten the screw to the specified torque.

NOTE: Engines with S/N 1B227000 and above are not equipped with a resonator support bracket.

16. Secure the air filter to the resonator.



5612

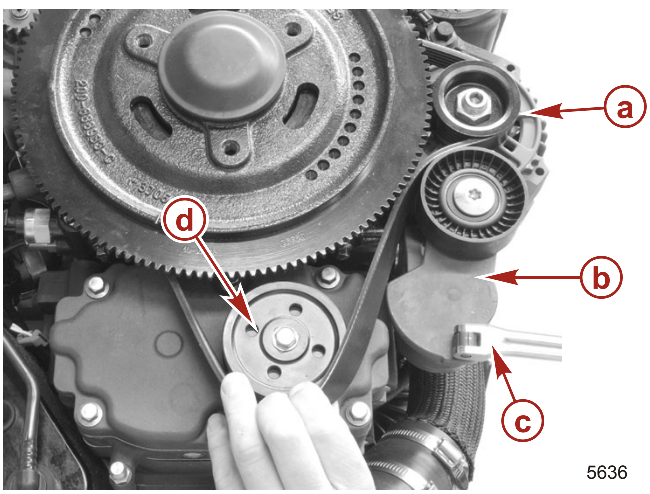
- a - Air cleaner hose clamp
- b - Resonator support screw (M6 x 25)
- c - Sensor harness
- d - Hose clamp securing the ETC isolator to the supercharger

Description	Nm	lb-in.	lb-ft
Resonator support screw (M6 x 25)	7.4	65.5	–
Hose clamp securing ETC isolator to supercharger	6.2	55	–

17. Connect the vent hose to the supercharger vent fitting on top of the supercharger. Secure the hose with a cable tie.

    NOTE: *Engines with S/N 1B226999 and below are not equipped with a supercharger vent hose.*

18. Insert a 3/8" in. breaker bar into the tensioner and compress the tensioner spring.
19. Guide the belt onto the alternator pulley. Ensure that the belt is centered on the alternator pulley.
20. Guide the belt onto the supercharger pulley. Ensure that the belt is centered on the supercharger pulley.



5636

- a - Alternator pulley
- b - Tensioner
- c - 3/8" in. breaker bar
- d - Supercharger pulley

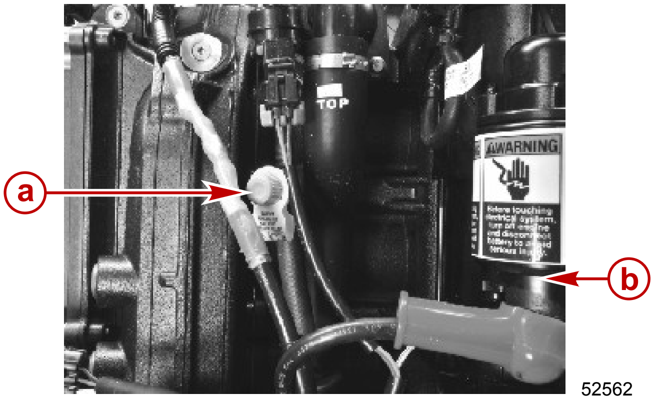
21. Slowly release the tensioner to apply tension to the belt.
22. Check the belt for proper belt alignment on the flywheel, alternator, and supercharger.

Fuel Rail Removal/Installation

Fuel Rail Removal

⚠ CAUTION
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

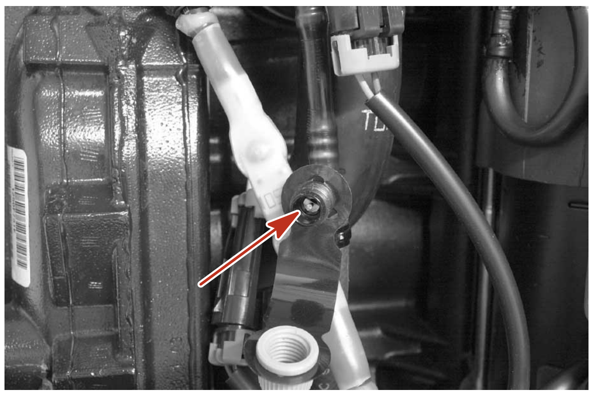
1. Remove the cap to access the pressure relief valve for the FSM.



52562

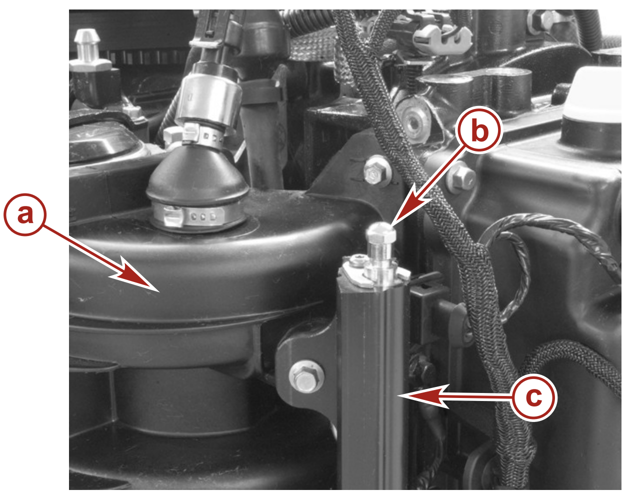
a - FSM pressure relief valve
b - Starter solenoid

2. Place a rag over the valve, then press in on the center of the valve to relieve any pressure inside the FSM.



3472

3. Attach a fuel pressure gauge to the fuel pressure relief valve on the fuel rail. Relieve the pressurized fuel into an appropriate container and dispose of the fuel in an appropriate manner.



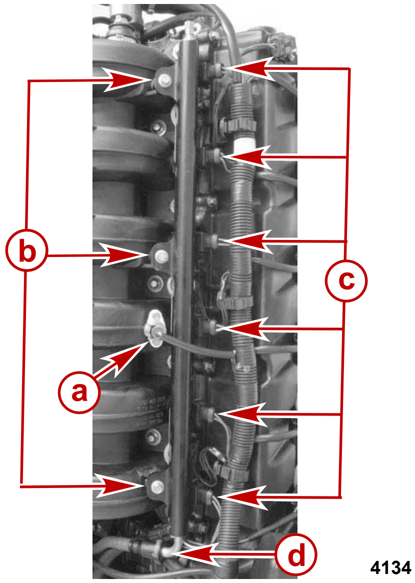
41765

a - Intake manifold
b - Fuel pressure relief valve
c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

4. Disconnect the fuel injector harness connector at each fuel injector.
5. Disconnect the manifold air temperature (MAT) sensor harness.
6. Place a rag or shop towel under the fuel line. Remove the fuel line. Dispose of the fuel soaked rag/shop towel into an appropriate container.

7. Remove the screws securing the fuel rail to the intake manifold.

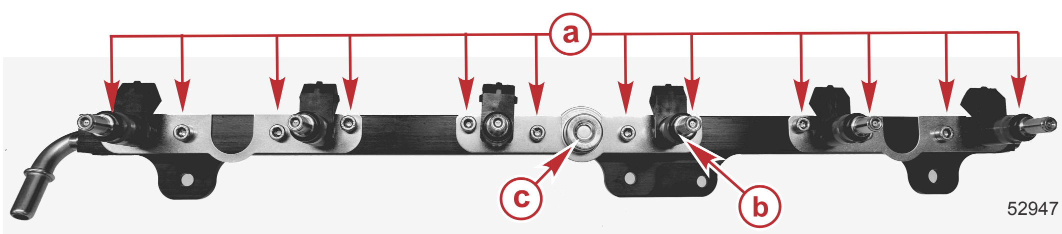


a - Manifold air temperature sensor
b - Screws (3)
c - Fuel injector harness connectors (6)
d - Fuel line

8. Pull the fuel rail off of the intake manifold.

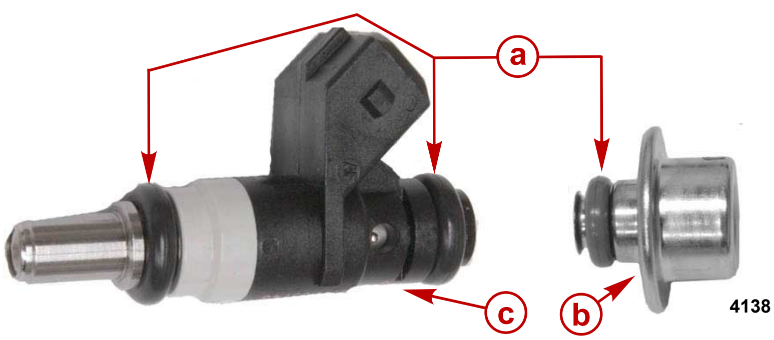
Fuel Rail Disassembly

1. Remove the 4 mm hex socket screws securing the fuel injector retainers to the fuel rail.



a - 4 mm hex socket screws (12)
b - Fuel injector
c - Damper

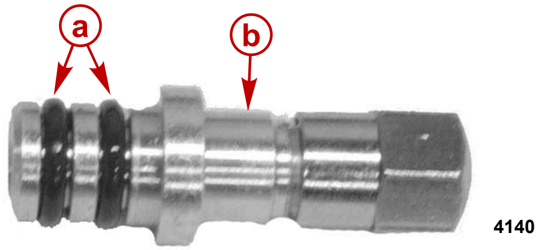
2. Remove the fuel injectors and damper.
3. Inspect the O-rings on the fuel injectors and damper. Replace the O-rings on the fuel injectors and the damper if they are damaged.



a - O-rings
b - Damper
c - Fuel injector

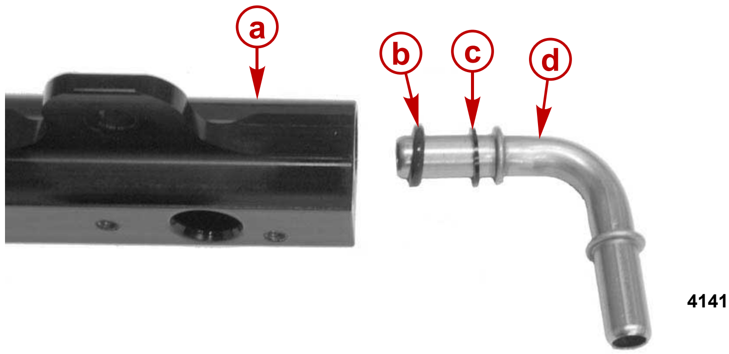
4. Remove the 4 mm screw securing the fuel pressure relief valve bracket to the fuel rail.
5. Remove the fuel pressure relief valve.

6. Inspect the O-rings on the fuel pressure relief valve. Replace the O-rings if they are damaged.



a - O-rings
b - Fuel pressure relief valve

7. Remove the 4 mm hex socket screw securing the fuel inlet bracket to the fuel rail.
8. Remove the fuel inlet tube.
9. Remove the O-ring and washer. Replace the O-ring if it is damaged.

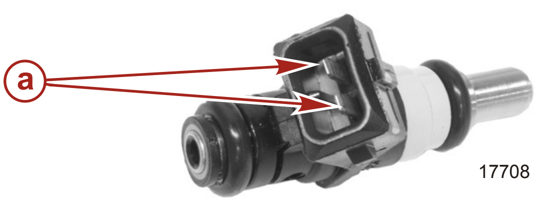


a - Fuel rail
b - O-ring
c - Washer
d - Fuel inlet tube

Fuel Injector Ohm Test

NOTE: A fuel injector test can be performed with the computer diagnostic system (CDS). The fuel injector is not polarity sensitive. An ohm test can be performed while the fuel injector is mounted to the fuel rail. It is not necessary to remove the fuel injector from the engine assembly when checking the resistance of the fuel injector.

Use a digital ohmmeter to test the resistance of the fuel injector.



a - Fuel injector pins

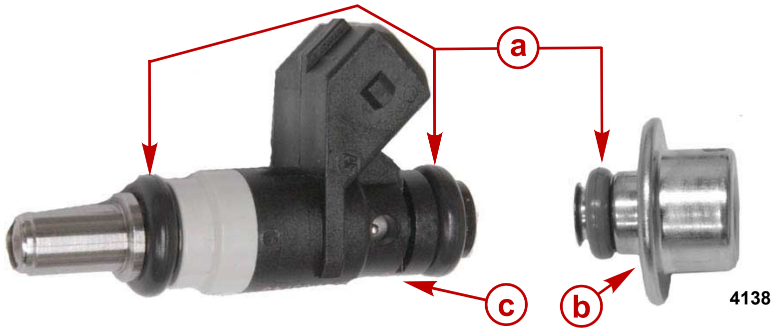
Computer Diagnostic System (CDS)	Purchase from SPX*

Fuel Injector	
Resistance at 21 °C (71 °F)	12 ± 0.5 ohms

Fuel Rail Assembly

1. Use a solvent and compressed air to remove any debris from the inside of the fuel rail.
2. Install new O-rings onto the fuel injectors and damper.

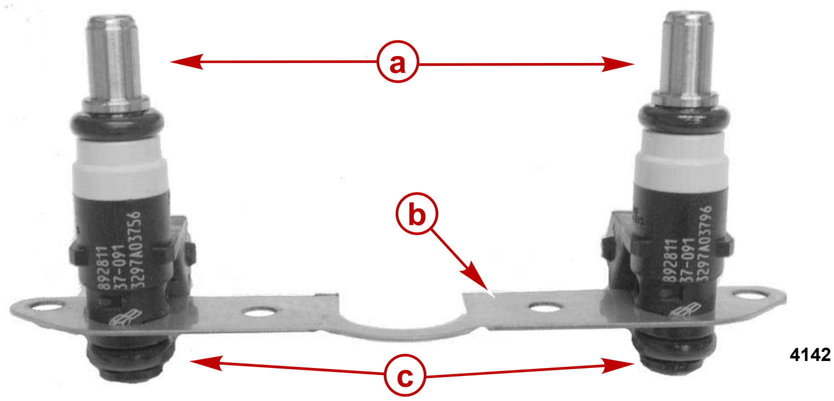
3. Lubricate the fuel injector and damper O-rings with Lubriplate SPO 255.



a - O-rings
b - Damper
c - Fuel injector

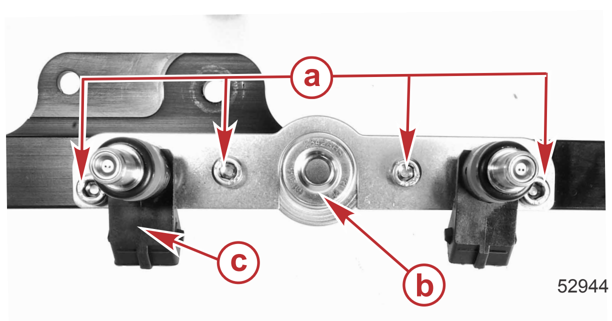
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Fuel injector O-ring, damper O-ring	Obtain Locally

4. Install the damper onto the fuel rail.
5. Slide the fuel injector onto the fuel injector retainer bracket.



a - Manifold side of fuel injector
b - Fuel injector retainer bracket
c - Fuel rail side of fuel injector

6. Install the fuel injectors onto the fuel rail.
7. Secure the fuel injector retainer bracket with 4 mm hex socket screws.

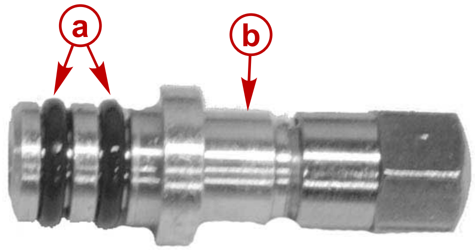


a - 4 mm hex socket screws
b - Damper
c - Fuel injector

8. Install the other fuel injectors onto the injector retainers and secure them to the fuel rail. Tighten the 4 mm hex socket screws to the specified torque.

Description	Nm	lb-in.	lb-ft
4 mm hex screw (M5 x 10)	6	53	–

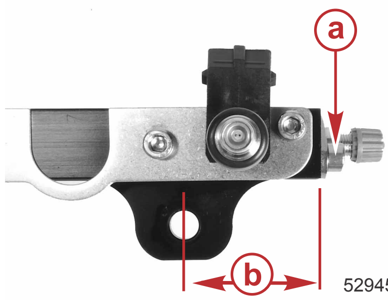
9. Install new O-rings onto the fuel pressure relief valve.



4140

a - O-rings
b - Fuel pressure relief valve

10. Measure from the edge of the fuel rail to the center of the mounting hole of the fuel rail.
11. Install the fuel pressure relief valve onto the fuel rail side that measures approximately 38 mm (1.5 in.).
12. Secure the Schrader valve to the fuel rail with a retaining bracket. Tighten the retaining bracket hex screw to the specified torque.



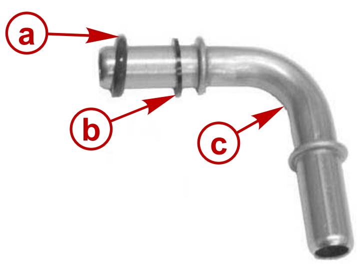
52945

a - Fuel pressure relief valve bracket hex socket screw
b - 38 mm (1.5 in.)

Description	Nm	lb-in.	lb-ft
T20 Torx screw (M5 x 10)	6	53	–

13. Install a washer onto the fuel inlet tube.
14. Install an O-ring onto the fuel inlet tube.

NOTE: The fuel inlet tube is the same on both ends.



4151

a - O-ring
b - Washer
c - Fuel inlet

15. Install the fuel inlet onto the fuel rail.
16. Secure the fuel inlet to the fuel rail with a retaining bracket. Tighten the retaining bracket hex screw to the specified torque.

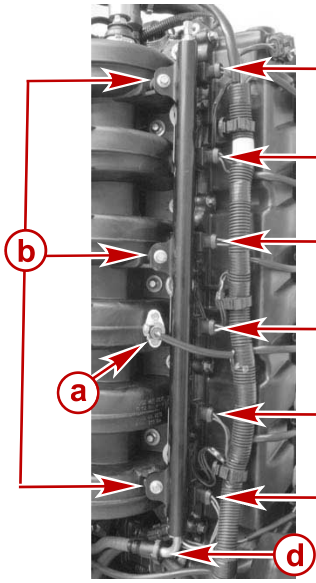
52946

Description	Nm	lb-in.	lb-ft
T20 Torx screw (M5 x 10)	6	53	–

Fuel Rail Installation

1. Install the fuel rail assembly onto the intake manifold.
2. Secure the fuel rail assembly to the intake manifold. Tighten the fuel rail screws to the specified torque.

3. Connect the fuel line to the fuel inlet tube.
4. Connect the injector harness connectors to the injectors.
5. Connect the manifold air temperature (MAT) sensor harness connector to the MAT sensor.



4134

a - MAT sensor
b - Screws (M6 x 15) (3)
c - Fuel injector harness connectors (6)
d - Fuel line

Description	Nm	lb-in.	lb-ft
Screws (M6 x 15)	7	62	–

Notes:

Fuel System

Section 3D - Emissions

Table of Contents

Exhaust Emission Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S. All engines sold in the state of California must also comply with the standards legislated by the California Air Resources Board (CARB). In accordance with these standards, and in preparation of future standards, Mercury Marine is working to reduce the following: carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx).

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. Since combustion is usually incomplete, not all of the exhaust gases burn, causing emissions. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasoline contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide, and nitrogen; which are not harmful to the environment. However, combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

Hydrocarbons (HC)

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen, but they are not totally consumed. When gasoline burns, oxidation occurs; however, some hydrocarbons do not oxidize. Lower engine temperatures, for example, make it harder for the hydrocarbons to oxidize. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide (CO)

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO_2). CO_2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide (CO). Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen (NOx)

Oxides of nitrogen (NOx) is a generic term for a group of chemical compounds that contain nitrogen (N) and oxygen (O) in varying amounts. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). Unlike CO and HC, which form when combustion temperatures are too low, NOx forms when the engine's combustion chamber temperatures are too high. NOx itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

The reduction of exhaust emissions is accomplished by controlling the air/fuel ratio that goes into the combustion chamber and by adjusting the timing curve of the spark ignition, based on engine sensor information. A microprocessor is used to manage the fuel injection duration and adjust the ignition timing. These adjustments are made in a microsecond during all engine operations. Adjustments are established by predetermined values programmed into the microprocessor and are based on various sensor inputs to the microprocessor on the engine.

Stoichiometric Air/Fuel Ratio

In the effort to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometry. The stoichiometric air/fuel ratio will vary slightly if the gasoline contains oxygenates such as ethanol or methanol. Most gasoline sold in the United States is blended with up to ten percent of an unspecified oxygenate. A stoichiometric air/fuel ratio provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. If the air/fuel ratio is lean, meaning that there is less gasoline in the combustion chamber than needed to reach a stoichiometric ratio, HC and CO levels are low. However, with a richer air/fuel ratio, meaning that there is more gasoline in the combustion chamber than needed to reach a stoichiometric ratio, HC and CO levels rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than stoichiometric. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. Enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. The solution to controlling NOx, as well as HC and CO, is to keep the air/fuel ratio as close to stoichiometric as possible.

Emissions Information

Manufacturer's Responsibility

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility

When performing service on all 1998 and newer outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturer's prescribed changes, such as that for altitude adjustments.

Owner Responsibility

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is **not** to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

Exceptions

- Carburetor jets may be changed for high altitude use in accordance with factory recommendations.
- Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations

All 1998 and newer outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the following locations:

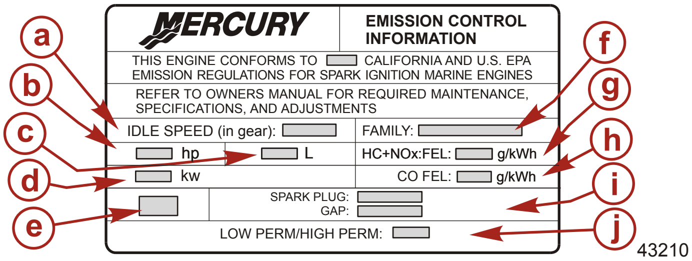
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources Engine Programs and Compliance Division Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460,

VIA EXPRESS or COURIER MAIL:
Office of Mobile Sources Engine Programs and Compliance Division Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001,

EPA INTERNET WEB SITE: http:/www.epa.gov/omswww

Manufacturer's Certification Label

The certification label must be placed on each engine at the time of manufacture and must be replaced in the same location if damaged or removed. Shown below is a typical certification label that is not representative of any one model. The label shown below is not to scale.



- a - Idle speed
- b - Engine horsepower
- c - Piston displacement
- d - Engine power in kilowatts
- e - Date of manufacture
- f - Family number
- g - Regulated emissions limit for the engine family
- h - Regulated emissions limit for the engine family
- i - Recommended spark plug and gap
- j - Percent of fuel line permeation

Service Replacement EPA Decal

IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification decal. If this decal is missing or damaged, contact Mercury Marine Service for a replacement.

Removal

Remove all remaining pieces of the damaged or illegible decal. Do not install the new decal over a damaged old decal. Use a suitable solvent to remove any traces of the old decal adhesive from the display location.

NOTE: If the original decal surface is in good condition, it is acceptable to clean the surface and apply the new decal over the original.

Installation

Apply the decal on a clean surface in the original factory location.

Powerhead

Section 4A - Cylinder Block/Crankcase

Table of Contents

Cylinder Block/Crankcase Specifications

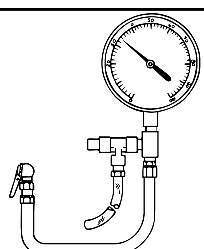
Cylinder Block/Crankcase Specifications	
Number of cylinders	6
Displacement	2.6 liters (158.6 CID)
Compression ratio	8.25:1
Standard bore	82.0 mm (3.228 in.)
Stroke	82.0 mm (3.228 in.)
Cylinder bore maximum taper (service)	0.0762 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.0762 mm (0.003 in.)
Cylinder block main bearing	65.997–66.013 mm (2.5982–2.5989 in.)
Crankshaft main bearing journal	59.985–60.001 mm (2.3616–2.3622 in.)
Crankshaft pin journal	49.982–50.0 mm (1.9678–1.968 in.)
Crankshaft end play	0.08–0.19 mm (0.003–0.007 in.)
Crankshaft runout	0.05 mm (0.002 in.)
Crankshaft main bearing oil clearance (without expansion)	0.014–0.042 mm (0.0005–0.0016 in.)
Crankshaft pin bearing oil clearance (without expansion)	0.020–0.050 mm (0.0008–0.0019 in.)
Connecting rod wrist pin bore diameter	22.005–22.014 mm (0.8663–0.8666 in.)
Connecting rod crankshaft pin diameter	53.000–53.018 mm (2.0866–2.0873 in.)
Piston skirt standard diameter	81.975 mm (3.2273 in.)
Piston wrist pin bore diameter	22.004–22.011 mm (0.8662–0.8665 in.)
Wrist pin diameter	21.997–22.000 mm (0.8660–0.8661 in.)
Top ring groove width	1.25 mm (0.049 in.)
Middle ring groove width	1.25 mm (0.049 in.)
Oil ring groove width	2.05 mm (0.081 in.)
Top ring thickness	1.19 mm (0.047 in.)
Middle ring thickness	1.19 mm (0.047 in.)
Oil ring thickness	1.98 mm (0.078 in.)
Top ring side clearance	0.04–0.08 mm (0.001–0.003 in.)
Middle ring side clearance	0.04–0.08 mm (0.001–0.003 in.)
Oil ring side clearance	0.05–0.17 mm (0.002–0.006 in.)
Top ring end gap	0.27–0.42 mm (0.010–0.016 in.)
Middle ring end gap	0.42–0.62 mm (0.016–0.024 in.)
Oil ring end gap	0.2–0.7 mm (0.007–0.027 in.)

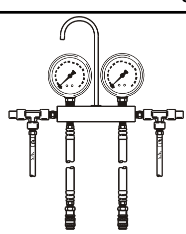
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Driveshaft splines	8M0071842
	25W50 Synthetic Blend 4-Stroke Racing Engine Oil	Engine oil sump	8M0078013
9	Loctite 567 PST Pipe Sealant	Water and oil galley plug threads	92-809822

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Bolt and starter ground wire eyelet	92- 25711 3
		Starter exciter wire, battery starter cable end	
		Ground wire eyelet and mounting screw	
		Alternator output lead nut	
		Alternator battery charging lead and alternator ground	
		Battery ground and electrical harness ground	
		Ignition pencil coil ground and fuel injector ground	
		Battery stud inside electrical box	
		Alternator ground cable at cylinder block and cylinder head	
		Starter power leads and ground cables	
		Battery positive and negative cable connection on engine	
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Long main bolts	Obtain Locally
135	Three Bond 1217F	Cylinder block cover	92-858005K02
136	Lubriplate SPO 255	Crankshaft, main bearings, top main bearing seal, bushing, connecting rod bearing, piston pin	Obtain Locally
		Crankshaft, main bearings, top main bearing seal, connecting rod bearing, piston pin	
		Piston pin	
		Connecting rod bearing	
		Crankpin	
		Main bearing	
		Chain guide bolts	
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston rings	92-858052K01
		Piston ring grooves	
		Piston rings, cylinder bore	
		Rod cap screw threads and the underside of the screw head	
		Timing chain tensioner	
		Inside diameter of cylinder block crankshaft seal area	
		Inside diameter of crankshaft seal	
		Engine oil sump	

Special Tools

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure

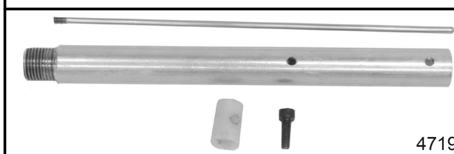
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously

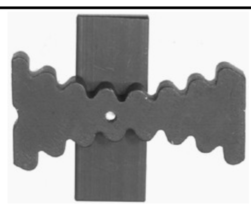
Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with computer diagnostic system (CDS)

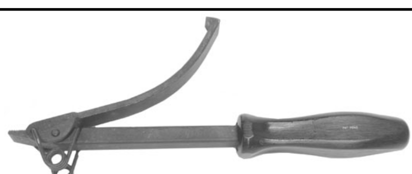
13 mm Torque Adapter	91-809905001
 4631	Aids in the removal and installation of powerhead nuts and tightening nuts to specification

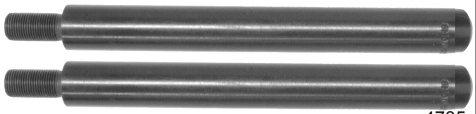
Flywheel Puller/Lifting Ring	91-895343T02
 14869	Removes flywheel from engine. Used for lifting powerhead/engine.

Dial Indicator	91- 58222A 1
 9479	Used to obtain precise measurements including gear backlash, pinion gear location, and TDC.

Dial Indicator Extension Adapter	91-805382T01
 4719	Extends the dial indicators reach.

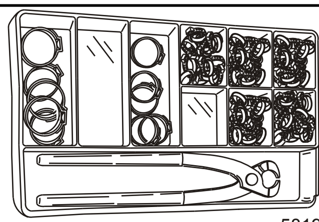
Cam Brake	91-896911A01
 5539	Prevents the intake and exhaust cam from turning while removing or installing cam retaining bolts

Flywheel Holding Tool	91- 52344
 4738	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.

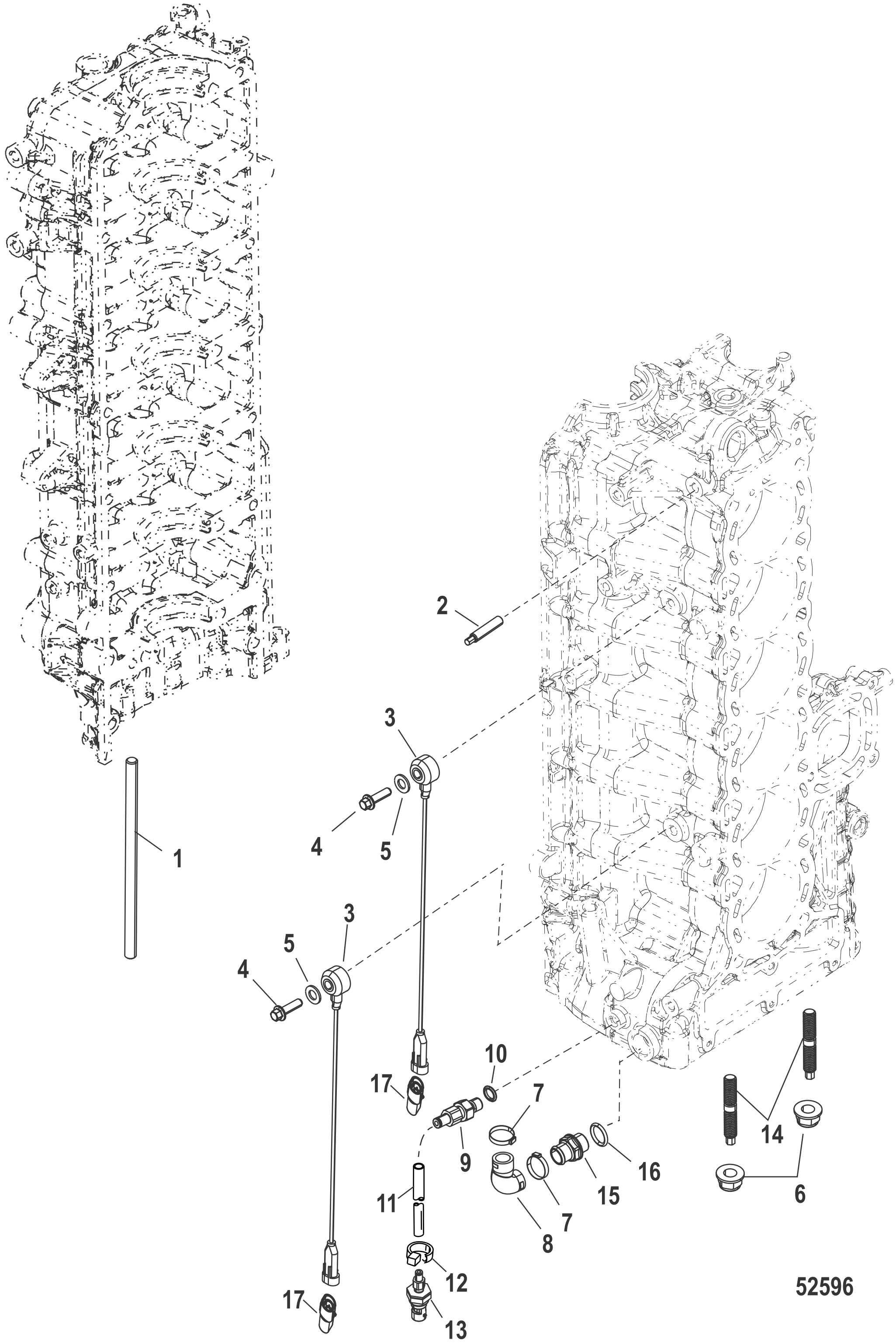
Rod Guide Dowel	91-8M0042904
 4735	Prevents cylinder bore and crankshaft from damage while installing or removing connecting rod assembly.

Ring Compressor	Obtain locally
 4739	Compresses piston rings when installing the piston into the cylinder block.

Crankshaft Retainer	91-8M0044311
 6191	Secures crankshaft to the cylinder block while rotating the block to install the cylinder head.

Hose Clamp Tool Kit	91-803146A04
 5819	Aids in the installation of high pressure (Oetiker®) hose clamps.

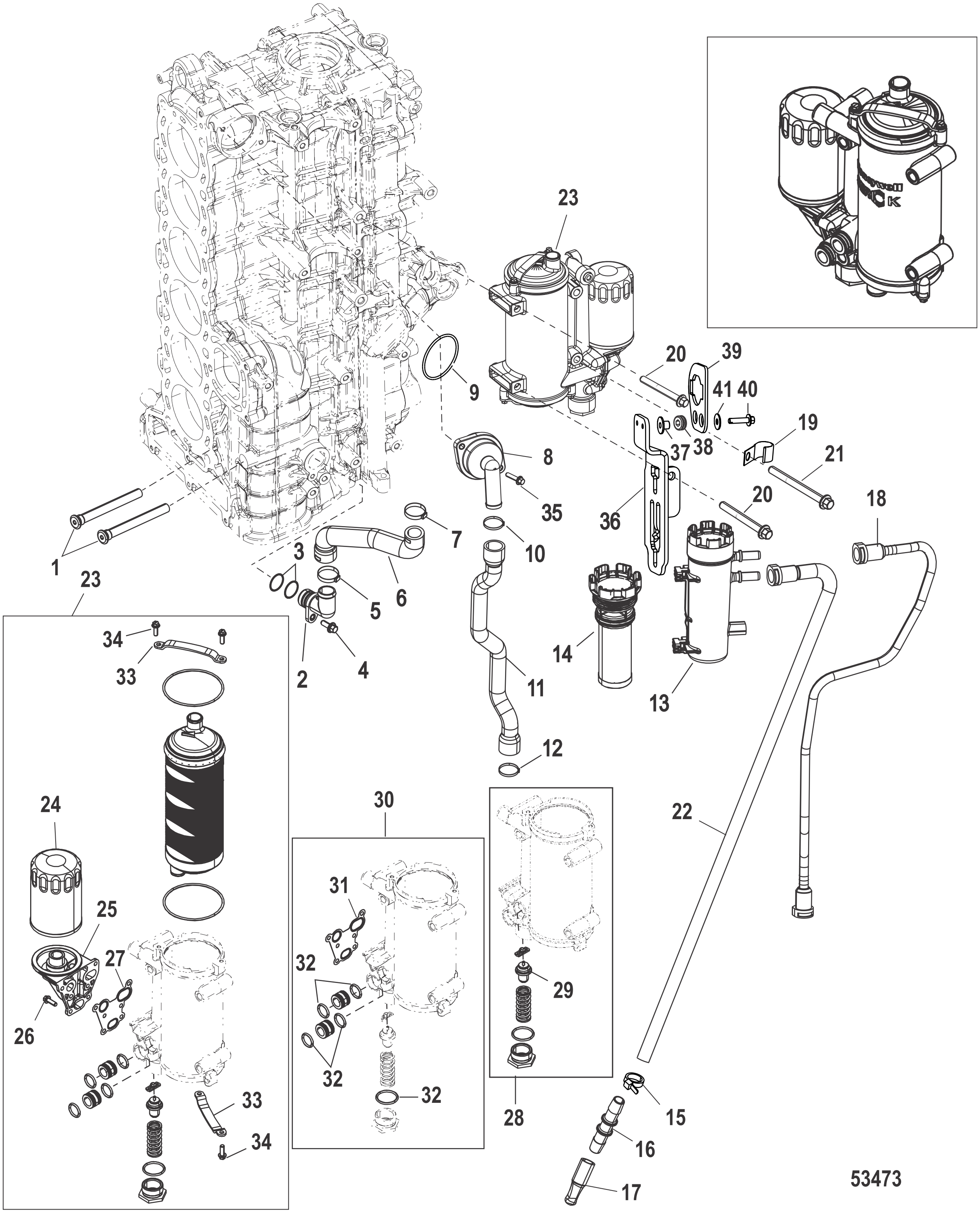
Port Cylinder Block Components



Port Cylinder Block Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	10	Stud	22.5	–	16.6
2	1	Stud	22	–	16.2
3	2	Knock sensor			
4	2	Screw (M10 x 35)	20	177	–
5	2	Washer			
6	6	Nut	26	–	19.2
7	2	Clamp (34.6 mm diameter)			
8	1	Hose			
9	1	Legris® fitting	15	133	–
10	2	O-ring			
11	1	Tubing			
12	1	Cable tie (8.00 in.)			
13	1	Water pressure sensor			
14	2	Stud (M8 x 57)	10	88.5	–
15	1	Fitting	20	177	–
16	1	O-ring			
17	2	Resistor cap			

Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)

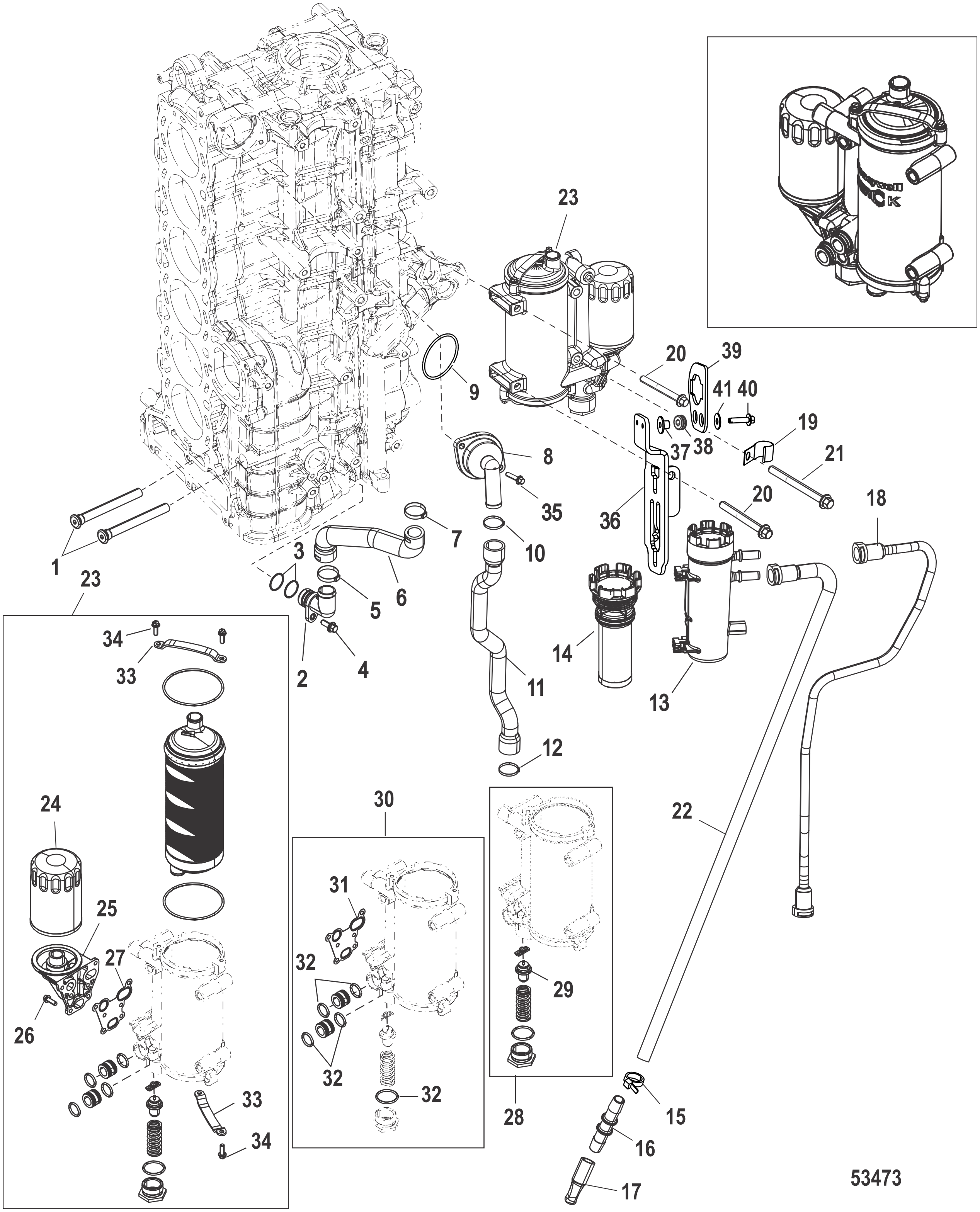


Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)

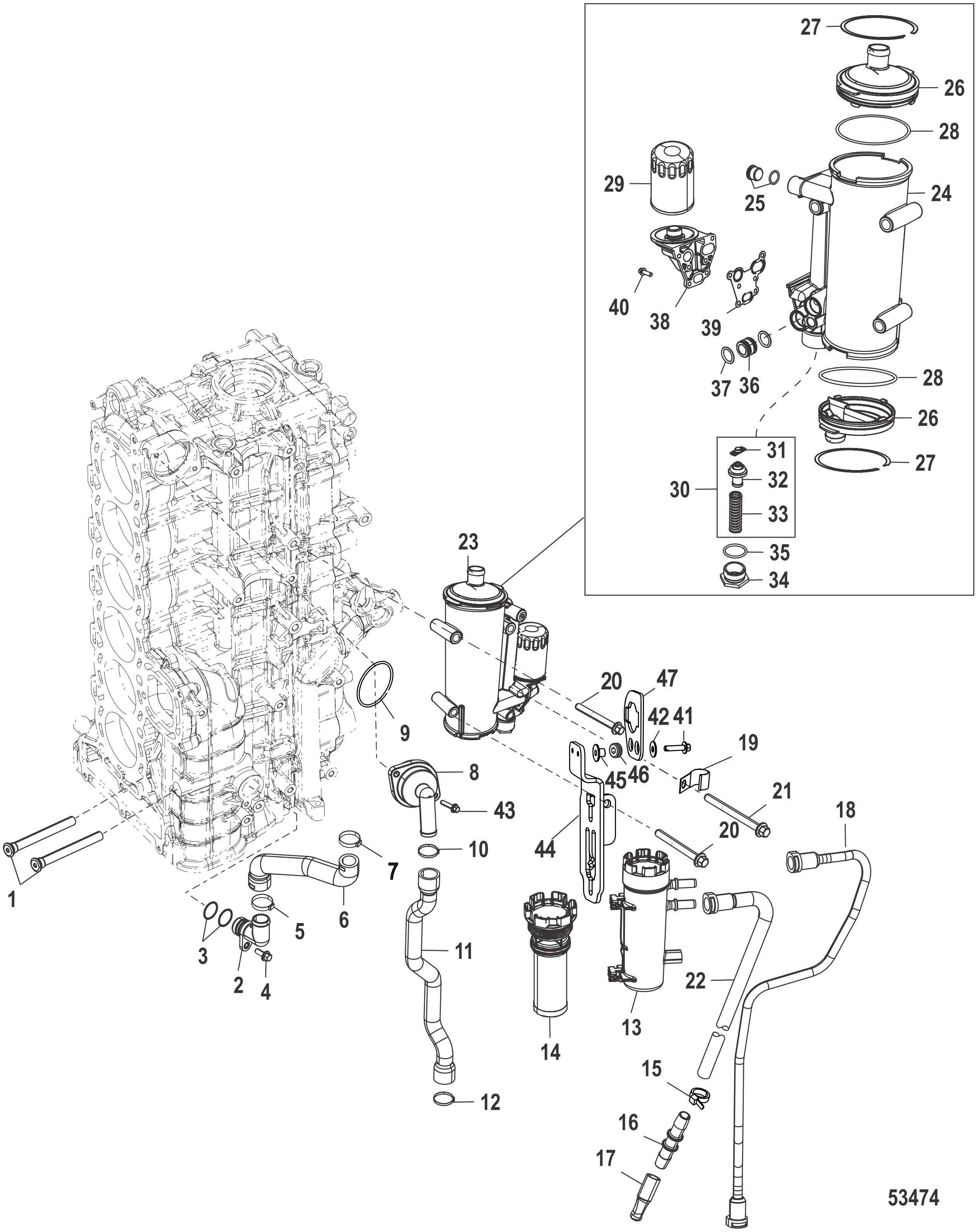
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Water deflector assembly	9	80	–
2	1	Fitting assembly			
3	2	O-ring			
4	1	Screw (M6 x 16), stainless steel	10	88.5	–
5	1	Clamp (38.1 mm)			
6	1	Hose			
7	1	Clamp (34.6 mm)			
8	1	Thermostat assembly			
9	1	O-ring			
10	1	Clamp (36.1 mm)			
11	1	Thermostat hose			
12	1	Clamp (42.5 mm)			
13	1	Fuel filter housing			
14	1	Fuel filter	7.5	66	–
15	1	Cable tie (8.00 in.)			
16	1	Connector			
17	1	Grab tab			
18	1	Fuel filter to lift pump hose			
19	1	J-clamp			
20	3	Screw (M10 x 85)	31	–	23
21	1	Screw (M10 x 105)	31	–	23
22	1	Fuel inlet hose			
23	1	Integrated oil module (IOM)			
24	1	Oil filter			
25	1	Integrated oil module housing assembly			
26	6	Screw (M6 x 18)	10	88.5	–
27	1	Gasket			
28	1	Thermostat guide kit			
29	1	Thermostat			
30	1	Overhaul kit			
31	1	Gasket			
32	1	O-ring kit			
33	2	Strap			
34	4	Screw (M6 x 18)	10	88.5	–
35	2	Screw (M6 x 25), stainless steel	8	71	–
36	1	Bracket			
37	2	Bushing			
38	2	Grommet			
39	1	Bracket			
40	2	Screw (M6 x 25)	8	71	–

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	2	Washer (0.265 x 0.750 x 0.048), stainless steel			

Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)



Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)

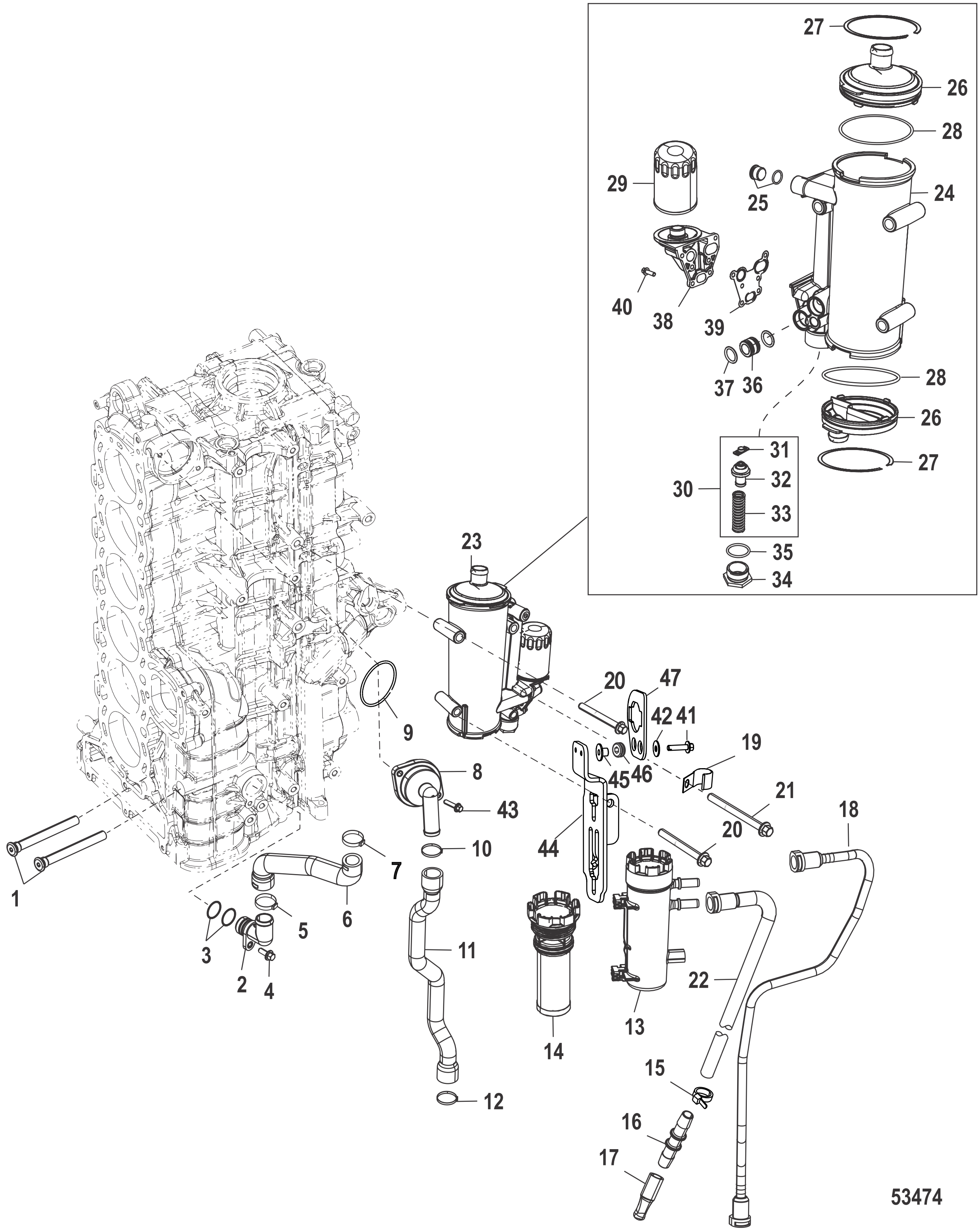


Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)

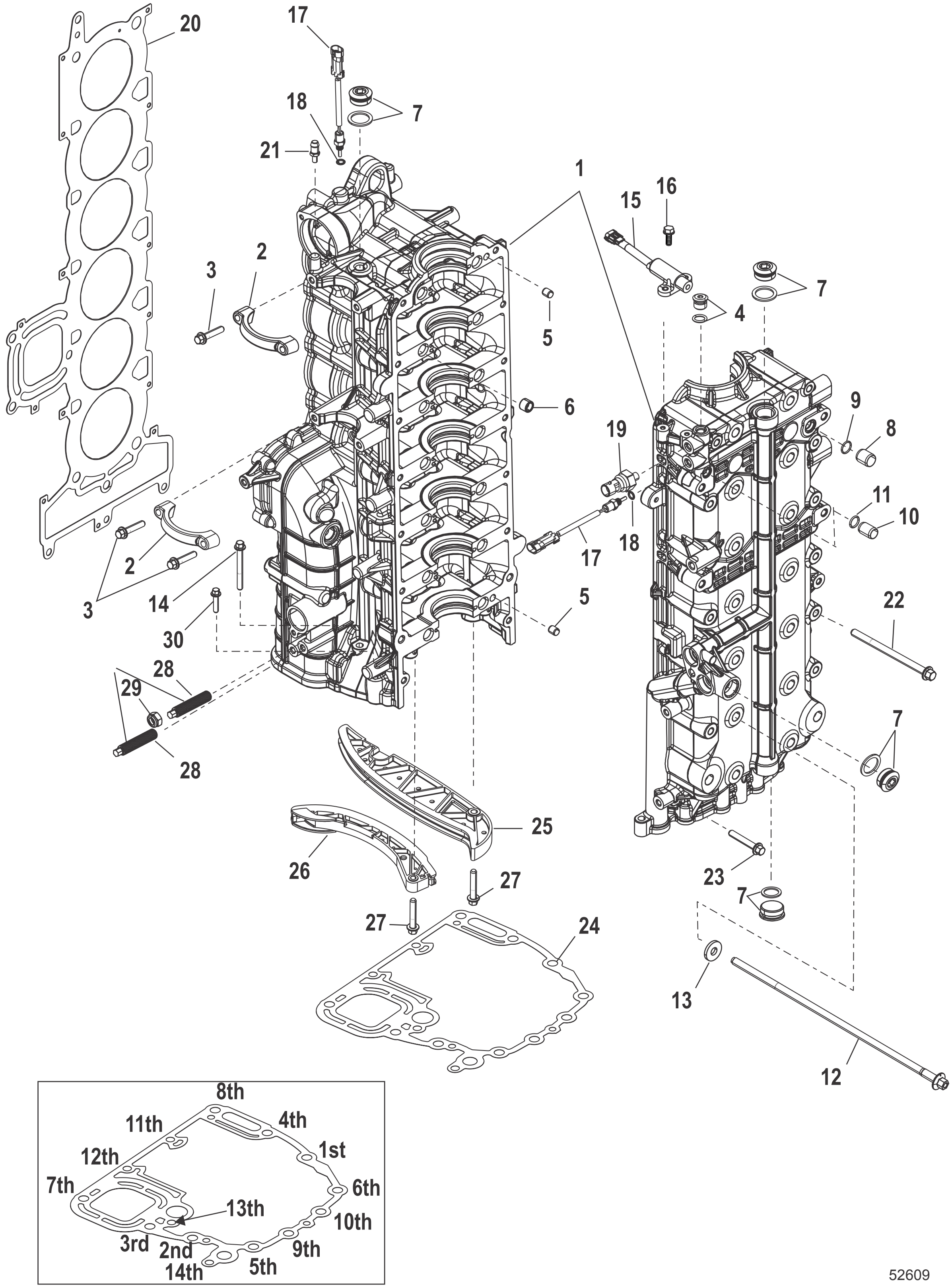
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Water deflector assembly	9	80	–
2	1	Fitting assembly			
3	2	O-ring			
4	1	Screw (M6 x 16), stainless steel	10	88.5	–
5	1	Clamp (38.1 mm)			
6	1	Hose			
7	1	Clamp (34.6 mm)			
8	1	Thermostat assembly			
9	1	O-ring			
10	1	Clamp (36.1 mm)			
11	1	Thermostat hose			
12	1	Clamp (42.5 mm)			
13	1	Fuel filter housing			
14	1	Fuel filter	7.5	66	–
15	1	Cable tie (8.00 in.)			
16	1	Connector			
17	1	Grab tab			
18	1	Fuel filter to lift pump hose			
19	1	J-clamp			
20	3	Screw (M10 x 85)	31	–	23
21	1	Screw (M10 x 105)	31	–	23
22	1	Fuel inlet hose			
23	1	Integrated oil module (IOM)			
24	1	Oil cooler housing			
25	2	Plug with O-ring			
26	2	End cap assembly			
27	2	Retaining ring			
28	2	O-ring			
29	1	Oil filter			
30	1	Thermostat assembly			
31	1	Thermostat stop			
32	1	Thermostat			
33	1	Spring			
34	1	Plug			
35	1	O-ring			
36	2	Adapter assembly			
37	4	O-ring			
38	1	Housing assembly			
39	1	Gasket			
40	6	Screw (M6 x 18)	10	88.5	–

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	2	Screw (M6 x 25)	8	71	–
42	2	Washer (0.265 x 0.750 x 0.048), stainless steel			
43	2	Screw (M6 x 25), stainless steel	8	71	–
44	1	Bracket			
45	2	Bushing			
46	2	Grommet			
47	1	Bracket			

Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)



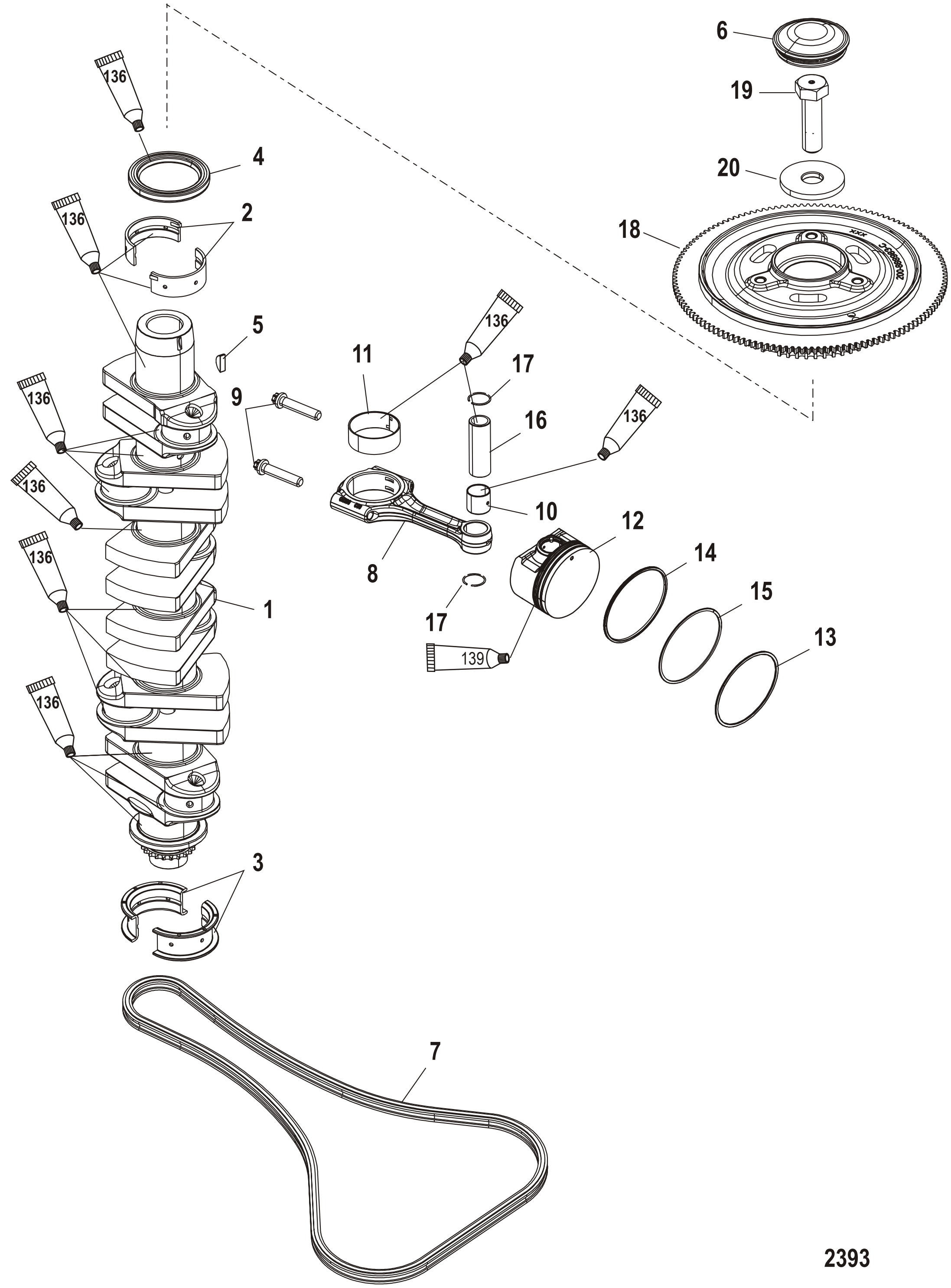
Cylinder Block Components



Cylinder Block Components

<table>
<tr><th rowspan="2">Ref. No.</th><th rowspan="2">Qty.</th><th rowspan="2" colspan="2">Description</th><th colspan="3">Torque</th></tr>
<tr><th>Nm</th><th>lb-in.</th><th>lb-ft</th></tr>
<tr><td>1</td><td>1</td><td colspan="2">Cylinder block</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>2</td><td colspan="2">Starter mounting bracket</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>4</td><td colspan="2">Screw (M8 x 40)</td><td>17</td><td>150</td><td>–</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">Plug (M12 mm) and washer</td><td>9</td><td>80</td><td>–</td></tr>
<tr><td>5</td><td>2</td><td colspan="2">Dowel pin</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>14</td><td colspan="2">Damper</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>4</td><td colspan="2">Plug (M24 mm) and washer</td><td>50</td><td>–</td><td>37</td></tr>
<tr><td>8</td><td>1</td><td colspan="2">Dowel pin (14 mm)</td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>1</td><td colspan="2">O-ring</td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td colspan="2">Dowel pin (11 mm)</td><td></td><td></td><td></td></tr>
<tr><td>11</td><td>1</td><td colspan="2">O-ring</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">12</td><td rowspan="3">14</td><td rowspan="3">Screw</td><td>First</td><td>27</td><td>–</td><td>20</td></tr>
<tr><td>Second</td><td>55</td><td>–</td><td>40.5</td></tr>
<tr><td>Final</td><td colspan="3">Turn additional 270º after second torque</td></tr>
<tr><td>13</td><td>14</td><td colspan="2">Washer</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>1</td><td colspan="2">Screw (M8 x 75)</td><td>27</td><td>–</td><td>20</td></tr>
<tr><td>15</td><td>1</td><td colspan="2">Crankshaft position sensor</td><td></td><td></td><td></td></tr>
<tr><td>16</td><td>2</td><td colspan="2">Screw (M5 x 16), stainless steel</td><td>5</td><td>44</td><td>–</td></tr>
<tr><td>17</td><td>2</td><td colspan="2">Temperature sensor</td><td>15</td><td>133</td><td>–</td></tr>
<tr><td>18</td><td>2</td><td colspan="2">O-ring</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>1</td><td colspan="2">Oil pressure sensor</td><td>15</td><td>133</td><td>–</td></tr>
<tr><td>20</td><td>1</td><td colspan="2">Head gasket</td><td></td><td></td><td></td></tr>
<tr><td>21</td><td>1</td><td colspan="2">Pin</td><td></td><td></td><td></td></tr>
<tr><td>22</td><td>12</td><td colspan="2">Screw (M8 x 115)</td><td>35</td><td>–</td><td>26</td></tr>
<tr><td>23</td><td>2</td><td colspan="2">Screw (M8 x 50)</td><td>35</td><td>–</td><td>26</td></tr>
<tr><td>24</td><td>1</td><td colspan="2">Cylinder block to adapter gasket</td><td></td><td></td><td></td></tr>
<tr><td>25</td><td>1</td><td colspan="2">Fixed guide</td><td></td><td></td><td></td></tr>
<tr><td>26</td><td>1</td><td colspan="2">Movable guide</td><td></td><td></td><td></td></tr>
<tr><td>27</td><td>2</td><td colspan="2">Screw</td><td>24</td><td>–</td><td>17.7</td></tr>
<tr><td>28</td><td>2</td><td colspan="2">Stud</td><td>10</td><td>88.5</td><td>–</td></tr>
<tr><td>29</td><td>1</td><td colspan="2">Nut (M8), stainless steel</td><td>17</td><td>150</td><td>–</td></tr>
<tr><td>30</td><td>1</td><td colspan="2">Screw (M8 x 35)</td><td>27</td><td>–</td><td>20</td></tr>
</table>

Crankshaft, Piston, and Connecting Rod Components (Design I)

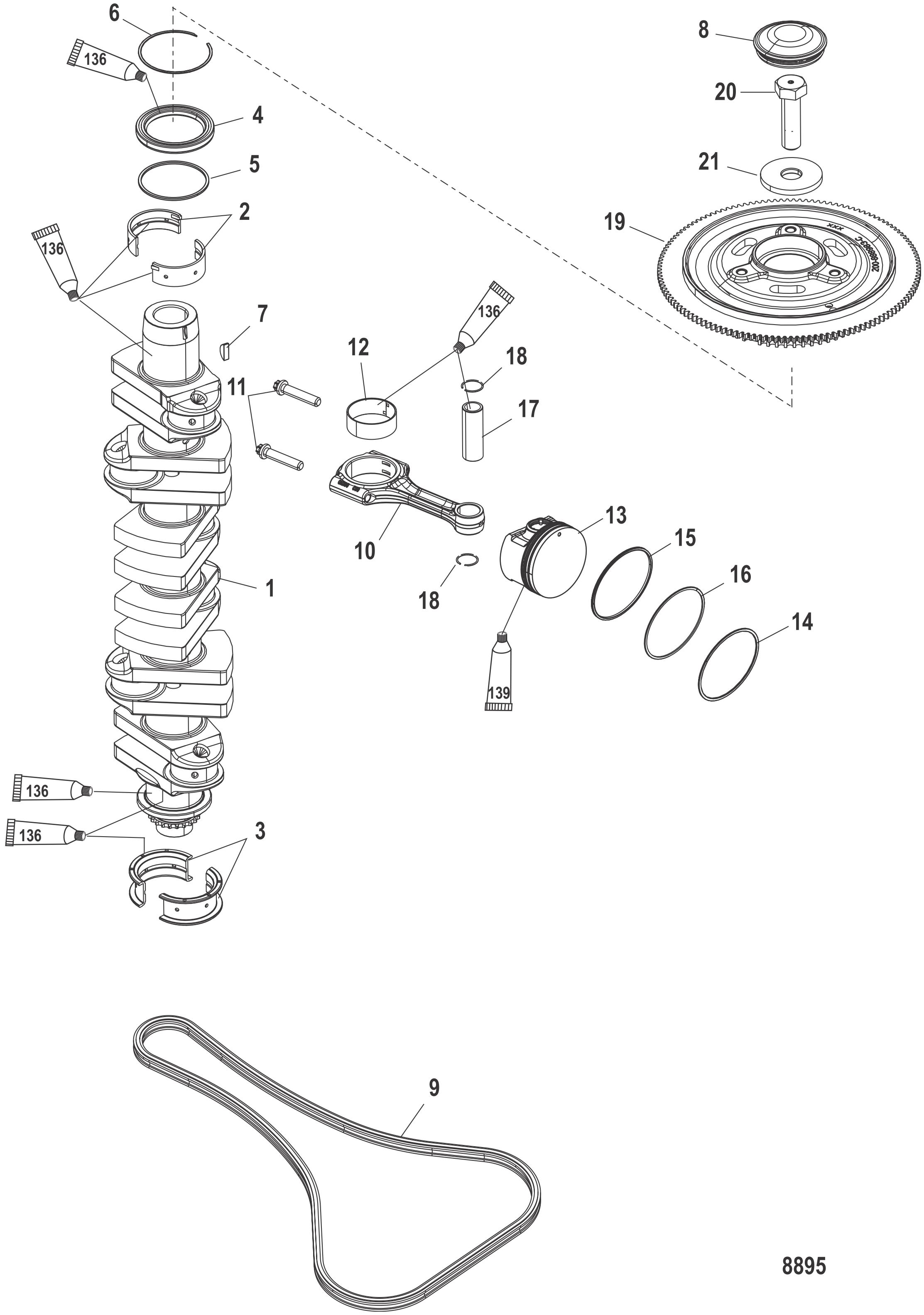


Crankshaft, Piston, and Connecting Rod Components (Design I)

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Crankshaft				
2	12	Main bearing				
3	12	Thrust bearing				
4	1	Top main bearing seal				
5	1	Woodruff key				
6	1	Flywheel bolt cap				
7	1	Camshaft drive roller chain				
8	6	Connecting rod				
9	12	Connecting rod screw	**First**	15	133	–
			Second	30	–	22
			Final	Turn additional 90º after second torque		
10	6	Bushing				
11	6	Connecting rod bearing				
12	6	Piston assembly				
13	6	Top piston ring				
14	6	Piston oil ring				
15	6	Second piston ring				
16	6	Piston pin				
17	12	Circlip				
18	1	Flywheel				
19	1	Flywheel bolt (M20 x 68)	**First**	60	–	44
			Final	120	–	88.5
20	1	Washer				

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Crankshaft, main bearings, top main bearing seal, bushing, connecting rod bearing, piston pin	Obtain Locally
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston rings	92-858052K01

Crankshaft, Piston, and Connecting Rod Components (Design II)



Crankshaft, Piston, and Connecting Rod Components (Design II)

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Crankshaft				
2	12	Main bearing				
3	2	Thrust bearing				
4	1	Top main bearing seal				
5	1	Spacer				
6	1	Retaining ring				
7	1	Woodruff key				
8	1	Flywheel bolt cap				
9	1	Camshaft drive roller chain				
10	6	Connecting rod				
11	12	Connecting rod screw	**First**	15	133	–
			Second	30	–	22
			Final	Turn additional 90º after second torque		
12	6	Connecting rod bearing				
13	6	Piston assembly				
14	6	Top piston ring				
15	6	Piston oil ring				
16	6	Second piston ring				
17	6	Piston pin				
18	12	Circlip				
19	1	Flywheel				
20	1	Flywheel bolt (M20 x 68)	**First**	60	–	44
			Final	120	–	88.5
21	1	Washer				

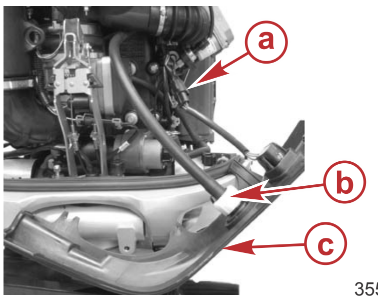
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Crankshaft, main bearings, top main bearing seal, connecting rod bearing, piston pin	Obtain Locally
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston rings	92-858052K01

Powerhead Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Starting with the negative (–) lead, disconnect the battery cables from the battery.
2. Drain the engine oil from the sump. Refer to **Changing Engine Oil** in **Section 1B** - **Maintenance.**
3. Remove the top cowl, rear cowl, port and starboard front cowls, and the driveshaft housing chaps. Refer to **Cowl Removal and Installation** in **Section 1B** - **Maintenance.**
4. Disconnect the trim switch harness connector.
5. Remove the flush hose and adapter from the cowl.
6. Remove the adapter from the flush hose. Retain the adapter for reassembly.



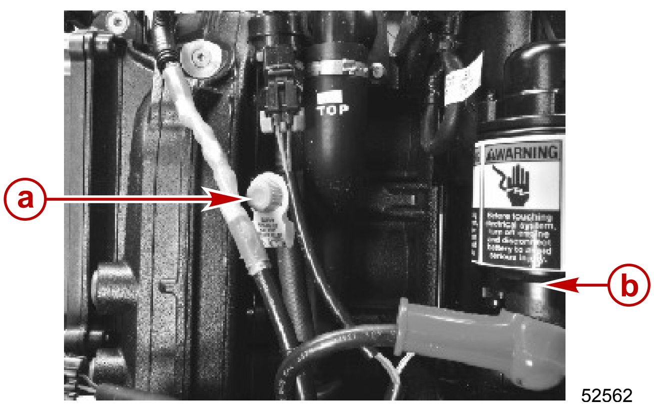
3559

a - Trim switch harness connector
b - Flush adapter
c - Port front cowl

7. Remove the cap to access the fuel vapor purge relief valve for the fuel supply module (FSM).

⚠ CAUTION

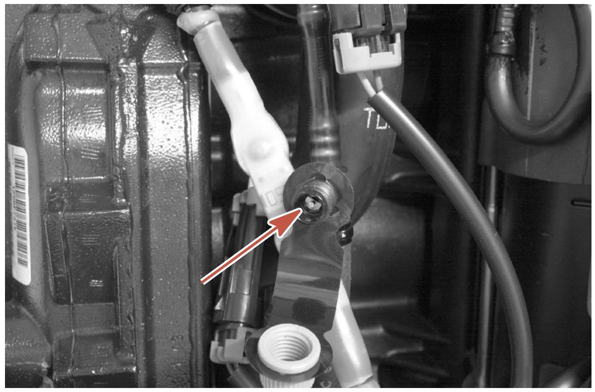
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.



52562

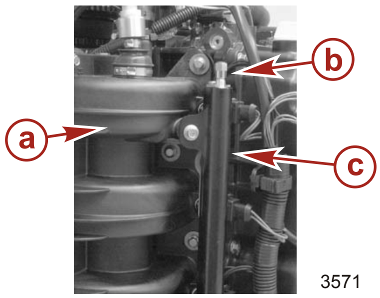
a - Fuel vapor purge relief valve
b - Starter solenoid

8. Place a rag over the valve, and then press in on the center of the valve to relieve any pressure inside the FSM.



3472

9. Connect a fuel pressure gauge to the fuel pressure relief valve on the fuel rail. Relieve the fuel pressure into an appropriate container.

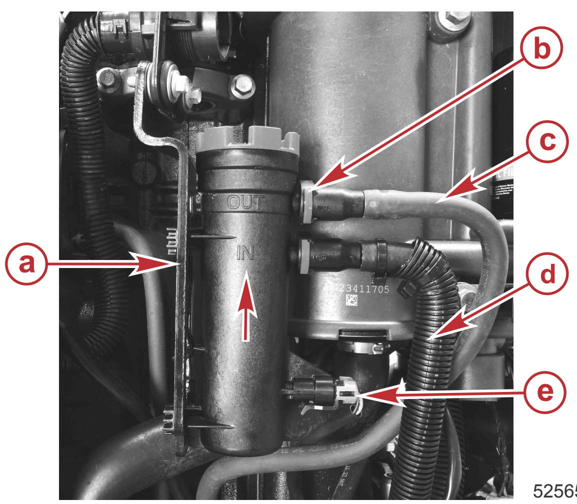


3571

a - Intake manifold
b - Fuel pressure relief valve
c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

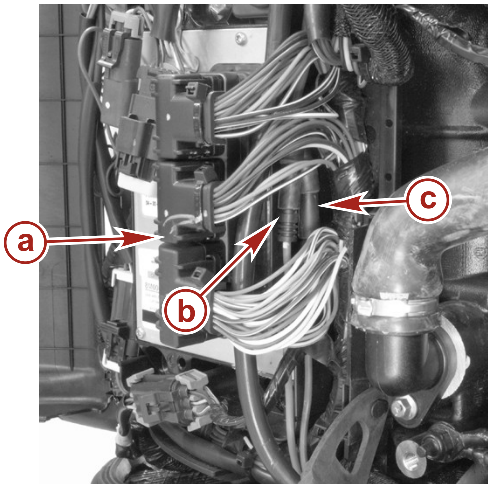
10. Push in on the fuel line retaining clips and remove both of the fuel lines from the fuel filter. Drain the lines into an appropriate container.
11. Disconnect the fuel filter water sensor connector from the engine harness connector.
12. Push the fuel filter assembly up to disengage it from the fuel filter bracket. Drain the fuel into an appropriate container.



52565

a - Fuel filter bracket
b - Fuel line retaining clip
c - Fuel line to adapter plate
d - Fuel line from boat
e - Fuel filter water sensor connector

13. Disconnect the green and blue trim harness bullet connectors.

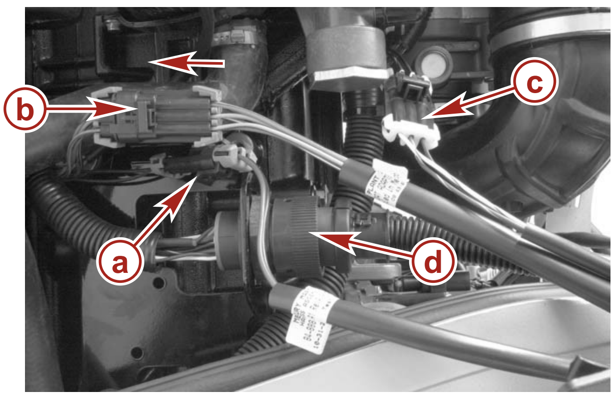


42312

a - Propulsion control module
b - Green trim harness bullet connector
c - Blue trim harness bullet connector

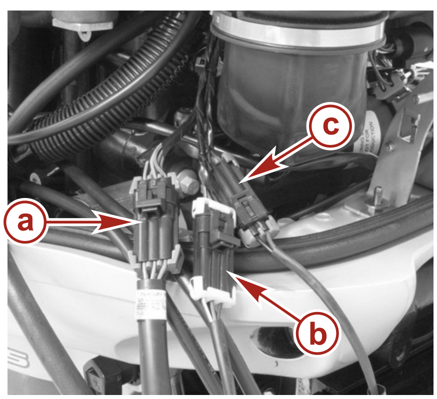
14. Disconnect the DTS power harness connector, boat sensor harness connector, power steering sensor harness connector, and the 14-pin engine harness connector.

NOTE: On engines with 1B517433 and below, the boat sensor harness is attached to the engine harness bracket. Push the boat sensor harness connector aft to disengage it from the harness bracket.



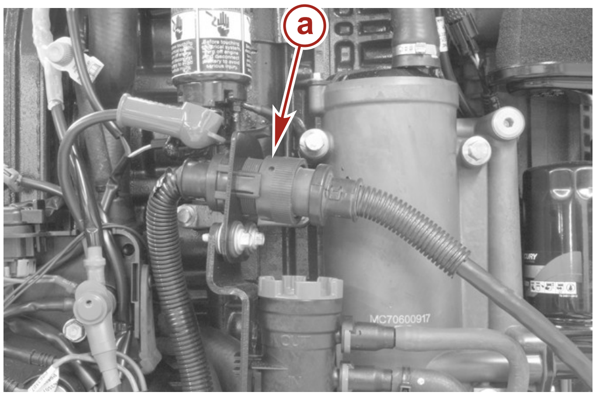
3573

S/N 1B517433 and below
a - DTS power harness connector
b - Boat sensor harness connector
c - Power steering sensor harness connector
d - 14-pin engine harness connector



32546

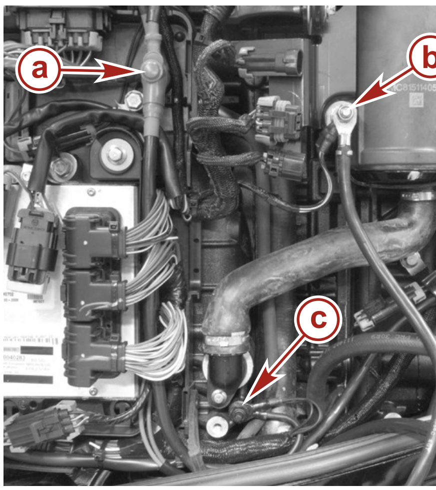
S/N 1B517434 and above
a - Boat sensor harness connector
b - Power steering sensor harness connector
c - DTS power harness connector


32547

S/N 1B517434 and above

a - 14-pin engine harness connector

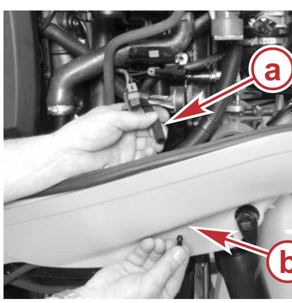
15. Disconnect the battery negative (–) and positive (+) cables from the engine.
16. Remove the screw securing the engine harness ground wires to the cylinder block.


42331

a - Positive (+) battery cable
b - Negative (–) battery cable
c - Engine harness ground wires

17. Pull up on the water pump indicator hose to remove it from the water pump indicator fitting in the mount cradle. Retain the water pump indicator fitting for reassembly.

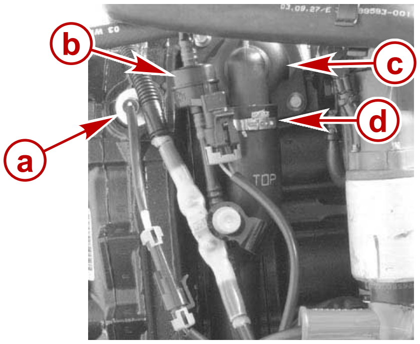
NOTE: The water pump indicator fitting will drop out of the mount cradle when removing the water pump indicator hose.


3695

a - Water pump indicator hose
b - Water pump indicator fitting

18. Pull the water pump indicator hose out from behind the air intake assembly towards the port side of the engine. Leave the hose attached to the water strainer.

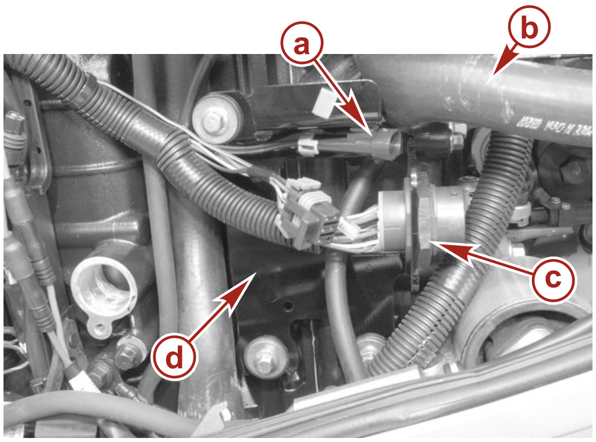
19. Remove the hose clamp securing the thermostat hose to the thermostat housing. Remove the hose from the thermostat housing.



3578

a - Cylinder head temperature sensor (S/N 1B51733 and below)
b - Vent canister purge valve
c - Thermostat housing
d - Hose clamp

20. Remove the nut securing the 14-pin connector to the engine harness bracket. Remove the 14-pin connector from the harness bracket. Install the 14-pin connector nut onto the connector.

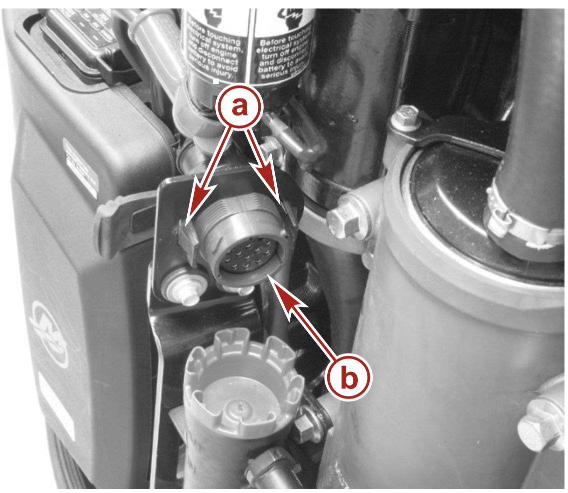


5376

S/N 1B517433 and below

a - DTS power harness connector
b - Lower IOM hose
c - 14-pin connector nut
d - Harness bracket

21. Squeeze in on the release tabs to release the 14-pin connector from the harness bracket.

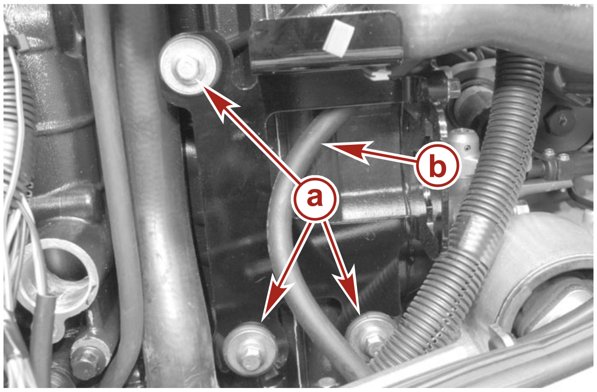


32551

S/N 1B517434 and above

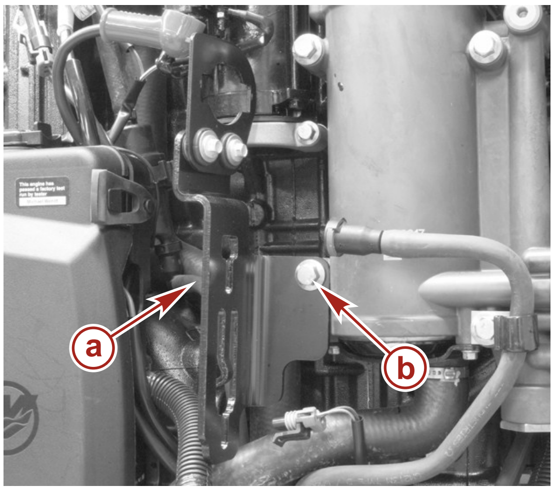
a - Release tabs
b - 14-pin connector

22. Remove the screws securing the harness bracket to the engine.



5377

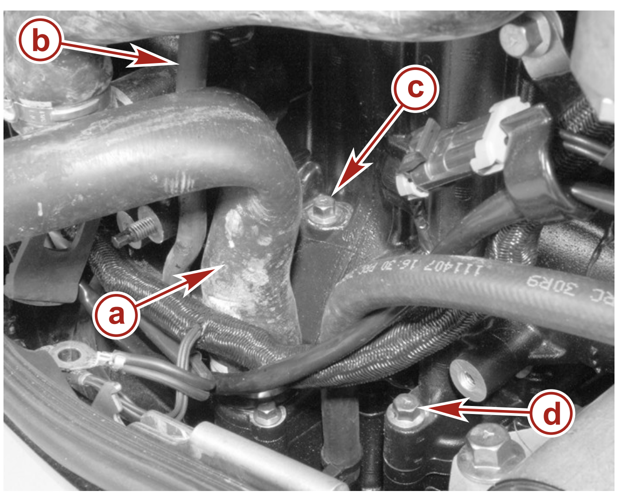
S/N 1B517433 and below
- a - Screws securing the harness bracket
- b - Water pump indicator hose



32563

S/N 1B517434 and above
- a - Engine harness bracket
- b - Bracket screw

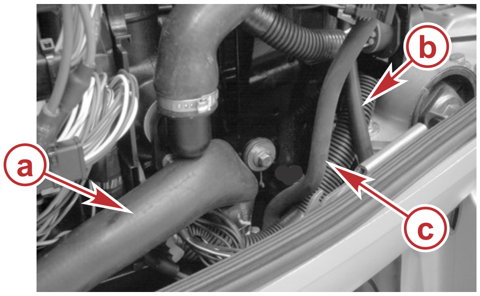
23. Guide the thermostat hose downward and out of the way to access the hidden screw behind the thermostat hose.
24. Remove the two screws securing the powerhead to the adapter plate.



42347

- a - Thermostat hose
- b - Purge hose
- c - Screw (M8 x 75)
- d - Screw (M8 x 35)

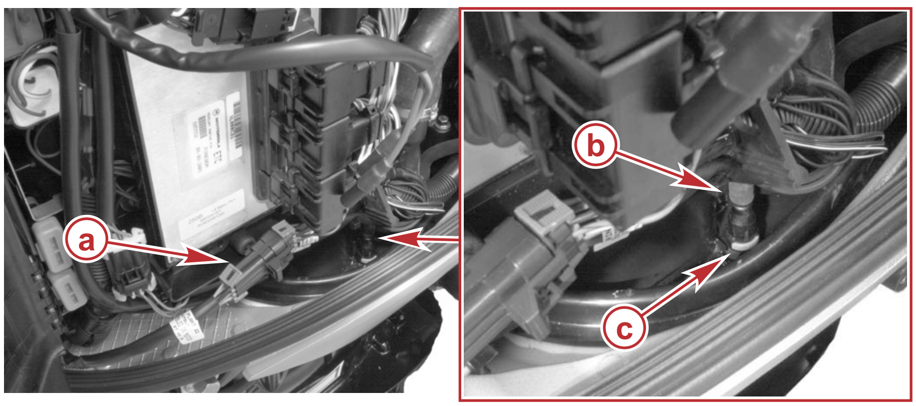
25. Remove the fuel line from the adapter plate by pressing in on the retaining clip at the bottom of the hose.



3580

a - Thermostat hose
b - Water pump indicator hose
c - Fuel line

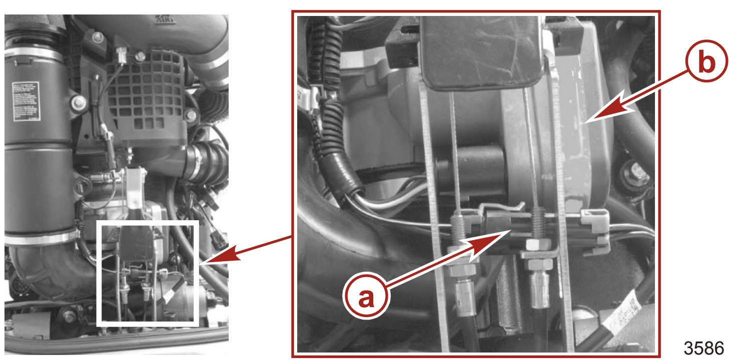
26. Push the fuel supply module (FSM) harness connector forward to disengage it from the connector retainer.
27. Disconnect the FSM harness connector.
28. Press in on the purge line retaining clip to disconnect the purge line from the adapter plate.



3582

a - FSM harness connector
b - Purge line
c - Retaining clip

29. Disconnect the shift position switch harness connector.

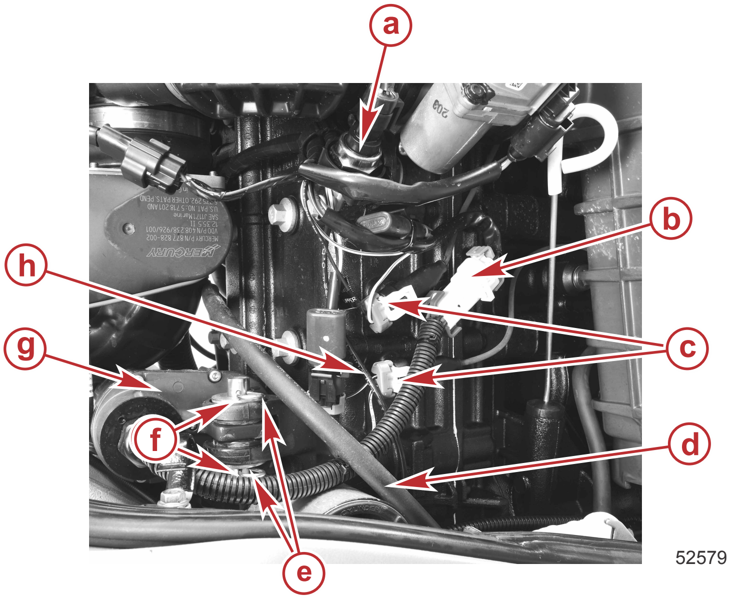


3586

a - Shift position switch harness connector
b - Electronic throttle control (ETC)

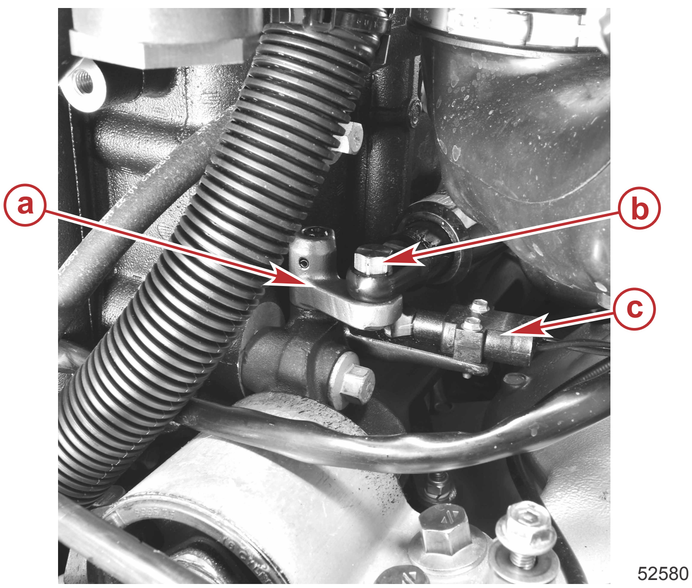
30. Remove the water pump indicator hose from behind the shift actuator harness.
31. Push the shift actuator harness connector aft to disengage it from the connector retainer.
32. Disconnect the shift actuator harness from the engine harness.
33. Remove the speedometer hose from the speedometer sensor.
34. Carefully pull the water pump indicator hose out from behind the knock sensor harness.

35. Remove the cotter pins and washers from the shift actuator pin. Remove the shift actuator pin.



a - Speedometer sensor
b - Shift actuator harness connector
c - Knock sensor harness connectors
d - Water pump indicator hose
e - Cotter pins
f - Washers
g - Shift actuator
h - Speedometer hose

36. Remove the shift actuator screw from the upper bell crank. Remove the shift actuator.
    IMPORTANT: Do not rotate the shift actuator piston.

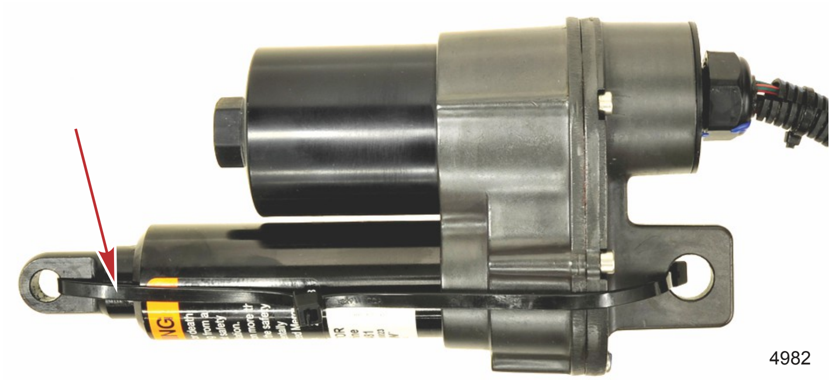


a - Upper bell crank
b - Shift actuator screw
c - Shift position switch

37. Cable tie the actuator to prevent the actuator piston from rotating.

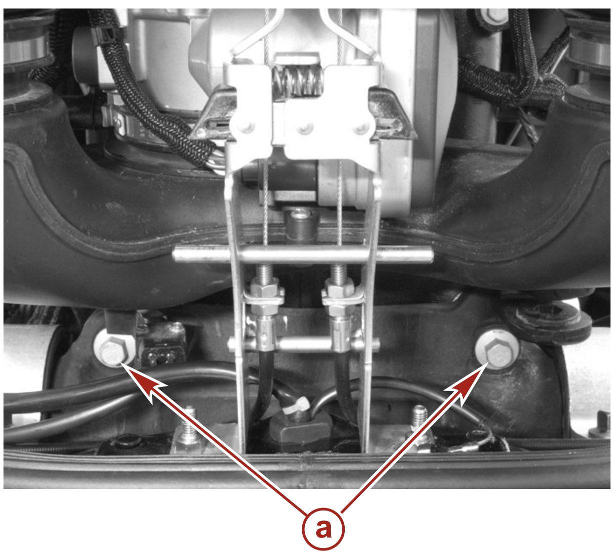
⚠ WARNING

To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through the electronic shift control piston to ensure that the piston does not rotate from the original factory position. Remove cable ties just prior to installation. Do not rotate the piston more than 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.



4982

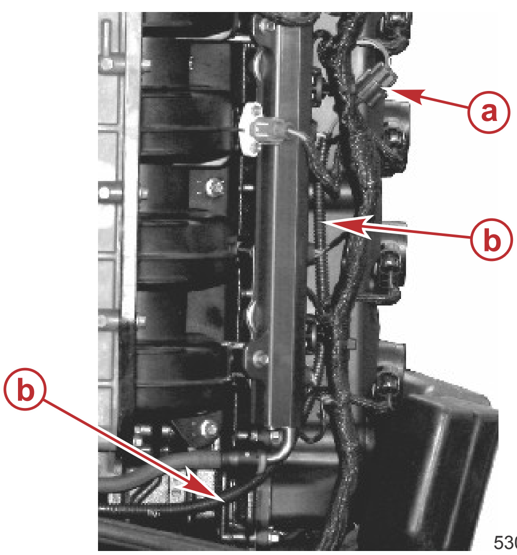
38. Remove the two front powerhead mounting screws.



42368

a - Front powerhead mounting screws

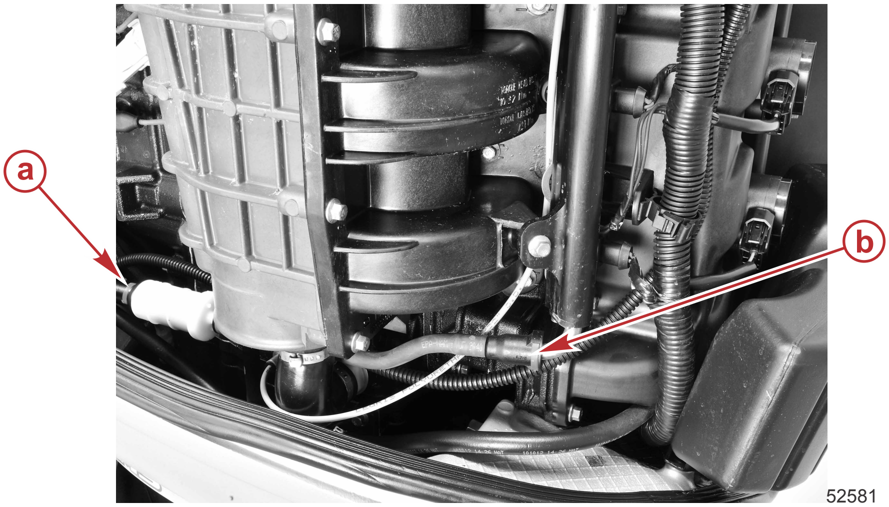
39. Disconnect the trim position sensor harness from the engine harness.



53014

a - Trim position sensor harness connector
b - Trim position sensor harness

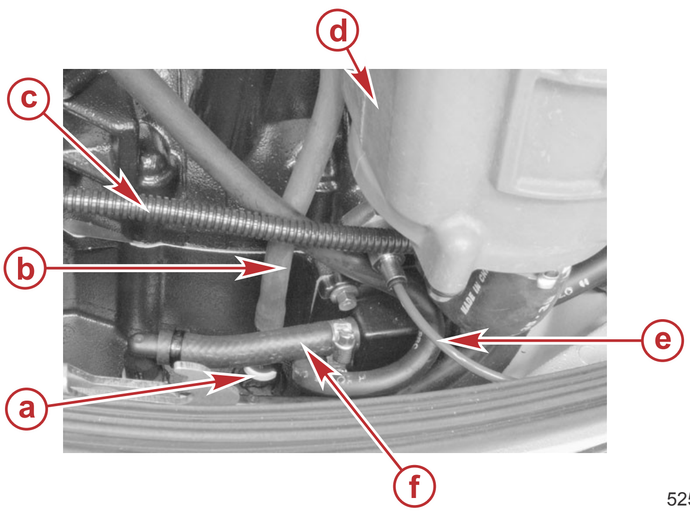
40. Disconnect the fuel filter inlet hose and the fuel rail inlet hose. Drain any fuel left in the filter and hose into an appropriate container.



52581

a - Fuel filter inlet hose
b - Fuel rail inlet hose

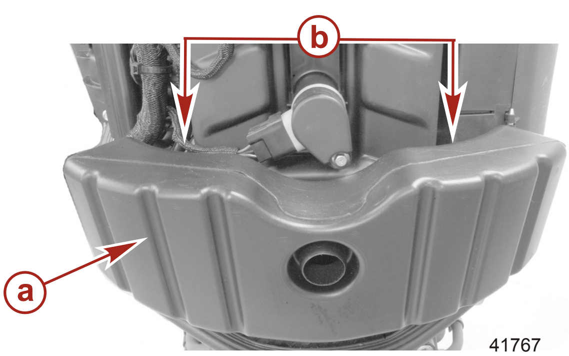
41. Press in on the retainer securing the MAP sensor reference hose from the adapter plate. Remove the MAP sensor hose from the adapter plate.
42. Gently guide the trim position sensor harness out from underneath the charge air cooler (CAC).
43. Press in on the retainer securing the FSM water-cooling hose from the adapter plate. Remove the FSM water-cooling hose from the adapter plate.



52582

a - MAP sensor reference hose clip
b - MAP sensor reference hose
c - Trim position sensor harness
d - Charge air cooler (CAC)
e - Block water pressure sensor hose
f - FSM water-cooling hose

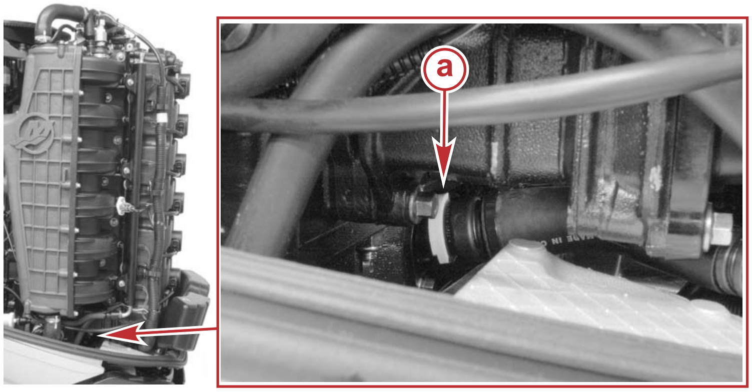
44. Remove the two exhaust plenum mounting screws.



41767

a - Exhaust plenum
b - Exhaust plenum screws (hidden)

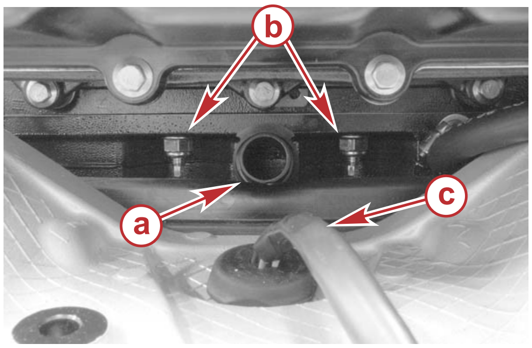
45. Disconnect the plenum tube by pushing in on the release clip and pulling the exhaust plenum and plenum tube aft.



4114

a - Plenum tube release clip

46. Remove the two aft nuts securing the powerhead to the adapter plate using a 13 mm torque adapter.

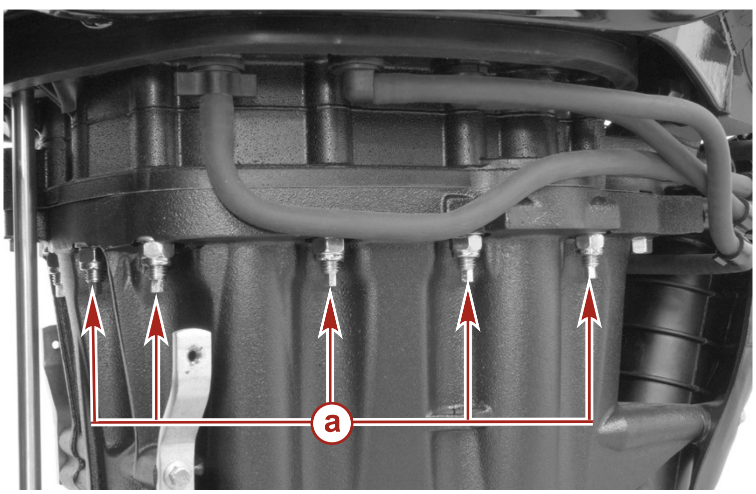


3617

a - Exhaust relief tube
b - Aft nuts securing the powerhead
c - FSM harness

13 mm Torque Adapter	91-809905001

47. Remove the ten nuts (five on each side) securing the powerhead to the adapter plate.



42375

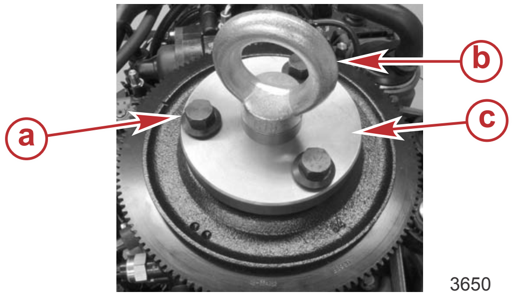
a - Mounting nuts (five on each side)

48. Remove the flywheel cover from the engine.
49. Install the lifting ring onto the flywheel. Tighten the lifting base screws to the specified torque.

Flywheel Puller/Lifting Ring	91-895343T02

Description	Nm	lb-in.	lb-ft
Lifting base screws	27	–	20

50. Install the lifting ring into the lifting base securely so that it bottoms out on the lifting base.



a - Lifting base screws
b - Lifting ring
c - Lifting base

⚠ CAUTION

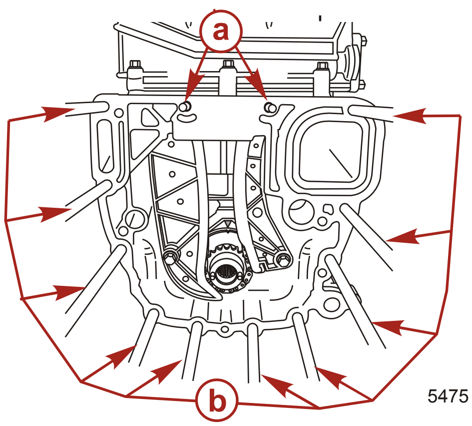
Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

51. Carefully lift the powerhead off of the adapter plate.

    NOTE: *While lifting the powerhead off the adapter plate, it may be necessary to gently rock the powerhead fore and aft to prevent the powerhead mounting studs from binding in the adapter plate.*

52. Remove the ten long powerhead mounting studs and the two short powerhead mounting studs from the bottom of the cylinder block.

    NOTE: *Use a stud removal tool or the double-nut method to remove the powerhead mounting studs from the powerhead if the studs do not have a hex drive on the end.*

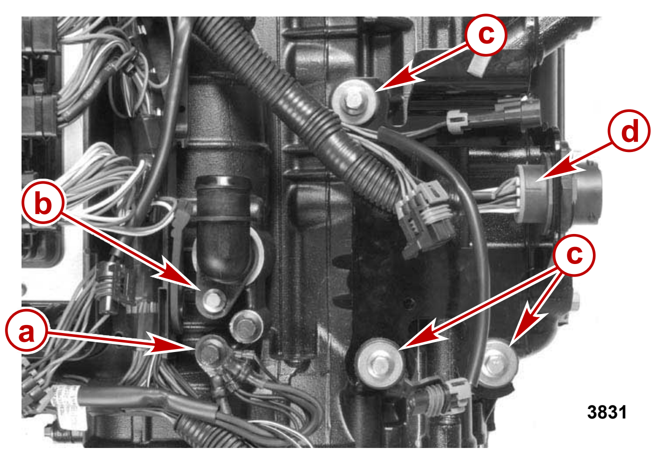


a - Short powerhead mounting studs
b - Long powerhead mounting studs

Removing Powerhead Components

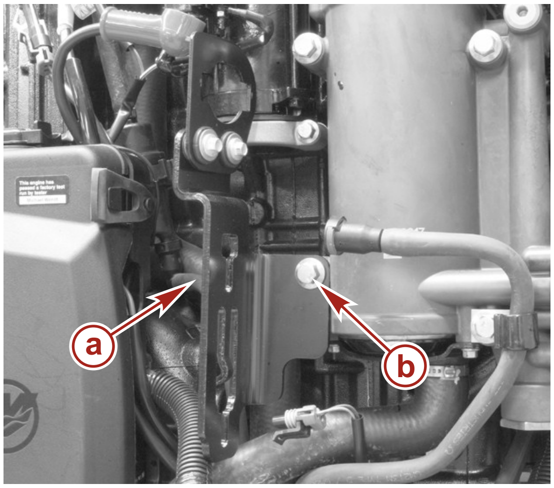
Engine Harness Bracket

1. Remove the three screws securing the engine harness bracket to the cylinder block.
2. Remove the screw securing the engine harness ground wires to the cylinder block.



S/N 1B517433 and below

a - Engine harness ground screw
b - Screw securing elbow
c - Engine harness bracket screws
d - 14-pin engine harness



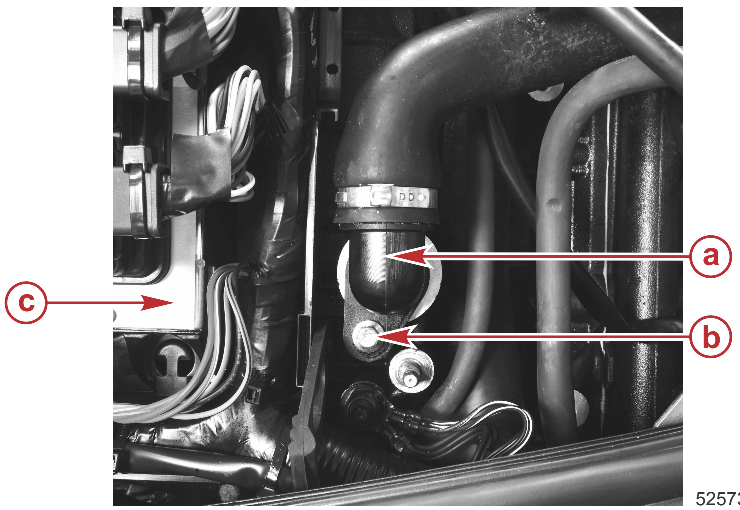
32563

S/N 1B517434 and above

a - Engine harness bracket
b - Bracket screw

Integrated Oil Module (IOM)

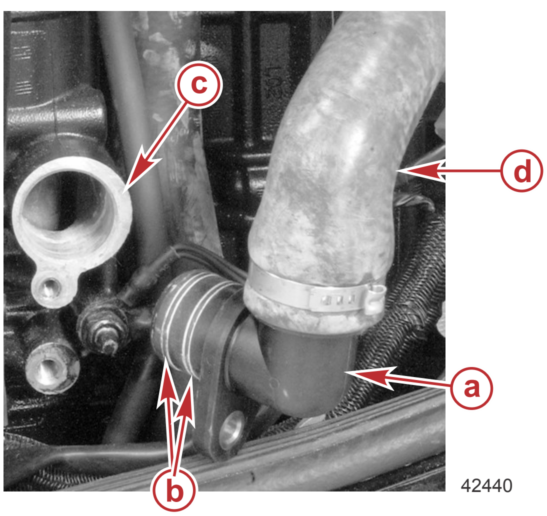
1. Remove the screw securing the lower IOM cooling hose elbow to the cylinder block. Remove the cooling hose elbow from the cylinder block.



52573

a - Elbow
b - Screw
c - Propulsion control module (PCM)

2. Remove and discard the O-rings from the cooling hose elbow. Clean any sealant from the cylinder block and elbow.

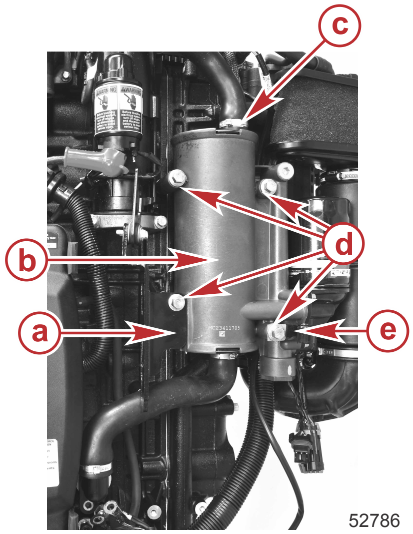


42440

a - Elbow
b - O-rings (discard)
c - Cylinder block—remove sealant
d - Lower IOM cooling hose

3. Remove the clamp securing the integrated oil module (IOM) top cooling hose to the IOM. Remove the hose from the IOM.

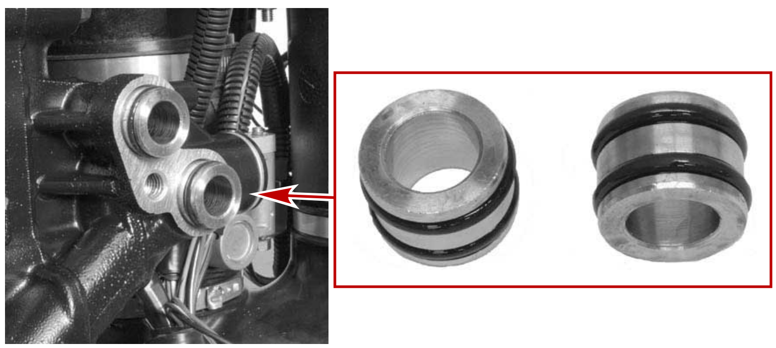
4. Remove the four screws securing the IOM to the cylinder block. Remove the fuel filter/engine harness bracket and wire harness retainer if not previously removed.



52786

- a - Fuel filter bracket
- b - IOM
- c - IOM top cooling hose clamp
- d - Screws securing the IOM to the cylinder block
- e - Wire harness retainer

5. Pull the IOM off of the oil delivery and oil return dowels.
6. Remove the dowels from the cylinder block.
7. Remove the O-rings from the IOM dowels and discard the O-rings.

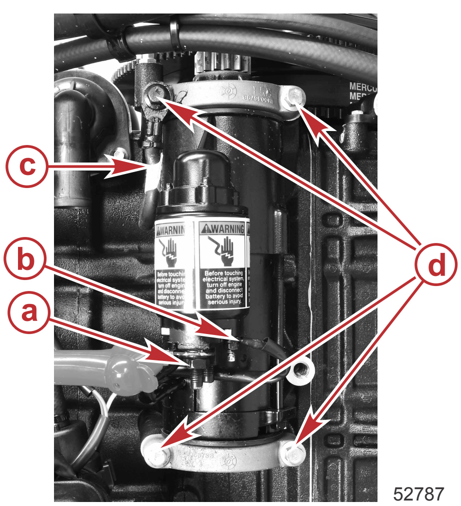


3772

Starter

1. Move the rubber boot away from the starter solenoid positive (+) battery cable terminal.
2. Remove the starter solenoid positive (+) battery cable from the starter solenoid.
3. Remove the starter solenoid exciter wire.
4. Remove the four screws retaining the starter to the cylinder block.

   NOTE: *The top aft starter mounting screw secures the ground cable to the starter.*

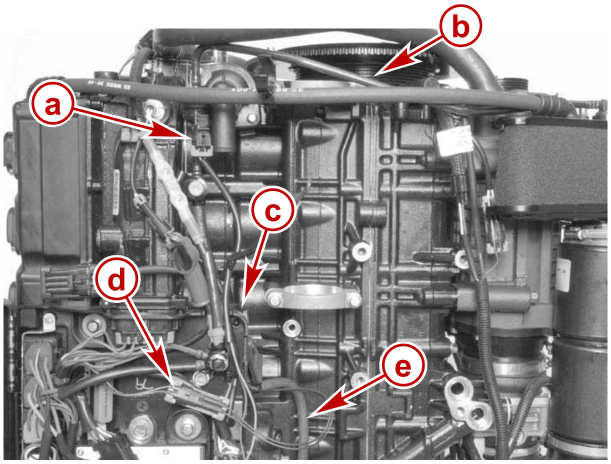


52787

- a - Starter solenoid positive (+) battery cable
- b - Starter solenoid exciter wire
- c - Starter ground cable
- d - Starter mounting screws

Purge Line

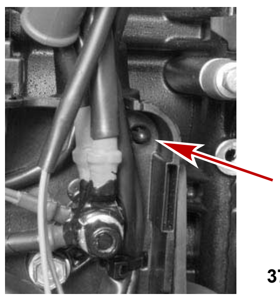
1. Open the electrical box cover.
2. Disconnect the purge valve harness connector from the purge valve.
3. Disconnect the FSM vent canister float switch harness connector.



3773

- a - Purge valve harness connector
- b - Purge line to air intake assembly
- c - FSM vent canister float switch
- d - FSM vent canister float switch harness connector
- e - FSM vent line

4. Pinch the FSM vent canister float switch retainer with a pair of pliers. Push the retainer through the electrical box.

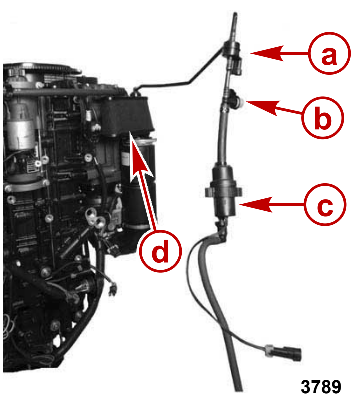


3790

5. Carefully remove the vent line assembly from behind the electrical box.

   NOTE: Do not kink the purge vent line when removing the purge vent line from the air intake filter.

6. Move the purge vent line assembly so it is approximately 90° to the port side of the air intake filter assembly to unlock the purge vent line from the air intake assembly. The purge vent line can now be lifted off the air intake assembly.



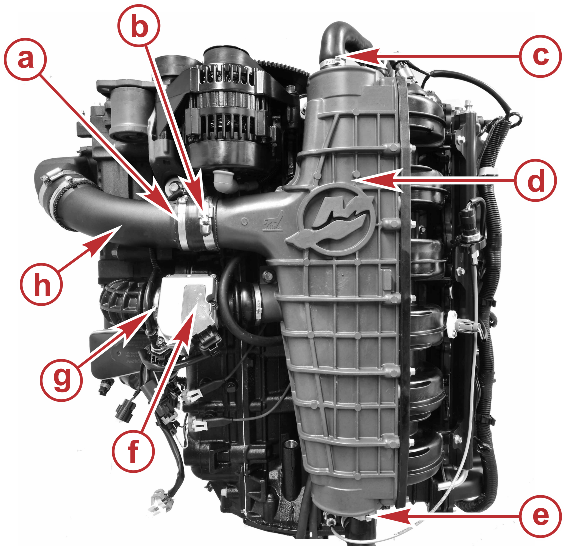
3789

- a - Purge solenoid
- b - Purge valve
- c - Vent canister float switch (VCFS)
- d - Air intake filter assembly

Induction System

1. Remove hose clamp **A** and loosen hose clamp **B** at the charge air cooler (CAC) inlet.
2. Remove the upper CAC hose clamp.
3. Remove the lower CAC hose clamp.

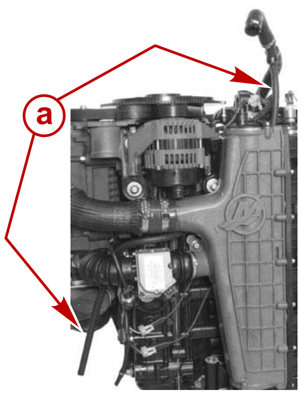
4. Remove the hose clamp at the forward side of the electronic boost control.



52860

a - Hose clamp **A** (remove)
b - Hose clamp **B** (loosen)
c - Upper CAC hose clamp (remove)
d - Charge air cooler (CAC)
e - Lower CAC hose clamp (remove)
f - Electronic boost control (EBC)
g - Hose clamp (remove)
h - CAC inlet tube

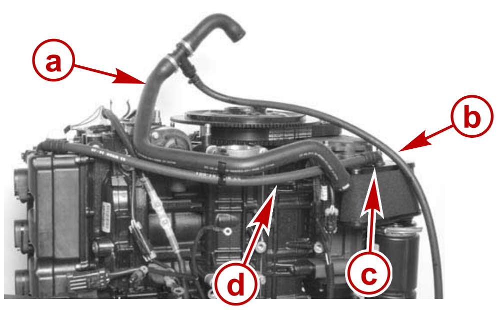
5. Remove the upper CAC hose from the CAC.
6. Carefully pull the flush hose from behind the charge air cooler.



3801

a - Flush hose

7. Remove the integrated oil module (IOM) hose and flush hose assembly.
8. Remove the breather hose from the air intake filter cover.

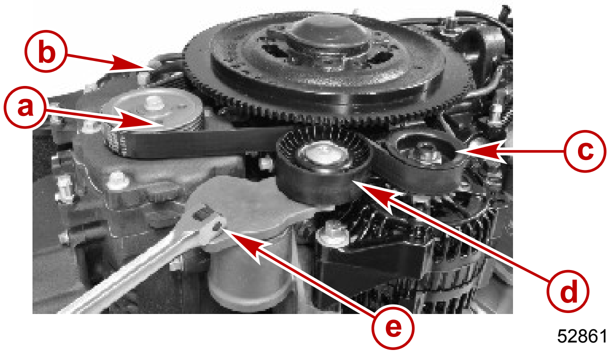


3802

a - Hose from the IOM
b - Flush hose
c - Air intake filter cover
d - Breather hose

9. Cut the cable tie and remove the vent hose from the fitting on the top of the supercharger, if equipped.
10. Install a 3/8 in. breaker bar into the square recess on the belt tensioner.

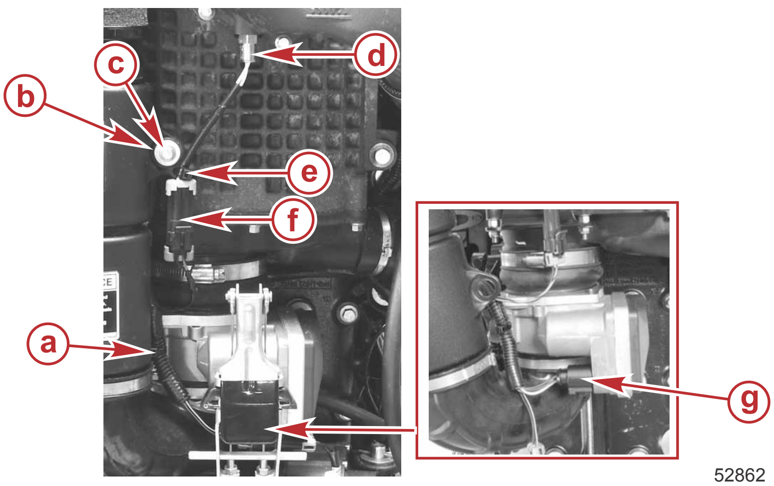
11. Release the belt tension and remove the alternator/supercharger belt.



52861

- a - Supercharger pulley
- b - Supercharger vent hose
- c - Alternator pulley
- d - Belt tensioner pulley
- e - 3/8 in. breaker bar

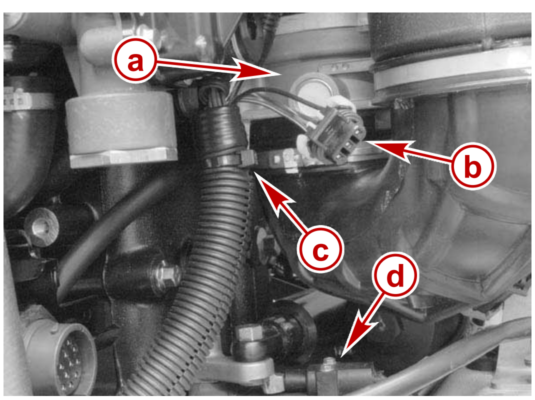
12. Remove the air intake support bolt from the supercharger or the supercharger support bracket (depending on model).
13. Disconnect the engine harness from the supercharger air temperature sensor.
14. Cut the cable tie securing the supercharger air temperature sensor harness.
15. Cut the cable tie securing the electronic throttle control harness to the support bracket.
16. Disconnect the engine harness from the electronic throttle control (ETC).



52862

- a - Cable tie securing the ETC harness
- b - Air intake support
- c - Air intake support screw
- d - Supercharger air temperature sensor
- e - Cable tie securing the supercharger air temperature sensor harness
- f - Supercharger air temperature sensor harness connector
- g - ETC harness connector

17. Cut the cable tie securing the engine harness to the support bracket at the rear of the electronic throttle control.

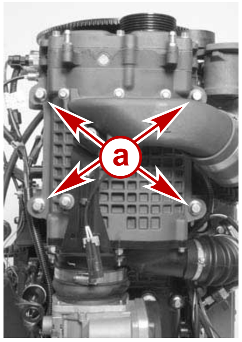


4599

- a - Electronic throttle control
- b - Power steering harness
- c - Cable tie
- d - Shift indicator switch

18. Route the ETC harness toward the aft end of the powerhead. Check that no disconnected wiring will pinch or snag while the supercharger is being removed.
19. Remove the four screws securing the supercharger to the cylinder block.

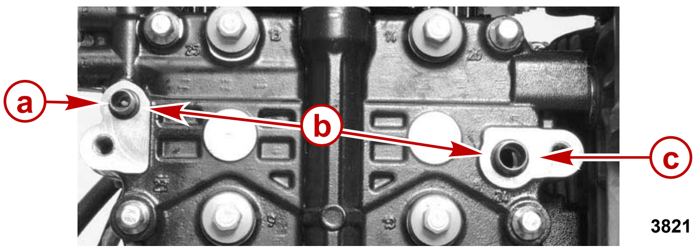
IMPORTANT: Use care when removing the supercharger. Once the screws are removed, the supercharger can fall off of the supercharger dowels.



3820

a - Supercharger mounting screw (4)

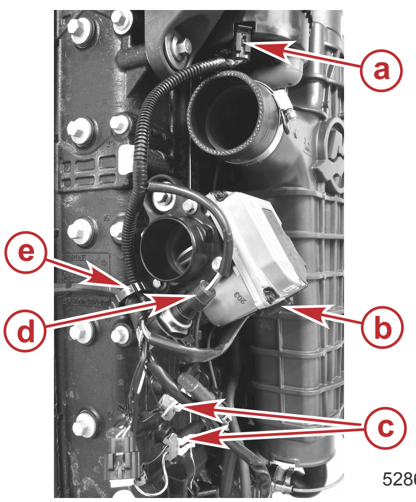
20. Pull the supercharger off the dowels.
21. Remove the supercharger dowel O-rings and discard them. Do not attempt to remove the supercharger dowels unless they are damaged.



3821

a - Oil delivery to supercharger
b - Supercharger dowel and O-rings
c - Oil return from supercharger

22. Disconnect the exciter harness connector from the alternator.
23. Disconnect the electronic boost control (EBC) harness.
24. Disconnect the two knock sensor connectors.
25. Disconnect the speedometer sensor harness connector.
26. Remove the engine harness from the retaining clip.

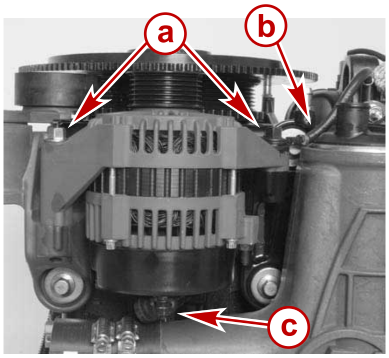


52863

a - Exciter harness connector
b - EBC harness connector
c - Knock sensor harness connectors
d - Speedometer sensor harness connector
e - Harness retaining clip

27. Push back the protective boot and remove the nut securing the battery charging lead to the alternator.
28. Remove the two screws securing the alternator to the tensioner bracket and alternator support bracket.

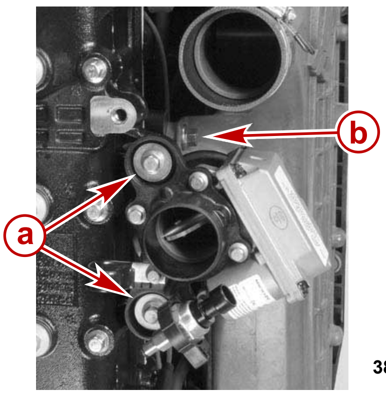
29. Remove the alternator.



3823

a - Screws securing the alternator
b - Alternator ground lead
c - Nut securing battery charging lead

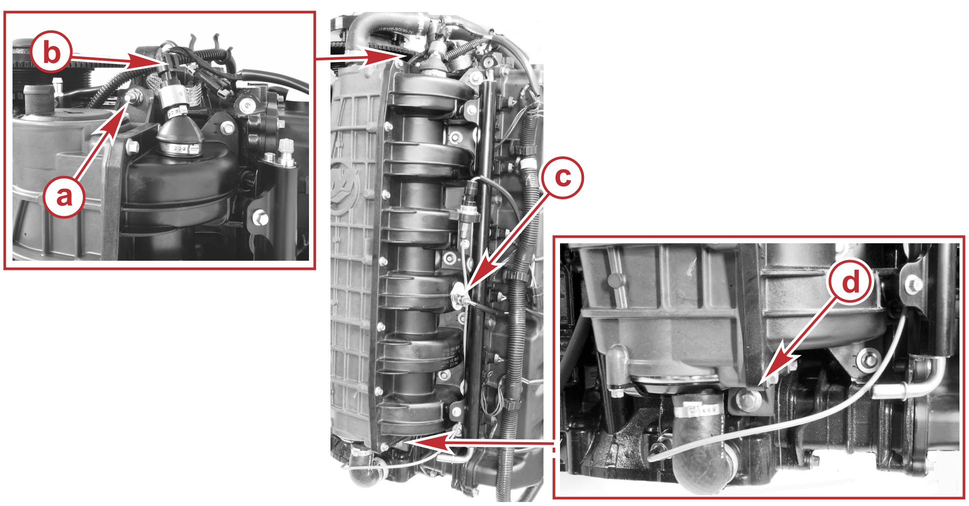
30. Remove the two screws securing the electronic boost control to the cylinder block.
31. Remove the front screw securing the charge air cooler to the cylinder block.



3824

a - Screws securing the electronic boost control
b - Front screw securing charge air cooler to cylinder block

32. Disconnect the manifold absolute pressure (MAP) sensor harness.
33. Disconnect the manifold air temperature (MAT) sensor harness.
34. Remove the water pressure sensor retaining clip from the fuel rail.
35. Remove the top nut securing the charge air cooler to the cylinder block.
36. Remove the bottom screw securing the charge air cooler to the cylinder block.

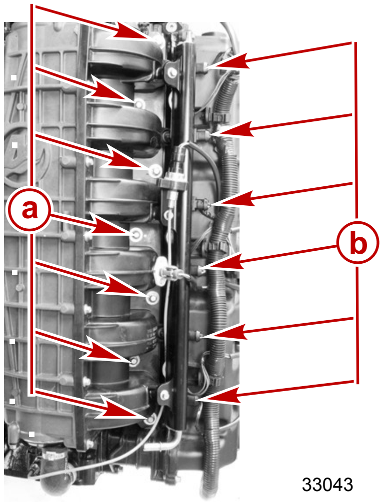


52865

a - Nut securing charge air cooler to cylinder block
b - MAP sensor harness connector
c - MAT sensor harness connector
d - Screw securing charge air cooler to cylinder block

37. Disconnect the injector harness connectors from the injectors.
38. Remove the seven screws securing the charge air cooler to the cylinder head.

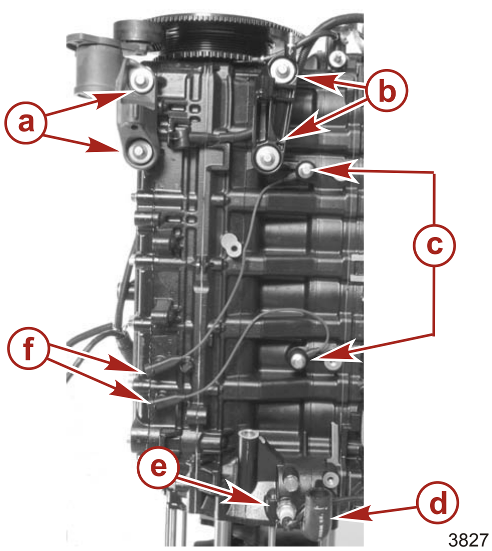
39. Pull the charge air cooler off the cylinder head and the lower cooling hose.



a - Screws securing charge air cooler to cylinder head
b - Injector harness connectors

Alternator Support Bracket and Knock Sensor

1. Remove the two screws securing the alternator support bracket to the cylinder block. Do not lose the washers behind the support bracket.
2. Remove the two screws securing the belt tensioner bracket to the cylinder block. Do not lose the washers behind the belt tensioner bracket.
3. Slide the upper and lower knock sensor harness connectors towards the front of the engine to remove the harness connectors from the harness supports.
4. Remove the knock sensor retaining screws.
5. Disconnect the water pressure hose at the cylinder block water pressure Legris connector. Remove the Legris connector from the cylinder block.
6. Remove the fitting from the cylinder block with the water hose attached.

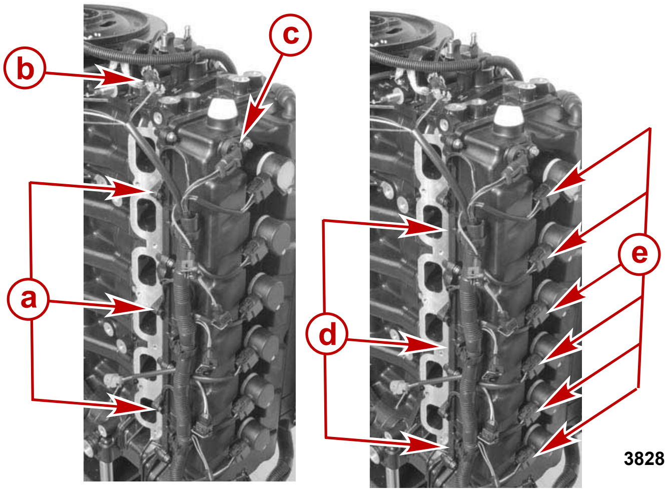


a - Belt tensioner bracket screws
b - Alternator support bracket screws
c - Knock sensor retaining screws
d - Brass or plastic water hose fitting (hidden)
e - Water pressure Legris connector
f - Knock sensor harness connectors

Injector/Coil Harness

1. Disconnect the cylinder block temperature sensor connector.
2. Disconnect the camshaft position sensor connector.
3. Remove the three screws securing the injector/coil harness ground wires to the cylinder head.
4. Disconnect the ignition harness connectors from the coils.

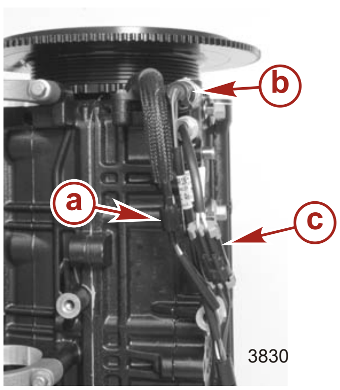
5. Pinch the back of the harness retainers with a pair of pliers to remove the harness retainer from the valve cover.



a - Injector/coil harness ground wires
b - Cylinder block temperature sensor
c - Camshaft position sensor
d - Harness retainers
e - Ignition coil harness connectors

Oil Pressure/Temperature Sensor

1. Disconnect the oil pressure sensor harness connector.
2. Disconnect the oil temperature sensor harness connector.
3. Disconnect the crankshaft position sensor (CPS) harness connector.
4. Remove the oil temperature sensor, oil pressure sensor, and CPS.

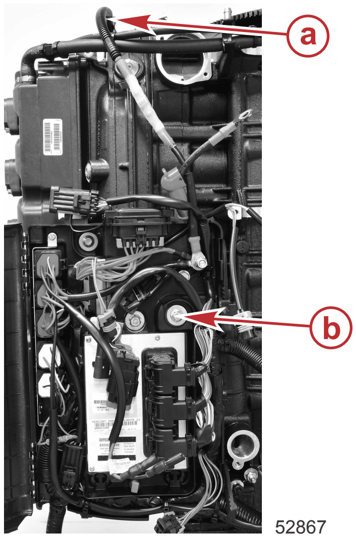


a - CPS harness connector
b - Oil pressure sensor harness connector
c - Oil temperature sensor harness connector

Electrical Box

1. Remove the alternator charge lead from its retainer on the top of the powerhead.
2. Remove the electrical box retaining screw and washer.
3. Disconnect the cylinder head temperature sensor harness connector from the cylinder head temperature sensor (S/N 1B517433 and below).

4. Slide the electrical box towards the rear of the engine to remove the electrical box from the support grommets.

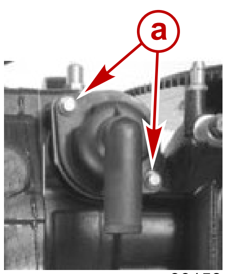


52867

a - Sensor harness connector
b - Retaining screw and washer

Thermostat Housing

1. Remove the two screws securing the thermostat housing to the cylinder block.
2. Remove the thermostat housing assembly from the cylinder block.



39158

a - Thermostat housing screws

3. Remove the old O-ring from the thermostat housing.

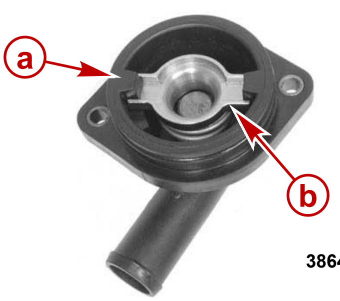
   NOTE: Replacement of the O-ring is recommended when the thermostat housing is removed.

4. Clean any sealant or debris from the sealing surfaces on the thermostat housing and the cylinder block.

Thermostat Removal

IMPORTANT: The thermostat housing may require cleaning if debris has entered the cooling system.

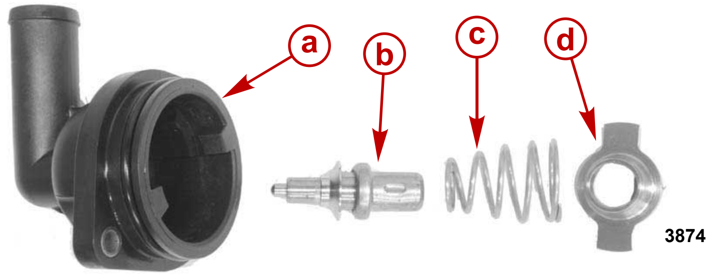
1. Push down on the thermostat retainer to disengage the thermostat retainer.
2. Turn the thermostat retainer to unlock it from the thermostat housing.



3864

a - Thermostat retainer lock
b - Thermostat retainer

3. Remove the thermostat, thermostat spring, and thermostat retainer from the thermostat housing. Inspect the thermostat for damage, corrosion, or signs of blockage, and test the thermostat if it is being reinstalled.

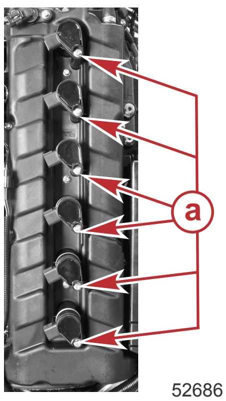


a - Thermostat housing
b - Thermostat
c - Thermostat spring
d - Thermostat retainer

Ignition Coil

1. Remove the screws securing the ignition coils to the valve cover.
2. Carefully pull the ignition coils off of the spark plugs.

   NOTE: *Do not bend the ignition coils. Bending the ignition coil will damage the coil and/or the spark plug.*



a - Ignition coil screws

3. Remove the spark plugs from the cylinder head.

Powerhead Disassembly

Cylinder Head Removal

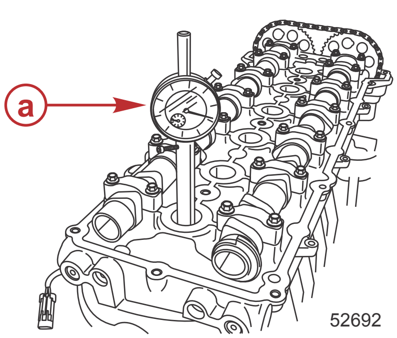
IMPORTANT: The powerhead must be removed from the outboard in order to remove the cylinder head.

IMPORTANT: The removal and disassembly procedure of the cylinder head and camshafts must be strictly followed. Failure to follow the removal procedure may damage the valve train components.

IMPORTANT: Do not intermix the location of the valve train parts.

IMPORTANT: This engine is an interference valve train design. Do not rotate the crankshaft or camshafts when the timing chain is loose or removed from the camshaft gears unless advised to do so. Inadvertent movement of the crankshaft or camshafts may result in valve and/or piston damage.

1. Remove the screws retaining the valve cover to the cylinder head. Remove the valve cover.
2. Install a dial indicator gauge with extension kit and rotate the engine so that the number one piston is at compression stroke top dead center (TDC).

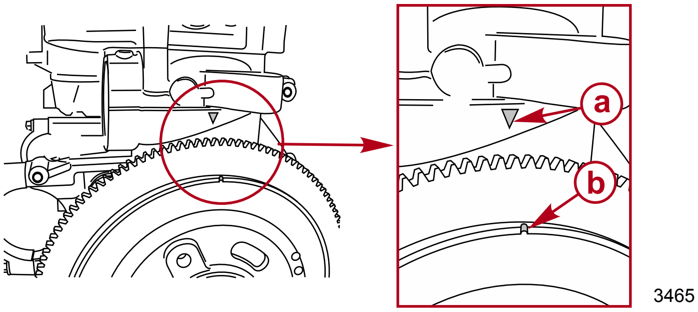


a - Dial indicator

Dial Indicator	91- 58222A 1

Dial Indicator Extension Adapter	91-805382T01

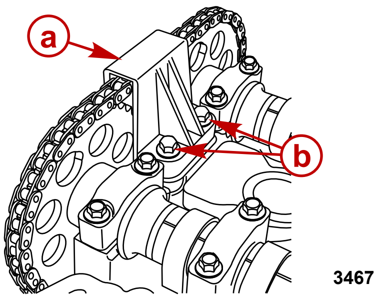
NOTE: The timing mark on the flywheel will be aligned with the timing mark on the cylinder block.



a - Timing mark on the cylinder block
b - Timing mark on the flywheel

3. Remove the short span chain guide screws (S/N1B733951 and below). Remove the short span chain guide.

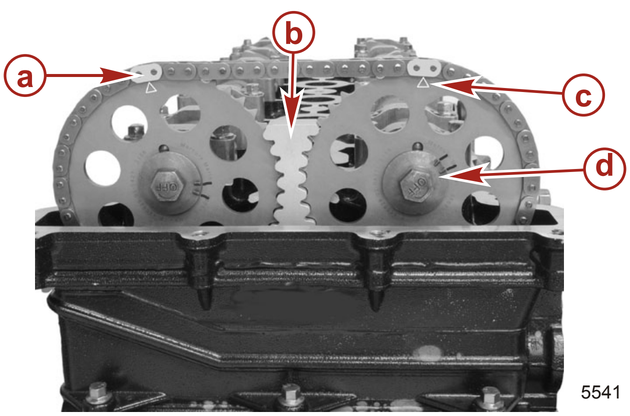
   NOTE: Engines with S/N 1B733952 and above do not have the short span chain guide mounted to the cylinder head. Instead, the camshaft cover has guides molded in the underside of the cover.



a - Short span chain guide
b - Screws

4. Install the cam brake between the intake and exhaust camshaft gears.

   NOTE: When installing the cam brake, it may be necessary to rotate one of the camshafts slightly to align the cam brake to the camshaft gears.



a - Timing chain anodized link
b - Cam brake
c - Camshaft gear timing mark
d - Camshaft gear retaining screw (left hand thread)

Cam Brake	91-896911A01

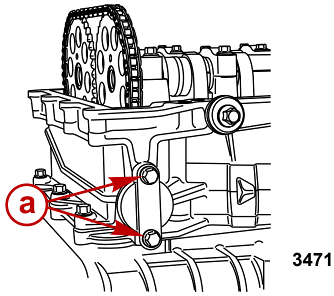
IMPORTANT: Camshafts must be locked with a special tool to prevent loading of the camshaft gears and chain. Loading the camshaft gear and chain may damage the camshaft gear and chain.

5. Loosen the camshaft gear retaining screws.

   NOTE: Camshaft gear retaining screws are left-hand threaded.

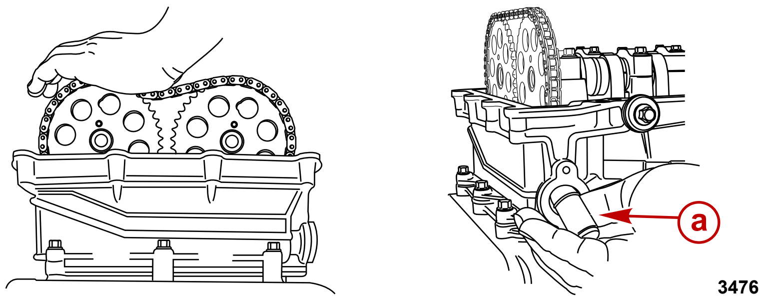
6. Remove the cam brake and camshaft gear retaining screws.

7. Remove the timing chain tensioner cover screws.



a - Timing chain tensioner cover screws

8. Place your hand over the chain tensioner bore. With the heel of your other hand, press on the timing chain between the camshaft gears. This will assist to dislodge the tensioner from the cylinder head bore.

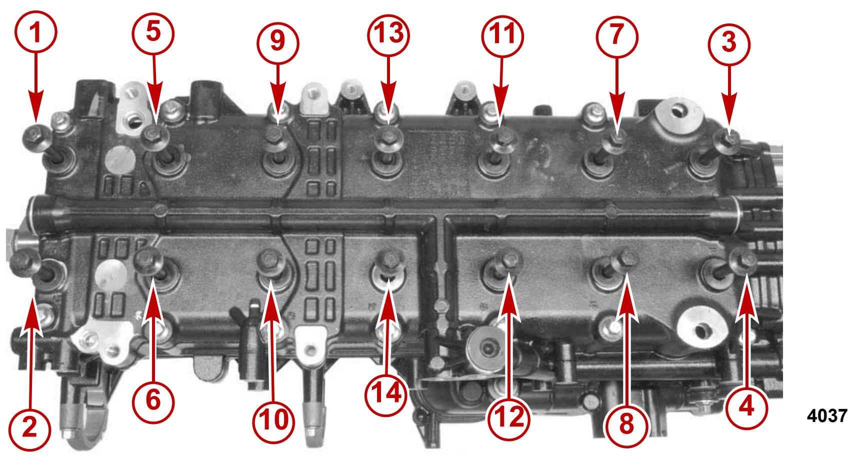


a - Timing chain tensioner

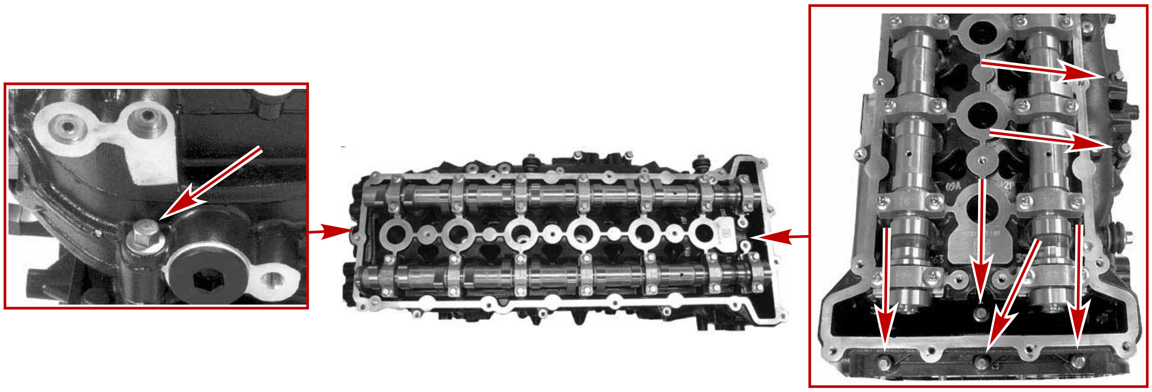
9. Remove the camshaft gears. Allow the timing chain to drop into the cylinder block area.
10. Loosen the long main bolts in the sequence shown. Completely remove the long main bolts only if you are completely disassembling the powerhead.

    IMPORTANT: It is not necessary to completely remove the long main bolts when removing only the cylinder head. If the cylinder block is to be disassembled, the long main bolts must be removed and replaced.

    NOTE: The cylinder block has rubber dampers for the long main bolts. The long main bolt threads will be difficult to pull past the dampers. Unthread the main long bolts past the rubber dampers.



11. Remove the cylinder head perimeter screws. Remove the cylinder head.



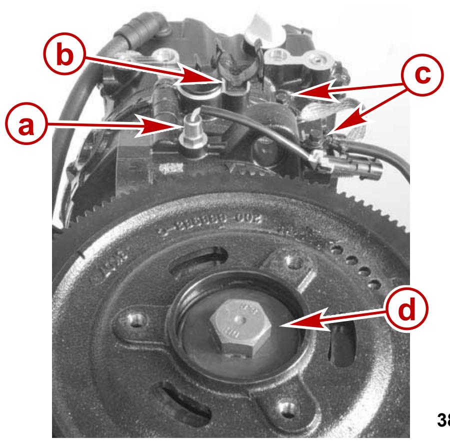
4004

IMPORTANT: Do not set the cylinder head down on its deck. Damage to the valves may result. Set the cylinder head on pillow blocks to prevent damage to the valves.

Refer to **Section 4B** - **Cylinder Head Disassembly** and **Section 4B** - **Cleaning/Inspection/Repair**.

Flywheel

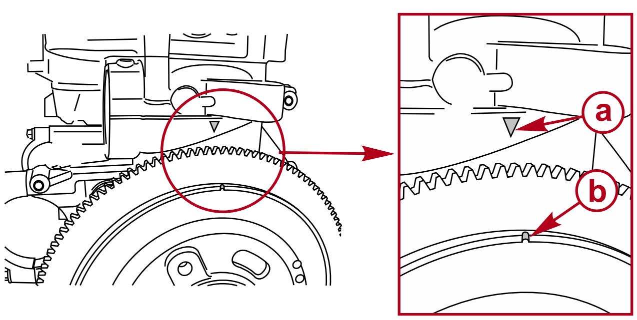
1. If you are removing the flywheel as part of a complete engine disassembly, complete the following steps. If you are only replacing the flywheel, skip ahead to **Step 5.**
2. Remove the cylinder block temperature sensor.
3. Remove the screws securing the ground wires to the cylinder head and cylinder block.
4. Unthread the integrated oil module (IOM) hose support from the cylinder block.



3835

a - Cylinder block temperature sensor
b - Integrated oil module hose support
c - Ground wire screws
d - Flywheel bolt

5. Remove the flywheel bolt cap from the flywheel.
6. Rotate the flywheel clockwise to align the timing marks.

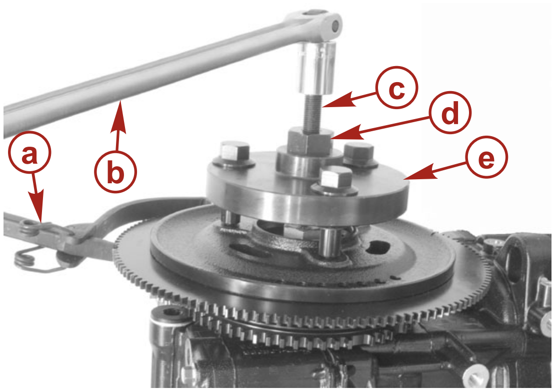


3465

a - Timing mark on the cylinder block
b - Timing mark on the flywheel

7. Loosen the flywheel bolt. Turn the flywheel bolt four turns out from a light seat.
8. Install the flywheel puller base onto the flywheel.
9. Thread the flywheel puller adapter onto the puller base until it bottoms out on the puller base.
10. Thread the flywheel puller bolt into the flywheel puller adapter.
11. Tighten the flywheel puller bolt until the flywheel becomes loose.

IMPORTANT: Do not use power tools to remove the flywheel. Using power tools to remove the flywheel will damage the flywheel puller bolt.



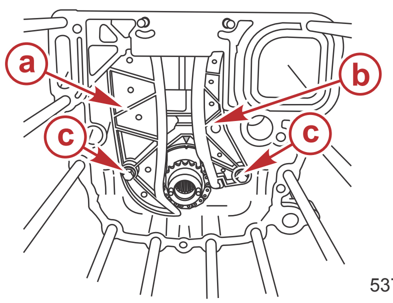
3840

- a - Flywheel holder
- b - Breaker bar
- c - Flywheel puller bolt
- d - Flywheel puller adapter
- e - Flywheel puller base

Flywheel Puller/Lifting Ring	91-895343T02
Flywheel Holding Tool	91- 52344

Crankcase and Crankshaft Disassembly/Removal

1. Remove the timing chain guide and tensioner.



53760

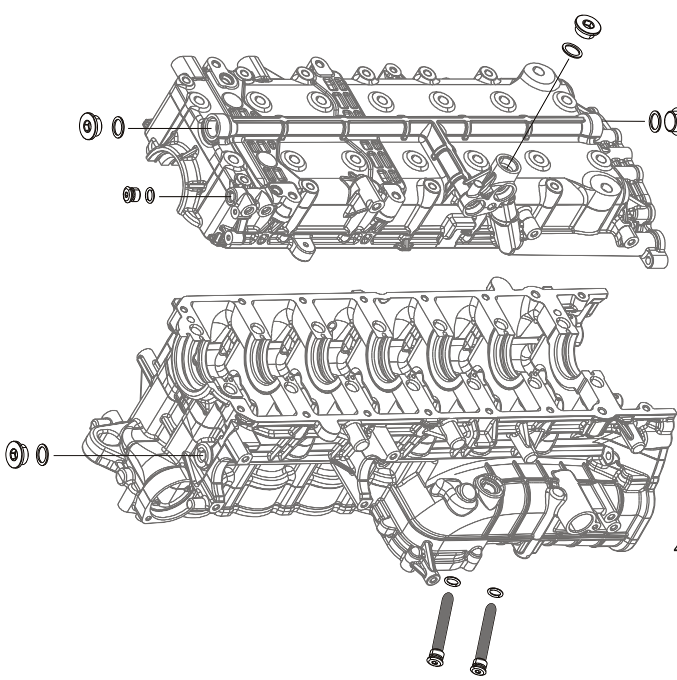
- a - Timing chain guide
- b - Timing chain tensioner
- c - Timing chain tensioner and guide screws

2. Remove the timing chain.

   NOTE: If the timing chain's three anodized links cannot be identified, a new chain must be installed.

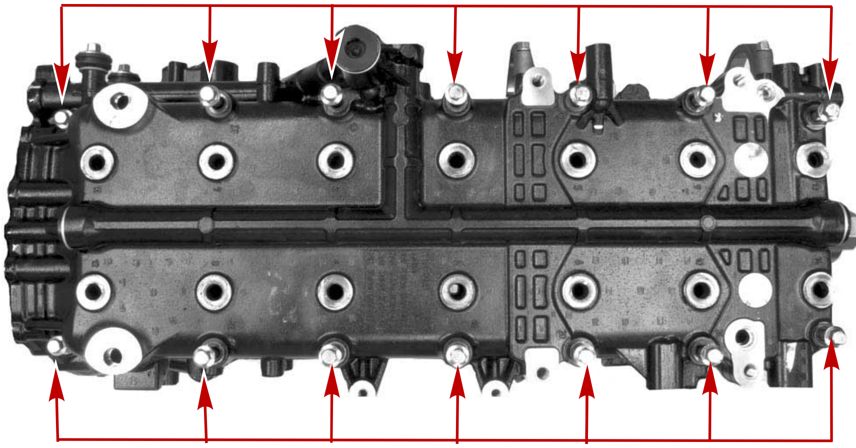
3. Remove all of the anodized aluminum oil passage plugs from the crankcase cover and cylinder block.

   NOTE: If any of the oil passage plugs or water galley plugs are difficult to remove, place a brass drift on the anodized plug and strike the brass drift lightly with a hammer to assist in breaking loose the plugs.



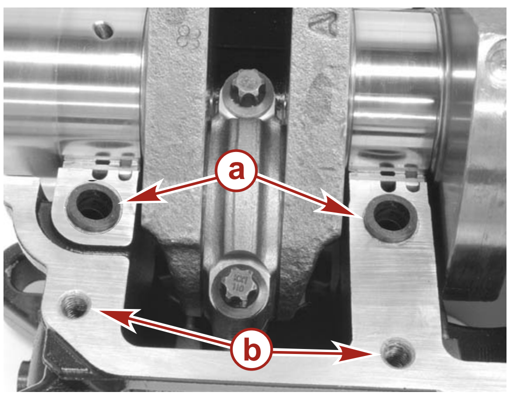
4689

4. Remove the perimeter crankcase cover screws.



4365

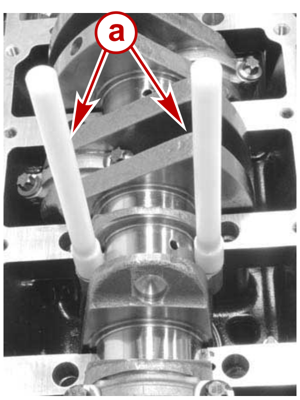
5. Pry the crankcase cover loose with two large screwdrivers. Lift the crankcase cover off of the cylinder block.
   IMPORTANT: Use extreme care to prevent damaging the crankcase mating surfaces.
6. Mark all of the connecting rod caps and rod locations with indelible marker or paint (example: 1, 2, 3, 4, 5, 6).
   IMPORTANT: Do not use a scribe or a metal punch on the connecting rod or rod cap for identification purposes. Using a scribe or metal punch will damage the connecting rod and may cause engine failure.
7. Remove the rubber dampers.



4486

a - Rubber dampers
b - Crankcase cover perimeter screw holes

8. Paint the rod cap screws to identify them as used.
   IMPORTANT: Rod cap screws that have been torqued to specification must not be used for reassembly.
9. Remove the rod cap screws with a Torx #E-12. Remove the rod cap.
10. Install the rod guides to protect the crankpin and cylinder bore from damage.



4834

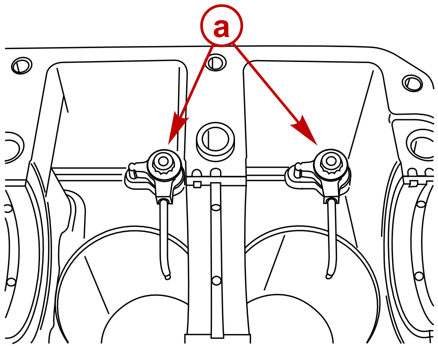
a - Rod guide dowel

Rod Guide Dowel	91-8M0042904

11. Push the connecting rod assembly out of the cylinder bore.
12. Mark the connecting rod up side orientation with indelible marker or paint.
    IMPORTANT: Do not use a scribe or a metal punch on the connecting rod or rod cap for identification purposes. Using a scribe or metal punch will damage the connecting rod and may cause engine failure.

NOTE: The up side orientation of the connecting rod is the same orientation as the dot on the dome of the piston.

13. Install the rod cap to the connecting rod assembly. Ensure that the rod cap fits perfectly. Thread the rod cap screw into the connecting rod. Tighten the rod cap screws securely, but do not torque.
14. Remove the remaining connecting rod assemblies the same way.
15. Remove the crankshaft. Secure the crankshaft in a manner that will prevent damage.
16. Remove the piston cooling jets.

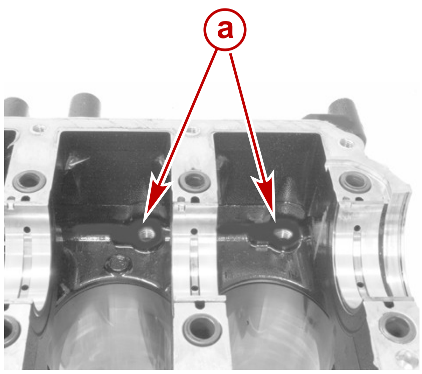


4368

S/N 1B517433 and below

a - Piston cooling jet

NOTE: Engines with S/N 1B517434 and above do not have piston cooling jets.



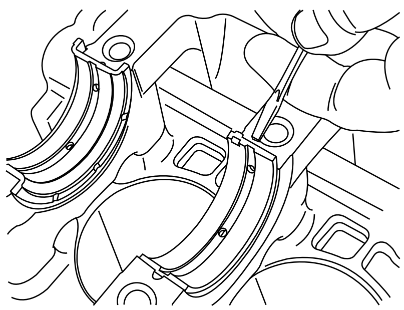
32542

S/N 1B517434 and above

a - Cooling jets are not installed

17. Remove the crankshaft main bearings from the cylinder block and crankcase cover.

NOTE: A small screwdriver or awl will assist in removing the crankshaft main bearings.



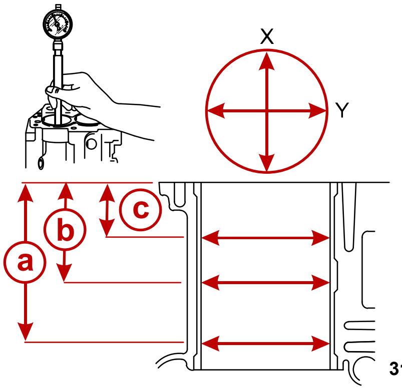
4369

Cleaning, Inspection, and Repair

Measuring Cylinder Bore

Measure the cylinder walls for taper, out of round, or an excessive ridge at the top of the ring travel. All measurements should be made with a cylinder bore dial indicator or an inside micrometer. Carefully move the gauge up and down the cylinder bore to determine taper. Turn the gauge to different points around the cylinder wall to determine the out of round condition.

The measurement for cylinder taper should be taken at three depth locations: 20 mm (0.8 in.), 60 mm (2.4 in.), and 100 mm (3.9 in.).



a - 100 mm (3.9 in.)
b - 60 mm (2.4 in.)
c - 20 mm (0.8 in.)

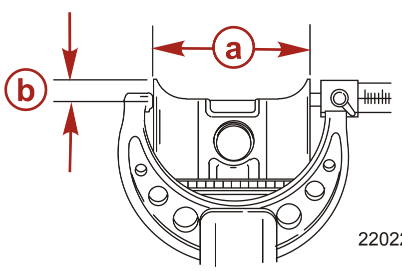
Cylinder Bore Specification	
Standard	82.0 mm (3.228 in.)
Out of round (production)	0.015 mm (0.0006 in.)
Out of round (service)	0.0762 mm (0.003 in.)
Taper (production)	0.015 mm (0.0006 in.)
Taper (service)	0.0762 mm (0.003 in.)

Measuring Piston

Inspect the piston wall for wear or damage. Replace the piston if necessary.

Piston Diameter

1. Measure the piston at a point 6 mm (0.236 in.) from the bottom, 90° to the piston pin. Replace the piston if it is out of specification.



a - Piston diameter
b - Measure point 6 mm (0.236 in.)

Piston	
Diameter	81.975 mm (3.227 in.)

2. Measure the piston-to-cylinder-wall clearance. If it is out of specification, examine the piston and cylinder bore further to determine repair/replacement.

The minimum piston-to-cylinder-wall clearance is defined by the formula: **Minimum cylinder bore measurement – maximum piston diameter measurement = piston-to-cylinder clearance.**

Piston-to-Cylinder-Wall Clearance	
Minimum clearance	0.060 mm (0.0024 in.)

Piston Ring Groove

Measure the piston ring groove. Replace the piston if it is out of specification.

32820

- a - Top ring groove
- b - Middle ring groove
- c - Oil ring groove

Piston Ring Groove	
Top ring groove	1.25 mm (0.049 in.)
Middle ring groove	1.25 mm (0.049 in.)
Oil ring groove	2.05 mm (0.081 in.)

Piston Ring Side Clearance

Measure the piston ring side clearance. Replace the piston rings as a set if they are out of specification.

32808

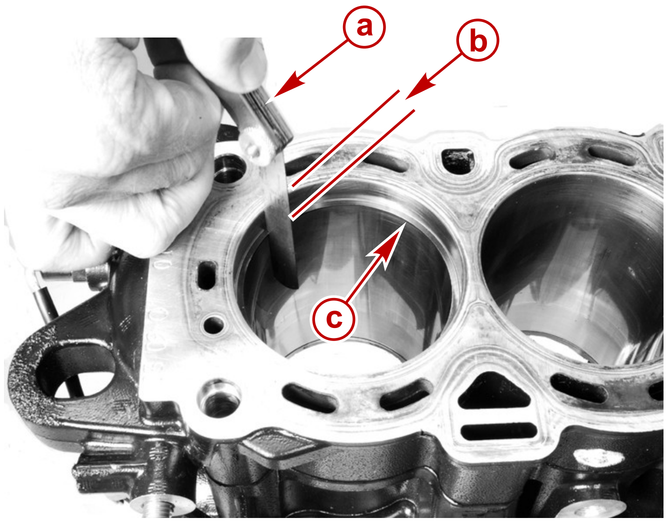
- a - Top ring
- b - Middle ring
- c - Oil ring

Piston Ring Side Clearance	
Top ring	0.04–0.08 mm (0.001–0.003 in.)
Middle ring	0.04–0.08 mm (0.001–0.003 in.)
Oil ring	0.05–0.17 mm (0.002–0.006 in.)

Piston Ring End Gap

Measure the piston ring end gap clearance. Replace the piston rings as a set if they are out of specification.

NOTE: The piston ring must be level inside of the cylinder bore for measurement. Push the ring 25.4 mm (1.00 in.) into the bore with the crown of a piston.



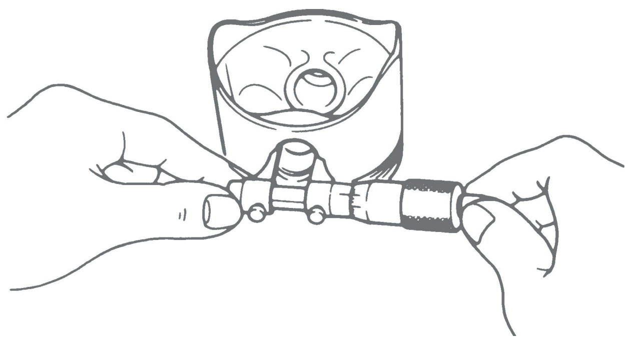
32822

a - Feeler gauge
b - 25.4 mm (1.00 in.)
c - Piston ring

Piston Ring End Gap	
Top	0.27–0.42 mm (0.010–0.016 in.)
Middle	0.42–0.62 mm (0.016–0.024 in.)
Oil	0.20–0.70 mm (0.007–0.027 in.)

Piston Wrist Pin Diameter

Measure the piston pin bore diameter. Replace the piston if it is out of specification.

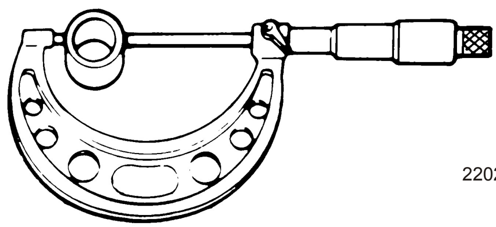


22025

Piston Pin	
Wrist pin bore diameter	22.004–22.011 mm (0.8662–0.8665 in.)

Piston Wrist Pin

Measure the piston wrist pin diameter. Replace the piston assembly if the pin is out of specification.



22026

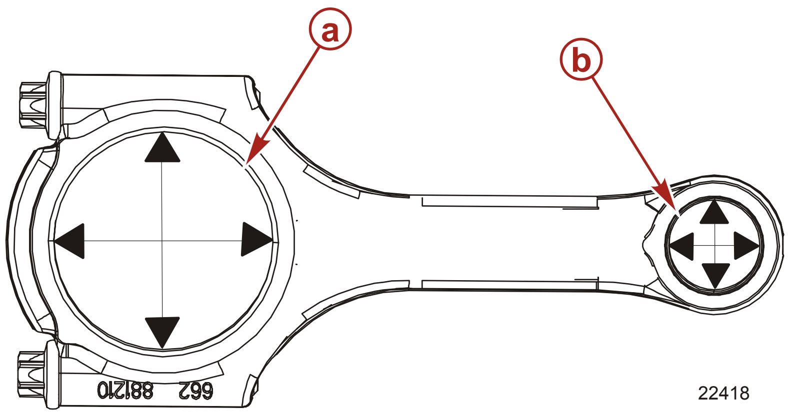
Piston Wrist Pin	
Diameter	21.997–22.000 mm (0.8660–0.8661 in.)

Measuring Connecting Rod

1. Ensure that the rod cap fits perfectly on the connecting rod. Tighten the connecting rod cap bolts to the specified torque.

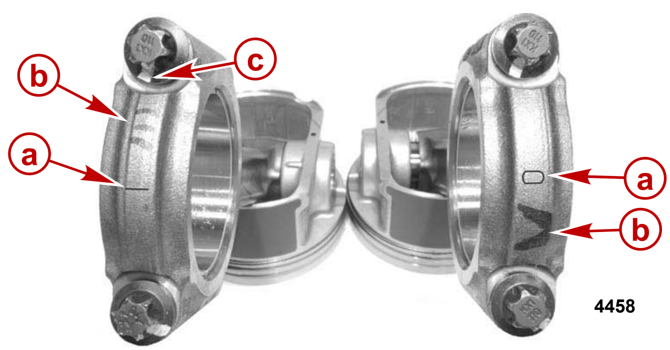
Description	Nm	lb-in.	lb-ft
Rod cap bolts	10	88.5	–

2. Measure the small (piston pin) and large (crankpin journal) ends of the connecting rod.



a - Crankshaft journal end
b - Piston pin end

3. Compare the connecting rod crankpin journal measurement with the crankpin journal grade specifications listed in the following chart. If the connecting rod crankpin journal measurement does not match the stamped connecting rod crankpin journal grade, replace the connecting rod.



a - Stamped connecting rod crankpin journal grade
b - Marker indicating cylinder location
c - Paint on rod cap screw

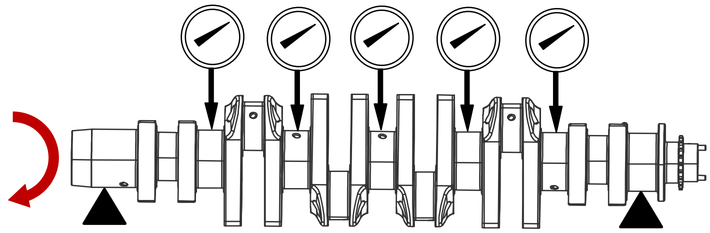
Connecting Rod	
Piston pin	22.005–22.014 mm (0.8663–0.8666 in.)
Crankpin journal grade "I"	53.000–53.009 mm (2.0866–2.0869 in.)
Crankpin journal grade "0"	53.009–53.018 mm (2.0869–2.0873 in.)

Measuring Crankshaft

Crankshaft Runout

1. Thoroughly clean the crankshaft and inspect the bearing surfaces. Replace the crankshaft if the bearing surfaces are pitted, scored, or discolored.
2. Measure runout on all of the main bearing journals. Replace the crankshaft if it is out of specification.

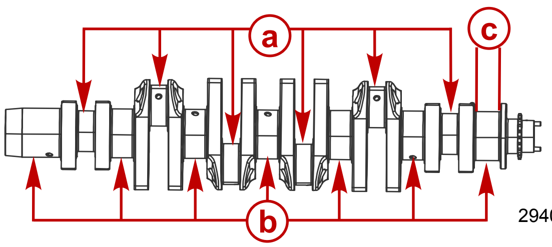
3. Clean the oil holes in the crankshaft.



Crankshaft	
Runout limit	0.05 mm (0.002 in.)

Crankshaft Main Bearing and Crankpin Measurement

1. Measure crankshaft main bearing journal diameters and crankpin journal diameters. Replace the crankshaft if the diameters are out of specification.
2. Measure the bottom main bearing width. Replace the crankshaft if it is out of specification.



a - Crankpin journals
b - Main bearing journals
c - Bottom main bearing width

Crankshaft Journal Specifications		
Description	**Dimension**	**Grade**
Main bearing journal	59.993–60.001 mm (2.3619–2.3622 in.)	A
	59.985–59.993 mm (2.3616–2.3619 in.)	B
Crankshaft pin journal	49.991–50.000 mm (1.9681–1.9685 in.)	C
	49.982–49.991 mm (1.9678–1.9681 in.)	D
Bottom main bearing width	31.40–31.6 mm (1.236–1.244 in.)	–

Powerhead Assembly

Powerhead Preassembly Cleaning Recommendations

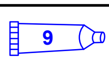
IMPORTANT: Any threaded hole or bolt with threadlocking compound that is contaminated with oil must be thoroughly cleaned with a solvent to remove all traces of oil contamination. Failure to remove oil contamination will result in poor threadlocking compound adhesion.

Prior to assembling the powerhead, all threaded holes on the cylinder head and cylinder block must be cleared of threadlocking compound dust. Use compressed air to clear threadlocking compound dust.

Wash the cylinder block and crankcase cover with hot soapy water to remove debris and honing compound. Dry the cylinder block with compressed air. Failure to thoroughly clean the cylinder block of honing compound and/or debris will result in premature engine failure.

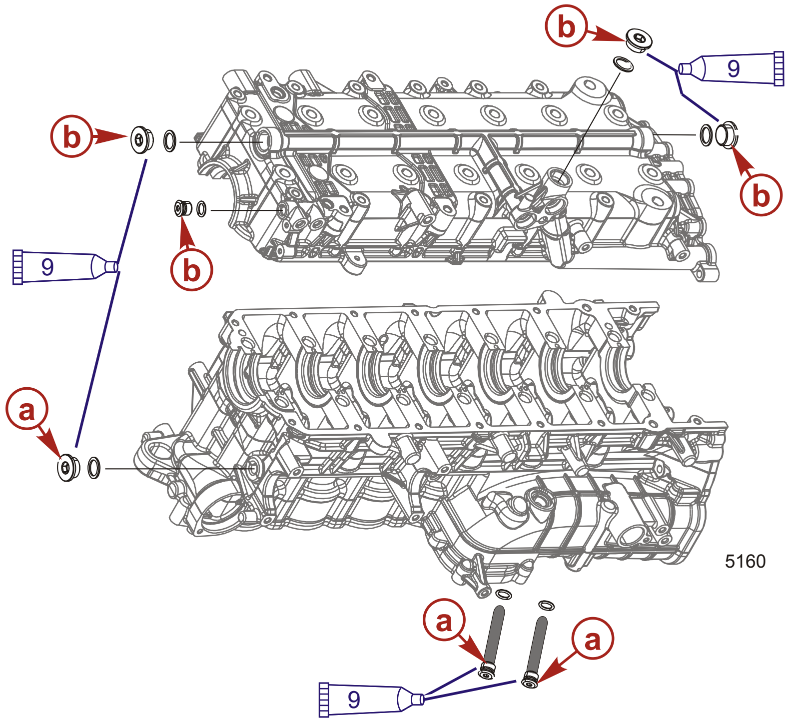
Installing Water and Oil Jacket Plugs

1. Install new O-rings onto the water and oil galley plugs.
2. Apply Loctite 567 PST Pipe Sealant on the threads of the water and oil galley plugs.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Water and oil galley plug threads	92-809822

3. Install the water galley plugs. Tighten them to the specified torque.

4. Install the oil galley plugs. Tighten them to the specified torque.

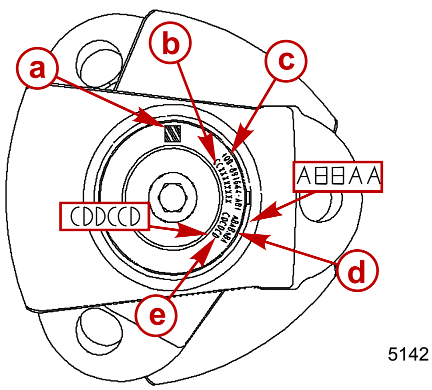


a - Water galley plugs
b - Oil galley plugs

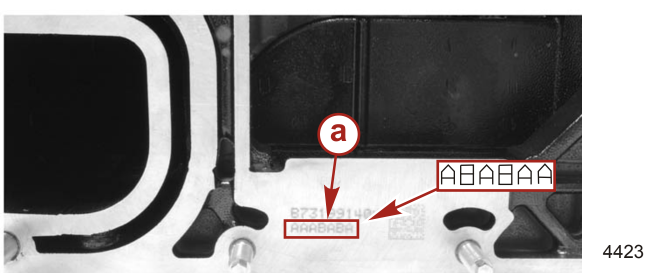
Description		Nm	lb-in.	lb-ft
Water galley plugs	M24 x 2	50	–	36.9
	M12 x 1.5	9	80	–
Oil galley plugs	M24 x 2	50	–	36.9
	M12 x 1.5	9	80	–

Selecting New Crankshaft Bearings

When replacing the crankshaft main bearings and crankpin bearings, select the suitable bearing from the bearing grade identifier located at the flywheel end of the crankshaft and on the bottom of the cylinder block.



a - Bar code
b - Manufacture date
c - Part number
d - Main bearing journal grade
e - Crankpin journal grade



a - Cylinder block main bearing journal grade

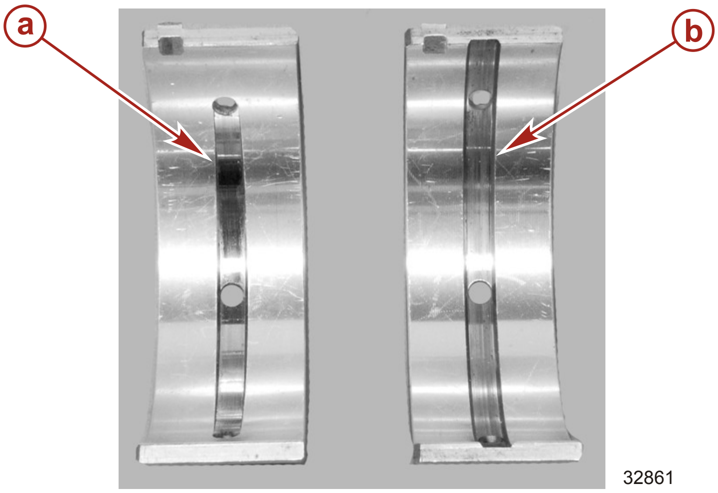
NOTE: When reading the main bearing journal grade on the crankshaft, the journal grade is in sequential order from J1 to J7 in a clockwise orientation.

NOTE: When reading the crankpin bearing journal grade on the crankshaft, the journal grade is in sequential order from P1 to P6 in a clockwise orientation.

NOTE: When reading the main bearing journal grade on the cylinder block, the journal grade is in sequential order from the top main bearing to the bottom thrust bearing.

Crankshaft Main Bearing Grade Selection

IMPORTANT: Two styles of main bearings are available: the eccentric groove main bearing is used on engines with S/N 1B517434 and above, and the full circle groove main bearing is used on engines with S/N 1B517433 and below. The eccentric main bearings do not backfit, nor can they be intermixed with full circle groove main bearings.



32861

a - Eccentric groove main bearing (S/N 1B517434 and above)
b - Full circle groove main bearing (S/N 1B517433 and below)

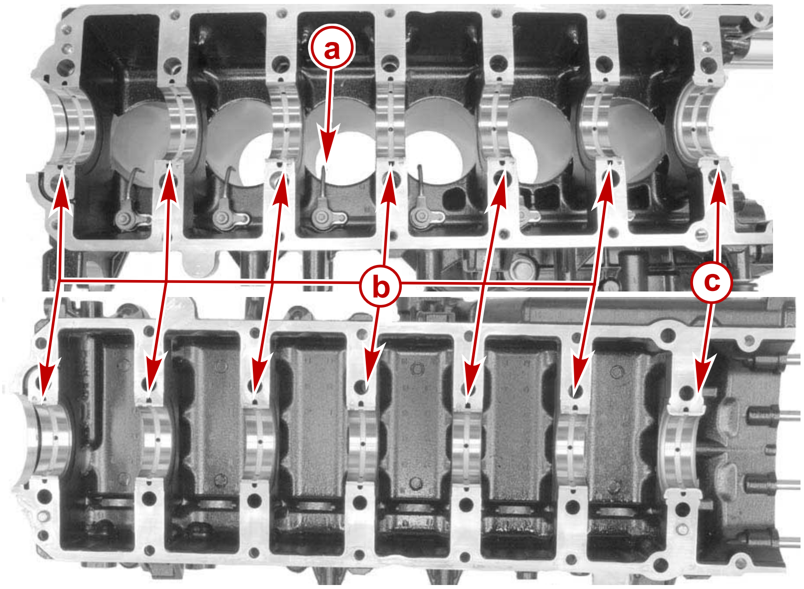
Crankshaft	
Main bearing oil clearance (without expansion)	0.014–0.042 mm (0.0005–0.0016 in.)

IMPORTANT: Ensure that all mating surfaces, oil passages, water jackets, and cylinder bores are clean prior to assembling the powerhead. Always install new gaskets, seals, O-rings, piston rings, and wrist pin retaining clips. Replace torque-to-yield screws where advised to do so. Follow all advised lubrication during assembly.

1. Check the crankshaft journal size code and the cylinder block main bearing code.
2. Refer to the bearing selection chart to select the correct crankshaft main bearings.
   IMPORTANT: After selecting the correct bearing, install the bearing halves in the cylinder block and crankcase cover matching journal location to avoid mixing the bearing sizes.

Crankshaft Journal Code	Cylinder Block Code	Bearing Color Selection
A	A	Green
A	B	Blue
A	C	White
B	A	Blue
B	B	White

Crankshaft Journal Code	Cylinder Block Code	Bearing Color Selection
B	C	Orange



4382

a - Piston cooling jet (S/N 1B517433 and below)
b - Main bearings
c - Main thrust bearing

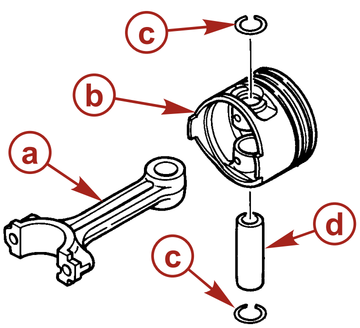
3. Ensure that all debris is removed from the cylinder block and crankcase cover main bearing area, and install the selected main bearings.

Piston/Connecting Rod Assembly

1. Lubricate the piston pin with Lubriplate SPO 255.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Piston pin	Obtain Locally

2. Assemble the piston, connecting rod, piston pin, and new piston pin retaining clips.
IMPORTANT: Always install new piston pin retaining clips.



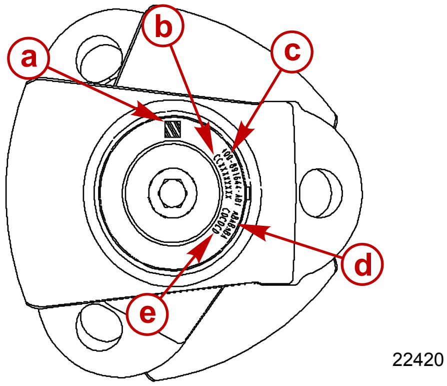
6366

a - Paint mark on connecting rod
b - Piston
c - Piston pin retaining clip
d - Piston pin

Connecting Rod Bearing Grade Selection

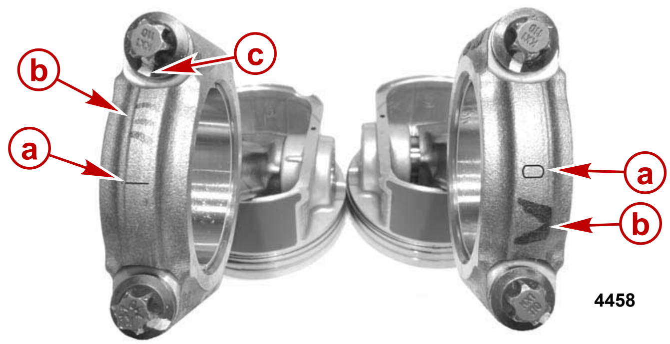
Connecting Rod	
Bearing oil clearance	0.020–0.050 mm (0.0008–0.0019 in.)

1. Check the crankpin journal size code on the flywheel end of the crankshaft.



a - Bar code
b - Manufacture date
c - Part number
d - Main bearing journal grade
e - Crankpin journal grade

2. Check the journal grade code on the connecting rod cap.



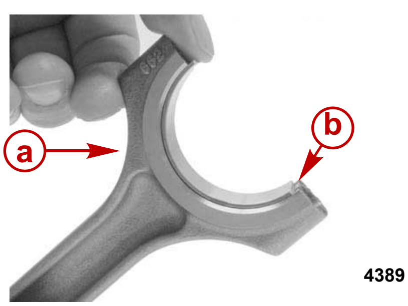
a - Stamped connecting rod crankpin journal grade
b - Marker indicating cylinder location
c - Paint on rod cap screw

Connecting Rod Specifications	
Piston pin	22.005–22.014 mm (0.8663–0.8666 in.)
Crankpin journal grade "I"	53.000–53.009 mm (2.0866–2.0869 in.)
Crankpin journal grade "0"	53.009–53.018 mm (2.0869–2.0873 in.)

3. Refer to the following bearing selection chart to select the correct crankshaft connecting rod bearings.
IMPORTANT: After selecting the correct bearing, install the bearing halves in the connecting rod and the matching connecting rod cap to avoid mixing bearing sizes.

Connecting Rod Journal Code	Crankshaft Pin Journal Code	Bearing Color Selection
I	C	Blue
I	D	White
0	C	White
0	D	Orange

4. Ensure that the connecting rod bearing area is free of debris.
5. Install the locating tab of the upper half of the bearing into the slot on the connecting rod, and the locating tab of the lower half of the bearing into the slot on the connecting rod cap. Carefully push the bearing onto the connecting rod and connecting rod cap.



a - Connecting rod
b - Connecting rod locating tab

Piston Ring Installation

IMPORTANT: Do not reuse the original rings during reassembly. Always install new rings when rebuilding the engine.
IMPORTANT: Use caution when installing piston rings to avoid scratching the piston.

1. Apply Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil to the piston ring grooves.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston ring grooves	92-858052K01

2. Install the oil ring spacer onto the lower ring groove of the piston.

   NOTE: Ensure that the oil ring spacer gap is properly oriented on the piston. The oil ring spacer cannot be rotated after the bottom and top oil control rings are installed.

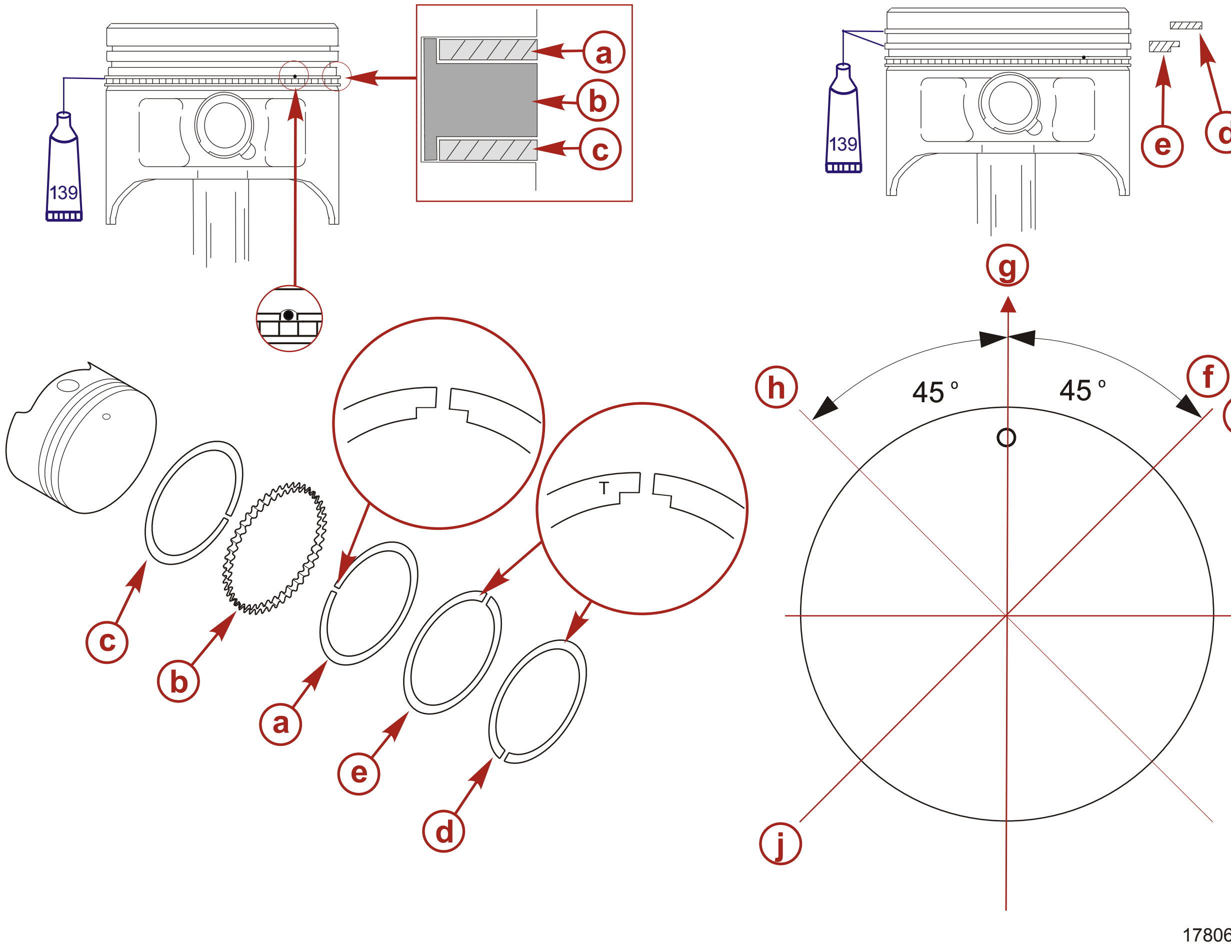
3. Install the bottom oil control ring.
4. Install the top oil control ring.

   NOTE: The top oil ring uses a locating pin on the piston.

5. Install the middle compression ring.
6. Install the top compression ring.

   NOTE: The top piston compression ring must be installed with the "T" side up. Spread the rings just enough to slip over the piston.

7. Position the piston ring gaps as shown.

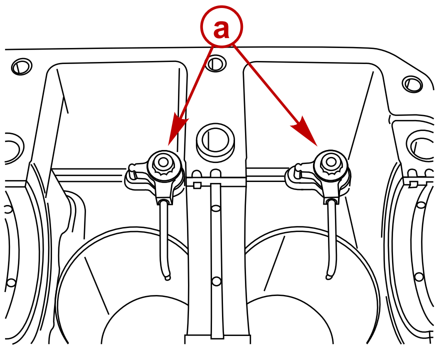


a - Top oil control ring
b - Oil ring spacer
c - Bottom oil control ring
d - Top compression ring
e - Middle compression ring
f - Bottom oil control ring gap
g - Oil ring spacer
h - Top oil control ring gap
i - Top compression ring gap
j - Middle compression ring gap

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston ring grooves	92-858052K01

Piston Assembly Installation

1. On engines with S/N 1B517433 and below, install the piston cooling jets. Tighten them to the specified torque.



4368

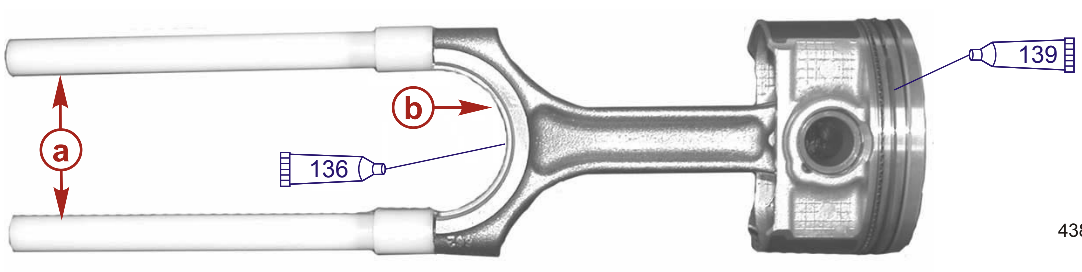
a - Piston cooling jets

Description	Nm	lb-in.	lb-ft
Piston cooling jet	23.6	–	17.3

2. Install the piston rod guide dowels onto the connecting rod assembly. Lubricate the piston rings with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.

Rod Guide Dowel	91-8M0042904

3. Lubricate the connecting rod bearing with Lubriplate SPO255.
4. Lubricate the cylinder bore with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.



4388

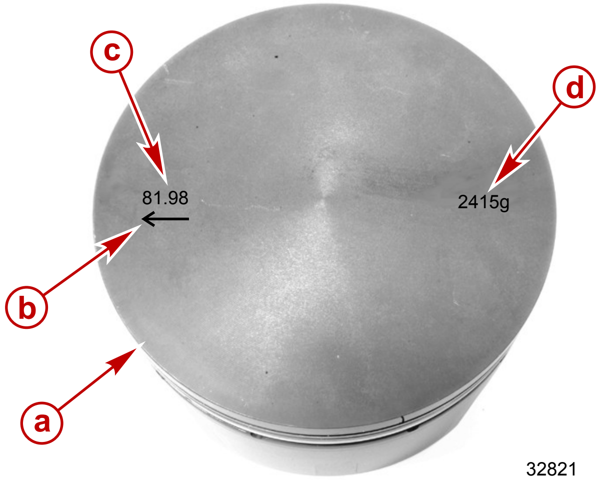
a - Piston rod guide dowel
b - Connecting rod bearing

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Piston rings, cylinder bore	92-858052K01
136	Lubriplate SPO 255	Connecting rod bearing	Obtain Locally

5. Slide the piston ring compressor (obtain locally) over the piston so that 50% of the piston is showing below the ring compressor.

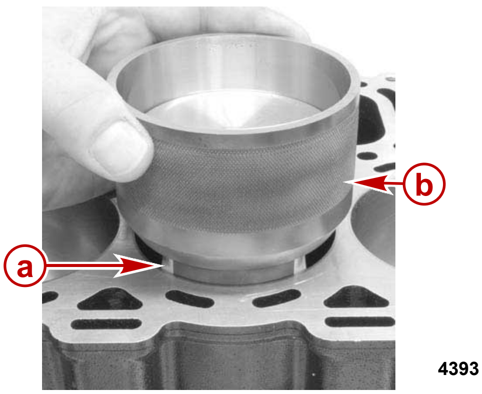
Ring Compressor	Obtain locally

6. Insert the piston assembly into the cylinder bore. Ensure that the dot or arrow on the piston is pointing towards the flywheel end of the crankshaft.



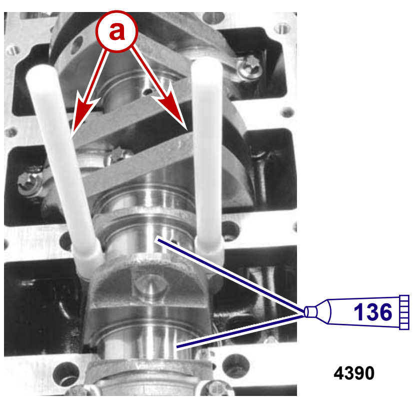
a - Forged piston
b - Arrow points toward flywheel
c - Diameter of piston in millimeters
d - Weight of piston in grams

7. Ensure that the ring compressor is fully seated onto the cylinder block.



a - Piston skirt
b - Ring compressor

8. Ensure that the rod guides straddle the crankpin.
9. Push the piston assembly into the cylinder bore and onto the crankpin.
10. Remove the rod guides.
11. Lubricate the crankpin with Lubriplate SPO 255.



a - Rod guide

Rod Guide Dowel	91-8M0042904

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Crankpin	Obtain Locally

12. Install the rod cap/bearing assembly.
13. Ensure that the rod cap orientation is correct. The rod cap must fit perfectly onto the connecting rod.

14. Lubricate the new rod cap screw threads and the underside of the screw head with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Rod cap screw threads and the underside of the screw head	92-858052K01

15. Install the new rod cap screws.
16. Tighten the rod cap screws to the specified torque.

    NOTE: After the second torque, paint a line on the rod cap screw parallel with the crankshaft. This will help determine when the rod cap screw has turned the additional 90°, or use a torque angle gauge to measure the additional 90° rotation.
17. Turn the rod cap screw an additional 90° after the second torque.

Description		Nm	lb-in.	lb-ft
Connecting rod screw	**First**	15	133	–
	Second	30	–	22
	Final	Turn additional 90° after second torque		

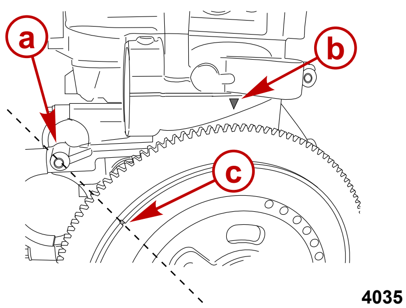
18. Install the remaining connecting rod assemblies in the same sequence.

Cylinder Head Installation

IMPORTANT: This engine uses an interference valve train design. Do not rotate the crankshaft or camshafts while the timing chain is loose or removed from the camshaft gears unless advised to do so. Failure to adhere to this caution may result in valve and/or piston damage.

IMPORTANT: The installation procedure for the cylinder head must be strictly followed. Failure to follow the installation procedure may damage the valve train components.

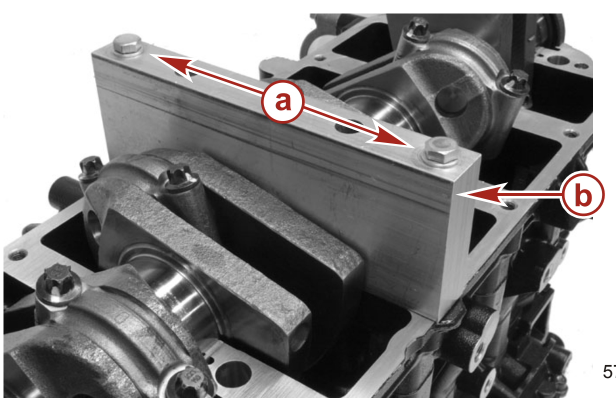
1. Install the flywheel key onto the crankshaft and install the flywheel.
2. Install the flywheel retaining bolt and washer. Tighten the flywheel bolt until it is snug.
3. Rotate the flywheel so that the flywheel timing mark aligns with the rear starter mount. This will allow sufficient piston-to-valve clearance to rotate the camshafts.



4035

a - Rear starter mount
b - Cylinder block timing mark
c - Flywheel timing mark

4. Install the crankshaft retainer onto one of the center main bearings. Tighten the crankshaft retainer bolts securely.



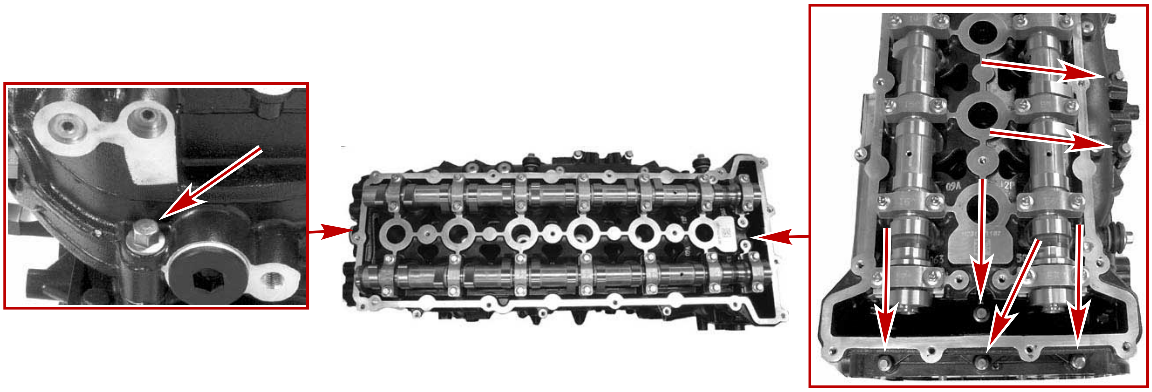
5755

a - Crankshaft retainer bolts
b - Crankshaft retainer

Crankshaft Retainer	91-8M0044311

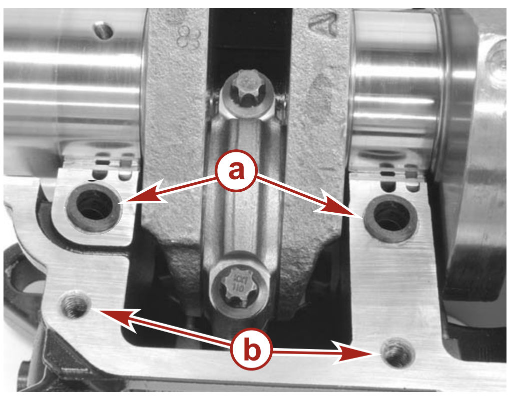
5. Rotate the cylinder block to install the head.

6. Place a new head gasket onto the cylinder block.
7. Install the cylinder head onto the cylinder block.
8. Install the cylinder head perimeter screws so that they are snug. Do not tighten the cylinder head perimeter screws at this time.



4004

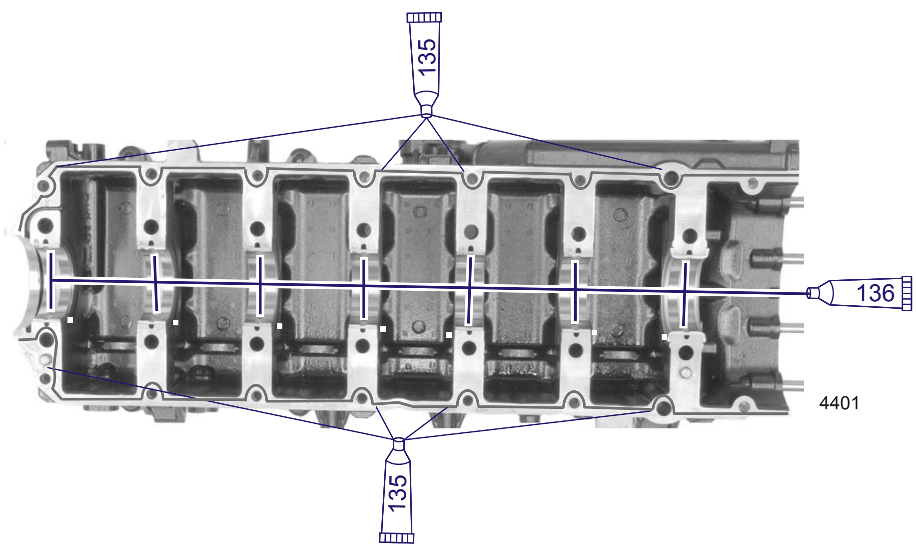
9. Rotate the cylinder block and remove the crankshaft retainer.
10. Install the rubber dampers into the cylinder block. Ensure that the dampers are seated completely in the cylinder block.



4486

a - Rubber dampers installed
b - Crankcase cover perimeter screw holes

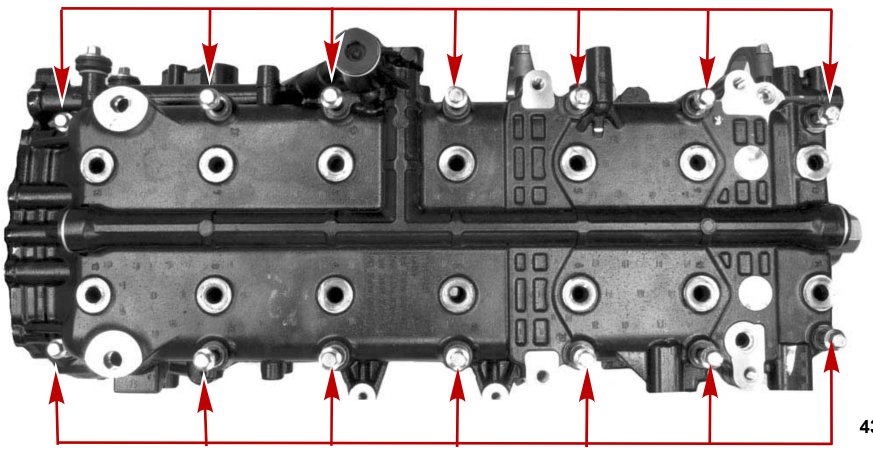
11. Apply a 1.0 mm (0.04 in.) by 1.0 mm (0.04 in.) thin continuous bead of Three Bond 1217F around the cylinder block cover perimeter. Do not allow Three Bond 1217F to contact the main bearings.
12. Lubricate the crankshaft main bearings with Lubriplate SPO 255.



4401

Tube Ref No.	Description	Where Used	Part No.
135	Three Bond 1217F	Cylinder block cover	92-858005K02
136	Lubriplate SPO 255	Main bearing	Obtain Locally

13. Carefully place the cylinder block cover onto the cylinder block.
14. Install the perimeter screws, but do not tighten them.



4365

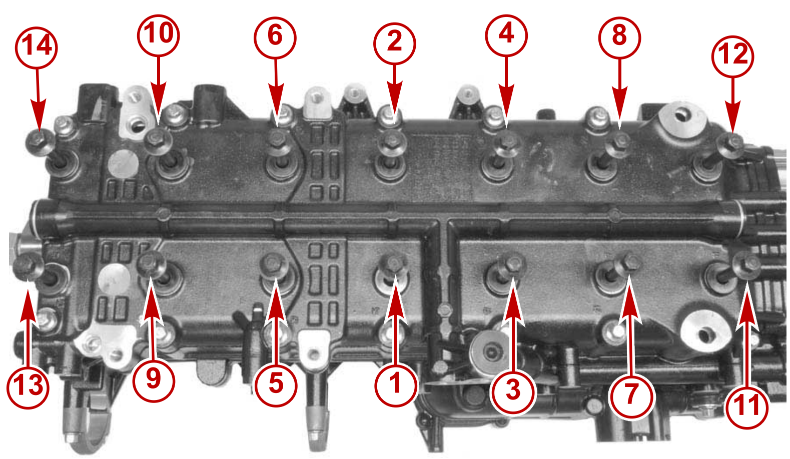
15. Lubricate the threads of the long main bolts with Molybdenum Disulfide Grease.

Tube Ref No.	Description	Where Used	Part No.
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Long main bolts	Obtain Locally

16. Insert the long main bolts into the cylinder block cover. Thread the long main bolts into the rubber dampers and into the cylinder head.

    NOTE: Do not force the long main bolts past the cylinder block rubber dampers. Forcing the long main bolts past the cylinder block rubber dampers may damage or fold the cylinder block rubber dampers.

17. In the order listed on the cylinder block cover, tighten the long main bolts following the first two torque specifications.
18. After the second torque specification is attained, mark all of the long main bolt heads with a line of paint, parallel to the crankshaft. This will help ensure the 270° turn is correctly attained. A torque angle gauge can also be used.



4000

Description		Nm	lb-in.	lb-ft
Long main bolt	**First**	27	–	20
	Second	55	–	40.5
	Final	Turn additional 270° after 2nd torque is attained		

19. Tighten the cylinder block perimeter screws in the order listed on the cylinder block to the specified torque.

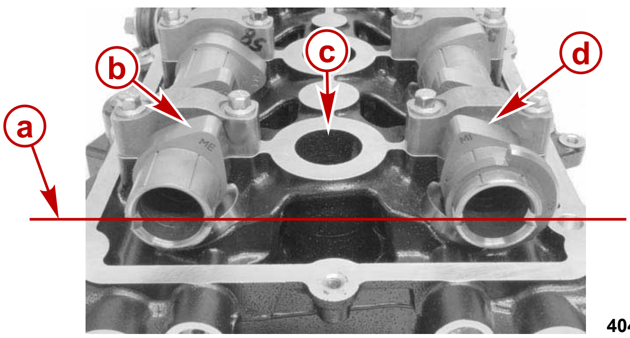
Description	Nm	lb-in.	lb-ft
Cylinder block perimeter screws	35	–	26

20. Tighten the cylinder head perimeter screws to the specified torque.

Description		Nm	lb-in.	lb-ft
Cylinder head perimeter screws	(M8 x 60)	28	–	20.6
	(M6 x 40)	11	97	–

21. Refer to **Section 4B** - **Valve Clearance and Adjustments** for valve clearance specifications, and check the valve lash clearance on all the valves. If the valve lash is not within specification, refer to **Section 4B** - **Valve Clearance and Adjustments.** If the valve lash is within specification, proceed with the next step.
22. Rotate the camshafts so that the camshaft lobes for cylinder number one, intake and exhaust, point towards the spark plug coil.

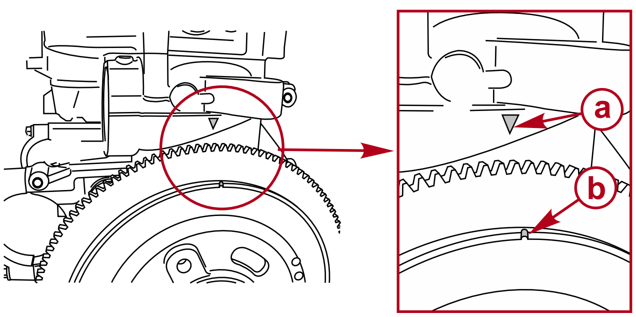
NOTE: The camshafts will be in correct alignment when the machined grooves on the top of the camshafts are aligned.



4044

a - Machined groove on top of camshafts
b - Exhaust camshaft lobe position
c - #1 spark plug hole
d - Intake camshaft lobe position

23. Rotate the flywheel clockwise so the flywheel timing mark aligns with the arrow on the cylinder block.



3465

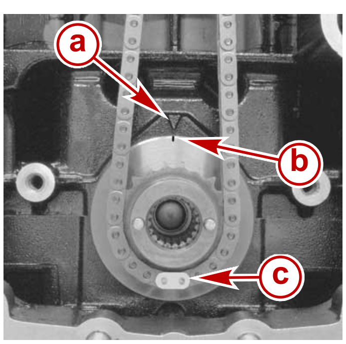
a - Timing mark on the cylinder block
b - Timing mark on the flywheel

Timing Chain

IMPORTANT: This engine uses an interference valve train design. Do not rotate the crankshaft or camshafts when the timing chain is loose or removed from the camshaft gears unless advised to do so. Inadvertent movement of the crankshaft or camshafts may result in valve and/or piston damage.

IMPORTANT: The removal, disassembly, reassembly, and installation procedure of the head and camshafts must be strictly followed. Failure to follow the removal outline procedure may damage the valve train components.

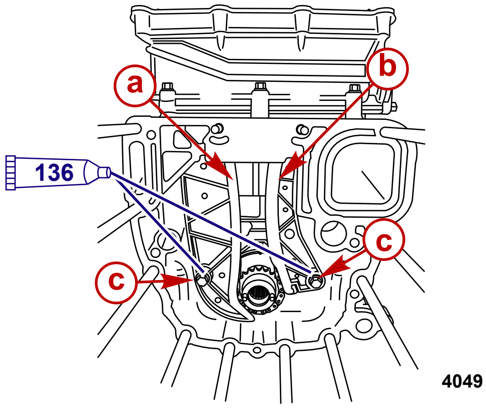
1. Ensure that the crankshaft timing mark is aligned with the cylinder block timing mark.
2. Install the timing chain with the anodized link directly below the timing marks on the cylinder block and the crankshaft.



4047

a - Cylinder block timing mark
b - Crankshaft timing mark
c - Timing chain anodized link

3. Install the fixed chain guide and the movable chain guide to the cylinder block.
4. Lubricate the chain guide bolts with Lubriplate SPO 255.



a - Fixed chain guide
b - Movable chain guide
c - Chain guide retaining bolts

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Chain guide bolts	Obtain Locally

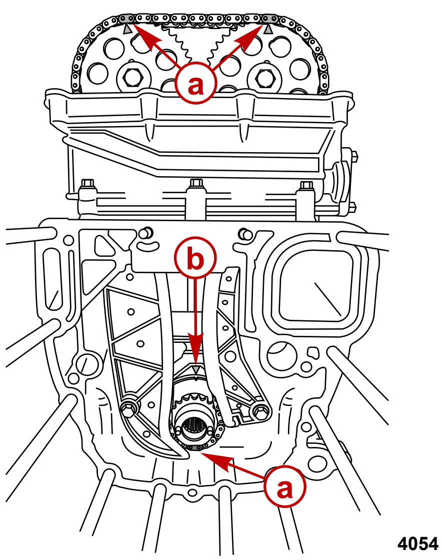
5. Tighten the chain guide bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Fixed and movable chain guide bolt	24	–	17.5

6. Install the camshaft gear onto the intake cam. Retain the camshaft gear with the camshaft gear screw and washer. **Do not tighten the camshaft gear screw at this time.**

   NOTE: Camshaft gear screws are left-hand threaded.

7. Install the timing chain on the intake camshaft gear. The anodized link of the timing chain must align with the timing mark on the camshaft gear. Rotating the crankshaft a few degrees may ease the installation of the timing chain/camshaft gear onto the camshaft. Secure the camshaft gear with the camshaft gear retaining screw and washer. **Do not tighten the camshaft gear screw at this time.**
8. Place the exhaust camshaft timing gear in the chain, ensuring that the timing mark on the camshaft gear and the anodized timing chain link are aligned. Install the camshaft gear with the timing chain onto the exhaust camshaft. Secure the camshaft gear with the camshaft gear retaining screw and washer. **Do not tighten the camshaft gear screw.**
9. Inspect the timing chain installation for correct alignment of the timing chain anodized links. Ensure that the crankshaft timing mark and the cylinder block timing marks are in alignment with each other.



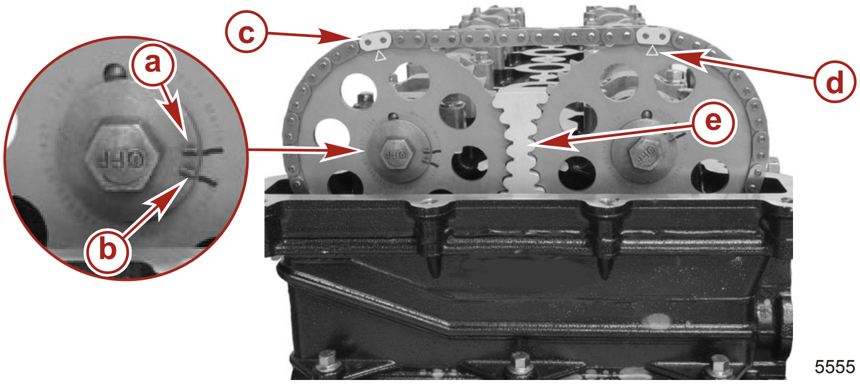
a - Timing chain anodized links
b - Cylinder block timing mark

10. Install the cam brake.

    IMPORTANT: Camshafts must be locked with a special tool to prevent loading of the camshaft gears and chain. Loading the camshaft gear and chain may damage the camshaft gear and chain.

Cam Brake	91-896911A01

11. The camshaft gear screws should be tightened in two steps. First, tighten the camshaft gear screw to 45 Nm (33 lb-ft).
12. Paint an orientation line on the camshaft gear, in line with the mark on the camshaft gear washer. Turn the camshaft gear screw so the second mark on the camshaft gear washer aligns with the paint orientation line. This is the additional 20° turn after the first torque is attained.



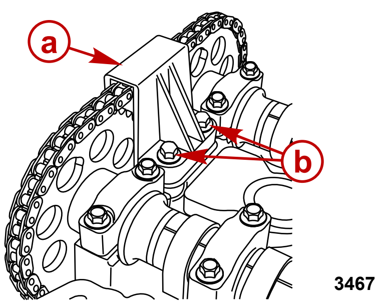
a - First torque
b - Second torque
c - Anodized link
d - Camshaft gear timing mark
e - Cam brake

NOTE: Camshaft gear screws are left-hand threaded.

Description		Nm	lb-in.	lb-ft
Camshaft gear screw (M12 x 40) **Left-hand threaded**	**First**	45	–	33
	Final	Turn additional 20° after first torque is attained		

13. Remove the cam brake.
14. Install the short span chain guide (S/N 1B733951 and below). Tighten the short span chain guide screws to the specified torque.

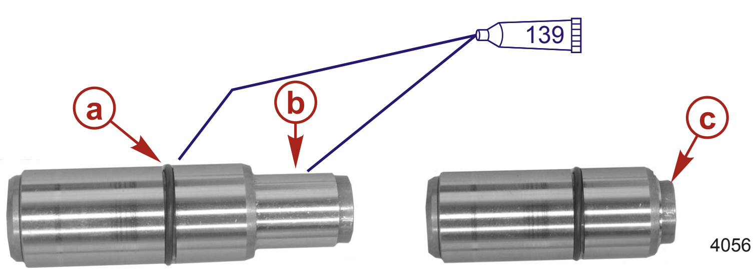
NOTE: Engines with S/N 1B733952 and above do not have the short span chain guide mounted to the cylinder head. Instead, the camshaft cover has guides molded in the underside of the cover.



a - Short span chain guide
b - Screws

Description	Nm	lb-in.	lb-ft
Short span chain guide screw (M6 x 30)	12	106	–

15. Place a new O-ring on the timing chain tensioner assembly.
16. Compress the timing chain tensioner assembly and release the tensioner slowly. The tensioner should remain compressed.
17. Lubricate the timing chain tensioner with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.

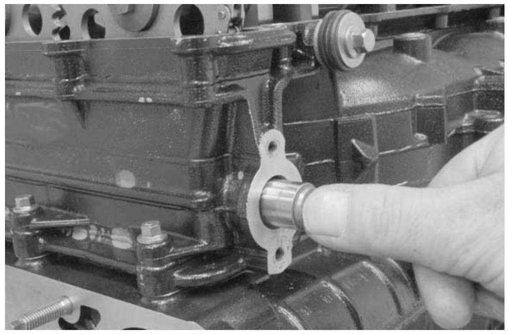


a - O-ring
b - Tensioner extended
c - Tensioner compressed

Tube Ref No.	Description	Where Used	Part No.
	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Timing chain tensioner	92-858052K01

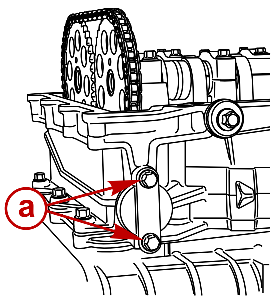
18. Carefully push the timing chain tensioner assembly into the cylinder head.

NOTE: The timing chain tensioner O-ring will retain the timing chain tensioner in the cylinder head.



4057

19. Install a new O-ring onto the timing chain tensioner cover.
20. Tighten the chain tensioner cover screws to the specified torque.

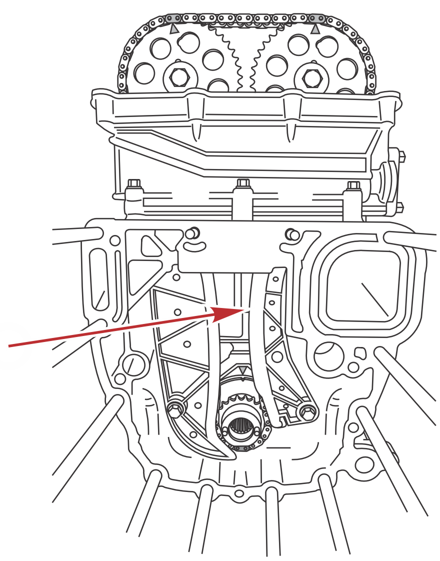


3471

a - Chain tensioner cover screw

Description	Nm	lb-in.	lb-ft
Chain tensioner cover screw (M6 x 25)	11	97	–

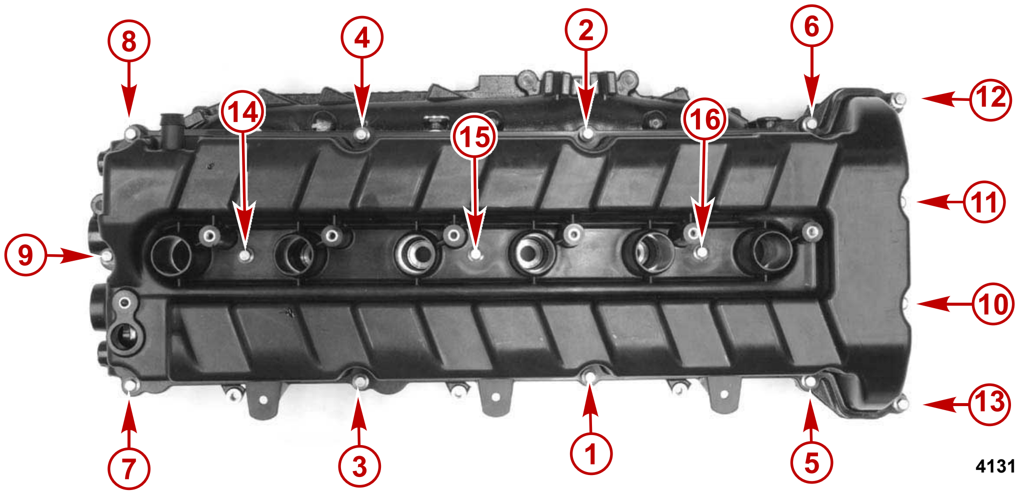
21. Push the movable chain guide towards the timing chain tensioner. The timing chain tensioner should expand and maintain proper timing chain tension.



53747

22. Install a new gasket onto the valve cover.
23. Install the valve cover.
24. Install all of the valve cover screws.
25. Tighten the valve cover screws to the specified torque, in the sequence shown.

26. After the final valve cover screw has been torqued, check the center valve cover screws for proper torque.



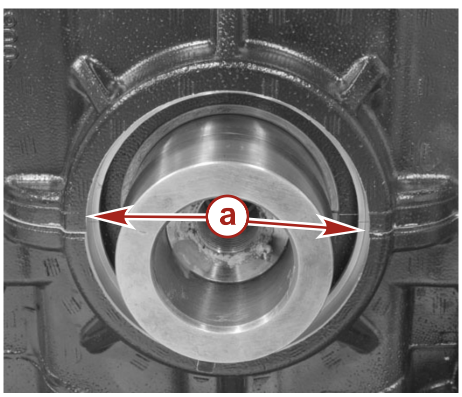
4131

Description	Nm	lb-in.	lb-ft
Valve cover screw (M6 x 25)	8	71	–

Installing the Upper Crankshaft Seal

Preparation

1. Thoroughly clean the inside diameter of the cylinder block crankcase seal area.
2. Lightly lubricate the inside diameter of the cylinder block crankcase seal area with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.

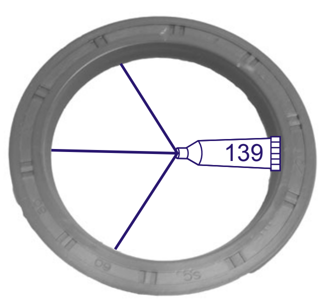


5856

a - Area to be lubricated

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Inside diameter of cylinder block crankshaft seal area	92-858052K01

3. Lightly lubricate the crankshaft seal inside diameter with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.



16027

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Inside diameter of crankshaft seal	92-858052K01

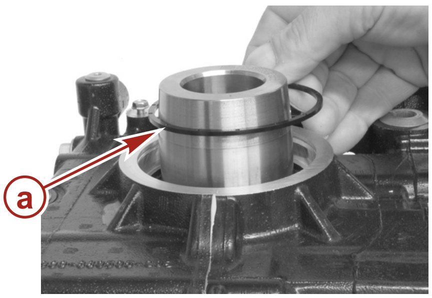
NOTICE

If the crankshaft's upper bore is contaminated prior to installation, the oil seal will not seat properly, leading to engine damage during operation. Ensure that the crankshaft's upper bore is completely clear of any oil or debris before installing the oil seal or other components.

New Crankshaft Installation

IMPORTANT: Use this procedure when using a new crankshaft in a replacement cylinder block, or reusing the original block with a new crankshaft.

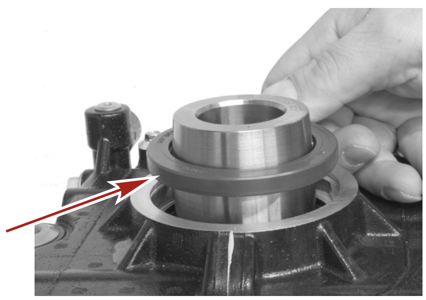
1. Place the seal spacer inside the seal bore area.



14806

a - Seal spacer

2. Install the crankshaft seal into the cylinder block seal bore.



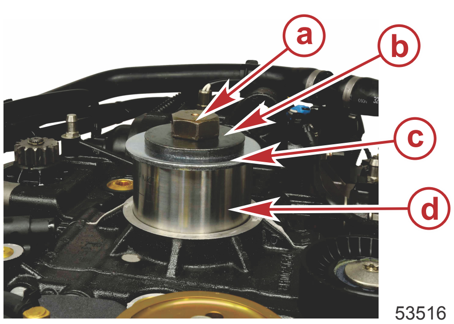
14807

3. Fabricate a seal installation tool from 3-1/8 in. outside diameter, 11 gauge or 1/8 in. wall tubing or appropriate size PVC pipe, and a large washer (at least 3-1/8" outside diameter). The tool should be between 3.81 cm (1.50 in.) and 4.45 cm (1.75 in.) tall.

   NOTE: Refer to the following step for a photo of the seal installation tool.

4. Install the seal installation tool, large washer, flywheel washer (if necessary), and the flywheel bolt. Slowly tighten the flywheel bolt to install the seal. Do not tighten the bolt after the seal has seated in its bore.

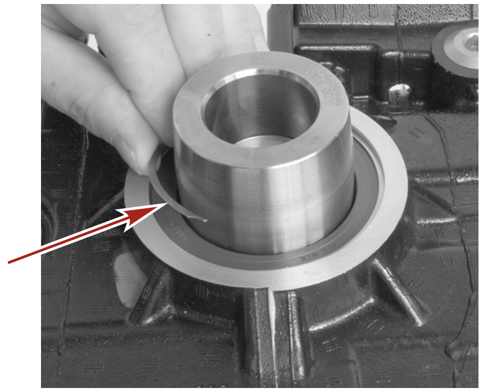
   NOTE: Use the flywheel washer to seat the head of the flywheel bolt on the tool, as shown, if necessary.



53516

a - Flywheel bolt
b - Flywheel washer
c - Large washer
d - Seal installation tool

5. Remove the installation tool and install the retaining ring onto the cylinder block retaining ring groove.

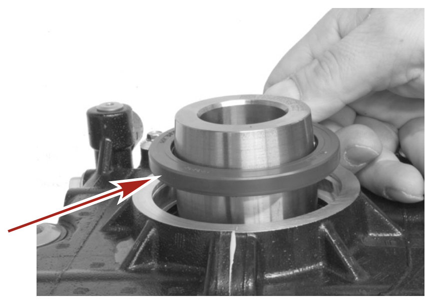


14818

Original Crankshaft Installation

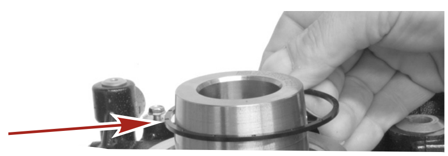
IMPORTANT: When using the original crankshaft in a replacement cylinder block, or reusing the original block and the original crankshaft, inspect the crankshaft seal area for a seal groove. If a seal groove is present, the crankshaft seal must be installed before the crankshaft seal spacer. If no seal groove is present, follow the installation instructions for a new crankshaft installation.

1. Install the crankshaft seal into the cylinder block seal bore.



14807

2. Install the seal spacer.



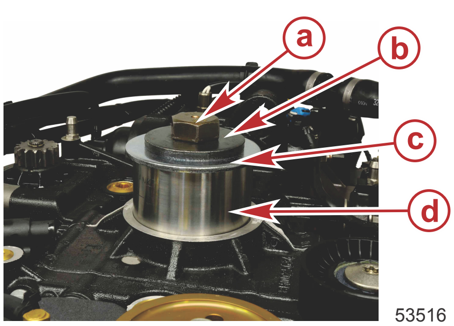
14829

3. Fabricate a seal installation tool from 3-1/8 in. outside diameter, 11 gauge or 1/8 in. wall tubing or appropriate size PVC pipe, and a large washer (at least 3-1/8" outside diameter). The tool should be between 3.81 cm (1.50 in.) and 4.45 cm (1.75 in.) tall.

   NOTE: Refer to the following step for a photo of the seal installation tool.

4. Install the seal installation tool, large washer, flywheel washer (if necessary), and the flywheel bolt. Slowly tighten the flywheel bolt to install the seal. Do not tighten the bolt after the seal has seated in its bore.

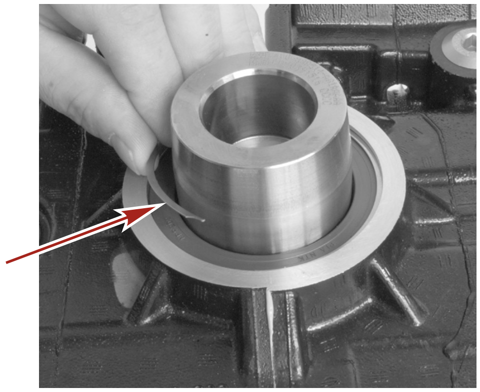
   NOTE: Use the flywheel washer to seat the head of the flywheel bolt on the tool, as shown, if necessary.



53516

a - Flywheel bolt
b - Flywheel washer
c - Large washer
d - Seal installation tool

5. Remove the installation tool and install the retaining ring onto the cylinder block retaining ring groove.



14818

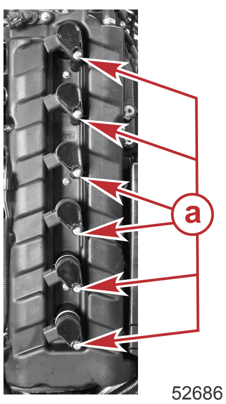
Installing Powerhead Components

Ignition Coil

1. Install the spark plugs. Tighten them to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plug	27	–	20

2. Install the ignition coils onto the spark plugs.
3. Ensure that the ignition coil seal is not distorted.
4. Align the ignition coil mounting hole with the threaded hole in the valve cover.
5. Install the ignition coil screws and tighten them to the specified torque.



52686

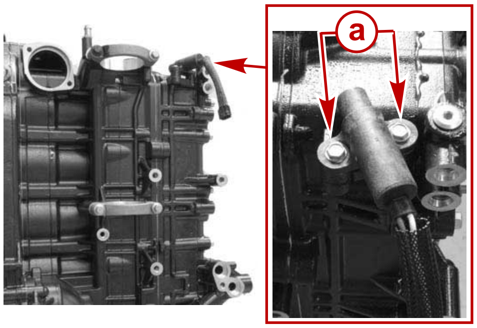
a - Ignition coil screws

Description	Nm	lb-in.	lb-ft
Ignition coil screws	8	71	–

Crankshaft Position Sensor Installation

1. Position the crankshaft position sensor on the engine and secure the sensor with two screws. Tighten the screws to the specified torque.

2. Connect the engine harness connector to the sensor connector.



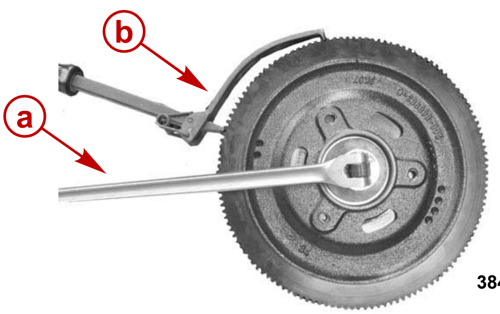
3854

a - Crankshaft position sensor mounting screws

Description	Nm	lb-in.	lb-ft
Screw (M5 x 16)	5	44	–

Flywheel Installation

1. Ensure that the contact surface of the flywheel and the crankshaft are void of debris and oil.
2. Insert the flywheel key onto the crankshaft.
3. Align the flywheel and flywheel key. Install the flywheel.
4. Ensure that the flywheel is completely seated on the taper of the crankshaft.
5. Install the washer and flywheel bolt.
6. Use the flywheel holding tool and ttighten the flywheel bolt in two steps to the specified torque.



3849

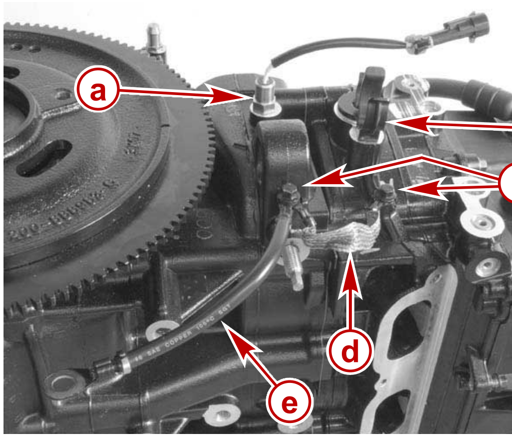
a - Torque wrench
b - Flywheel holding tool

Flywheel Holding Tool	91- 52344

Description		Nm	lb-in.	lb-ft
Flywheel bolt	**First**	60	–	44
	Final	120	–	88.5

7. Install a new O-ring onto the cylinder block temperature sensor.
8. Install the cylinder block temperature sensor. Tighten it to the specified torque.
9. Install the integrated oil module (IOM) hose support.

10. Install the alternator ground wire and the braided ground wire from the cylinder block to the cylinder head. Tighten the ground wire screws to the specified torque.



3853

a - Cylinder block temperature sensor
b - IOM hose support
c - Ground wire screw (M6 x 16)
d - Braided ground wire
e - Alternator ground wire

Description	Nm	lb-in.	lb-ft
Cylinder block temperature sensor	15	133	–
Ground wire screw (M6 x 16)	8	71	–

Thermostat

Thermostat Installation

1. Install the thermostat into the thermostat housing.

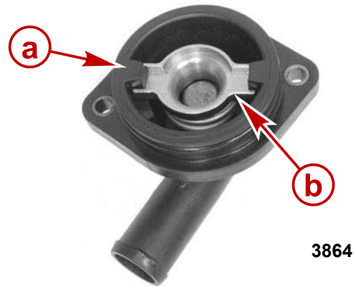
3871

2. Install the thermostat spring. Insert the smaller end of the spring into the thermostat housing.

3872

3. Install the thermostat retainer onto the thermostat spring.

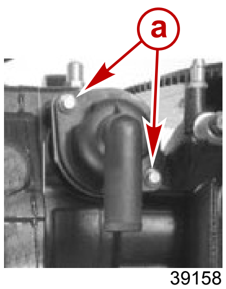
4. Push down on the thermostat retainer. Then turn the retainer to lock it into the thermostat housing.



a - Thermostat retainer lock
b - Thermostat retainer

Thermostat Housing Installation

1. Install a new O-ring onto the thermostat housing.
2. Install the thermostat housing onto the cylinder block. Tighten the screws to the specified torque.



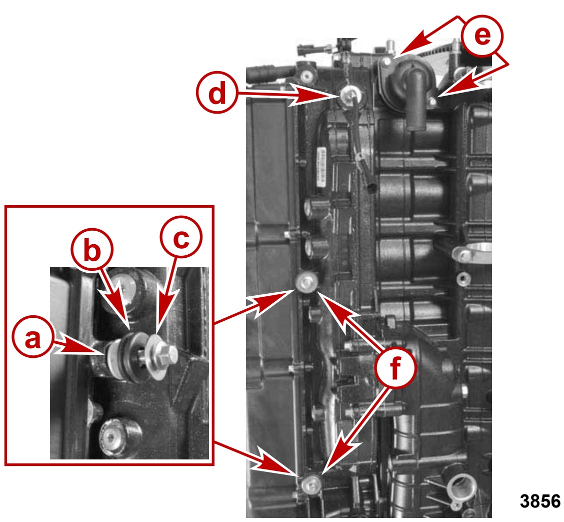
a - Thermostat housing screws

Description	Nm	lb-in.	lb-ft
Thermostat housing screws (M6 x 25)	8	71	–

Electrical Box

NOTE: Engines with S/N 1B517433 and below have a cylinder head temperature sensor. Engines with S/N 1B517434 and above do not have a cylinder head temperature sensor.

1. On engines with S/N 1B517433 and below, install a new O-ring onto the cylinder head temperature sensor. Install the sensor and tighten it to the specified torque.
2. Install the two electrical box mounting screws to the cylinder block. Tighten them to the specified torque.

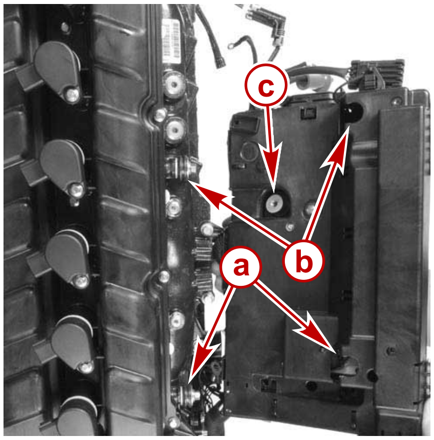


a - Bushing
b - Grommet
c - Washer
d - Cylinder head temperature sensor (S/N 1B517433 and below)
e - Thermostat housing screws
f - Electrical box mounting screws

Description	Nm	lb-in.	lb-ft
Cylinder head temperature sensor	15	133	–
Electrical box mounting screw (M8 x 35)	24	–	17.7

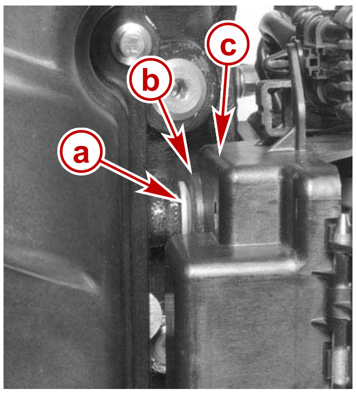
3. Align the electrical box mounting location with the electrical box mounting screws.

4. Slide the electrical box onto the two mounting screws.



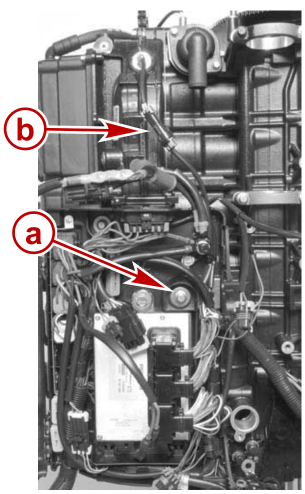
a - Electrical box lower mount location
b - Electrical box upper mount location
c - Bushing

5. Ensure that the two electrical box grommets are seated correctly before proceeding.



a - Bushing (upper shown)
b - Half of the grommet
c - Electrical box

6. Align the electrical box mounting hole with the threaded hole in the cylinder block.
7. Secure the electrical box with a retaining screw and washer. Tighten the retaining screw to the specified torque.
8. Connect the cylinder head temperature sensor connector to the engine harness connector (S/N 1B517433 and below).



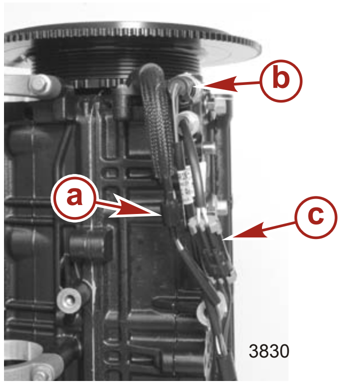
S/N 1B517433 and below
a - Retaining screw and washer
b - Sensor harness connector

Description	Nm	lb-in.	lb-ft
Retaining screw (M8 x 35)	24	–	17.7

Oil Pressure/Temperature Sensors

1. Install the oil pressure sensor. Tighten it to the specified torque.
2. Install a new O-ring onto the oil temperature sensor.
3. Install the oil temperature sensor. Tighten it to the specified torque.

4. Connect the engine harnesses to the crankshaft position sensor (CPS), oil pressure sensor, and oil temperature sensor.

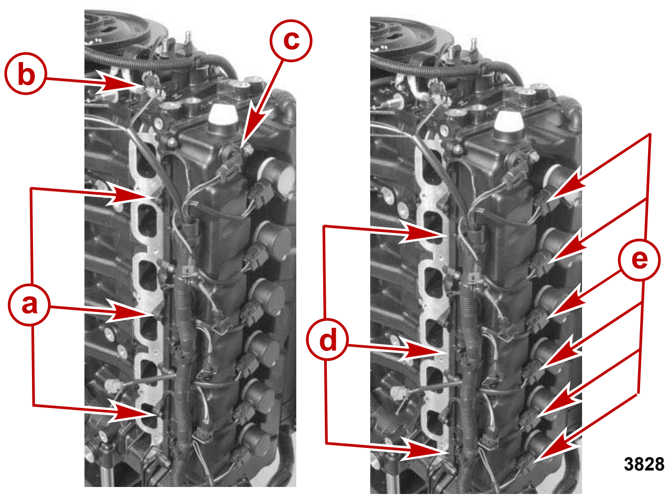


a - CPS harness connector (white, red)
b - Oil pressure sensor harness connector (blue, black/orange, purple/yellow)
c - Oil temperature sensor harness connector (black/orange, brown)

Description	Nm	lb-in.	lb-ft
Oil pressure sensor	15	133	–
Oil temperature sensor	15	133	–

Injector/Coil Harness

1. Install the harness retainers onto the valve cover.
2. Connect the injector/coil harness ground wires to the cylinder head. Secure the ground leads with retaining screws. Tighten the screws to the specified torque.
3. Connect the coil harness connectors to the coils.
4. Connect the camshaft position sensor harness connector to the camshaft position sensor.
5. Connect the cylinder block temperature sensor harness connector to the cylinder block temperature sensor.

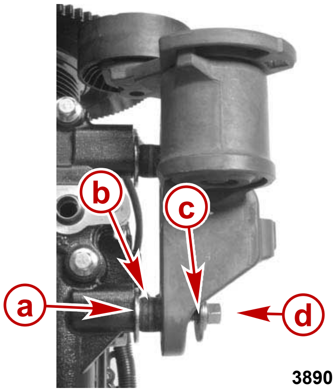


a - Injector/coil harness ground wires
b - Cylinder block temperature sensor
c - Camshaft position sensor
d - Engine harness retainers
e - Ignition coil harness connectors

Description	Nm	lb-in.	lb-ft
Ground retaining screw	8	71	–

Alternator Support and Knock Sensors

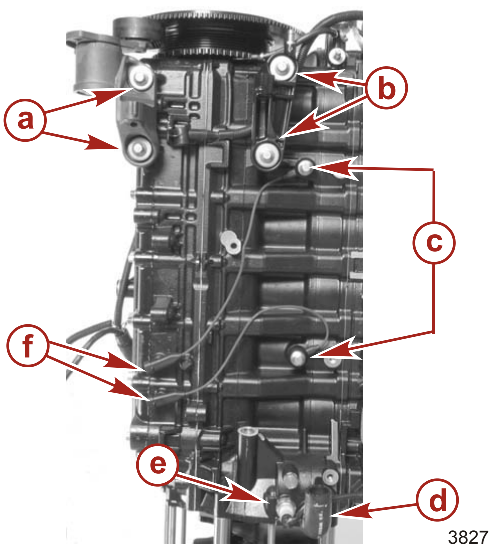
1. Install the belt tensioner. Tighten the belt tensioner retaining screw to the specified torque.



- a - Washer
- b - Mount
- c - Washer
- d - Screw (M10 x 45)

NOTE: Engines with S/N 1B517433 and below have a brass water fitting for the charge air cooler water hose. Engines with S/N 1B517434 and above have a plastic water fitting for the charge air cooler water hose. Both brass and plastic fittings have O-rings.

2. Install a new O-ring on the brass or plastic water fitting.
3. Install the brass or plastic water fitting. Tighten it to the specified torque.
4. Install a new O-ring onto the cylinder block water pressure fitting.
5. With the water pressure hose attached, install the cylinder block water pressure fitting into the cylinder block. Tighten it to the specified torque.
6. Install the knock sensors. Tighten the knock sensor retaining screws to the specified torque.
   IMPORTANT: The knock sensor is an interrelated part of the ignition and fuel delivery system. It is imperative that the knock sensor retaining screws are torqued to the stated value.
   Failure to tighten the knock sensor retaining screws to the stated value may result in an inaccurate knock sensor signal output to the PCM.
   The upper knock sensor harness must be connected to the upper knock sensor. The lower knock sensor harness must be connected to the lower knock sensor. Failure to connect the appropriate harness to the correct knock sensor may result in engine damage due to incorrect information being sent to the PCM when knock conditions are encountered.
7. Install the alternator support bracket. Tighten the alternator support bracket retaining screws to the specified torque.

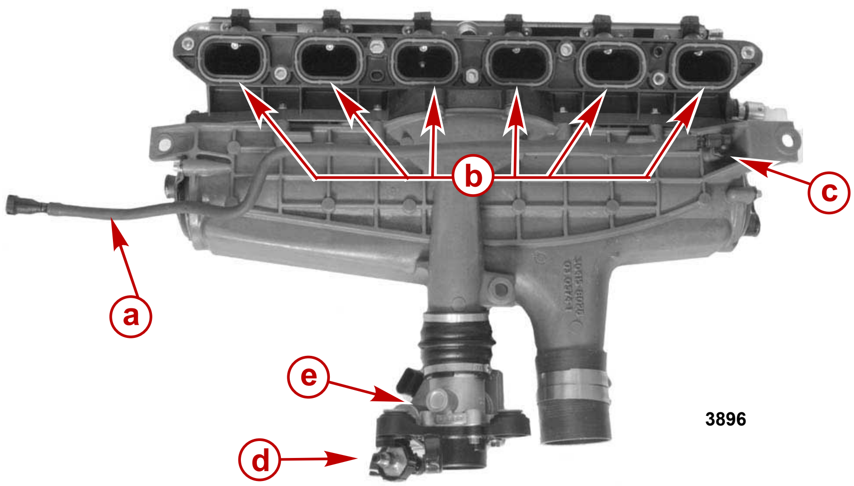


- a - Belt tensioner bracket screws
- b - Alternator support bracket screws
- c - Knock sensor retaining screw
- d - Brass or plastic water hose fitting (hidden)
- e - Water pressure Legris connector
- f - Knock sensor harness connectors

Description	Nm	lb-in.	lb-ft
Belt tensioner bracket screw (M8 x 45)	47.5	–	35
Alternator support bracket screw (M8 x 45)	47.5	–	35
Knock sensor retaining screw (M10 x 35)	20	177	15
Brass or plastic water hose fitting	20	177	15
Water pressure Legris connector	15	133	11

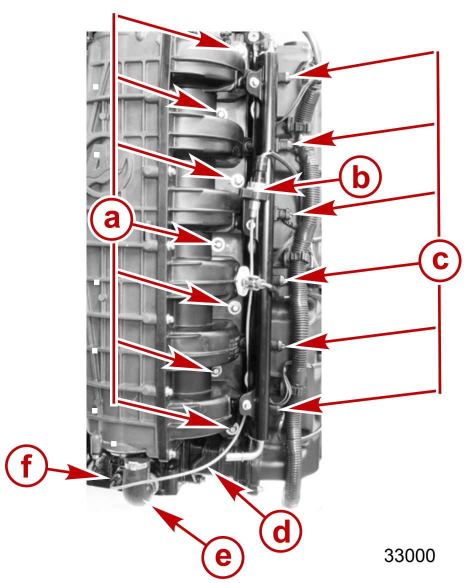
Induction System

1. Install new seal rings onto the charge air cooler (CAC).



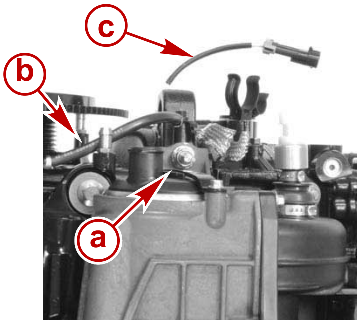
a - Manifold absolute pressure (MAP) reference line
b - Seal rings
c - MAP reference line manifold port
d - Speedometer sensor
e - Electronic boost control (EBC) assembly

2. Install a 34.6 mm diameter hose clamp onto the lower CAC hose.
3. Insert the CAC lower intercooler fitting onto the lower charge air cooler hose.
4. Install the CAC onto the cylinder head. Secure the CAC to the cylinder head with seven M6 x 33 screws. Do not tighten the screws at this time.
5. Connect the injector harness connectors to the injectors, if not done previously.
6. Connect the water pressure sensor wire harness connector to the water pressure sensor.



a - CAC screws
b - Water pressure sensor
c - Injector harness connectors
d - Water pressure tube
e - Lower CAC hose
f - Water pressure tube fitting

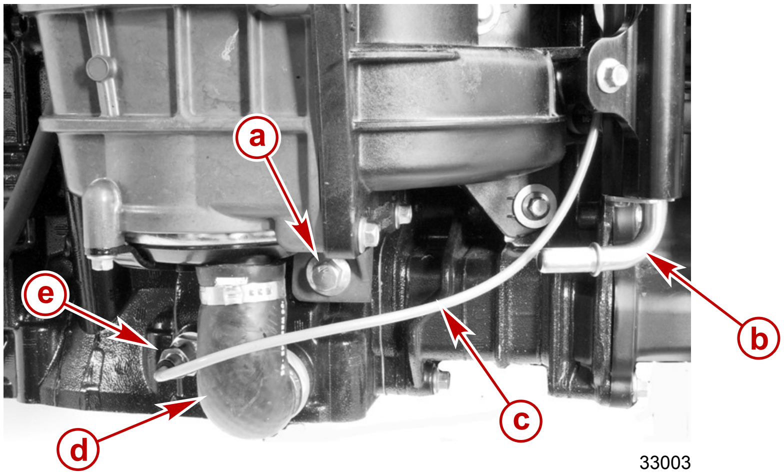
7. Install the upper CAC mounting nut. Do not tighten it at this time.



3907

a - Upper CAC mounting nut
b - Ground wire for alternator
c - Cylinder block temperature sensor

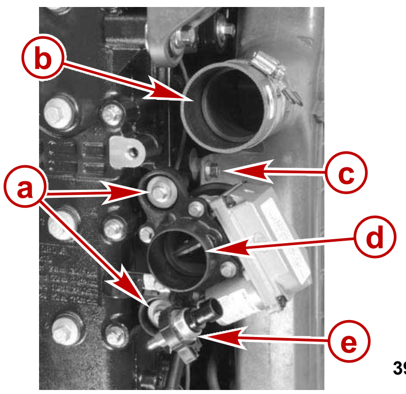
8. Install the lower CAC mounting screw. Do not tighten it at this time.



33003

a - Lower charge air cooler mounting screw
b - Fuel rail inlet
c - Water pressure tube
d - Lower charge air cooler hose
e - Water pressure tube Legris fitting

9. Install the center charge air cooler mounting screw. Do not tighten at this time.
10. Install two screws to retain the electronic boost control (EBC) assembly to the cylinder block. Tighten the screws to the specified torque.



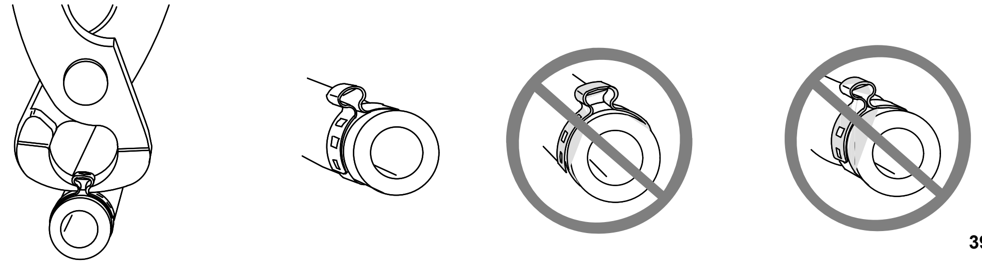
3910

a - EBC screws (M8 x 35)
b - Air inlet
c - Center CAC mounting screw
d - EBC assembly
e - Speedometer sensor

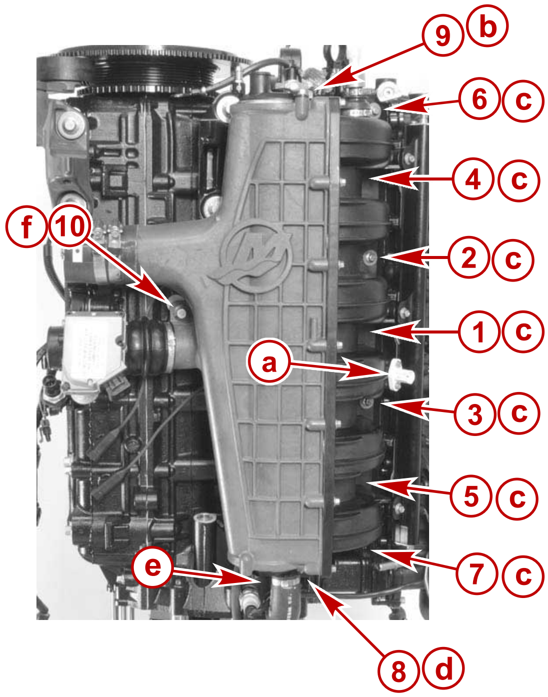
Description	Nm	lb-in.	lb-ft
Screw (M8 x 35)	24	–	17.7

11. Tighten the nut and screws holding the charge air cooler to the cylinder head/cylinder block to the specified torque and in the sequence shown.
12. Connect the manifold air temperature (MAT) harness connector to the MAT sensor.
13. Compress the lower charge air cooler hose clamp with the appropriate tool.

IMPORTANT: Only use tool 91-803146T (or Snap-On equivalent YA3080) to crimp the full circle hose clamp. Using a different tool could result in a crimp that is too loose or too tight. Do not use a screw type hose clamp as it may damage the hose.



3924



3911

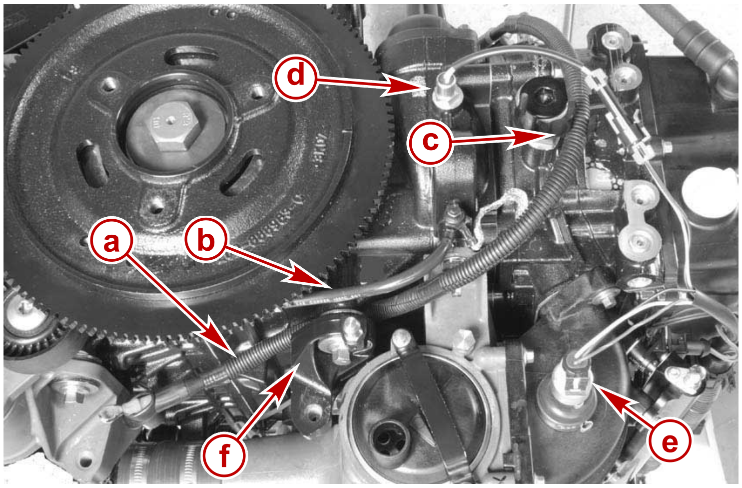
a - MAT sensor
b - Upper CAC mounting nut
c - Screws retaining the CAC (7)
d - Lower CAC mounting screw
e - Lower CAC hose clamp
f - Center CAC mounting screw

Description	Nm	lb-in.	lb-ft
Upper charge air cooler mounting nut (**b**)	32.5	–	24
Screw retaining charge air cooler (M6 x 33) (**c**)	9	80	–
Lower charge air cooler mounting screw (M10 x 30) (**d**)	32.5	–	24
Center charge air cooler mounting screw (M10 x 30) (**f**)	32.5	–	24

Hose Clamp Tool Kit	91-803146A04

14. Route the alternator battery charge wire behind the alternator support bracket. Insert the alternator battery charge wire into the support clip.
15. Connect the cylinder block temperature sensor wire harness connector to the cylinder block temperature sensor.

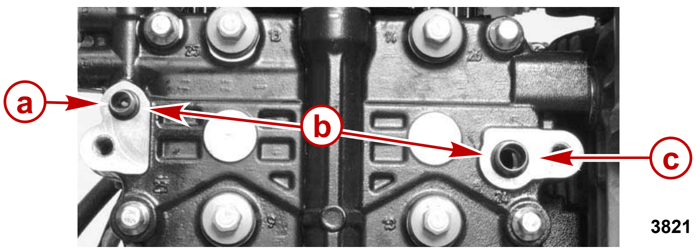
16. Connect the manifold absolute pressure sensor wire harness connector to the manifold absolute pressure (MAP) sensor.



3917

a - Alternator battery charge wire
b - Alternator ground wire
c - Support clip
d - Cylinder block temperature sensor
e - MAP sensor
f - Alternator support bracket

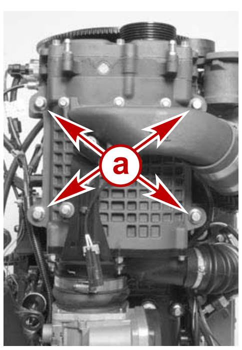
17. Install new O-rings on the supercharger dowels.
18. Install the supercharger dowels, if they were removed.



3821

a - Oil delivery to supercharger
b - Supercharger dowel and O-ring
c - Oil return from supercharger

19. Install a hose clamp on the electronic boost control (EBC) hose.
20. Guide the supercharger outlet tube to the intake manifold and the EBC hose to the EBC assembly while installing the supercharger onto the dowels.
21. Secure the supercharger to the cylinder block. Tighten the supercharger mounting screws in two steps to the specified torque.



3820

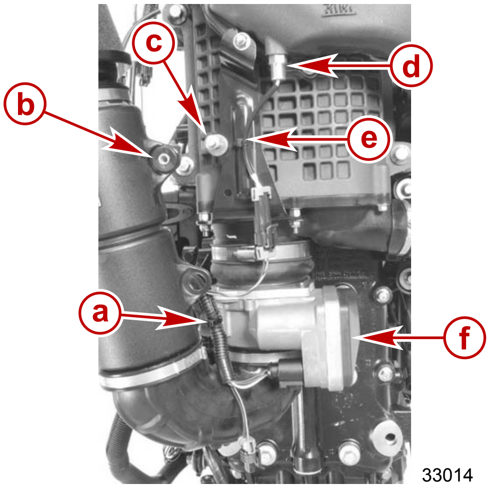
a - Supercharger mounting screws

Description		Nm	lb-in.	lb-ft
Supercharger mounting screw (M10 x 105)	**First**	15	133	–
	Final	43	–	31.7

22. Connect the supercharger air temperature sensor harness connector to the supercharger air temperature sensor.
23. Secure the supercharger air temperature sensor harness to the air intake support bracket (or the air intake tube) with a cable tie.

    NOTE: *Verado engines with S/N 1B226999 and below are not equipped with an air intake support bracket.*
24. Connect the electronic throttle control (ETC) harness to the electronic throttle control (ETC) assembly.
25. Secure the ETC harness to the ETC assembly with a cable tie.
26. Secure the air intake to the air intake support bracket (or supercharger). Tighten the screw to the specified torque.

NOTE: Some Verado engines are not equipped with an air intake support bracket.



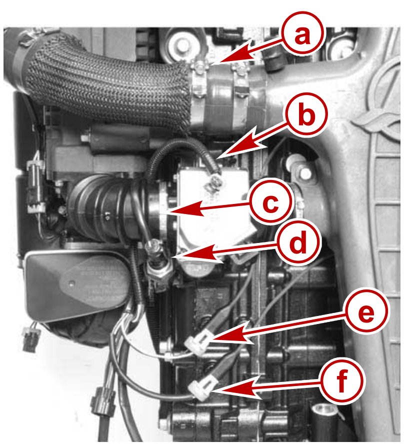
33014

- a - Cable tie for ETC harness
- b - Air intake support
- c - Air intake support bracket screw
- d - Post supercharger air temperature sensor
- e - Cable tie for the supercharger air temperature sensor harness
- f - ETC assembly

Description	Nm	lb-in.	lb-ft
Air intake support screw (M6 x 25)	7.5	66	–

IMPORTANT: Failure to connect the correct knock sensor harness to the appropriate knock sensor may result in engine damage due to improper signals being sent to the PCM while the engine is operating in a knock producing condition.

27. Connect the knock sensor harness connector with the black sleeve to the lower knock sensor, if not already done.
28. Connect the remaining knock sensor harness connector to the upper knock sensor, if not already done.
29. Connect the speedometer harness connector to the speedometer sensor.
30. Tighten the hose clamp on the supercharger outlet to the specified torque.
31. Compress the electronic boost control assembly hose clamp with the appropriate tool.



3925

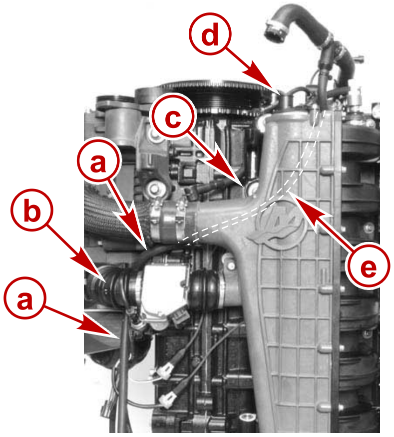
- a - Supercharger outlet hose clamp
- b - Alternator exciter wire harness
- c - Electronic boost control assembly hose clamp
- d - Speedometer sensor
- e - Upper knock sensor harness connector
- f - Lower knock sensor harness connector with black sleeve

Description	Nm	lb-in.	lb-ft
Supercharger hose clamp	6	53	–

Hose Clamp Tool Kit	91-803146A04

32. Guide the flush line behind the charge air cooler, under the alternator bracket, and behind the electronic boost control hose.

33. Install a hose clamp onto the hose and install the hose onto the upper charge air cooler port. Compress the hose clamp with the appropriate tool to secure the hose to the charge air cooler port.



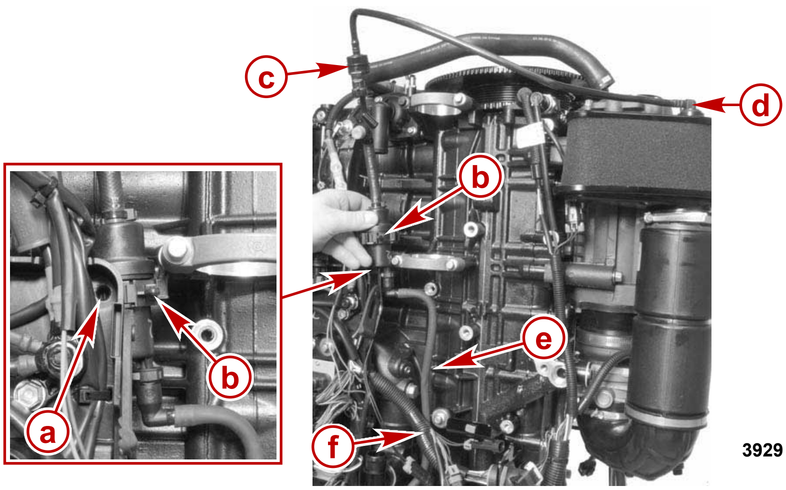
3927

a - Flush line
b - Electronic boost control hose
c - Alternator bracket
d - Upper charge air cooler port
e - Approximate route of flush line

Hose Clamp Tool Kit	91-803146A04

Purge Line

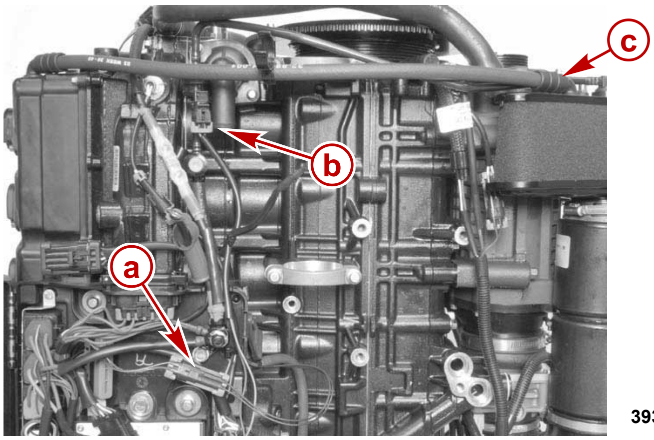
1. Install the locking end of the purge line into the air filter cover.
2. Place the vent canister float switch (VCFS) vent line behind the engine harness.
3. Install the vent canister float switch retainer into the electrical box hole.



3929

a - Electrical box hole
b - Vent canister float switch retainer
c - Purge valve
d - Locking end of purge line
e - Vent canister float switch vent line
f - Engine harness

4. Connect the vent canister float switch harness connector to the vent canister float switch.
5. Connect the purge harness connector to the purge valve.
6. Install the breather hose onto the air cleaner cover.

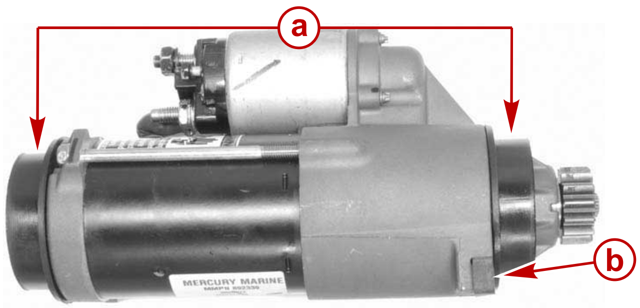


3930

a - Vent canister float switch harness connector
b - Purge harness connector
c - Breather hose

Starter

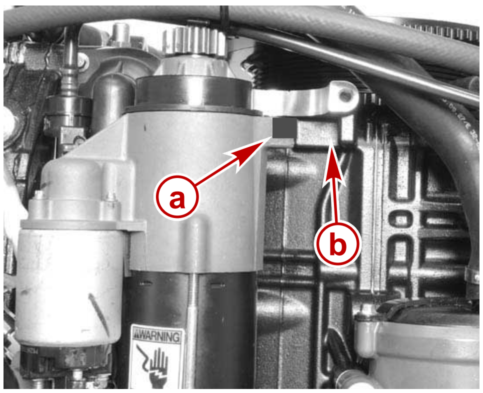
1. Ensure that the bottom and top collars are on the starter end caps.
2. Ensure that the starter stop is on the upper end cap.



3955

a - Starter collar
b - Starter stop

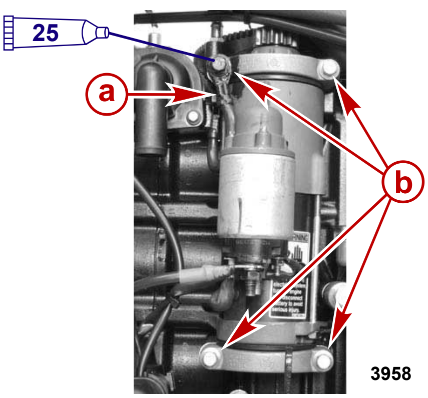
3. Place the starter onto the cylinder block starter mounting boss with the starter stop facing the starter stop boss.



3956

a - Starter stop
b - Starter stop boss

4. Insert a starter mounting screw through the starter ground eyelet.
5. Secure the starter to the cylinder block with the starter retainers and mounting screws. Tighten the starter bolts to the specified torque.
6. Cover the bolt and starter ground wire eyelet with Liquid Neoprene.



3958

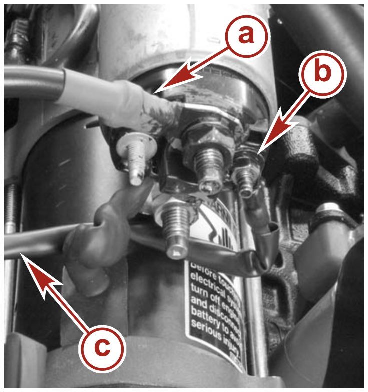
a - Starter ground wire
b - Starter bolt

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Bolt and starter ground wire eyelet	92- 25711 3

Description	Nm	lb-in.	lb-ft
Starter bolt (M8 x 40)	17	150	–

7. Guide the starter exciter wire behind the solenoid and connect the exciter wire to the solenoid exciter wire terminal. Tighten the exciter wire terminal nut to the specified torque.
8. Connect the battery starter cable to the starter solenoid terminal. Tighten the battery starter cable nut to the specified torque.

9. Cover the starter exciter wire/terminal and battery starter cable end/terminal with Liquid Neoprene.



3965

a - Battery starter cable
b - Solenoid exciter wire terminal
c - Starter exciter wire

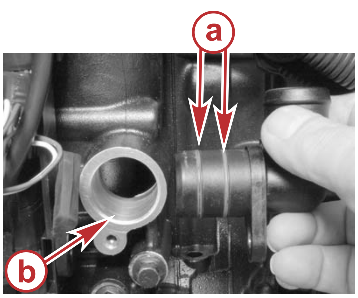
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter exciter wire, battery starter cable end	92- 25711 3

Description	Nm	lb-in.	lb-ft
Exciter wire terminal nut	2.5	22	–
Battery starter cable nut	9	80	–

10. Move the rubber boot over the starter solenoid positive (+) battery cable terminal.

Integrated Oil Module (IOM)

1. Remove any old sealant and the old O-rings from the cylinder block elbow.
2. Install new O-rings onto the cylinder block elbow.
3. Tighten the M6 x 16 elbow retaining screw to the specified torque.

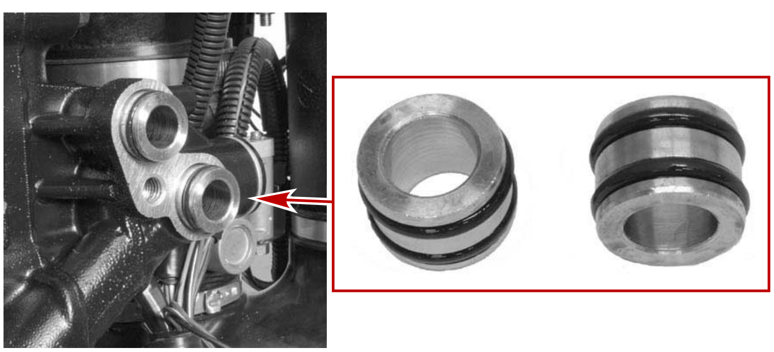


3832

a - O-rings
b - Remove old sealant

Description	Nm	lb-in.	lb-ft
M6 x 16 elbow retaining screw	10	88.5	–

4. Install new O-rings onto the IOM dowels.
5. Install the IOM dowels into the cylinder block.

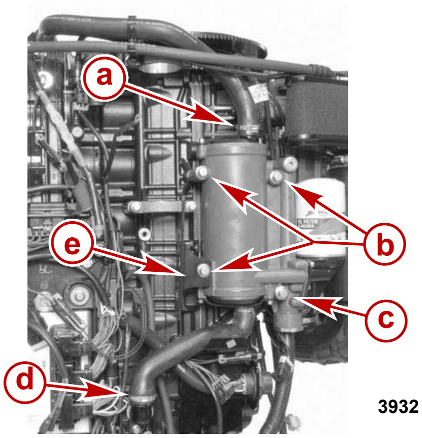


3772

6. Align the IOM with the dowels on the cylinder block.
7. Secure the IOM to the cylinder block. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Integrated oil module screws	31	–	23

8. Install a hose clamp onto the IOM lower hose.
9. Install and secure the lower IOM hose onto the cylinder block elbow with the appropriate tool.
10. Install a hose clamp onto the upper IOM hose.
11. Install and secure the upper IOM hose onto the IOM with the appropriate tool.



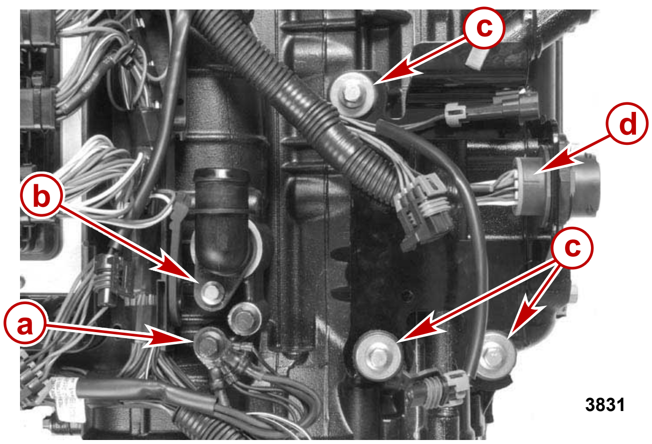
3932

a - Upper integrated oil module hose clamp
b - Integrated oil module screws (M10 x 85)
c - Integrated oil module screw (M10 x 105)
d - Lower integrated oil module hose clamp
e - Fuel filter support bracket

Hose Clamp Tool Kit	91-803146A04

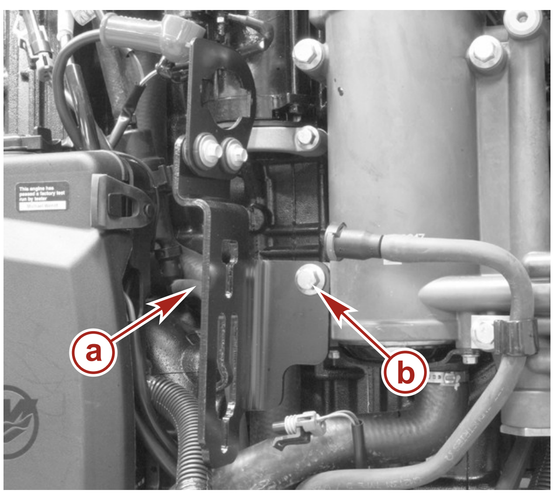
Engine Harness Bracket

1. Install the 14-pin engine harness connector bracket onto the cylinder block. Tighten the screws to the specified torque.
2. Install and the secure the engine harness ground wires. Tighten the engine harness ground screw to the specified torque.



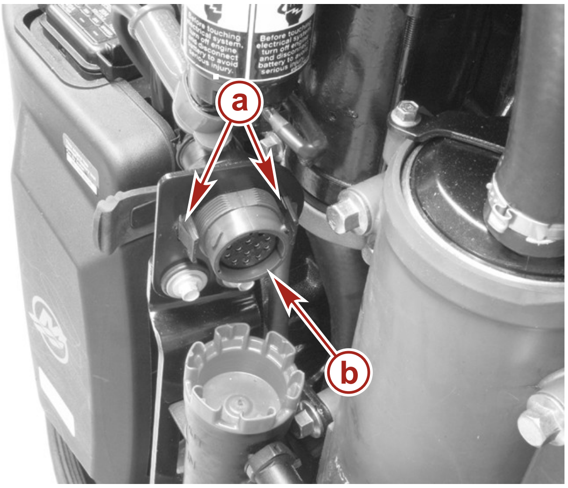
3831

S/N 1B517433 and below
a - Engine harness ground screw
b - Screw securing elbow (M6 x 16)
c - Engine harness bracket screw
d - 14-pin engine harness



32563

S/N 1B517434 and above
a - Engine harness bracket
b - Bracket screw (M8 x 35)

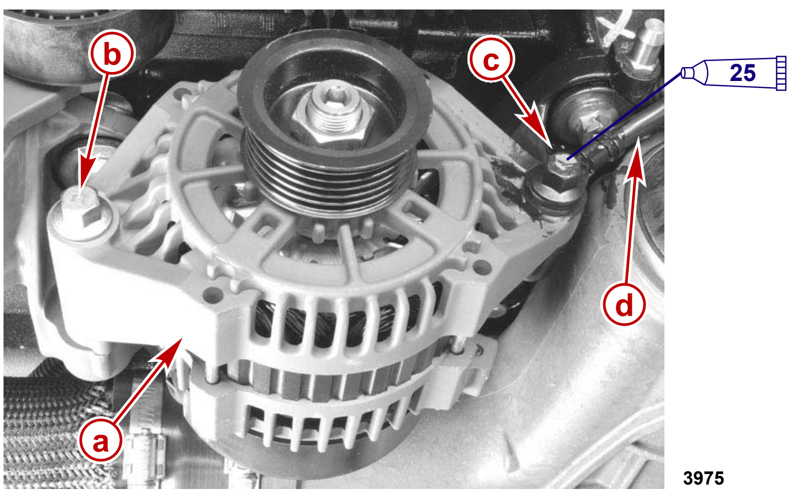


S/N 1B517434 and above
a - Release tabs
b - 14-pin connector

Description	Nm	lb-in.	lb-ft
Engine harness ground screw	10	88.5	–
Screw (M6 x 16)	10	88.5	–
Screw (M8 x 35)	24	–	17.7

Alternator

1. Place the alternator on the alternator mounting brackets.
2. Insert the short alternator mounting screw through the alternator ground wire eyelet.
3. Install the short alternator mounting screw with the ground wire into the aft mounting hole of the alternator.
4. Install the long alternator mounting screw into the fore mounting hole of the alternator.
5. Tighten the alternator mounting screws to the specified torque.
6. Coat the ground wire eyelet and mounting screw with Liquid Neoprene.



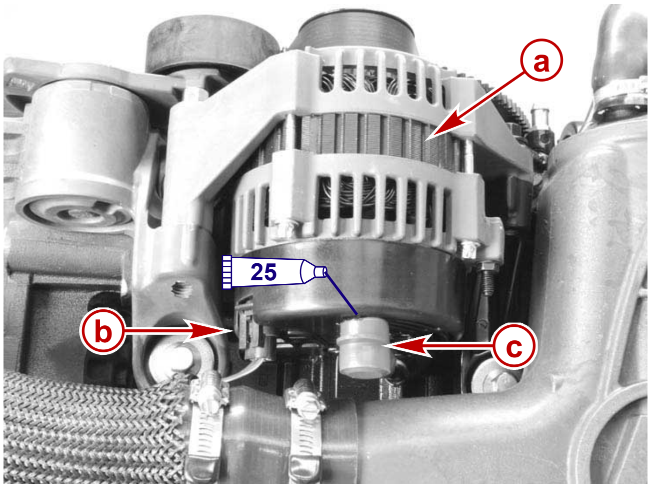
a - Alternator
b - Long alternator mounting screw
c - Short alternator mounting screw
d - Ground wire

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Ground wire eyelet and mounting screw	92- 25711 3

Description	Nm	lb-in.	lb-ft
Short mounting screw (M8 x 45)	47.5	–	35
Long mounting screw (M8 x 85)	47.5	–	35

7. Connect the output lead and the field exciter harness connector.
8. Tighten the output lead nut to the specified torque.
9. Coat the output lead with Liquid Neoprene.

10. Allow the Liquid Neoprene to dry. Cover the output lead with the insulator.



3990

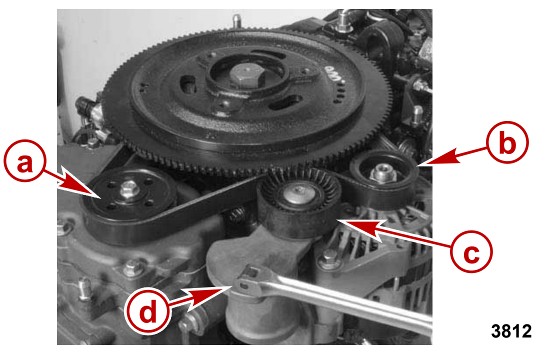
a - Alternator
b - Field exciter harness connector
c - Output lead insulator

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Alternator output lead nut	92- 25711 3

Description	Nm	lb-in.	lb-ft
Output lead nut	7	62	–

Alternator/Supercharger Belt

1. Insert a 3/8 inch breaker bar into the belt tensioner socket.
2. Compress the belt tensioner spring.
3. Install the alternator/supercharger belt.
4. Slowly release the belt tensioner.
5. Inspect the belt alignment.



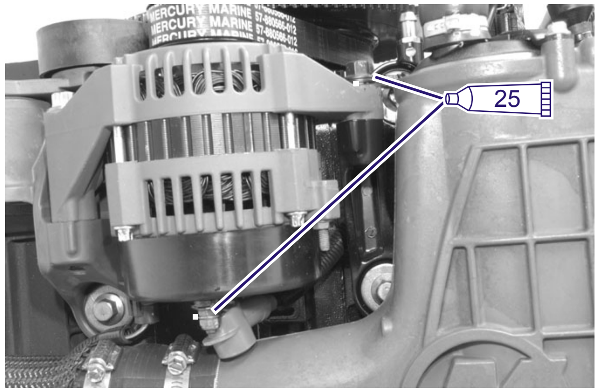
3812

a - Supercharger pulley
b - Alternator pulley
c - Belt tensioner
d - 3/8 inch breaker bar

After Servicing Engine

Applying Liquid Neoprene to the following specific locations after servicing the engine will reduce the possibility of ignition, starting, or charging system failures. These locations are very important to protect when the outboard is used in harsh environments such as saltwater and/or brackish water.

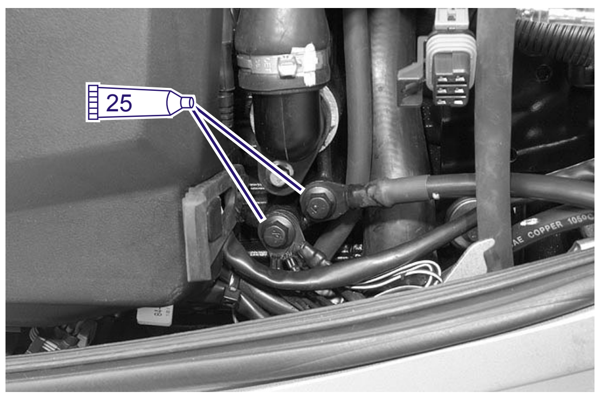
- Alternator charging and ground location



5357

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Alternator battery charging lead and alternator ground	92- 25711 3

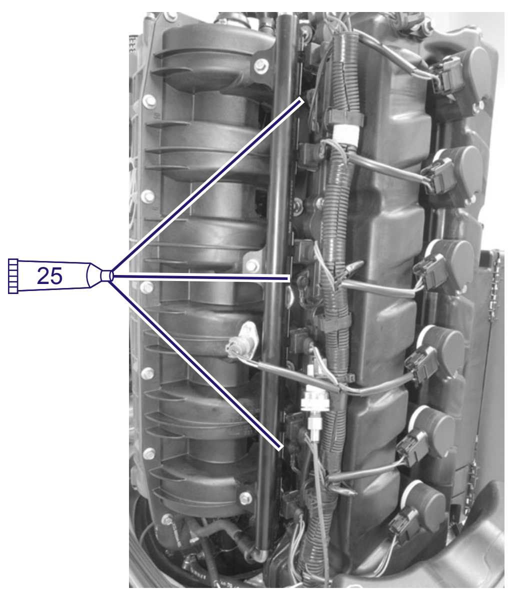
- Battery ground and electrical harness ground



5359

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Battery ground and electrical harness ground	92- 25711 3

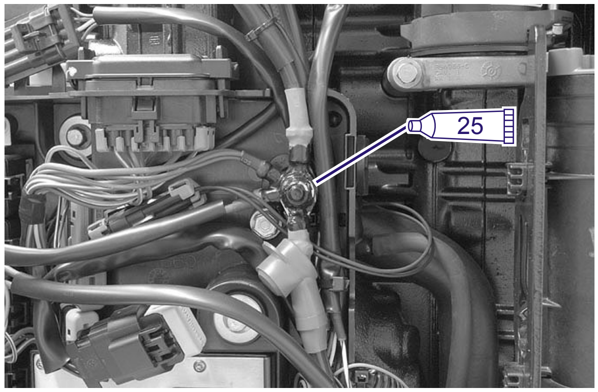
- Ignition pencil coil and fuel injector ground



5360

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Ignition pencil coil ground and fuel injector ground	92- 25711 3

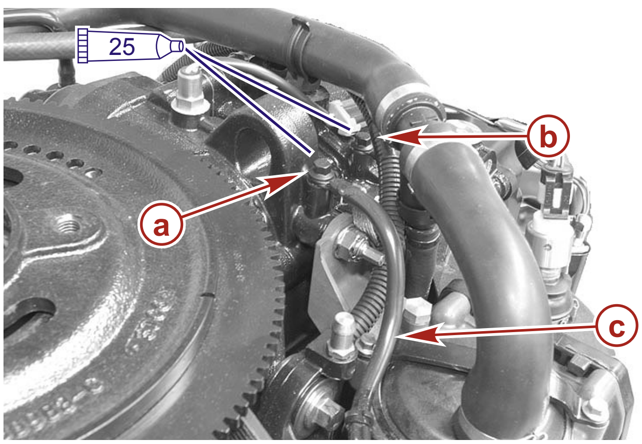
- Battery stud inside electrical box



5361

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Battery stud inside electrical box	92- 25711 3

- Alternator ground cable to cylinder block and cylinder head

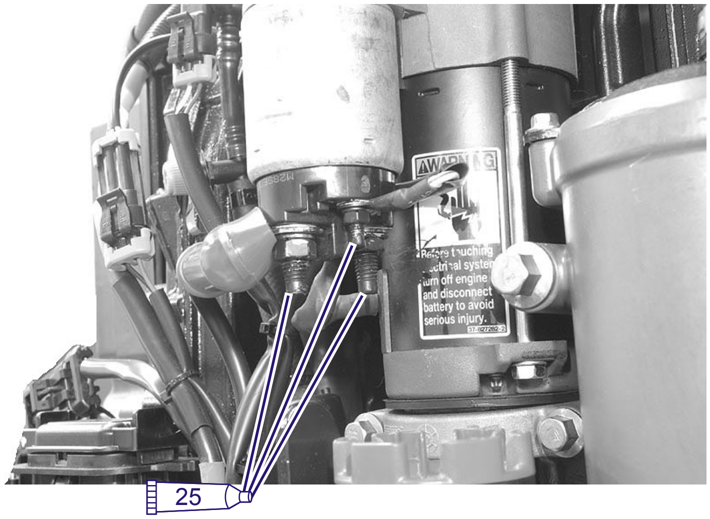


5362

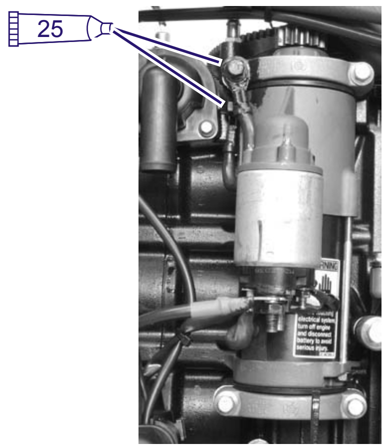
a - Cylinder block ground
b - Cylinder head ground
c - Alternator ground cable

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Alternator ground cable at cylinder block and cylinder head	92- 25711 3

- Starter power leads and ground cables



5363

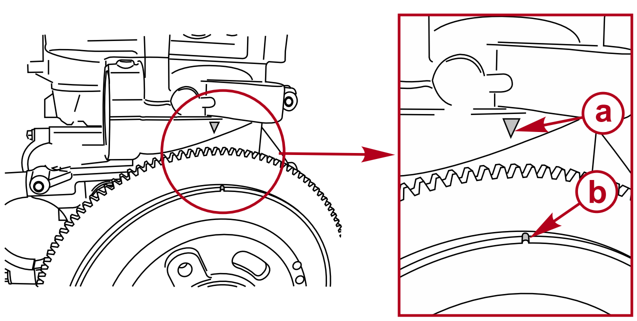


5364

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter power leads and ground cables	92- 25711 3

Dressed Powerhead Installation

1. Ensure that the flywheel points towards the timing mark on the cylinder block.

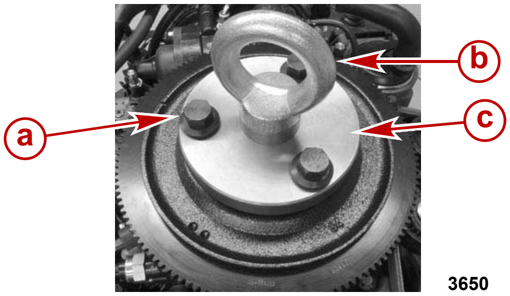


3465

a - Timing mark on the cylinder block
b - Timing mark on the flywheel

2. Install the lifting base onto the flywheel. Tighten the lifting base screws to the specified torque.

3. Thread the lifting ring onto the lifting base securely so that it bottoms out on the lifting base.



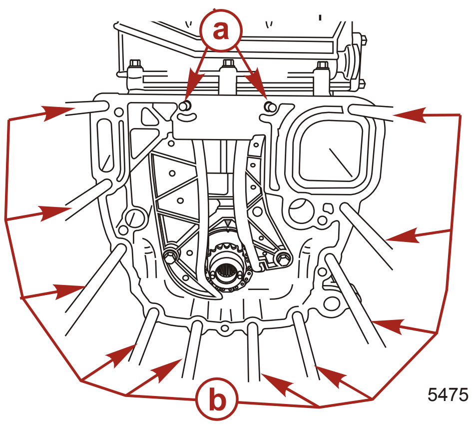
a - Lifting base screws
b - Lifting ring
c - Lifting base

Description	Nm	lb-in.	lb-ft
Lifting base screws	27	–	20

Flywheel Puller/Lifting Ring	91-895343T02

4. Install the ten long powerhead mounting studs and the two short powerhead mounting studs. Tighten the long and short powerhead mounting studs to the specified torque.

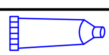
   NOTE: Use a stud installation tool or the double-nut method to install the powerhead studs if they do not have a hex drive on the end.



a - Short powerhead mounting studs
b - Long powerhead mounting studs

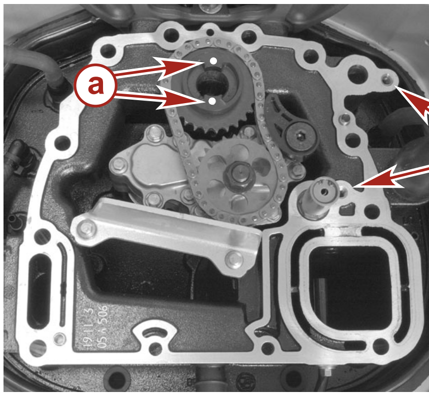
Description	Nm	lb-in.	lb-ft
Short powerhead mounting studs	10	88.5	–
Long powerhead mounting studs	22.5	–	16.6

5. Place a new powerhead gasket on the adapter plate.
6. Lubricate the driveshaft splines with Extreme Grease.

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Driveshaft splines	8M0071842

7. Turn the oil pump drive gear so that the drive pins point fore and aft.
8. Use a cotton swab to remove any oil that may have accumulated in two of the adapter plate threaded mounting holes.

IMPORTANT: Remove all traces of oil in the two adapter plate threaded mounting holes. Failure to remove the oil will damage the adapter plate while torquing the powerhead to the adapter plate.



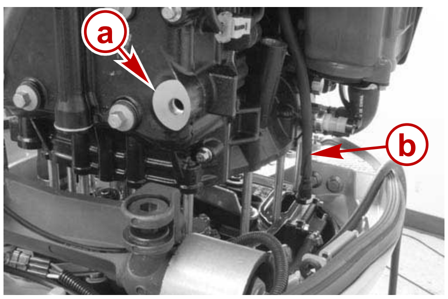
5387

a - Drive pins point fore and aft
b - Remove oil from threaded holes

9. Carefully lower the powerhead onto the adapter plate while aligning the powerhead mounting studs with the adapter plate holes.

NOTE: It may be necessary to gently rock the powerhead once the powerhead mounting studs are partially through the adapter plate.

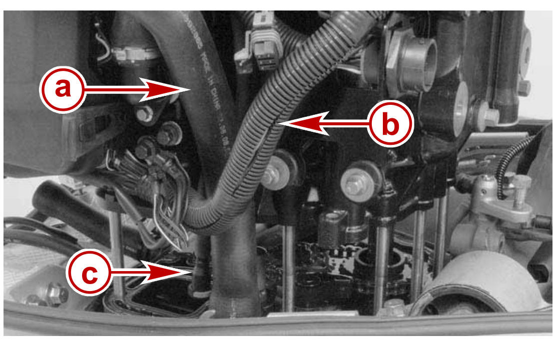
IMPORTANT: Do not damage the powerhead front mounting boss and the front mounting support when lowering the powerhead onto the adapter plate.



3657

a - Powerhead front mounting boss
b - Map sensor reference hose

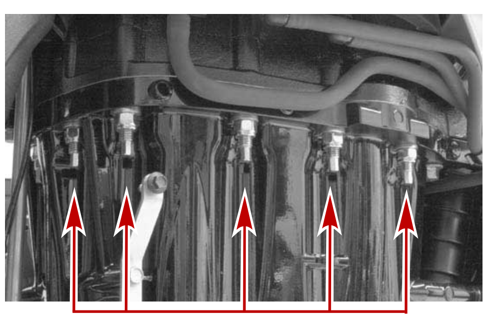
10. Guide the thermostat hose and FSM purge line (hidden behind the thermostat hose in the following graphic) behind the engine harness while lowering the powerhead onto the adapter plate.



3656

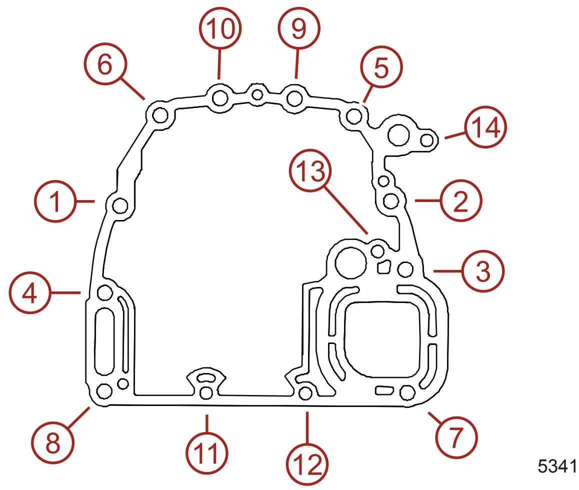
a - Thermostat hose
b - Engine harness
c - FSM purge line

11. Install the ten nuts (five on each side) securing the powerhead to the adapter plate.



3645

12. Tighten the nuts and screws that secure the powerhead to the adapter plate in the following torque sequence.



Description	Nm	lb-in.	lb-ft
Powerhead nut	61	–	45

13. Install the two aft nuts securing the powerhead to the adapter plate. Tighten the aft nuts to the specified torque with the 13 mm torque adapter and a torque wrench. Use the following calculations to determine the correct torque value.

13 mm Torque Adapter	91-809905001

IMPORTANT: You must calculate the torque value of the aft nuts securing the powerhead to the adapter plate.

a. On beam-type torque wrenches, measure from the square drive to the fulcrum (pivot) point of the handle. Follow steps d through h.
b. On electronic digital type torque wrenches, measure from the square drive to the center of the handle. Follow steps d through h.
c. On click-stop or dial type torque wrenches, adjust the torque wrench to the specified torque. Measure the length from the square drive to the center of the handle. Follow steps d through k.
d. Measure the torque adapter from the center of the square drive to the center of the nut drive. Tool 91-809905001 is 30.48 cm (12 in.).
e. Add the torque wrench length and the torque adapter length to find the sum.

   NOTE: Example: Torque wrench length (19.5 in.) + torque adapter length (12 in.) = 31.5 in.

f. Divide the sum by the torque wrench length to find the quotient.

   NOTE: Example: Sum (31.5 in.) ÷ torque wrench length (19.5 in.) = 1.6154 (quotient)

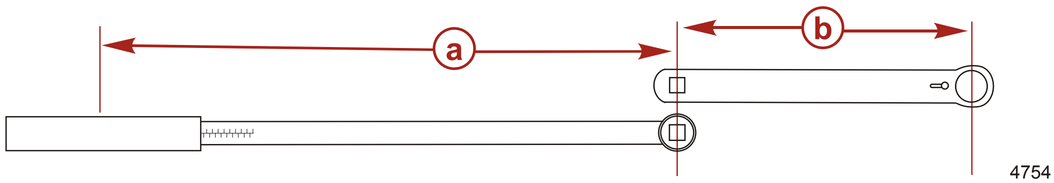
g. Divide the torque specification by the quotient. The result will be the torque calculation for the aft nut.

   NOTE: Example: Torque specification (19 lb-ft) ÷ quotient (1.6154) = 11.76 lb-ft (torque calculation)

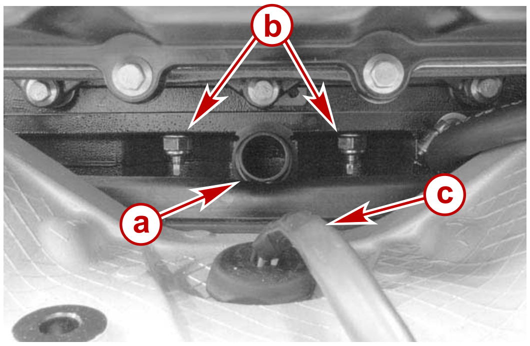
h. Adjust the torque wrench to reflect the new torque calculation.

   NOTE: Steps i through k apply to click-type torque wrenches only.

i. For greater accuracy, redetermine the effective length of the torque wench and the extension tool.
j. Compute for the corrected torque setting.
k. Adjust the torque wrench to reflect the second new torque calculation. This is the final torque specification for the aft nut when using a click-stop or dial type torque wrench.



a - Torque wrench length
b - Torque adapter



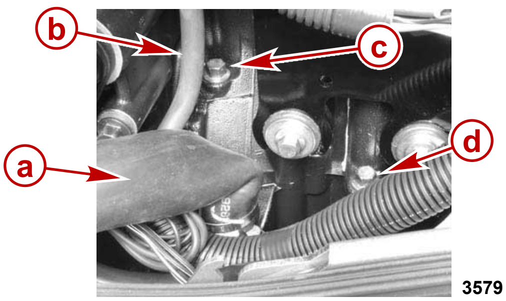
3617

- a - Exhaust relief tube
- b - Aft nuts securing the powerhead
- c - FSM harness

Description	Nm	lb-in.	lb-ft
Aft nut securing the powerhead	26	–	19

13 mm Torque Adapter	91-809905001

14. Install the two starboard side powerhead mounting screws. Tighten them to the specified torque.

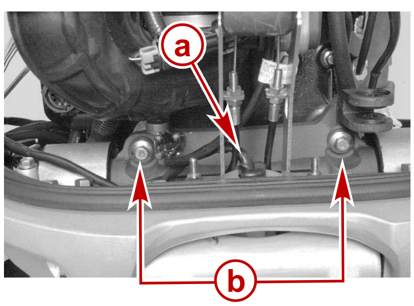


3579

- a - Thermostat hose
- b - FSM purge line
- c - Mounting screw (M8 x 75)
- d - Mounting screw (M8 x 35)

Description	Nm	lb-in.	lb-ft
Starboard side powerhead mounting screws (M8 x 75, M8 x 35)	27	–	20

15. Install the front powerhead mounting screws. Tighten them to the specified torque, then turn an additional 45º.



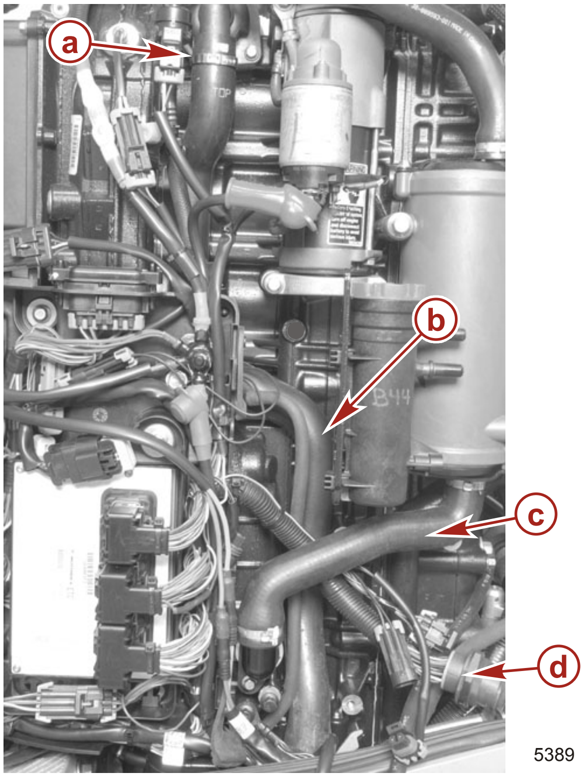
3644

- a - Power trim wire harness
- b - Front powerhead mounting screws

Description		Nm	lb-in.	lb-ft
Front powerhead mounting screws	**First**	40	–	29.5
	Final	Turn additional 45º		

16. Guide the thermostat hose behind the IOM lower hose and up to the thermostat housing.
17. Install a 36.1 mm diameter hose clamp onto the thermostat hose.

18. Install the thermostat hose onto the thermostat housing. Secure the thermostat hose to the thermostat housing with the appropriate tool.

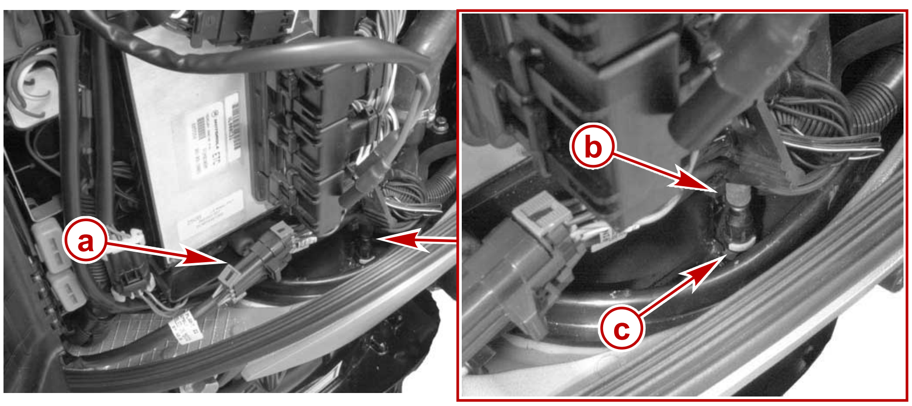


5389

a - 36.1 mm clamp
b - Thermostat hose
c - Lower IOM hose
d - 14-pin connector

Hose Clamp Tool Kit	91-803146A04

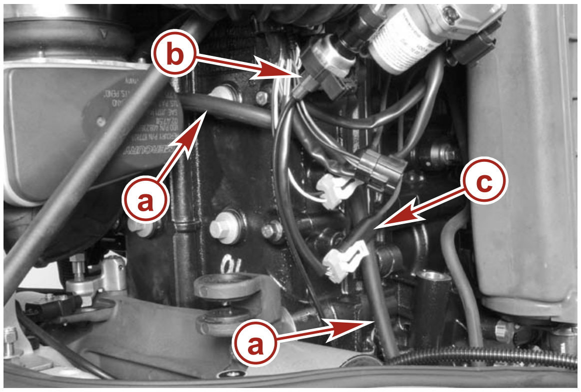
19. Connect the FSM harness connector to the engine harness.
20. Install the purge line into the adapter plate.



3582

a - FSM harness connector
b - Purge line
c - Retaining clip

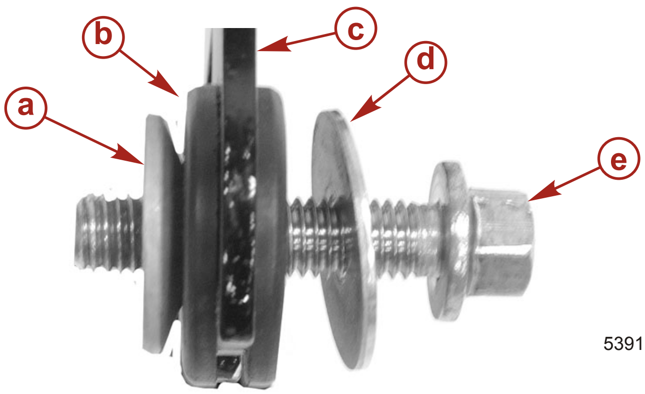
21. Guide the water pump indicator hose behind the knock sensors, past the front of the motor, and over to the starboard side of the engine.



5402

- a - Water pump indicator hose
- b - Speedometer sensor
- c - Knock sensor

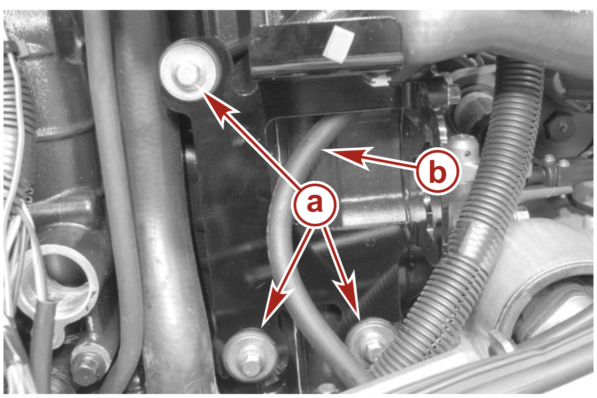
22. Ensure that the harness bracket mounting grommets are assembled correctly to the harness bracket.



5391

- a - Bushing
- b - Grommet
- c - Harness bracket
- d - Washer
- e - Screw

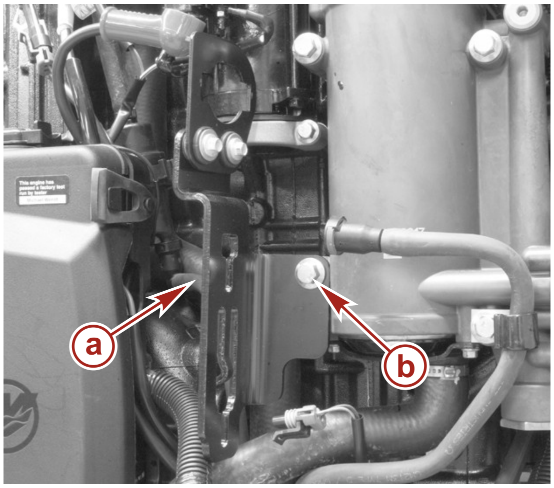
23. Install the harness bracket onto the cylinder block. Tighten the harness bracket screws to the specified torque.



5377

S/N 1B517433 and below

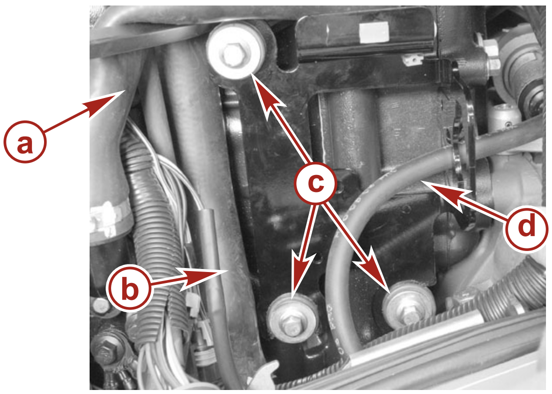
- a - Screws securing the harness bracket
- b - Water pump indicator hose



32563

S/N 1B517434 and above
a - Engine harness bracket
b - Bracket screw

24. Guide the water pump indicator hose through the harness bracket.

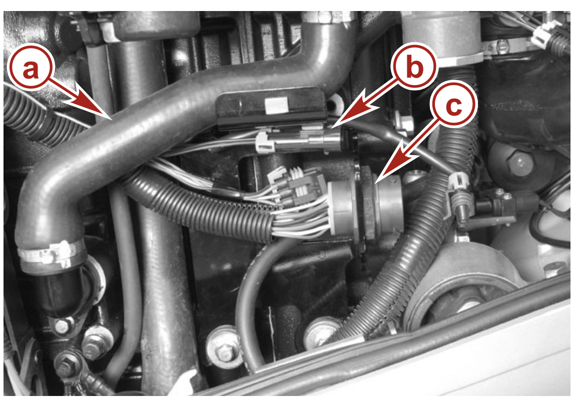


5392

S/N 1B517433 and below
a - Lower IOM hose
b - Thermostat hose
c - Harness bracket screws
d - Water pump indicator hose

Description	Nm	lb-in.	lb-ft
Harness bracket screws (M8 x 35)	24	–	17.7

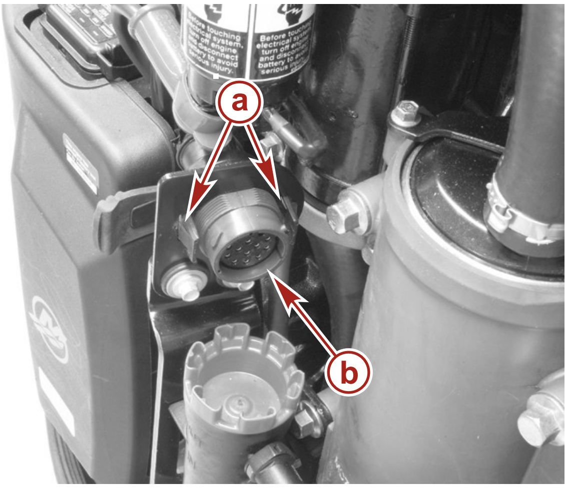
25. Install the DTS power harness connector onto the harness bracket. Install the 14-pin connector onto the harness bracket. Tighten the 14-pin connector nut to the specified torque.



5393

S/N 1B517433 and below
a - Lower IOM hose
b - DTS power harness connector
c - 14-pin connector nut

Description	Nm	lb-in.	lb-ft
14-pin connector nut	8	71	–



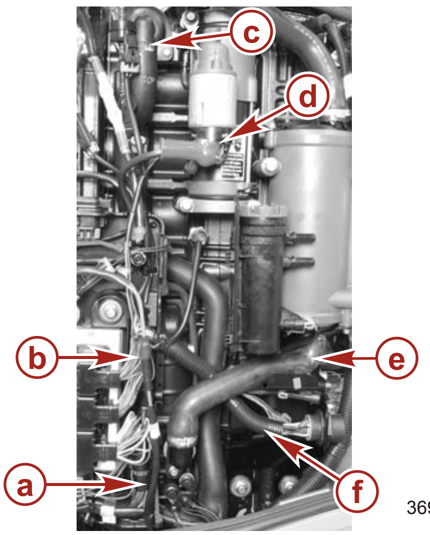
32551

S/N 1B517434 and above

a - Release tabs

b - 14-pin connector

26. Connect the blue and green power trim harness to the blue and green power trim relay harness.



3690

a - Power trim harness

b - Power trim relay harness

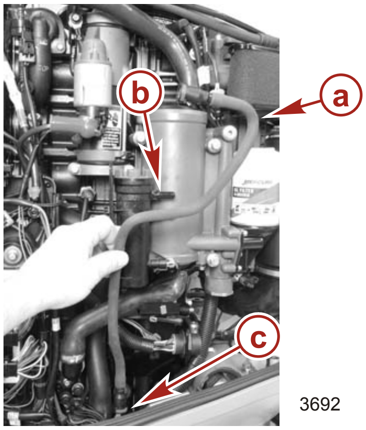
c - Thermostat hose

d - Starter battery cable

e - Lower IOM hose

f - Engine harness

27. Install the fuel hose onto the adapter plate fitting.
28. Install the fuel hose onto the fuel filter top fitting.



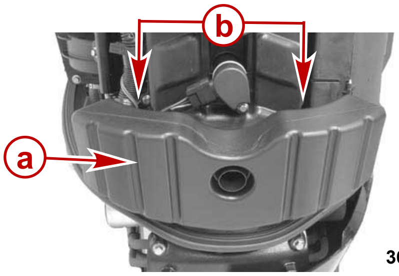
3692

a - Fuel line

b - Fuel filter top fitting

c - Adapter plate fitting

29. Install the exhaust plenum to the exhaust relief hose and secure it to the mount cradle. Tighten the exhaust plenum screws to the specified torque.

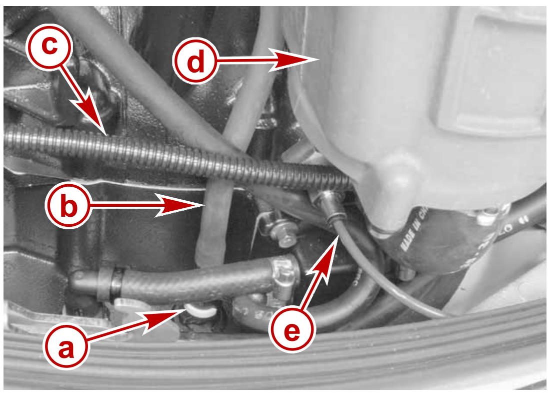


3615

a - Exhaust plenum
b - Exhaust plenum screws

Description	Nm	lb-in.	lb-ft
Exhaust plenum screw (M6 x 16)	6	53	–

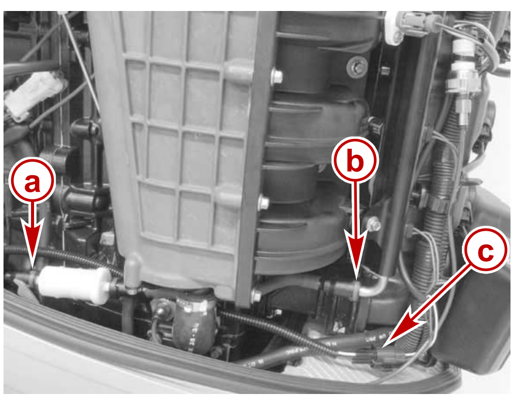
30. Connect the MAP sensor reference hose to the adapter plate fitting.
31. Guide the trim position sensor harness underneath the charge air cooler.



3614

a - MAP sensor reference hose clip
b - MAP sensor reference hose
c - Trim position sensor harness
d - Charge air cooler
e - Block water pressure line

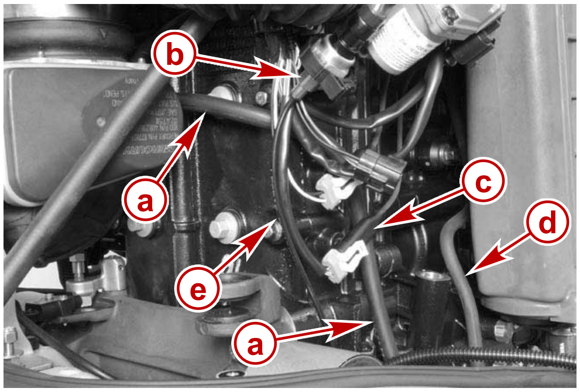
32. Connect the trim position sensor to the engine harness connector.
33. Insert the fuel line/filter behind the charge air cooler hose.
34. Connect the fuel inlet hose to the fuel filter.
35. Connect the fuel line to the fuel rail fitting.



3612

a - Fuel inlet hose
b - Fuel rail inlet fitting
c - Trim position sensor harness

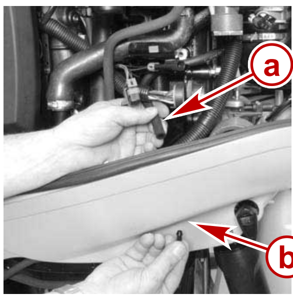
36. Connect the speedometer hose to the speedometer sensor.



3694

a - Water pump indicator hose
b - Speedometer sensor
c - Knock sensor harness connector
d - MAP sensor reference hose
e - Speedometer hose

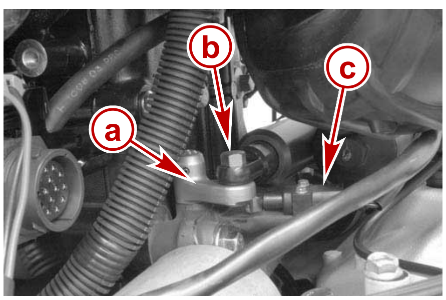
37. Insert the water pump indicator fitting into the mount cradle.
38. Connect the water pump indicator hose to the water pump indicator fitting.



3695

a - Water pump indicator hose
b - Water pump indicator fitting

39. Install the shift actuator onto the upper bell crank. Secure it with the shift actuator screw. Tighten the screw to the specified torque.



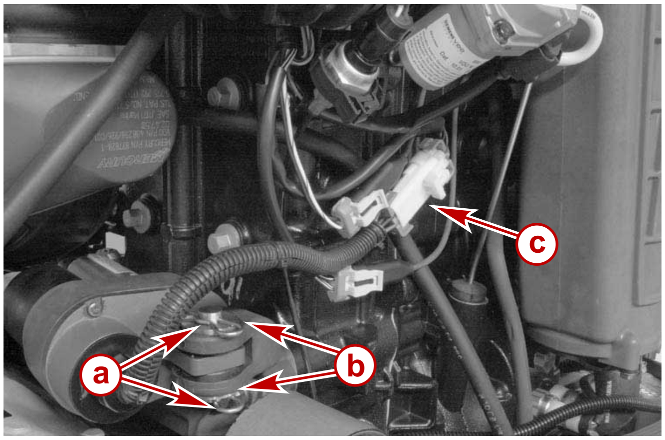
3596

a - Upper bell crank
b - Shift actuator screw
c - Shift indicator switch

Description	Nm	lb-in.	lb-ft
Shift actuator screw	20	177	–

40. Insert the shift actuator pin through the mounting boss and shift actuator. Install the washer and the cotter pin.
41. Attach the shift actuator harness connector to the connector retainer.
42. Connect the engine harness connector to the shift actuator harness connector.

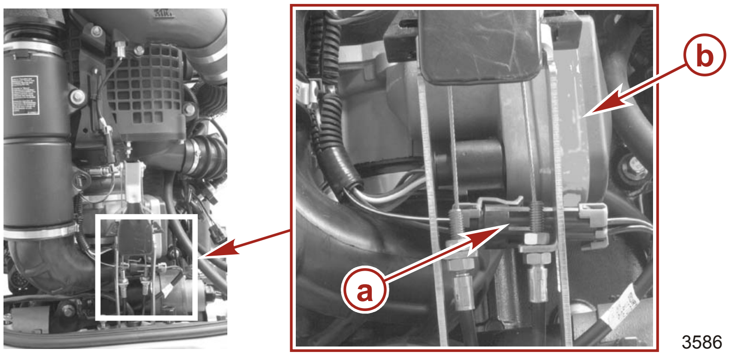
43. Install the engine oil dipstick.



3696

a - Cotter pin
b - Washer
c - Shift actuator harness connector

44. Connect the shift position switch harness connector to the engine harness connector.

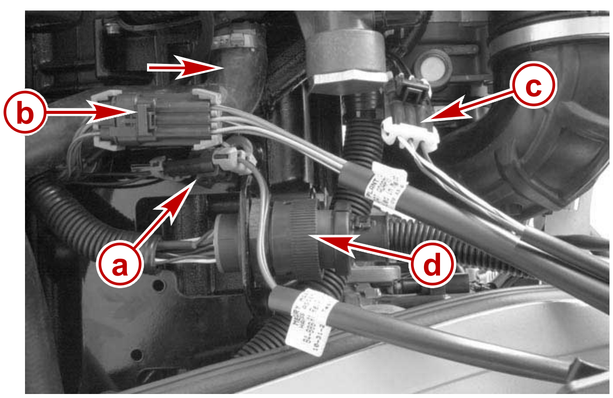


3586

a - Shift position switch harness connector
b - ETC

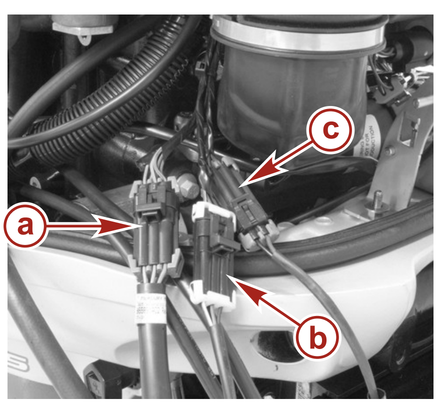
45. Connect the DTS power harness connector, boat sensor harness connector, power steering sensor harness connector, and 14 pin engine harness connector.

NOTE: The boat sensor harness connector must be supported with the harness retainer. Align the slot on the back of the boat sensor harness with the harness retainer. Slide the boat sensor harness connector onto the harness retainer.



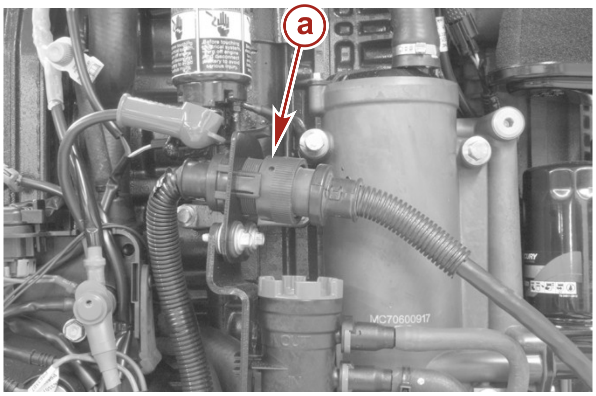
3698

S/N 1B517433 and below
a - DTS power harness connector
b - Boat sensor harness connector
c - Power steering sensor harness connector
d - 14-pin engine harness connector



32546

S/N 1B517434 and above
a - Boat sensor harness connector
b - Power steering sensor harness connector
c - DTS power harness connector

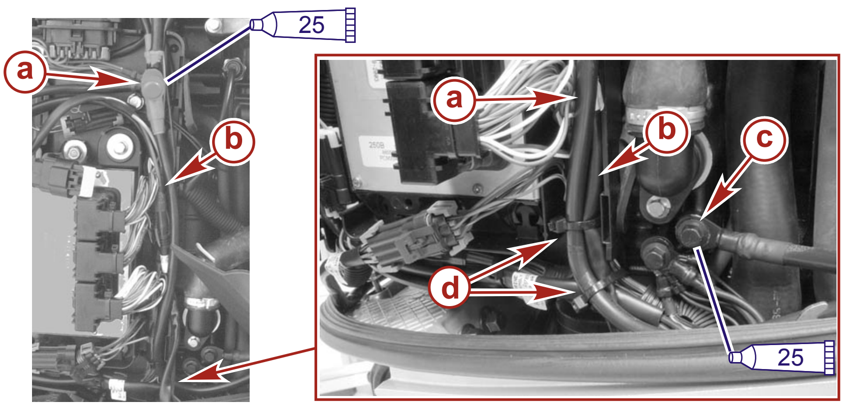


32547

S/N 1B517434 and above

a - 14-pin engine harness connector

46. Connect the battery positive and negative cables. Tighten the cable nuts to the specified torque. Secure the positive battery cable and the trim wire harness with two cable ties. Cover the battery positive and negative cable connection on the engine with Liquid Neoprene.



3702

a - Positive (+) battery cable

b - Trim wire harness

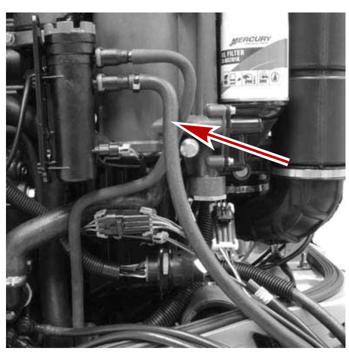
c - Negative (–) battery cable

d - Cable ties

Description	Nm	lb-in.	lb-ft
Battery positive cable nut	9	80	–
Battery negative cable nut	17	150	–

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Battery positive and negative cable connection on engine	92- 25711 3

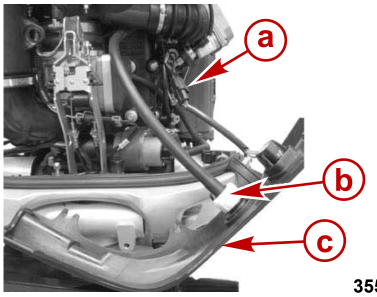
47. Connect the fuel hoses to the fuel filter.



3700

48. Connect the trim switch harness connector on the port front cowl to the engine harness.

49. Connect the flush adapter and hose to the engine cowl.



3559

a - Trim switch harness connector
b - Flush adapter
c - Port front cowl

50. Install the port and starboard front cowls, the lower chaps, and the rear cowl. Refer to **Cowl Removal and Installation** in **Section 1B** - **Maintenance**.
51. Starting with the positive lead, connect the engine battery cables to the battery.
52. Fill the oil sump with 7 Liter (7.4 US qt) of engine oil.

Tube Ref No.	Description	Where Used	Part No.
	25W50 Synthetic Blend 4-Stroke Racing Engine Oil	Engine oil sump	8M0078013
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Engine oil sump	92-858052K01

Notes:

Powerhead

Section 4B - Cylinder Head

Table of Contents

4
B

Cylinder Head Specifications

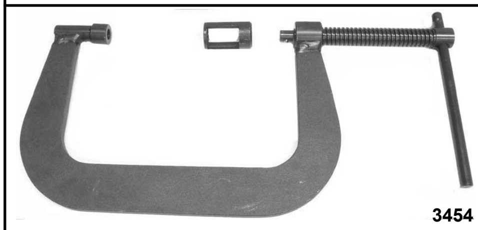
Cylinder Head Specifications	
Maximum deck warp	0.075 mm (0.003 in.)
Number of valves	24
Number of valves per cylinder	4
Number of cams	2
Camshaft bearing journal (intake and exhaust)	28.94–28.96 mm (1.139–1.140 in.)
Camshaft bearing cap ID	29.000–29.021 mm (1.1417–1.1425 in.)
Camshaft lobe (S/N 1B517433 and below)	
Intake (minimum)	42.44 mm (1.6709 in.)
Exhaust (minimum)	43.49 mm (1.7122 in.)
Camshaft lobe (S/N 1B517434 and above)	
Intake (minimum)	43.49 mm (1.7122 in.)
Exhaust (minimum)	43.49 mm (1.7122 in.)
Valve lash clearance	
Intake	0.150–0.270 mm (0.0059–0.0106 in.)
Exhaust	0.350–0.470 mm (0.0137–0.0185 in.)
Valve seat angles	30°, 44.625–45°, 55°
Valve spring free length	48.77 mm (1.920 in.)
Valve spring installed height	34 mm (1.339 in.)
Measure load at installed height	222 ± 10 N (49.91 ± 2.25 lb-force)
Valve outside diameter	
Intake	31.85–32.15 mm (1.253–1.265 in.)
Exhaust	27.05–27.35 mm (1.065–1.077 in.)
Valve face width (intake and exhaust)	2.25 mm (0.0886 in.)
Valve margin thickness (minimum)	
Intake	0.424 mm (0.0167 in.)
Exhaust	0.420 mm (0.0165 in.)
Valve guide bore ID (intake and exhaust)	6.00–6.016 mm (0.2362–0.2368 in.)
Valve stem diameter	
Intake	5.96–5.98 mm (0.2346–0.2354 in.)
Exhaust	5.95–5.97 mm (0.2343–0.2350 in.)
Valve stem runout (maximum)	0.038 mm (0.0015 in.)
Valve stem to valve guide clearance	
Intake	0.020–0.050 mm (0.0008–0.0020 in.)
Exhaust	0.030–0.060 mm (0.0012–0.0024 in.)
Valve seat contact width	
Intake	1.4–1.6 mm (0.0551–0.0630 in.)
Exhaust	1.5–1.7 mm (0.0591–0.0669 in.)

Lubricant, Sealant, Adhesives

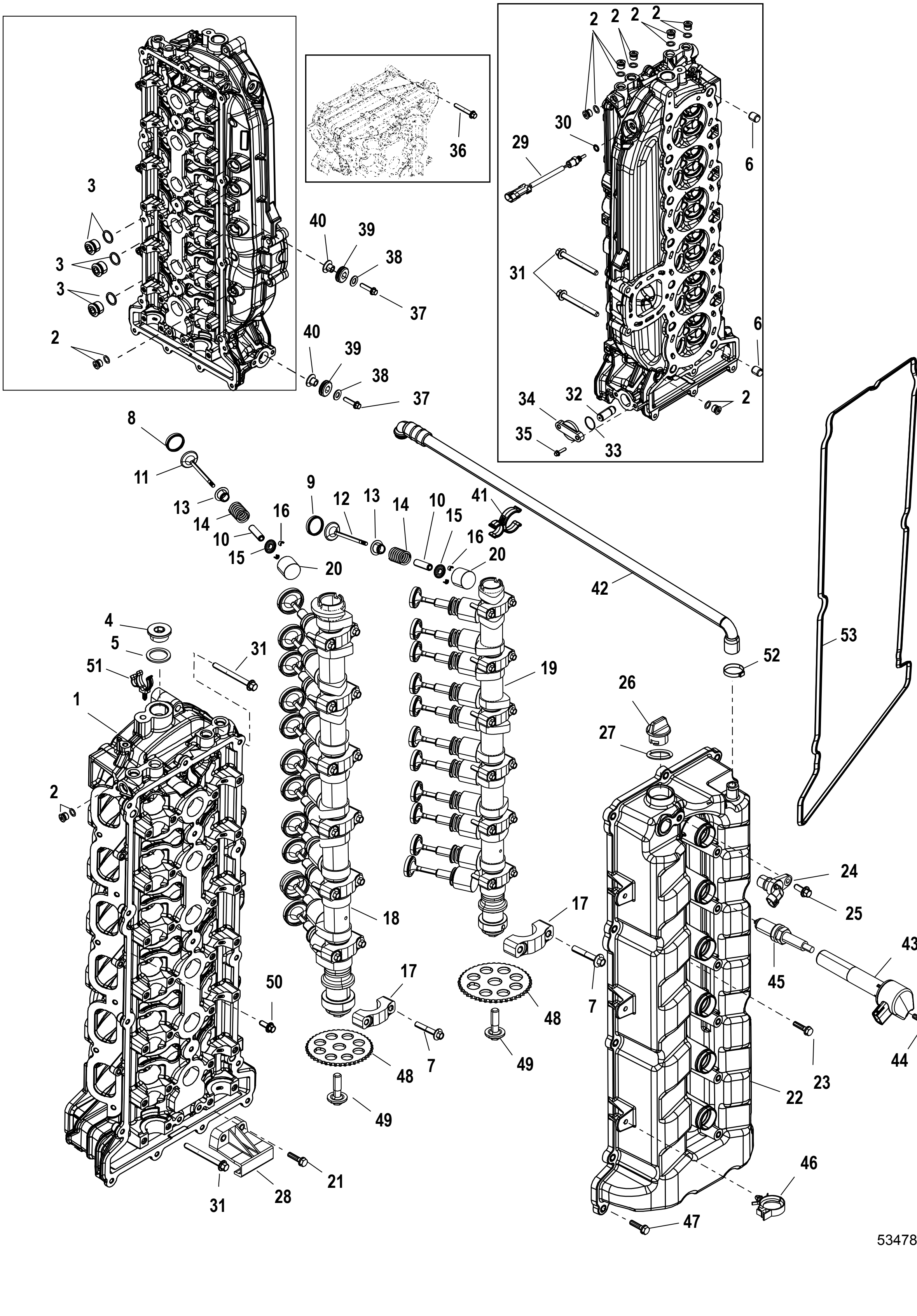
Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil and water galley plugs	92-809822

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Installing valve spring retaining cotter	92-802859A 1
136	Lubriplate SPO 255	Valve bucket tappet outside diameter	Obtain Locally
		Camshaft bearing	
		Camshaft journal	
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Valve guide seal	92-858052K01
		Valve stem	

Special Tools

Valve Spring Compressor	91-809494A 1
	Removes and installs valve springs.

Cylinder Head Components (S/N 1B517433 and Below)

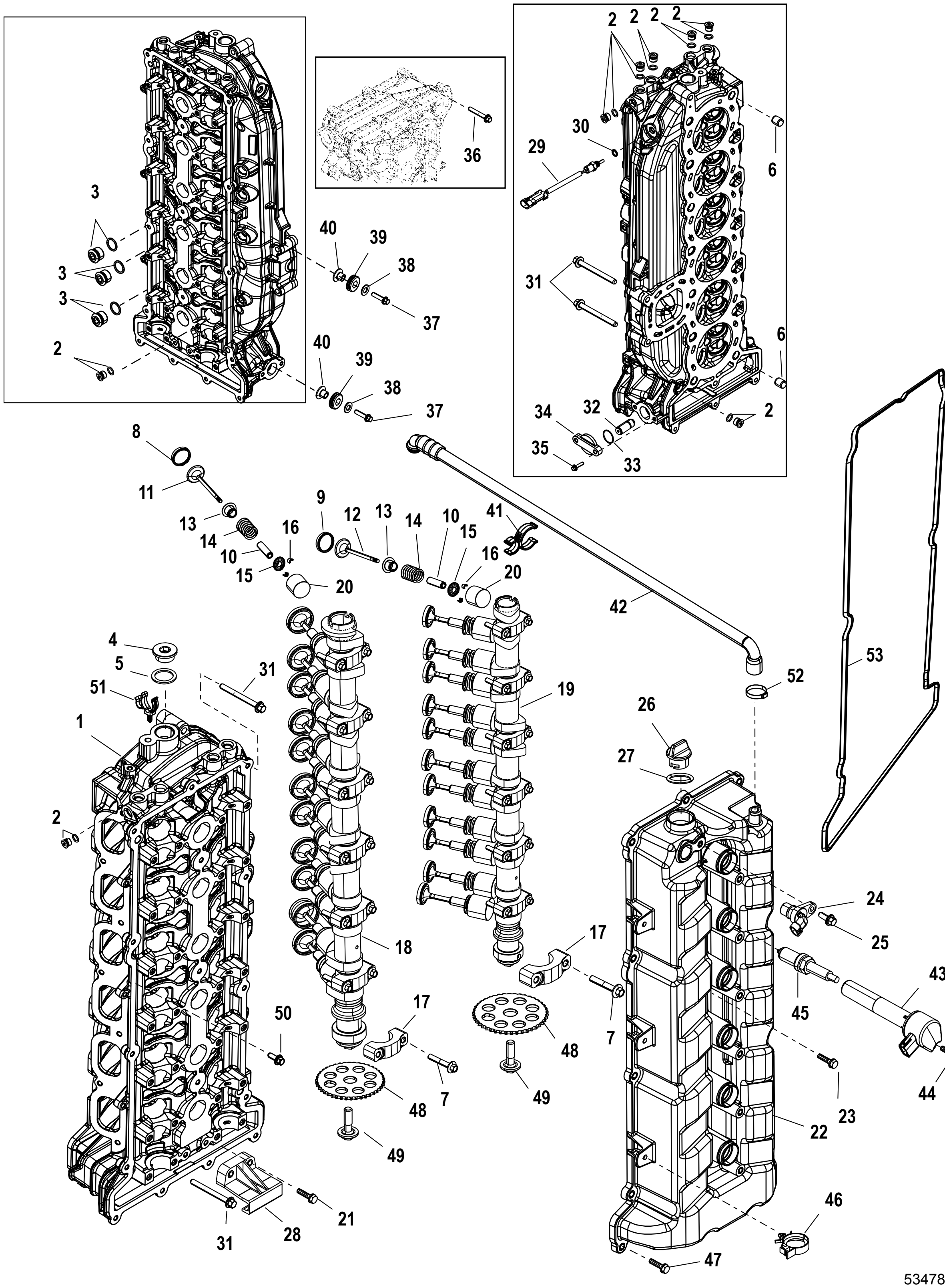


Cylinder Head Components (S/N 1B517433 and Below)

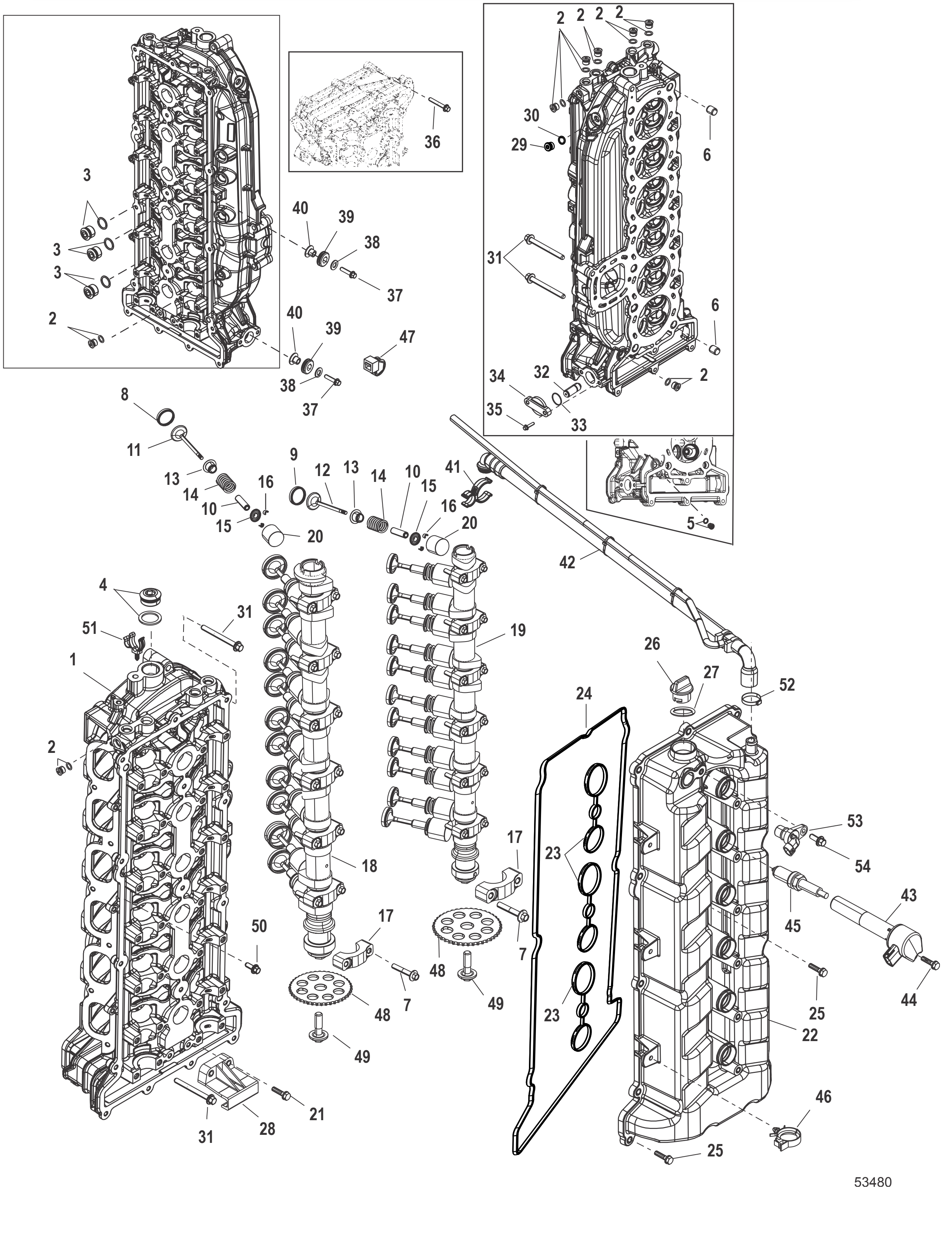
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cylinder head			
2	8	Plug (12 mm) and O-ring	9	80	–
3	3	Plug (18 mm) and O-ring	22	–	16
4	1	Plug (24 mm)	55	–	40.5
5	1	Washer			
6	2	Dowel pin (14 mm)			
7	28	Bolt (M6 x 35)	12	106	–
8	12	Intake valve seat			
9	12	Exhaust valve seat			
10	24	Intake and exhaust valve guide			
11	12	Intake valve			
12	12	Exhaust valve			
13	24	Spring seat valve seal			
14	24	Valve spring			
15	24	Valve retainer			
16	48	Key			
17	14	Cap			
18	1	Intake camshaft			
19	1	Exhaust camshaft			
20	24	Bucket tappet			
21	2	Screw (M6 x 30)	12	106	–
22	1	Camshaft cover			
23	3	Screw (M6 x 25)	8	71	–
24	1	Camshaft position sensor			
25	1	Screw (M6 x 16)	8	71	–
26	1	Oil plug assembly			
27	1	O-ring (0.921 x 0.139 mm)			
28	1	Short guide			
29	1	Cylinder head temperature sensor			
30	1	O-ring (1.78 mm x 0.08 mm)			
31	4	Screw (M8 x 60)	28	–	20.7
32	1	Timing chain tensioner			
33	1	O-ring			
34	1	Tensioner end cap			
35	2	Screw (M6 x 25)	11	97	–
36	3	Screw (M6 x 40)	8	71	–
37	2	Screw (M8 x 35)	24	–	17.7
38	2	Washer (0.344 x 1.00 x 0.063)			
39	2	Grommet			
40	2	Bushing			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	1	Clip			
42	1	Breather hose			
43	6	Pencil coil			
44	6	Screw (M6 x 25)	8	71	–
45	6	Spark plug (NGK-ILFR6GE)	27	–	20
46	3	Clip			
47	13	Screw (M6 x 25)	8	71	–
48	2	Camshaft drive sprocket			
49	2	Screw (M6 x 40) **Left Hand**	45	–	33
			Turn additional 20° after initial torque		
50	2	Screw (M6 x 12)	8	71	–
51	2	Clip			
52	1	Clamp (22.6 mm)			
53	1	Seal			

Cylinder Head Components (S/N 1B517433 and Below)



Cylinder Head Components (S/N 1B517434–1B733951)

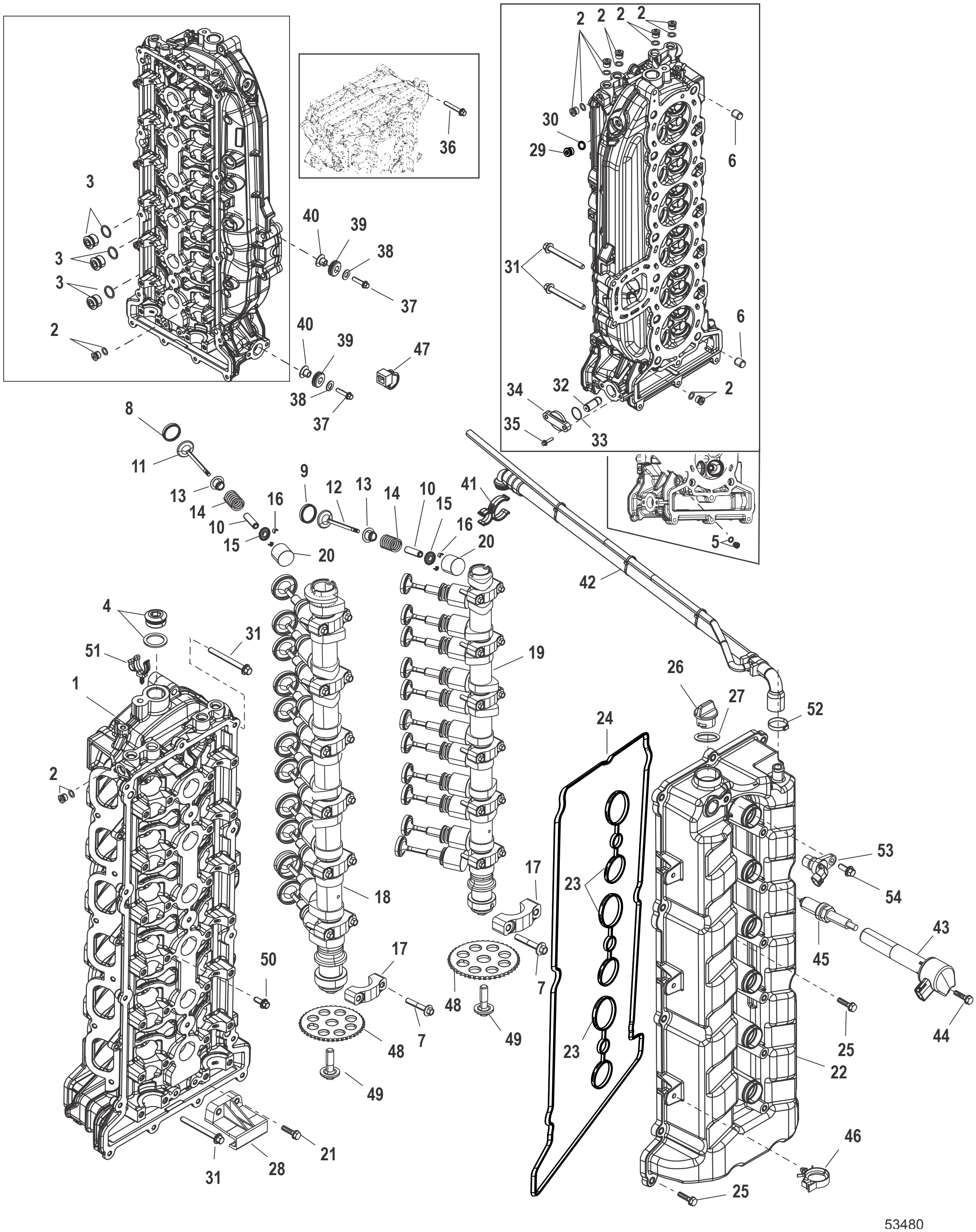


Cylinder Head Components (S/N 1B517434–1B733951)

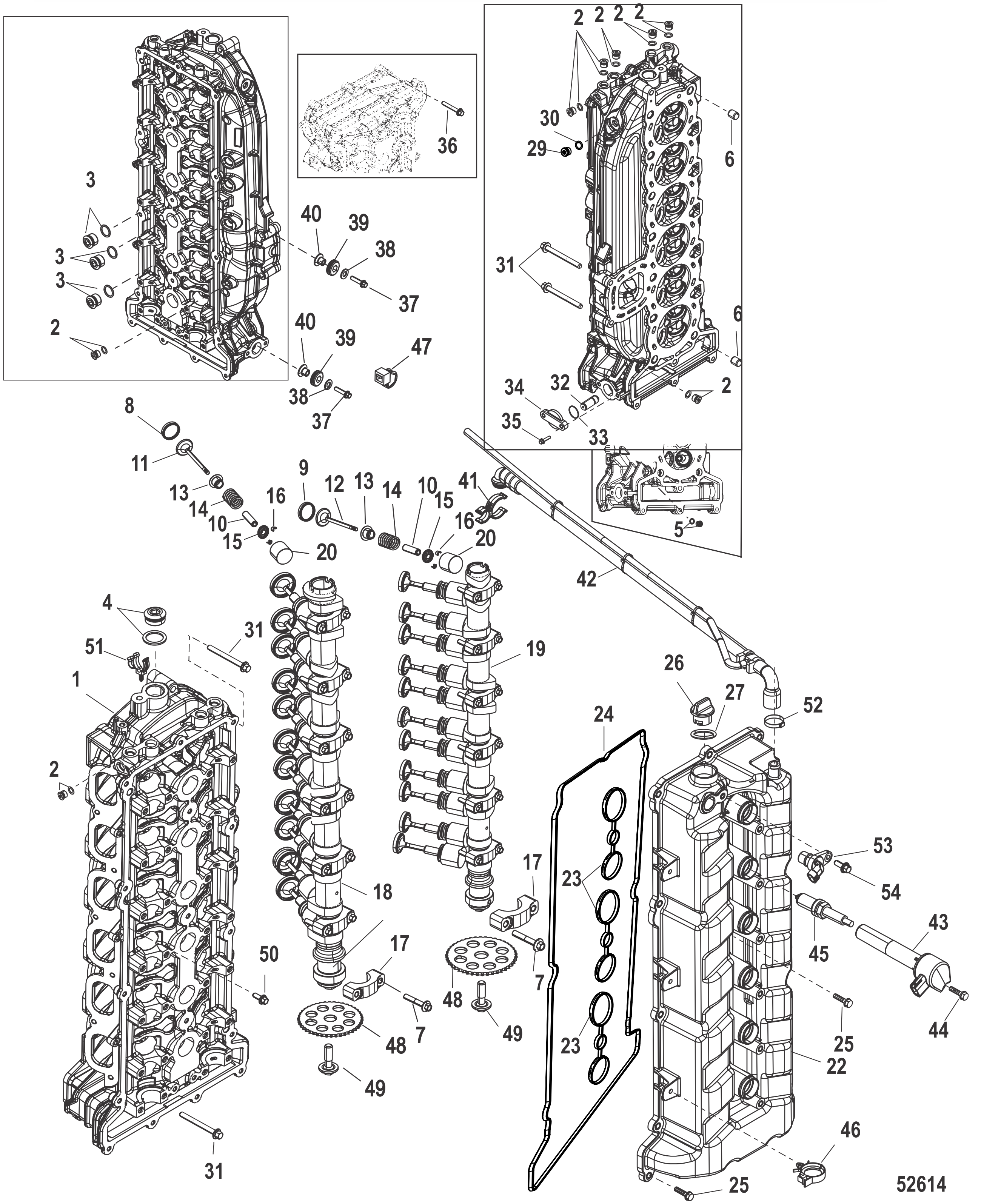
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cylinder head			
2	8	Plug (12 mm) and O-ring	9	80	–
3	3	Plug (18 mm) and O-ring	22	–	16
4	1	Plug (24 mm) and O-ring	55	–	40.5
5	1	Plug (10 mm) and O-ring	9	80	–
6	2	Dowel pin (14 mm)			
7	28	Bolt (M6 x 35)	12	106	–
8	12	Intake valve seat			
9	12	Exhaust valve seat			
10	24	Intake and exhaust valve guide			
11	12	Intake valve			
12	12	Exhaust valve			
13	24	Spring seat valve seal			
14	24	Valve spring			
15	24	Valve retainer			
16	48	Key			
17	14	Cap			
18	1	Intake camshaft			
19	1	Exhaust camshaft			
20	24	Bucket tappet			
21	2	Screw (M6 x 30)	12	106	–
22	1	Camshaft cover			
23	3	Seal			
24	1	Seal			
25	16	Screw (M6 x 25)	8	71	–
26	1	Oil plug assembly			
27	1	O-ring (0.921 x 0.139 mm)			
28	1	Short guide			
29	1	Plug (M10 x 1.5)	9	80	–
30	1	O-ring (1.78 mm x 0.08 mm)			
31	4	Screw (M8 x 60)	28	–	20.7
32	1	Timing chain tensioner			
33	1	O-ring			
34	1	Tensioner end cap			
35	2	Screw (M6 x 25)	11	97	–
36	3	Screw (M6 x 40)	8	71	–
37	2	Screw (M8 x 35)	24	–	17.7
38	2	Washer (0.344 x 1.00 x 0.063)			
39	2	Grommet			
40	2	Bushing			

Ref. No.	Qty.	Description	Torque Nm	Torque lb-in.	Torque lb-ft
41	1	Clip			
42	1	Breather hose			
43	6	Pencil coil			
44	6	Screw (M6 x 25)	8	71	–
45	6	Spark plug (NGK-ILFR6GE)	27	–	20
46	3	Clip (0.625)			
47	1	Cable tie (11.75 in.)			
48	2	Camshaft drive sprocket			
49	2	Screw (M6 x 40) **Left Hand**	45	–	33
			Turn additional 20° after initial torque		
50	2	Screw (M6 x 12)	8	71	–
51	1	Clip			
52	1	Clamp (22.6 mm)			
53	1	Camshaft position sensor			
54	1	Screw (M6 x 16)	8	71	–

Cylinder Head Components (S/N 1B517434–1B733951)



Cylinder Head Components (S/N 1B733952 and Above)

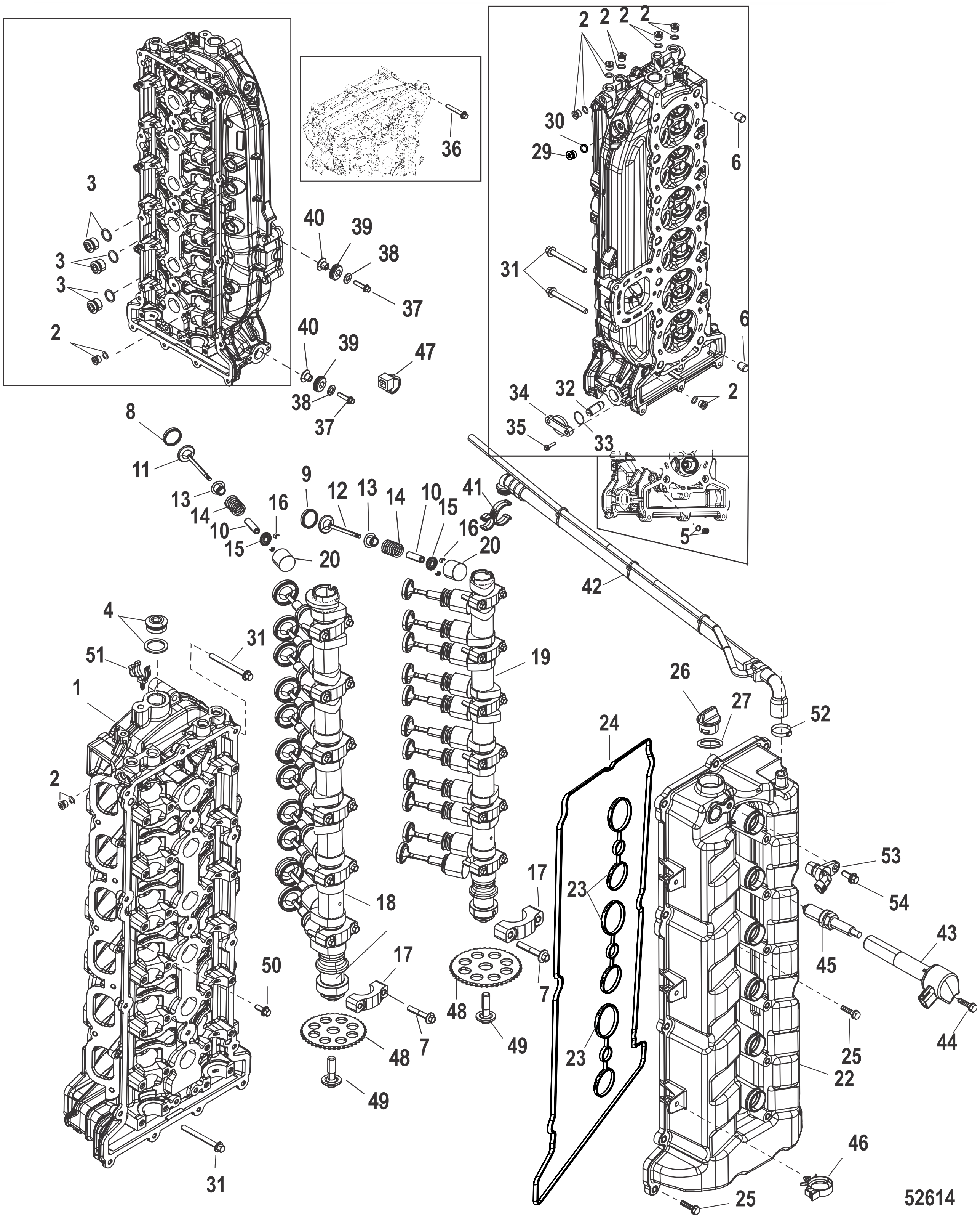


Cylinder Head Components (S/N 1B733952 and Above)

Ref. No.	Qty.	Description	Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Cylinder head			
2	8	Plug (12 mm) and O-ring	9	80	–
3	3	Plug (18 mm) and O-ring	22	–	16
4	1	Plug (24 mm) and O-ring	55		40.5
5	1	Plug (10 mm) and O-ring	9	80	–
6	2	Dowel pin (14 mm)			
7	28	Bolt (M6 x 35)	12	106	–
8	12	Intake valve seat			
9	12	Exhaust valve seat			
10	24	Intake and exhaust valve guide			
11	12	Intake valve			
12	12	Exhaust valve			
13	24	Spring seat valve seal			
14	24	Valve spring			
15	24	Valve retainer			
16	48	Key			
17	14	Cap			
18	1	Intake camshaft			
19	1	Exhaust camshaft			
20	24	Bucket tappet			
22	1	Camshaft cover			
23	3	Seal			
24	1	Seal			
25	16	Screw (M6 x 25)	8	71	–
26	1	Oil plug assembly			
27	1	O-ring (0.921 x 0.139 mm)			
29	1	Plug (M10 x 1.5)	9	80	–
30	1	O-ring (1.78 mm x 0.08 mm)			
31	4	Screw (M8 x 60)	28	–	20.7
32	1	Timing chain tensioner			
33	1	O-ring			
34	1	Tensioner end cap			
35	2	Screw (M6 x 25), stainless steel	11	97	–
36	3	Screw (M6 x 40), stainless steel	8	71	–
37	2	Screw (M8 x 35)	24	–	17.7
38	2	Washer (0.344 x 1.00 x 0.063), stainless steel			
39	2	Grommet			
40	2	Bushing			
41	1	Clip			
42	1	Breather hose			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
43	6	Pencil coil			
44	6	Screw (M6 x 25), stainless steel	8	71	–
45	6	Spark plug (NGK-ILFR6GE)	27	–	20
46	3	Clip (0.625 in.)			
47	1	Cable tie (11.75 in.)			
48	2	Camshaft drive sprocket			
49	2	Screw (M6 x 40) **Left Hand**	45	–	33
			Turn additional 20° after initial torque		
50	2	Screw (M6 x 12)	8	71	–
51	1	Clip			
52	1	Clamp (22.6 mm)			
53	1	Camshaft position sensor			
54	1	Screw (M6 x 16) stainless steel	8	71	–

Cylinder Head Components (S/N 1B733952 and Above)



Cylinder Head Service Recommendations

All engines, from a single cylinder low horsepower to a multicylinder high-performance racing engine, require frequent maintenance and inspection schedules because of the extreme duty cycles and related stress these products endure. Failure to follow the maintenance and service schedule could lead to catastrophic engine failure and increased owner expense.

The cylinder head is the most important component of the engine. It has extremely close tolerance machined components that must be repaired by an accomplished Master Technician with experience servicing high-performance engines. A skilled machine shop that is familiar with automotive engine machining techniques, must be utilized when the cylinder head requires any type of machining or clearance correction repair. Damage to the cylinder head combustion chamber area from a component failure, debris, or improper machining, will alter the emissions output of the engine and may require the cylinder head be replaced instead of repaired. Careful attention to details, proven repair techniques, and factory supplied high quality parts are required to restore this engine to the original factory emissions and performance output.

IMPORTANT: The cylinder head is machined to extremely close tolerances and should not be modified by inexperienced personnel. Cutting the valve seat without close attention to detail, can change the combustion chamber area where the engine is not within the factory emissions specification and may effect the engine's performance.

Cylinder Head Disassembly

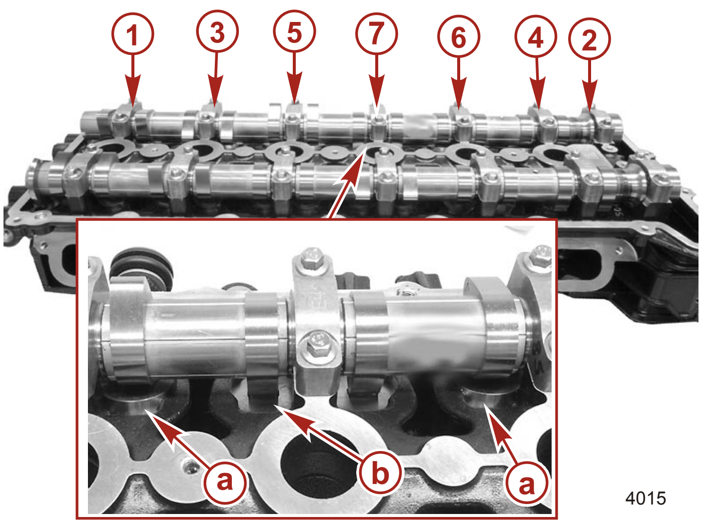
Camshaft Removal

*NOTE: Refer to **Section 4A - Cylinder Block/Crankcase** for cylinder head removal procedures.*

IMPORTANT: The removal and disassembly procedure for the cylinder head and camshafts must be strictly followed. Failure to follow the removal outline procedure may damage the valve train components and/or cylinder head.

1. Starting with the camshaft cap furthest away from the camshaft lobes that are engaging the valve bucket and working towards the camshaft lobe that is engaging the valve bucket, release the pressure on the camshaft caps one quarter (1/4) turn at a time. Continue this sequence and release the pressure one quarter (1/4) turn at a time until all tension on the camshaft caps is released.

NOTICE
Improperly loosening cam cap bolts will damage the cam cap, cam cap guides, cam cap-to-cylinder head mating surface, or cam. Do not release the tension from the cam cap screws more than one quarter turn at a time, alternating as you go.



a - Camshaft lobe not engaging the valve bucket
b - Camshaft lobe engaging the valve bucket

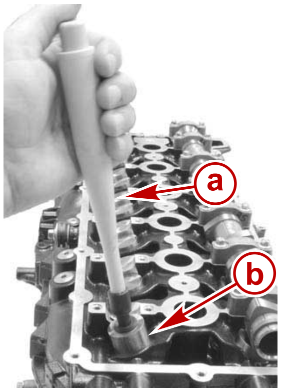
NOTE: All camshaft caps are marked in sequence, starting from the top with number 1 and working down to number 7, and have an I or E designation (for intake or exhaust). The camshaft caps also have a direction arrow pointing to the top of the cylinder head.

2. Remove the camshaft caps.
3. Lift the camshaft off of the cylinder head camshaft cradles.
4. Repeat steps 1–3 for the remaining camshaft.

Valve Removal

1. Clean the surface of the valve buckets with a solvent to remove any oil residue. With an indelible marker, write on the top of the valve bucket its location: E1, E2, E3, I1, I2, I3, etc.
2. Remove the valve bucket tappet with a vacuum-assisted valve lashing tool. Do not use a magnet to remove the valve bucket tappets.

IMPORTANT: Do not intermix the location of the valve train parts.
The valve bucket tappets have different dimensions to correct for proper valve lash clearance. Note the location of the valve bucket tappets and valves.



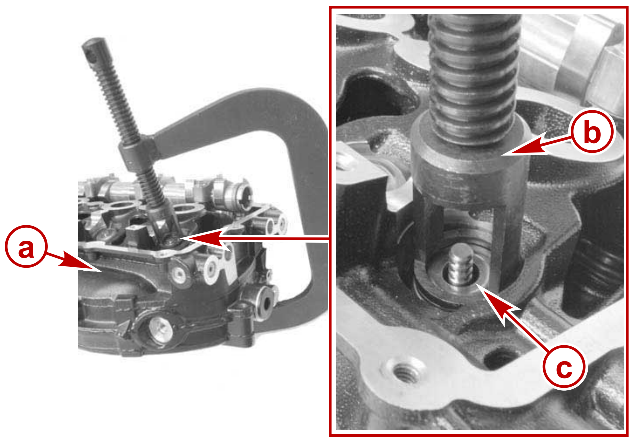
4016

a - Vacuum-assisted valve lashing tool
b - Valve bucket tappet

3. Use a valve spring compressor to collapse the valve spring and remove the valve spring retainers and keys.

   NOTE: Do not damage the cylinder head valve bucket tappet bore when using the valve spring compressor.

   IMPORTANT: Do not intermix the location of the valve train parts.

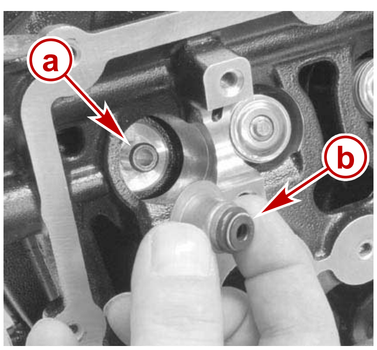


4018

a - Cylinder head
b - Valve spring compressor
c - Valve stem

Valve Spring Compressor	91-809494A 1

4. Release the valve spring compressor.
5. Remove the valve.
6. Remove the valve guide seal.



4019

a - Valve guide
b - Valve guide seal

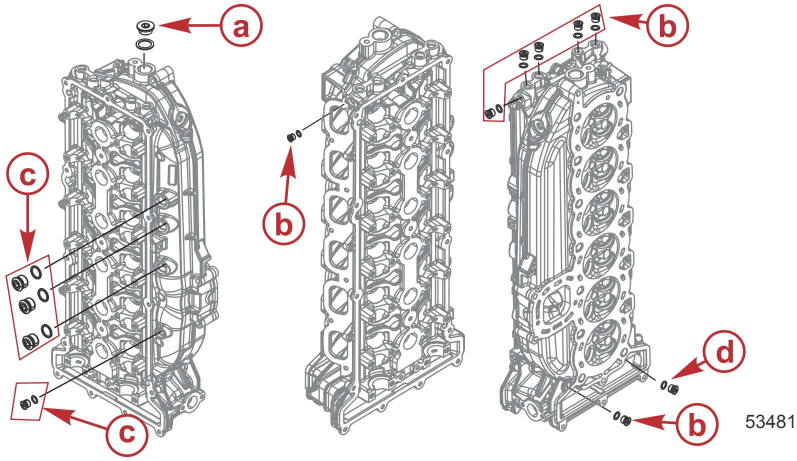
IMPORTANT: Do not reuse valve guide seals after the valve has been removed.

Cylinder Head Galley Plug Removal

1. Remove all of the oil and water galley plugs from the cylinder head.

   NOTE: It may be necessary to lightly tap on the galley plugs with a brass drift and hammer to break the galley plug seal.

2. Remove the O-rings from the oil and water galley plugs and discard the galley plug O-rings.

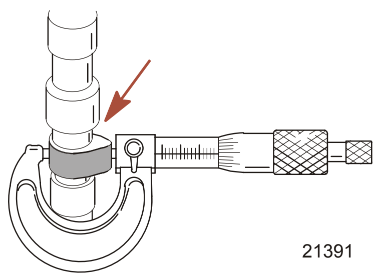


a - Water galley plug
b - Oil galley plug (12 mm)
c - Water galley plug
d - Water galley plug (later models only)

Cleaning/Inspection/Repair

Camshaft

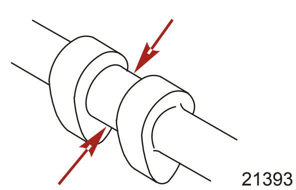
1. Measure the camshaft lobe at its maximum valve lift. Replace the camshaft if the dimensions are out of specification.



Camshaft Lobe Specifications (S/N 1B517433 and Below) - Minimum	
Intake cam	42.44 mm (1.6709 in.)
Exhaust cam	43.49 mm (1.7122 in.)

Camshaft Lobe Specifications (S/N 1B517434 and Above) - Minimum	
Intake cam	43.49 mm (1.7122 in.)
Exhaust cam	43.49 mm (1.7122 in.)

2. Measure all of the camshaft bearing journals with a micrometer. Replace the camshaft if the journal dimensions are out of specification.

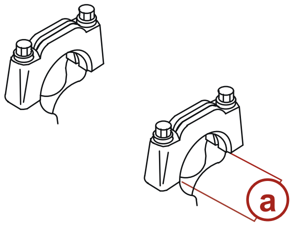


Camshaft Bearing - Minimum	
Intake and exhaust journal O.D.	28.94 mm (1.1394 in.)

3. Install the camshaft bearing caps in their correct location and orientation. Tighten the camshaft bearing cap screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Camshaft bearing cap screw	12	106	–

4. Measure the inside diameter of the camshaft bearing cap. Replace the cylinder head if the dimension is out of specification.

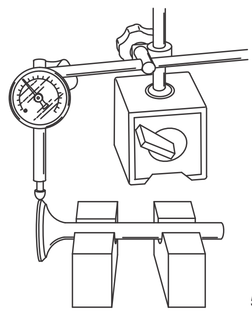


a - Camshaft bearing cap inside dimension

Camshaft Bearing Cap	
Inside diameter	29.000–29.021 mm (1.1417–1.1425 in.)

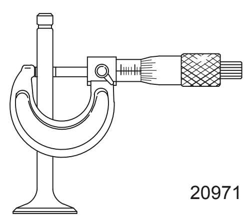
Valves

1. Inspect the valves for damage or warpage. Replace the valves if necessary.
2. Measure the valve stem runout. Replace the valves if they are out of specification.



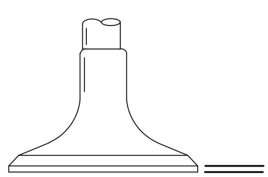
Valve Stem	
Runout	0.038 mm (0.0015 in.) maximum

3. Measure the valve stem diameter. Replace the valves if they are out of specification.



Valve Stem Minimum Diameter	
Intake	5.960 mm (0.2346 in.)
Exhaust	5.950 mm (0.2343 in.)

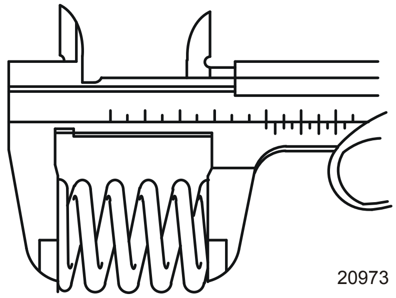
4. Measure the valve margin thickness. Replace the valve if it is out of specification.



Valve Margin Minimum Thickness	
Intake	0.424 mm (0.0167 in.)
Exhaust	0.420 mm (0.0165 in.)

Valve Springs

1. Check free length of each valve spring. Replace the valve springs if they are out of specification.



20973

Valve Spring	
Free length	48.77 mm (1.920 in.)

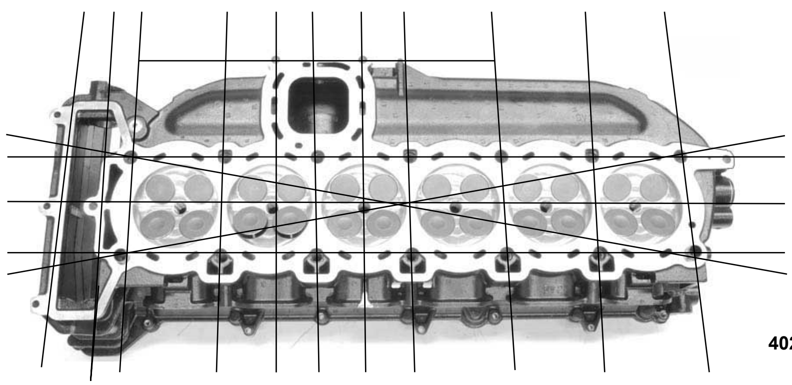
2. Using a valve spring tester, test the valve spring load at the installed height. Refer to the following table for height and load specifications.

Valve Spring	
Installed height	34 mm (1.339 in.)
Measured load	222 ± 10 N (49.91 ± 2.25 lb-force)

Cylinder Head

1. Inspect the cylinder head for mineral deposits and corrosion in the water passageways. Clean any deposits or corrosion observed.
2. Pressure test the cylinder head to ensure that there are no leaks or cracks.
3. Inspect the cylinder head for carbon deposits in the combustion chamber. Use a round scraper to clean away deposits. Be careful not to scratch or remove material from the cylinder head.
4. Measure the cylinder head for warpage. Replace the cylinder head if it is out of specification.

NOTE: Use a straight edge and a feeler gauge to inspect the cylinder head for warpage.



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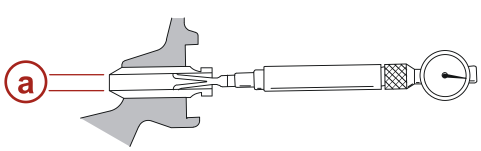
Cylinder Head	
Maximum deck warp	0.075 mm (0.003 in.)

Valve Guides

Measure the valve guide bore with a valve guide bore gauge. If valve guide wear is out of specification, replace the valve guide.



20975

a - Valve guide bore

Valve Guide Bore	
Intake and exhaust	6.00–6.016 mm (0.2362–0.2368 in.)

Valve Guide Replacement

NOTE: Inexperienced personnel should not attempt to replace the valve guide. A reputable engine machine shop will have the tools to replace the valve guides and ream the guides to proper tolerance.

IMPORTANT: The valve guide must be removed and installed at room temperature. Use a pneumatic impact hammer to remove and install the valve guide.

Cylinder Head	
Valve guide height	15.0–15.2 cm (0.591–0598 in.)

Valve Stem to Valve Guide Clearance	
Intake	0.020–0.050 mm (0.0008–0.0020 in.)
Exhaust	0.030–0.060 mm (0.0012–0.0024 in.)

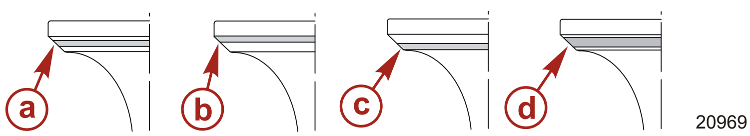
Valve Seat Reconditioning

The cylinder head is the most important component of an internal combustion engine. It has extremely close tolerance machined components that must be repaired by an accomplished Master Technician with experience servicing high-performance engines. A skilled machine shop that is familiar with automotive engine machining techniques must be utilized when the cylinder head requires any type of machining or clearance correction repair. Damage to the cylinder head combustion chamber area from a component failure, debris, or improper machining will alter the emissions output of the engine and may require the cylinder head be replaced instead of repaired. Careful attention to details, proven repair techniques, and factory supplied high quality parts are required to restore this engine to the original factory emissions levels and performance output.

IMPORTANT: The cylinder head is machined to extremely close tolerances and should not be modified by inexperienced personnel. Cutting the valve seat without paying close attention to details such as valve seat angles can change the combustion chamber area and flow characteristics to a point where the engine is not within the factory emissions specification and may effect the engine's performance.

NOTE: Several different types of equipment are available for reseating valve seats. Follow the equipment manufacturer's instructions.

1. Clean the carbon deposits from the combustion chambers and valve seats. Check the valve seats for pitting.
2. Minimal and light pitting should be cleaned up with 600 grit lapping compound.
   IMPORTANT: The exhaust valve and seat should be replaced if the pitting cannot be cleaned up with minimal amount of lapping the valve to the seat. If the valve seat is replaced, the top cut of the valve seat must not go below or alter the factory machining of the combustion chamber.
3. Apply a thin, even layer of mechanic's bluing dye (Dykem) onto the valve seat.
4. Insert the valve into the valve guide and lap the valve slowly on the valve seat.
5. Remove the valve and measure the valve seat contact pattern width.



a - Correct valve seat contact area
b - Valve seat too high
c - Valve seat too low
d - Valve seat contact too wide

Valve Face Angle	
Intake and exhaust	45.25 ± 0.25°

Valve Seat Contact Width	
Intake	1.4–1.6 mm (0.0551–0.0630 in.)
Exhaust	1.5–1.7 mm (0.0591–0.0669 in.)

Valve Seat Angles	
Intake	30°, 44.625–45°, 55°

Valve Seat Angles	
Exhaust	30°, 44.625–45°, 55°

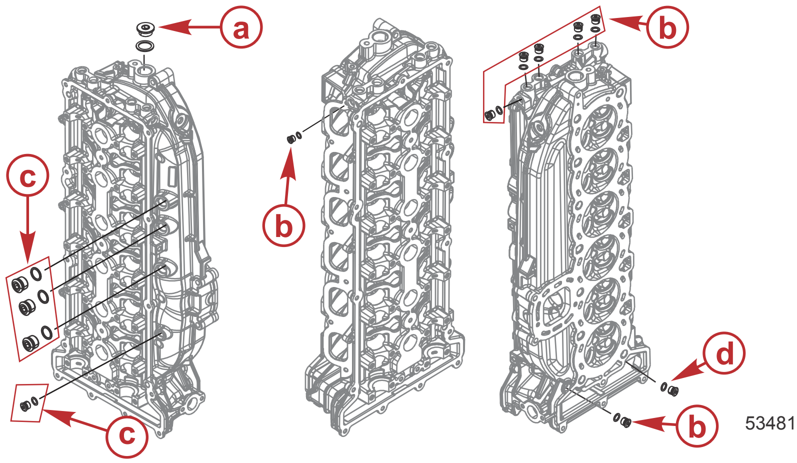
IMPORTANT: After refacing the valve seat, or replacing the valve and valve guide, the valve seat and valve face should be lapped.

IMPORTANT: After reconditioning the valve seat, the valve stem protrusion must be checked.

Cylinder Head Reassembly

Cylinder Head Galley Plug Installation

1. Install new O-rings on the oil and water galley plugs.
2. Seal the threads of the oil and water galley plugs with Loctite 567 PST Pipe Sealant.
3. Tighten the oil and water galley plug to the specified torque.



a - Water galley plug
b - Oil galley plug (12mm)
c - Water galley plug
d - Water galley plug (later models only)

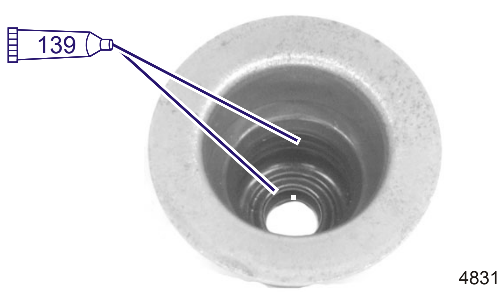
Description	Nm	lb-in.	lb-ft
Water galley plug "a"	55	–	40.5
Oil galley plug "b"	9	80	–
Water galley plug "c"	22	–	16.2
Water galley plug "d" (later models only)	9	80	–

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil and water galley plugs	92-809822

Valves

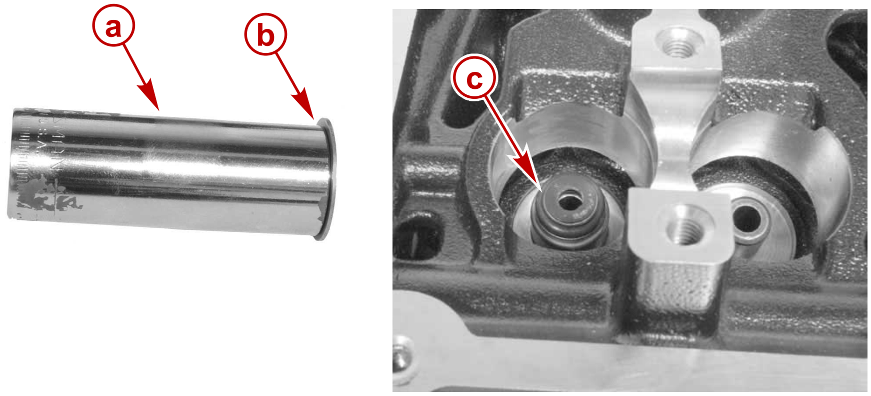
IMPORTANT: The reassembly procedure for the cylinder head must be strictly followed. Failure to follow the assembly procedure may damage the valves, camshaft, or cylinder head.

1. Lubricate the valve guide seals with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.



Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Valve guide seal	92-858052K01

2. Insert the valve guide seal into a 17 mm (11/16 in.) deep well socket.
3. Install the valve guide seal onto the valve guide. Lightly push the valve guide seal with the socket until it is seated on the cylinder head.



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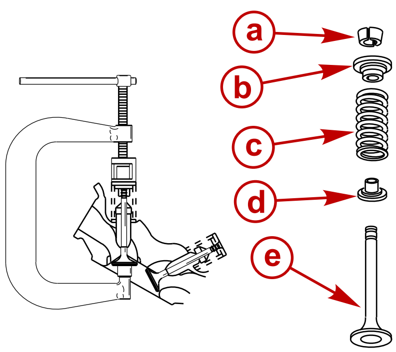
a - 17 mm (11/16 in.) socket
b - Valve guide seal
c - Valve guide seal installed on valve guide

4. Lubricate the valve stem with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil and push the valve through the valve guide seal.
5. Place the valve spring and valve spring retainer over the valve stem.
6. Compress the valve spring with a valve spring compressor.

   NOTE: The valve springs can be installed in any direction.

   IMPORTANT: Use caution when compressing the valve spring. Do not damage the valve, valve spring retainer, or the cylinder head valve bucket tappet bore.



28952

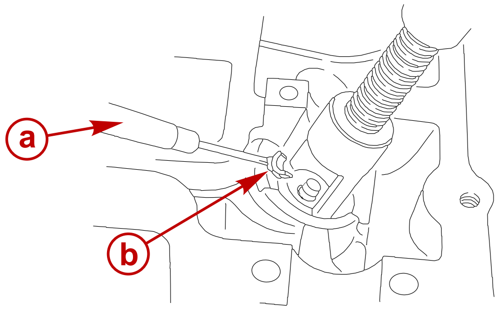
a - Valve spring retaining cotter
b - Valve spring retainer
c - Valve spring
d - Valve guide seal
e - Valve (intake and exhaust)

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Valve stem	92-858052K01

Valve Spring Compressor	91-809494A 1

7. Place the valve spring retaining cotter onto the end of a small screwdriver. A small amount of 2-4-C with PTFE applied to the end of the screwdriver will help the valve spring retaining cotter to adhere to the screwdriver. Install the valve spring retaining cotters onto the valve stem.

IMPORTANT: Two valve spring retaining cotters are required per valve.



a - Small screwdriver
b - Valve spring retaining cotter

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Installing valve spring retaining cotter	92-802859A 1

8. Release the valve spring compressor.
9. Repeat steps 1–8 to install the remaining valves onto the cylinder head.

Cams

1. Lubricate the valve bucket tappet outside diameter with Lubriplate SPO 255 and install it in the same location it was removed from during disassembly.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve bucket tappet outside diameter	Obtain Locally

IMPORTANT: If the valve or the valve seat was replaced/refaced, or the cam and/or cylinder head was replaced, you must install the 2.996 mm (0.118 in.) valve bucket tappet as a starting point to ensure an accurate valve measurement lash clearance.

2. Lubricate all of the cylinder head camshaft bearing journals with Lubriplate SPO 255.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Camshaft bearing	Obtain Locally

3. Carefully place either camshaft on the cylinder head camshaft journals. The intake camshaft location is on the port side. The exhaust camshaft is on the starboard side. Ensure the camshaft lobes for the top cylinder (number 1 cylinder) are facing away from the valves.

   NOTE: The intake camshaft is identified by the letters "MI" on the top side of all the camshaft lobes. The exhaust camshaft is identified by the letters "ME" on the top side of all the camshaft lobes.

4. Lubricate the camshaft journal with Lubriplate SPO 255.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Camshaft journal	Obtain Locally

5. Install the cylinder head camshaft caps in their proper location.

   NOTE: All of the cylinder head camshaft caps are identified as to which side, intake (I) and exhaust (E), orientation (up or down), and to which journal the cap was removed from. The number one (1) cylinder head camshaft cap location is at the top of the cylinder head.

6. Tighten the camshaft cap screws one quarter (1/4) turn at a time.
   IMPORTANT: Maintain the camshaft parallel to the cylinder head camshaft journals while the camshaft caps are installed and tightened. Failure to keep the camshaft parallel to the camshaft journals may damage the cylinder head, camshaft, or camshaft caps.

7. After all the camshaft caps are seated on the cylinder head, tighten the camshaft cap screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Camshaft cap screw	12	106	–

8. Install the other camshaft following the same procedure.

9. Check the valve lash as described in the service manual section **Valve Clearance and Adjustments**.

Valve Clearance and Adjustments

Valve Clearance Measurement Steps

Valve Lash Clearance Specification	
Intake	0.150–0.270 mm (0.0059–0.0106 in.)
Exhaust	0.350–0.470 mm (0.0137–0.0185 in.)

IMPORTANT: Accurate valve clearance measurements must be made on a cold engine at room temperature, with the cylinder head mated to the cylinder block and torqued to specification.

All of the cam caps must be at their torque specification prior to checking the valve lash measurement.

The valve lash measurement must be made with the cam lobe facing 180° from the valve bucket tappet.

1. Insert the feeler gauge between the cam and the valve bucket tappet. A slight drag on the feeler gauge will indicate the feeler gauge dimension measurement is accurate.

   NOTE: An offset feeler gauge will work best for checking the valve lash measurement. A straight feeler gauge will contact the cylinder head. This contact with the cylinder head may be misleading when checking the valve lash measurement.
2. Record the feeler gauge valve lash measurement and its location on all the valves.
3. If any of the valve lash measurements are out of specification, remove the cam as described in **Cylinder Head Disassembly**.

NOTE: It is not necessary to remove the cylinder head from the cylinder block to change the valve lash. The powerhead must be removed from the adapter plate when changing valve lash.

Changing Valve Clearance

IMPORTANT: The following procedure must be completed with the cylinder head mated to the cylinder block and torqued to specification. Failure to have the cylinder head mated and torqued to specification when changing the valve clearance will result with inaccurate formula measurements.

Valve Lash Clearance Specification	
Intake	0.150–0.270 mm (0.0059–0.0106 in.)
Exhaust	0.350–0.470 mm (0.0137–0.0185 in.)

1. If the valve lash clearance is out of valve lash clearance specification, remove the valve bucket tappet and measure its height. Record your measurement of the valve bucket tappet dimension.

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2. Add the valve bucket tappet height measurement and the feeler gauge valve lash measurement.
3. Subtract the specified valve lash clearance from the sum of the valve bucket tappet height measurement/feeler gauge valve lash measurement. This is the valve bucket tappet height measurement you need to install.

EXAMPLE

If the removed valve bucket tappet height is 2.996 mm (0.118 in.), the feeler gauge valve lash measurement is 0.30 mm (0.012 in.) and the specified valve lash clearance is 0.20 mm (0.008 in.), then the formula will appear like:

Metric Measurement: 2.996 + 0.30 - 0.20 = 3.096 mm. New valve bucket tappet height measurement is 3.096 mm.

English Measurement: 0.118 + 0.012 - 0.008 = 0.122 in.. New valve bucket tappet height measurement is 0.122 in.

NOTE: Photocopy the following table for additional valve clearance measurement work sheets.

MEASUREMENT TABLE								
INTAKE (cold) 0.150–0.270 mm (0.0059–0.0106 in.)					**EXHAUST (cold)** 0.350–0.470 mm (0.0137–0.0185 in.)			
Cylinder	Valve Bucket Tappet Height	Feeler Gauge Valve Lash Measurement	Specified Clearance	New Valve Bucket Tappet Height	Valve Bucket Tappet Height	Feeler gauge Valve Lash Measurement	Specified Clearance	New Valve Bucket Tappet Height
#1								
#2								
#3								
#4								
#5								
#6								

Powerhead

Section 4C - Lubrication

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C

Oil System Specifications

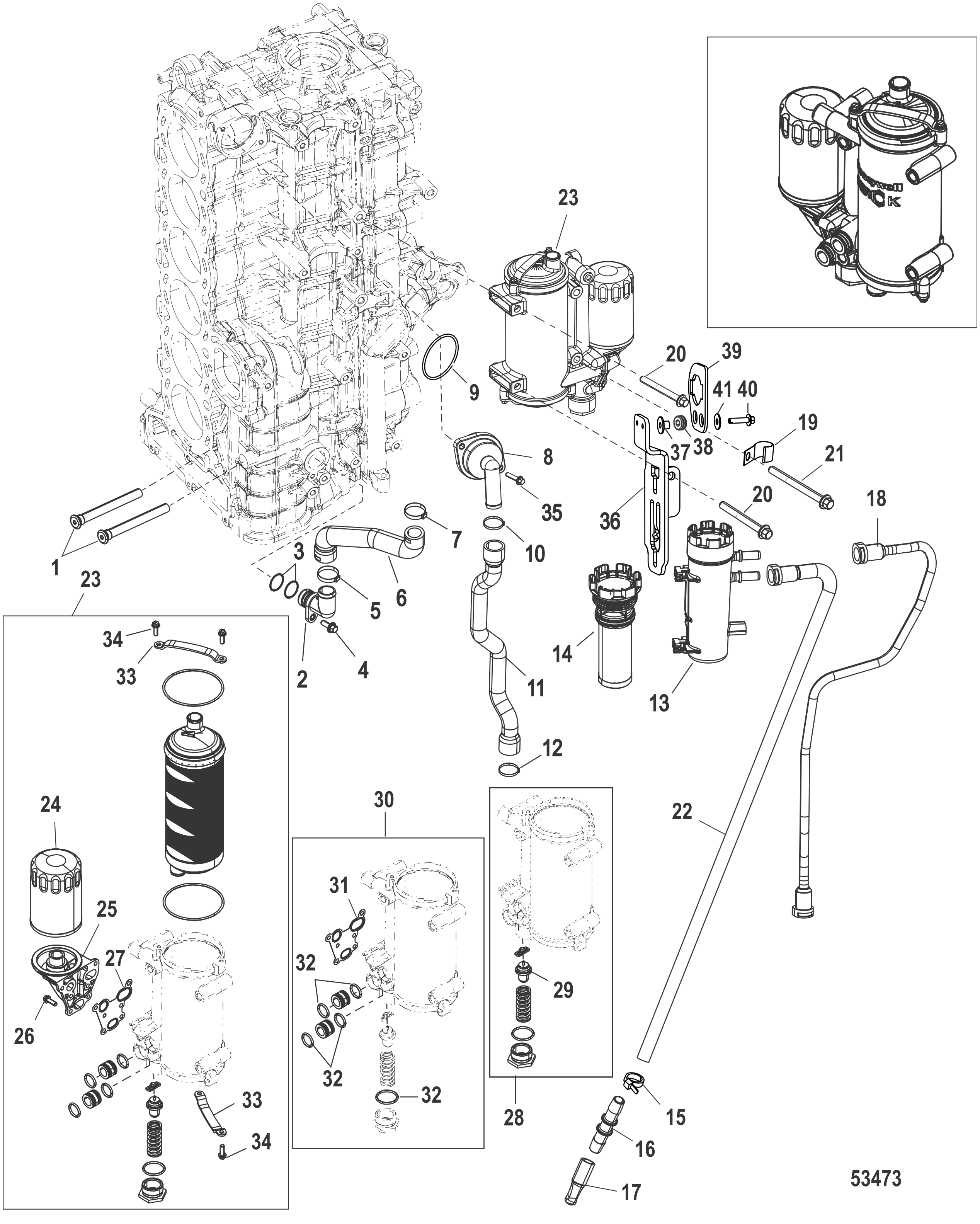
Engine capacity wet	7 L (7.4 US qt)
Engine capacity dry	8 L (8.4 US qt)
Oil filter part number (S/N 1B517433 and below)	883701K01
Oil filter part number (S/N 1B517434 and above)	877769KO1
Oil type recommendation	Mercury Racing 4-Stroke Oil or NMMA FC-W SAE 25W-50 Synthetic Blend (preferred) or NMMA FC-W SAE 25W-40 Synthetic Blend 4-Stroke Outboard Oil
S/N 1B517433 and below	
Oil pressure (minimum) at 550 RPM	70 kPa (10 psi)
Oil pressure (minimum) at 6000 RPM	220 kPa (32 psi)
S/N 1B517434 and above	
Oil pressure (minimum) at 550 RPM	35 kPa (5 psi)
Oil pressure (minimum) at 6000 RPM	200 kPa (29 psi)
IOM thermostat opening temperature	105 °C (221 °F)

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Oil pump mounting screw	92-809821
91	Engine Coupler Spline Grease	Oil pump drive sprocket	8M0071842
		Drive hub O-rings	
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump	92-858052K01
		Priming the oil pump prior to oil pump installation	
		Driveshaft seals	

Notes:

Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)

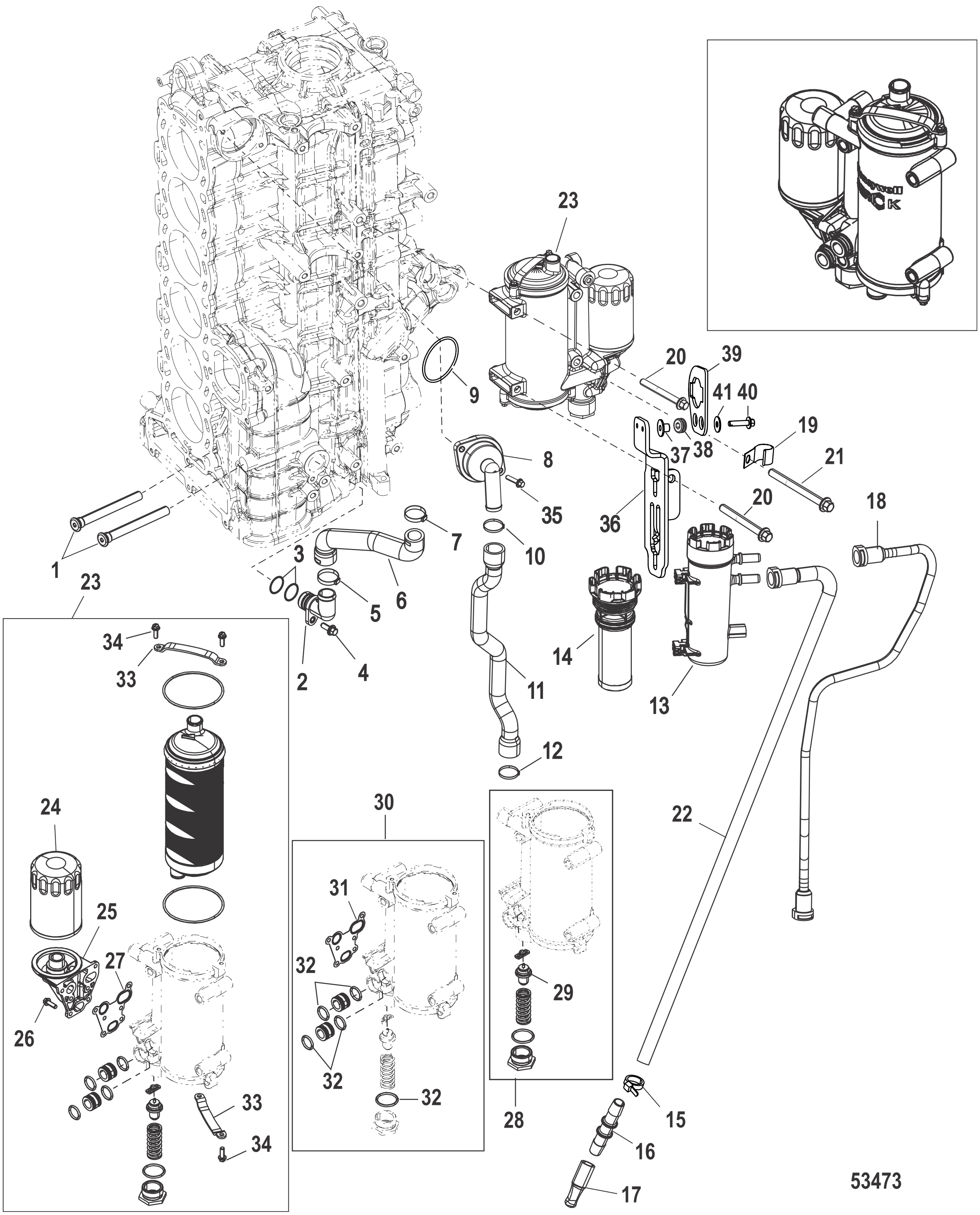


Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)

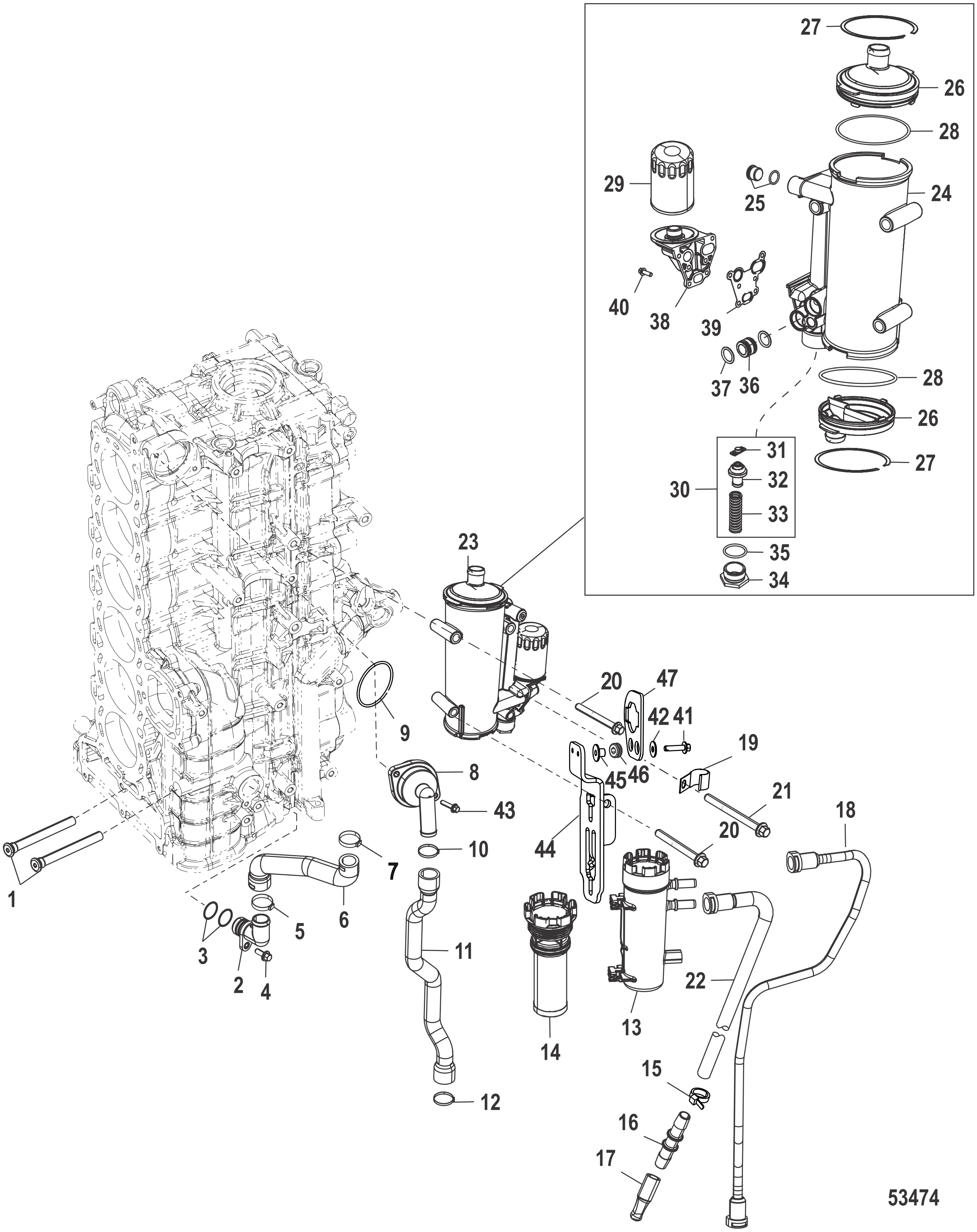
Ref. No.	Qty.	Description	Torque Nm	lb-in.	lb-ft
1	2	Water deflector assembly	9	80	–
2	1	Fitting assembly			
3	2	O-ring			
4	1	Screw (M6 x 16), stainless steel	10	88.5	–
5	1	Clamp (38.1 mm)			
6	1	Hose			
7	1	Clamp (34.6 mm)			
8	1	Thermostat assembly			
9	1	O-ring			
10	1	Clamp (36.1 mm)			
11	1	Thermostat hose			
12	1	Clamp (42.5 mm)			
13	1	Fuel filter housing			
14	1	Fuel filter	7.5	66	–
15	1	Cable tie (8.00 in.)			
16	1	Connector			
17	1	Grab tab			
18	1	Fuel filter to lift pump hose			
19	1	J-clamp			
20	3	Screw (M10 x 85)	31	–	23
21	1	Screw (M10 x 105)	31	–	23
22	1	Fuel inlet hose			
23	1	Integrated oil module (IOM)			
24	1	Oil filter			
25	1	Integrated oil module housing assembly			
26	6	Screw (M6 x 18)	10	88.5	–
27	1	Gasket			
28	1	Thermostat guide kit			
29	1	Thermostat			
30	1	Overhaul kit			
31	1	Gasket			
32	1	O-ring kit			
33	2	Strap			
34	4	Screw (M6 x 18)	10	88.5	–
35	2	Screw (M6 x 25), stainless steel	8	71	–
36	1	Bracket			
37	2	Bushing			
38	2	Grommet			
39	1	Bracket			
40	2	Screw (M6 x 25)	8	71	–

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	2	Washer (0.265 x 0.750 x 0.048), stainless steel			

Starboard Cylinder Block/Oil Cooler (S/N 1B830815 and Below)



Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)

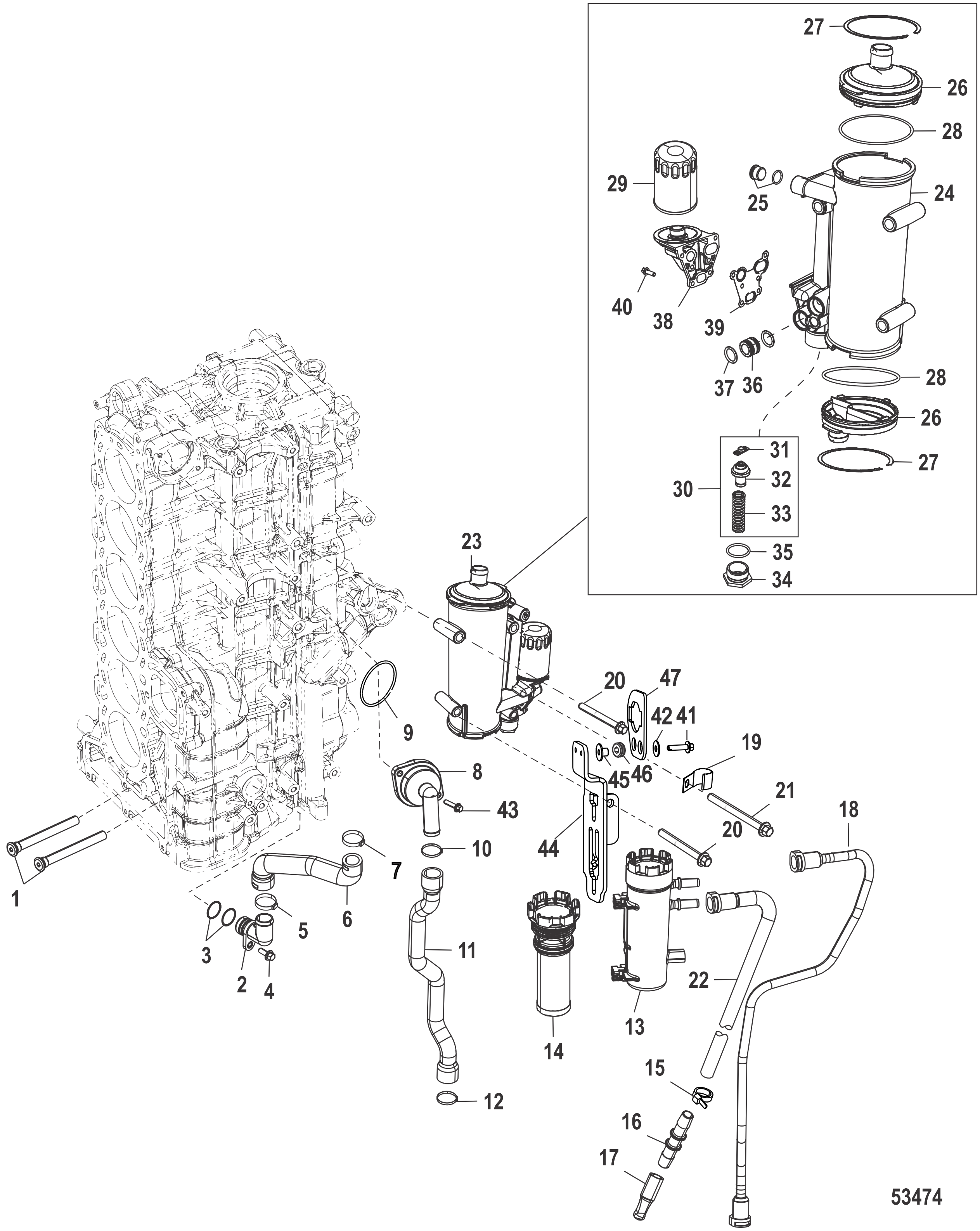


Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)

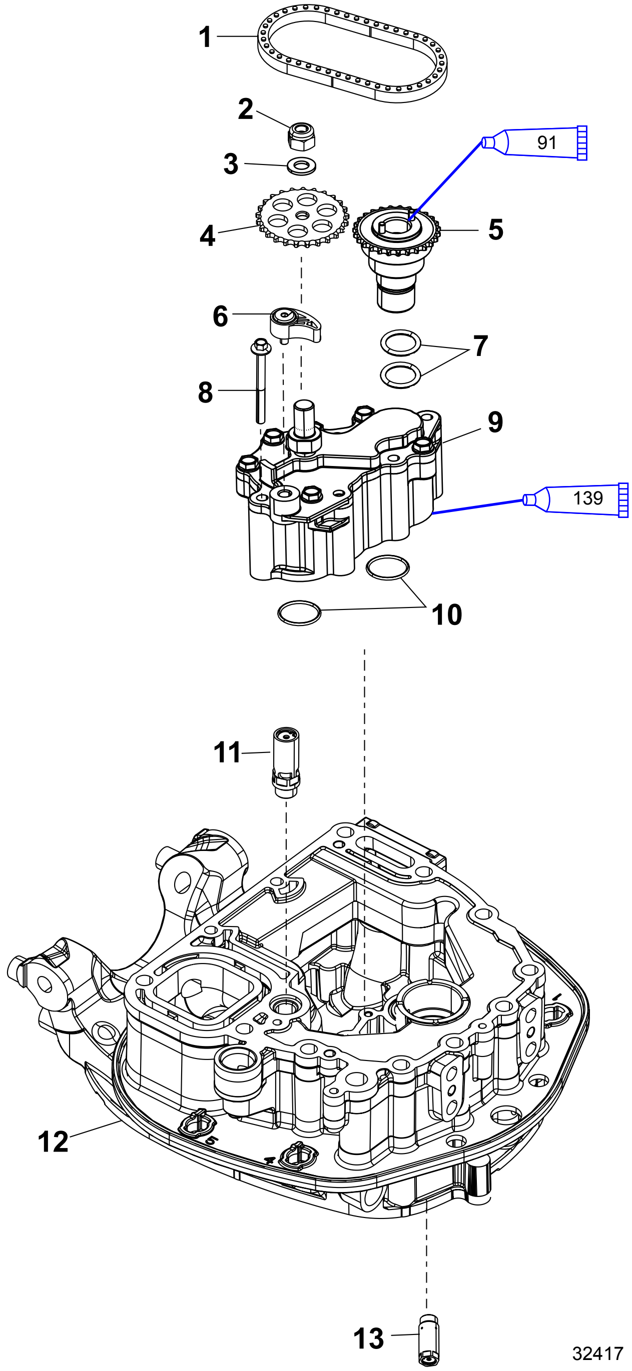
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Water deflector assembly	9	80	–
2	1	Fitting assembly			
3	2	O-ring			
4	1	Screw (M6 x 16), stainless steel	10	88.5	–
5	1	Clamp (38.1 mm)			
6	1	Hose			
7	1	Clamp (34.6 mm)			
8	1	Thermostat assembly			
9	1	O-ring			
10	1	Clamp (36.1 mm)			
11	1	Thermostat hose			
12	1	Clamp (42.5 mm)			
13	1	Fuel filter housing			
14	1	Fuel filter	7.5	66	–
15	1	Cable tie (8.00 in.)			
16	1	Connector			
17	1	Grab tab			
18	1	Fuel filter to lift pump hose			
19	1	J-clamp			
20	3	Screw (M10 x 85)	31	–	23
21	1	Screw (M10 x 105)	31	–	23
22	1	Fuel inlet hose			
23	1	Integrated oil module (IOM)			
24	1	Oil cooler housing			
25	2	Plug with O-ring			
26	2	End cap assembly			
27	2	Retaining ring			
28	2	O-ring			
29	1	Oil filter			
30	1	Thermostat assembly			
31	1	Thermostat stop			
32	1	Thermostat			
33	1	Spring			
34	1	Plug			
35	1	O-ring			
36	2	Adapter assembly			
37	4	O-ring			
38	1	Housing assembly			
39	1	Gasket			
40	6	Screw (M6 x 18)	10	88.5	–

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	2	Screw (M6 x 25)	8	71	–
42	2	Washer (0.265 x 0.750 x 0.048), stainless steel			
43	2	Screw (M6 x 25), stainless steel	8	71	–
44	1	Bracket			
45	2	Bushing			
46	2	Grommet			
47	1	Bracket			

Starboard Cylinder Block/Oil Cooler (S/N 1B830816 and Above)



Oil Pump and Adapter Plate Components (S/N 1B517433 and Below)

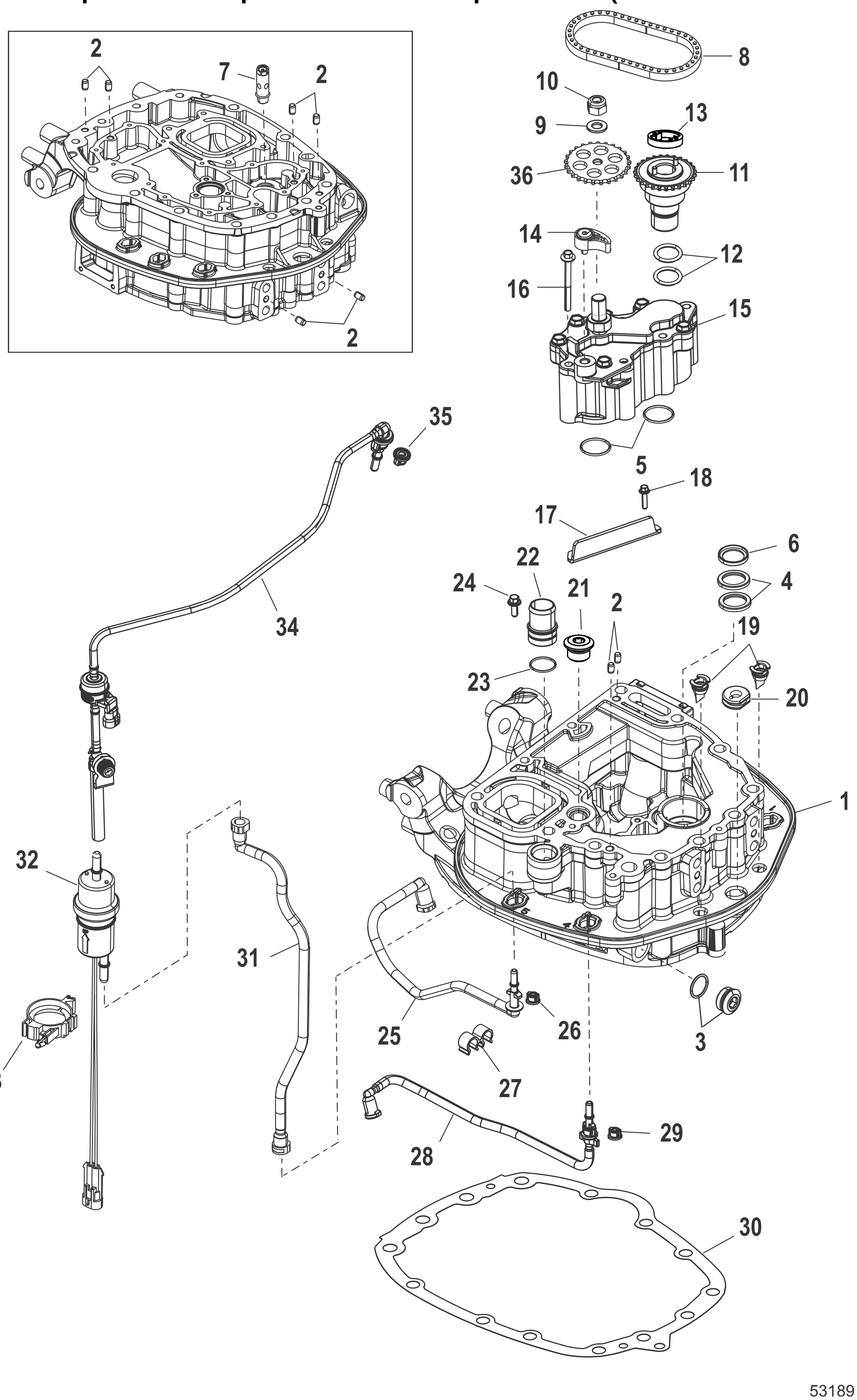


Oil Pump and Adapter Plate Components (S/N 1B517433 and Below)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Oil pump drive chain			
2	1	Driven sprocket nut	80	–	59
3	1	Washer			
4	1	Oil pump driven sprocket			
5	1	Oil pump drive sprocket			
6	1	Tensioner			
7	2	O-ring			
8	5	Screw (M6 x 65)	10	88.5	–
9	1	Oil pump assembly			
10	2	O-ring			
11	1	Piston cooling check valve assembly	40	–	29.5
12	1	Adapter plate			
13	1	Oil pump pressure relief check valve assembly	40	–	29.5

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Oil pump drive sprocket	8M0071842
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump	92-858052K01

Oil Pump and Adapter Plate Components (S/N 1B517434 and Above)



Oil Pump and Adapter Plate Components (S/N 1B517434 and Above)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Adapter plate kit			
2	8	Dowel pin			
3	1	Plug (24 mm) with O-ring	50	–	37
4	2	Water seal			
5	2	O-ring			
6	1	Oil seal			
7	1	Oil pump pressure relief check valve assembly	35	–	25.8
8	1	Oil pump drive chain			
9	1	Washer			
10	1	Driven sprocket nut	80	–	59
11	1	Oil pump drive sprocket			
12	2	O-ring			
13	1	Plastic insert			
14	1	Tensioner			
15	1	Oil pump assembly			
16	5	Screw (M6 x 65)	10	88.5	–
17	1	Oil deflector			
18	2	Screw (M6 x 16)	10	88.5	–
19	2	Cowl drain			
20	1	Grommet			
21	1	Plug (M18 x 1.5)	40	–	29.5
22	1	Dump fitting			
23	1	O-ring (1.239 x 0.070)			
24	1	Screw (M6 x 12)	6	53	–
25	1	Lower vent hose			
26	1	Grommet			
27	1	Clip			
28	1	Fuel supply module inlet fuel hose			
29	1	Grommet			
30	1	Gasket			
31	1	Fuel vent hose			
32	1	Vent canister assembly			
33	1	Clip			
34	1	Fuel line purge valve assembly			
35	1	Grommet			
36	1	Oil pump driven sprocket			

Engine Guardian System

The Engine Guardian system monitors the critical sensors on the engine for early indications of problems. The system will respond to a problem by:

S/N 1B460632 and below

- Emitting a continuous beep
- Reducing engine power in order to provide engine protection

NOTE: Engines with serial number 1B460632 and below that have had the PCM reflashed will have the latest warning strategy as found in engines with serial number 1B460633 and above.

S/N 1B460633 and above

- Emitting a continuous six-second beep for critical engine conditions
- Emitting an intermittent six-second beep for noncritical engine conditions
- Reducing engine power in order to provide engine protection

If the Engine Guardian system has been activated, reduce engine speed. The problem will need to be identified and corrected, if possible. The system must be reset before the engine will operate at higher speeds.

Low Oil Pressure, Engine Guardian

S/N 1B460432 and below

When the PCM receives information that the engine oil pressure is below a predetermined value at any given RPM, the Engine Guardian system will sound a continuous horn and reduce the engine RPM. The amount of RPM reduction is dependent on the amount of oil pressure.

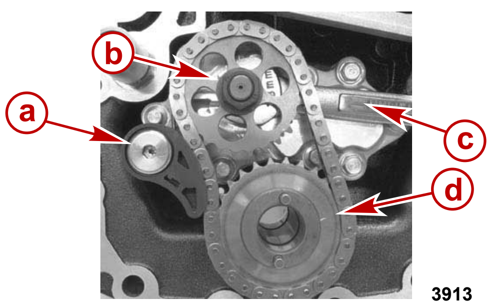
S/N 1B460433 and above

When the PCM receives information that the engine oil pressure is below a predetermined value at any given RPM, the Engine Guardian system will sound an intermittent horn and reduce the engine RPM. The amount of RPM reduction is dependent on the amount of oil pressure.

Oil Pump Removal

NOTE: The powerhead must be removed to access the oil pump.

1. Remove the powerhead. Refer to **Section 4A** - **Powerhead Removal**.
2. Remove the chain tensioner.
3. Place an 18 mm wrench on the oil pump shaft and remove the oil pump driven gear retaining nut.



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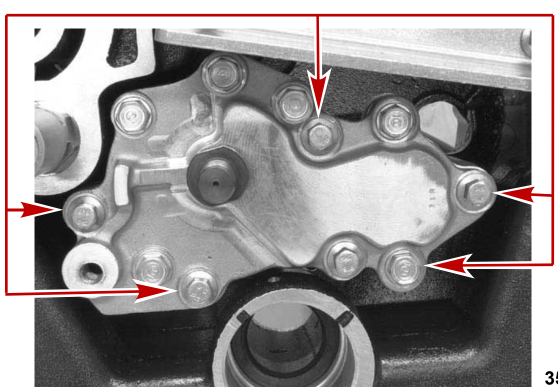
a - Chain tensioner—6 mm internal hex
b - Oil pump driven gear retaining nut
c - 18 mm wrench
d - Oil pump drive gear

4. Carefully remove the oil pump driven gear, the oil pump drive chain, and the oil pump drive gear.
5. Remove the five 8 mm hex bolts securing the oil pump to the adapter plate.



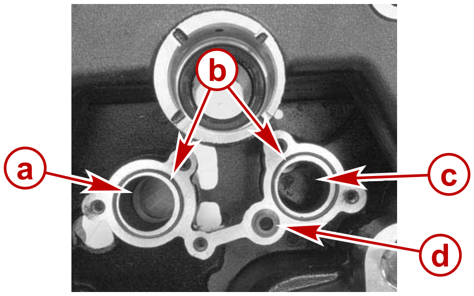
3505

6. Lift the oil pump off of the adapter plate.

NOTE: The oil pump is a nonserviceable component and must be replaced as an assembly.

Oil Pump Installation

1. Install new O-rings onto the adapter plate.



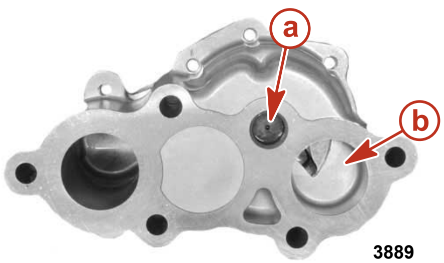
3534

- a - Oil pickup port
- b - O-rings
- c - Oil pump outlet port
- d - Oil pump locating dowel

2. Prelubricate the oil pump by pouring 5 ml (1 teaspoon) of Synthetic Blend 4-Stroke Outboard Oil 25W-40 into the oil pump outlet port.

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Priming the oil pump prior to oil pump installation	92-858052K01

3. Rotate the oil pump driven shaft to distribute the oil throughout the oil pump.



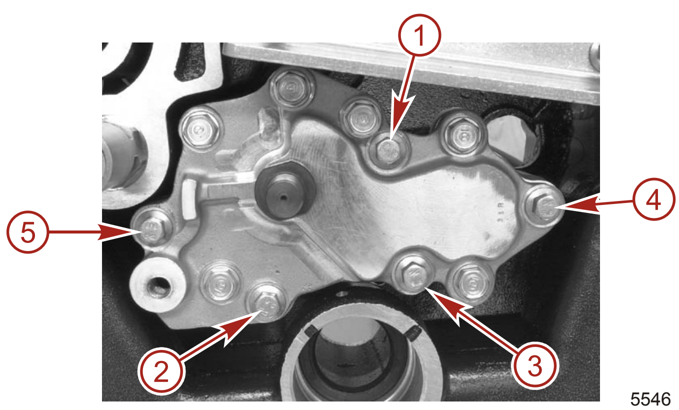
3889

- a - Oil pump driven shaft
- b - Oil pump outlet

4. Install the oil pump assembly onto the adapter plate.
5. Apply a small amount of Loctite 242 Threadlocker onto the oil pump mounting screws.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Oil pump mounting screw	92-809821

6. Install the oil pump mounting screws and tighten them, in the sequence shown, to the specified torque.

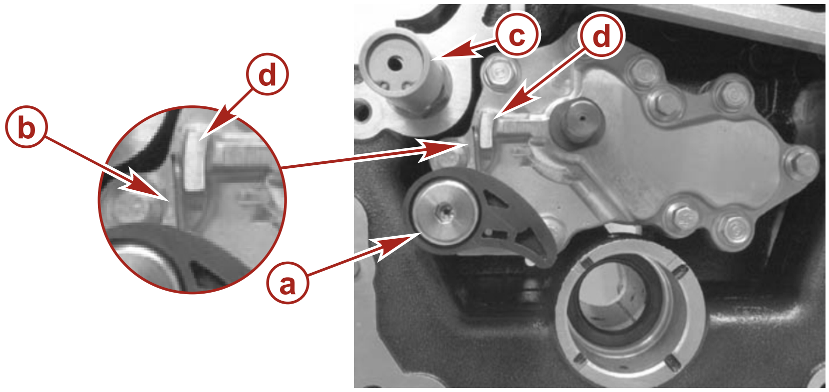


5546

Description	Nm	lb-in.	lb-ft
Oil pump mounting screw (M6 x 65)	10	88.5	–

7. Install the chain tensioner. Tighten the 6 mm internal hex pocket screw to the specified torque.

IMPORTANT: Ensure that the chain spring leg is on the left side of the spring dam.



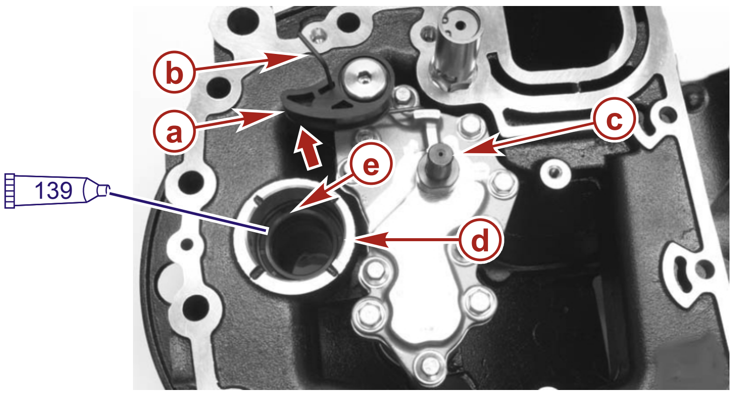
3539

- a - Chain tensioner
- b - Chain tensioner spring leg
- c - Piston cooling jet pressure control valve (S/N 1B517433 and below)

  NOTE: Engines with S/N 1B517434 and above are equipped with an anodized plug in place of the cooling jet pressure control valve.
- d - Spring dam

Description	Nm	lb-in.	lb-ft
Chain tensioner screw	19	168	–

8. Rotate the chain tensioner away from the pump and hold it in position with a retaining tool, a small drift pin, or a hex wrench.
9. Lubricate the driveshaft seals with Synthetic Blend 4-Stroke Outboard Oil 25W-40.

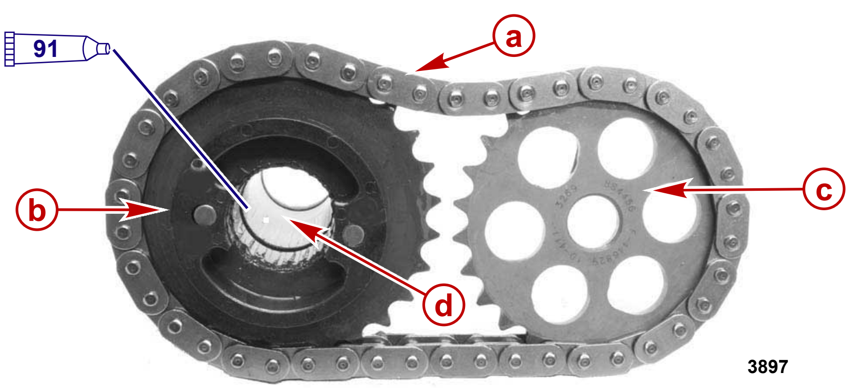


3891

- a - Chain tensioner
- b - Hex wrench used to retain the tensioner
- c - Oil pump shaft
- d - Drive hub cavity
- e - Driveshaft seals

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Driveshaft seals	92-858052K01

10. Assemble the oil pump chain onto the oil pump drive gear and the oil pump driven gear with the numbered side of the oil pump driven gear facing up.
11. Lubricate the two O-rings inside the drive gear drive hub with Engine Coupler Spline Grease.



3897

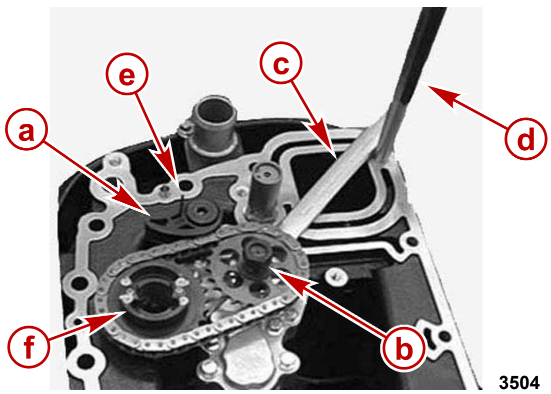
- a - Oil pump chain
- b - Drive gear
- c - Driven gear (numbered side facing up)
- d - Drive gear drive hub

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Drive hub O-rings	8M0071842

12. Slide the oil pump drive gear into the drive hub cavity while aligning the oil pump driven gear onto the oil pump shaft.
13. Align the chain tensioner with the oil pump chain.
14. Place an 18 mm wrench on the oil pump shaft.
15. Place a drift pin in a bolt hole to retain the wrench during the torquing procedure.
16. Install a washer and nut onto the oil pump shaft.
17. Tighten the oil pump driven gear nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil pump driven gear nut	80	–	59

18. Remove the retaining tool (installed in step 8) from the chain tensioner.



a - Chain tensioner
b - Oil pump driven gear nut and washer
c - 18 mm wrench
d - Drift pin
e - Retaining tool (installed in step 8)
f - Oil pump drive gear

Integrated Oil Module (IOM)

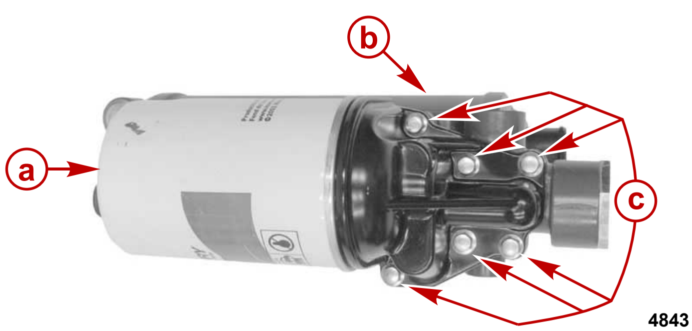
IOM Removal

Refer to **Integrated Oil Module (IOM)** in **Section 4A** - **Removing Powerhead Components**.

IOM Disassembly

IMPORTANT: On engines with S/N 1B890339 and below, the tube stack portion of the IOM is nonserviceable. The IOM should be replaced as an assembly if fouled, damaged, or if blockage is suspected.

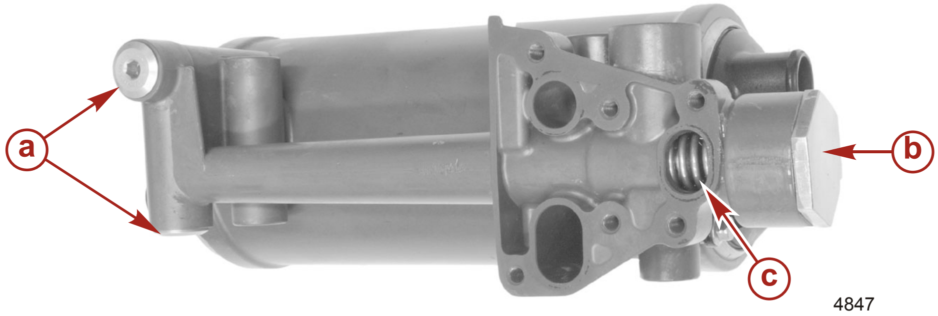
1. Remove the oil filter.
2. Remove the six screws securing the oil filter adapter to the IOM.
3. Remove the adapter and gasket.



a - Filter
b - IOM
c - Screws securing filter adapter

4. Remove the galley plugs.
5. Discard the galley plug O-rings.

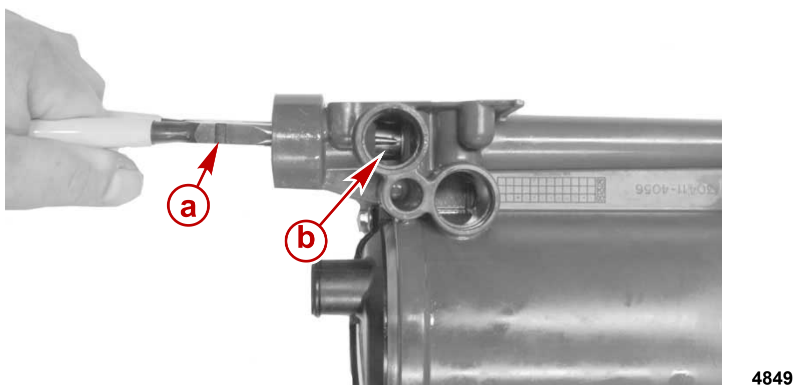
6. Remove the thermostat retaining nut.



a - Galley plugs
b - Thermostat retaining nut
c - Thermostat spring

7. Remove the O-ring on the thermostat retaining nut and discard.
8. Remove the thermostat spring.

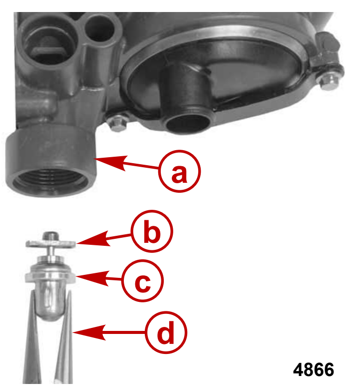
   NOTE: *The oil thermostat regulates the oil temperature to approximately 93–116 °C (200–240 °F) running at mid-throttle and above under load.*
9. Use a needle-nose pliers to carefully remove the thermostat and thermostat brace.



a - Needle-nose pliers
b - Thermostat

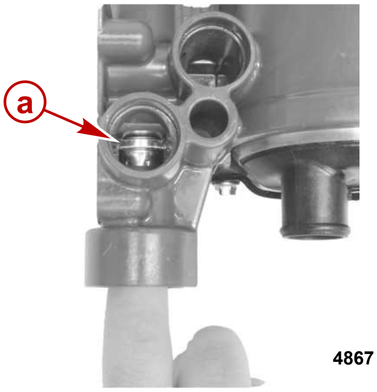
IOM Assembly

1. Install the thermostat brace onto the thermostat.
2. With a pair of needle-nose pliers, slide the thermostat with the brace into the IOM thermostat cavity until it is seated in the IOM.



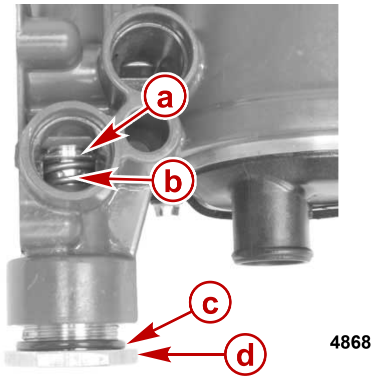
a - IOM
b - Thermostat brace
c - Thermostat
d - Needle-nose pliers

3. Check to ensure that the thermostat brace has not fallen off of the thermostat by pushing on the thermostat. The thermostat should spring back slightly when finger pressure is released.



a - Thermostat

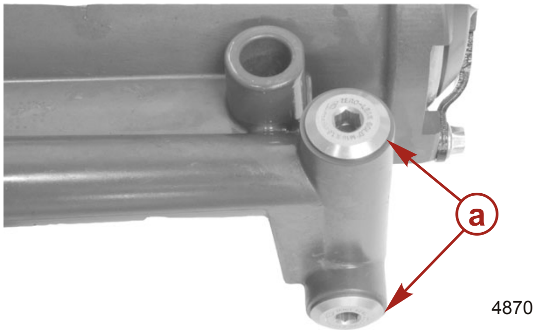
4. Install the thermostat spring.
5. Install a new O-ring onto the thermostat retaining nut. Install the thermostat nut and tighten it to the specified torque.



a - Thermostat
b - Thermostat spring
c - O-ring
d - Thermostat retaining nut

Description	Nm	lb-in.	lb-ft
Thermostat retaining nut	24	–	18

6. Install new O-rings onto the galley plugs.
7. Install the galley plugs and tighten them to the specified torque.

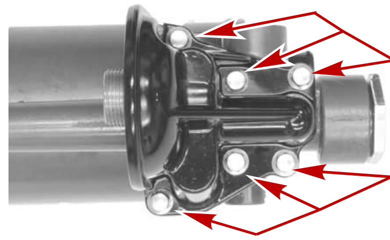


a - Galley plugs

Description	Nm	lb-in.	lb-ft
Galley plug	22	–	16

8. Install a new gasket onto the IOM housing.

9. Install the oil filter adapter onto the IOM housing. Secure the oil filter adapter with six screws. Tighten the oil filter adapter screws to the specified torque.



4875

Description	Nm	lb-in.	lb-ft
Oil filter adapter screws (M6 x 18)	10	88.5	–

10. After installing the IOM onto the powerhead, install a new oil filter.

IOM Installation

Refer to **Integrated Oil Module (IOM)** in **Section 4A** - **Installing Powerhead Components**.

Midsection

Section 5A - Pedestal/Mount Cradle and Driveshaft Housing

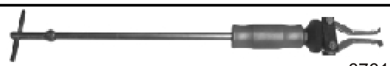
Table of Contents

5
A

Lubricants, Sealants, Adhesives

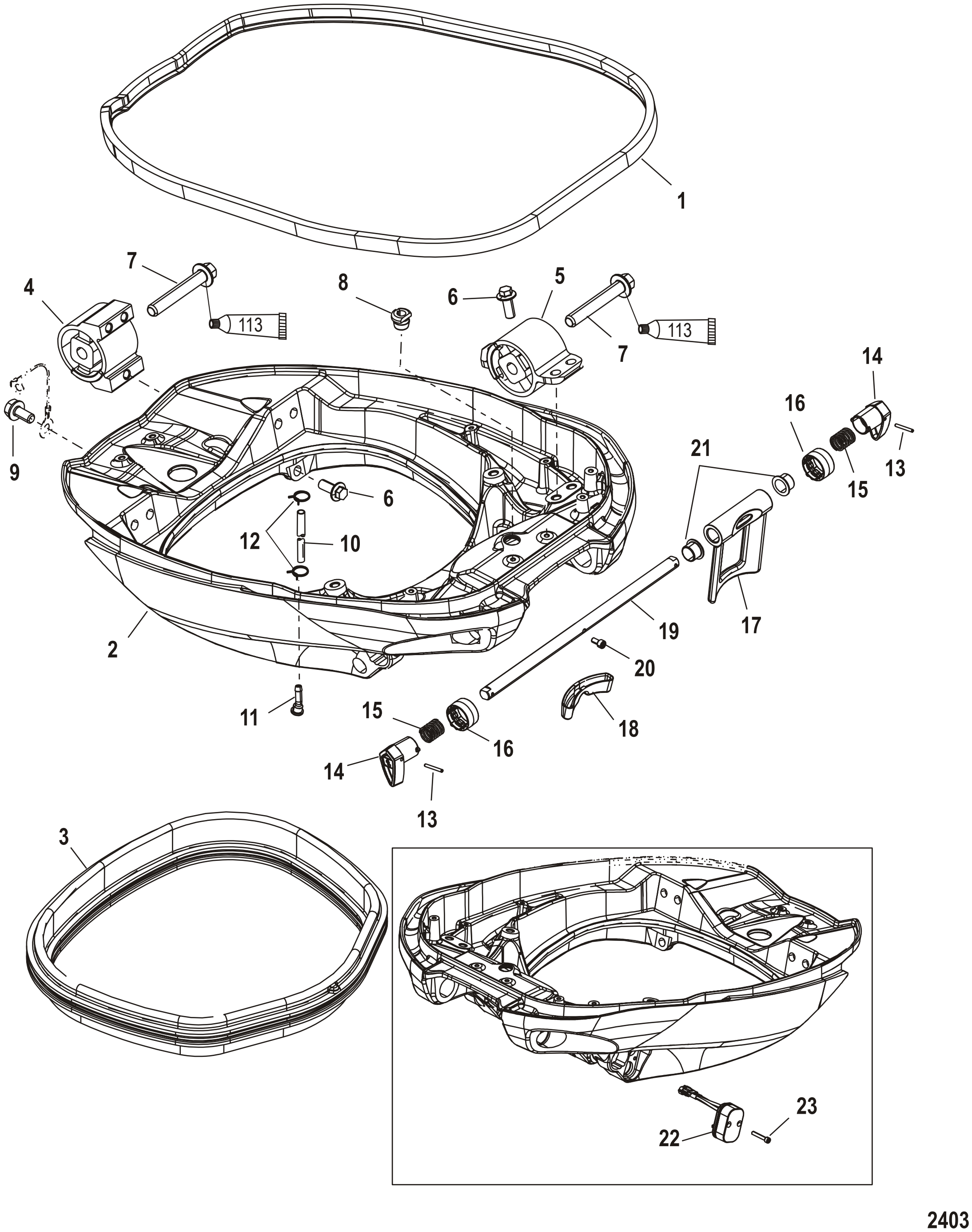
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	M12 driveshaft housing mounting screw threads	92-809819
36	P80 Rubber Lubricant	Flush fitting	Obtain Locally
66	Loctite 242 Threadlocker	Poppet cover screw threads	92-809821
		Rear motor mount screw threads	
		Tilt lock bracket screw threads	
		M8 driveshaft housing mounting screw threads	
		Fuel supply module mounting screw threads	
		Shroud mounting screw threads	
95	2-4-C with PTFE	Flush plug O-ring	92-802859A 1
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Front and rear upper mount pivot screws	Obtain Locally

Special Tools

Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components. Use with puller jaws.

Notes:

Mount Cradle Components

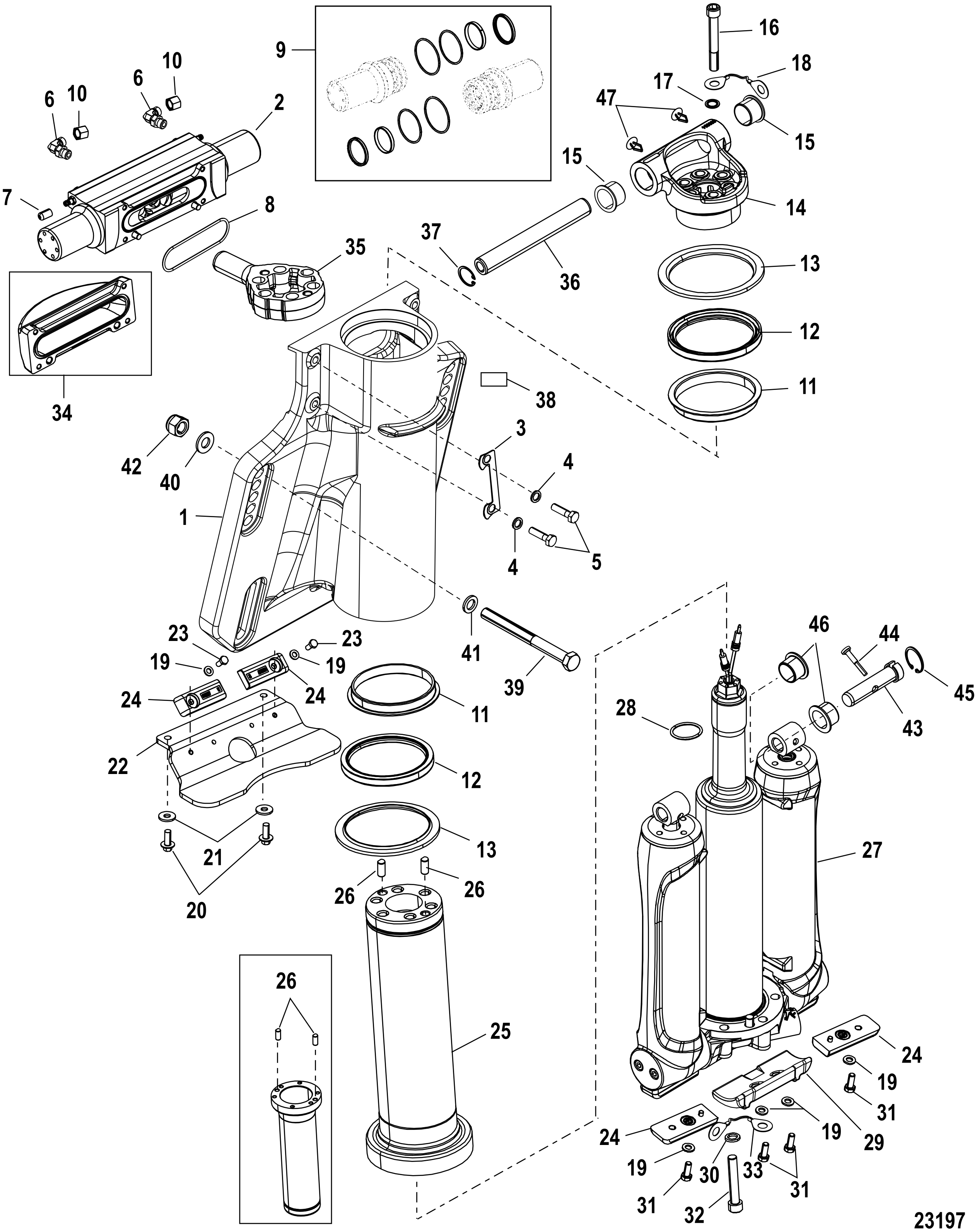


Mount Cradle Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Seal			
2	1	Mount cradle			
3	1	Seal			
4	2	Rear mount			
5	2	Front mount			
6	12	Screw (M12)	125		92
7	4	Screw (M16)	225		166
8	1	Grommet			
9	1	Screw (M6 x 13)	8	70	
10	1	Tubing (35 in.)			
11	1	Tell-tale fitting			
12	2	Clamp			
13	2	Roll pin (0.125 x 1.125 in.)			
14	2	Tilt lock lever			
15	2	Spring			
16	2	Tilt lock clutch			
17	1	Tilt lock bracket			
18	1	Tilt lock pad			
19	1	Tilt lock shaft			
20	1	Screw (M5 x 10)	4	35	
21	2	Bearing (0.625 in.)			
22	1	Trim angle sensor			
23	2	Screw (M5 x 30)	4	35	

Tube Ref No.	Description	Where Used	Part No.
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Front and rear upper mount pivot screws	Obtain Locally

Pedestal/Power Trim/Steering Cylinder Components

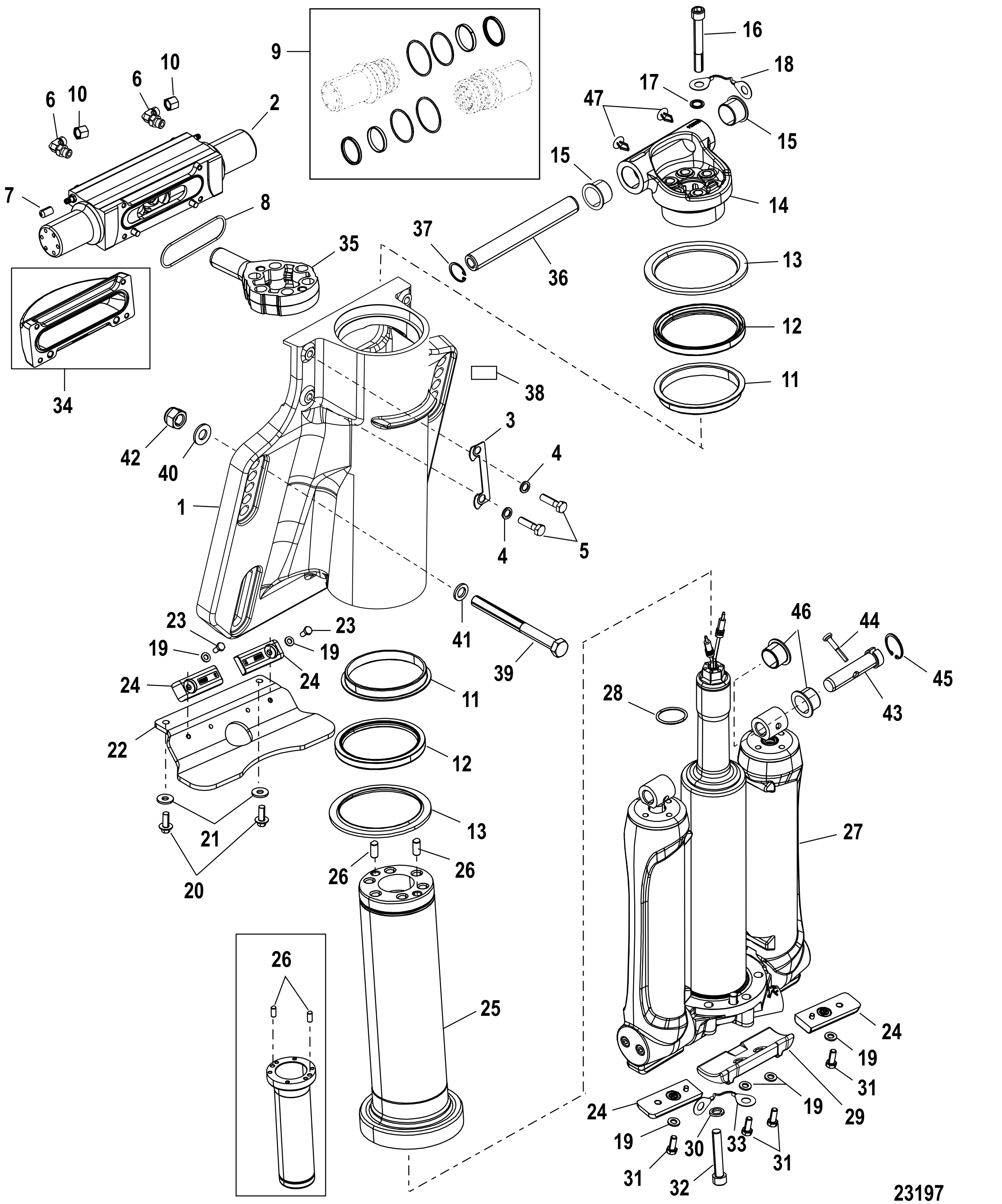


Pedestal/Power Trim/Steering Cylinder Components

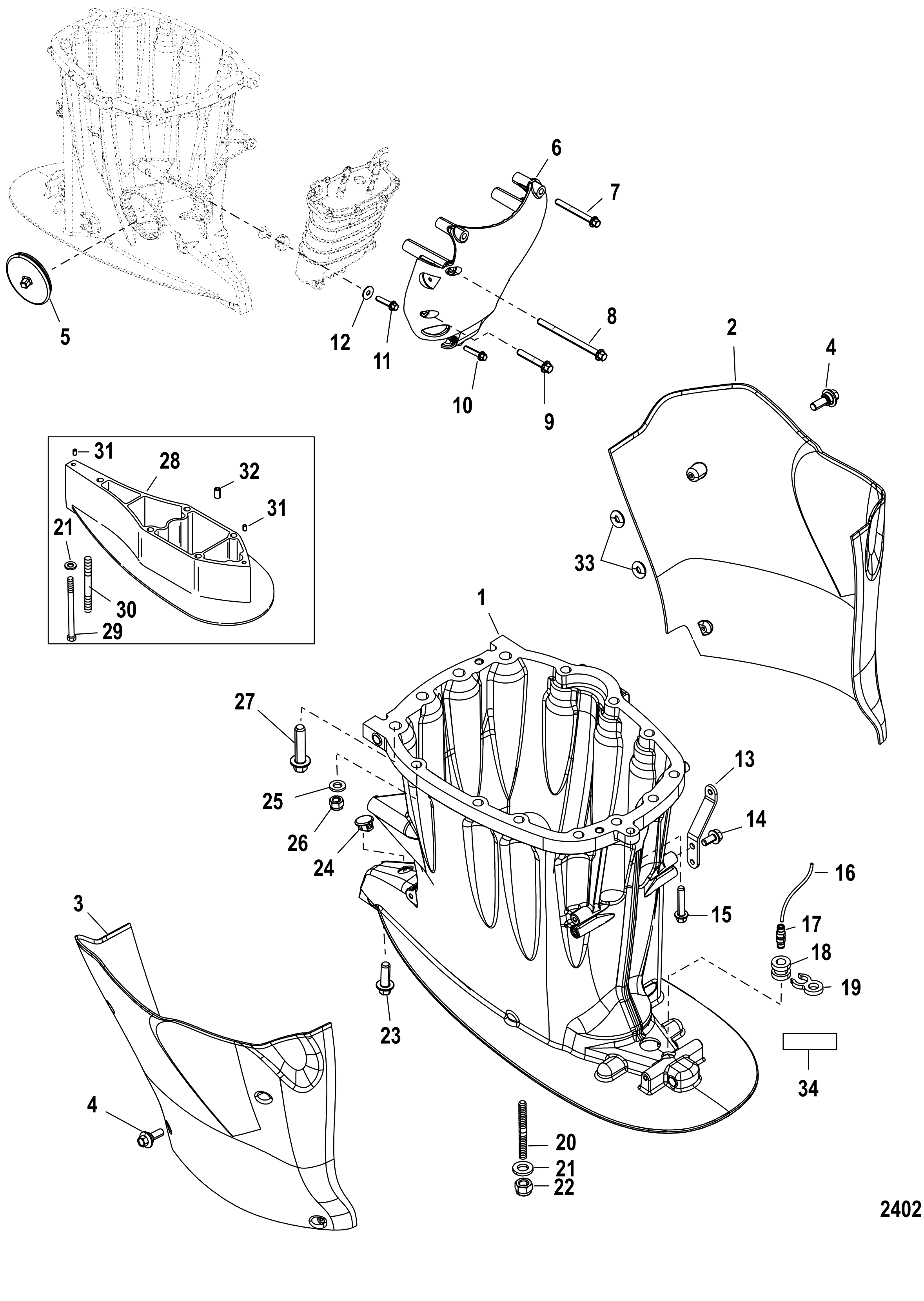
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Pedestal			
2	1	Steering cylinder assembly			
3	2	Retainer			
4	4	Washer			
5	4	Screw (M8 x 30)	25		18.4
6	2	Elbow	28		20.7
7	2	Bleeder cap			
8	1	Seal			
9	1	Steering cylinder seal kit			
10	1	Fitting cap			
11	2	Bearing			
12	2	Seal			
13	2	Bearing			
14	1	Steering head			
15	2	Bearing (1.250 in.)			
16	6	Screw (M14 x 105)	108.5		80
17	7	Washer			
18	1	Cable assembly			
19	6	Washer			
20	2	Screw (M8 x 20)	14	123	
21	2	Washer			
22	1	Deflector plate			
23	2	Screw (M6 x 14)	5.6	50	
24	4	Anode			
25	1	Steering tube			
26	6 or 8	Dowel pin (0.375 x 0.875)			
27	1	Power trim assembly			
28	1	O-ring			
29	1	Anode			
30	6	Washer			
31	4	Screw (M6 x 16)	5.6	50	
32	6	Screw (M10 x 60)	47.5		35
33	1	Cable assembly			
34	1	Counter rotation cover			
35	1	Steering arm			
36	1	Tilt pin			
37	1	Retaining ring			
38	1	Serial number decal			
39	4	Screw (0.50-20 x 5.5 in.)			
40	4	Washer (1.5 x 3.05 x 0.13)			

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
41	4	Washer			
42	4	Nut (0.50-20)			
43	2	Pin			
44	2	Trilobe pin			
45	2	Retaining ring			
46	4	Bearing (0.625 in.)			
47	2	Plug			

Pedestal/Power Trim/Steering Cylinder Components



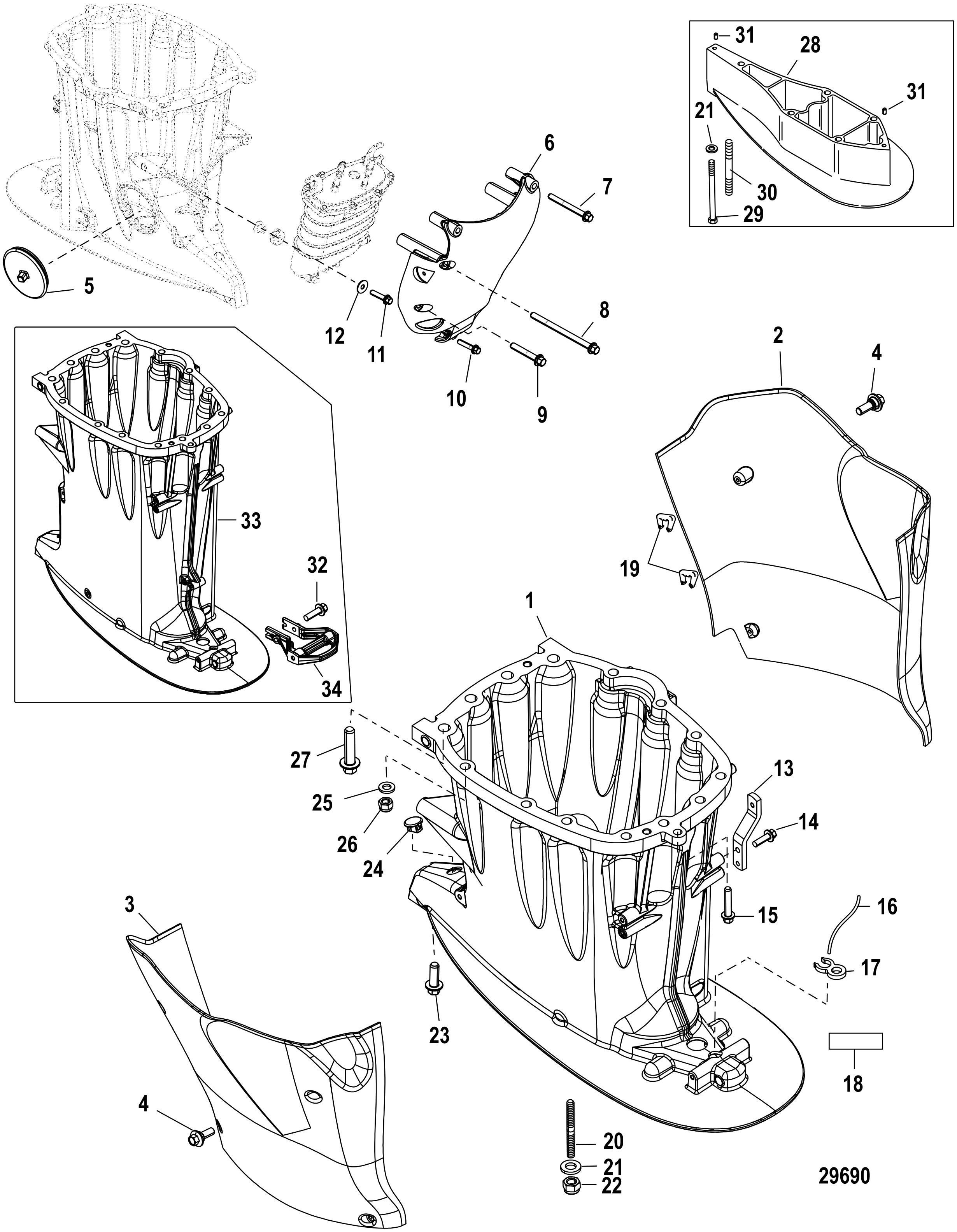
Driveshaft Housing Components (S/N 1B229697 and Below)



Driveshaft Housing Components (S/N 1B229697 and Below)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Driveshaft housing			
2	1	Port chap			
3	1	Starboard chap			
4	8 or 12	Screw	6	53	
5	1	Water poppet grommet			
6	1	Fuel supply module shroud			
7	2	Screw (M8 x 75)	24		18
8	2	Screw (M8 x 120)	24		18
9	2	Screw (M8 x 50)	24		18
10	1	Screw (M8 x 40)	24		18
11	3	Screw (M8 x 35)	24		18
12	3	Washer			
13	2 or 4	Upper chap bracket			
14	2 or 4	Screw (M6 x 13)	6	53	
15	1	Screw (M8 x 30)	24		18
16	1	Tubing (26 in.)			
17	1	Fitting			
18	1	Grommet			
19	1	Retainer			
20	4	Stud (M12 x 52) (Long/XL)	30		22
21	4	Washer			
22	4	Nut	75		55
23	1	Screw (M12 x 35)	75		55
24	1	Rubber plug			
25	10	Washer (0.406 x 0.750 x 0.105)			
26	10	Nut	61		45
27	4	Screw (M12 x 45)	48		35
28	1	Spacer (XXL)			
29	1	Screw (M12 x 160) (XXL)	75		55
30	4	Stud (M12 x 179) (XXL)	30		22
31	2	Dowel pin (without hole) (0.375 x 0.625) (XXL)			
32	1	Bushing (XXL)			
33	2	O-ring			
34	1	Oil drain decal			

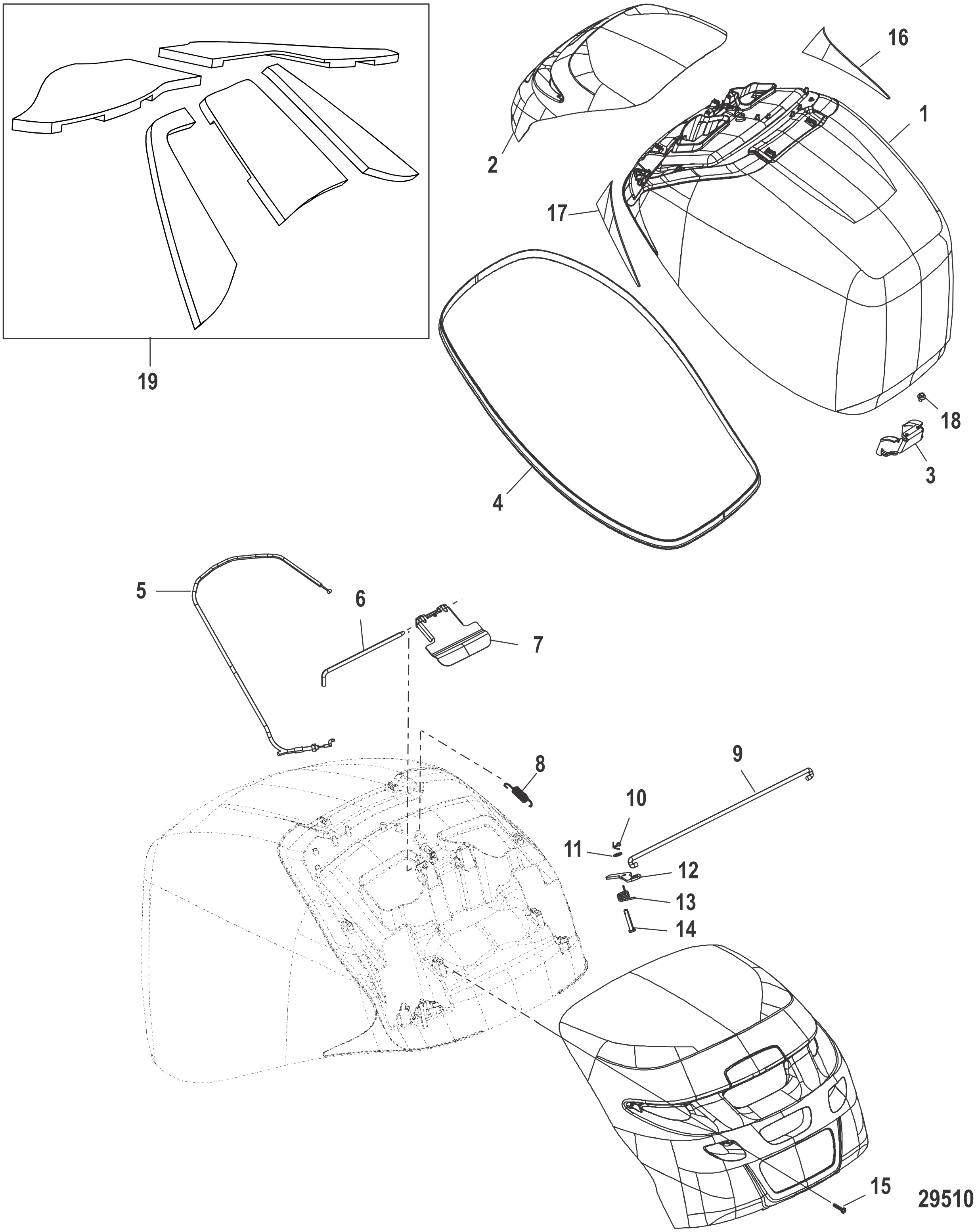
Driveshaft Housing Components (S/N 1B229698 and Above)



Driveshaft Housing Components (S/N 1B229698 and Above)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Driveshaft housing			
2	1	Port chap			
3	1	Starboard chap			
4	8 or 12	Screw	6	53	
5	1	Water poppet grommet			
6	1	Fuel supply module shroud			
7	2	Screw (M8 x 75)	24		18
8	2	Screw (M8 x 120)	24		18
9	2	Screw (M8 x 50)	24		18
10	1	Screw (M8 x 40)	24		18
11	3	Screw (M8 x 35)	24		18
12	3	Washer (0.344 x 1.00 x 0.63)			
13	2	Upper chap bracket			
14	2	Screw (M6 x 20)	6	53	
15	1	Screw (M8 x 30)	24		18
16	1	Tubing (26 in.)			
17	1	Retainer			
18	1	Oil drain decal			
19	2	Clip			
20	4	Stud (M12 x 52) (Long/XL)	30		22
21	4 or 5	Washer (0.500 x 0.810 x 0.090)			
22	4	Nut (M12)	75		55
23	1	Screw (M12 x 35)	75		55
24	1	Rubber plug			
25	10	Washer (0.406 x 0.750 x 0.105)			
26	10	Nut	61		45
27	4	Screw (M12 x 45)	48		35
28	1	Spacer (XXL)			
29	1	Screw (M12 x 160) (XXL)	75		55
30	4	Stud (M12 x 179) (XXL)	30		22
31	2	Dowel pin (without hole) (0.375 x 0.625) (XXL)			
32	2	Screw (M6 x 20) (XL/XXL)	6	53	
33	1	Driveshaft housing (XL/XXL)			
34	1	Cowl bracket (XL/XXL)			

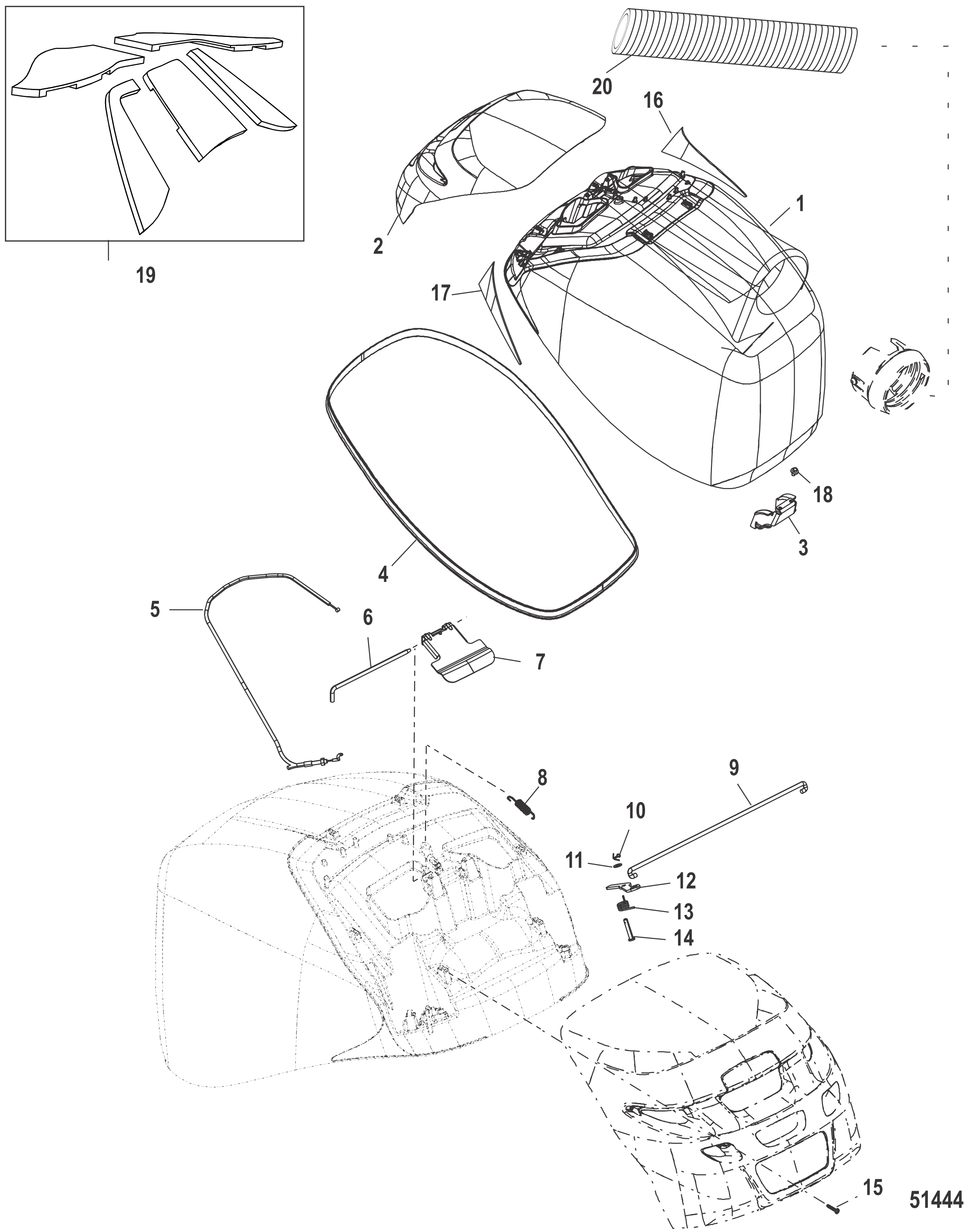
Top Cowl Components



Top Cowl Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Top cowl assembly			
2	1	Air dam cap			
3	1	Front latch receiver			
4	1	Seal			
5	1	Cable			
6	1	Hinge pin			
7	1	Hand lever latch			
8	1	Spring			
9	1	Latch connecting link			
10	2	Cotter pin			
11	2	Washer			
12	2	Linkage arm			
13	2	Spring			
14	2	Pin			
15	4	Screw (#8 x 1.25)			
16	1	Port applique			
17	1	Starboard applique			
18	2	Screw (M6 x 12)			
19	1	Sound blanket			

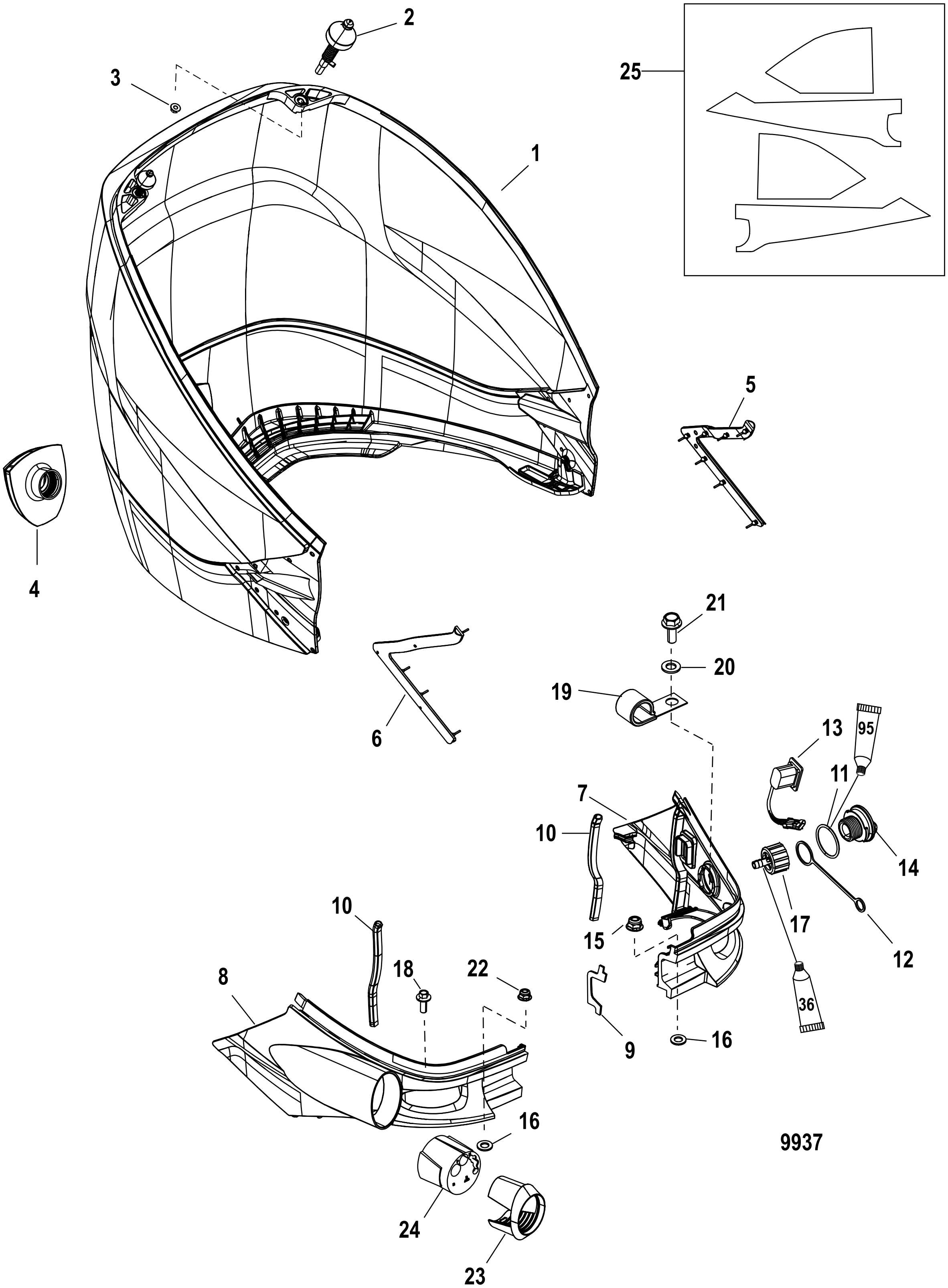
CCT Top Cowl Components



CCT Top Cowl Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	CCT top cowl assembly			
2	1	Air dam cap			
3	1	Front latch receiver			
4	1	Seal			
5	1	Cable			
6	1	Hinge pin			
7	1	Hand lever latch			
8	1	Spring			
9	1	Latch connecting link			
10	2	Cotter pin			
11	2	Washer			
12	2	Linkage arm			
13	2	Spring			
14	2	Pin			
15	4	Screw (#8 x 1.25)			
16	1	Port applique			
17	1	Starboard applique			
18	2	Screw (M6 x 12)			
19	1	Sound blanket			
20	1	Hose			

Rear Cowl Components

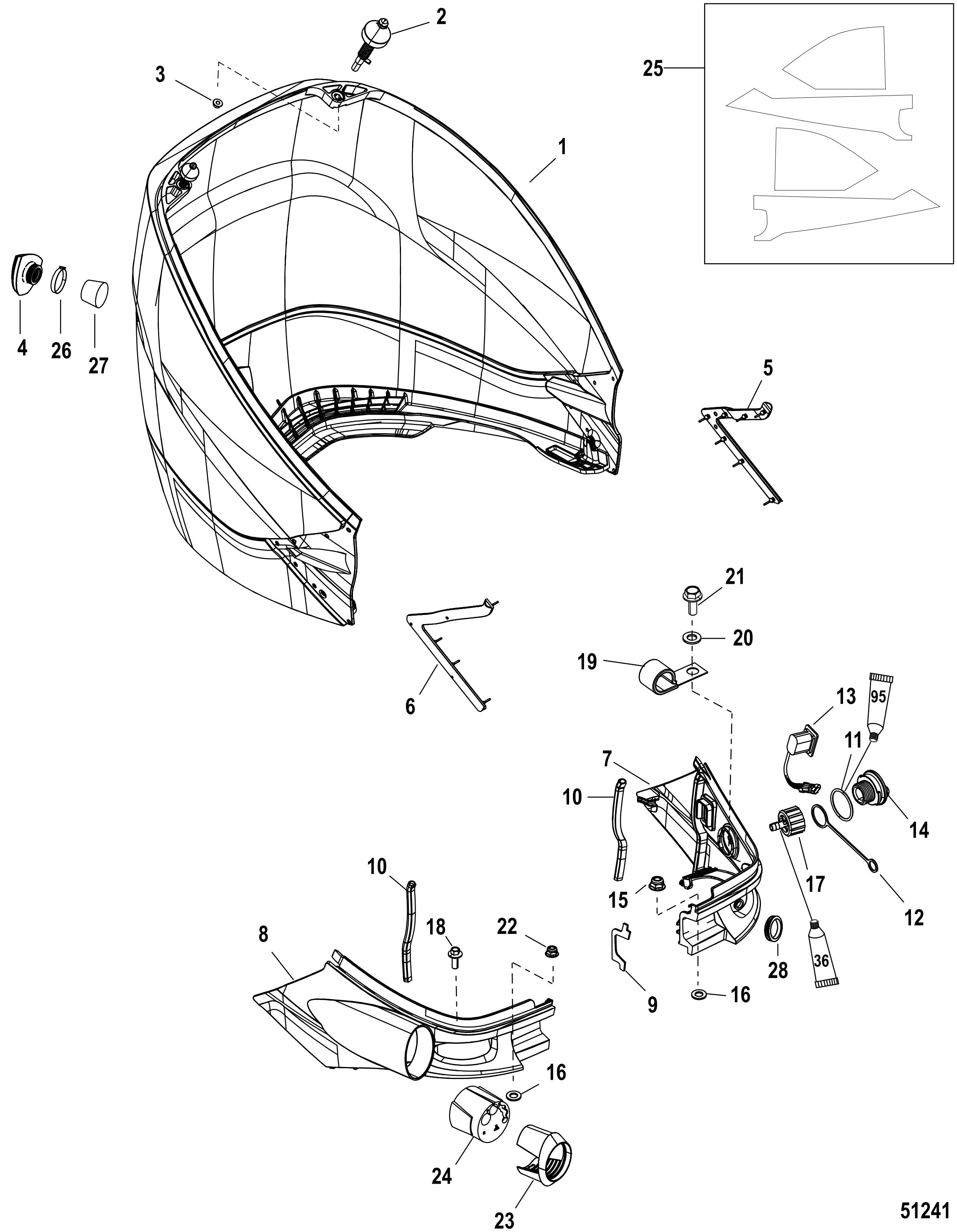


Rear Cowl Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Rear cowl assembly			
2	2	Pin assembly			
3	4	Nut (M6)			
4	1	Idle relief			
5	1	Port seal			
6	1	Starboard seal			
7	1	Port front cowl			
8	1	Starboard front cowl			
9	1	Gasket			
10	2	Seal			
11	1	O-ring			
12	1	Tether			
13	1	Trim switch			
14	1	Flush plug			
15	1	Nut (M6)			
16	2	Washer			
17	1	Flush fitting assembly			
18	1	Screw (M6 x 16)			
19	1	Clamp kit			
20	1	Washer			
21	1	Screw (M6 x 16)			
22	1	Nut (M6)			
23	1	Adapter			
24	1	Grommet			
25	1	Sound blanket			

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	Flush fitting	Obtain Locally
95	2-4-C with PTFE	Flush plug O-ring	92-802859A 1

CCT Rear Cowl Components

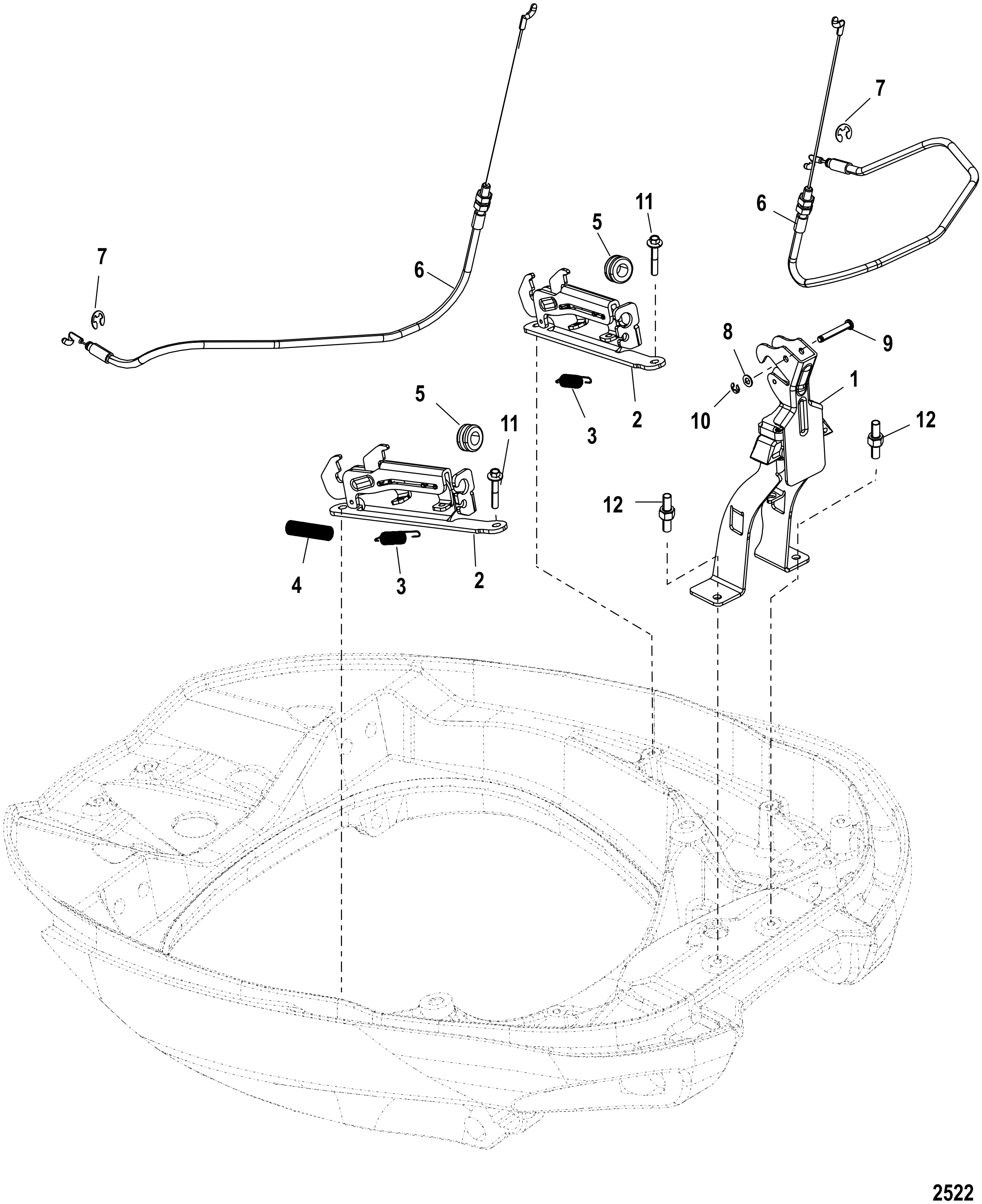


CCT Rear Cowl Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Rear cowl assembly			
2	2	Pin assembly			
3	4	Nut (M6)			
4	1	Idle relief			
5	1	Port seal			
6	1	Starboard seal			
7	1	Port front cowl			
8	1	Starboard front cowl			
9	1	Gasket			
10	2	Seal			
11	1	O-ring			
12	1	Tether			
13	1	Trim switch			
14	1	Flush plug			
15	1	Nut (M6)			
16	2	Washer			
17	1	Flush fitting assembly			
18	1	Screw (M6 x 16)			
19	1	Clamp kit			
20	1	Washer			
21	1	Screw (M6 x 16)			
22	1	Nut (M6)			
23	1	Adapter			
24	1	Grommet			
25	1	Sound blanket			
26	1	Clamp			
27	1	Plug			
28	1	Grommet			

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	Flush fitting	Obtain Locally
95	2-4-C with PTFE	Flush plug O-ring	92-802859A 1

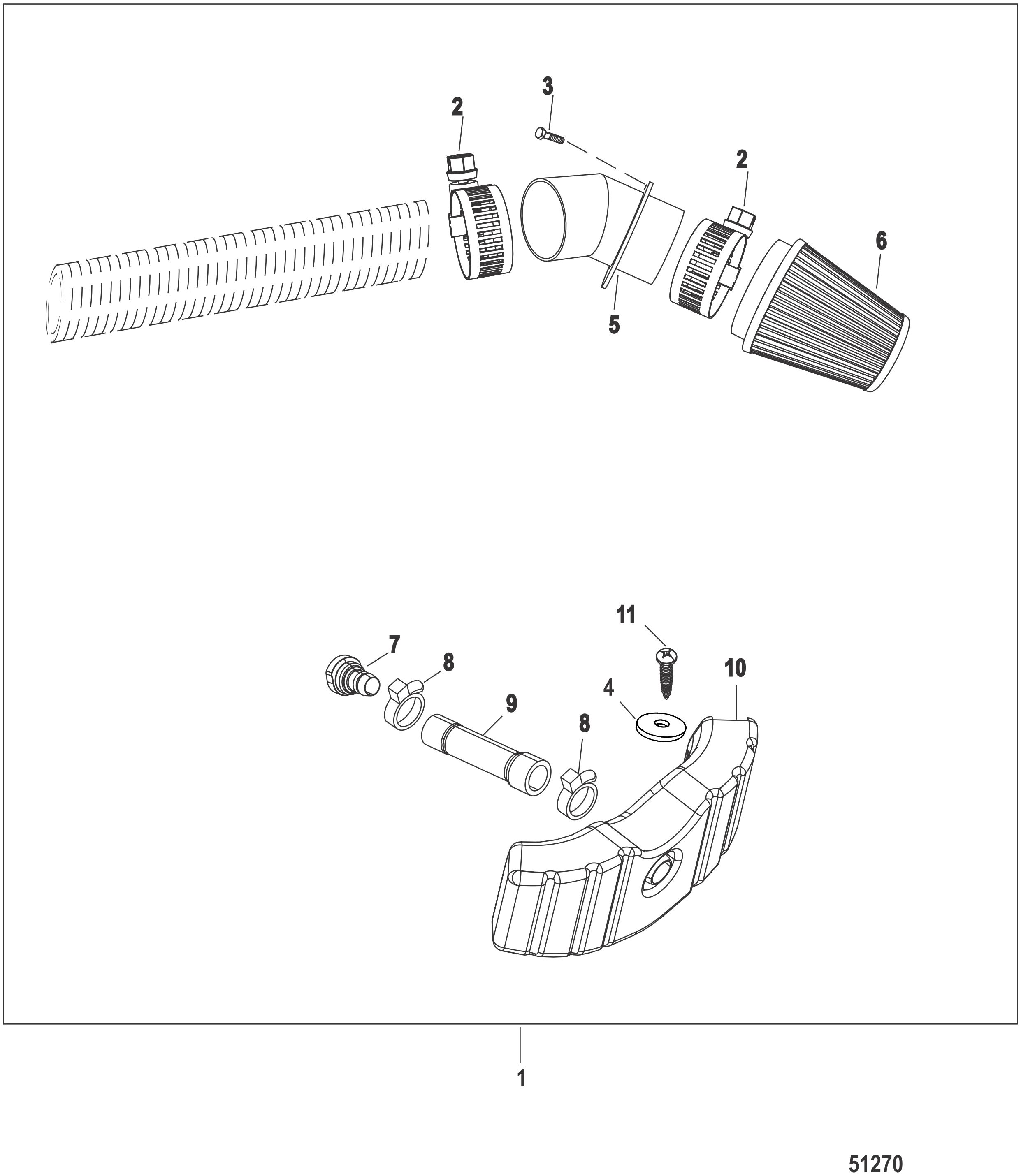
Cowl Latching Components



Cowl Latching Components

Ref. No.	Qty.	Description	Torque Nm	Torque lb. in.	Torque lb. ft.
1	1	Latch base bracket			
2	2	Side latch assembly			
3	4	Spring			
4	4	Sleeve			
5	2	Grommet			
6	2	Cable			
7	2	Retaining ring			
8	1	Washer (0.192 x 0.375 x 0.0312)			
9	1	Clevis pin			
10	1	E-ring			
11	4	Screw (M6 x 16)	6	53	
12	2	Stud	6	53	

CCT Rigging Components



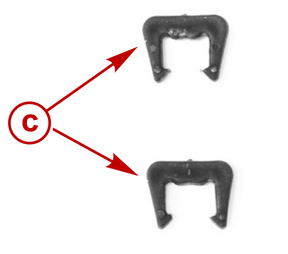
CCT Rigging Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	CCT rigging kit			
2	4	Worm gear clamp			
3	3	Screw (#12 x 0.750)			
4	2	Washer			
5	1	Snorkle			
6	1	Filter			
7	1	Fitting			
8	2	Worm gear clamp			
9	1	Idle relief hose			
10	1	Exhaust plenum			
11	2	Screw (#12 x 1.250)			

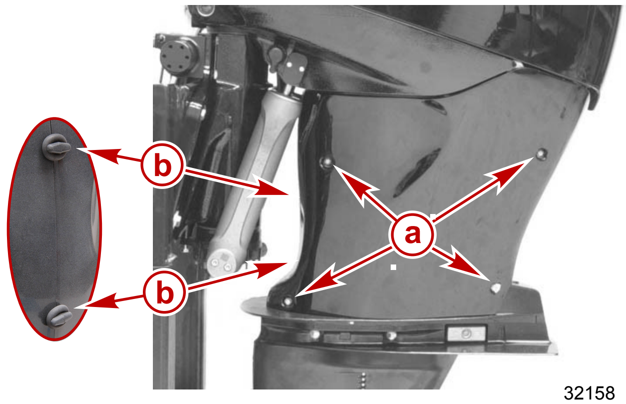
Water Poppet Removal/Installation

Removal and Disassembly

1. Remove the two O-rings or clips from the front of the chaps.
2. Remove the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing. Remove the chap.



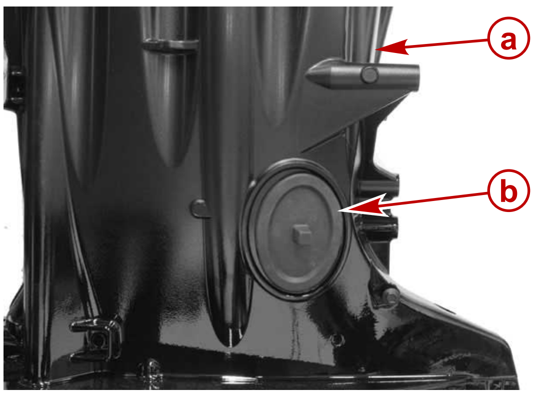
32157



32158

a - Chap mounting screw (M6)
b - O-ring
c - Clip (used on later models in place of O-ring)

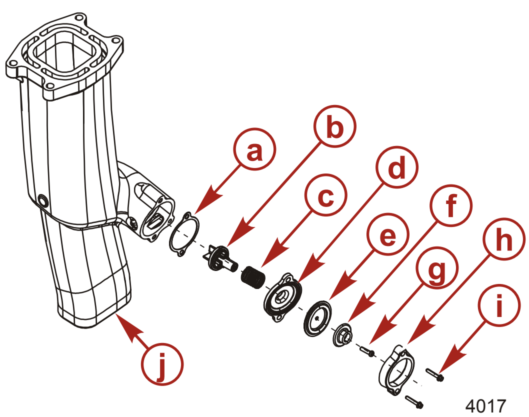
3. Remove the grommet in the driveshaft housing to access the water poppet.



4846

a - Port side of driveshaft housing
b - Grommet

4. Remove the two screws from the poppet cover. Remove the cover.
5. Remove the retainer and poppet assembly.
6. Remove the retaining screw from the poppet assembly.
7. Inspect the components. Replace as required.
8. Remove the gasket and clean the gasket surfaces of the exhaust tube and poppet retainer.



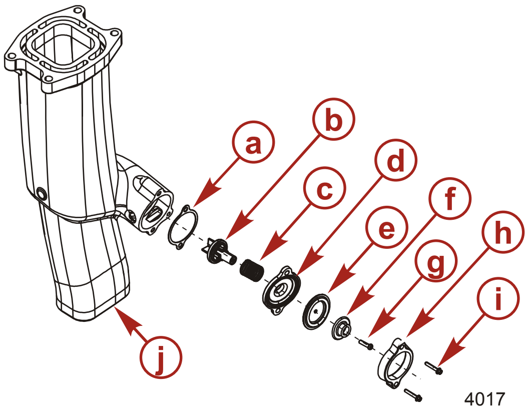
4017

a - Gasket
b - Poppet assembly
c - Spring
d - Retainer
e - Diaphragm
f - Washer
g - Retaining screw (10-16 x 0.75 in.)
h - Poppet cover
i - Poppet cover screw (M6 x 35) (2)
j - Exhaust tube

Reassembly and Installation

1. Assemble the poppet, spring, retainer, diaphragm, and washer. Install the retaining screw through the components into the poppet. Drive the screw tight.
2. Install the new gasket on a clean surface.
3. Apply Loctite 242 Threadlocker to the poppet cover screw threads.

4. Install the two screws through the poppet cover and assemble on the exhaust tube. Tighten the screws to the specified torque.



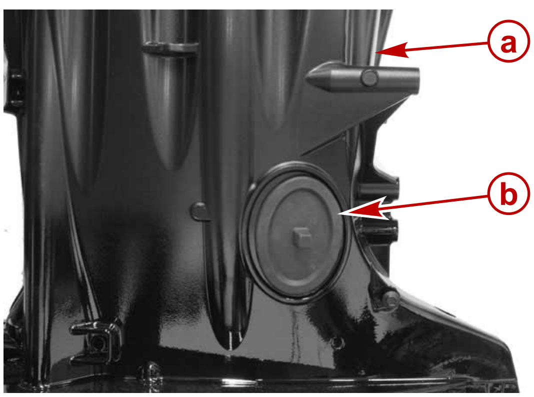
4017

a - Gasket
b - Poppet assembly
c - Spring
d - Retainer
e - Diaphragm
f - Washer
g - Retaining screw (10-16 x 0.75 in.)
h - Poppet cover
i - Poppet cover screw (M6 x 35) (2)
j - Exhaust tube

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Poppet cover screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
Poppet cover screw (M6 x 35) (2)	5	44	
Retaining screw (10-16 x 0.75 in.)	Drive tight		

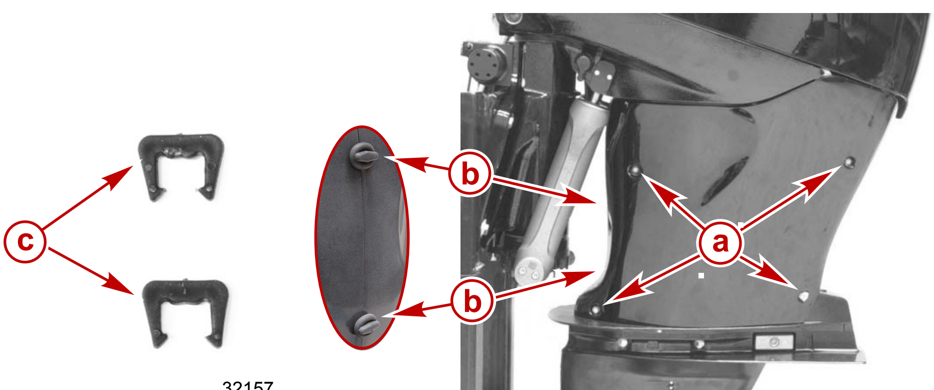
5. Install the water poppet grommet into the driveshaft housing.



4846

a - Port side of driveshaft housing
b - Water poppet grommet

6. Attach the lower port chap to the driveshaft housing. Secure with screws (four or six for XXL shaft). Tighten the screws to the specified torque.
7. Attach O-rings or clips to the tabs on the front of the chaps.



32157

32158

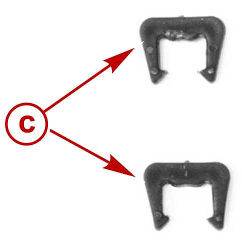
a - Chap mounting screw (M6)
b - O-ring
c - Clip (used on later models in place of O-ring)

Description	Nm	lb. in.	lb. ft.
Chap mounting screws	6	53	

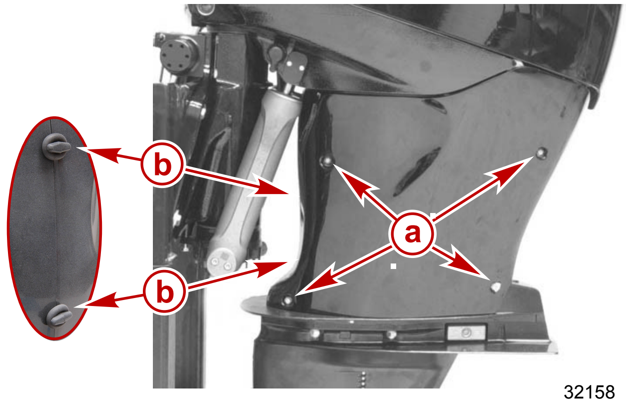
Midsection Disassembly

Preparing Outboard for Midsection Disassembly

1. Remove the two O-rings or clips from the front of the chaps.
2. Remove the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing and remove the chap.



32157



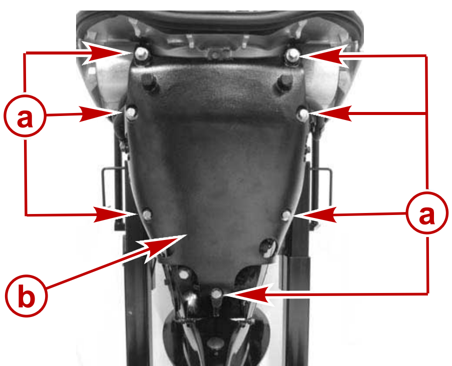
32158

a - Chap mounting screw (M6)
b - O-ring
c - Clip (used on later models in place of O-ring)

3. Remove the screws (four or six for XXL shaft) securing the starboard chap to the driveshaft housing and remove the chap.
4. Remove the powerhead from the adapter plate/driveshaft housing. Refer to **Section 4A** - **Powerhead Removal** for instructions.
5. Remove the gearcase from the driveshaft housing. Refer to **Section 6** - **Gearcase Removal.**

Fuel Supply Module (FSM)

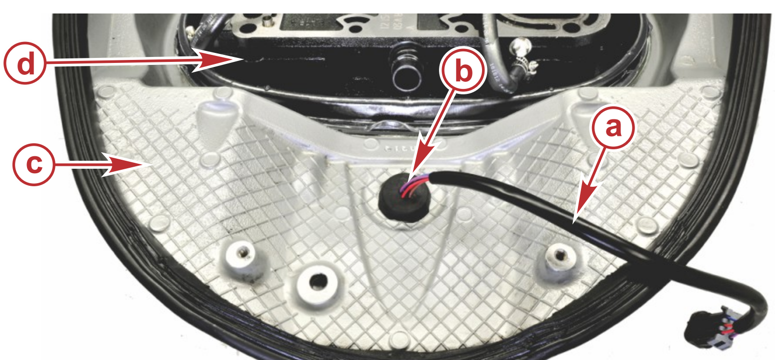
1. Remove the seven screws securing the fuel supply module shroud to the driveshaft housing.



3850

a - Shroud mounting screw
b - Fuel supply module shroud

2. Push the fuel supply module harness grommet down through the mount cradle. Pull the harness through the hole in the mount cradle.

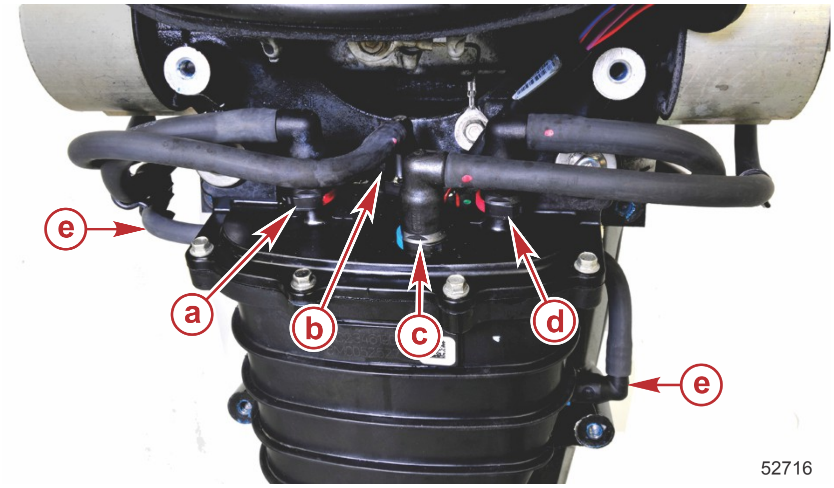


52715

a - Harness
b - Grommet
c - Mount cradle
d - Adapter plate

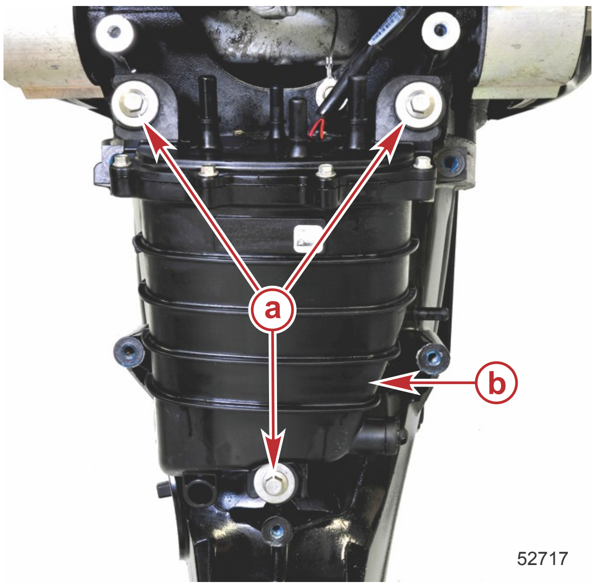
3. Remove the four hoses on top of the fuel supply module and one hose on the starboard side.

NOTE: Fuel may be present in the fuel lines. Use a proper container to capture the fuel.



- a - High-pressure outlet (10 mm red tab)
- b - Manifold reference to fuel pressure regulator (8 mm white tab)
- c - Vent to vent canister switch (0.375 in. blue tab)
- d - FSM fuel inlet from fuel filter/water separator (10 mm red tab)
- e - Water-cooling inlet hose (8 mm blue tab)

4. Remove the three screws securing the fuel supply module to the driveshaft housing.

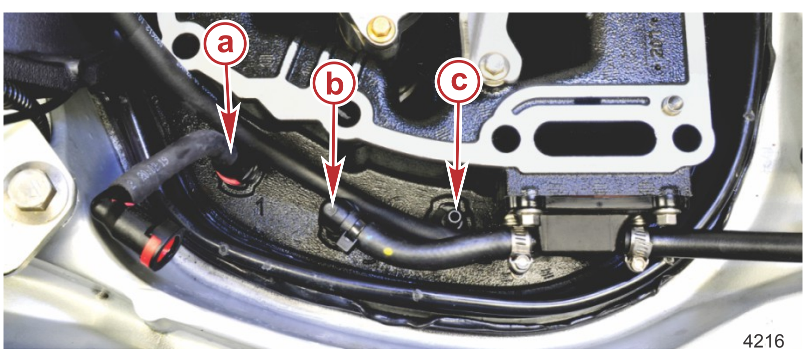


- a - Mounting screws (M8 x 35)(3)
- b - Fuel supply module

5. Remove the fuel supply module from the driveshaft housing.

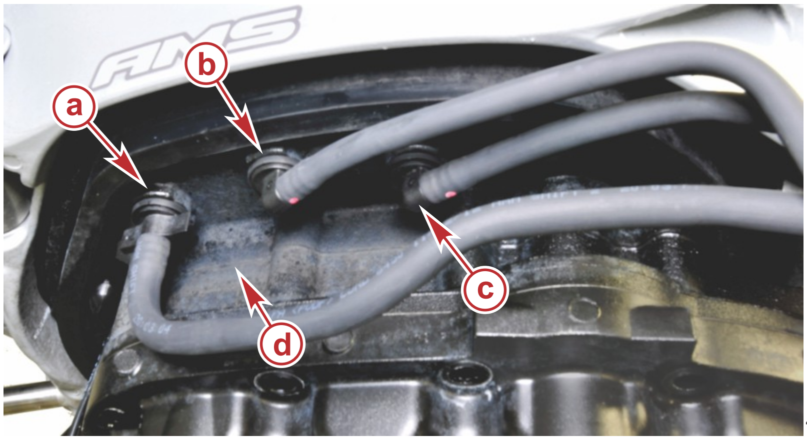
Hoses and Harnesses

1. Disconnect the two remaining hoses on the top port side of the adapter plate. Press the colored lock tab and pull up on the connector to remove.



- a - FSM outlet hose (10 mm red tab)
- b - FSM water inlet hose (8 mm blue tab)
- c - Manifold hose connector

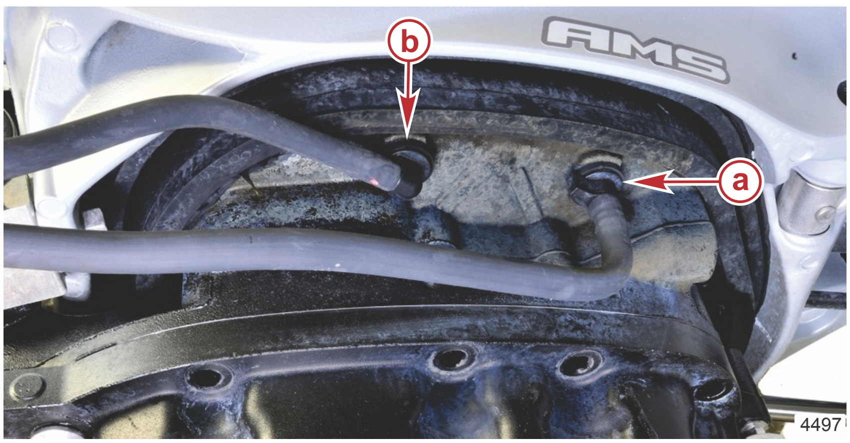
2. Remove the three hoses from the bottom side of the adapter plate. Rotate the hose/connector counterclockwise to align the tab with the slot in the adapter plate and pull each hose down through the adapter plate.



4215

- a - FSM high-pressure outlet hose (10 mm red tab)
- b - FSM water-cooling inlet hose (8 mm blue tab)
- c - Manifold reference hose (8 mm white tab)
- d - Adapter plate

3. Remove the hoses from the bottom side of the adapter plate on the starboard side, following the same procedure as above.

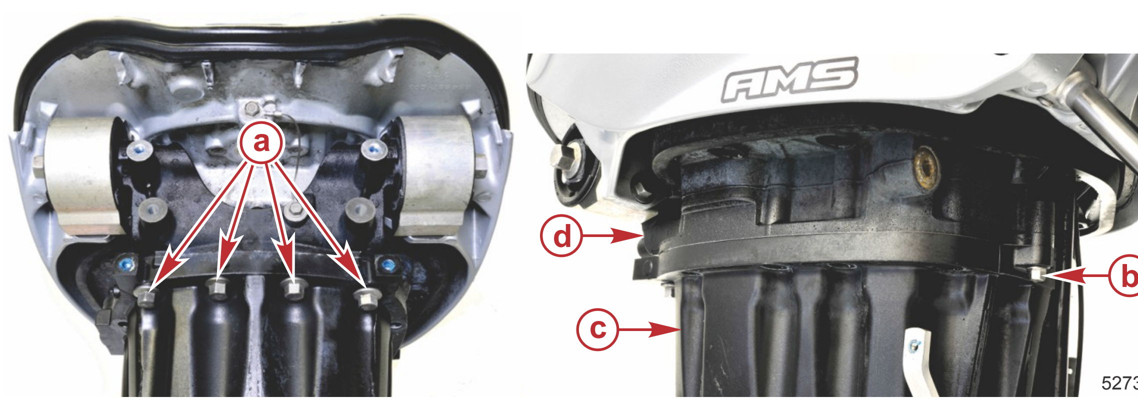


4497

- a - FSM fuel inlet hose (10 mm red tab)
- b - Vent hose (0.375 in. blue tab)

Driveshaft Housing

1. Hold the driveshaft housing securely while removing the mounting screws.
2. Remove the four screws at the rear and one screw in the front securing the driveshaft housing to the adapter plate.



52735

- a - Driveshaft housing mounting screw (M12 x 45) (4)
- b - Driveshaft housing mounting screw (M8 x 30) (1)
- c - Driveshaft housing
- d - Adapter plate

3. Remove the driveshaft housing from the adapter plate.

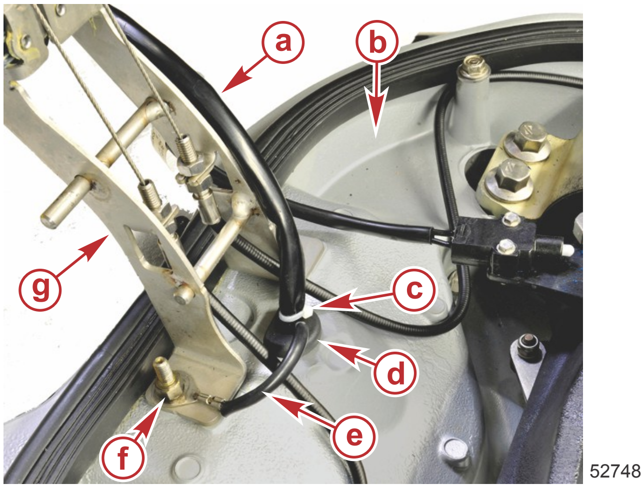
Pedestal

Mount Cradle Removal

NOTE: The adapter plate assembly may be removed before removing the mount cradle. Refer to ***Section 5B - Adapter Plate Disassembly****.*

Detach the power trim cylinder rod ends from the mount cradle. Refer to **Section 5C** - **Power Trim System**.

1. Remove the cable tie from the power trim harness.
2. Remove the grommet from the mount cradle.
3. Pull the power trim harness down through the mount cradle.
4. Remove the ground cable from the latch bracket mounting stud.

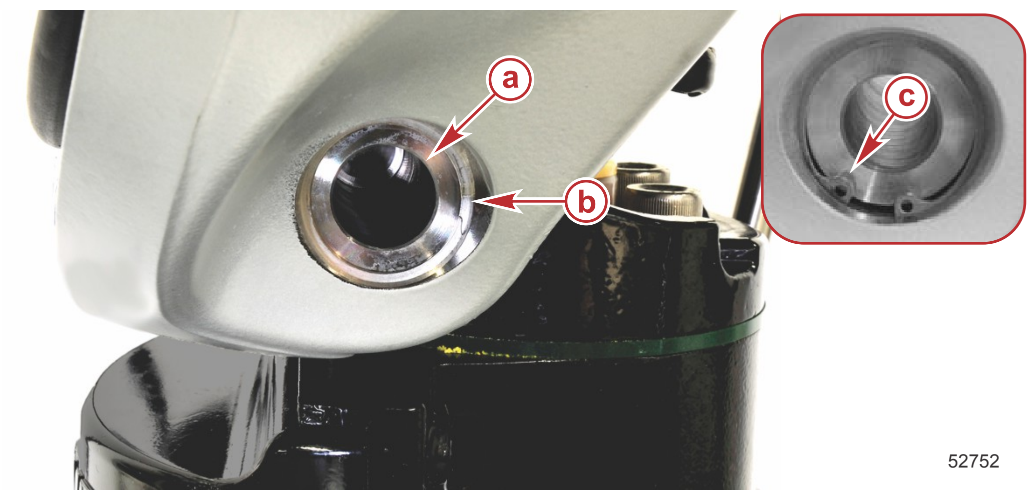


a - Power trim harness
b - Mount cradle
c - Cable tie
d - Grommet
e - Ground cable
f - Nut (M6)
g - Latch bracket

5. Remove the spiral ring on the port end of the tilt pin.

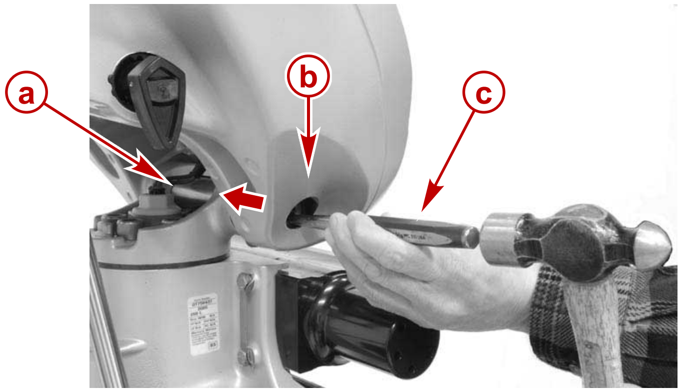
   NOTE: Early models used a snap ring to retain the tilt pin.

   IMPORTANT: If equipped, remove the starboard snap ring. Discard the snap rings and use spiral rings during assembly.



a - Tilt pin
b - Spiral ring
c - Snap ring used on early models

6. Securely hold the mount cradle. Using a drift pin, remove the tilt pin from the starboard side of the mount cradle.



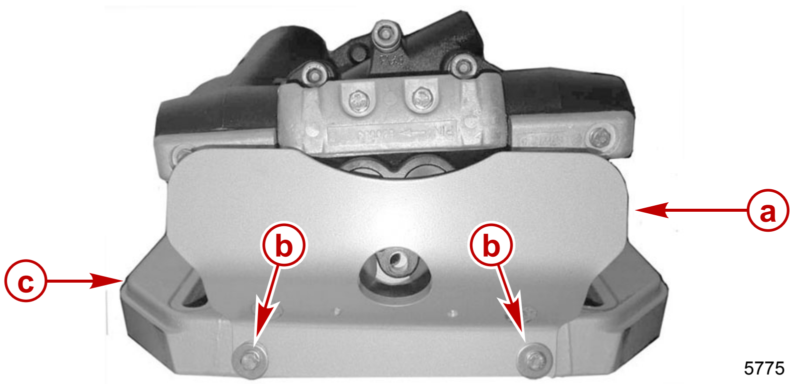
4048

a - Tilt pin
b - Starboard side of mount cradle
c - Drift pin

7. Remove the mount cradle from the pedestal and trim rods.

Power Trim System Removal

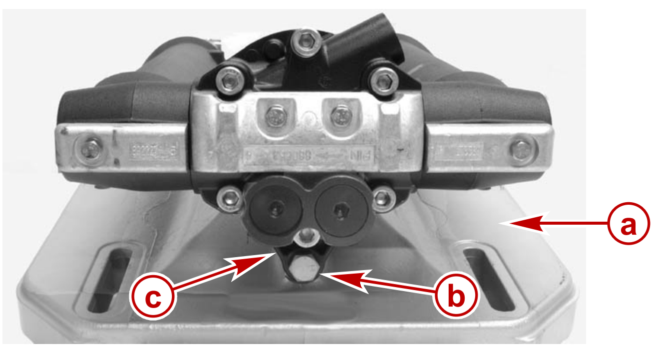
1. Remove the two screws and washers securing the splash plate to the pedestal. Remove the splash plate from the pedestal.



5775

a - Splash plate
b - Splash plate mounting screw and washer
c - Pedestal

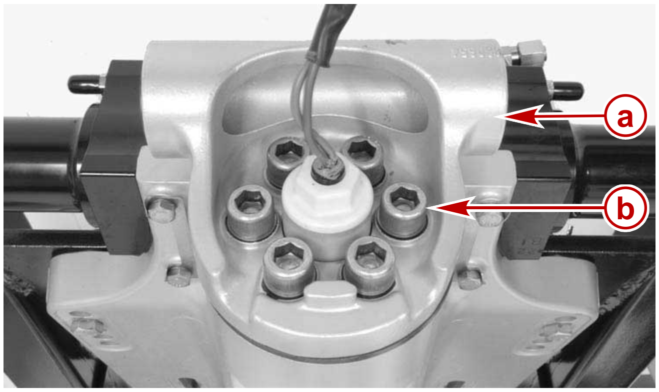
2. Support the power trim system assembly by installing a 10 mm screw in the power trim manifold and pedestal.



4050

a - Pedestal
b - Screw (10 mm)
c - Power trim manifold

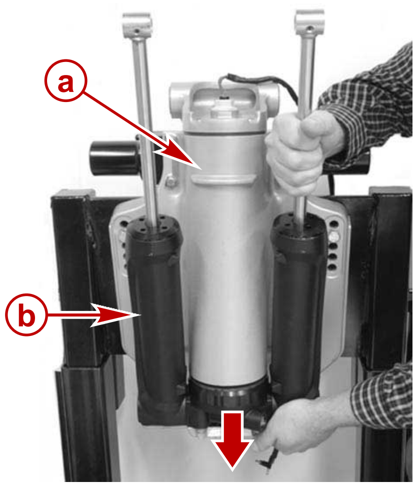
3. Remove the six screws attaching the steering head to the steering tube inside of the pedestal.



4051

a - Steering head
b - Steering head screw (12 mm internal hex)

4. Securely hold the power trim system assembly while removing the 10 mm screw from the power trim manifold. Remove the power trim system assembly.

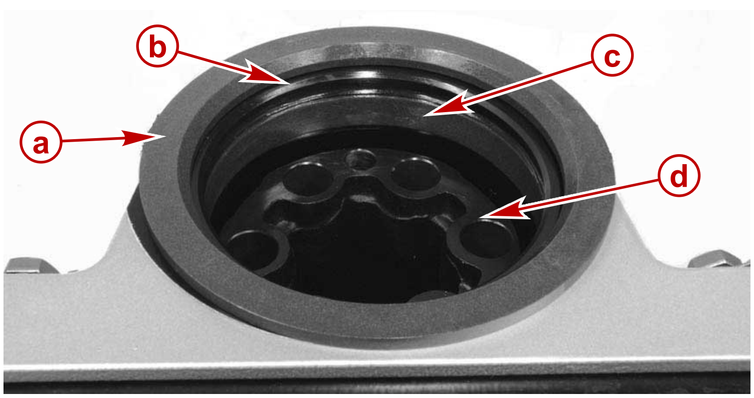


4052

a - Pedestal
b - Power trim system assembly

Pedestal Bearings and Seals

1. Remove the top outer bearing from the pedestal.

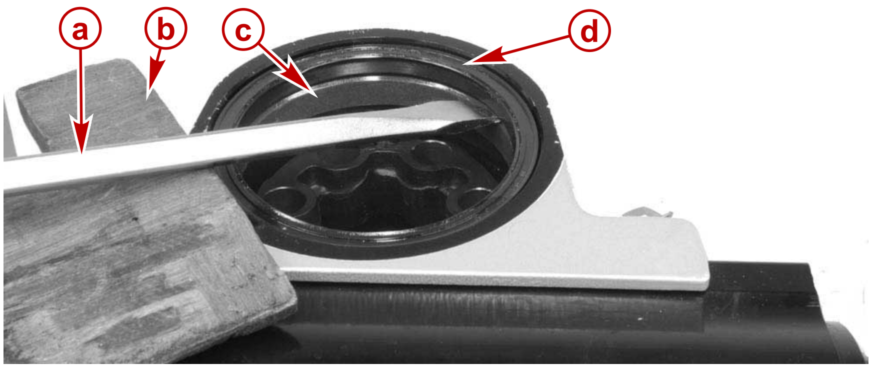


4055

a - Top outer bearing
b - Seal
c - Top inner bearing
d - Steering arm

2. Place a wooden block on top of the pedestal to protect it during the seal removal. Use a flat blade screwdriver to remove the seal and the top inner bearing inside the pedestal.

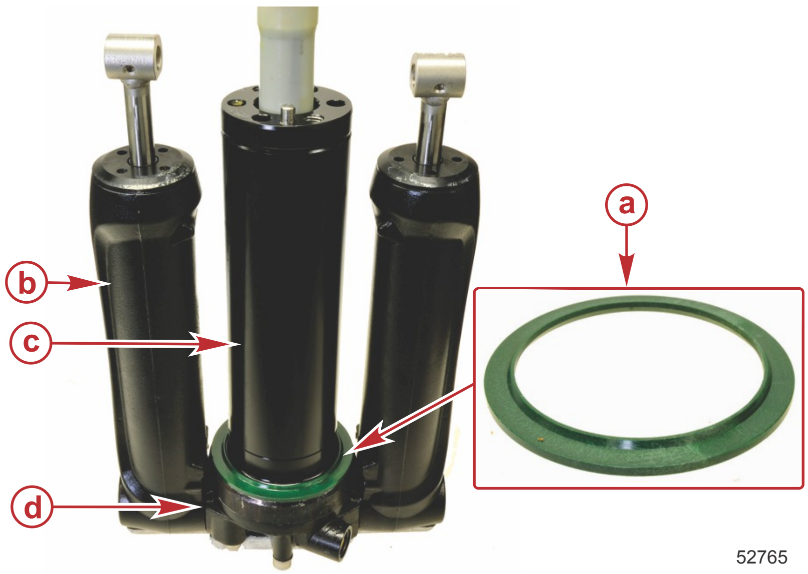
3. Remove the inner bearing and seal.



4053

a - Flat blade screwdriver
b - Wooden block
c - Top inner bearing
d - Seal

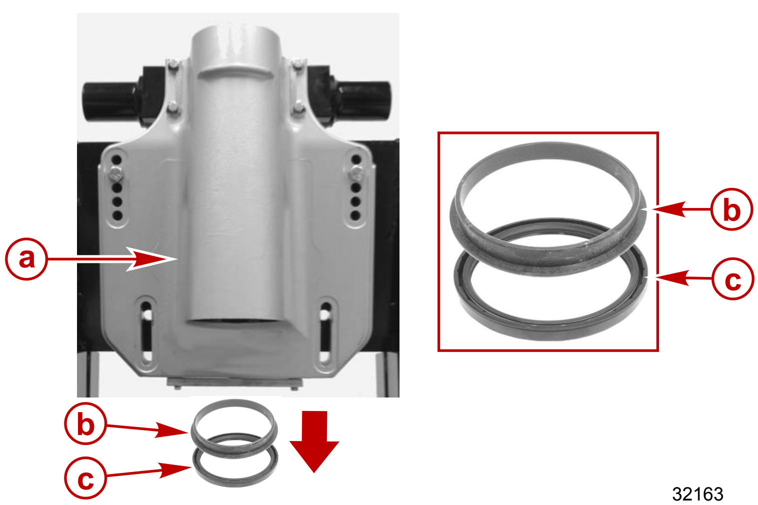
4. Remove the bottom outer bearing from the steering tube.



52765

a - Bottom outer bearing
b - Power trim cylinder
c - Steering tube
d - Power trim manifold

5. Remove the bottom seal using the same procedure as on the top seal.
6. Remove the bottom inner bearing.

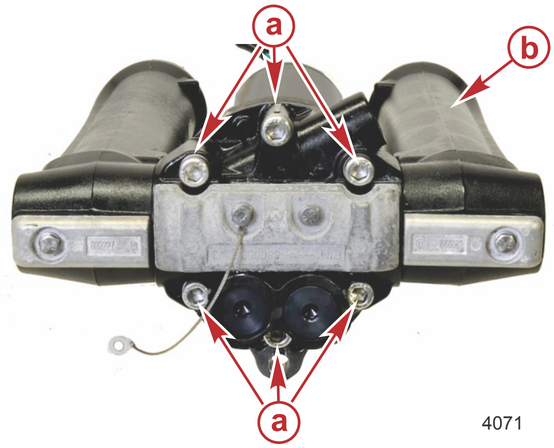


32163

a - Pedestal
b - Bottom inner bearing
c - Bottom seal

Steering Tube

1. Remove the six screws attaching the steering tube to the power trim system assembly.



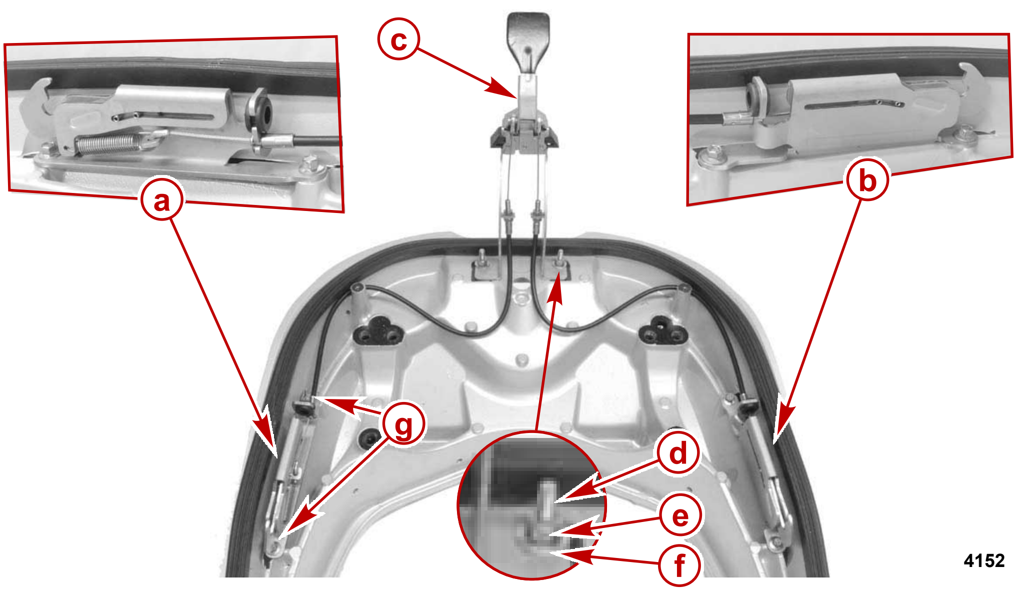
a - Mounting screw and washer (M10 x 60) (8 mm internal hex)
b - Power trim assembly manifold

2. Remove the steering tube from the power trim system assembly.

Mount Cradle

Cowl Latches

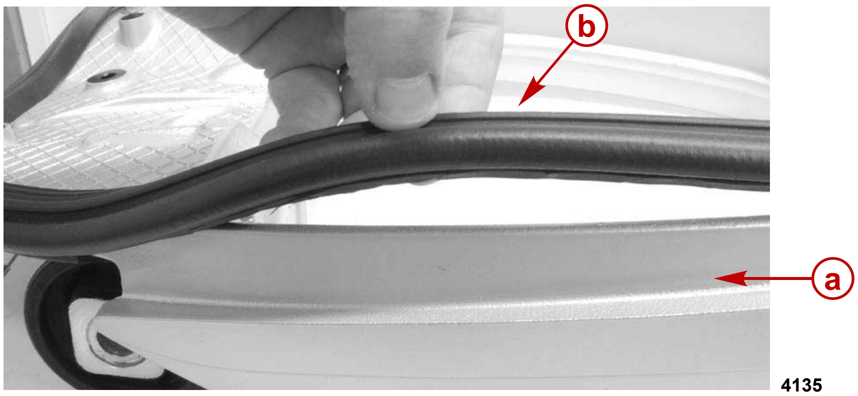
Remove the front and side latches.



a - Port side latch
b - Starboard side latch
c - Front and side latch
d - Stud (2)
e - Nut (2)
f - Washer (2)
g - Mounting screw (two each side)

Seal

Remove the mount cradle seal from the mount cradle.

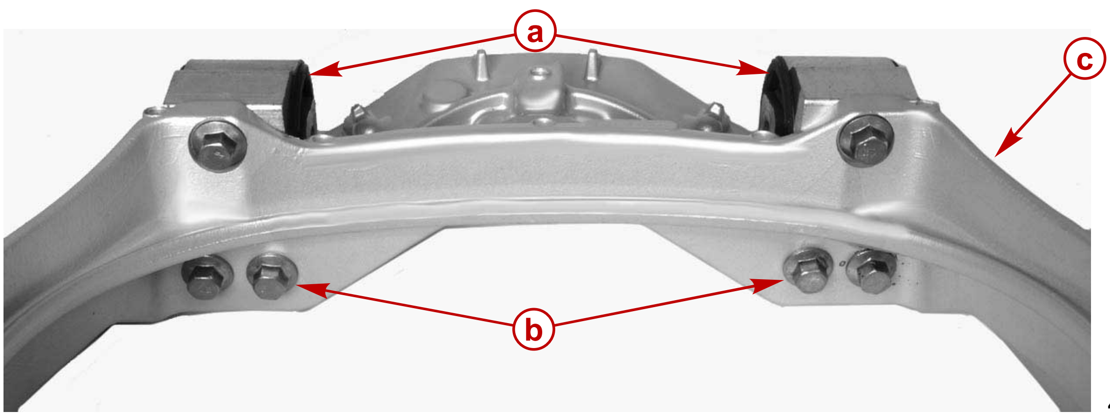


4135

a - Mount cradle
b - Seal

Rear Motor Mounts

Remove the three screws securing each rear motor mount.

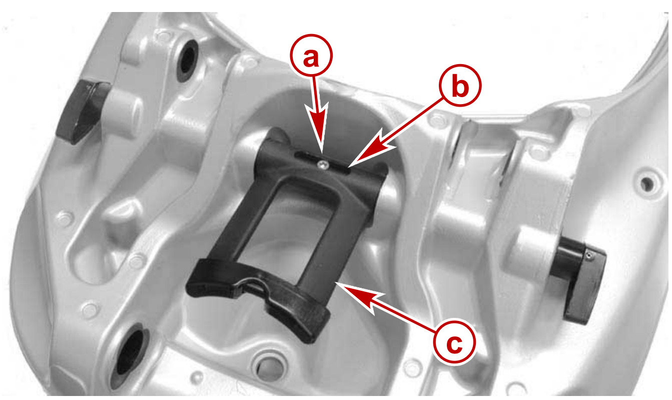


4137

a - Rear motor mount (2)
b - Rear motor mount screw (6)
c - Mount cradle

Tilt Lock

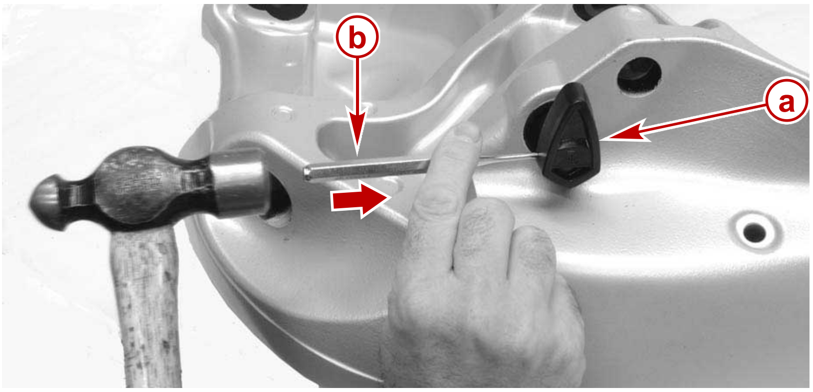
1. Remove the screw from the tilt lock bracket and tilt lock shaft.



4106

a - Tilt lock bracket screw (T27 Torx)
b - Tilt lock shaft
c - Tilt lock bracket

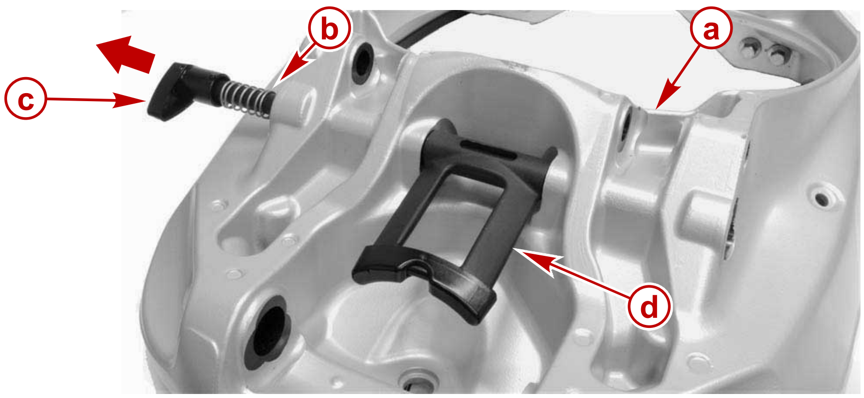
2. Using a drift pin and hammer, remove the roll pin from the tilt lock lever.



4123

- a - Tilt lock lever with roll pin
- b - Drift pin

3. Remove the tilt lock lever and spring.
4. Slide the tilt lock shaft out of the bore from the opposite side of the cradle mount.
5. Remove the tilt lock bracket.

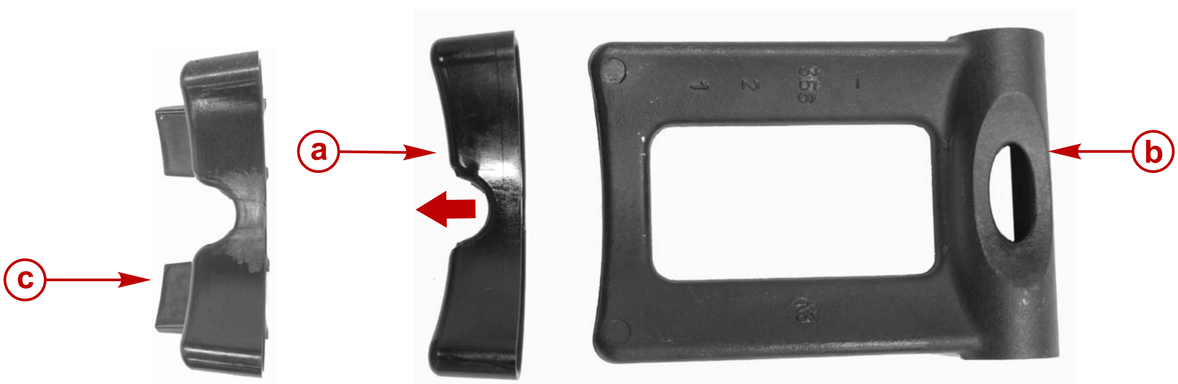


4124

- a - Mount cradle
- b - Tilt lock shaft and spring
- c - Tilt lock lever
- d - Tilt lock bracket

6. If a Design I pad is installed: Remove the pad from the tilt lock bracket.

*NOTE: Design I pads should be replaced with Design II pads. Design II pads will prevent the tilt support bracket from moving past its seat on the steering head and damaging the power trim electrical harness. Refer to **Midsection Assembly.***

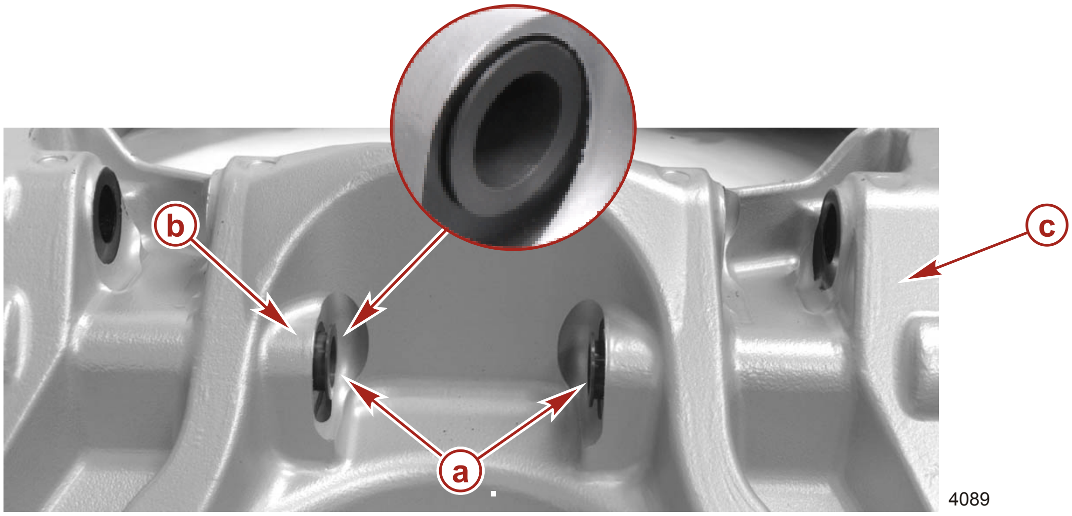


32159

32160

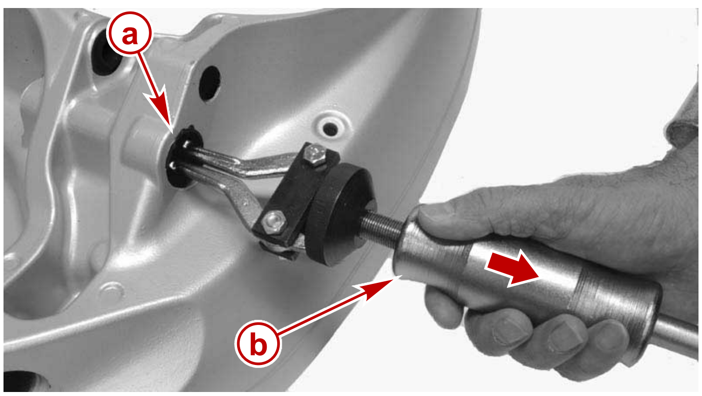
- a - Pad (Design I)
- b - Tilt lock bracket
- c - Pad (Design II)

7. Remove the two bearings from each tilt lock shaft bore.



a - Tilt lock bearing (4)
b - Tilt lock shaft bore
c - Mount cradle

8. Use a slide hammer puller to remove the tilt lock clutch from the port and starboard side of the mount cradle.



a - Tilt lock clutch
b - Slide hammer

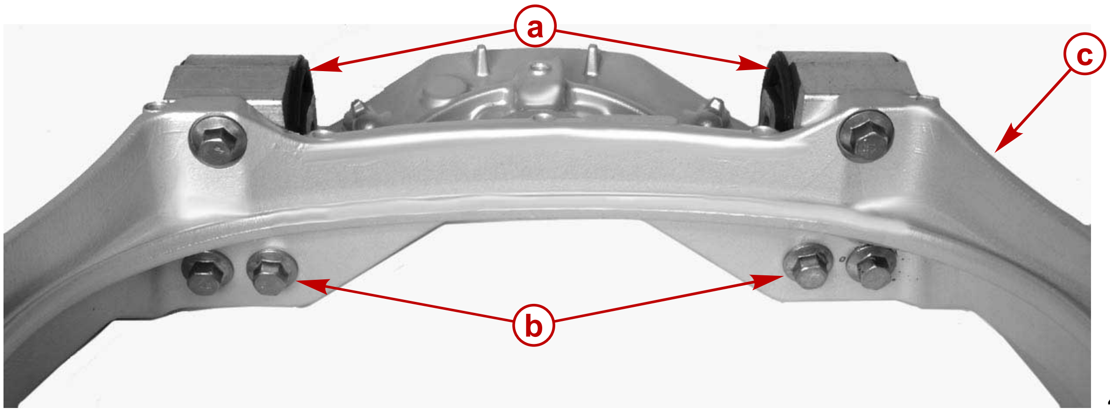
Slide Hammer	91-34569A 1

Midsection Assembly

Mount Cradle

Rear Motor Mounts

Apply Loctite 242 Threadlocker to the rear motor mount screw threads. Install three screws in each rear motor mount and attach the motor mounts to the mount cradle. Tighten the screws to the specified torque.



4137

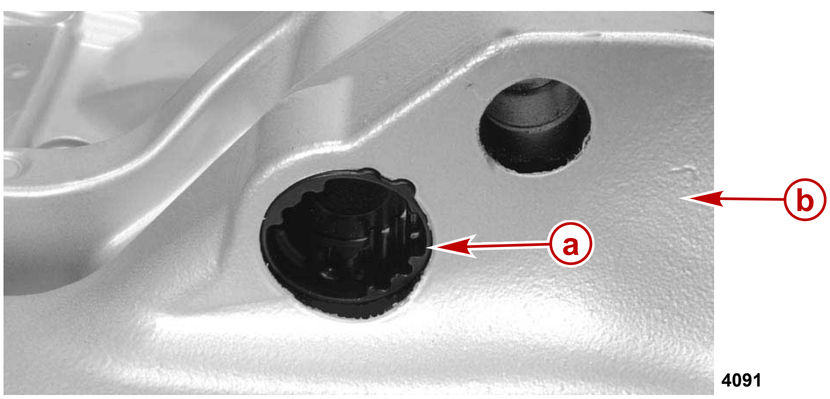
a - Rear motor mount (2)
b - Rear motor mount screw (6)
c - Mount cradle

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Rear motor mount screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Rear motor mount attaching screws	125	–	92

Tilt Lock

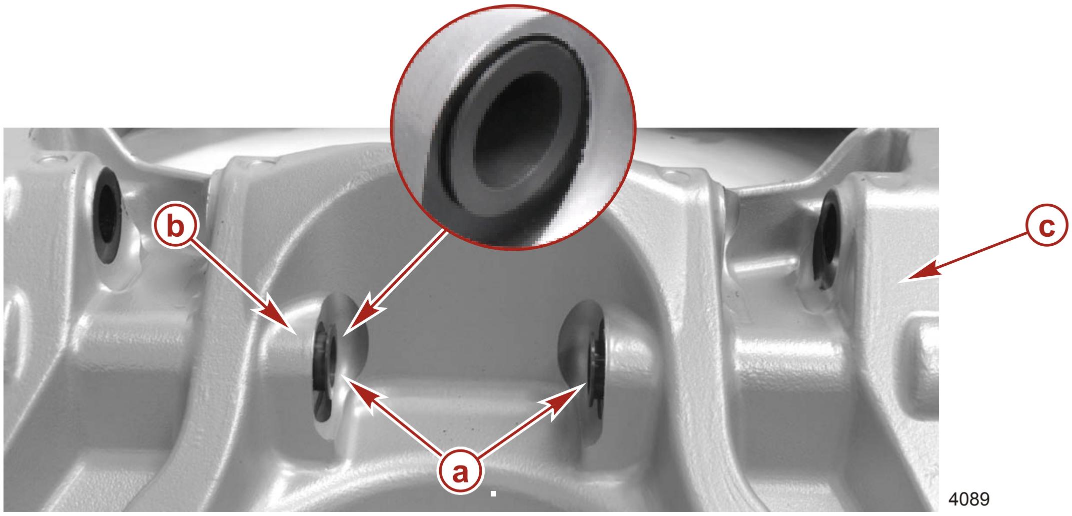
1. Install the tilt lock clutch in the port and starboard side of the mount cradle.



4091

a - Tilt lock clutch
b - Mount cradle

2. Install two bearings into the tilt lock shaft bore.

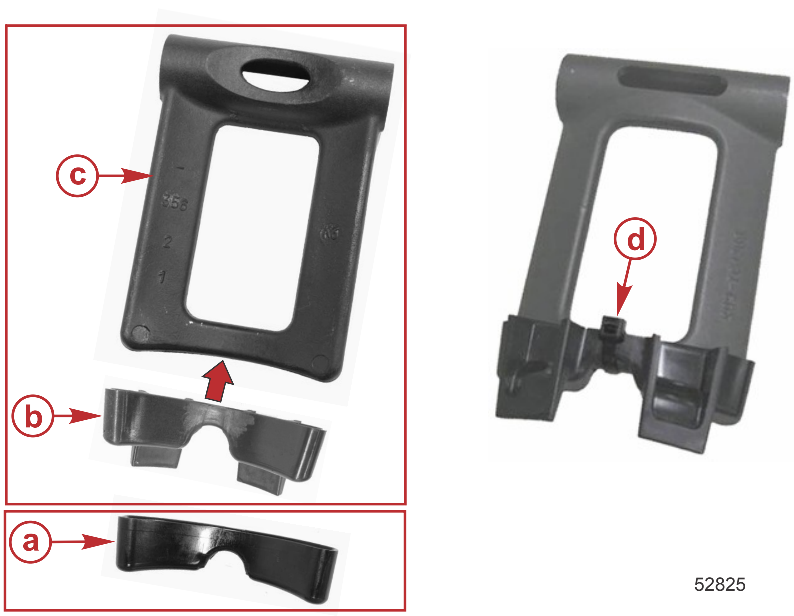


a - Tilt lock bearing (4)
b - Tilt lock shaft bore
c - Mount cradle

3. Install the pad onto the tilt lock bracket.

NOTE: Outboard models with Design I pads should be replaced with Design II pads. Design II pads will prevent the tilt support bracket from moving past its seat on the steering head and damaging the power trim electrical harness.

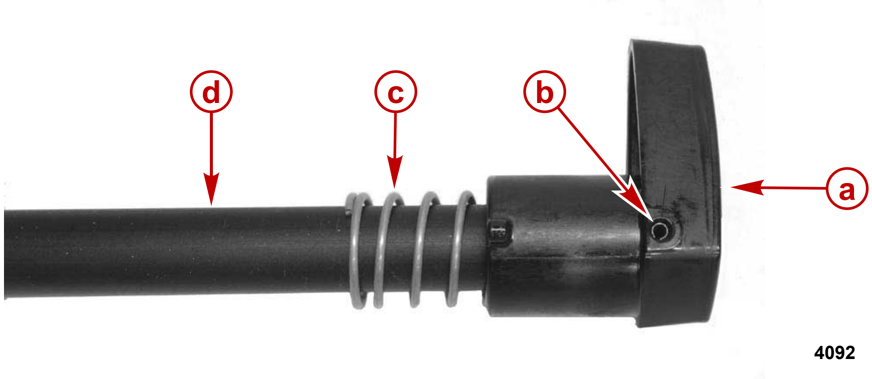
- Remove and discard the Design I pad.
- Install the Design II pad onto the tilt lock bracket.
- Secure the pad to the bracket with a cable tie.



a - Pad (Design I) (discard)
b - Pad (Design II)
c - Tilt lock bracket
d - Cable tie

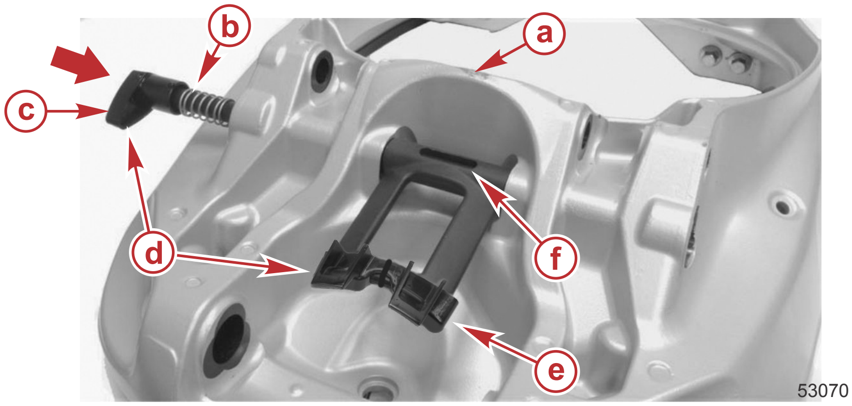
4. Assemble the tilt lock lever onto the shaft. Install the roll pin.

5. Install the spring onto the tilt lock shaft.



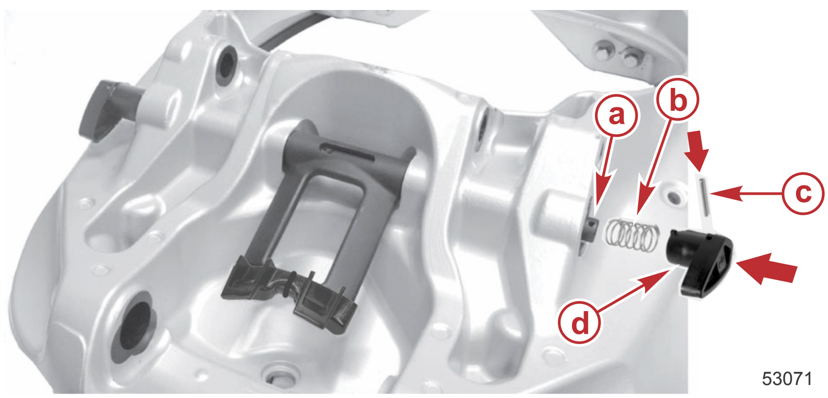
a - Tilt lock lever
b - Roll pin
c - Spring
d - Tilt lock shaft

6. Slide the tilt lock shaft with the spring partially into the bore.
7. Align the tilt lock lever with the tilt lock bracket.
8. Slide the tilt lock shaft through the bracket into the opposite bore.



a - Mount cradle
b - Tilt lock shaft and spring
c - Tilt lock lever
d - Lever and bracket aligned
e - Tilt lock bracket pad
f - Tilt lock bracket

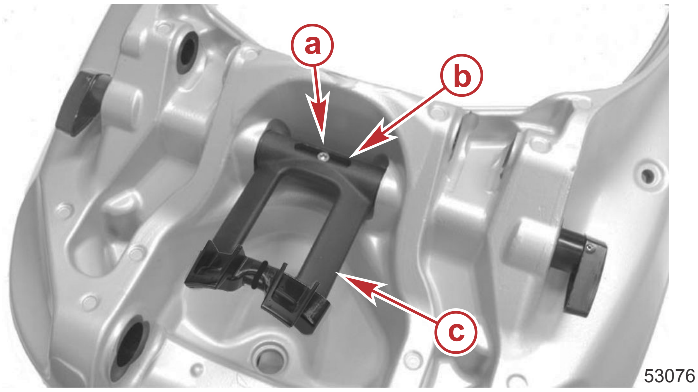
9. Assemble the tilt lock lever and spring and install on the tilt lock shaft. Secure the lever with a roll pin.



a - Tilt lock shaft
b - Spring
c - Roll pin
d - Tilt lock lever

10. Apply Loctite 242 Threadlocker to the tilt lock bracket screw threads.
11. Align the hole in the tilt lock bracket with the threaded hole in the tilt lock shaft.

12. Install the screw through the tilt lock bracket into the tilt lock shaft. Tighten the screw to the specified torque.



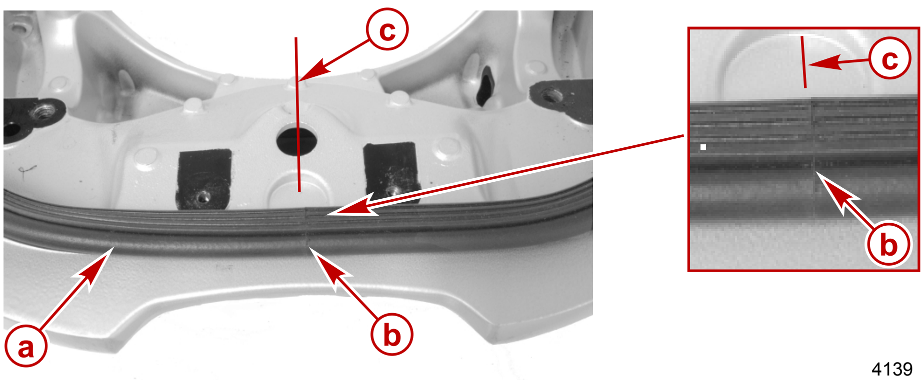
a - Tilt lock bracket screw (T27 Torx) (M5 x 10)
b - Tilt lock shaft
c - Tilt lock bracket

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Tilt lock bracket screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Screw (M5 x 10)	4	35	–

Seal

1. Install the upper mount cradle seal on the mount cradle. Position the seal at the rear of the mount cradle with the notch of the seal aligned with the centerline of the mount cradle.
2. Press the seal down on the mount cradle and continue around the mount cradle until the seal is fully seated.



a - Seal
b - Notch on seal aligned with mount cradle centerline
c - Mount cradle centerline

Adapter Plate

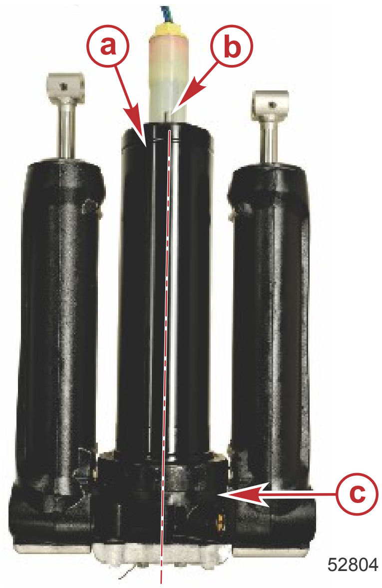
For the adapter plate installation, refer to **Section 5B** - **Adapter Plate Reassembly**.

Pedestal

Steering Tube

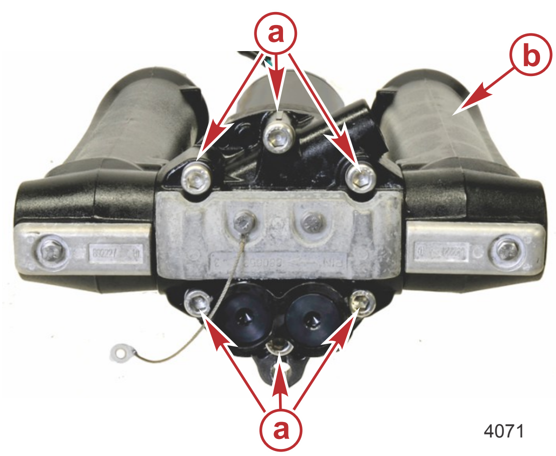
1. Install the steering tube onto the power trim assembly manifold.

2. Align the dowel pin as shown.



a - Steering tube
b - Dowel pin
c - Power trim assembly manifold

3. Install the six screws and washers securing the steering tube to the power trim assembly manifold.
4. Tighten the screws to the specified torque.



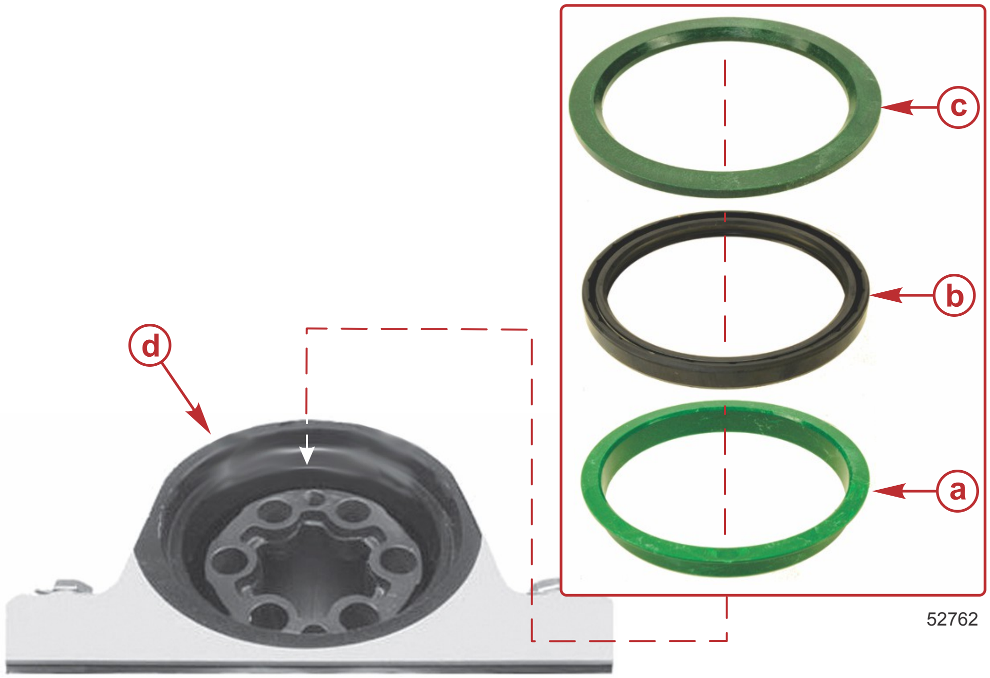
a - Mounting screw and washer (M10 x 60) (6) (8 mm internal hex)
b - Power trim assembly manifold

Description	Nm	lb-in.	lb-ft
Mounting screw (M10 x 60)	47.5	–	35

Bearings and Seals

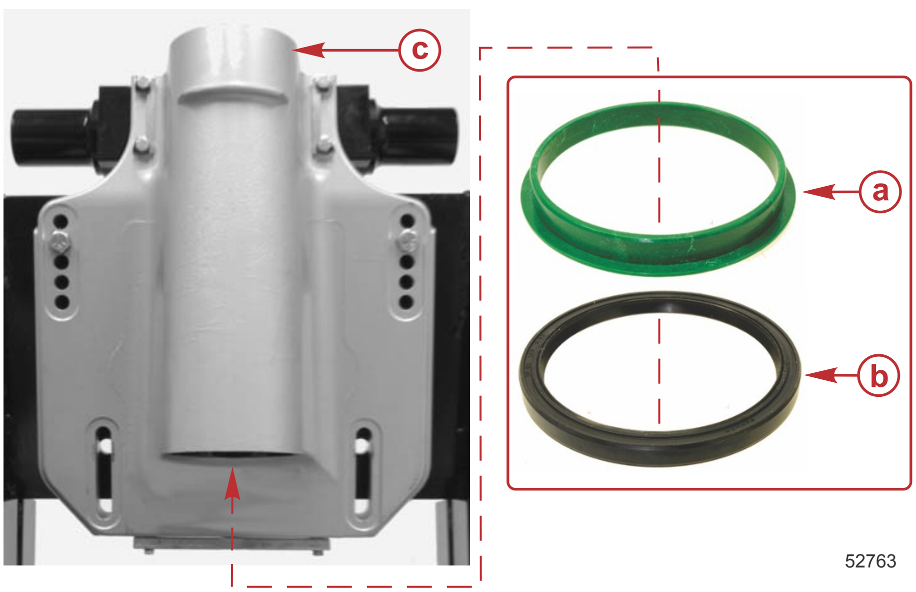
1. Install the top inner bearing into the top of the pedestal.
2. Press the seal with the spring side up into the top of the pedestal.

3. Install the top outer bearing on the top of the pedestal.



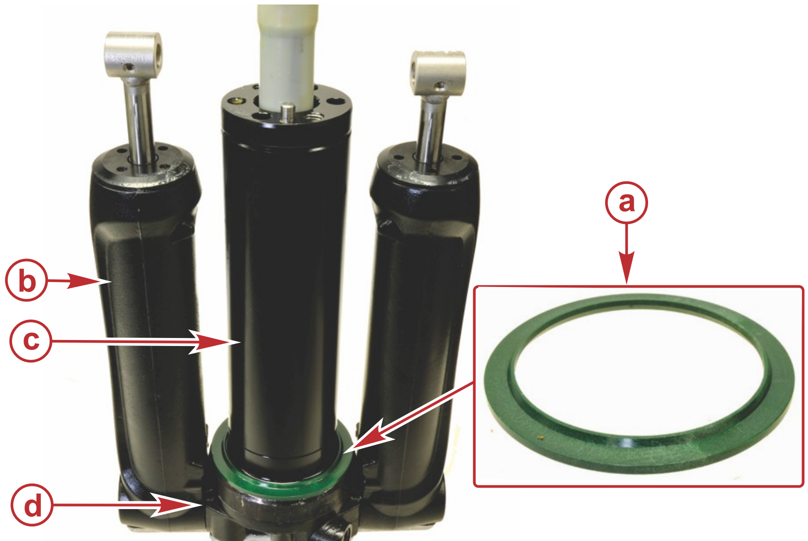
a - Top inner bearing
b - Seal–spring side up
c - Top outer bearing
d - Pedestal

4. Install the bottom inner bearing into the bottom of the pedestal.
5. Press the seal with the spring side down into the bottom of the pedestal.



a - Bottom inner bearing
b - Bottom seal
c - Pedestal

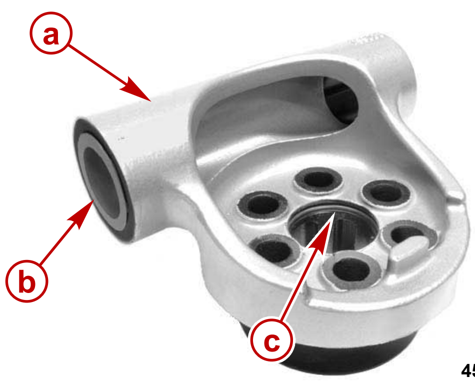
6. Install the bottom outer bearing over the steering tube on the power trim manifold.



52765

a - Bottom outer bearing
b - Power trim cylinder
c - Steering tube
d - Power trim manifold

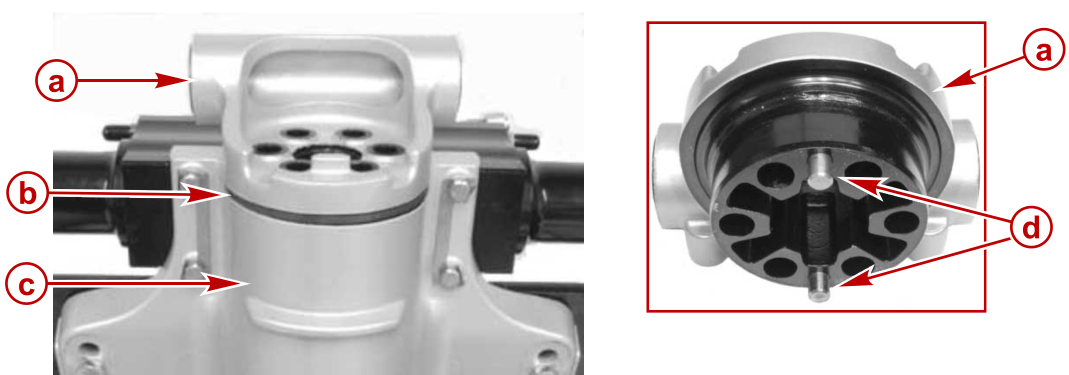
7. Remove and replace the two bearings and O-ring in the steering head if required.



4551

a - Steering head
b - Bearing (2)
c - O-ring

8. Install the steering head into the pedestal. Insert the dowel pins of the steering head into the holes of the steering arm.



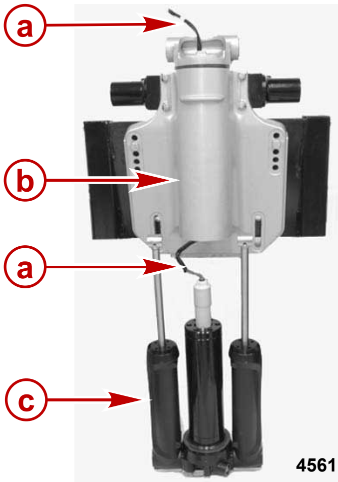
4550

a - Steering head
b - Pedestal bearing
c - Pedestal
d - Steering head dowel pins

Power Trim System

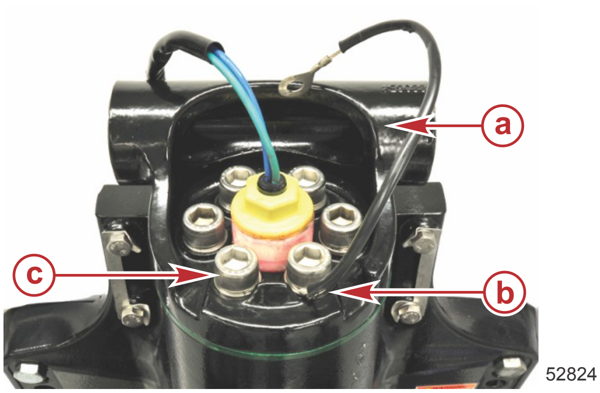
1. Connect the power trim wires to a 12 volt power supply and extend the trim cylinder rods.

2. Insert the power trim harness through the bottom of the pedestal and out the top of the pedestal.



a - Power trim harness
b - Pedestal
c - Power trim assembly

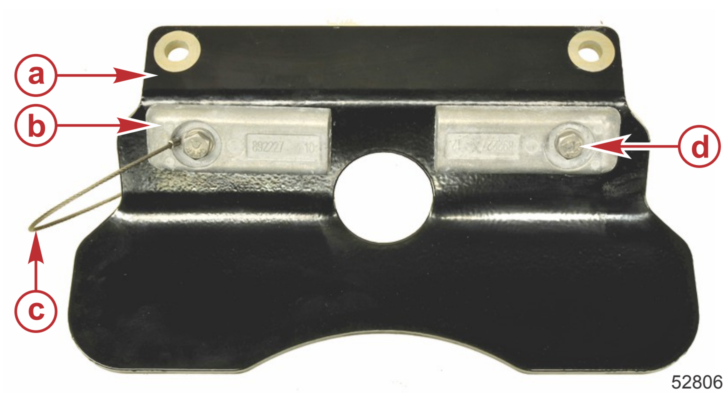
3. Install the power trim assembly into the pedestal.
4. Install the screw with the ground cable in the hole location shown.
5. Fasten the power trim assembly to the pedestal and the steering head with six screws. Tighten the screws to the specified torque.



a - Steering head
b - Ground cable
c - Steering head screw (M14 x 105) (6) (12 mm internal hex)

Description	Nm	lb-in.	lb-ft
Steering head screws (6)	108.5	–	80

6. Attach the two anodes and ground cable to the splash plate. Tighten the screws to the specified torque.

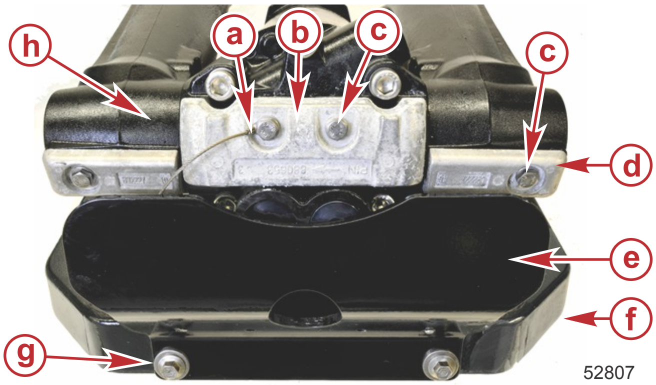


a - Splash plate
b - Anode (2)
c - Ground cable
d - Screw and washer (M6 x 16) (2)

Description	Nm	lb-in.	lb-ft
Anode mounting screw (M6 x 16)	5.6	50	–

7. Attach the anodes and ground cable to the power trim assembly. Tighten the screws to the specified torque.

8. Attach the splash plate to the pedestal. Secure the plate with two screws and washers. Tighten the screws to the specified torque.

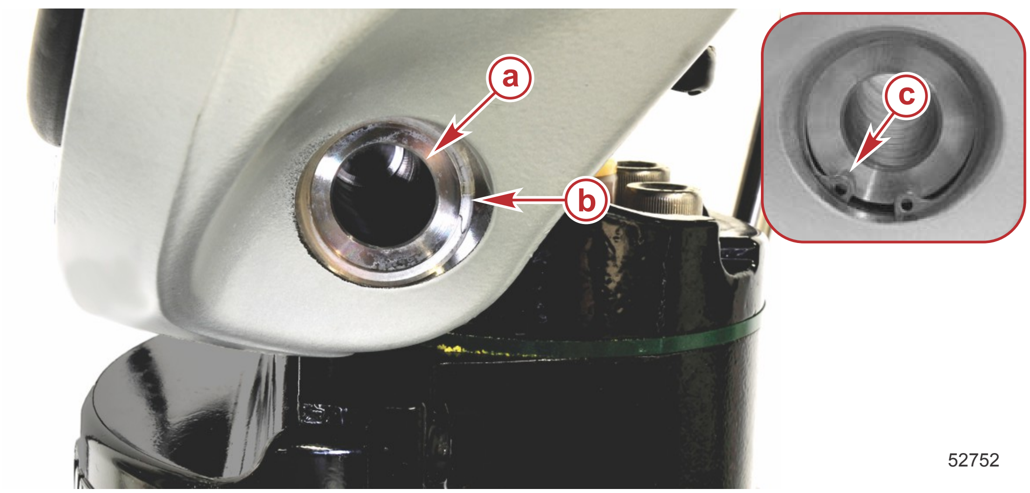


a - Ground cable
b - Anode
c - Screw and washer (M6 x 16) (4)
d - Anode (2)
e - Splash plate
f - Pedestal
g - Flange head screw and washer (M8 x 12) (2)
h - Power trim assembly

Description	Nm	lb-in.	lb-ft
Anode mounting screws (M6 x 16) (4)	5.6	50	–
Splash plate mounting screws (M8 x 12) (2)	14	124	–

Mount Cradle Tilt Pin

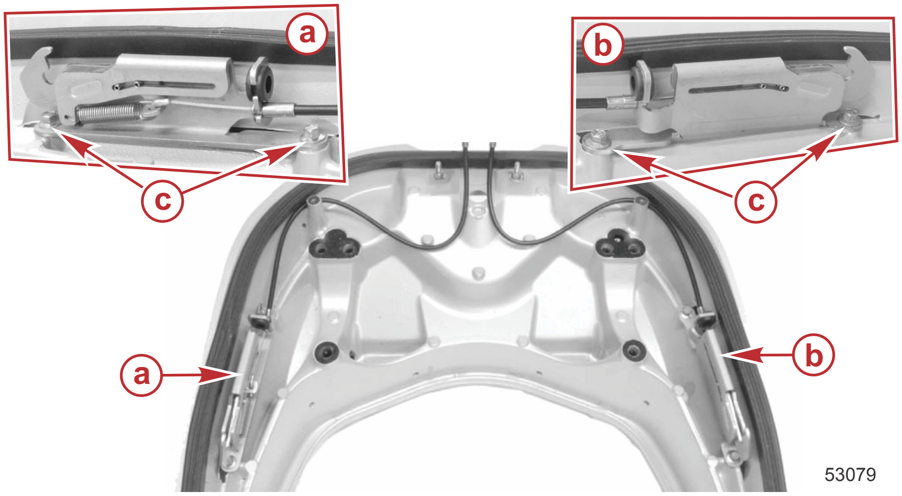
1. Align the mount cradle pivot bore to the steering head.
2. Insert the tilt pin from the port side of the mount cradle through the steering head.
3. Install the spiral ring on the port side of the mount cradle.
   IMPORTANT: If a snap ring was originally installed, replace the snap ring with a spiral ring.



a - Tilt pin
b - Spiral ring
c - Snap ring used on early models

Cowl Side Latches

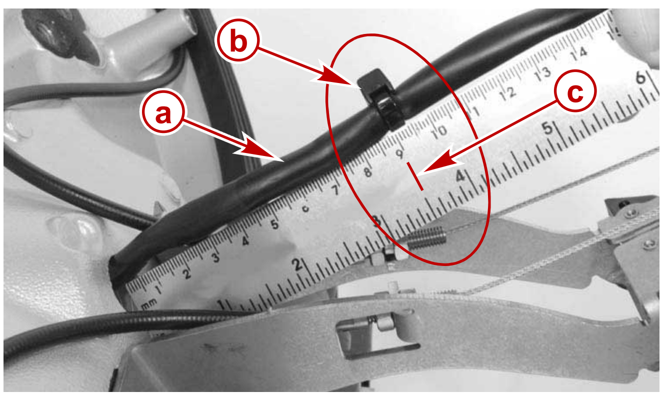
Install the front and side latches.



a - Port side latch
b - Starboard side latch
c - Mounting screw (two each side)

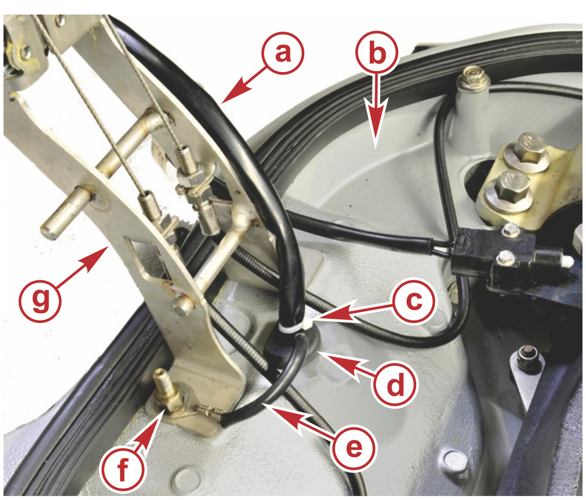
Power Trim Harness

1. Route the power trim harness and the ground cable through the hole in the mount cradle.
2. Attach a cable tie on the harness a distance of 18.5 cm (7.25 in.) from the reservoir fill cap. With the mount cradle attached, place the cable tie 9.0 cm (3.5 in.) from the cradle top surface when trimmed fully up.



a - Power trim harness
b - Cable tie
c - Measured distance

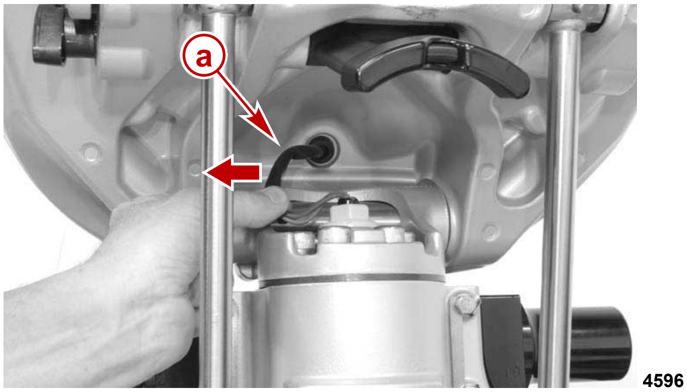
3. Place the power trim grommet on the ground cable and power trim harness below the cable tie.
4. Push the grommet and harness into the mount cradle. As the grommet is pushed in, rotate the grommet so the flat edge faces either side of the engine when installed.
5. Attach the ground cable to the latch bracket mounting stud, and secure it with an M6 nut. Tighten the nut to the specified torque.



a - Power trim harness
b - Mount cradle
c - Cable tie
d - Grommet
e - Ground cable
f - Nut (M6)
g - Latch bracket

Description	Nm	lb-in.	lb-ft
Latch bracket/ground cable M6 nut	6	53	–

6. To ensure that the harness will coil when the mount cradle is trimmed down, gently pull on the harness to check that it is off-center.



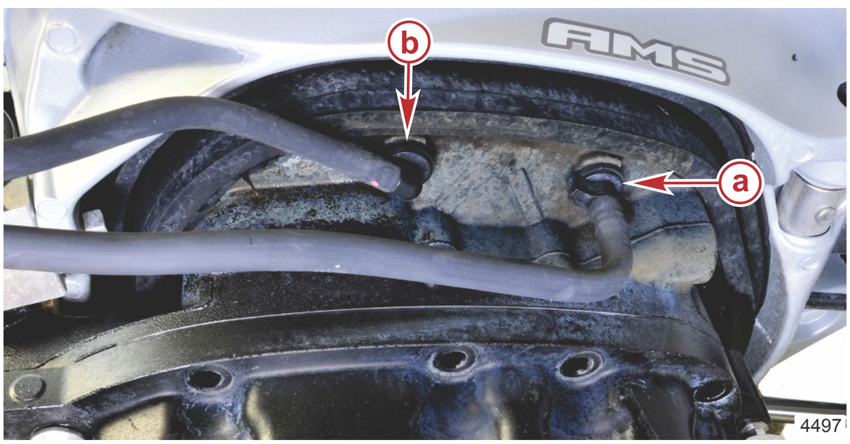
a - Power trim harness

Trim Cylinder Rod Ends

Assemble the trim cylinder rod ends to the mount cradle. Refer to **Section 5C** - **Power Trim System**.

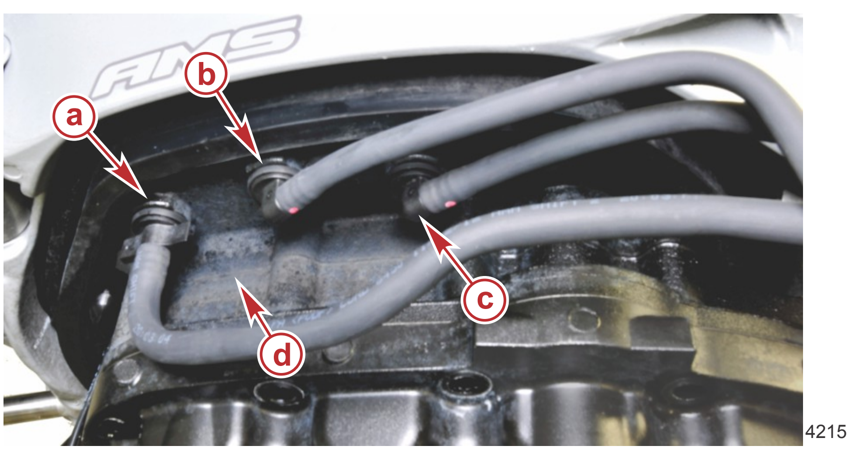
Hoses and Harnesses

1. Assemble the FSM fuel inlet hose and vent hose to the adapter plate on the starboard side. Install the hose connector from the bottom side of the adapter plate. Align the connector tab with the slot in the adapter plate, then rotate clockwise to lock in position.



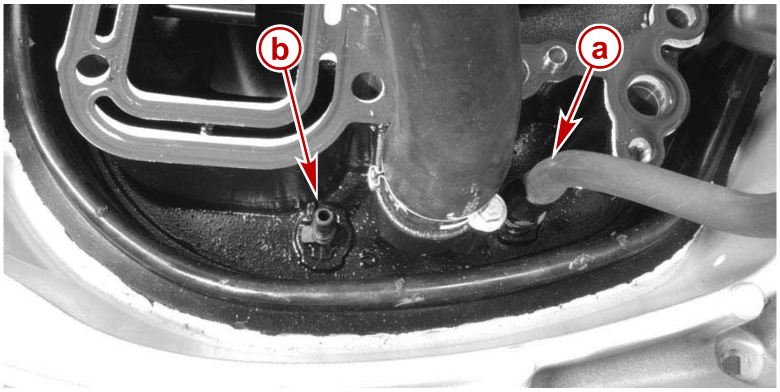
a - FSM fuel inlet hose (10 mm red tab)
b - Vent hose (0.375 in. blue tab)

2. Assemble the FSM outlet hose, FSM water inlet hose, and the manifold hose to the adapter plate on the port side. Install the hose connector from the bottom side of the adapter plate. Align the connector tab with the slot in the adapter plate, then rotate clockwise to lock in position.



a - FSM high-pressure outlet hose (10 mm red tab)
b - FSM water-cooling inlet hose (8 mm blue tab)
c - Manifold reference hose (8 mm white tab)
d - Adapter plate

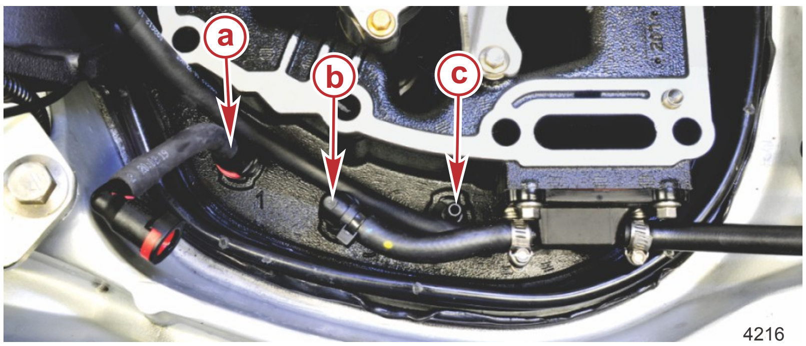
3. Position and assemble two hose clips to the port hoses and one clip to the starboard hoses.
4. Connect the FSM fuel inlet hose on the top starboard side of the adapter plate. Push the colored lock tab on the hose end down on the connector to install.



4496

a - FSM fuel inlet hose (10 mm red tab)
b - Vent hose connector

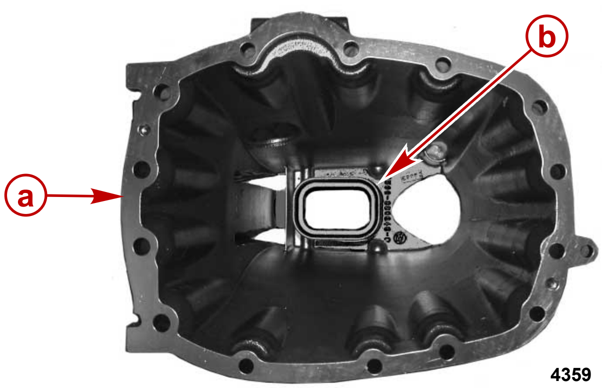
5. Connect the FSM outlet hose and the FSM water inlet hose on the top port side of the adapter plate. Push the colored lock tab on the hose end down on the connector to install.



a - FSM outlet hose (10 mm red tab)
b - FSM water inlet hose (8 mm blue tab)
c - Manifold hose connector

Driveshaft Housing

1. Install the new exhaust tube seal in the groove in the bottom of the driveshaft housing.

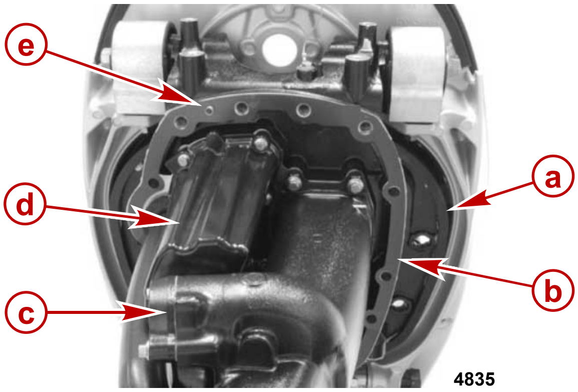


4359

a - Driveshaft housing
b - Exhaust tube seal

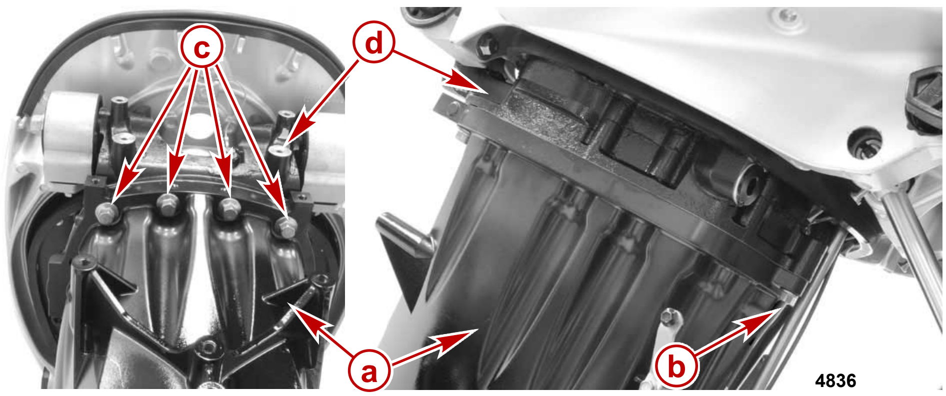
2. Clean the mating surfaces of the adapter plate and driveshaft housing.

3. Place a new gasket over the dowel pins on the adapter plate.



a - Adapter plate
b - Driveshaft housing gasket
c - Exhaust tube
d - Oil sump
e - Dowel pin (1 of 2)

4. Apply Loctite 271 Threadlocker to the four M12 mounting screw threads.
5. Apply Loctite 242 Threadlocker to the M8 mounting screw threads.
6. Assemble the driveshaft housing to the adapter plate with four screws in the rear of the housing and one in the front. Tighten the screws to the specified torque.



a - Driveshaft housing
b - Driveshaft housing mounting screw (M8 x 30) (1)
c - Driveshaft housing mounting screw (M12 x 45) (4)
d - Adapter plate

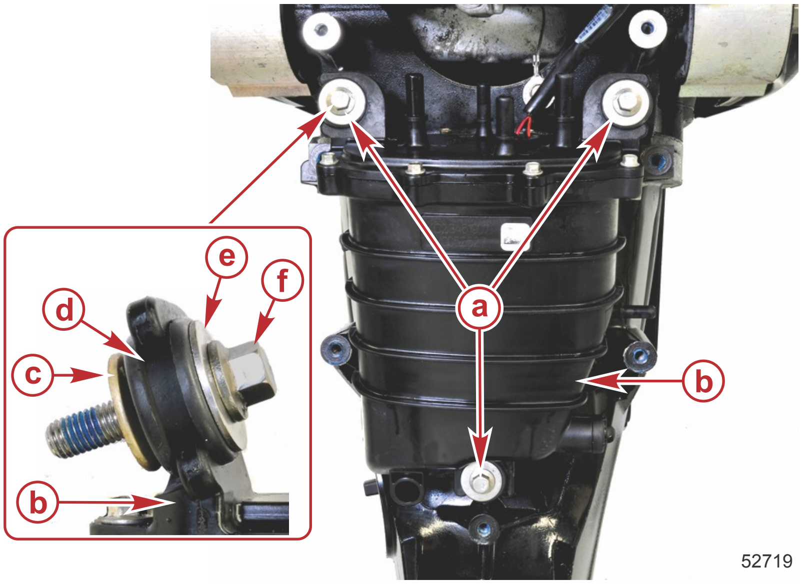
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	M12 driveshaft housing mounting screw threads	92-809819
66	Loctite 242 Threadlocker	M8 driveshaft housing mounting screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Screw (M12 x 45)	48		35
Screw (M8 x 30)	24		17.5

Fuel Supply Module (FSM)

1. Apply Loctite 242 Threadlocker to the three fuel supply module mounting screw threads.
2. Route the water cooling inlet hose to the starboard side of the driveshaft housing behind the FSM.

3. Loosely attach the fuel supply module to the driveshaft housing with three screws, washers, grommets, and bushings.

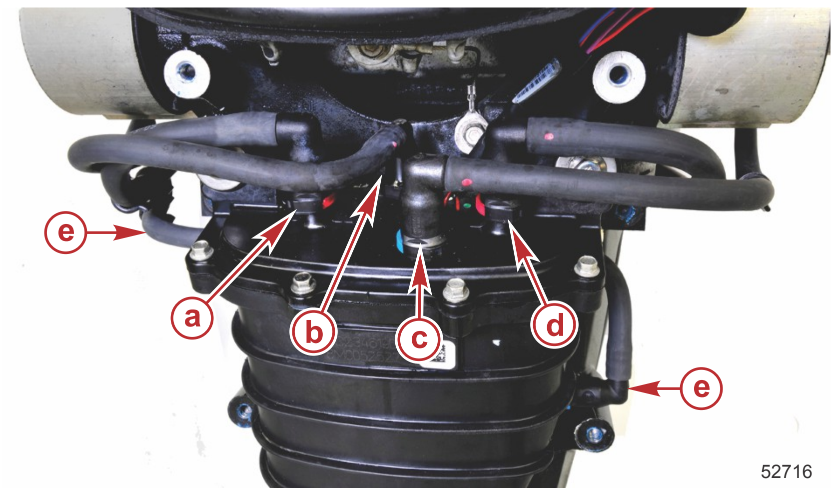


a - Fuel supply module mounting hardware
b - Fuel supply module
c - Bushing (3)
d - Grommet (3)
e - Washer (3)
f - Mounting screw (M8 x 35) (3)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Fuel supply module mounting screw threads	92-809821

4. Connect the fuel out line, manifold reference line, fuel in line, vent canister line, and the fuel cooler line.

NOTE: The fuel lines at the fuel supply module are preformed and only fit on the correct FSM port.



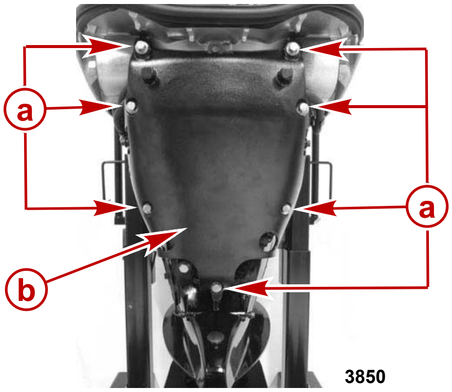
a - High-pressure outlet (10 mm red tab)
b - Manifold reference to fuel pressure regulator (8 mm white tab)
c - Vent to vent canister switch (0.375 in. blue tab)
d - FSM fuel inlet from fuel filter/water separator (10 mm red tab)
e - Water-cooling inlet hose (8 mm blue tab)

5. Tighten the three FSM mounting screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Mounting screws	24	–	18

6. Apply Loctite 242 Threadlocker to the seven shroud mounting screw threads.

7. Secure the fuel supply module shroud to the driveshaft housing with seven screws. Tighten the screws to the specified torque.

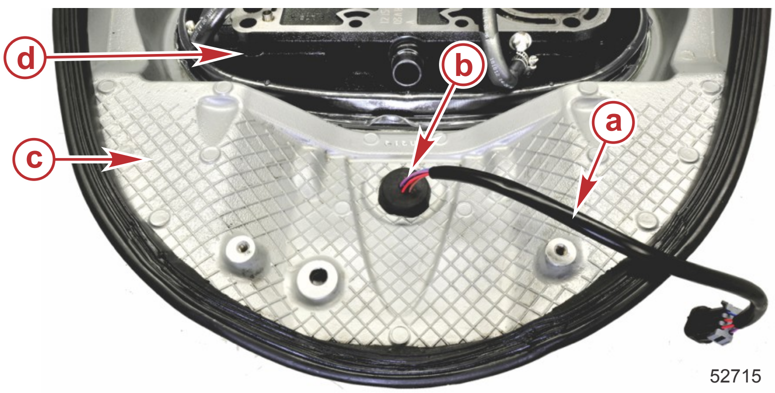


a - Shroud mounting screw (M8)
b - Fuel supply module shroud

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Shroud mounting screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Shroud mounting screws	24	–	18

8. Install the fuel supply module harness grommet into the adapter plate.

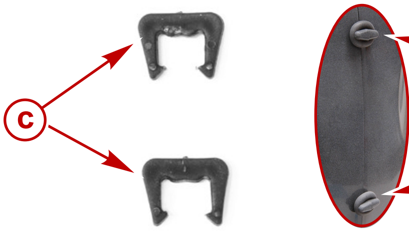


a - Harness
b - Grommet
c - Mount cradle
d - Adapter plate

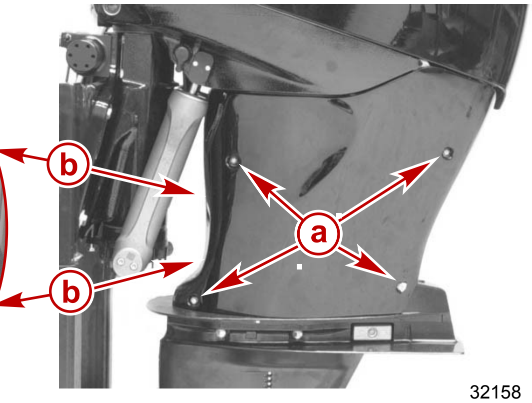
Completing Mid-Section Reassembly

1. Assemble the gearcase to the driveshaft housing. Refer to **Section 6** - **Gearcase Installation**.
2. Assemble the engine to the mid-section. Refer to **4A** - **Dressed Powerhead Removal/Installation.**
3. Install the port chap to the driveshaft housing. Secure with screws (four or six for XXL shaft). Tighten the screws to the specified torque.
4. Install the starboard chap onto the driveshaft housing. Secure with screws (four or six for XXL shaft). Tighten the screws to the specified torque.

5. Attach two O-rings or clips securing the front tabs on the port and starboard chaps.



32157



32158

a - Chap mounting screw (M6)
b - O-ring and tab
c - Clip (used on later models in place of O-ring)

Description	Nm	lb. in.	lb. ft.
Chap mounting screws	6	53	

Midsection

Section 5B - Adapter Plate

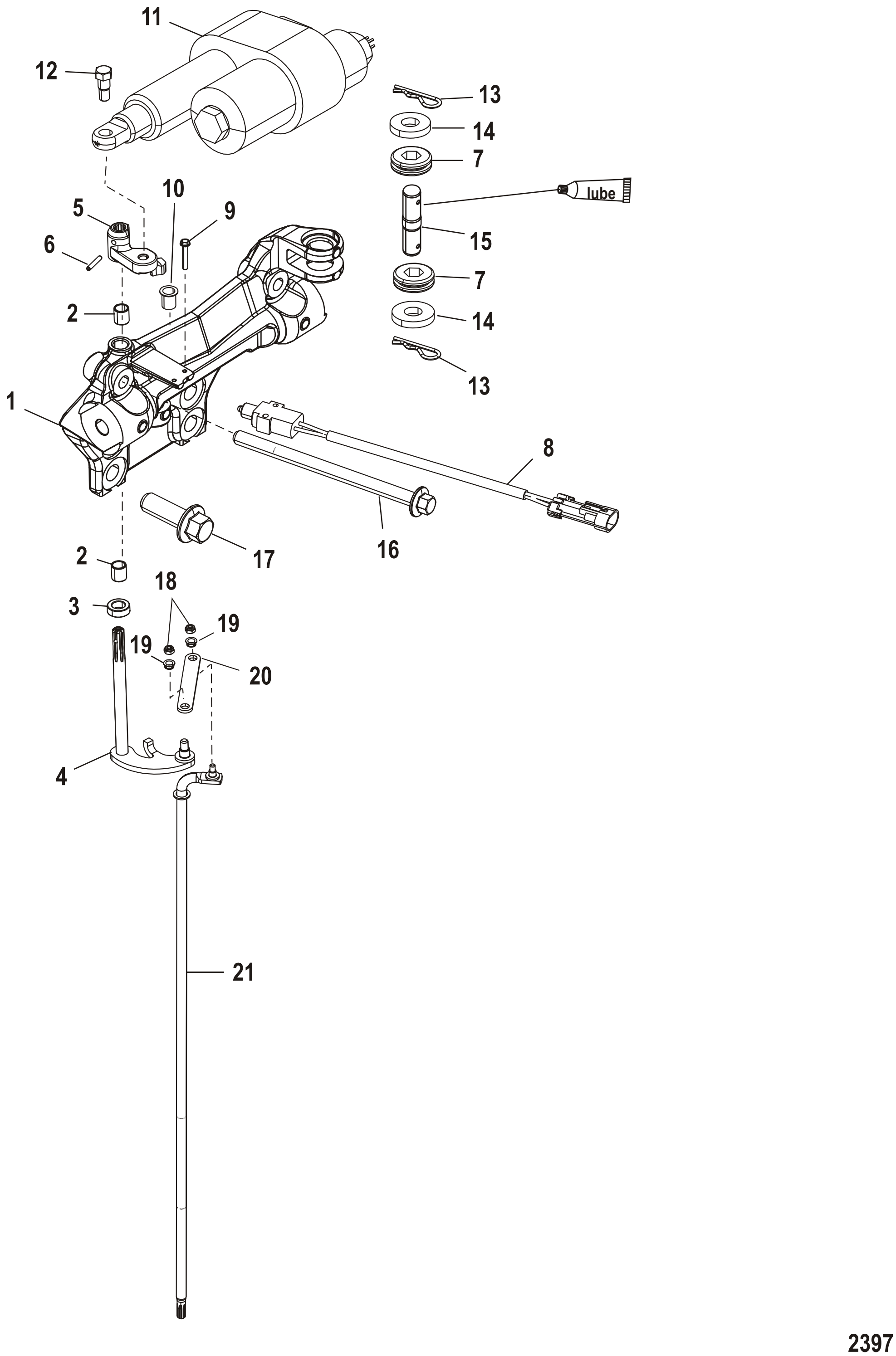
Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Front motor mount screw threads	92-809819
		Rear motor mount screw threads	
9	Loctite 567 PST Pipe Sealant	Plug threads	92-809822
36	P80 Rubber Lubricant	Installed dump fitting	Obtain Locally
		O-rings	
66	Loctite 242 Threadlocker	Idle relief fitting mounting screw threads and evaporative cooling fitting mounting screw threads	92-809821
		Water strainer mounting screw threads	
		Dump fitting mounting screw threads	
		Front motor mount screw threads	
		Oil pickup tube screws	
		Oil sump mounting screw threads	
		Exhaust tube mounting screw threads	
87	High Performance Gear Lubricant	Dump fitting and O-ring	92-858064K01
91	Engine Coupler Spline Grease	Oil pump driveshaft	8M0071842
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Underside of flange head	Obtain Locally
137	Three Bond Adhesive TB-1530	Adapter plate seal	92-858006K02
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump and oil seals	92-858052K01
		Water seals	
		Oil seals	
		Cooling jet check valve and dump fitting O-rings	

Notes:

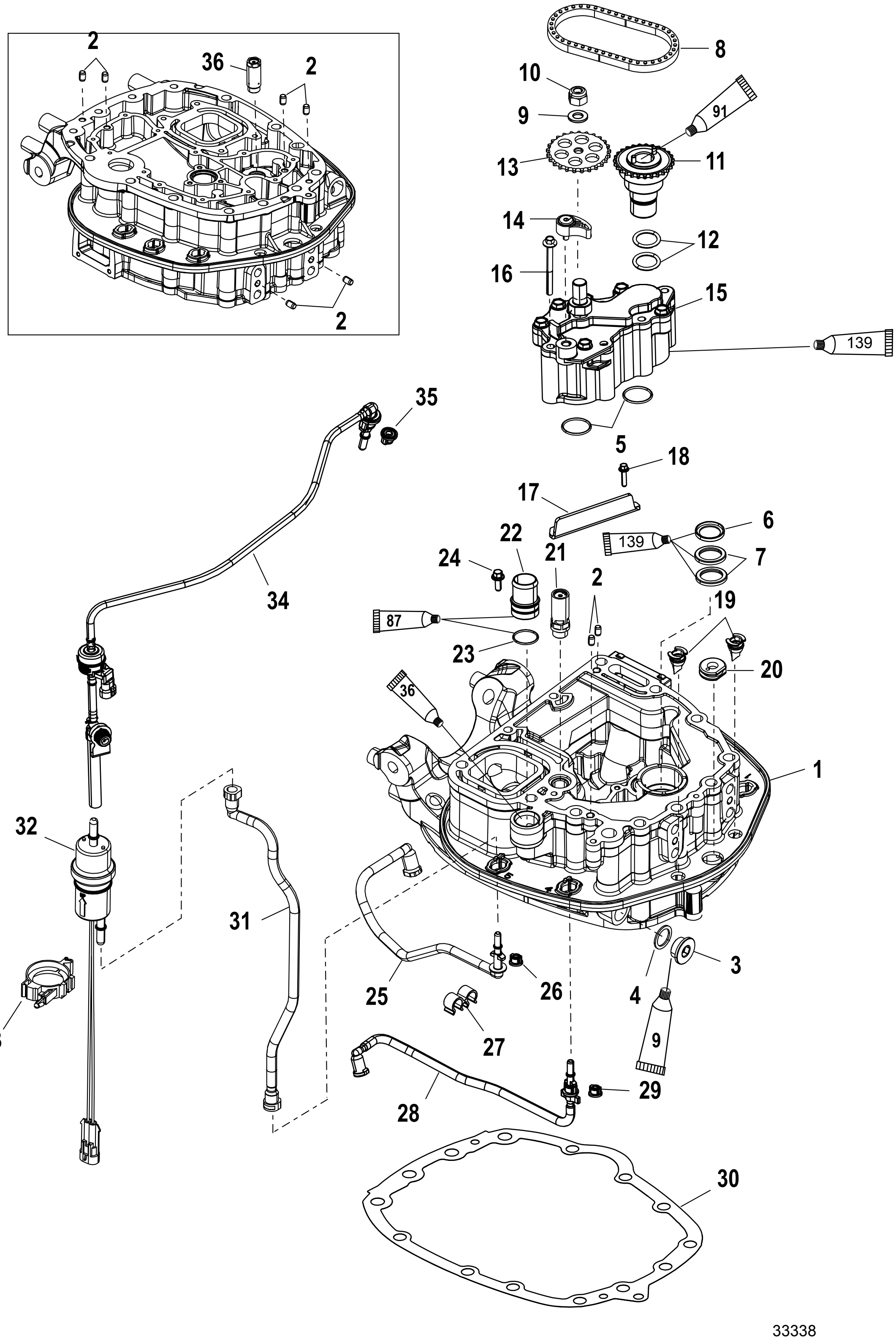
Upper Shift Components



Upper Shift Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Bracket			
2	2	Bushing			
3	1	Spacer			
4	1	Bell crank shift shaft			
5	1	Upper bell crank			
6	1	Roll pin (0.125 x 0.75)			
7	2	Grommet			
8	1	Switch			
9	2	Screw (M3 x 20)	2.3	20	
10	1	Bushing			
11	1	Shift actuator			
12	1	Screw	20		14.7
13	2	Cotter pin			
14	2	Washer			
15	1	Pivot pin			
16	2	Screw (M10 x 155)	40		29.5
			Plus 45 degree turn		
17	4	Screw (M14)	185		136.4
18	2	Nut (M6)	6	53	
19	2	Bushing			
20	1	Shift shaft link			
21	1	Shift shaft			

Oil Pump/Adapter Plate - Upper Components (S/N 1B517433 and Below)



Oil Pump/Adapter Plate - Upper Components (S/N 1B517433 and Below)

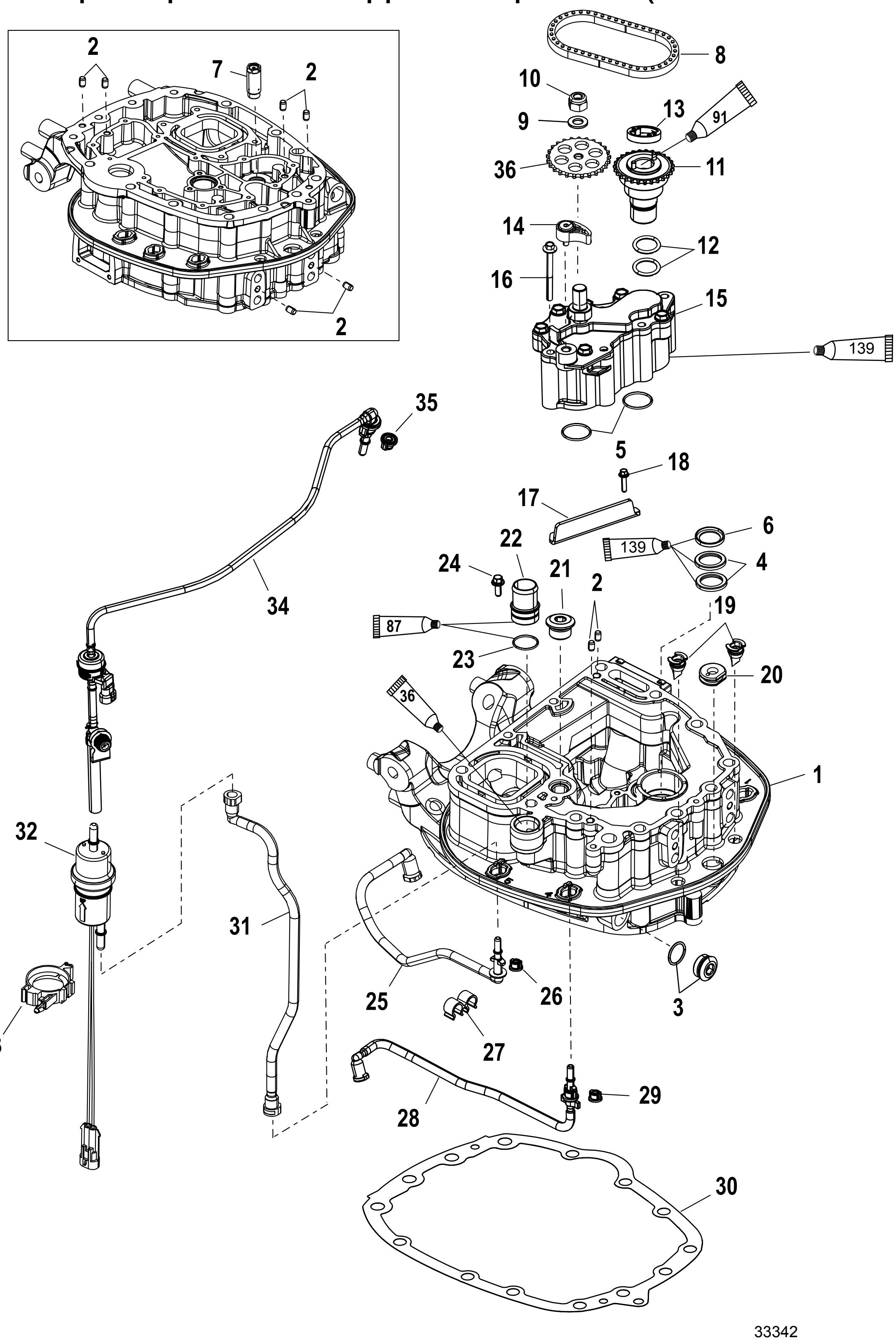
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Adapter plate			
2	8	Dowel pin			
3	1	Plug (24 mm)	55		40.5
4	1	Seal			
5	2	O-ring			
6	1	Oil seal			
7	2	Water seal			
8	1	Oil pump drive chain			
9	1	Washer			
10	1	Nut	80		59
11	1	Oil pump driveshaft			
12	2	O-ring			
13	1	Driven sprocket			
14	1	Oil pump drive tensioner assembly			
15	1	Oil pump assembly			
16	5	Screw	10	88	
17	1	Oil deflector			
18	2	Screw (M6 x 16)	10	88	
19	2	Cowl drain			
20	1	Grommet			
21	1	Check valve assembly	40		29.5
22	1	Dump fitting			
23	1	O-ring (1.239 x 0.070)			
24	1	Screw (M6 x 12)	6	53	
25	1	Lower vent hose			
26	1	Grommet			
27	1	Clip			
28	1	Fuel supply module inlet fuel hose			
29	1	Grommet			
30	1	Gasket			
31	1	Fuel vent hose			
32	1	Vent canister			
33	1	Clip			
34	1	Fuel line purge valve assembly			
35	1	Grommet			
36	1	Oil pump pressure relief valve	40		29.5

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Plug threads	92-809822

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	Installed dump fitting	Obtain Locally
87	High Performance Gear Lubricant	Dump fitting and O-ring	92-858064K01
91	Engine Coupler Spline Grease	Oil pump driveshaft	8M0071842
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump and oil seals	92-858052K01

Notes:

Oil Pump/Adapter Plate - Upper Components (S/N 1B517434 and Above)



Oil Pump/Adapter Plate - Upper Components (S/N 1B517434 and Above)

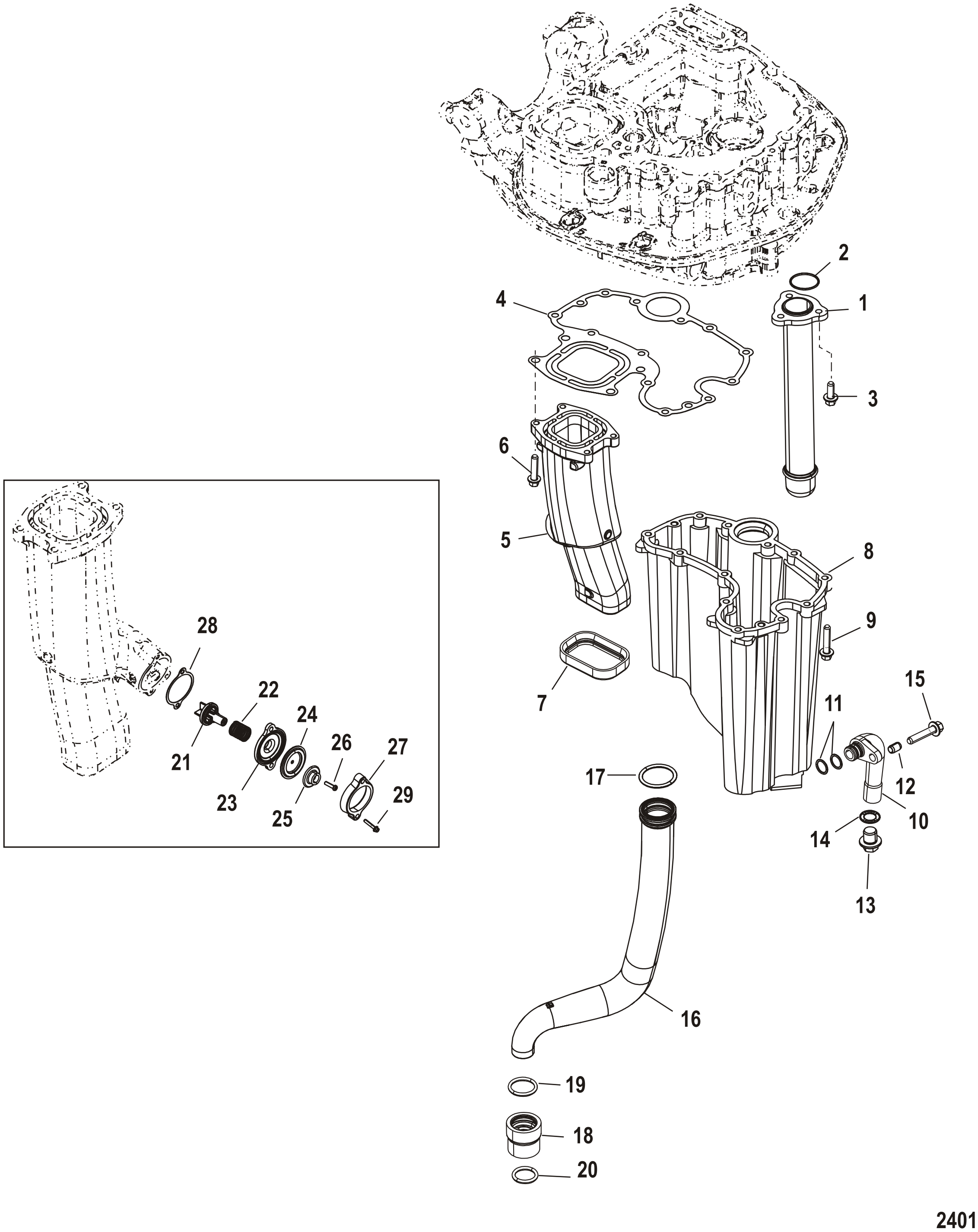
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Adapter plate			
2	8	Dowel pin			
3	1	Plug (24 mm) and seal	55		40.5
4	2	Water seal			
5	2	O-ring			
6	1	Oil seal			
7	2	Oil pump valve assembly			
8	1	Oil pump drive chain			
9	1	Washer			
10	1	Nut	80		59
11	1	Oil pump driveshaft			
12	2	O-ring			
13	1	Plastic insert			
14	1	Oil pump drive tensioner assembly			
15	1	Oil pump assembly			
16	5	Screw	10	88	
17	1	Oil deflector			
18	2	Screw (M6 x 16)	10	88	
19	2	Cowl drain			
20	1	Grommet			
21	1	Plug (M18 x 1.5)	40		29.5
22	1	Dump fitting			
23	1	O-ring (1.239 x 0.070)			
24	1	Screw (M6 x 12)	6	53	
25	1	Lower vent hose			
26	1	Grommet			
27	1	Clip			
28	1	Fuel into fuel supply module hose			
29	1	Grommet			
30	1	Gasket			
31	1	Fuel vent hose			
32	1	Vent canister			
33	1	Clip			
34	1	Fuel line purge valve assembly			
35	1	Grommet			
36	1	Driven sprocket			

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	Installed dump fitting	Obtain Locally

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Dump fitting and O-ring	92-858064K01
91	Engine Coupler Spline Grease	Oil pump driveshaft	8M0071842
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump and oil seals	92-858052K01

Notes:

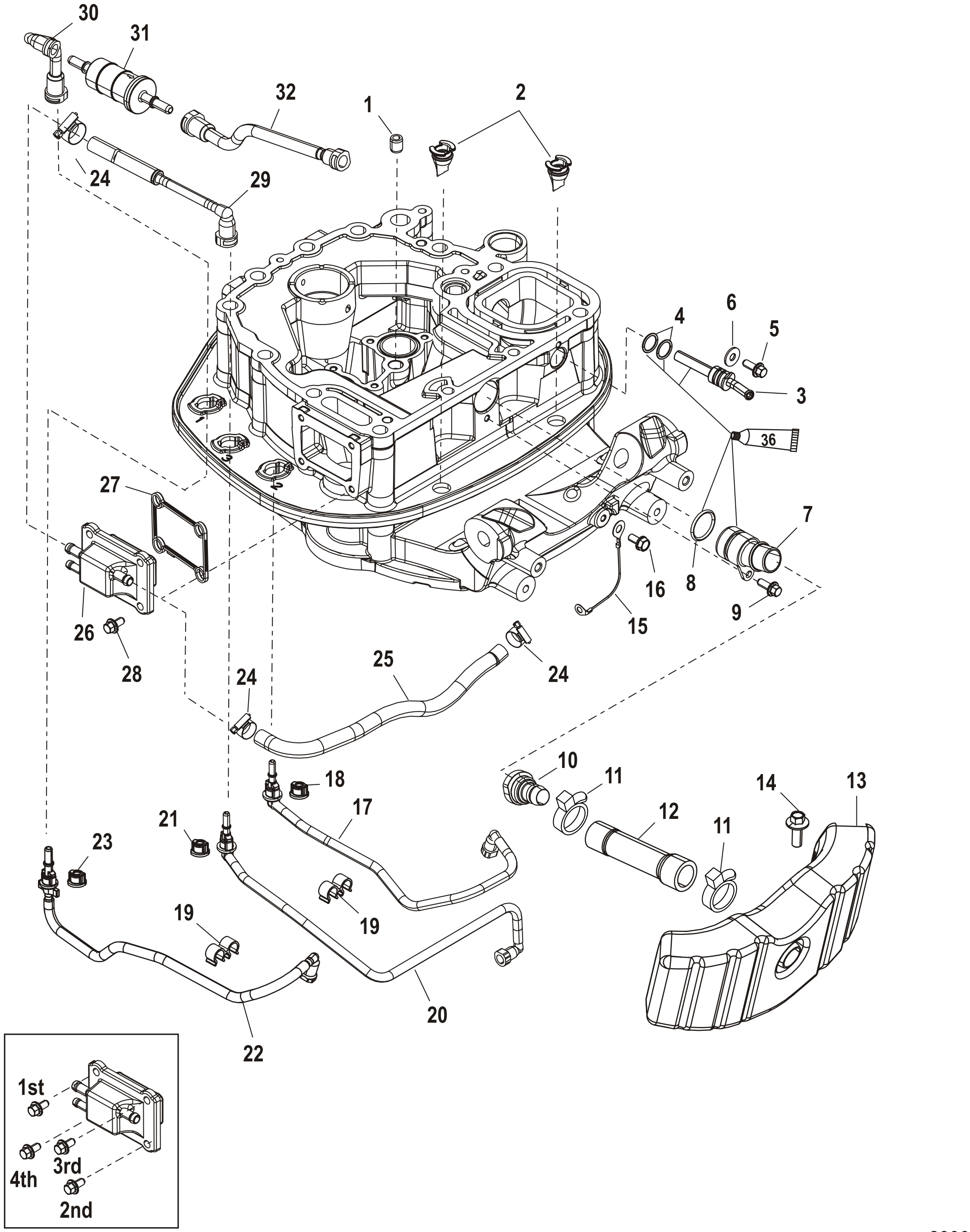
Adapter Plate - Lower Components



Adapter Plate - Lower Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Oil pickup			
2	1	O-ring (1.239 x 0.070)			
3	3	Screw (M6 x 25)	10	88	
4	1	Oil sump gasket			
5	1	Exhaust tube			
6	4	Screw (M8 x 35)	34		25
7	1	Exhaust tube seal			
8	1	Oil sump			
9	12	Screw (M6 x 20)	15	133	
10	1	Oil drain tube			
11	2	O-ring			
12	1	Dowel pin			
13	1	Oil drain plug	10	88	
14	1	Drain plug seal			
15	1	Screw (M6 x 20)	10	88	
16	1	Water tube assembly			
17	1	O-ring			
18	1	Coupling			
19	1	O-ring (0.921 x 0.139)			
20	1	O-ring (0.796 x 0.139)			
21	1	Poppet assembly			
22	1	Spring			
23	1	Retainer			
24	1	Diaphragm			
25	1	Washer			
26	1	Screw (10-16 x 0.75 in.)			
27	1	Poppet cover			
28	1	Poppet gasket			
29	2	Screw	5	44	

Adapter Plate Hose Routings Components

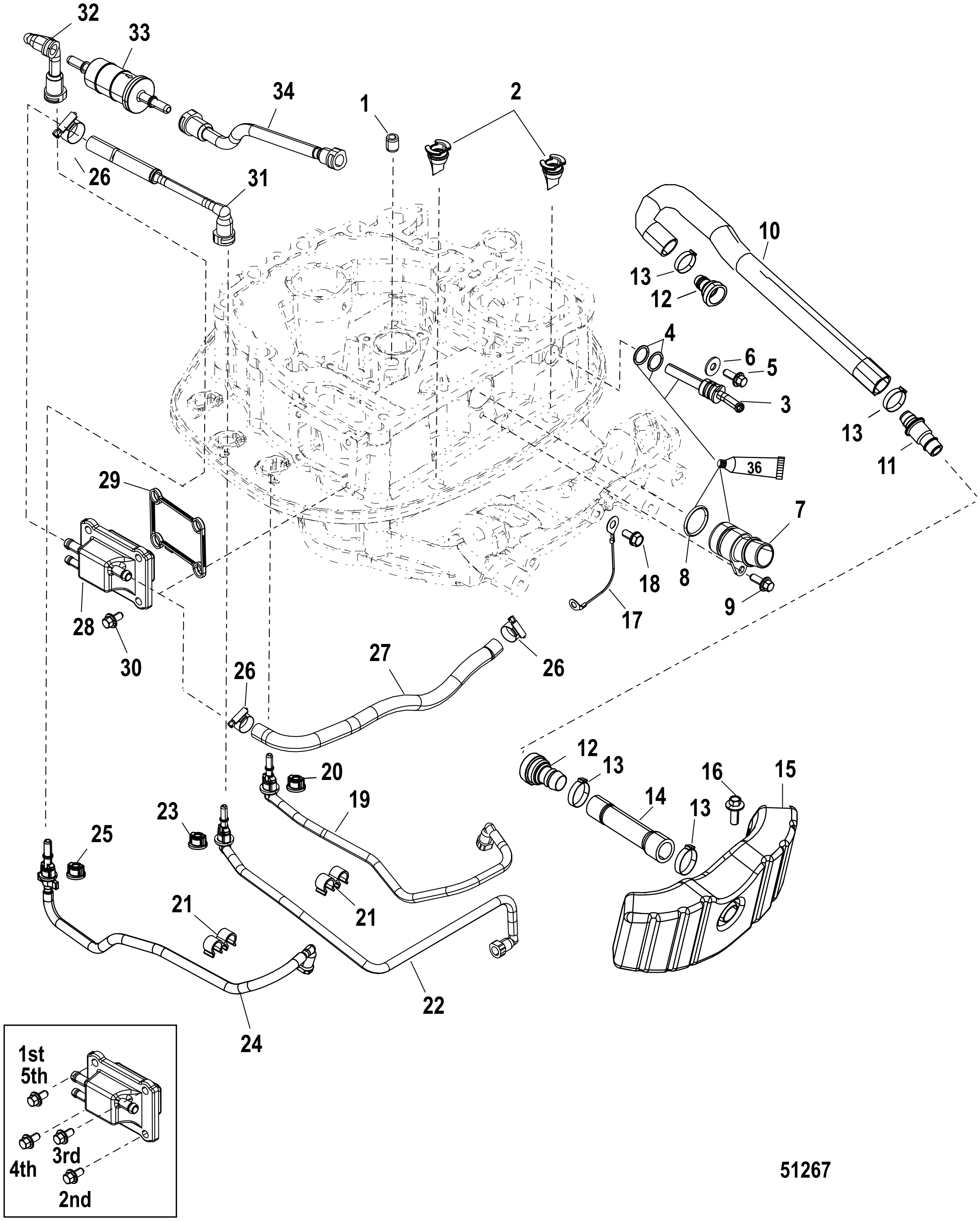


Adapter Plate Hose Routings Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Dowel pin (12 mm)			
2	2	Cowl drain			
3	1	Fitting kit			
4	2	O-ring			
5	1	Screw (M6 x 12)	6	53	
6	1	Washer			
7	1	Idle exhaust fitting kit			
8	1	O-ring (0.924 x 0.103)			
9	1	Screw (M6 x 12)	6	53	
10	1	Fitting			
11	2	Cable tie (8 in.)			
12	1	Idle exhaust hose			
13	1	Exhaust plenum			
14	2	Screw (M6 x 16)	6	53	
15	1	Cable			
16	1	Screw (M6 x 13)	8	70	
17	1	Manifold reference hose (lower)			
18	1	Grommet			
19	2	Clip			
20	1	Water in hose (lower)			
21	1	Grommet			
22	1	FSM hose (out)			
23	1	Grommet			
24	3	Worm gear clamp			
25	1	Tubing (0.312 ID) (53 cm [21 in.])			
26	1	Manifold housing			
27	1	Seal			
28	4	Screw (M6 x 16)	Hand start and drive 1st screw snug. Drive remaining 3 screws in "X" pattern sequence to 6 Nm (53 lb-in.). Return to 1st screw and drive to torque.		
29	1	Water in hose (upper)			
30	1	High-pressure filter hose (PRE)			
31	1	High-pressure filter			
32	1	High-pressure filter to fuel rail hose (POST)			

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	O-rings	Obtain Locally

CCT Adapter Plate Hose Routings Components

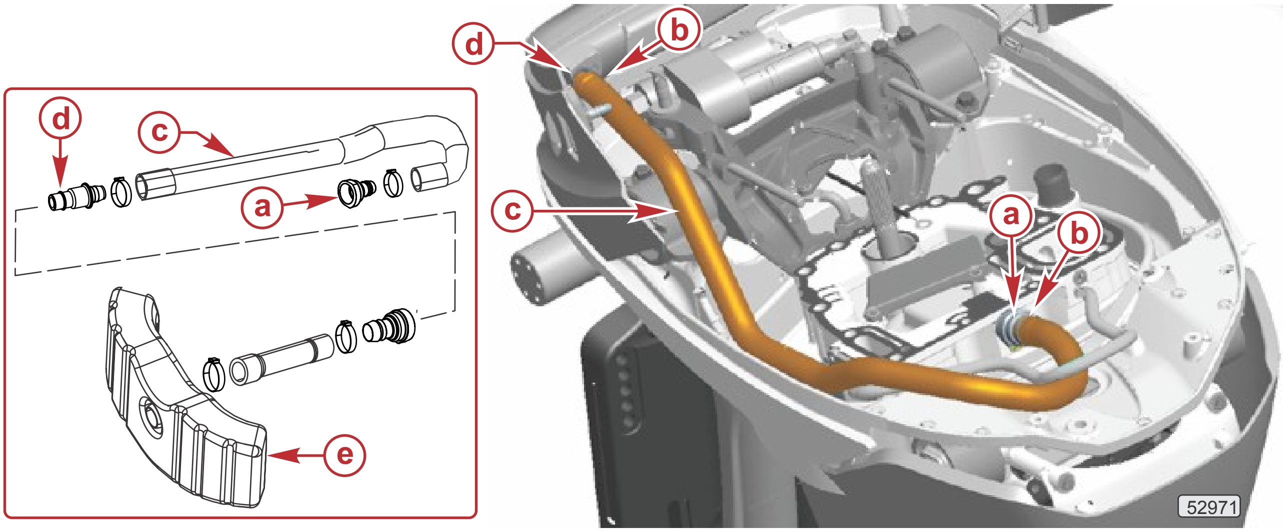


CCT Adapter Plate Hose Routings Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Dowel pin (12 mm)			
2	2	Cowl drain			
3	1	Fitting kit			
4	2	O-ring			
5	1	Screw (M6 x 12)	6	53	–
6	1	Washer			
7	1	Idle exhaust fitting kit			
8	1	O-ring (0.924 x 0.103)			
9	1	Screw (M6 x 12)	6	53	–
10	1	Idle exhaust hose			
11	1	7/8 in. quick disconnect fitting			
12	2	Fitting			
13	4	Clamp			
14	1	Idle exhaust hose			
15	1	Exhaust plenum (remotely located)			
16	2	Screw (M6 x 16)	6	53	–
17	1	Ground cable			
18	1	Screw (M6 x 13)	8	71	–
19	1	Manifold reference hose (lower)			
20	1	Grommet			
21	2	Clip			
22	1	Water in hose (lower)			
23	1	Grommet			
24	1	FSM hose (out)			
25	1	Grommet			
26	3	Worm gear clamp			
27	1	Tubing (0.312 ID) (53 cm [21 in.])			
28	1	Manifold housing			
29	1	Seal			
30	4	Screw (M6 x 16)	Hand start and drive 1st screw snug. Drive remaining 3 screws in "X" pattern sequence to 6 Nm (53 lb-in.). Return to 1st screw and drive to torque.		
31	1	Water in hose (upper)			
32	1	High-pressure filter hose (PRE)			
33	1	High-pressure filter			
34	1	High-pressure filter to fuel rail hose (POST)			

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	O-rings	Obtain Locally

CCT Idle Exhaust Relief Hose Routing



- **a -** Quick disconnect fitting
- **b -** Clamp
- **c -** Idle exhaust relief hose
- **d -** Quick disconnect fitting
- **e -** Exhaust plenum - remotely mounted

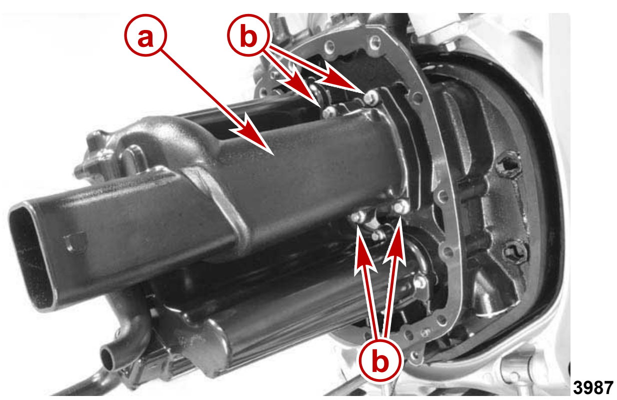
Adapter Plate Disassembly

Preparing Outboard for Adapter Plate Disassembly

1. Remove the powerhead. Refer to **Section 4A** - **Dressed Powerhead Removal/Installation**.
2. Remove the driveshaft housing. Refer to **Section 5A** - **Mid-Section Disassembly**.

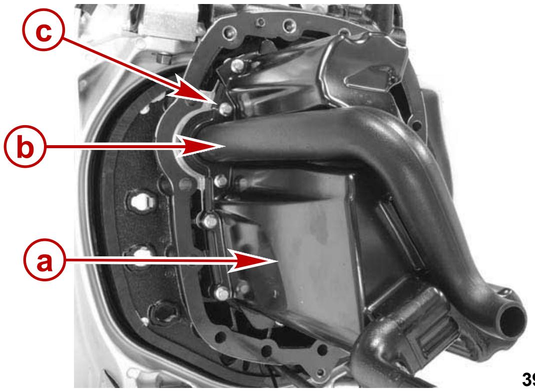
Exhaust Tube and Oil Sump

1. Tilt the outboard to the up position. Engage the tilt lock.
2. Remove the four screws securing the exhaust tube to the adapter plate. Remove the exhaust tube.



- **a -** Exhaust tube
- **b -** Mounting screw

3. Remove the 12 screws securing the oil sump to the adapter plate. Remove the oil sump.



3988

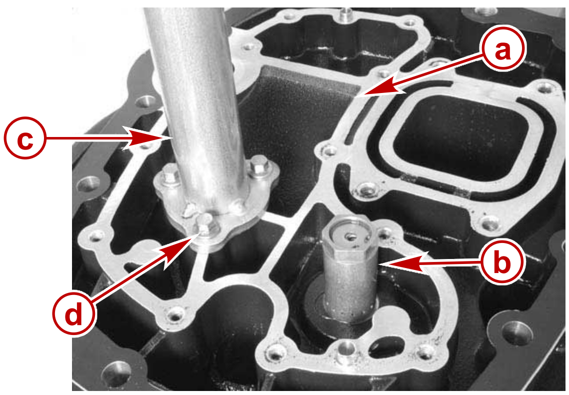
a - Oil sump
b - Water pickup tube
c - Mounting screw (12)

Adapter Plate

For removal of the adapter plate, refer to **Removing from Mount Cradle** in this section.

Lower Components

1. Tilt the outboard to the up position. Engage the tilt lock.
2. Remove the oil pump pressure relief valve.
   IMPORTANT: Use a socket or box end wrench to remove and install the valve. Using an open end wrench may damage the valve.
3. Remove the three screws securing the oil pickup tube. Remove the oil pickup tube.



4003

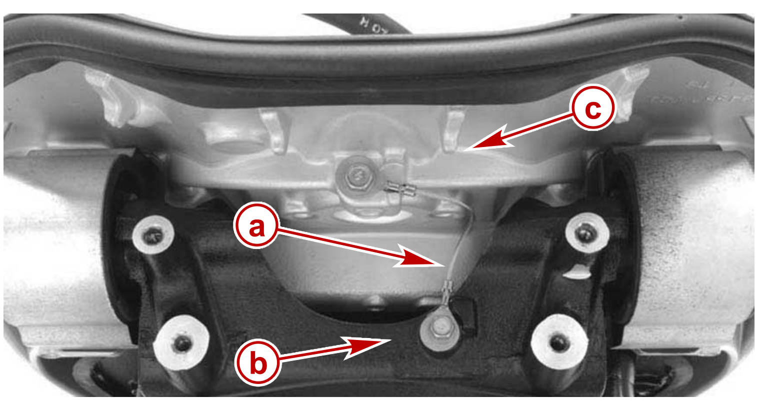
a - Adapter plate
b - Pressure relief valve
c - Oil pickup tube
d - Screw (3)

4. Disengage the tilt lock. Trim the outboard down.
5. Thoroughly clean the adapter plate cavities and passages.
6. Clean both the upper and lower adapter plate surfaces. Remove the old gasket material from the surfaces.

NOTE: If the outboard is disassembled due to powerhead removal, inspect and thoroughly clean the adapter plate surfaces and internal passages. It is not necessary to remove the adapter plate from the mount cradle.

Removing from Mount Cradle

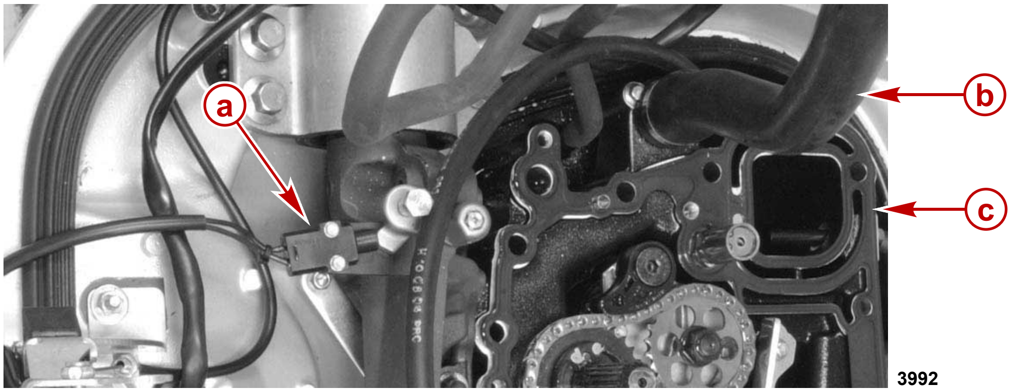
1. Remove the ground strap from the adapter plate.



3991

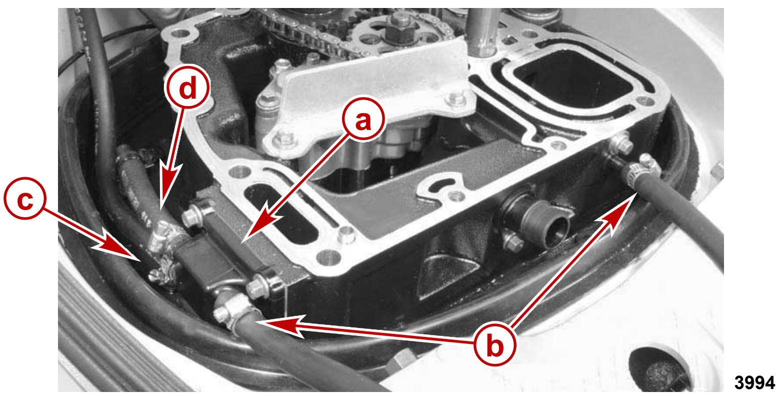
a - Ground strap
b - Adapter plate
c - Rear mount cradle

2. Remove the neutral start switch from the front mount bracket. Remove the dump hose and gasket from the adapter plate.



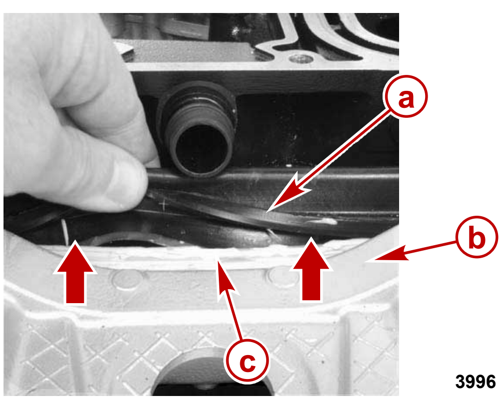
a - Neutral start switch
b - Dump hose
c - Gasket

3. Remove the water hoses from the water strainer and adapter plate.



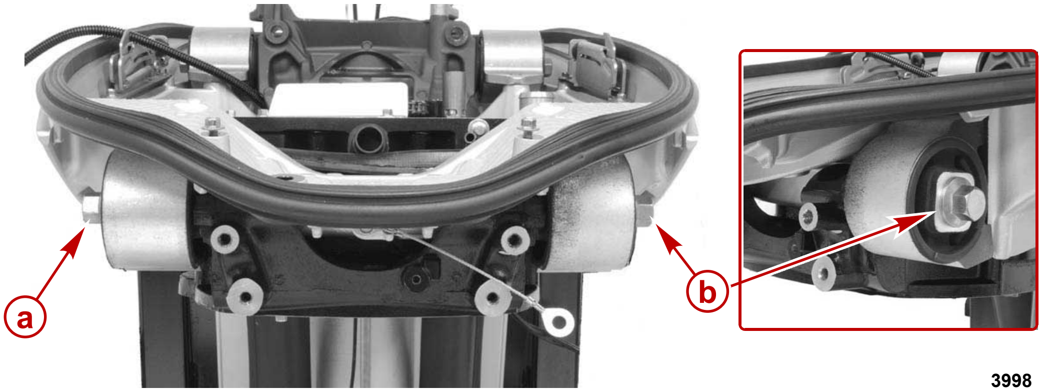
a - Water strainer
b - Evaporative cooling water supply hose
c - Tell-tale hose
d - FSM cooling water supply hose (blue tab)

4. Break loose the adapter plate to mount cradle rubber seal. The rubber seal is glued in place with a silicone type adhesive. Start at the rear and work around the adapter plate until the seal is completely loose from the mount cradle.
IMPORTANT: Do not damage or remove the paint from either surface when removing the seal.
NOTE: It may be necessary to use a pry bar to loosen the adapter plate seal or, in extreme cases, it may be necessary to cut the seal to remove. Carefully remove all adhesive and seal material from the adapter plate and mount cradle.



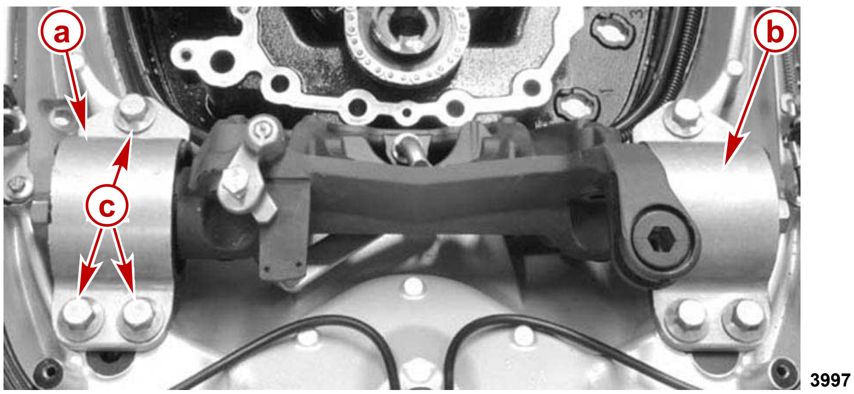
a - Seal
b - Mount cradle
c - Adhesive sealant

5. Remove the screw attaching the port and starboard rear motor mounts to the adapter plate.



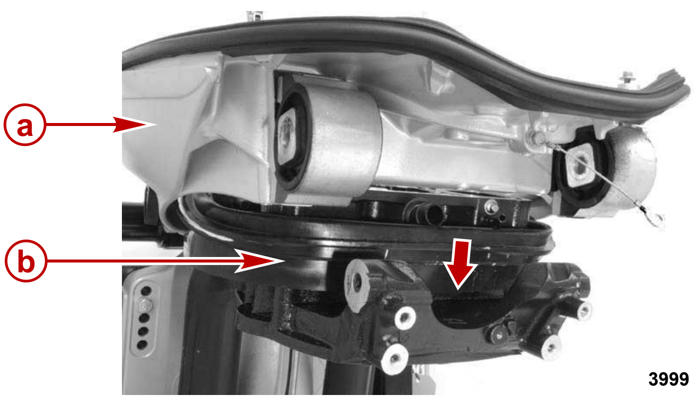
a - Port rear motor mount screw
b - Starboard rear motor mount screw

6. Remove the six screws securing the front motor mounts to the bracket.



a - Starboard front motor mount
b - Port front motor mount
c - Mounting screw (3 each mount)

7. Remove the adapter plate by pivoting the adapter plate down through the opening in the mount cradle.

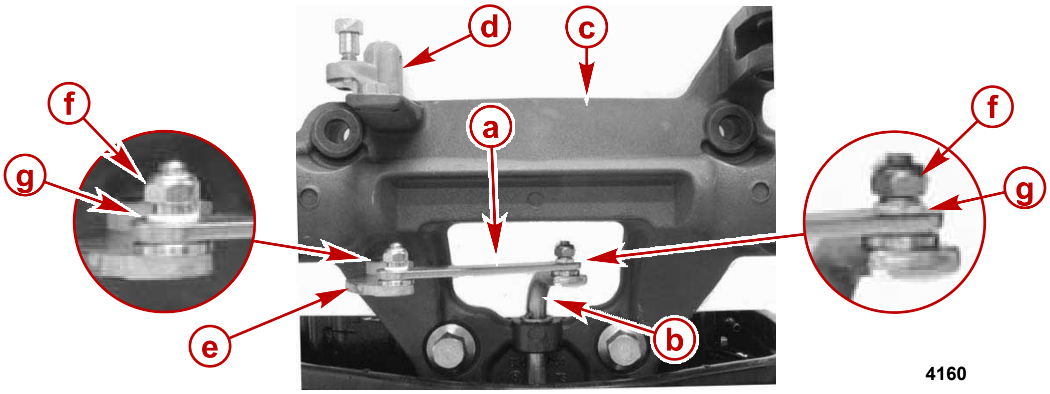


a - Mount cradle
b - Adapter plate

Front Bracket Disassembly

1. Remove the nuts from the shift shaft and lower bell crank.
2. Remove the shift shaft link.
3. Remove the shift shaft.

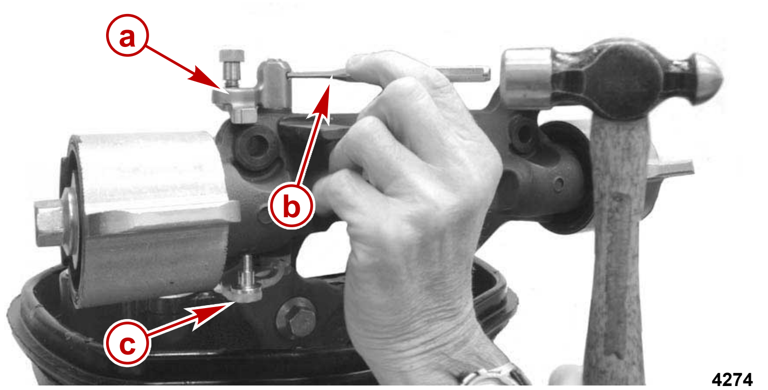
4. Inspect the bushings for wear or damage.



4160

a - Shift shaft link
b - Shift shaft
c - Front bracket
d - Upper bell crank
e - Lower bell crank
f - Nut (2)
g - Bushing (2)

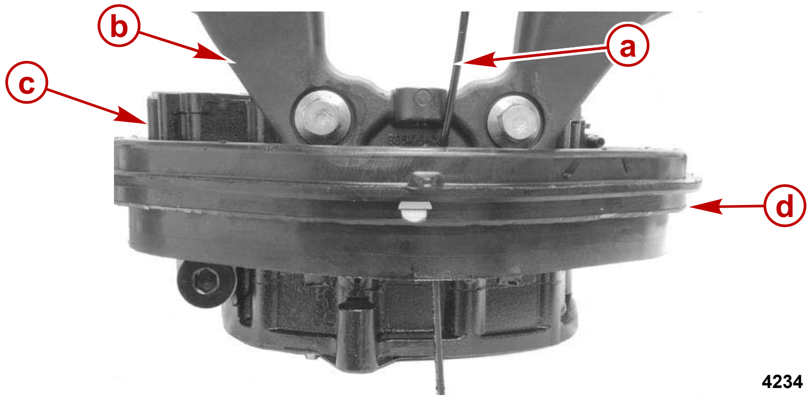
5. Remove the roll pin from the upper bell crank using a drift punch.
6. Remove the upper and lower bell cranks from the front bracket.



4274

a - Upper bell crank
b - Drift punch
c - Lower bell crank

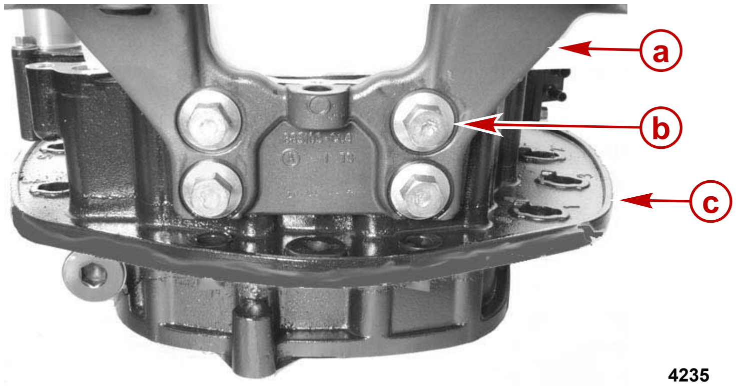
7. Remove the speedometer tube.
8. Remove the seal.



4234

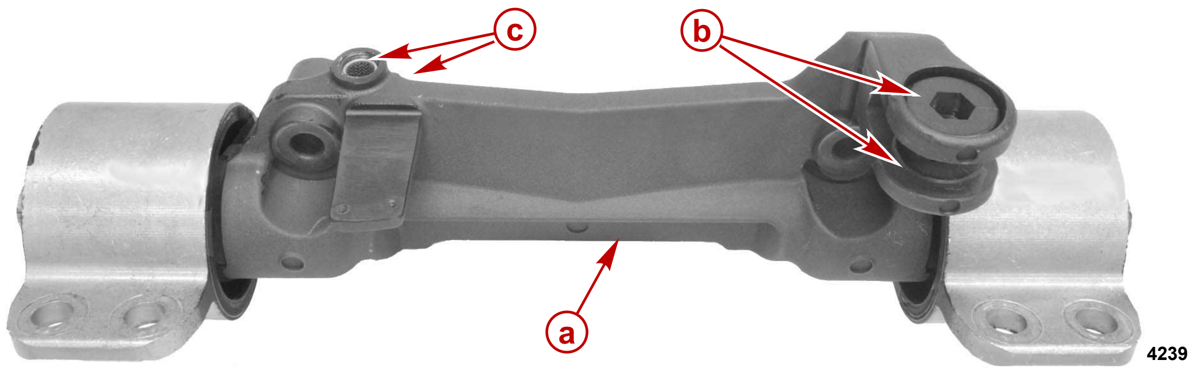
a - Speedometer tube
b - Front bracket
c - Adapter plate
d - Seal

9. Remove the four screws securing the front motor mounts to the adapter plate.



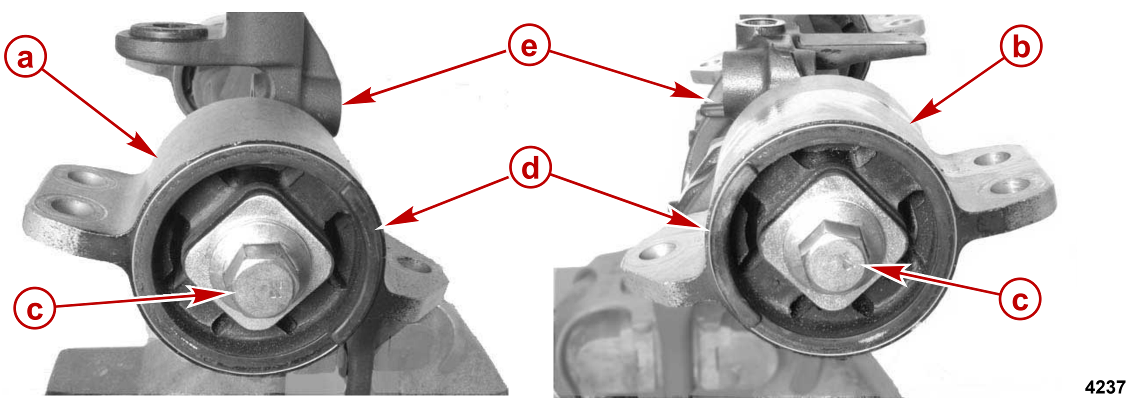
a - Front motor mount
b - Mounting screw (4)
c - Adapter plate

10. Inspect the pivot pin grommets and bell crank bushings for wear or damage. Replace if required.



a - Front bracket
b - Pivot pin grommet (2)
c - Bell crank bushing (2)

11. Remove the screw attaching the port front motor mount to the bracket. Remove the port front motor mount.
12. Remove the screw attaching the starboard front motor mount to the bracket. Remove the starboard front motor mount.

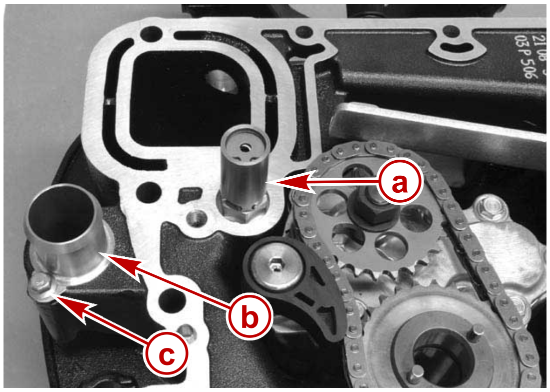


a - Port front motor mount
b - Starboard front motor mount
c - Motor mount screw
d - Notch on motor mounts
e - Front bracket

Upper Components

NOTE: The cooling jet check valve is used only on engine models S/N 1B517433 and below. Engine models S/N 1B517434 and above do not have oil cooling jets. A plug is installed on these models in place of the oil cooling jet check valve.

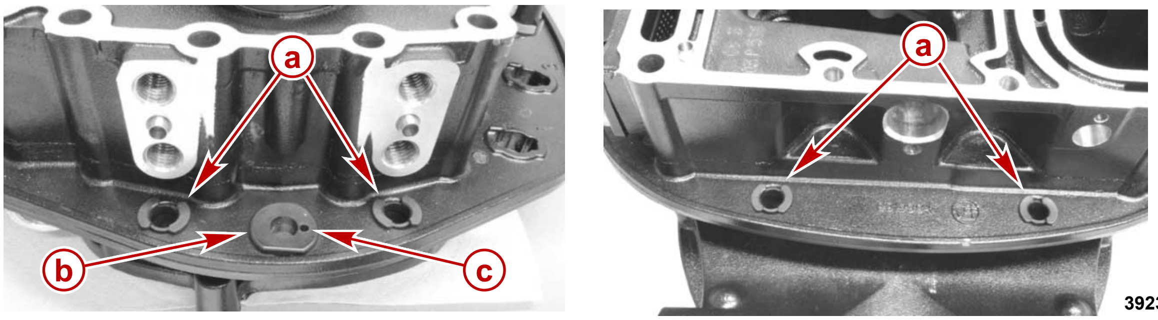
1. Remove the cooling jet check valve from the adapter plate.
   IMPORTANT: Use a socket or box end wrench to remove and install the valve. Using an open end wrench may damage the valve.
2. Remove the dump fitting from the adapter plate.



3926

a - Cooling jet check valve (S/N 1B517433 and below)
b - Dump fitting
c - Mounting screw

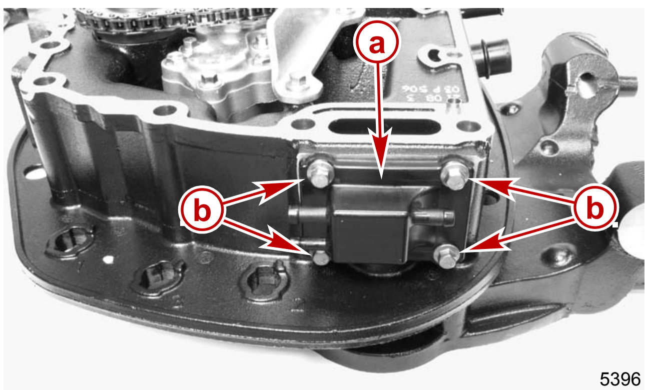
3. Remove the four cowl drain check valves from the adapter plate.
4. Remove the upper shift shaft grommet from the adapter plate.



3923

a - Cowl drain check valves
b - Shift shaft grommet
c - Speedometer tube hole

5. Remove the water strainer with the seal and four mounting screws.

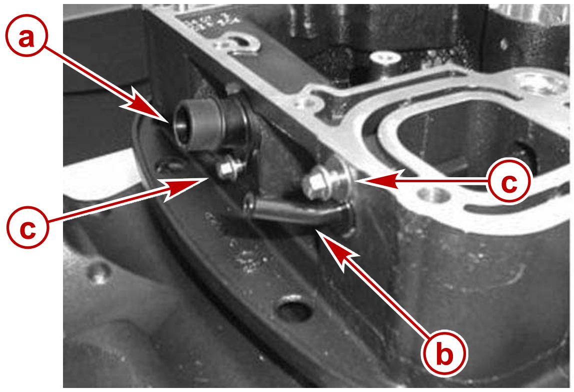


5396

a - Water strainer
b - Mounting screws

6. Remove the screw and washer securing the evaporative cooling fitting. Remove the evaporative cooling fitting.

7. Remove the screw securing the idle relief fitting. Remove the idle relief fitting.



3916

a - Idle relief fitting
b - Evaporative cooling fitting
c - Mounting hardware

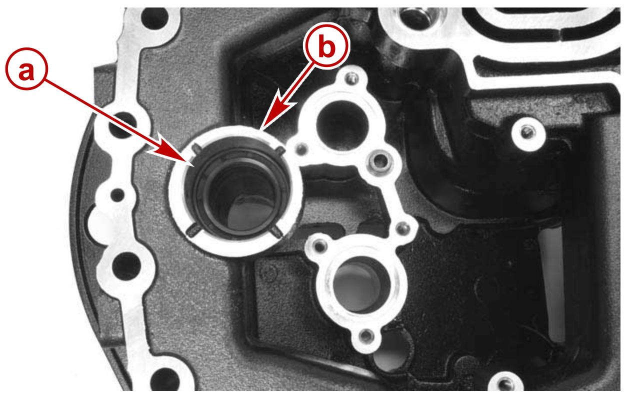
8. Clean the adapter plate surfaces. Do not damage the gasket surfaces when cleaning.

Oil Pump

Remove the oil pump. Refer to **Section 4C** - **Oil Pump Removal**.

Driveshaft Seals

Remove the three driveshaft seals in the oil pump drive gear hub cavity.



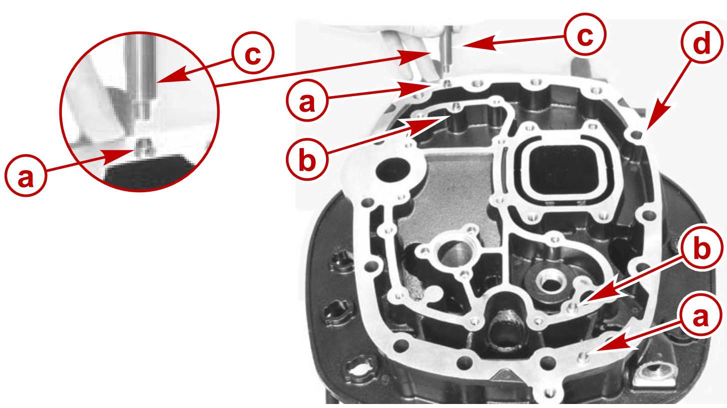
4275

a - Driveshaft seal (3)
b - Oil pump drive gear hub cavity

Adapter Plate Reassembly

Dowel Pins and Plugs

1. Install the two oil sump and two driveshaft housing dowel pins in the bottom side of the adapter plate.

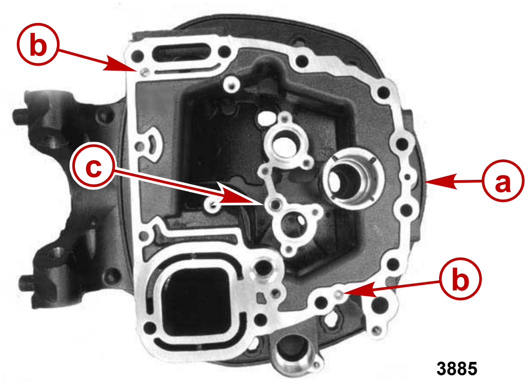


3884

a - Driveshaft housing dowel pin
b - Oil sump housing dowel pin
c - Dowel pin installation tool
d - Bottom side of adapter plate

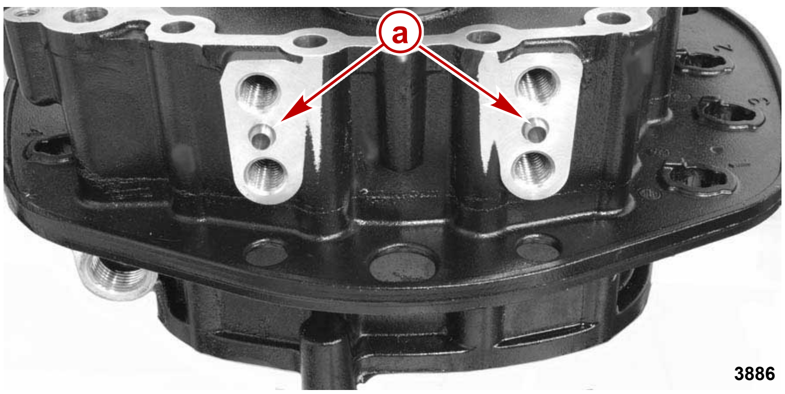
2. Assemble the two powerhead to adapter plate dowel pins to the top side.
3. Install the oil pump dowel pin until it bottoms in the bore. Measure the exposed length of the dowel pin to ensure it is installed to the correct depth.

Dowel Pin	
Maximum exposed height	6.0 mm (0.236 in.)



a - Top side of adapter plate
b - Engine block dowel pin
c - Oil pump dowel pin

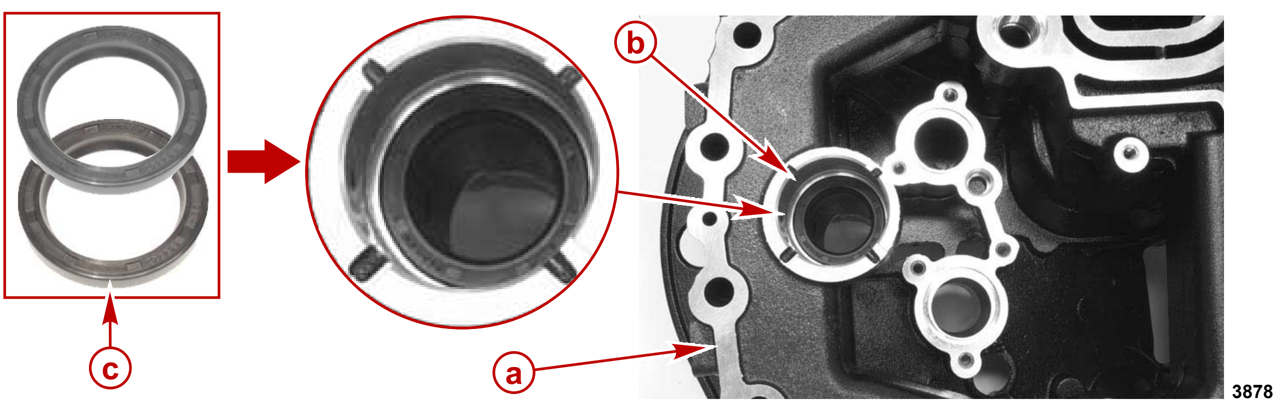
4. Assemble the two front mount bracket dowel pins.



a - Front mount bracket dowel pin

Driveshaft Seals

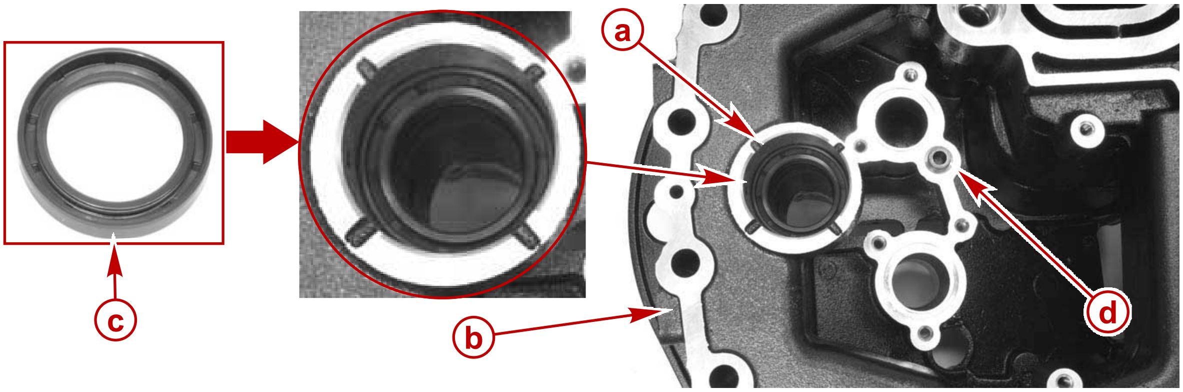
1. Lubricate the two water seals with 4-Stroke Outboard Oil. Install the two water seals, spring side down, into the oil pump drive gear hub bore. Press the seals into the bore until seated.



a - Adapter plate
b - Oil pump drive gear hub cavity
c - Water seals (spring side down)

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Water seals	92-858052K01

2. Lubricate the oil seal with 4-Stroke Outboard Oil. Install the oil seal, spring side up, into the oil pump drive gear hub cavity. Press the seal into the bore until it reaches the top ridge.



3880

a - Oil pump drive gear hub cavity
b - Adapter plate
c - Oil seal (spring side up)
d - Oil pump dowel pin

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil seals	92-858052K01

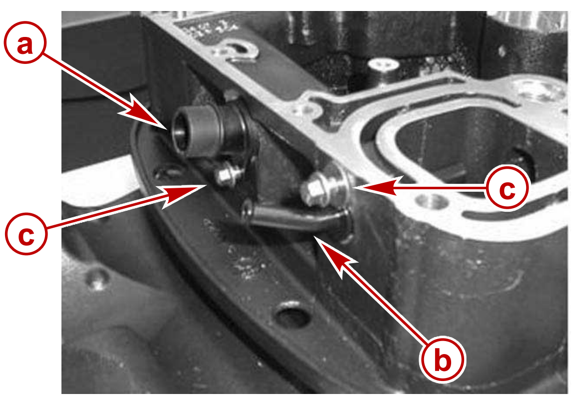
Oil Pump

Install the oil pump. Refer to **Section 4C** - **Oil Pump Installation**.

Upper Components

NOTE: Lightly lubricate the O-rings and grommets before installation.

1. Install the evaporative cooling fitting with an O-ring, washer, and screw. Apply Loctite 242 Threadlocker to the screw threads. Tighten the screw to the specified torque.
2. Install the idle relief fitting with an O-ring and screw. Apply Loctite 242 Threadlocker to the screw threads. Tighten the screw to the specified torque.



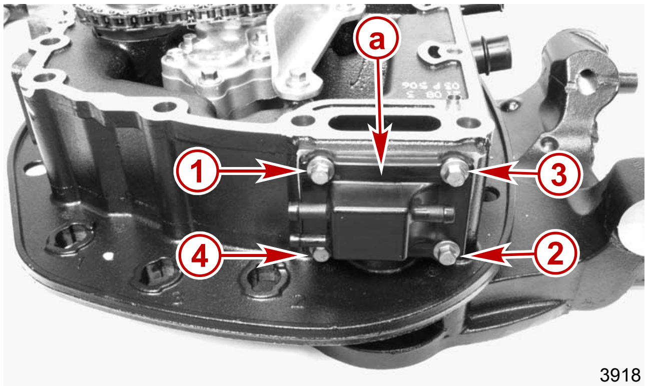
3916

a - Idle relief fitting
b - Evaporative cooling fitting
c - Mounting hardware

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Idle relief fitting mounting screw threads and evaporative cooling fitting mounting screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
Evaporative cooling fitting screw	6	53	
Idle relief fitting screw	6	53	

3. Install the water strainer with a seal and four screws. Apply Loctite 242 Threadlocker to the screw threads. Tighten the screws in sequence to the specified torque.

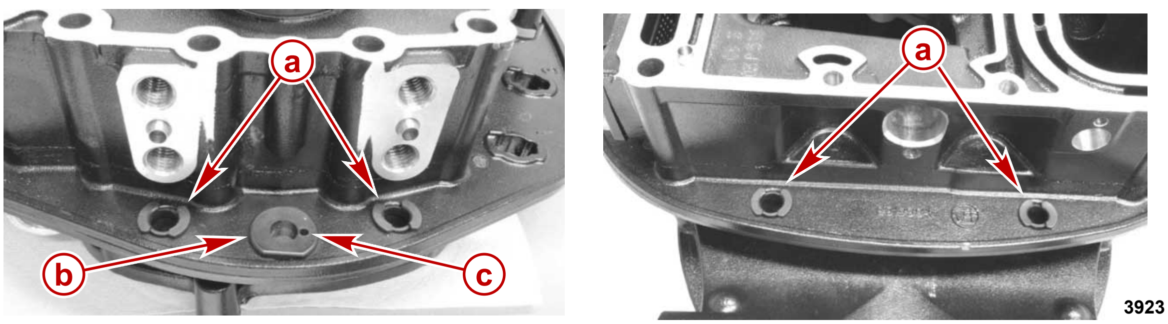


a - Water strainer

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Water strainer mounting screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
Water strainer screw - drive 1st screw snug. Drive remaining three screws in specified pattern sequence to specified torque. Return to 1st screw and drive to specified torque.	6	53	

4. Install the four cowl drain check valves into the adapter plate.
5. Install the upper shift shaft grommet into the adapter plate.

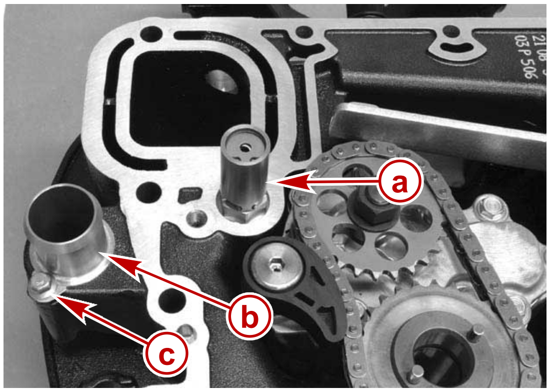


a - Cowl drain check valves
b - Shift shaft grommet
c - Speedometer tube hole

NOTE: The cooling jet check valve is used only on engine models S/N 1B517433 and below. Engine models S/N 1B517434 and above do not have oil cooling jets. A plug is installed on these models in place of the oil cooling jet check valve.

6. Install the cooling jet check valve with a lubricated O-ring into the adapter plate.
IMPORTANT: Use a socket or box end wrench to remove and install the valve. Using an open end wrench may damage the valve.

7. Install the dump fitting with a lubricated O-ring and screw into the adapter plate. Apply Loctite 242 Threadlocker to the screw threads. Tighten the screw to the specified torque.



3926

a - Cooling jet check valve (S/N 1B517433 and below)
b - Dump fitting
c - Mounting screw

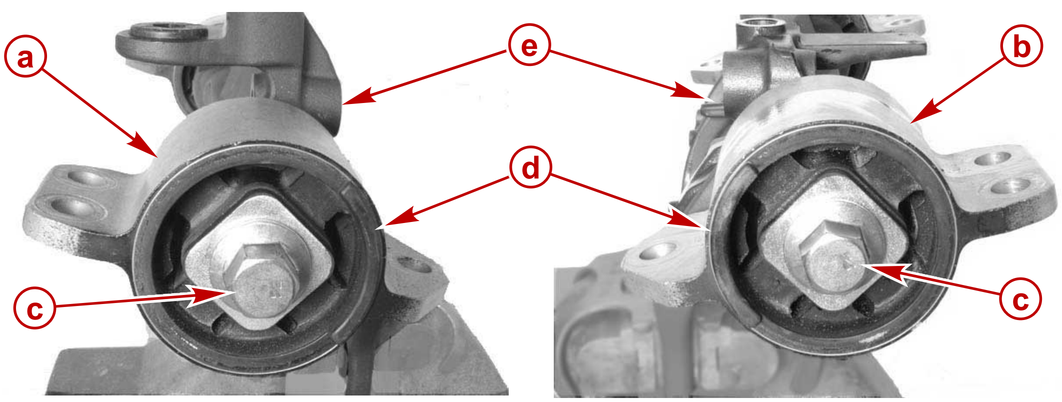
Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Cooling jet check valve and dump fitting O-rings	92-858052K01
66	Loctite 242 Threadlocker	Dump fitting mounting screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
Cooling jet check valve	40		29.5
Dump fitting mounting screw	6	53	

Front Bracket Reassembly

Motor Mounts

1. Clean the threads and flat surface of the front bracket.
2. Place the port motor mount on the front bracket with the notch facing aft. Place a small amount of Loctite 271 Threadlocker on the motor mount screw threads. Install the screw attaching the port front motor mount to the bracket. Tighten the motor mount screw to the specified torque.
3. Place the port motor mount on the front bracket with the notch facing aft. Place a small amount of Loctite 271 Threadlocker on the motor mount screw threads. Install the screw attaching the starboard front motor mount to the bracket. Tighten the motor mount screw to the specified torque.



4237

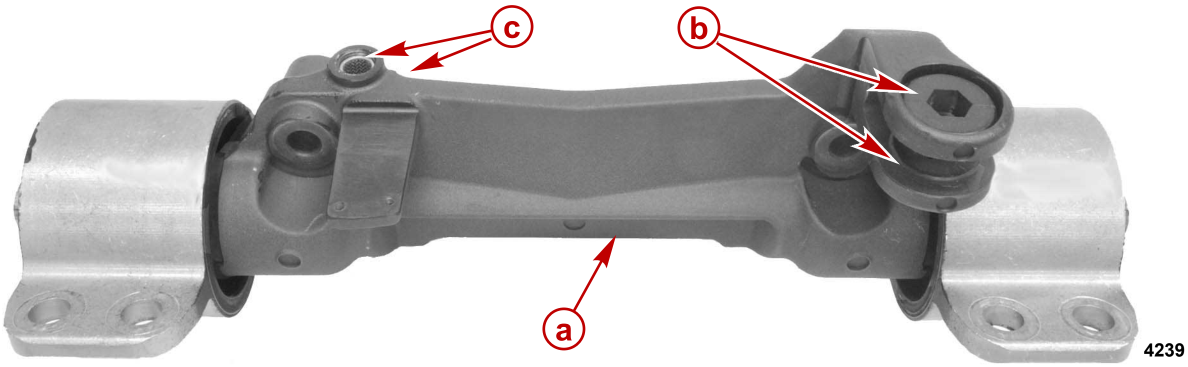
a - Port front motor mount
b - Starboard front motor mount
c - Motor mount screw
d - Notch on motor mounts
e - Front bracket

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Front motor mount screw threads	92-809819

Description	Nm	lb. in.	lb. ft.
Front motor mount screw	225		166

Grommets and Bushings

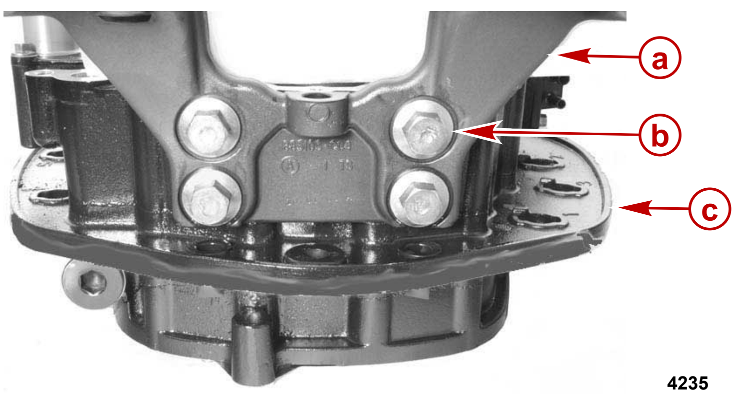
Inspect the pivot pin grommets and bell crank bushings for wear or damage. Replace if required.



- a - Front bracket
- b - Pivot pin grommet (2)
- c - Bell crank bushing (2)

Mounting

1. Clean the old adhesive from the adapter plate flange.
2. Apply a small amount of Loctite 242 Threadlocker to the screw threads. Install the four mounting screws attaching the front motor mounts to the adapter plate. Tighten the mounting screws to the specified torque.



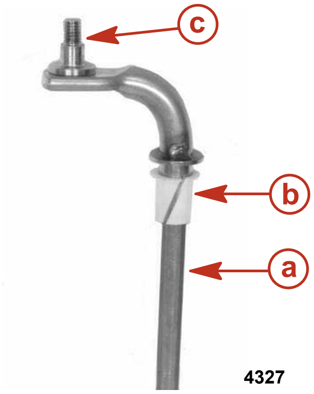
- a - Front motor mount
- b - Mounting screw (4)
- c - Adapter plate

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Front motor mount screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
Front bracket mounting screws	185		136.4

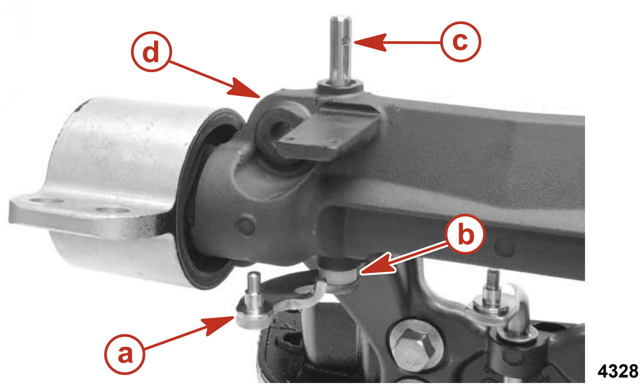
Shift Components

1. Install the bushing onto the shift shaft. Install the shift shaft down through the support and grommet in the front bracket.



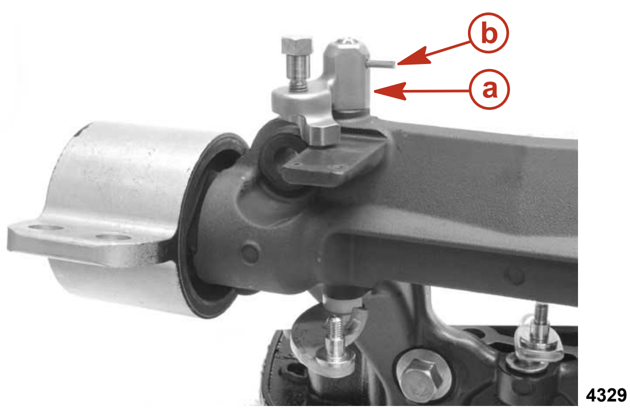
a - Shift shaft
b - Bushing
c - Link stud

2. Install the bushing on the lower bell crank shaft. Install the lower bell crank up through the bore in the front bracket.



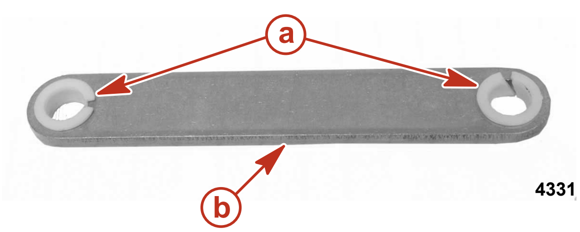
a - Lower bell crank
b - Lower bell crank bushing
c - Lower bell crank shaft
d - Front bracket

3. Install the upper bell crank. Align the splines so the hole in the lower bell crank shaft and the hole in the upper bell crank are in line. Ensure the upper and lower bell cranks are positioned as shown. Install the roll pin through the upper bell crank.



a - Upper bell crank
b - Roll pin

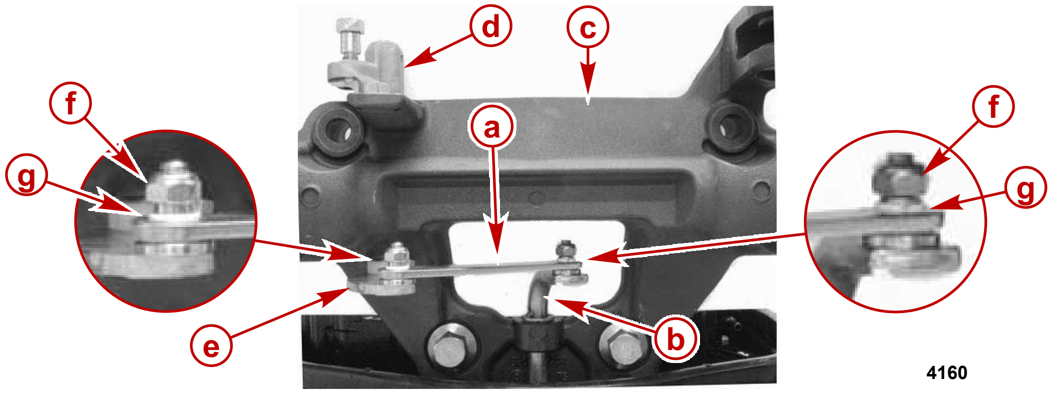
4. Install the bushings into the shift shaft link.



a - Link bushing (2)
b - Link

5. Install the shift shaft link onto the shift shaft and lower bell crank studs.

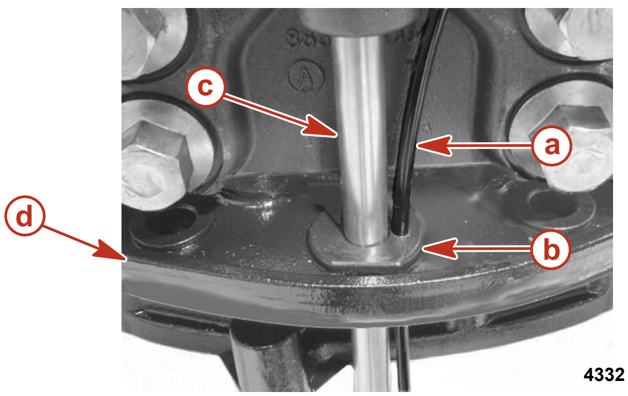
6. Install a nut on each lower bell crank stud and shift shaft stud. Tighten the nut to the specified torque.



a - Shift shaft link
b - Shift shaft
c - Front bracket
d - Upper bell crank
e - Lower bell crank
f - Nut (2)
g - Bushing (2)

Description	Nm	lb. in.	lb. ft.
Shift shaft link nut	6	53	

7. Install the speedometer tube through the small hole in the shift shaft grommet.

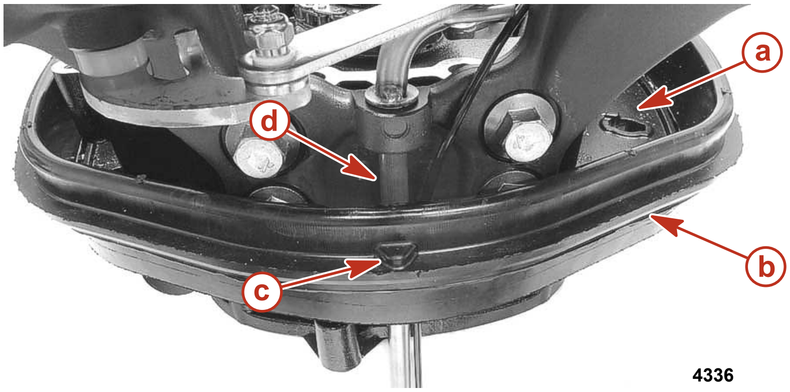


a - Speedometer tube
b - Shift shaft grommet
c - Shift shaft
d - Adapter plate

Adapter Plate to Mount Cradle Seal

1. Remove the old sealant from the edge of the adapter plate flange.
2. Slip the seal over the adapter plate.
3. Align the triangular marker on the seal with the shift shaft.

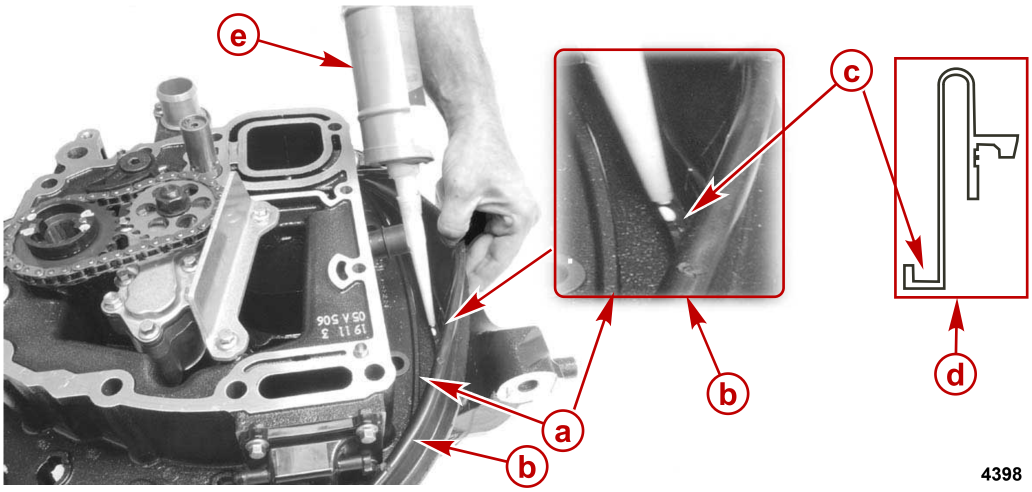
4. Pull the adapter plate seal up to the bottom side of the adapter plate flange.



4336

a - Adapter plate flange
b - Seal
c - Triangular marker
d - Shift shaft

5. Pull the seal away from the adapter plate to expose the bottom lip of the seal. Apply a 6 mm (0.250 in.) wide continuous bead of sealant on the bottom lip of the adapter plate seal.
IMPORTANT: Ensure that there are no gaps in the sealant bead.



4398

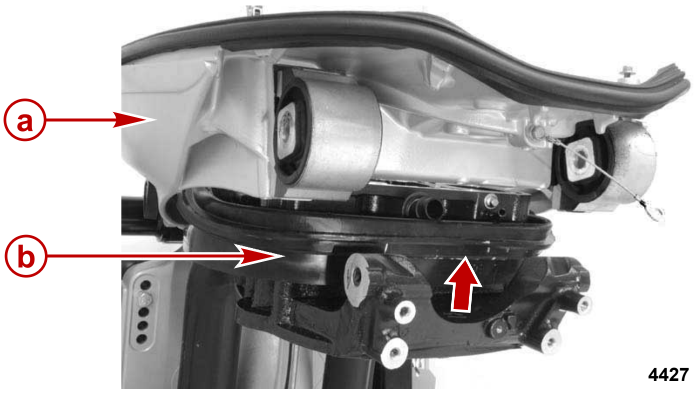
a - Adapter plate flange
b - Adapter plate seal
c - Bottom lip of adapter plate seal (apply adhesive to this surface)
d - Cross section view of seal
e - Caulk tube

Tube Ref No.	Description	Where Used	Part No.
137	Three Bond Adhesive TB-1530	Adapter plate seal	92-858006K02

6. Press the seal onto the adapter plate flange to ensure that a good bond develops between the seal and the adapter plate. Allow the sealant to cure for approximately five minutes.

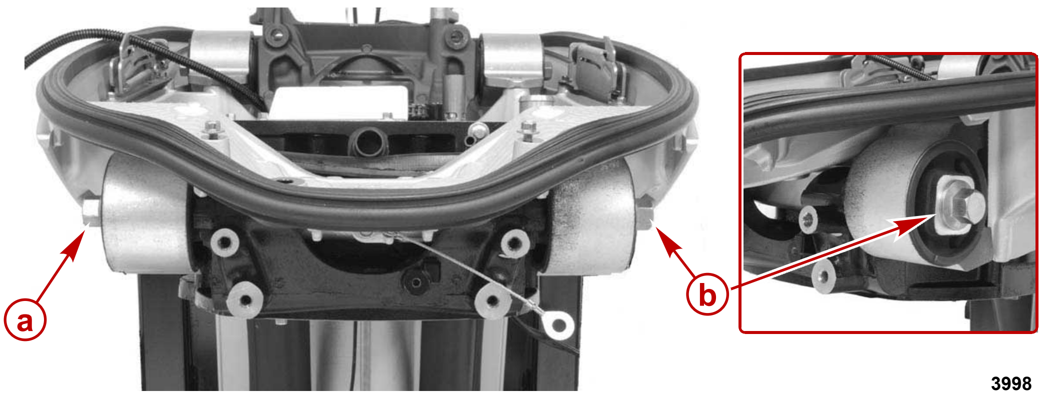
Installing in Mount Cradle

1. Install the adapter plate with the seal into the mount cradle by pivoting the adapter plate up through the opening in the mount cradle.



a - Mount cradle
b - Adapter plate

2. Apply Loctite 271 Threadlocker to the rear motor mount screw threads. Apply molybdenum disulfide grease to the underside of the flange head. Assemble the port and starboard rear motor mounts to the adapter plate. Tighten the screws to the specified torque.

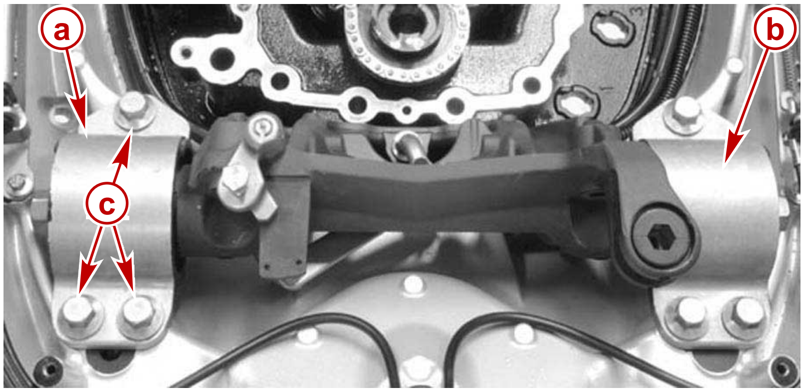


a - Port rear motor mount screw
b - Starboard rear motor mount screw

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Rear motor mount screw threads	92-809819
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Underside of flange head	Obtain Locally

Description	Nm	lb-in.	lb-ft
Rear motor mount screws (M16)	270	–	199

3. Apply Loctite 242 Threadlocker to the motor mount screw threads. Install the six screws securing the front motor mount to the bracket. Tighten the screws to the specified torque.



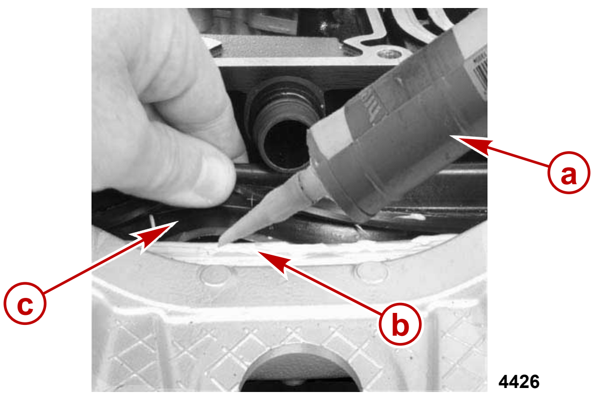
3997

a - Starboard front motor mount
b - Port front motor mount
c - Mounting screw (3 each mount)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Front motor mount screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Front motor mount screws	125	–	92

4. Lift the seal from the mount cradle flange and apply a bead of Three Bond Adhesive. Start at the rear and work around the adapter plate until the adhesive is applied completely. Press the seal in place.

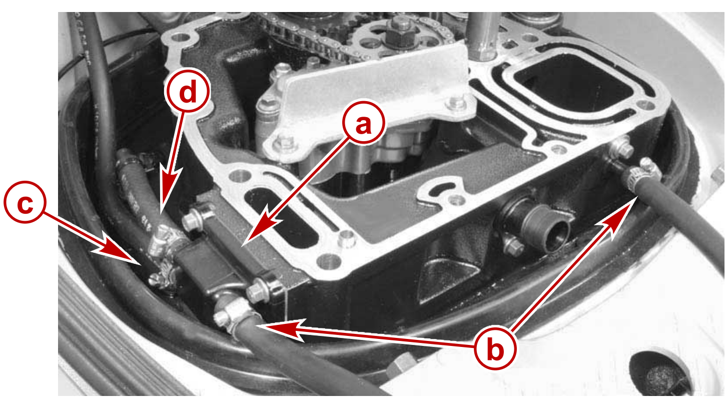


4426

a - Caulk tube
b - Mount cradle flange
c - Adapter plate seal

Tube Ref No.	Description	Where Used	Part No.
137	Three Bond Adhesive TB-1530	Adapter plate seal	92-858006K02

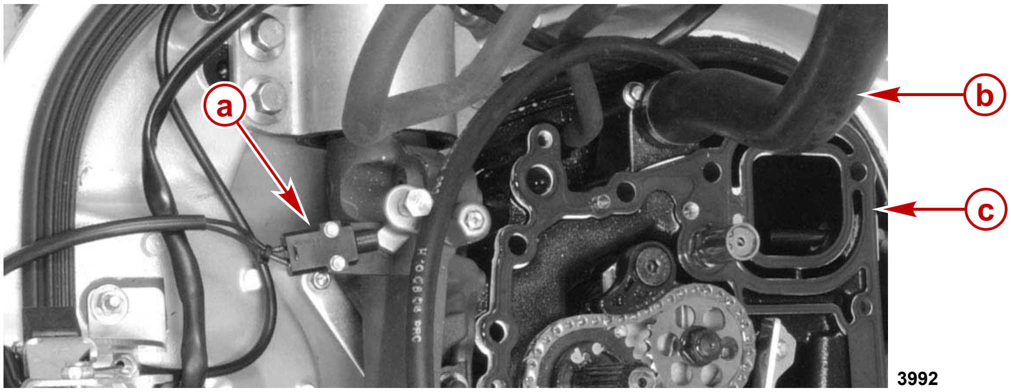
5. Install the water hoses to the water strainer and adapter plate. Tighten the hose clamps.



3994

a - Water strainer
b - Evaporative cooling water supply hose
c - Tell-tale hose
d - FSM cooling water supply hose (blue tab)

6. Install the neutral start switch to the front mount bracket. Install the dump hose and gasket to the adapter plate.

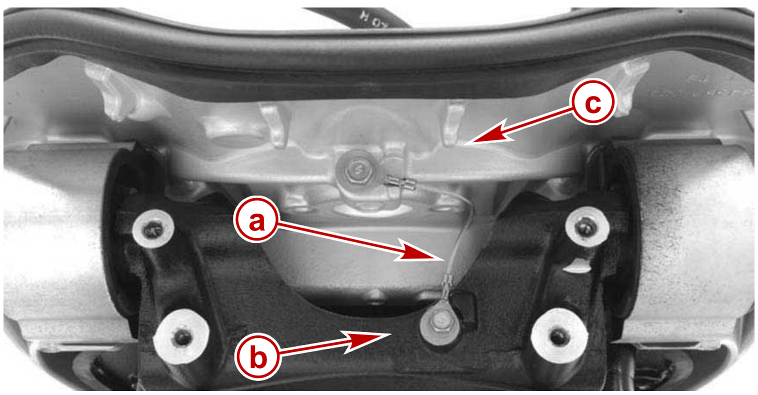


3992

a - Neutral start switch
b - Dump hose
c - Gasket

Description	Nm	lb-in.	lb-ft
Neutral start switch screws (M3 x 20)	2.3	20	–

7. Install the ground cable to the adapter plate. Tighten the screw to the specified torque.



3991

a - Ground cable
b - Adapter plate
c - Rear mount cradle

Description	Nm	lb-in.	lb-ft
Ground cable screw (M6 x 13)	8	71	–

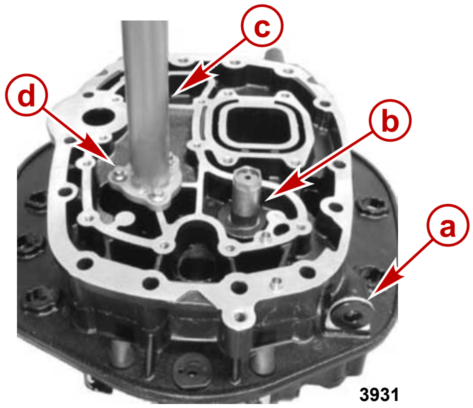
Lower Components

NOTE: Lightly lubricate O-rings and grommets before installation.

NOTE: Before installing adapter plate components, thoroughly clean mounting and gasket surfaces.

1. Install oil galley plug with washer in front of adapter plate. Tighten plug to specified torque.
2. Apply Loctite 242 to threads of the oil pickup tube screws. Assemble O-ring to oil pickup tube. Install oil pickup tube with O-ring and 3 screws. Tighten screws to specified torque.
3. Install oil pump check valve into adapter plate.

IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.



a - Oil galley plug
b - Oil pump check valve
c - Oil pick up tube
d - Oil pick up tube screws (3) (M6 x 25)

Description	Nm	lb. in.	lb. ft.
Oil galley plug	55		40.5
Oil pick up tube screws (M6 x 25)	10	88	
Oil pump check valve	40		29.5

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Oil pickup tube screws	92-809821

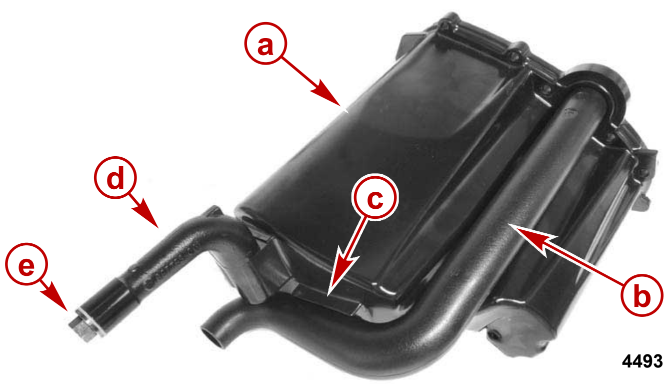
Exhaust Tube/Oil Sump

NOTE: Lightly lubricate the O-rings and grommets before installation.

1. Install the O-ring onto the water tube.

a - Water tube
b - O-ring

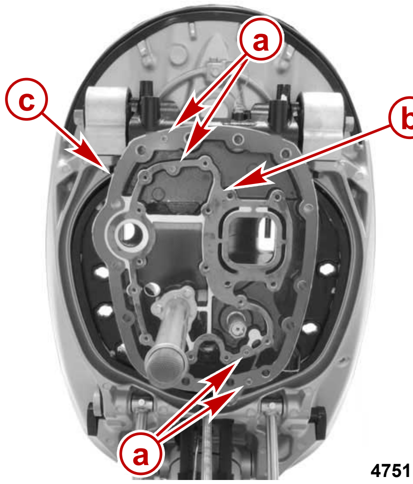
2. Assemble the water tube through the opening in the oil sump. Ensure that it locks into the mounting pad on the bottom of the sump.
3. Install the drain plug and seal washer into the drain tube.



a - Oil sump
b - Water tube
c - Mounting pad for water tube
d - Oil drain tube
e - Plug and seal

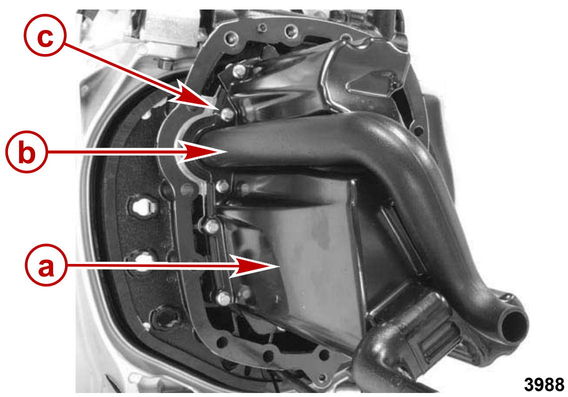
Description	Nm	lb-in.	lb-ft
Oil drain plug	10	89	–

4. Clean the gasket surface of the adapter plate and oil sump.
5. Install the oil sump gasket over the dowel pins in the adapter plate.



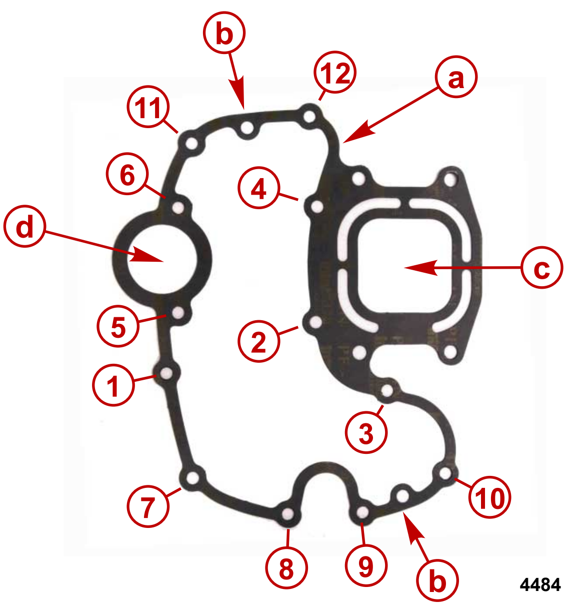
a - Dowel pins
b - Oil sump gasket
c - Driveshaft housing gasket

6. Apply Loctite 242 Threadlocker to the oil sump mounting screw threads.
7. Assemble the oil sump to the adapter plate with 12 screws.



a - Oil sump
b - Water pickup tube
c - Mounting screw (12)

8. Tighten the screws in sequence to the specified torque.

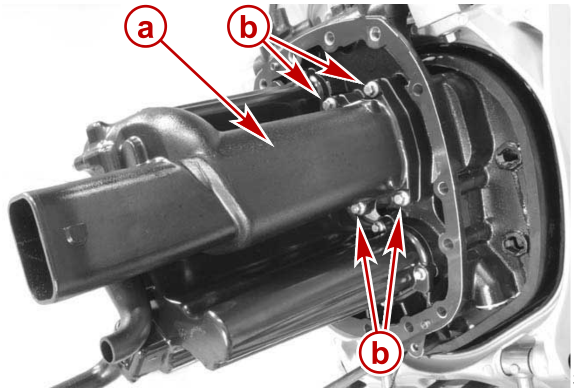


a - Oil sump pattern
b - Dowel pin location (2)
c - Exhaust tube location
d - Water tube location

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Oil sump mounting screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Oil sump mounting screws (M6 x 20)	10	89	–

9. Clean the gasket surface of the exhaust tube.
10. Assemble the exhaust tube to the adapter plate with four screws. Apply Loctite 242 Threadlocker to the threads of the exhaust tube mounting screws. Tighten the screws to the specified torque.

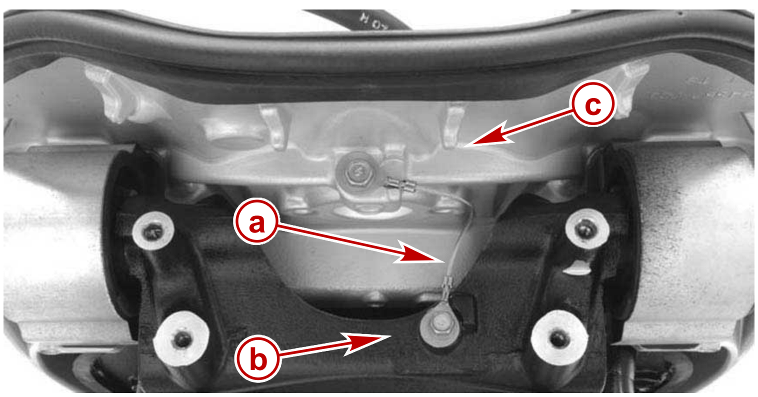


a - Exhaust tube
b - Mounting screws

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Exhaust tube mounting screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Exhaust tube mounting screws (M8 x 35)	34	–	25

11. Assemble the ground cable between the adapter plate and the cradle with two screws.



a - Ground cable
b - Adapter plate
c - Mount cradle (rear)

Description	Nm	lb-in.	lb-ft
Ground screws (M6 x 13)	8	71	–

Completing Outboard Adapter Plate Reassembly

1. Install the driveshaft housing to the adapter plate. Refer to **Section 5A** - **Pedestal/Mount Cradle and Driveshaft Housing**.
2. Install the powerhead. Refer to **Section 4A** - **Dressed Powerhead Removal/Installation.**

Notes:

Midsection

Section 5C - Power Trim

Table of Contents

5
C

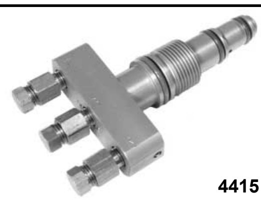
Power Trim Specifications

Power Trim Specifications	
Trim up circuit pressure, maximum	18,270–28,960 kPa (2650–4200 psi)
Trim down circuit pressure	1255–2765 kPa (182–401 psi)
System fluid	Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III)

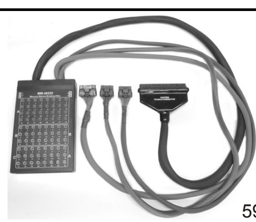
Lubricant, Sealant, Adhesives

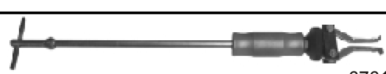
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Power trim sensor screws	92-809819
114	Power Trim and Steering Fluid	Power trim system	92-858074K01
		Manual release valve O-rings and power trim system fluid	
		Memory piston O-ring	
		Rod seal, rod wiper, bushing, and O-ring	
		Shock piston O-ring	
		Manifold bushings and O-rings	
		Pivot pin and trim cylinder O-rings	
		Manifold O-rings and pivot pin	

Special Tools

Power Trim Adapter Fitting	91-822778004
 4415	Replaces power trim manual release valve when testing power trim circuits.

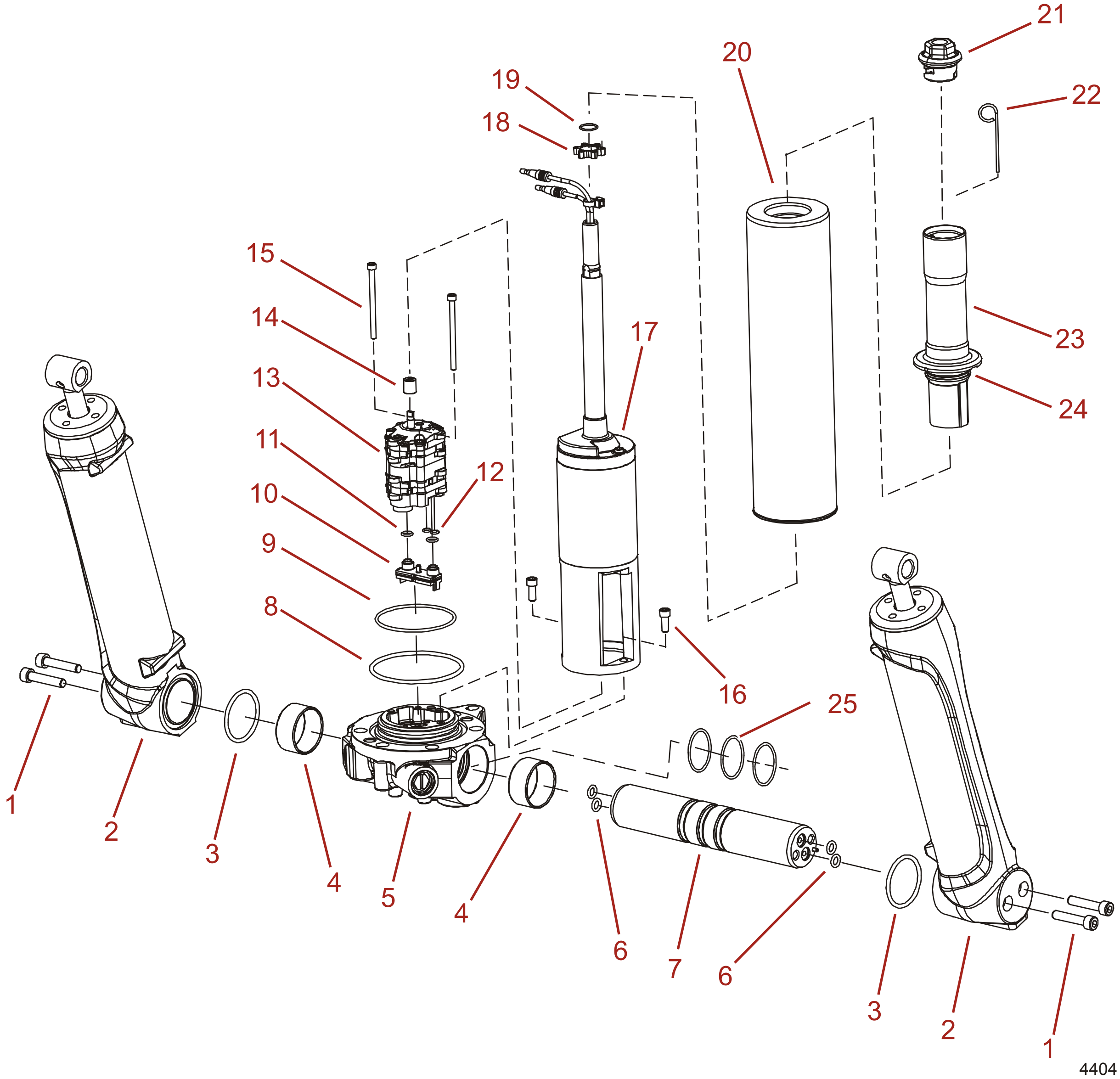
Power Trim Test Gauge Kit	91- 52915A 6
 3753	Tests circuit pressures for various trim pumps.

Breakout Box	SPX P/N MM- 46225
 5974	Connects to propulsion control module (PCM) to test engine circuits and components without probing wires. May be used with computer diagnostic system (CDS).

Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components. Use with puller jaws.

Trim Cylinder End Cap Tool	91-821709T
 10691	Allows easy removal of the trim cylinder end caps. Required if tilt limit spacers are to be installed or if the trim in limit spacer is to be removed (to allow additional trim in range).

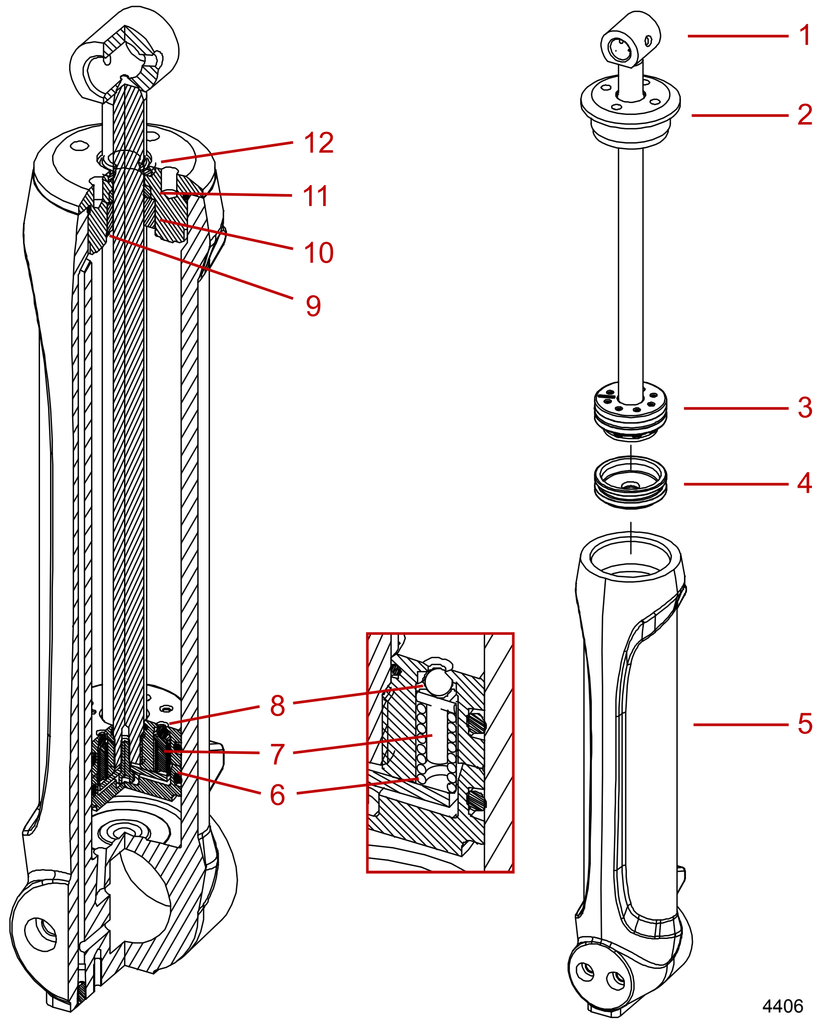
Power Trim System Components



Power Trim System Components

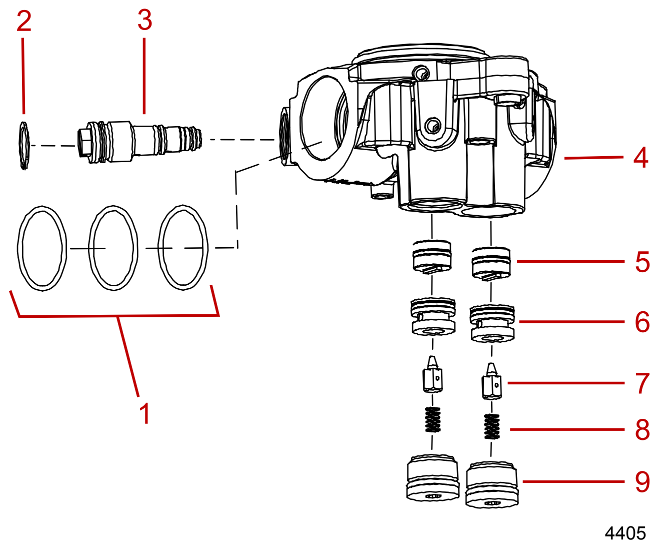
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	4	Screw	26		19.2
2	2	Trim cylinder assembly			
3	2	O-ring - Trim cylinder			
4	2	Bearing			
5	1	Pressure operated check manifold assembly			
6	4	O-ring - Tilt pin			
7	1	Tilt pin			
8	1	O-ring - Steering tube			
9	1	O-ring - Reservoir			
10	1	Filter			
11	2	O-ring - Filter			
12	2	O-ring - Pump to manifold			
13	1	Pump assembly			
14	1	Coupling			
15	2	Screw - 10-32 UNF X 3 in.	8	70	
16	2	Screw - 1/4-20 X 0.625 in.	8.5	75	
17	1	Electric motor			
18	1	Locking ring			
19	1	Clip			
20	1	Reservoir			
21	1	Cap			
22	1	Pin			
23	1	Reservoir neck			
24	1	O-ring			
25	3	O-ring			

Power Trim Cylinder Components



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cylinder rod			
2	1	End cap assembly	61		45
3	1	Shock piston assembly	122		90
4	1	Memory piston with O-ring			
5	1	Cylinder tube			
6	7	Check ball spring			
7	7	Check ball guide			
8	7	Check ball			
9	1	End cap snap ring			
10	1	End cap bushing			
11	1	End cap rod seal			
12	1	End cap rod wiper			

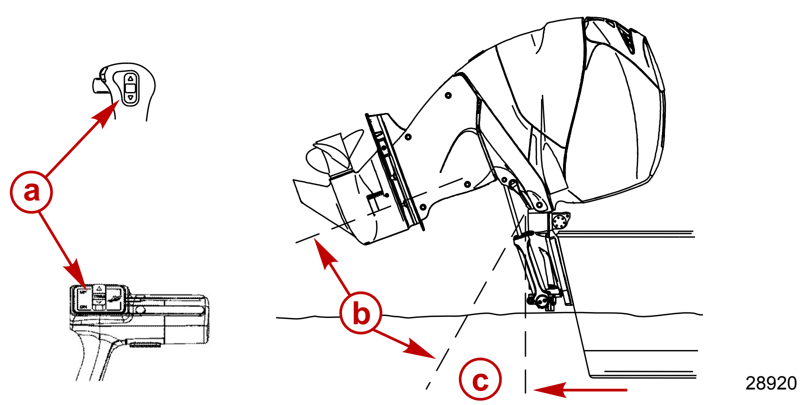
Pressure Operated Check Manifold Components



Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	3	O-ring			
2	1	Snap ring			
3	1	Manual release valve with O-rings			
4	1	Manifold			
5	2	Shuttle spool with O-ring			
6	2	Check seat with O-ring			
7	2	Hex poppet			
8	2	Spring			
9	2	Retainer plug	40.7		30

Power Trim and Tilt

The outboard has a trim/tilt control called power trim. This enables the operator to easily adjust the position of the outboard by pressing the trim switch. Moving the outboard in closer to the boat transom is called trimming in or trimming down. Moving the outboard further away from the boat transom is called trimming out or trimming up. The term trim generally refers to the adjustment of the outboard within the first 20° range of travel. This is the range used while operating the boat on plane. The term tilt is generally used when referring to adjusting the outboard further up out of the water. With the engine not running and the key switch in the "ON" position, the outboard can be tilted out of the water. At low idle speed (2000 RPM and below), the outboard can also be tilted up past the trim range to permit shallow water operation.



a - Trim switch
b - Tilt range of travel
c - Trim range of travel

Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim the outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, this being an awareness of some potential control hazards.

Consider the following lists carefully:

1. Trimming in or down can:
   - Lower the bow.
   - Result in quicker planing off, especially with a heavy load or a stern heavy boat.
   - Generally improve the ride in choppy water.
   - In excess, can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or oversteering) if any turn is attempted, or if a significant wave is encountered.

⚠ WARNING

Operating the boat at high speeds with the outboard trimmed too far under can create excessive bow steer, resulting in the operator losing control of the boat. Install the trim limit pin in a position that prevents excessive trim under and operate the boat in a safe manner.

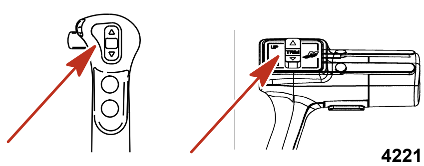
2. Trimming out or up can:
   - Lift the bow higher out of the water.
   - Generally increase top speed.
   - Increase clearance over submerged objects or a shallow bottom.
   - In excess, can cause boat porpoising (bouncing) or propeller ventilation.
   - Cause engine overheating if any cooling water intake holes are above the waterline.

Tilting To Full Up Position

Tilt At Helm

IMPORTANT: Turning key to the "START" position while the engine is running will result in engine shut down, while leaving the DTS system active. This will allow the use of the power trim/tilt from the remote control handle.

1. Shut off engine by:
   a. Turning the key to the "START" position, then releasing it to the "ON" position.
   b. Turning the key to the "OFF" position and returning it to the "ON" position.
2. Press the trim/tilt switch to the up position. The outboard will tilt up until the switch is released or it reaches its maximum tilt position.



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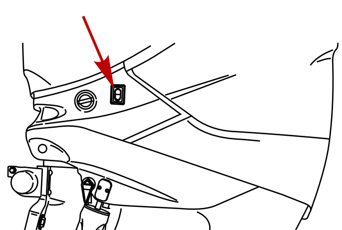
Tilt At Engine

The cowl mounted auxiliary tilt switch can be used to tilt the outboard with the key switch in the "OFF" position.



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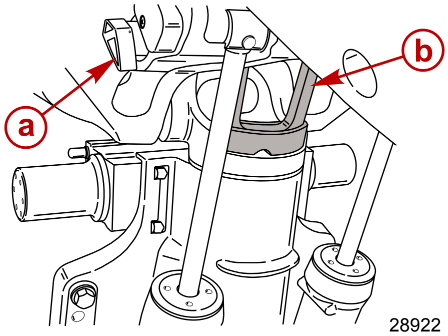
1. Rotate the tilt support lever down.
2. Lower outboard until tilt support bracket rests on the pedestal.

3. Disengage the tilt support bracket, by raising the outboard up and rotating the tilt support lever up. Lower the outboard.



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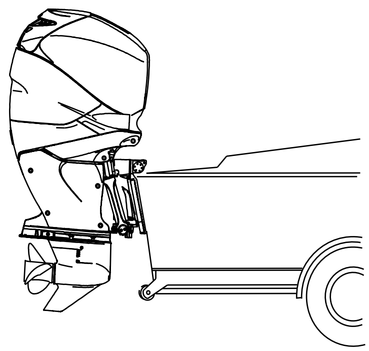
a - Tilt support lever
b - Tilt support bracket

Trailering Boat/Outboard

When transporting the boat on a trailer, the outboard should be positioned and/or supported in one of the following ways:

1. If the boat trailer provides sufficient ground clearance, the outboard may be tilted down to the vertical operating position with no additional support required.



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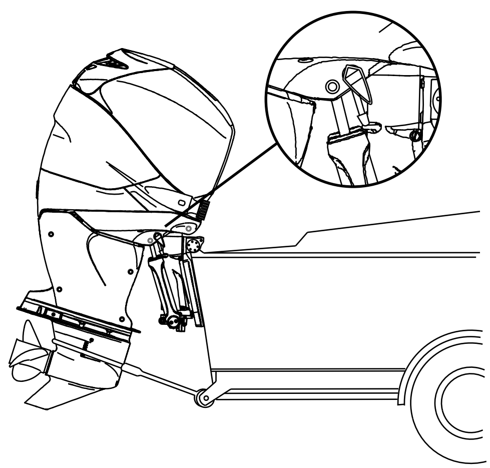
2. If additional ground clearance is required, the outboard should be tilted up and supported using the outboard's tilt support bracket (trailering position) and/or an accessory transom support device.



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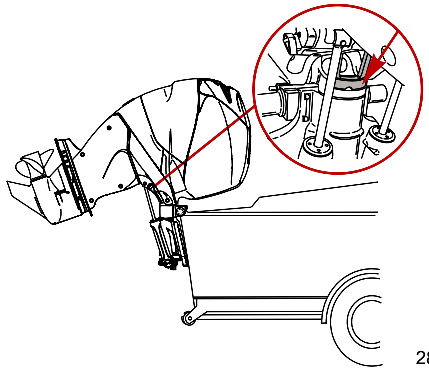
3. For maximum ground clearance, the outboard can be tilted to the full tilt position and supported using the outboard's tilt support bracket and/or an accessory transom support device.



28779

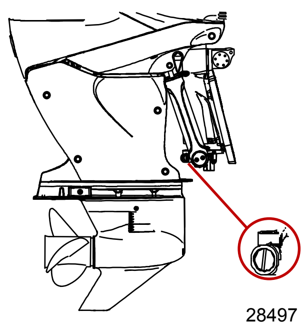
Additional clearance may be required for railroad crossings, driveways, and trailer bouncing. Refer to your local dealer for recommendations.

IMPORTANT: Do not rely on the power trim/tilt system to maintain proper ground clearance for trailering. The power trim/tilt system is not intended to support the outboard for trailering.

Shift the outboard to forward gear. This prevents the propeller from spinning freely when boat is trailered.

Manual Tilting

If the outboard cannot be tilted using the power trim/tilt switch, the outboard can be manually tilted.



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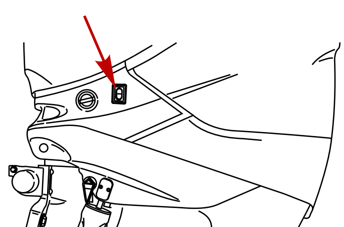
NOTE: The manual tilt release valve must be tightened before operating the outboard to prevent the outboard from tilting up during reverse operation.

Turn out the manual tilt release valve three turns counterclockwise. This allows manual tilting of the outboard. Tilt the outboard to the desired position and tighten the manual tilt release valve.

Auxiliary Tilt Switch

The auxiliary tilt switch can be used to tilt the outboard up or down using the power trim system.



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Shallow Water Operation

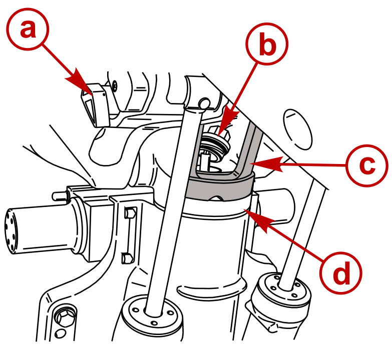
When operating your boat in shallow water, you can tilt the outboard beyond the maximum trim range to prevent hitting bottom.

1. Reduce engine speed below 2000 RPM.
2. Tilt outboard up. Make sure all the water intake holes stay submerged at all times.
3. Operate the engine at slow speed only. With the outboard tilted past 20° trim limit, the warning horn will sound and engine speed will be automatically limited to approximately 2000 RPM. The outboard must be tilted (trimmed) down below the maximum trim range to allow operation above 2000 RPM.

Check Fluid and Purge the Power Trim System

Checking Power Trim Fluid

1. Tilt outboard to the full up position.
2. Rotate the tilt support bracket down.
3. Lower outboard until tilt support bracket rests on pedestal.
4. Remove the power trim fill cap. The fill cap only requires 1/4 turn to remove.



a - Tilt support lever
b - Power trim fill cap
c - Tilt support bracket
d - Pedestal

29312

5. The fluid level should be approximately 25 mm (1 in.) from the top of the fill neck. Add Quicksilver or Mercury Precision Lubricants Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim system	92-858074K01

6. Install the power trim fill cap. Tighten fill cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.

Purging Power Trim System

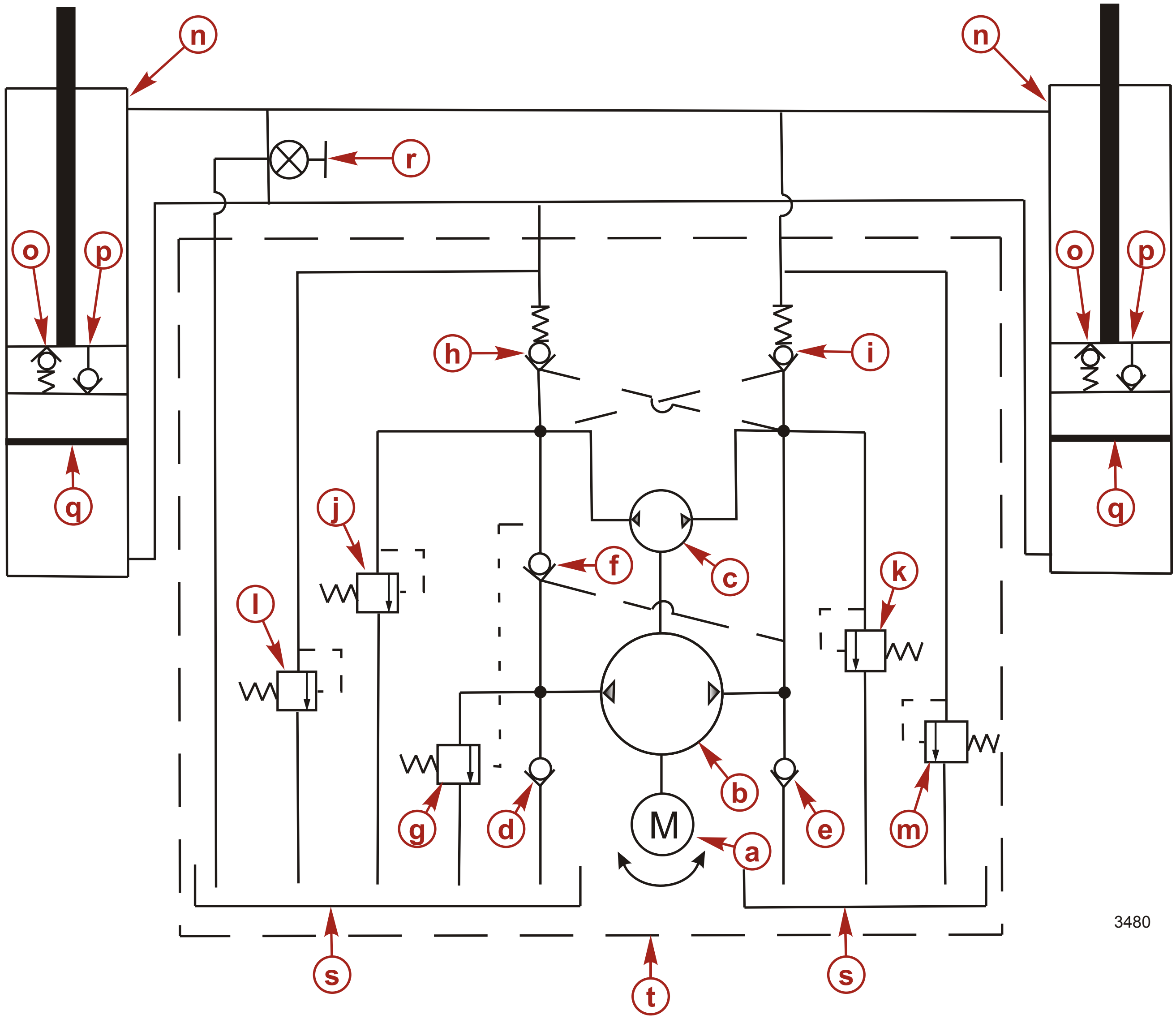
IMPORTANT: The fill cap with O-ring must be tightened securely before operating the power trim system.

IMPORTANT: Operate the power trim system in short spurts until the hydraulic pump is primed and the trim cylinders move.

- Cycle the outboard through the entire trim/tilt range four times.
- To check for presence of air in the system, extend cylinders slightly and push down on outboard. If the trim rams retract more than 3 mm (0.125 in.), air is present. Cycle trim system again and repeat this step.
- Check fluid level. Refer to **Checking Power Trim Fluid**.

Theory of Operation

Power Trim Hydraulic Diagram



- a - Electric motor
- b - Large displacement pump
- c - Small displacement pump
- d - Trim down inlet check valve
- e - Trim up inlet check valve
- f - Unloading circuit check valve
- g - Unloading valve
- h - Trim up pressure operated check valve
- i - Trim down pressure operated check valve
- j - Up circuit relief valve 18270–28960 kPa (2650–4200 psi) nominal
- k - Down circuit relief valve 1255–2765 kPa (182–401 psi)
- l - Up circuit thermal relief valve
- m - Down circuit thermal relief valve
- n - Trim cylinder
- o - Impact relief valve
- p - Return check valve
- q - Memory piston

r - Manual release valve
s - Reservoir
t - Power unit

Operation

The power trim system consists of an integral two stage pump, manifold, reservoir, and two trim cylinders. A two stage pump is used to increase cylinder extend speed during tilt operation. When the outboard is trimmed up at idle or slow running speed, the fluid output of both pumps are used to extend the trim cylinders. The combined output of the two pumps extend the cylinders at the same rate as one pump of the same displacement. When the pressure required to raise the outboard motor increases, the unloading valve diverts the large pump's flow back to the reservoir and the output of the small pump continues to extend the trim cylinders at a higher pressure. Using the small pump flow at high pressure requires less power than using a larger single pump. A high-pressure relief valve limits the pressure to 18,270–28,960 kPa (2650–4200 psi) in the up circuit. The system is protected from thermal expansion of trapped oil in the trim cylinders by two thermal relief valves, one for the up circuit and one for the down circuit.

Trim Circuit - Up

When the up circuit is activated, the electric motor rotates the two stage hydraulic pump. As the pump gears rotate, fluid is drawn through a check valve and into the inlet passages of the two pumps. The large pump's flow passes through a check valve and combines with the small pump's flow. The combined flow then passes through a pressure operated check valve in the manifold and to the bottom of the trim cylinders. The fluid pushes the pistons out, trimming the engine up. When the pressure required to raise the outboard motor increases, a check valve and unloading valve divert the large pump's flow back to the reservoir and the output of the small pump continues to extend the cylinders. Oil, from the top side of the cylinder, returns through a passage in the cylinder wall into the manifold to the inlet side of each pump. When the engine is not running, the outboard may be tilted to the full up position by activating the cowl trim switch. In this mode, as the trim cylinders extend to their limit, up pressure increases to 18,270–28,960 kPa (2650–4200 psi) and opens the up pressure relief valve. When the engine is running above 2000 RPM, trim angle is limited to 20 degrees by the trim angle sensor and the PCM.

Trim Circuit - Down

When the down circuit is activated, the electric motor rotates in the opposite direction. As the pump gears rotate, fluid is drawn through a check valve and into the inlet passages of the two pumps. The large pump and small pump flow is combined and passes through a pilot operated check valve and to the top of the trim cylinders. The fluid pushes the pistons down and trims the engine down. Oil, from the bottom side of the cylinder, returns through the manifold to the inlet side of each pump. As the trim cylinders retract fully, down pressure increases to 1255–2765 kPa (182–401 psi) and opens the down pressure relief valve.

Trail Over System

Should the outboard motor strike a submerged object while in forward motion, hydraulic pressure on the top side of the cylinder will increase to cause the impact relief valve in the trim cylinders to open. This allows the lower unit to trail over the obstruction. The fluid in the top side of the cylinder opens the impact relief valve and flows into the cavity between the memory piston and the cylinder piston. When the lower unit clears the submerged object, the thrust of the engine forces the engine back down. As the cylinder piston is lowered, fluid trapped between the memory piston and the cylinder piston escapes through a return check valve. Fluid below the memory piston is trapped in place, therefore, stopping the cylinder piston and returning the trim position to its previous position.

Troubleshooting the Power Trim System

Preliminary

Determine if problem is hydraulic or electrical related. Most often, if the electric motor operates, the problem is in the hydraulic system. If the electric motor does not operate, the problem is in the electrical system.

IMPORTANT: Operate power trim system after each check to see if the problem is corrected. If problem has not been corrected proceed with the next check.

1. Check that the manual release valve is tightened fully (clockwise).
2. Check trim pump fluid level in full up position. Fill if necessary. Refer to **Check Fluid and Purge the Power Trim System** in this section.
3. Check for external leakage in the power trim system. Replace/repair defective component if leak is found. Maximum acceptable power trim cylinder leak down is 25 mm (1 in.) within a 24 hour period.

Hydraulic System Troubleshooting

Condition/Problem

Condition of Trim System	Problem
Trim motor runs; trim system does not move up or down	1, 2, 5, 7, 10
Does not trim full down. Up trim OK.	2, 3, 4, 6, 7
Does not trim full up. Down trim OK.	1, 4, 6, 7
Partial or jerky down/up	1, 3, 6
Thump noise when shifting	2, 3, 5
Does not trim under load	2, 5, 8, 9, 10, 12
Does not hold trim position under load	4, 5, 6, 7
Trail out when backing off from high speed	3, 4
Leaks down and does not hold trim	4, 5, 6, 7
Trim motor working hard and trims slow up and down	8, 9
Trims up very slow	1, 2, 8, 9
Starts to trim up from full down position when the down trim button is depressed	3, 4
Trim position will not hold in reverse	2, 3, 4, 5, 13

Problem/Solution

No.	Problem	Solution
1.	Low fluid level	Add Power Trim and Steering Fluid or ATF (Type Dexron III).
2.	Defective hydraulic pump	Pressure test pump. Refer to **Testing Power Trim System**, following.
3.	Trim cylinder shock piston ball not seated	Inspect ball seat for nicks or contamination.
4.	Trim cylinder piston or memory piston O-rings leaking or cut	Inspect O-rings for cuts or abrasion.
5.	Manual release valve leaking (check condition of O-rings) (valve not fully closed)	Ensure that valve is fully closed. Inspect O-rings.
6.	Thermal relief valve not seated	Inspect seat for debris and damage.
7.	Debris in system	Inspect for debris. Refill system with clean fluid.
8.	Battery low	Check battery.
9.	Electric motor defective	Refer to **Electrical System Troubleshooting.**
10.	Broken motor/pump driveshaft	Inspect for damage.
11.	Air pocket under pump	Purge system. Refer to **Purging Power Trim System**, preceding.
12.	Defective up relief valve	Replace power trim pump assembly.
13.	Defective down relief valve	Replace power trim pump assembly.

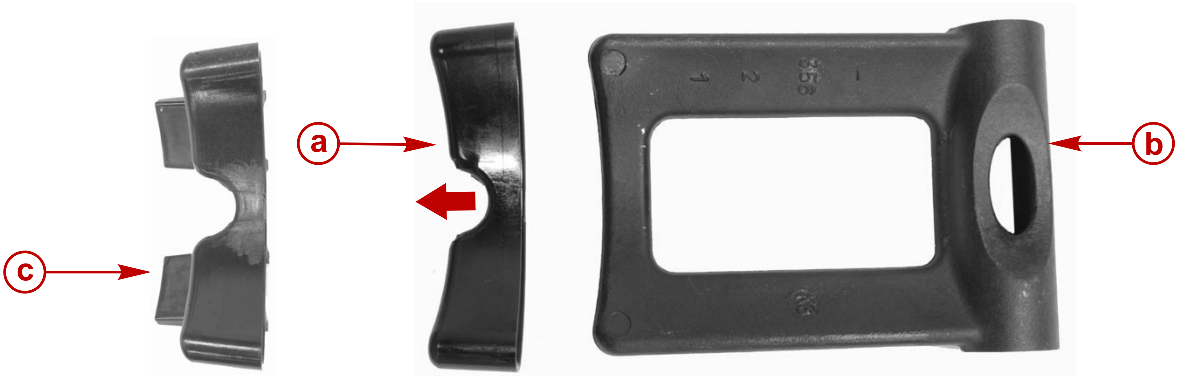
Testing Power Trim System

Install Test Gauge Adapter Fitting for Up Pressure Test

IMPORTANT: Tilt the outboard to the full up position and engage the tilt lock lever before checking the fluid level. The system is pressurized. Completely extend the trim cylinders to depressurize the system.

1. Trim the engine up and engage the tilt lock lever.

NOTE: A new tilt lever pad (P/N 889539001) should be installed on all engine models S/N 1B108510 and below. The new tilt lever pad will prevent the tilt support bracket from moving past its seat on the steering head and damaging the power trim electrical harness.



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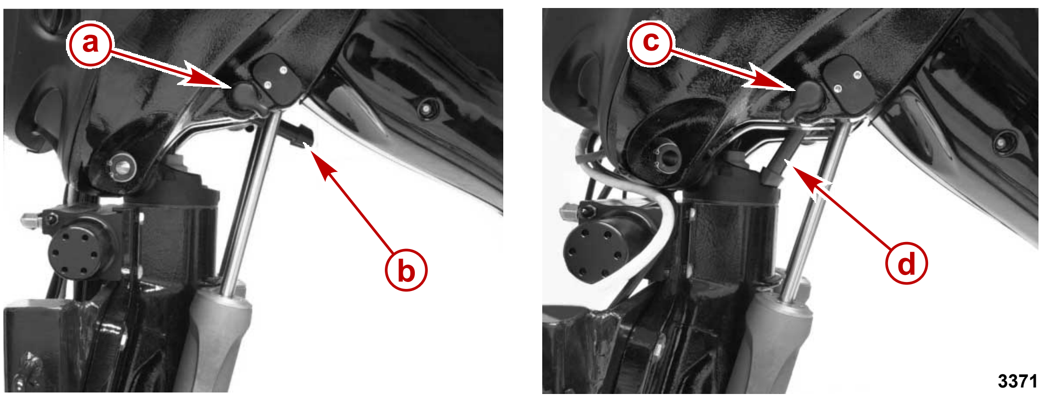
a - Pad (Design I) (discard)
b - Tilt support bracket
c - Pad (Design II) (P/N 889539001) (install)

2. Momentarily actuate the trim switch in the opposite direction from the last operation to relieve the pressure in the system.



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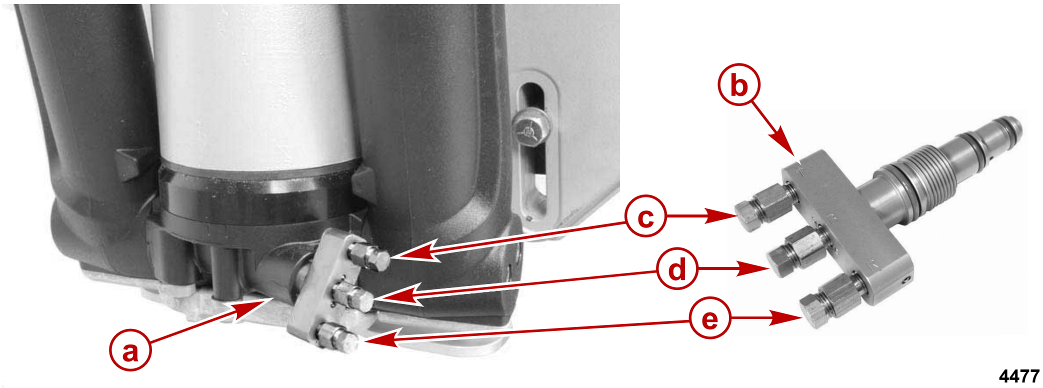
a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged
c - Tilt lock lever engaged
d - Tilt lock bracket engaged

3. Check for external leaks.
4. Slowly remove the reservoir cap to relieve the pressure.
5. Remove the snap ring securing the manual release valve and remove the manual release valve.

   NOTE: A small amount of fluid may drip from the manual release port. Place a container under the trim assembly to collect any leakage.

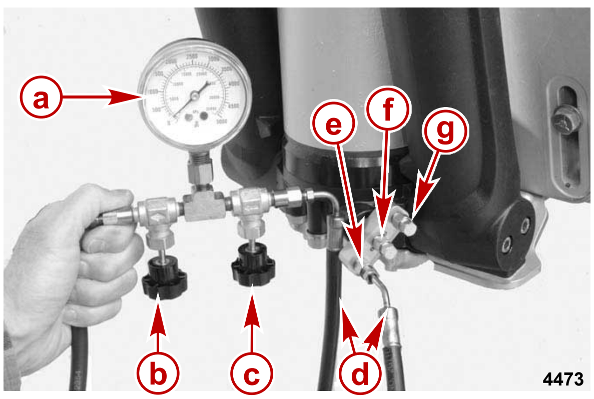
6. Install the power trim adapter fitting into the manual release port.



a - Manual release port
b - Adapter fitting
c - Test port "T"
d - Test port "R"
e - Test port "B"

Power Trim Adapter Fitting	91-822778004

7. Thread the hose at valve "c" from the test gauge kit into the adapter test port "B".



a - Test gauge
b - Valve "b"
c - Valve "c"
d - Test hose - adapter fitting to gauge
e - Test port "B"
f - Test port "R"
g - Test port "T"

Power Trim Test Gauge Kit	91- 52915A 6

8. Check the power trim fluid level. If necessary, add fluid to bring the level to 25 mm (1 in.) below the top of the reservoir neck.
9. Reinstall the reservoir cap.
   IMPORTANT: The reservoir cap must be installed to ensure accurate test results.

Up Pressure Circuit Test

1. Ensure all fittings are tight prior to testing.
2. Trim the engine up slightly and disengage the tilt lock lever.
3. Open valve "c" on the power trim test gauge.
4. Run the trim down.
5. Run the trim up. Hold and observe the pressure for a few seconds. Release the trim button.

Up Pressure Relief Valve Specification	
Pressure	18,270–28,960 kPa (2650–4200 psi)
Current draw	130 amp maximum

*NOTE: If the pressure is out of specification, the pump or up pressure relief valve is defective. Replace the trim pump assembly. Refer to **Power Unit Disassembly/Reassembly** for instructions.*

*NOTE: If testing the down circuit pressure, proceed to **Down Pressure Circuit Test**.*

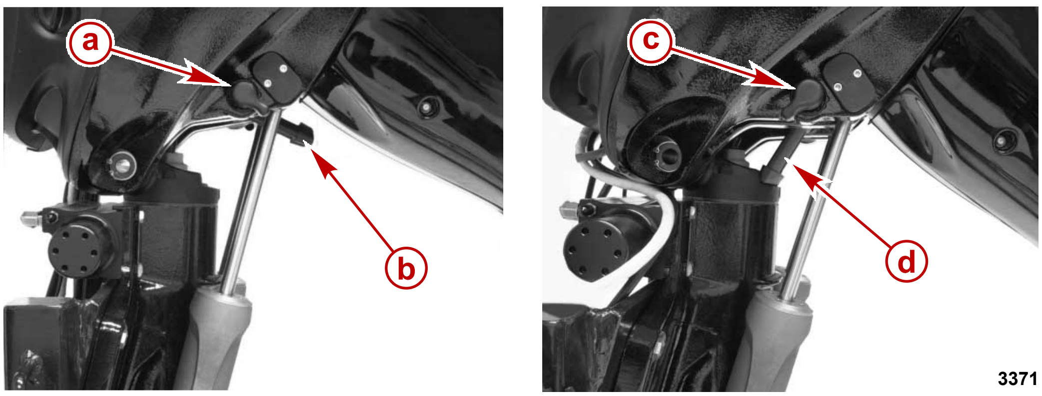
6. Run the trim down to release the pressure.
7. Place the outboard in the full up position and engage the tilt lock lever.
8. Momentarily actuate the trim switch in the opposite direction from the last operation to relieve the pressure in the system.
9. Momentarily open the reservoir cap to relieve the pressure, then retighten the cap.
10. Remove the test gauge hose and adapter fitting.
11. Install the manual release valve and snap ring. Ensure the snap ring is fully seated in the groove.
12. Check the power trim fluid level.
13. Reinstall the reservoir cap.

Install Test Gauge Adapter Fitting for Down Pressure Test

If the power trim adapter fitting is installed from the previous test, proceed to step 7.

IMPORTANT: Tilt the outboard to the full up position and engage the tilt lock lever before checking the fluid level. The system is pressurized. Completely extend the trim cylinders to depressurize the system.

1. Trim the engine up and engage the tilt lock lever.
2. Momentarily actuate the trim switch in the opposite direction from the last operation to relieve the pressure in the system.

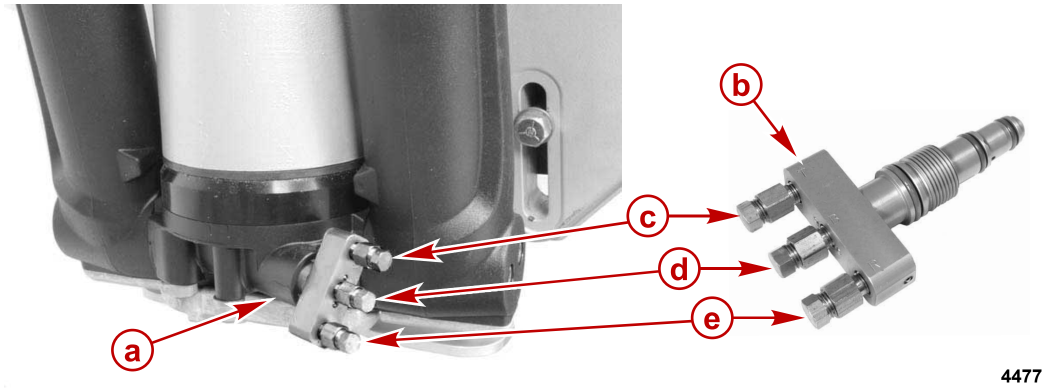


a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged
c - Tilt lock lever engaged
d - Tilt lock bracket engaged

3. Check for external leaks.
4. Slowly remove the reservoir cap to relieve the pressure.
5. Remove the snap ring securing the manual release valve and remove the manual release valve.

   NOTE: A small amount of fluid may drip from the manual release port. Place a container under the trim assembly to collect any leakage.

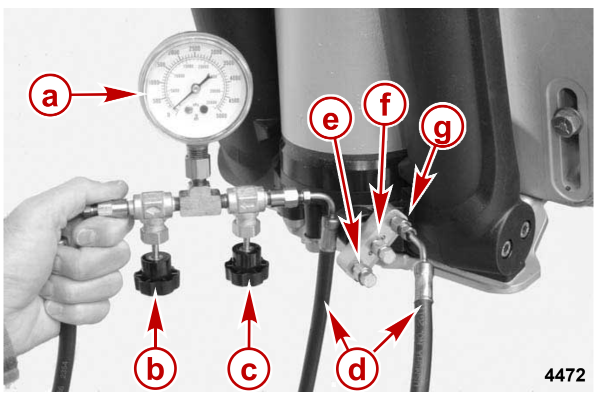
6. Install the power trim adapter fitting into the manual release port.



a - Manual release port
b - Adapter fitting
c - Test port "T"
d - Test port "R"
e - Test port "B"

Power Trim Adapter Fitting	91-822778004

7. Ensure test port "B" and "R" are plugged.
8. Thread the hose at valve "c" from the test gauge kit into the adapter test port "T".



a - Test gauge
b - Valve "b"
c - Valve "c"
d - Test hose (adapter fitting to gauge)
e - Test port "B"
f - Test port "R"
g - Test port "T"

Power Trim Test Gauge Kit	91- 52915A 6

9. Check the power trim fluid level. If necessary, add fluid to bring the level to 25 mm (1 in.) below the top of the reservoir neck.
10. Reinstall the reservoir cap.
IMPORTANT: The reservoir cap must be installed to ensure accurate test results.

Down Pressure Circuit Test

1. Ensure all fittings are tight prior to testing.
2. Trim the engine up slightly and disengage the tilt lock lever.
3. Open valve "c" on the power trim test gauge.
4. Cycle the trim down and up.
5. Run the trim down. Hold and observe the pressure for a few seconds. Release the trim button.

Down Pressure Relief Valve Specification	
Pressure	1255–2765 kPa (182–401 psi)
Current draw	90 amp maximum

NOTE: If the pressure is out of specification, the pump or down pressure relief valve is defective. Replace the trim pump assembly. Refer to ***Power Unit Disassembly/Reassembly*** *for instructions.*

6. Run the trim down to release the pressure.
7. Place the outboard in the full up position and engage the tilt lock lever.
8. Momentarily actuate the trim switch in the opposite direction from the last operation to relieve the pressure in the system.
9. Slowly remove the reservoir cap to relieve the pressure.
10. Remove the test gauge hose and adapter fitting.
11. Install the manual release valve and snap ring. Ensure the snap ring is fully seated in the groove.
12. Check the power trim fluid level. If necessary, add fluid to bring the level to 25 mm (1 in.) below the top of the reservoir neck.
13. Reinstall the reservoir cap.

Electrical System Troubleshooting

General Checks

Before troubleshooting the power trim electrical system, check the following:

- Disconnected wires
- Connections are tight and corrosion free
- Plug-in connections are fully engaged
- Battery is fully charged

Condition/Problem

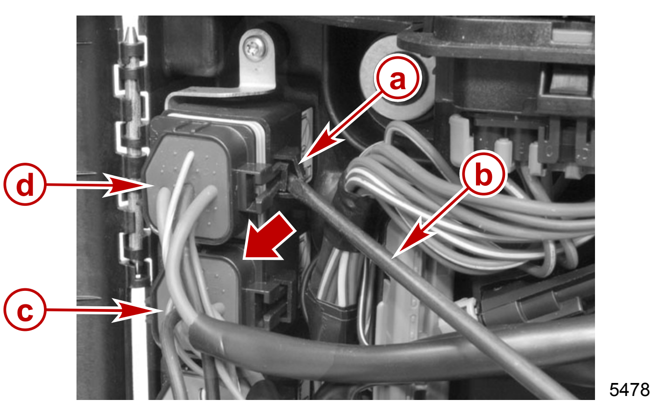
Condition of Trim System	Problem No.
Trim motor does not run when trim button is depressed	1, 2, 4, 5, 6, 7
Trim system trims opposite of buttons	3
Cowl mounted trim buttons do not activate trim system	2, 4, 5, 6

Problem/Solution

No.	Problem	Solution
1.	Battery low or discharged	Check battery.
2.	Open circuit in trim wiring	Check for an open connection.
3.	Wiring reversed in remote control, cowl switch, or trim leads	Verify connections.
4.	Wire harness corroded through	Replace wire harness.
5.	Internal motor problem (brushes, shorted armature)	Check for open connection. Replace motor.
6.	Trim switch failure	Replace switch.
7.	Relay not operating	Verify relays are functioning correctly. Check voltage at trim bullets.

Power Trim Relay Test Procedure

NOTE: To remove the power trim relays, insert a flat blade screwdriver in the relay lock tab. Gently twist the blade and pry the relay loose. Pull the relay out. Do not pull with the wires.



a - Lock tab
b - Flat blade screwdriver
c - Down trim relay
d - Up trim relay

The trim motor relay system used on permanent magnet trim systems connect each of the two wires from the trim motor to either ground or positive in order to allow the motor to run in both directions.

If the motor will not run in the up direction, it may be either the up relay is not making contact to 12 volts or the down relay is not making contact to ground. The opposite is true if the system will not run down. When the system is not energized, both relays should connect the heavy motor leads to ground.

To test which relay is faulty if the trim system does not operate in one direction:

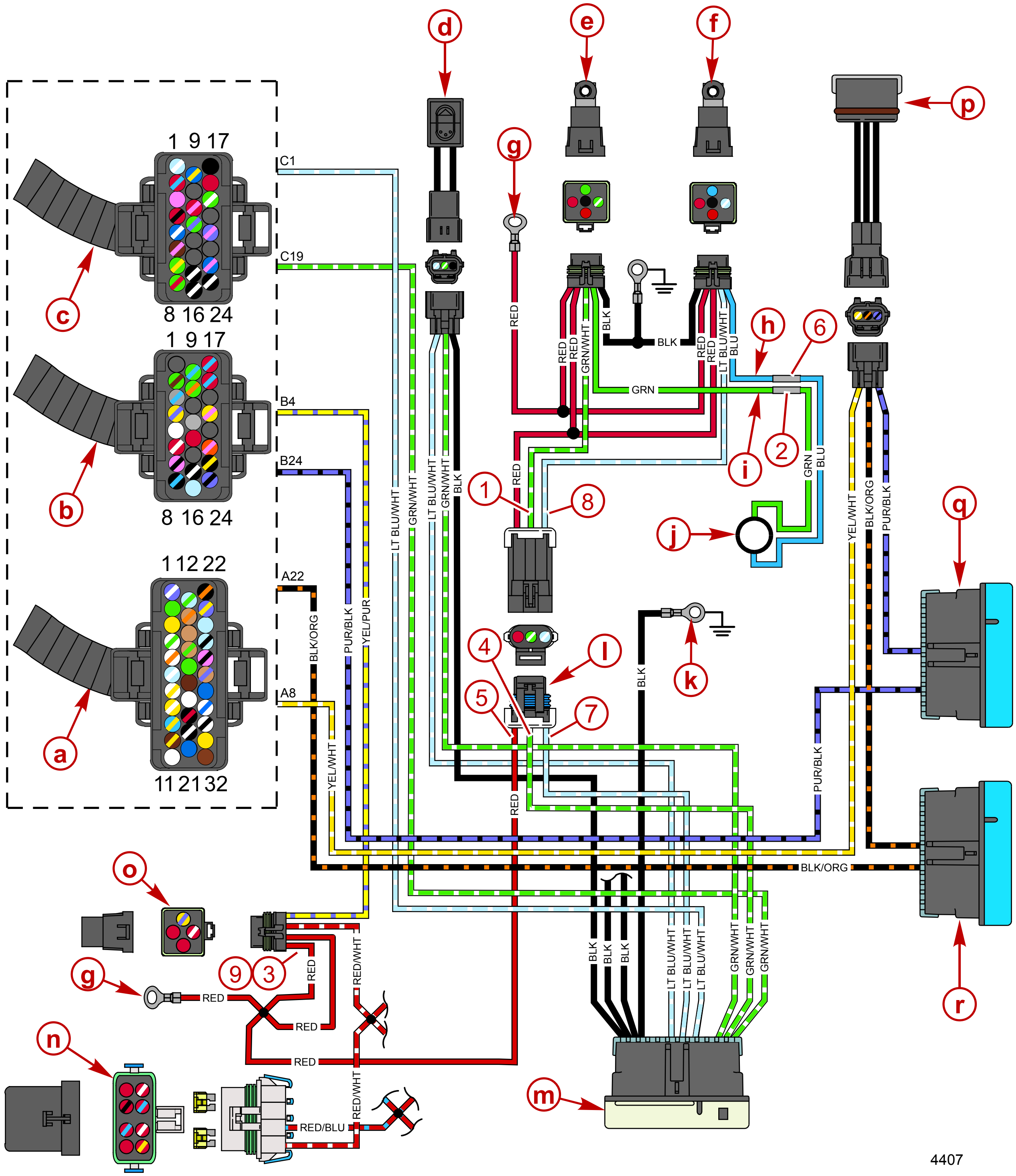
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

Meter Test Leads		Meter Scale	Reading (Ω)
Red	**Black**		
Green	Ground	Full continuity (R x 1)	< 20 Ω
Blue	Ground	Full continuity (R x 1)	< 20 Ω

3. Replace the relay that does not have continuity.
4. Connect a voltmeter to the heavy blue lead and to ground. You should have 12 volts on the blue lead when the up switch is pushed. You should also have 12 volts on the green lead when the down switch is pushed. Replace the relay that does not switch the lead to positive.

Notes:

Power Trim Electrical Circuit



- a - PCM connector A
- b - PCM connector B
- c - PCM connector C
- d - Cowl tilt switch
- e - Down relay
- f - Up relay
- g - +12 V power
- h - Up lead at motor
- i - Down lead at motor
- j - Power trim motor
- k - –12 V ground
- l - Power trim harness connector
- m - Splice saver SP1
- n - Fuse holder
- o - Main power relay
- p - Trim position sensor
- q - Splice saver SP6
- r - Splice saver SP5

Troubleshooting the Down Circuit

Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check for battery voltage at Point 1.	☐ Disconnect down relay. ☐ Connect voltmeter black lead to Point 1 and red lead to battery positive. ☐ Depress the down trim button.	Battery voltage measured: • Reconnect down trim relay. • Go to Step 2. No battery voltage measured: • Go to Step 3.
Step 2: Check for battery voltage at Point 3.	☐ Connect voltmeter red lead to Point 3 and black lead to ground.	Battery voltage measured: • Go to Step 5. No battery voltage measured: • There is an open circuit between Point 3 and positive (+) battery terminal. • Check for loose or corroded connections. • Check wires for open.
Step 3: Check for battery voltage at Point 4.	☐ Disconnect 3 pin connector ☐ Connect voltmeter black lead to Point 4 and red lead to battery positive. ☐ Depress the down trim button.	Battery voltage measured: • Wire is open between Points 4 and 1. No battery voltage measured: • Reconnect 3 pin connector. • Go to Step 4.
Step 4: Check for battery voltage at Point 5.	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	Battery voltage measured: • Trim switch is faulty. No battery voltage measured: • Check for loose or corroded wire at Point 5. • Open circuit in wire supplying current to Point 5.
Step 5: Check for battery voltage at Point 2.	☐ Connect voltmeter red lead to Point 2 (female bullet connector) and black lead to ground. ☐ Depress the down trim button.	Battery voltage measured: • Go to Step 6. No battery voltage measured: • Relay is defective.
Step 6: Check up relay.	☐ Test up relay. Refer to **Power Trim Relay Test**, preceding.	Relay is good: • Pump motor wiring is defective. • Pump motor is defective. Relay is faulty: • Replace relay.

Troubleshooting the Up Circuit

NOTE: Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check for battery voltage at Point 8.	☐ Disconnect up relay. ☐ Connect voltmeter black lead to Point 8 and red lead to battery positive. ☐ Depress the up trim button.	Battery voltage measured: • Reconnect up trim relay. • Go to Step 2. No battery voltage measured: • Go to Step 3.
Step 2: Check for battery voltage at Point 9.	☐ Connect voltmeter red lead to Point 9 and black lead to ground.	Battery voltage measured: • Go to Step 5. No battery voltage measured: • There is an open circuit between Point 9 and positive (+) battery terminal. • Check for loose or corroded connections. • Check wires for open.
Step 3: Check for battery voltage at Point 7.	☐ Connect voltmeter black lead to Point 7 and red lead to battery positive. ☐ Depress the up trim button.	Battery voltage measured: • Wire is open between Points 7 and 8. No battery voltage measured: • Reconnect 3 pin connector. • Go to Step 4.
Step 4: Check for battery voltage at Point 5.	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	Battery voltage measured: • Trim switch is faulty. No battery voltage measured: • Check for loose or corroded wire at Point 5. • Open circuit in wire supplying current to Point 5.
Step 5: Check for battery voltage at Point 6.	☐ Connect voltmeter red lead to Point 6 and black lead to ground. Depress the up trim button.	Battery voltage measured: • Go to Step 6. No battery voltage measured: • Relay is defective.
Step 6: Check up relay.	☐ Test down relay. Refer to **Power Trim Relay Test**, preceding.	Relay is good: • Pump motor wiring is defective. • Pump motor is defective. Relay is faulty: • Replace relay.

Troubleshooting the Down and Up Circuits (All Circuits Inoperative)

NOTE: Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check fuse.	☐ Visually inspect power trim motor fuse.	Fuse blown: • Correct problem that caused to blow, and • Replace fuse. Fuse not blown: • Go to Step 2.
Step 2: Check battery voltage.	☐ Connect voltmeter red lead to Point 3 and black lead to ground.	No battery voltage: • Check battery leads for poor connections or open circuit. • Check battery charge. Battery voltage measured: • Go to Step 3.

Step	Test Procedure	Test Result
Step 3: Up trim switch.	☐ Connect voltmeter black lead to Point 1 and red lead to battery positive. ☐ Depress up trim button.	No battery voltage: • Go to Step 4. Battery voltage measured: • Check black ground wires for connection or poor ground at Point 10. • Pump motor is faulty.

Step 4: Open circuits.	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	No voltage measured:
		• Go to Step 5.
		Battery voltage measured:
		• Trim switch is faulty or
		• Open circuit in wires (grn/wht or blu/wht) between trim buttons and and trim pump motor.
		• Check
		  • Trim switch.
		  • All trim harness connections for loose or corroded connections.
		  • Pinched or severed wires.

Step 5: Check voltage.	Check that voltage is being supplied to control by performing the following checks:
	☐ Do not start engine.
	☐ Turn ignition switch to "RUN" position.
	☐ Check for voltage at any instrument using a voltmeter.
		No voltage measured:
		• Red wire is open between Point 3 and red terminal on back of ignition switch.
		  • Check for loose or corroded connections
		  • Check for open in wire.
		Battery voltage measured:
		• There is an open circuit between Point 5 and red terminal on back of ignition switch.

Trim Position Sensor

The trim position sensor is located on the port side of the cradle mount. It supplies the propulsion control module (PCM) with trim position information. The trim position sensor and PCM limit the trim angle when engine speed is greater than 2000 RPM and limits the tilt angle for trailering. The PCM will generate and store a failure code when the trim position sensor fails, but it will not sound an alarm horn.

The trim sensor only effects trim functions controlled by the helm trim switch. The trim system will function with the cowl tilt switch and will operate regardless of the position being reported by the trim position sensor. This means that there are no trim or trailer limits when using the cowl tilt switch. The engine will trim as long as the tilt switch is depressed or until the mechanical stop is reached.

The following are some of the problems encountered with a faulty trim position sensor:

- Engine speed limited to 2000 RPM
- Engine will trim higher than the set trim limit at speeds above 2000 RPM
- Engine trims past the maximum trailer limits
- Engine trims normally, but there are no trailer limits

NOTE: *If an operator tries to set trim limits with a faulty trim position sensor without noticing that the sender output is not changing, and sets the trim and trailer limits to the same point, the trim system will not function. The PCM needs to be reprogrammed or replaced.*

Troubleshooting the Trim Position Circuit

Breakout Box	SPX P/N MM- 46225

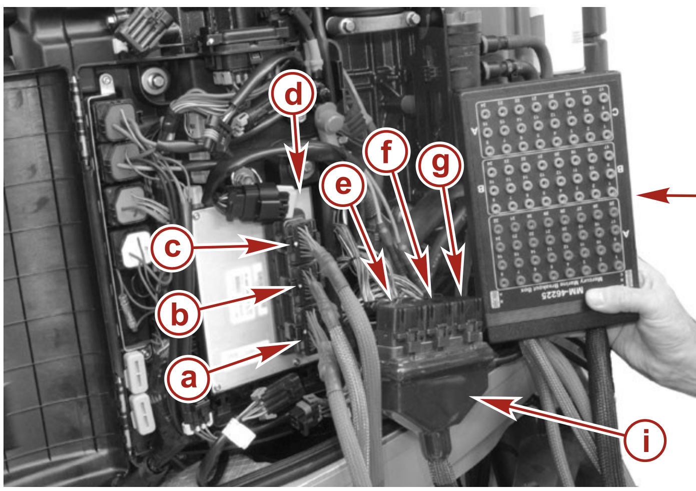
Step	Test Procedure	Test Result
Step 1: Check trim position sensor using trim gauge.	☐ Turn key to "ON" position. ☐ Trim engine up and down. ☐ Observe trim position gauge on instrument panel.	Trim position gauge varies with engine trim position: • Trim position sensor is good. • Go to Step 2. Trim position gauge does not vary with engine trim position: • Go to Step 2.
Step 2: Check trim position sensor using CDS.	☐ Turn key to "OFF" position. ☐ Connect computer diagnostic systems (CDS) to engine. ☐ Turn key to "ON" position. ☐ Observe trim position sensor counts on CDS. ☐ Trim engine up and down.	Count increases as engine trims up and decreases as engine trims down: • Trim position sensor is good. Count does not vary with engine trim position: • Go to Step 3.
Step 3: Check PCM harness for open or short circuit.	☐ Turn key to "OFF" position. ☐ Disconnect computer diagnostic systems (CDS) from engine. ☐ Connect breakout box, SPX P/N MM-46225, black lead to PCM harness connectors. Do not connect red, green, or blue leads to PCM. Refer to **Breakout Box Connections,** following. ☐ Disconnect trim position sensor harness connectors. Refer to **Trim Position Sensor Location**, following. ☐ Check resistance from breakout box pin to trim position sensor harness connector (PCM harness side). ☐ Pin B24 to pur/blk ☐ Pin A22 to blk/orn ☐ Pin A8 to yel/wht	Resistance measured is less than 0.8 ohms: • Go to Step 4. Resistance measured is greater than 0.8 ohms: • PCM harness may be faulty.
Step 4: Check transducer voltage.	☐ Turn key to "OFF" position. ☐ Connect trim position sensor harness connectors. ☐ Connect red, green, and blue breakout box leads to PCM. ☐ Turn key to "ON" position. ☐ Check transducer power between pin A22 and A23 of breakout box.	Voltage measured is 5 ± 0.1 VDC: • Go to Step 5. Voltage measured is out of specified range: • Go to Step 6.
Step 5: Check trim position sensor output voltage.	☐ Turn key to "ON" position. ☐ Check trim position sensor voltage output between pin A22 and A8 of breakout box. ☐ Trim outboard from full in to full out.	Voltage measured varies between a minimum of 0.5 VDC and a maximum of 4.5 VDC: • Trim position sensor is good. Voltage measured is out of specified range: • Go to Step 6.
Step 6: Check trim position sensor resistance.	☐ Turn key to "OFF" position. ☐ Disconnect red, green, and blue breakout box leads from PCM. ☐ Check trim position sensor resistance. Refer to chart following for specifications.	Resistance measured is within specification in Table: • Go to Step 7. Resistance measured is not within specification in Table: • Trim position sensor is faulty. • Go to Step 7.

Step	Test Procedure	Test Result
Step 7: Check resistance sensor signal pin and ground in PCM.	☐ Disconnect PCM harness leads from breakout box black lead. ☐ Connect red, green, and blue breakout box leads to PCM. ☐ Check resistance between pin A8 and B24 of breakout box.	Resistance measured is 215.6 kΩ to 224.4 kΩ. • Replace trim position sensor. Open or short measured: • Replace PCM.

Trim Position Senor Resistance Table

Meter Test Leads		Meter Scale	Reading (Ω)
Red	**Black**		
Breakout box pin B24	Breakout box pin A22	Ω	6000
Breakout box pin B24	Breakout box pin A8	Ω	168
Breakout box pin A22	Breakout box pin A8	Ω	6000

Breakout Box Connections



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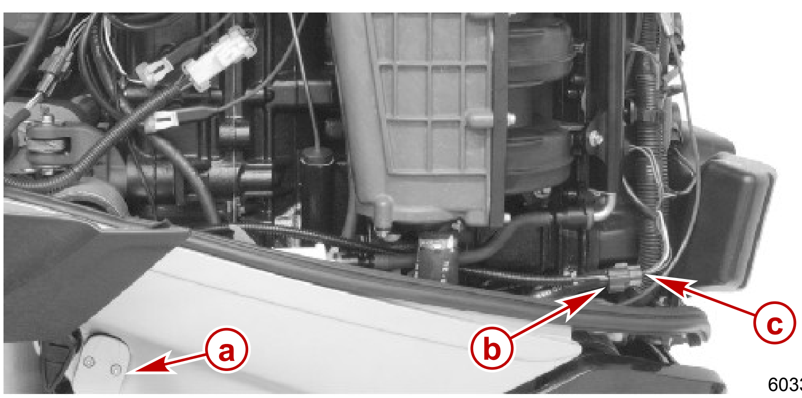
a - "A" connector - Red lead
b - "B" connector - Green lead
c - "C" connector - Blue lead
d - PCM
e - "C" connector
f - "B" connector
g - "A" connector
h - Breakout box
i - Main connector - Black lead

Breakout Box	SPX P/N MM- 46225

Trim Position Sensor Location

Disconnect the trim position sensor connector from the PCM harness connector.



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Port side view

a - Trim position sensor
b - Trim position sensor connector
c - Trim position sensor PCM harness connector

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

The power trim system may be disassembled in 3 sub-assemblies (power unit, trim cylinders, and manifold pressure operated check) or as a complete assembly. This service manual section is structured for the disassembly and reassembly of any one of the sub-assemblies without the disassembly of another sub-assembly. If complete disassembly of the system is required for cleaning or inspection, start with the removal of the system from the outboard, then proceed to the **Power Unit Disassembly, Trim Cylinder Disassembly**, and then **Manifold Pressure Operated Check Disassembly**.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to ensure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

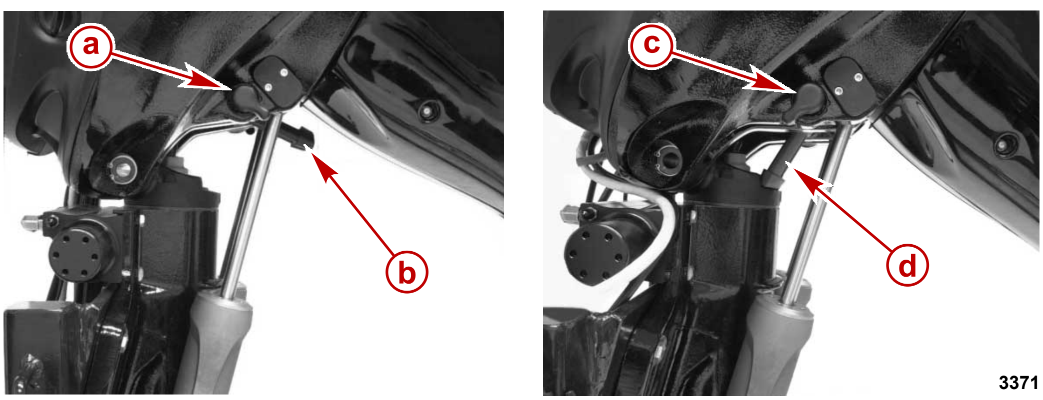
Seals

As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) on all O-rings. To prevent wear, apply 2-4-C with PTFE on I.D. of oil seals.

Power Trim System

Power Trim System Removal

Trim the engine up and engage the tilt lock lever. Momentarily actuate the trim switch in the opposite direction from the last operation to relieve the pressure in the system.



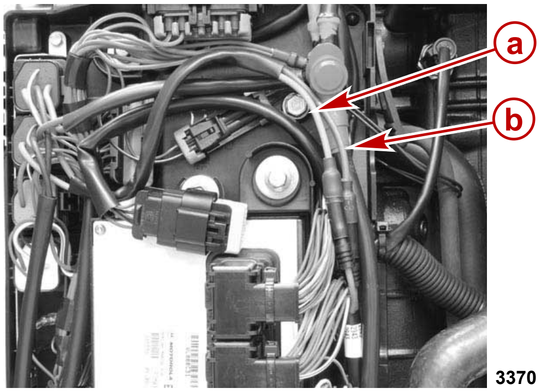
a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged
c - Tilt lock lever engaged
d - Tilt lock bracket engaged

Power Trim Harness

1. Disconnect the trim motor harness (blue and green) bullet connectors located in the electrical box.
2. Remove the power trim harness grommet from the mount cradle. Remove the grommet from the harness.

   NOTE: Tape a fish wire to the power trim leads before removing. The wire will be used during installation to pull the power trim leads through the cowl area.

3. Pull the power trim motor harness through the grommet in the mount cradle.



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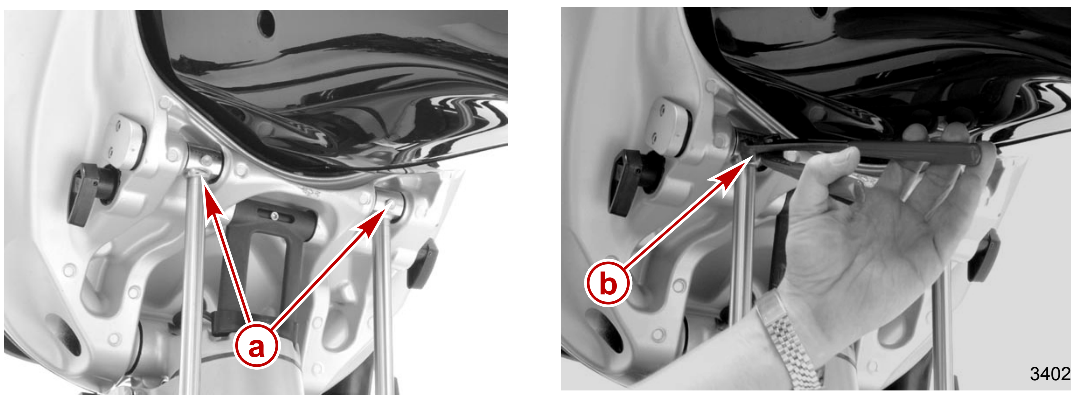
a - Green wire
b - Blue wire

4. Remove the fish wire from the power trim leads. Leave the fish wire in the mount cradle for installation.

Trim Cylinder Rod Ends

1. Use Oetiker® crimp tool pliers to remove the two trilobe cross pins from the upper pivot pins.

   NOTE: The lower chap may be removed to aid in the cross pin removal.



3402

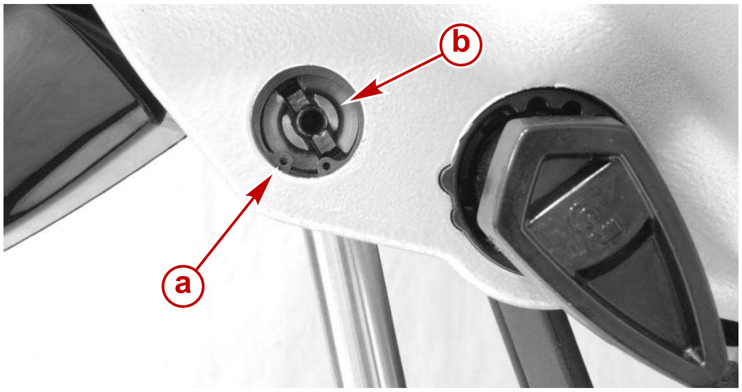
a - Trilobe pin
b - Oetiker® pliers

2. Remove the two screws securing the trim sensor (T27 Torx bit). Use the screws to remove the sensor from the mount cradle.

3401

a - Trim sensor

3. Remove the snap ring from the starboard and port pivot pins.



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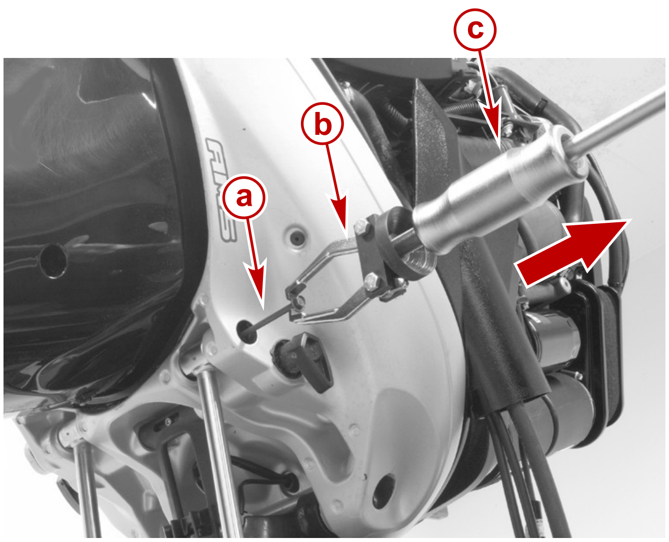
a - Starboard pivot pin
b - Snap ring

4. Thread a 6 mm screw with a washer into the starboard pivot pin. Using a slide hammer and jaws assembly, pull against the screw/washer and remove the pivot pin.



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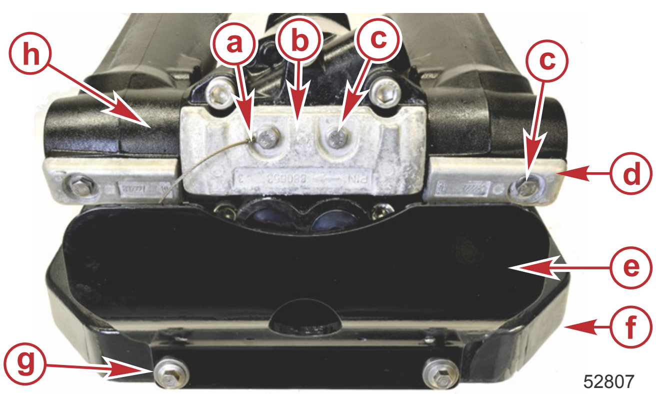
a - 6 mm screw and washer
b - Jaws
c - Slide hammer

Slide Hammer	91-34569A 1

Power Trim Assembly

1. Remove the splash plate and ground cable.



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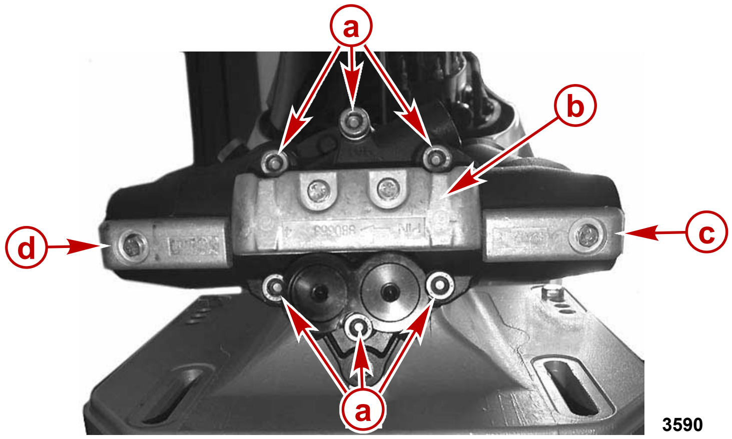
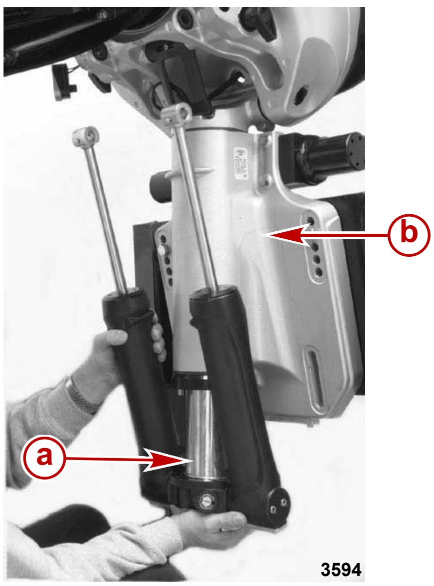
a - Ground cable
b - Anode
c - Screw and washer (M6 x 16) (4)
d - Anode (2)
e - Splash plate
f - Pedestal
g - Flange head screw and washer (M8 x 12) (2)
h - Power trim assembly

2. Remove five of the six mounting screws from the bottom of the power trim assembly. Leave one screw in place to prevent the power trim assembly from falling.



a - Power trim mounting screws
b - Power trim assembly
c - Starboard trim cylinder
d - Port trim cylinder

3. Support the power trim assembly while removing the remaining screw. Remove the power trim assembly from the pedestal.

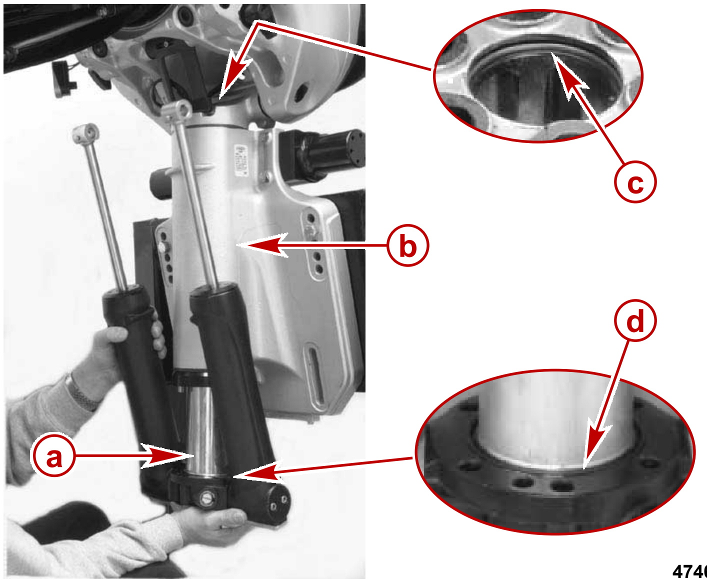


a - Power trim assembly
b - Pedestal

Power Trim System Installation

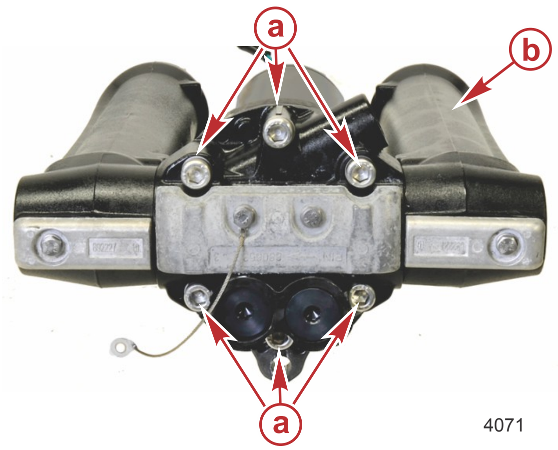
1. Retape the power trim harness to the fish wire used for removal. Pull the fish wire up through the pedestal and the hole in the mount cradle.
2. Ensure that the O-ring is in place in the steering head.
3. Ensure that the steering tube O-ring is in place on the manifold base.

4. Install the power trim assembly into the pedestal.



a - Power trim assembly
b - Pedestal
c - Steering head O-ring
d - Steering tube O-ring

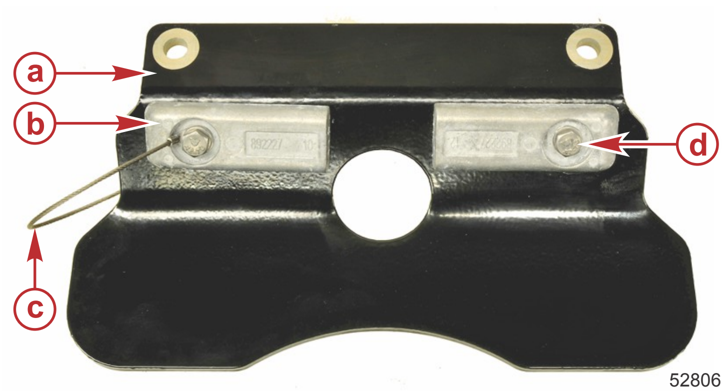
5. Install the six screws into the bottom of the power trim assembly. Tighten the screws to the specified torque.



a - Mounting screw (8 mm internal hex)
b - Power trim manifold

Description	Nm	lb-in.	lb-ft
Power trim assembly mounting screws	47.5	–	35

6. Attach the two anodes and ground cable to the splash plate. Tighten the screws to the specified torque.

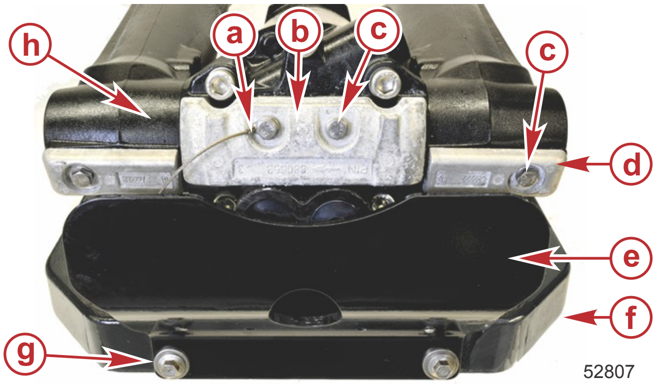


a - Splash plate
b - Anode (2)
c - Ground cable
d - Screw and washer (M6 x 16) (2)

Description	Nm	lb-in.	lb-ft
Anode mounting screw (M6 x 16)	5.6	50	–

7. Secure the ground cable to the power trim assembly. Tighten the screws to the specified torque.

8. Attach the splash plate to the pedestal. Secure the plate with two screws and washers. Tighten the screws to the specified torque.

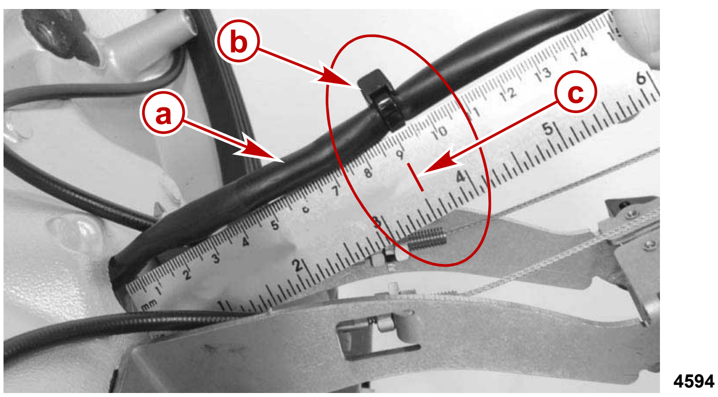


- a - Ground cable
- b - Anode
- c - Screw and washer (M6 x 16) (4)
- d - Anode (2)
- e - Splash plate
- f - Pedestal
- g - Flange head screw and washer (M8 x 12) (2)
- h - Power trim assembly

Description	Nm	lb-in.	lb-ft
Anode mounting screws (M6 x 16) (4)	5.6	50	–
Splash plate mounting screws (M8 x 12) (2)	14	124	–

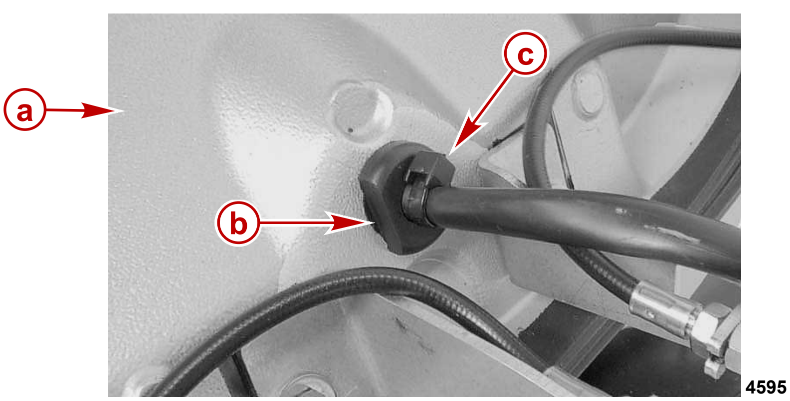
Power Trim Harness

1. Continue pulling the fish wire to route the power trim motor harness up through the hole in the mount cradle to the bullet connectors in the electrical component box. Remove the fish wire from the harness.
2. Attach a cable tie on the harness a distance of 18.5 cm (7.25 in.) from the reservoir fill cap. With the mount cradle attached, place the cable tie 9.0 cm (3.5 in.) from the cradle top surface when trimmed fully up.



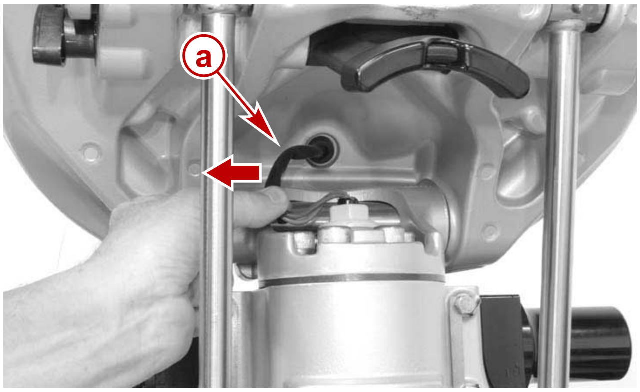
- a - Power trim harness
- b - Cable tie
- c - Measured distance

3. Place the power trim grommet on the harness below the cable tie.
4. Push the grommet and harness into the mount cradle. As the grommet is pushed in, rotate the grommet so the flat edge faces either side of the engine when installed.



- a - Mount cradle
- b - Grommet - flat edge facing side of engine
- c - Cable tie

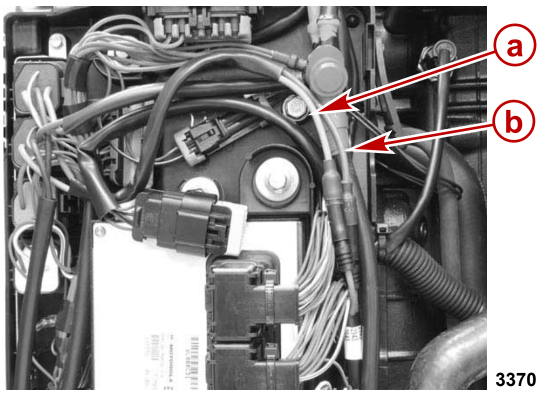
5. To ensure that the harness will coil when the mount cradle is trimmed down, gently pull on the harness to check that it is off-center.



4596

a - Power trim harness (pulled towards side of engine)

6. Connect trim motor harness (blue and green) bullet connectors.

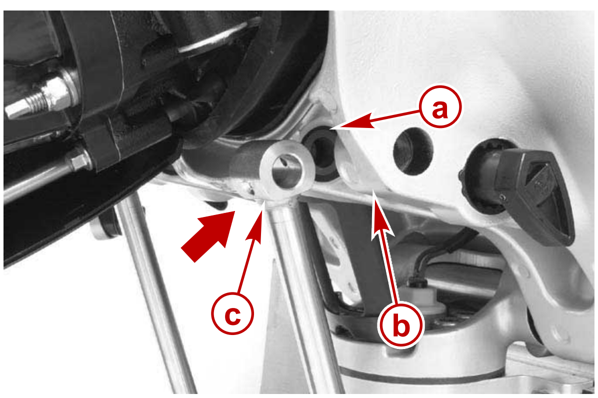


3370

a - Green wire
b - Blue wire

Trim Cylinder Rod Ends

1. Ensure that the four rod end bearings are in place in the mount cradle lugs.
2. Position the port and starboard trim cylinder rod ends into the mount cradle.

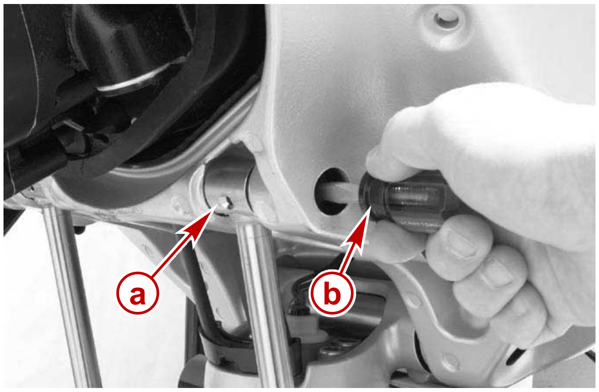


3659

a - Trim cylinder rod end bearing (4)
b - Mount cradle lug
c - Trim cylinder rod end

3. Install the port and starboard pivot pins.

4. Using a screwdriver, align the hole in the pivot pin with the hole in the trim cylinder rod end.

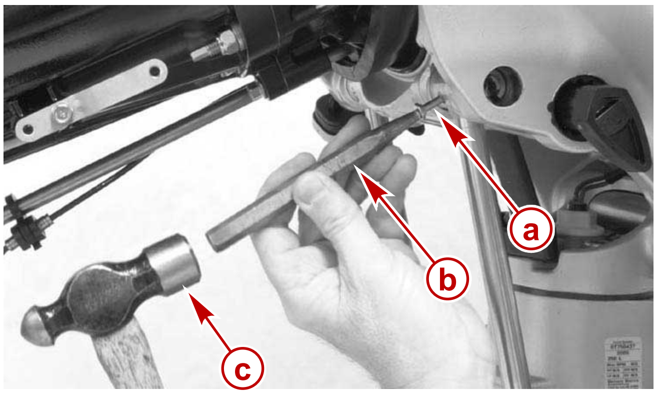


3661

a - Trim cylinder rod end
b - Screwdriver

5. Using a brass drift or soft metal hammer, install new trilobe pins fully into the trim cylinder rod ends and upper pivot pins.

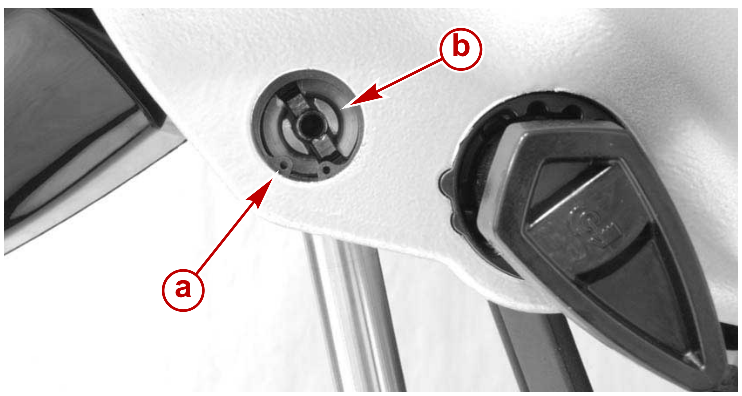
NOTE: Do not use a steel drift punch to install trilobe cross pins. It may cause corrosion to develop on the pins.



3660

a - Trilobe pin
b - Brass drift punch
c - Hammer

6. Install a snap ring in the mount cradle to secure each pivot pin. Ensure that the snap ring is fully seated in the snap ring groove.



3589

a - Starboard pivot pin
b - Snap ring

7. Install the trim sensor in the port side of the mount cradle. Align the tang on the sensor with the slot in the pivot pin.

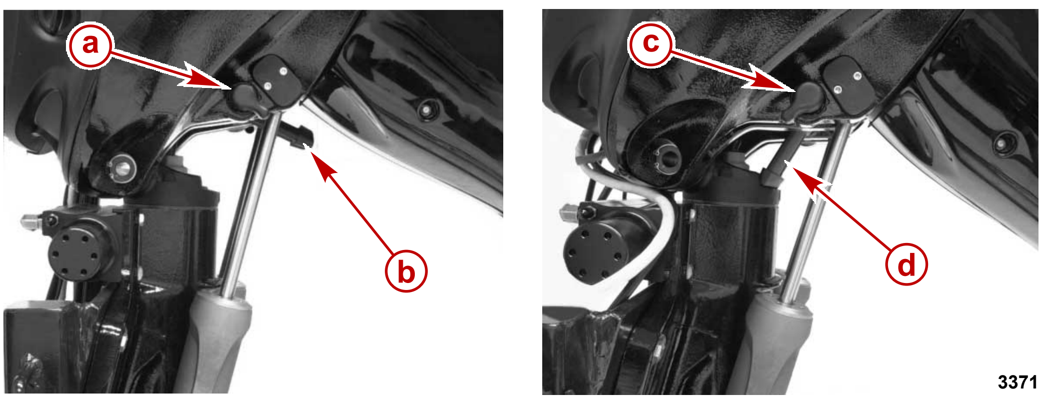
8. Apply Loctite 271 Threadlocker to the sensor screws. Tighten the sensor screws to the specified torque.

a - Trim sensor

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Power trim sensor screws	92-809819

Description	Nm	lb-in.	lb-ft
Power trim sensor screws	4	35	–

9. Install the lower chaps if removed during disassembly.
10. Trim the engine up slightly and disengage the tilt lock lever.



a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged
c - Tilt lock lever engaged
d - Tilt lock bracket engaged

11. Trim the outboard down.

Purging the Power Trim System

Purge air from the power trim system. Refer to **Check Fluid and Purge the Power Trim System.**

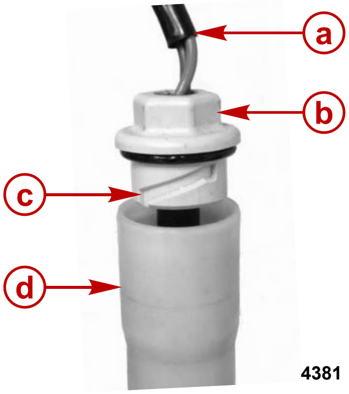
Power Unit

Power Unit Disassembly

Remove power trim system from outboard. Refer to **Power Trim System Removal** .

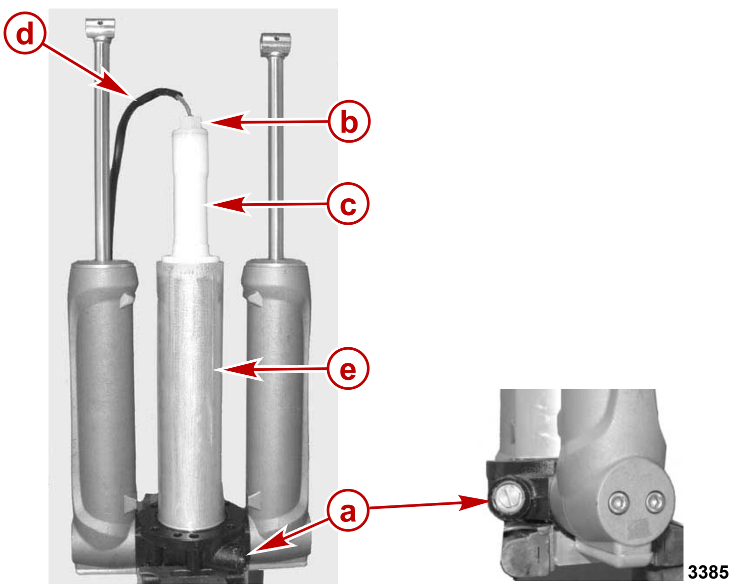
Draining the System

1. Remove reservoir cap from reservoir neck. The reservoir cap only requires 1/4 turn to remove.



a - Power trim harness
b - Reservoir cap
c - Quarter turn channel
d - Reservoir neck

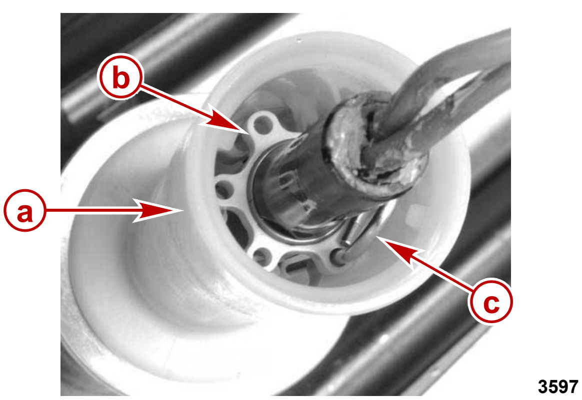
2. Remove reservoir cap from harness.
3. Drain fluid from reservoir.
4. Remove snap ring and manual release valve. Allow additional fluid to drain from internal components.



a - Manual release valve
b - Reservoir cap
c - Reservoir neck
d - Power trim motor harness
e - Reservoir

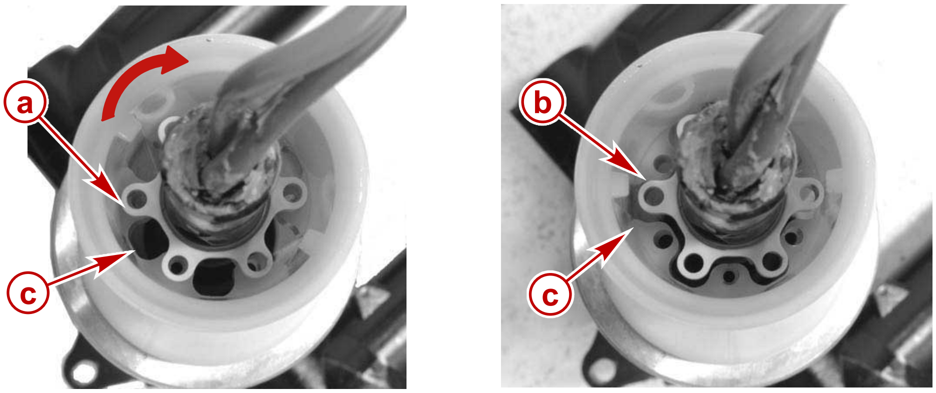
Reservoir

1. Remove locking pin from reservoir neck.



a - Filler neck
b - Retaining ring
c - Retaining pin

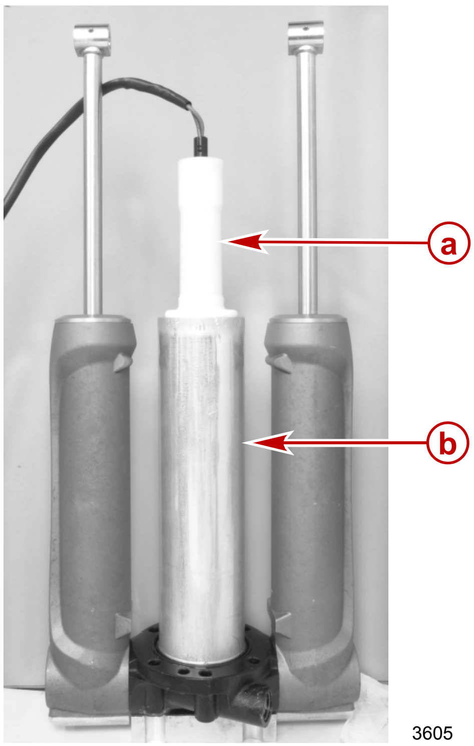
2. Rotate reservoir neck to align slots in reservoir neck to match outline of locking ring.



3598

a - Locking ring in locked position - not aligned with slots in reservoir neck
b - Locking ring aligned with slots in reservoir neck
c - Reservoir neck

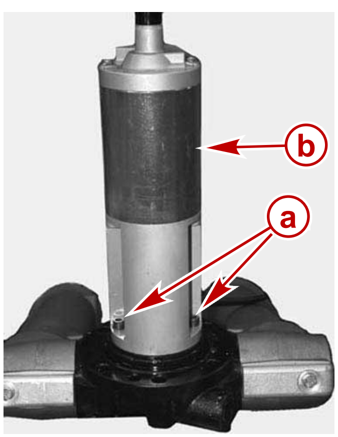
3. Remove reservoir neck. It may be necessary to wiggle the reservoir neck to break the seal.
4. Remove aluminum reservoir.



3605

a - Reservoir neck
b - Aluminum reservoir

5. Remove two motor mounting screws securing trim motor assembly. Remove trim motor.

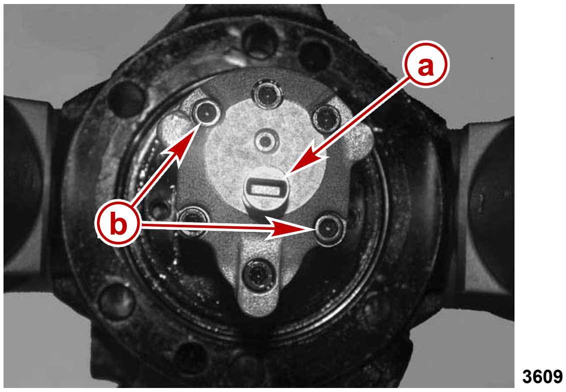


3607

a - Motor mounting screws (4.5 mm internal hex)
b - Trim motor

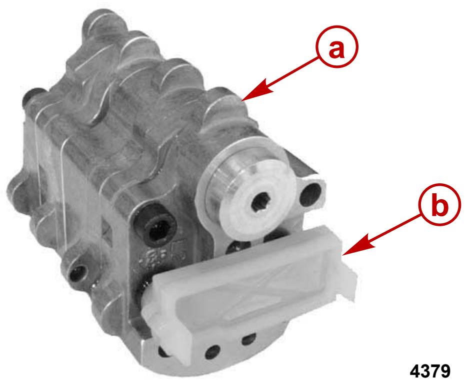
Pump and Filter

1. Remove motor/pump coupling. Remove two trim pump mounting screws securing pump and remove pump.



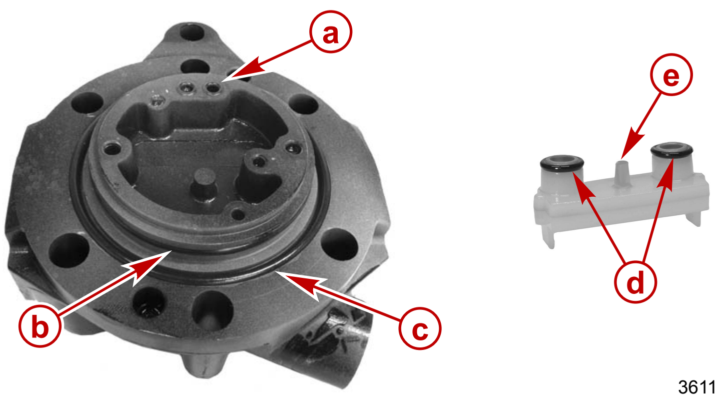
a - Motor/pump coupling
b - Trim pump mounting screws (4.0 mm internal hex)

2. Remove filter assembly from power trim pump.



a - Power trim pump
b - Pump filter

3. Remove and discard O-rings from filter and manifold. Use new O-rings when assembling the power trim components.



a - Pump port O-rings
b - Reservoir base O-ring on diameter
c - Steering tube O-ring on face
d - Pump filter O-rings
e - Guide post for installation

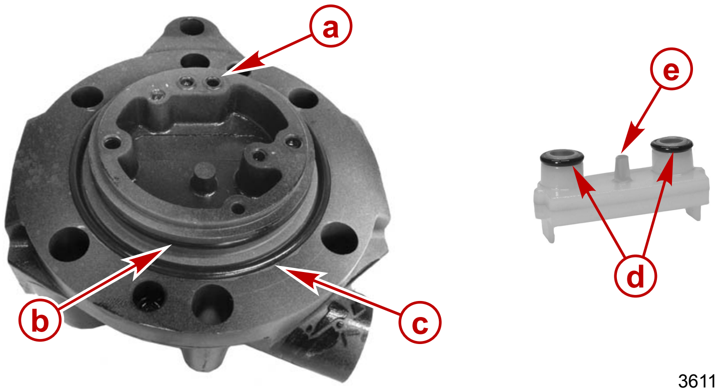
4. Inspect manifold and components for wear and contamination. Clean components if contamination is found.

Power Unit Reassembly

NOTE: *Replace all O-rings with new O-rings when reassembling the power unit. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.*

Pump and Filter

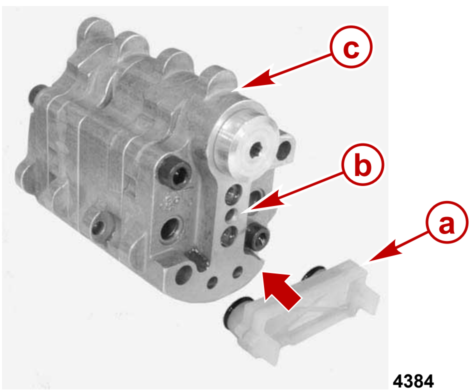
1. Install lubricated O-rings on manifold base. Install lubricated O-rings on pump filter.



3611

- a - Pump port O-rings
- b - Reservoir base O-ring on diameter
- c - Steering tube O-ring on face
- d - Pump filter O-rings
- e - Guide post for installation

2. Install filter on power trim pump. Insert guide post on filter into hole in pump base.

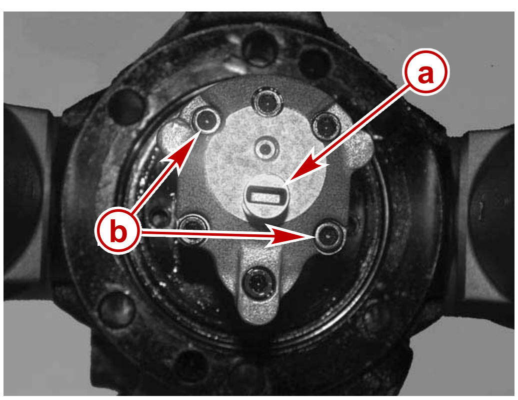


4384

- a - Pump filter
- b - Hole in pump base for filter installation
- c - Power trim pump

3. Install pump assembly onto manifold. Secure with two trim pump mounting screws. Tighten to specified torque.
4. Place motor/pump coupler on the trim pump input shaft.

   NOTE: Coupler ends have different size slots. The small slot installs on pump shaft.



3609

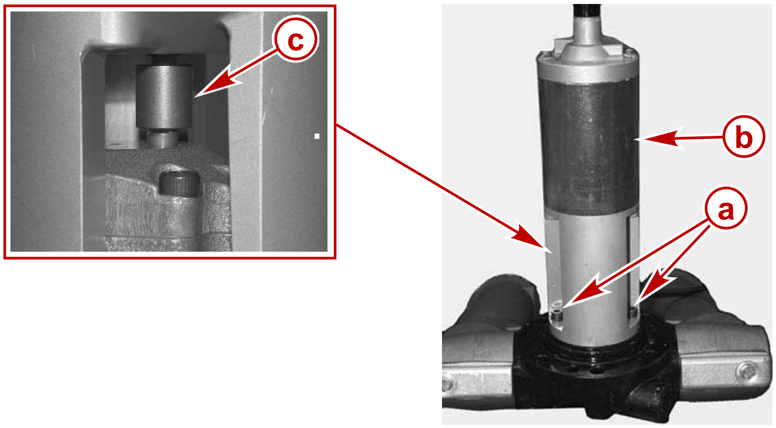
- a - Motor/pump coupler
- b - Trim pump mounting screws (4 mm internal hex)

Description	Nm	lb. in.	lb. ft.
Trim pump mounting screws	8	70	

Trim Motor

1. Place trim motor on the trim pump and manifold while aligning the tang on the motor shaft with the slot in the coupler.
2. Rotate coupler by hand to ensure proper installation of coupler.

3. Secure the power trim motor with two motor mounting screws. Tighten screws to specified torque.



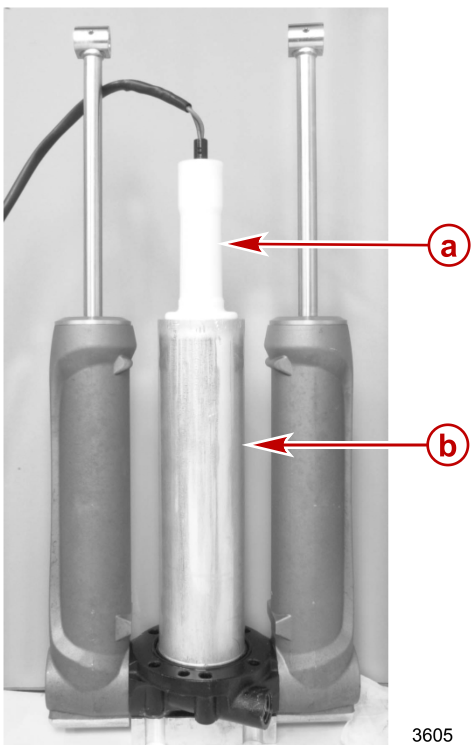
3637

a - Motor mounting screws (4.5 mm internal hex)
b - Trim motor
c - Motor/pump coupler

Description	Nm	lb. in.	lb. ft.
Motor mounting screws	8.5	75	

Reservoir

1. Assemble reservoir neck to reservoir canister. Ensure reservoir neck is fully seated on reservoir.
2. Route electric motor harness through reservoir.

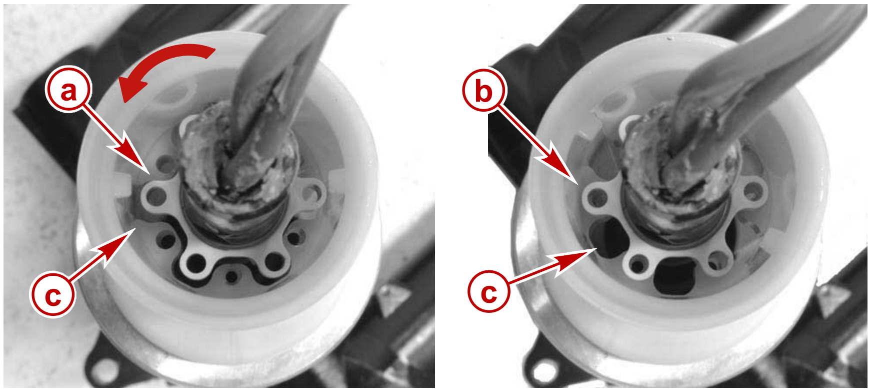


3605

a - Reservoir neck
b - Reservoir

3. Align reservoir neck with locking ring and seat reservoir onto manifold base.

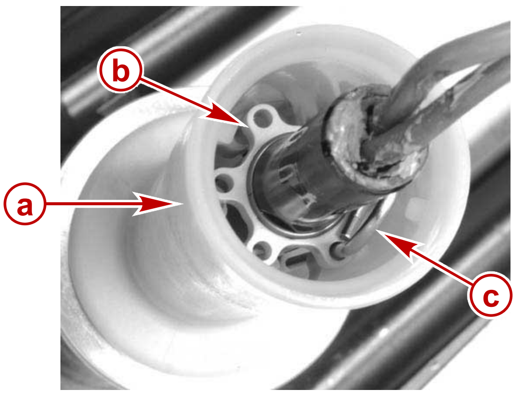
4. Rotate reservoir neck to align locking pin hole with hole in reservoir neck.



3638

a - Locking ring aligned with assembly slot in reservoir neck
b - Locking ring in locked position
c - Reservoir neck

5. Install locking pin through locking ring and reservoir neck.
   IMPORTANT: Recheck engagement of locking pin, locking ring and reservoir neck. Improper assembly of components may result in loss of system fluid.

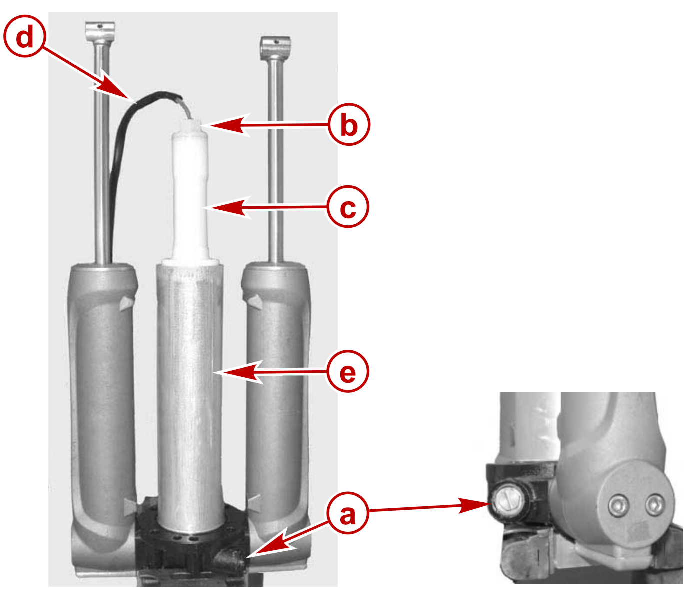


3597

a - Reservoir neck
b - Locking ring
c - Locking pin

Filling and Purging System

1. Install new lubricated O-rings on manual release valve.
2. Install manual relief valve in manifold.
3. Install snap ring securing manual release valve. Verify snap ring is fully seated in groove.
4. Close manual release valve.
5. Fill reservoir through reservoir neck to 25 mm (1 in.) from top of reservoir neck. Use Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III).
6. Route electric motor harness through reservoir neck cap.

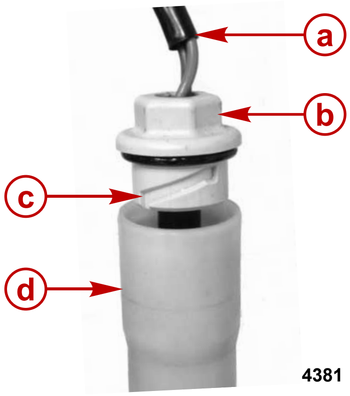


3385

a - Manual release valve
b - Reservoir cap
c - Reservoir neck
d - Power trim motor harness
e - Reservoir

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Manual release valve O-rings and power trim system fluid	92-858074K01

7. Tighten reservoir cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.



a - Power trim motor harness
b - Reservoir cap
c - Quarter turn channel
d - Reservoir neck

8. Connect trim motor harness (blue and green) bullet connectors to a 12 volt power supply.
9. Operate trim system, cycle trim rams up and down several times to remove air.
10. Check for leaks.
11. Check fluid level. Add fluid if necessary to bring fluid to 25 mm (1 in.) from top of reservoir neck. Install reservoir cap.
12. Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

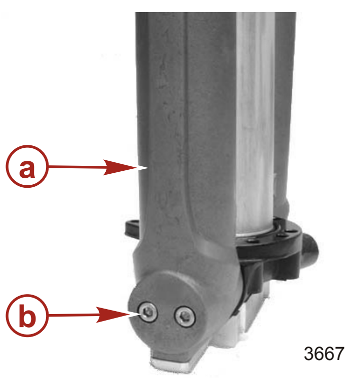
Trim Cylinder and Pivot Pin

Trim Cylinder and Pivot Pin Removal

1. Remove power trim system from outboard. Refer to **Power Trim System Removal** preceding.
2. Drain fluid from the power trim system. Refer to **Power Unit Disassembly** preceding.

Disassembly

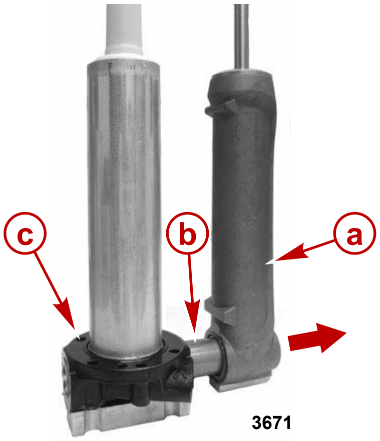
1. Remove two 6 mm internal hex mounting screws securing port trim cylinder to pivot pin.



a - Port trim cylinder
b - Internal hex mounting screws

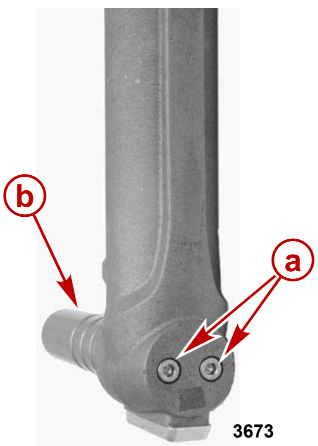
2. Remove port trim cylinder assembly from pivot pin.

3. Remove pivot pin and starboard trim cylinder from manifold.



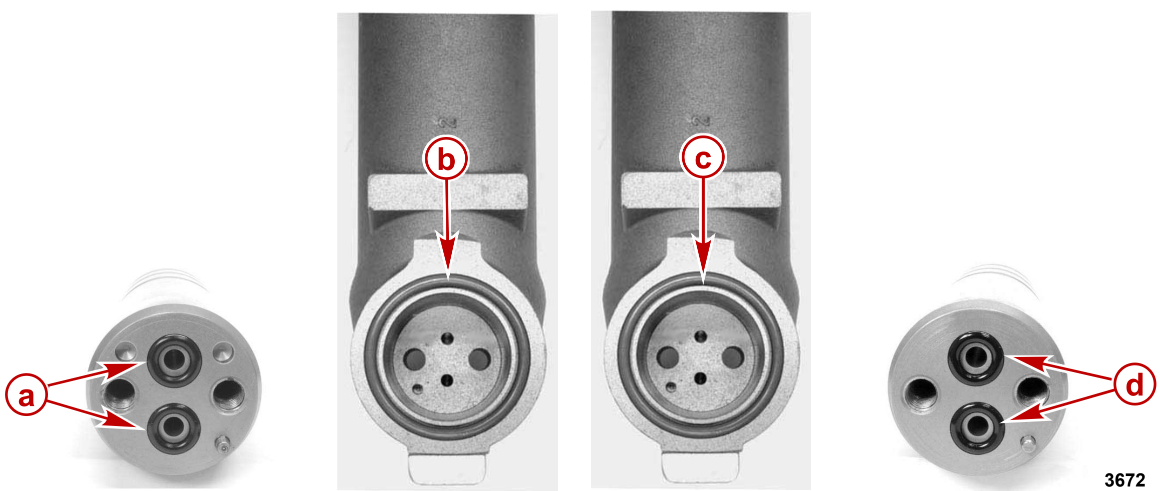
a - Starboard trim cylinder
b - Pivot pin
c - Manifold

4. Remove two 6 mm internal hex mounting screws securing starboard trim cylinder to pivot pin.
5. Remove starboard trim cylinder assembly from pivot pin.



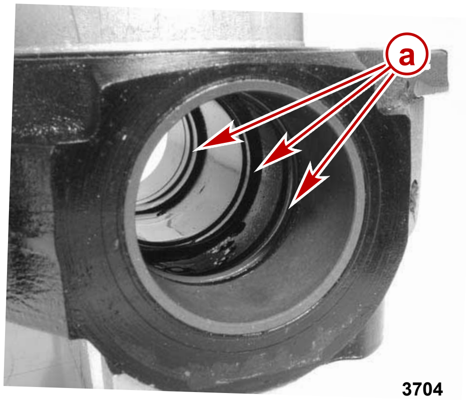
a - Internal hex mounting screws
b - Pivot pin

6. Remove and discard O-rings from pivot pin and trim cylinders.



a - Pivot pin port end O-rings
b - Port trim cylinder O-ring
c - Starboard trim cylinder O-ring
d - Pivot pin starboard end O-ring

7. Remove and discard internal O-rings from the pivot pin bore in the manifold.



3704

a - Manifold O-rings (3)

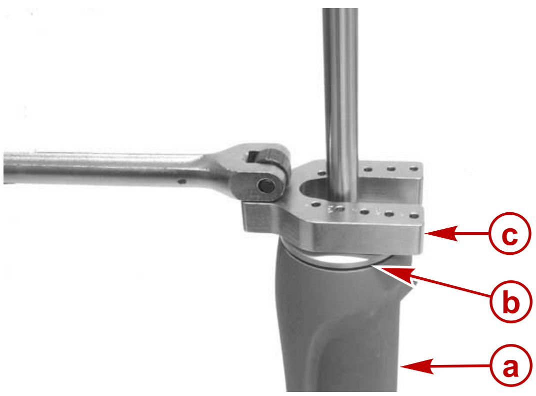
8. Inspect pivot pin for wear.

Trim Cylinder Disassembly

Cylinder Rod

1. Remove end cap from trim cylinder using trim cylinder end cap tool.

   NOTE: Use the 4.57 mm (0.180 in.) diameter pins in the 1.5 in. span position.



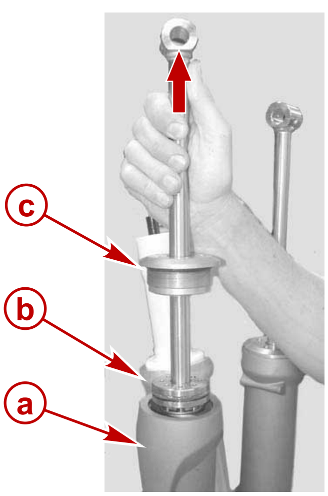
3616

a - Cylinder tube
b - End cap
c - Trim cylinder end cap tool

Trim Cylinder End Cap Tool	91-821709T

2. Remove cylinder rod and shock piston from cylinder tube.

   NOTE: Use a suitable tool (drift punch) to open one of the check valves in the shock piston to break the cylinder suction and ease piston removal.



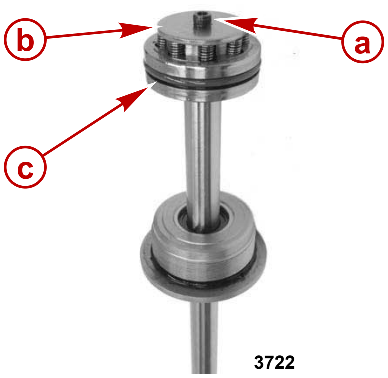
3618

a - Cylinder tube
b - Shock piston
c - End cap

Shock Piston

1. Remove and discard O-ring from shock piston.

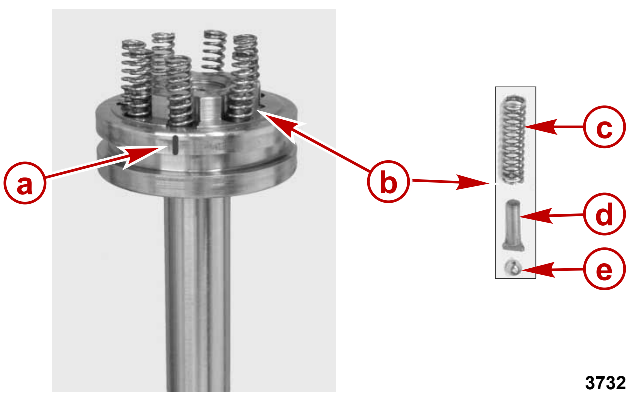
2. Remove 4 mm internal hex screw securing retaining plate from cylinder rod piston.



3722

a - 4 mm internal hex screw
b - Retaining plate
c - O-ring

3. Mark check ball cavity with marker. This is number 1 cavity. Moving in a clockwise direction, the remaining check components are numbered 2 through 7.
4. Remove check ball components from first shock piston cavity. Keep components from each cavity separate from each other and numbered from 1 through 7. Proceed in a clockwise pattern to remove remaining check ball components from each cavity.

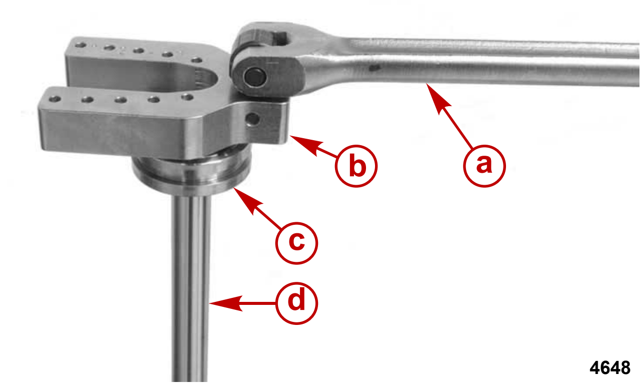


3732

a - Mark for number 1 cavity
b - Check ball components
c - Spring
d - Spring guide
e - Ball

5. Place cylinder rod in a soft jawed vise.
6. Loosen shock piston using trim cylinder end cap tool.

   NOTE: Use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner to extend approximately 9.5 mm (0.375 in.).
7. Remove piston from rod.



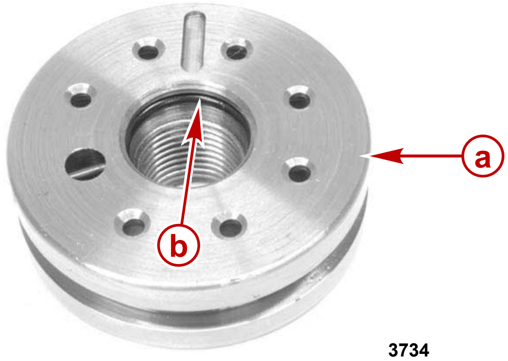
4648

a - Breaker bar
b - Trim cylinder end cap tool
c - Memory piston
d - Cylinder rod

Trim Cylinder End Cap Tool	91-821709T

8. Inspect check valve cavity and components for contamination. Clean components if contamination is found.

9. Remove inner O-ring from shock piston.

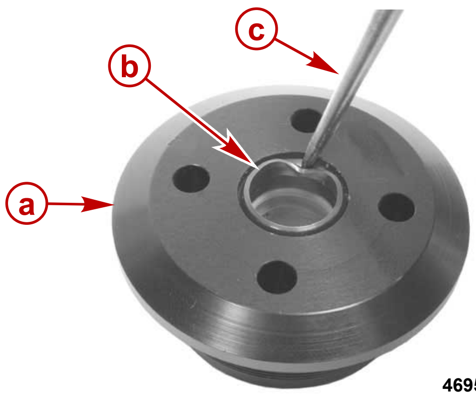


3734

a - Shock piston
b - O-ring

End Cap

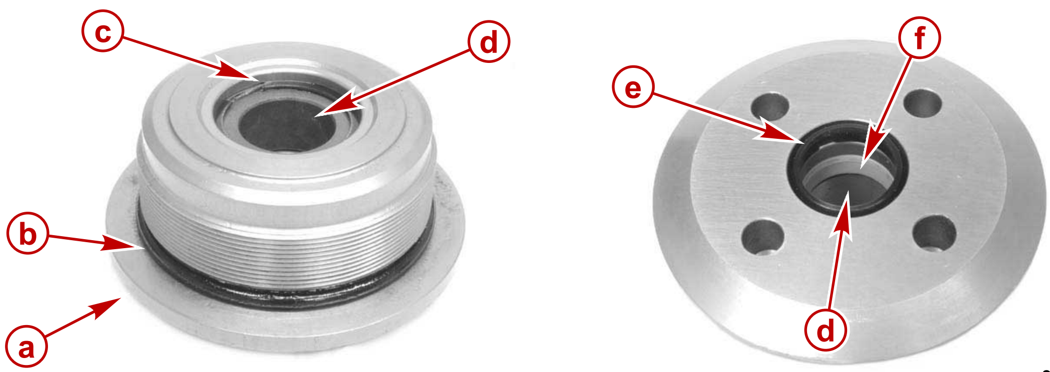
1. Remove cylinder end cap from cylinder rod.
2. Inspect end cap. If cylinder rod wiper has failed to keep rod clean, remove wiper.



4695

a - Cylinder end cap
b - Cylinder rod wiper
c - Pick tool

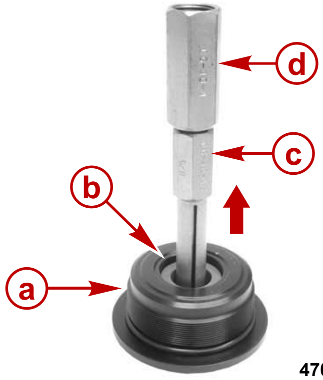
3. Place end cap on clean surface.
4. Remove snap ring from end cap.
5. Remove and discard O-ring.



3735

a - Cylinder end cap
b - O-ring
c - Snap ring
d - Cylinder rod wiper
e - Rod seal
f - Bushing

6. Using collet and expanding rod, remove and discard bushing and rod seal.

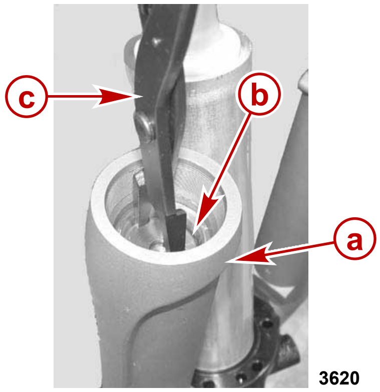


4706

- a - Trim cylinder end cap
- b - Bushing and seal
- c - Collet (CG-40-A6)
- d - Expanding rod (CG-40-4)

Memory Piston

1. Using lock ring pliers, remove memory piston from cylinder tube.



3620

- a - Cylinder tube
- b - Memory piston
- c - Lock ring pliers

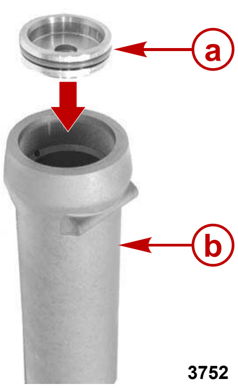
2. Remove and discard O-ring from memory piston.
3. Inspect components for wear and damage. Replace as required.

Trim Cylinder Reassembly

NOTE: Replace all O-rings with new O-rings when reassembling the trim cylinders and pivot pin. Lubricate the O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

Memory Piston

1. Install a new lubricated O-ring on the memory piston.
2. Install the memory piston into the cylinder tube.



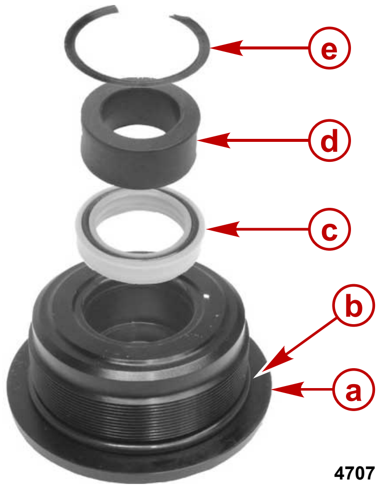
3752

- a - Memory piston
- b - Cylinder tube

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Memory piston O-ring	92-858074K01

End Cap

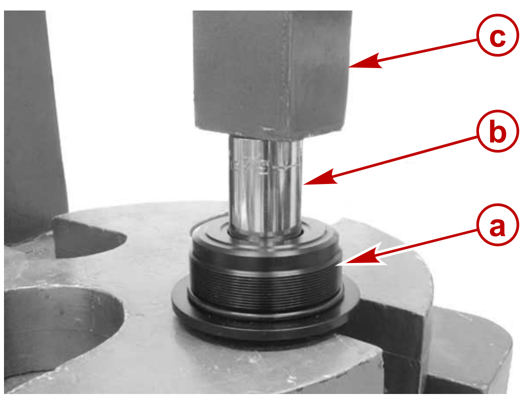
1. Install a lubricated O-ring onto the end cap.



4707

- a - Trim cylinder end cap
- b - O-ring
- c - Rod seal
- d - Bushing
- e - Snap ring

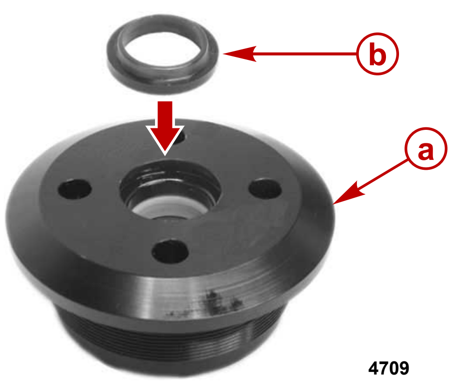
2. With the O-ring facing up, install the rod seal into the trim cylinder end cap using a arbor press and seal driver.
3. Using a seal driver, install the trim cylinder end cap bushing.
4. Install the snap ring.



4708

- a - Trim cylinder end cap
- b - Seal driver
- c - Arbor press

5. Install the cylinder rod wiper.



4709

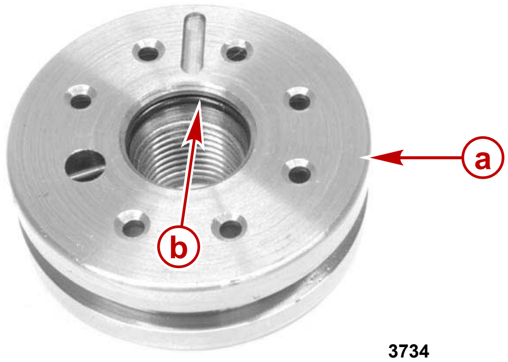
- a - Trim cylinder end cap
- b - Cylinder rod wiper

6. Lubricate rod seal, rod wiper, bushing, threads of end cap, and O-ring. Install the end cap onto the cylinder rod.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Rod seal, rod wiper, bushing, and O-ring	92-858074K01

Shock Piston and Cylinder Rod

1. Install a new lubricated inner O-ring onto the shock piston.



3734

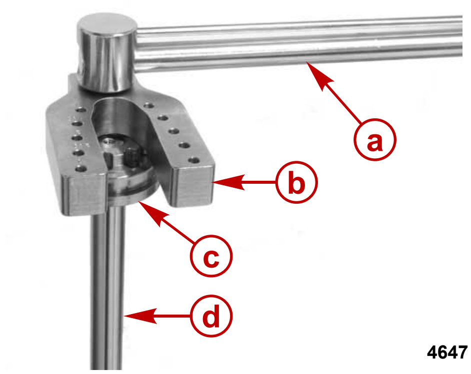
a - Shock piston
b - O-ring

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Shock piston O-ring	92-858074K01

2. Thread the shock piston onto the cylinder rod. Tighten the shock piston to the specified torque.

   NOTE: Assemble a torque wrench and a trim cylinder end cap tool 90 degrees to each other to obtain the most accurate torque reading.

   NOTE: Use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner to extend approximately 9.5 mm (0.375 in.).



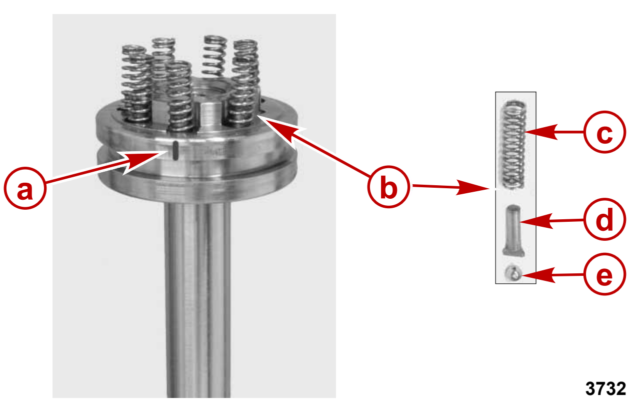
4647

a - Torque wrench
b - Trim cylinder end cap tool
c - Shock piston
d - Trim cylinder rod

Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb. in.	lb. ft.
Shock piston	122		90

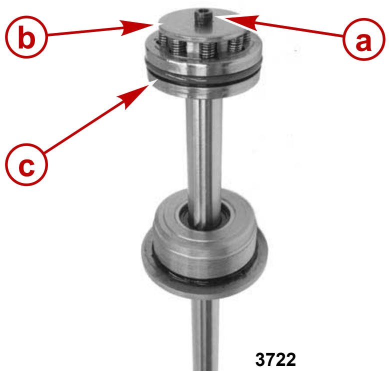
3. Install the retained check ball components in their respective cavity. Install number 1 set of spring, spring guide, and ball into cavity 1. Repeat in the same order as disassembled for sets 2 through 7.



3732

a - Mark for number 1 cavity
b - Check ball components
c - Spring
d - Spring guide
e - Ball

4. Secure the check ball spring retaining plate with a 4 mm internal hex screw. Tighten to the specified torque.
5. Install a new lubricated O-ring onto the shock piston.

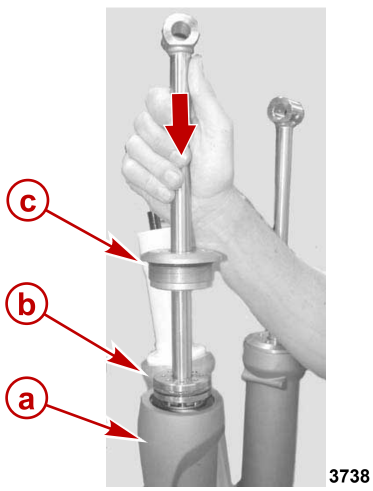


a - 4 mm internal hex screw
b - Spring retaining plate
c - O-ring

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Shock piston O-ring	92-858074K01

Description	Nm	lb. in.	lb. ft.
Spring retaining plate screw	6.8	60	

6. Install assembled cylinder rod into cylinder tube.

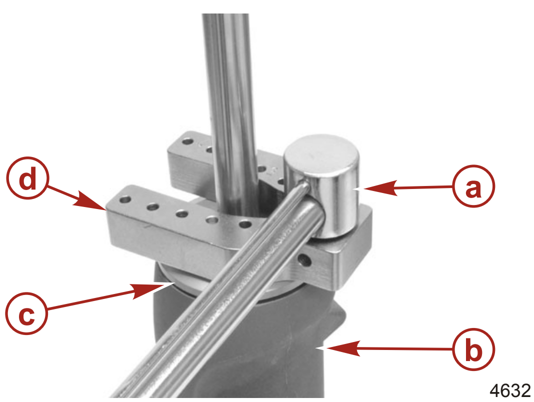


a - Cylinder tube
b - Shock piston
c - End cap

7. Thread the end cap into the cylinder tube. Tighten the end cap to the specified torque.

NOTE: Assemble a torque wrench and a trim cylinder end cap tool 90 degrees to each other to obtain the most accurate torque reading.

NOTE: Use the 4.57 mm (0.180 in.) diameter pins in the 1.5 in. span position.



a - Torque wrench
b - Cylinder tube
c - End cap
d - Trim cylinder end cap tool

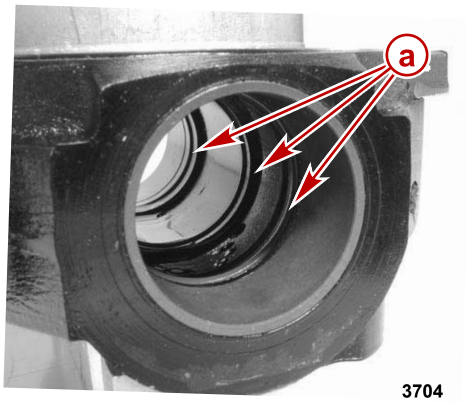
Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb. in.	lb. ft.
Cylinder end cap	61		45

Trim Cylinder and Pivot Pin Installation

NOTE: Replace all O-rings with new O-rings when reassembling the trim cylinders and pivot pin. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

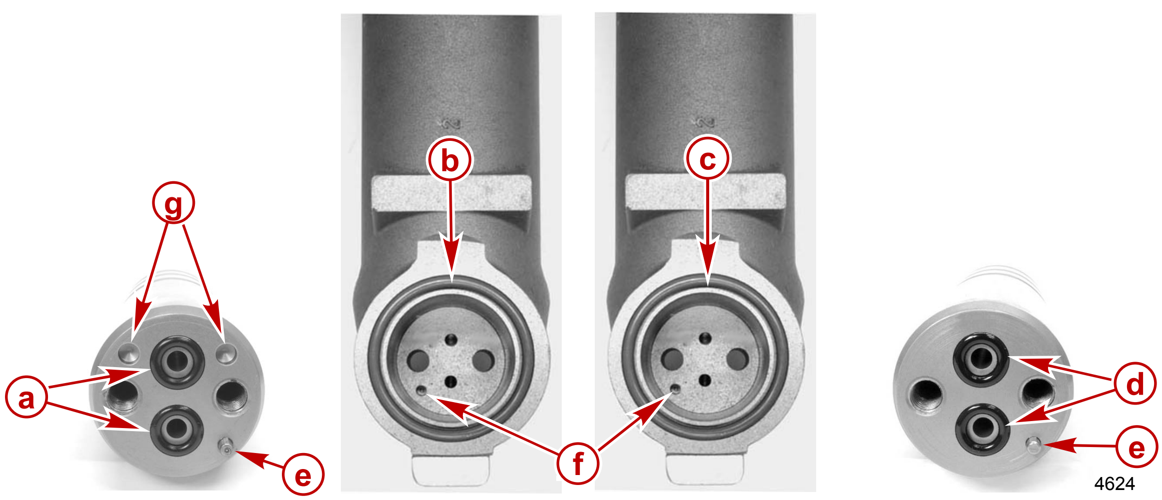
1. Lubricate O-rings and wear bushings inside of manifold.
2. Install lubricated O-rings in the pivot pin bore in the manifold.



a - Manifold O-rings (3)

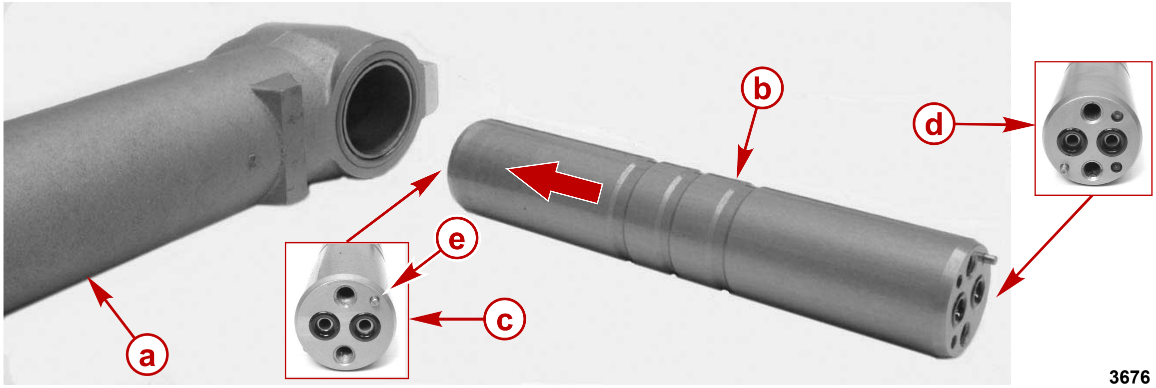
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Manifold bushings and O-rings	92-858074K01

3. Install lubricated O-rings on pivot pin and trim cylinders.



a - Pivot pin port end O-ring
b - Port trim cylinder O-ring
c - Starboard trim cylinder O-ring
d - Pivot pin starboard end O-ring
e - Pivot pin locating pin
f - Trim cylinder locating hole
g - Identification marks on port end of pivot pin

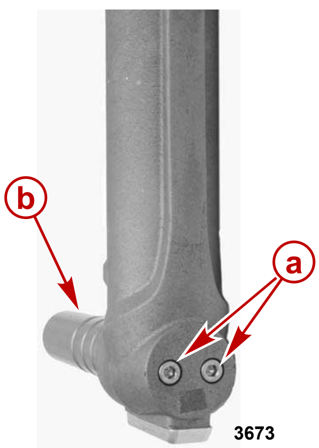
4. Install starboard end of pivot pin into starboard trim cylinder. Ensure that locating pin on end of pivot pin engages hole in trim cylinder.



a - Starboard trim cylinder
b - Pivot pin
c - Starboard end of pivot pin
d - Port end of pivot pin
e - Locating pin

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Pivot pin and trim cylinder O-rings	92-858074K01

5. Secure starboard trim cylinder to pivot pin with two 6 mm internal hex screws. Tighten screws to specified torque.



a - Starboard trim cylinder mounting screws
b - Pivot pin

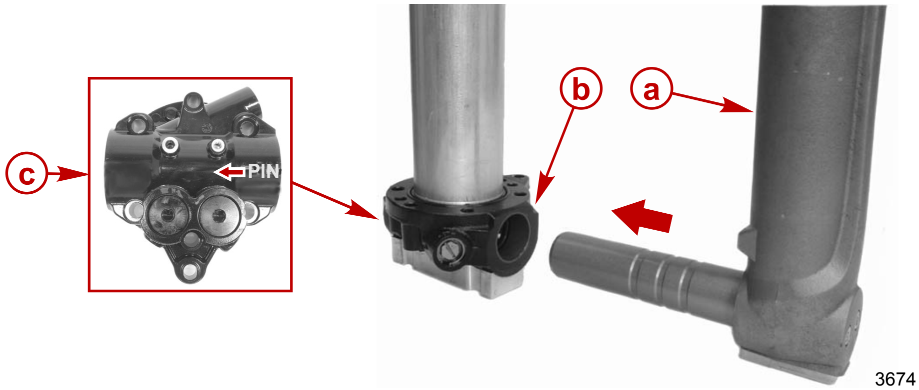
Description	Nm	lb. in.	lb. ft.
Internal hex mounting screws	26		19.2

6. Lubricate O-ring in pivot pin bore in manifold and pivot pin.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Manifold O-rings and pivot pin	92-858074K01

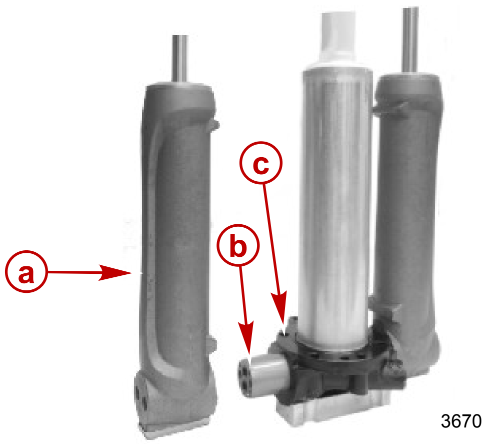
7. Ensure that 3 O-rings are installed in the manifold pivot pin bore.
8. Install pivot pin and starboard trim cylinder into starboard end of manifold.

NOTE: Manifold has an arrow indicating direction of pivot pin insertion.



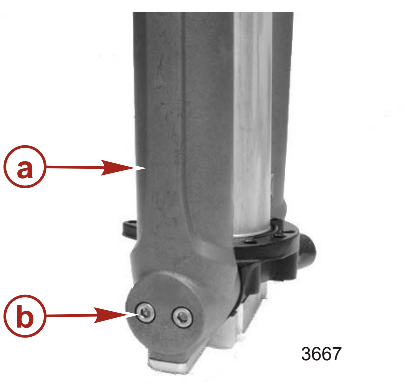
a - Starboard trim cylinder
b - Manifold
c - Bottom side of manifold showing arrow

9. Install port trim cylinder assembly to pivot pin. Ensure that 2 O-rings are in place on port end of pivot pin. Ensure that small pin on end of pivot pin engages hole in trim cylinder.



a - Port trim cylinder
b - Pivot pin
c - Manifold

10. Secure port trim cylinder to pivot pin with two 6 mm internal hex bolts. Tighten bolts to specified torque.



a - Port trim cylinder
b - Trim cylinder mounting bolts

Description	Nm	lb. in.	lb. ft.
Trim cylinder mounting bolt	26		19.2

11. Fill power trim system with Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid. Refer to **Check Fluid and Purge the Power Trim System** for instructions.

System Installation

Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

Pressure Operated Check Manifold

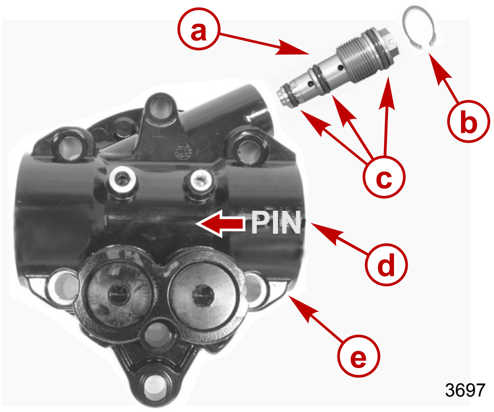
Manifold Disassembly

Removing and Draining the Power Trim System

1. Remove power trim system from outboard. Refer to **Power Trim System Removal** .
2. Drain fluid from the power trim system. Refer to **Power Unit Disassembly** .

Manual Release Valve

1. Remove manual release snap ring from manifold.
2. Remove manual release valve from manifold.
3. Discard 3 O-rings from manual release valve.

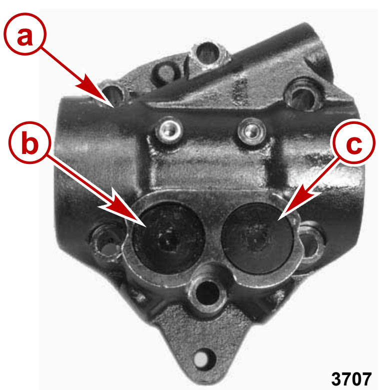


a - Manual release valve
b - Snap ring
c - O-rings
d - Pivot pin insertion direction
e - Manifold

4. Inspect components for wear and contamination. Replace if required.

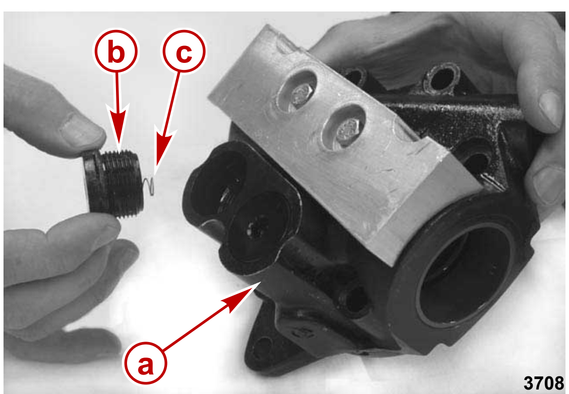
Pressure Operated Check Valve

1. Remove plugs (5/16 in. internal hex) from pressure operated check valve manifold.



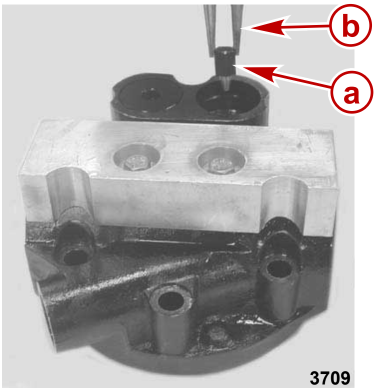
a - Manifold
b - Plug - trim up check valve assembly
c - Plug - trim down check valve assembly

2. Remove plug and spring.



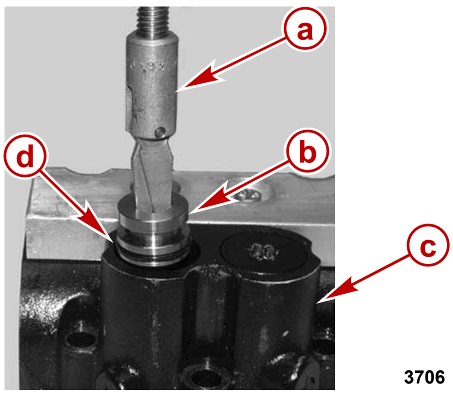
a - Manifold
b - Plug
c - Spring

3. Using a needle nose pliers, remove poppet.



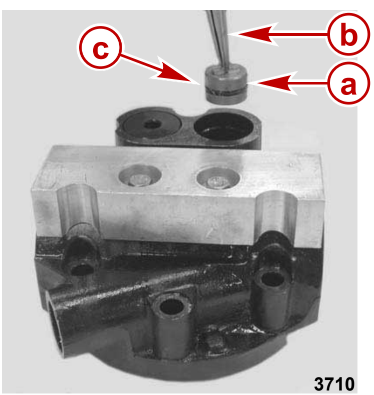
a - Poppet
b - Needle nose pliers

4. Remove the hex check seat. Remove and discard O-ring.



a - Check seat removal tool (Snap-On p/n CJ-93-4)
b - Check valve
c - Manifold
d - O-ring

5. Remove shuttle spool from manifold. Remove and discard O-ring.



a - Shuttle spool
b - Needle nose pliers
c - O-ring

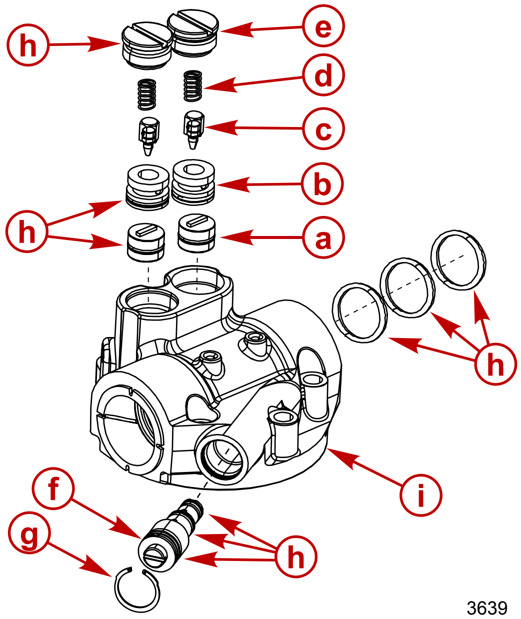
6. Inspect components for wear and contamination. Replace if required.

Manifold Reassembly

NOTE: Replace all O-rings with new O-rings when reassembling the manifold pressure operated check components. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

1. Place a lubricated shuttle spool in each pressure operated check cavity.
2. Position the shuttle spool into place with needle nose pliers.
3. Place a lubricated check seat in each cavity.
4. Press the check seats into place using Snap-On check seat tool (CJ-93-4).
5. Place a poppet in each cavity.
6. Dip the end of each spring into petroleum jelly and place in the counterbore of retainer plug.
7. Install a retainer plug and spring into each cavity.

8. Tighten the retainer plug to the specified torque.



a - Shuttle spool
b - Check seat
c - Poppet
d - Spring
e - Retainer plug
f - Manual release valve
g - Snap ring
h - O-ring
i - Manifold

Description	Nm	lb. in.	lb. ft.
Retainer plug	40.7		30

9. Fill power trim system with Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid. Refer to **Check Fluid and Purge the Power Trim System** for instructions.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim system	92-858074K01

System Installation

Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

Notes:

Gear Housing

Section 6A - Right-Hand Rotation (4.8 in. Diameter)

Table of Contents

6
A

Gear Housing Specifications (Standard Rotation)

Gear Housing Specifications (Standard Rotation)	
Gear ratio	
Model 200/225/250/275	1.85:1 (13/24 teeth)
Model 300	1.75:1 (12/21 teeth)
Gearcase capacity	970 ml (32.8 fl oz)
Gear lubricant type	High Performance Gear Lubricant
Pinion height	0.635 mm (0.025 in.)
Forward gear backlash	0.482–0.660 mm (0.019–0.026 in.)
Reverse gear backlash	1.27–1.47 mm (0.050–0.058 in.)
Water pressure at RPM	
at 550 RPM (Idle)	15.2 kPa (2.2 psi)
at 6000 RPM (WOT) warm water fast boat	60 kPa (8.7 psi)
at 6000 RPM (WOT) cold water fast boat	260 kPa (37.8 psi)
Gear housing pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)
Propeller shaft runout	0.23 mm (0.009 in.)

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift cover assembly screws	92-809819
		Pinion gear nut threads	
		Threads of pinion nut	
19	Perfect Seal	Speedometer connector threads	92-34227Q02
87	High Performance Gear Lubricant	Tapered bearing race bore	92-858064K01
		Bearing bore in carrier	
		Inside diameter of driveshaft tapered bearing	
		Inside diameter of the driveshaft tapered bearing	
		Inside diameter of forward gear	
		Pinion bearing bore	
		Forward gear bearing cup bore	
		Gear housing	
91	Engine Coupler Spline Grease	Driveshaft splines	8M0071842

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft splines, retainer threads, O-rings, oil seal lips, pinion needle bearing, water pump housing, driveshaft roller bearing	92-802859A 1
		Forward gear, forward gear race, reverse gear, propeller shaft splines, clutch detent pin, propeller shaft seals, bearing carrier O-ring, bearing carrier contact surfaces, bearing carrier retainer	
		Oil seal lips and between oil seals	
		Oil seal lips and between oil seals	
		Bearing carrier O-ring	
		Seat of the shift shaft cover assembly O-ring diameter and lip of the oil seal	
		O-ring	
		Pinion needle bearings	
		Retainer threads	
		Bearing carrier retainer nut threads and corresponding gear housing threads, bearing carrier O-ring, upper driveshaft bearing retainer threads	
		Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	
		Bearing carrier retainer nut threads and corresponding gear housing threads	
		Oil seal carrier seal lips, space between oil seals, O-ring	
		Flat surface of the impeller key	
		Inside of water pump cover	
		Driveshaft splines; shift shaft splines	
134	Loctite 380	Outer diameter of oil seals	Obtain Locally
		Outer diameter of bearing carrier oil seal	
		Outside diameter of the oil seal	

Special Tools

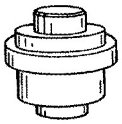
Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates

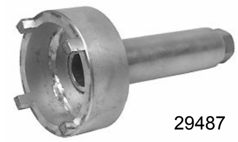
Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

Dial Indicator Adapter	91-83155
 2999	Dial indicator holding fixture.

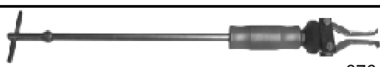
Right-Hand Rotation (4.8 in. Diameter)

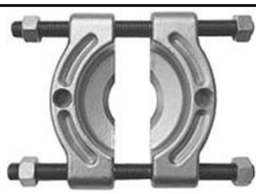
Dial Indicator Holding Tool	91- 89897
 29496	Secures the dial indicator to gear housing when checking backlash.

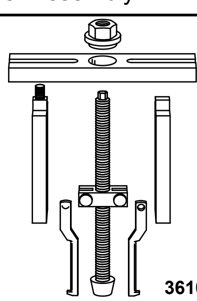
Oil Seal Driver	91-889844T
 29498	Installs seals in driveshaft seal carrier.

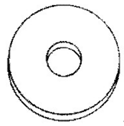
Bearing Carrier Retainer Nut Wrench	91-61069T
 29487	Installs and removes the bearing carrier retainer nut; for use with (15 spline) 1-3/16 inch prop shafts

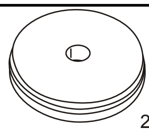
Puller Jaws Assembly	91-46086A1
 9514	Removes bearing carrier and bearing races; use with Puller Bolt (91-85716)

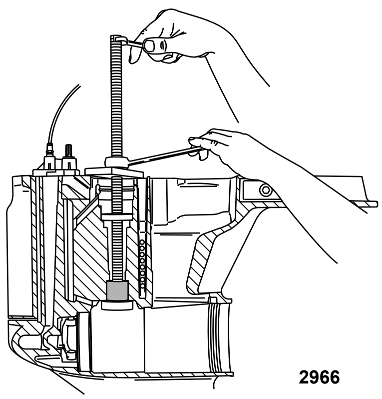
Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components; use with puller jaws

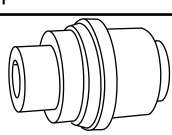
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft

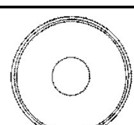
Bearing Puller Assembly	91- 83165T
 3610	Removes bearings, races and bearing carriers

Pilot Washer	91-36571T
 29490	Used in pinion gear and pinion bearing installation

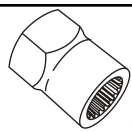
Seal Driver Guide	91-889845
 29590	Aids in the installation of bearing carrier seals

Bearing Removal and Installation Kit	91- 31229A 7
 2966	Installs and removes the bearings in all gearcases 91- 31229A 7 tool assembly includes the following components: 11- 24156 Hex Nut 12- 34961 Washer 91- 15755T Bearing Carrier 91- 29310 Plate 91- 30366T 1 Mandrel 91- 31229 Puller Shaft 91- 32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91- 36569T Driver Head 91- 36571T Pilot Washer 91-37292 Roller Bearing 91- 37311 Driver Head 91- 37312T Driver Head 91- 37323 Driver Head Rod 91- 37324T Pilot Washer 91- 37350T Pilot Mandrel 91- 38628T Puller/Driver Head 91-52393T Driver Needle Bearing 91-52394 Head Pull Rod

Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
 6229	Installs bearing carrier cup and seals

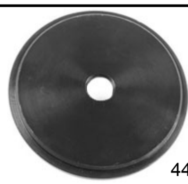
Bearing Cup Driver	91-885592T
 29492	Installs reverse gear bearing cup

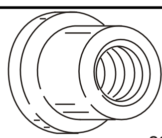
Driveshaft Bearing Retainer Wrench	91-43506T
 9520	Removes and installs the threaded bearing retainer

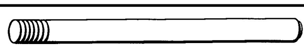
Driveshaft Holding Tool	91-889958T
 28677	Holds driveshaft during pinion nut removal on the Verado models

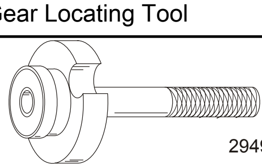
Pinion Nut Wrench	91- 61067T03
 29501	Holds the pinion nut when removing the pinion gear and driveshaft

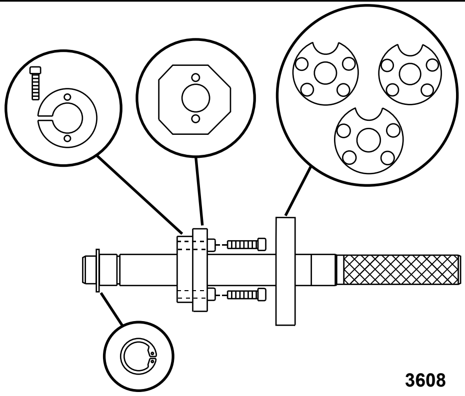
Propeller Shaft/Driveshaft Adapter	91-61077T
 **10805**	Provides a hex surface to turn the propeller shaft. For use with (15 spline) 1-3/16 inch prop

Guide Plate	91-816243
 4481	Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase and the reverse gear bearing on a counter rotation gearcase

Driver Head	91- 36569T
 29499	Used in pinion gear and bearing installation.

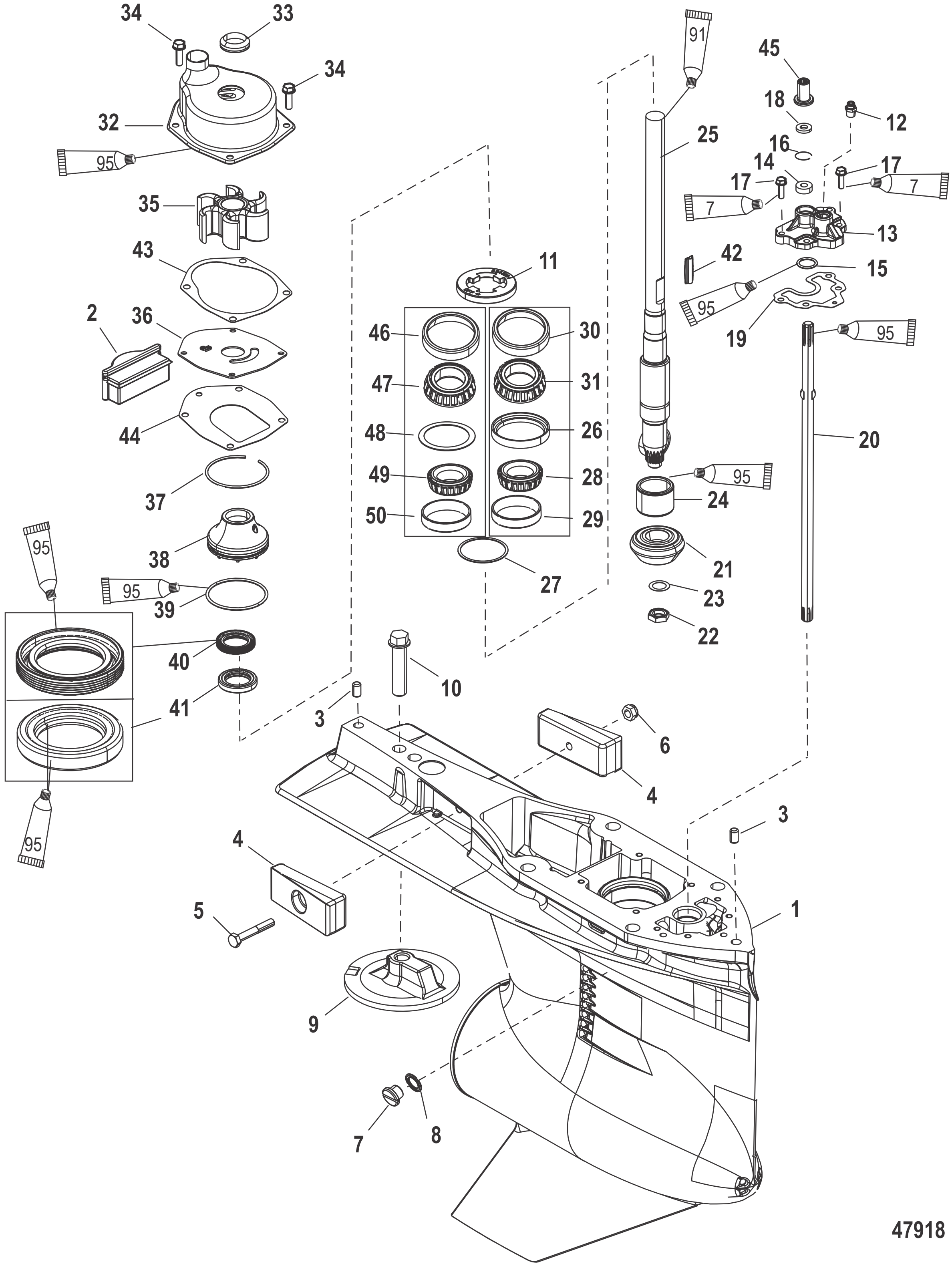
Driver Rod	91- 37323
 25431	Aids in the removal and installation of various bearings and bearing races

Pinion Gear Locating Tool	91- 56048001
 29493	Measures pinion gear height.

Pinion Gear Locating Tool	91- 12349A05
 3608	Measures pinion gear height.

Backlash Indicator Rod	91- 78473
 9450	Aids in checking gear backlash

Gear Housing (Driveshaft)



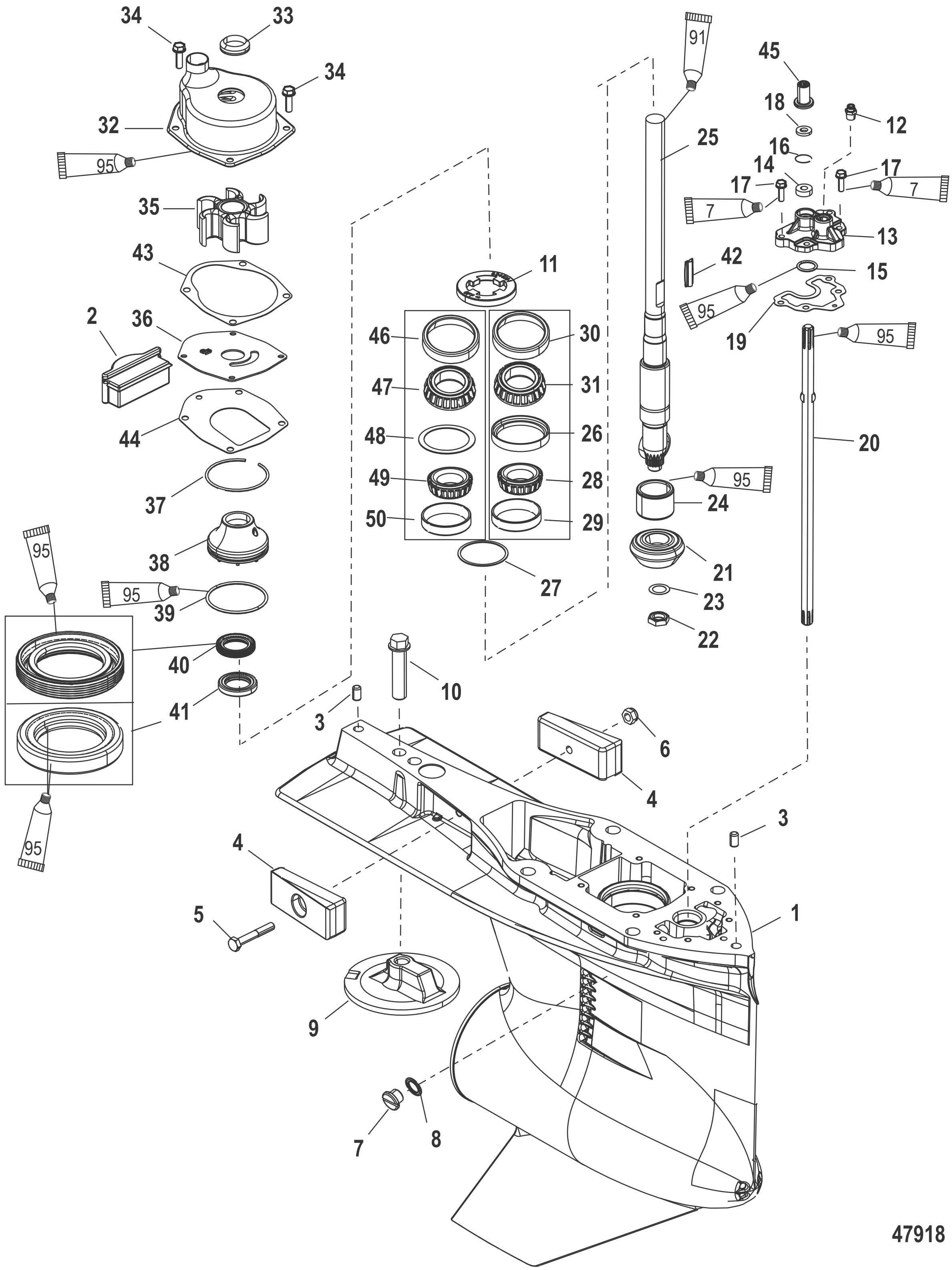
Gear Housing (Driveshaft)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	1	Filler block			
3	2	Dowel pin			
4	2	Anode			
5	1	Screw (M6 x 40)			
6	1	Nut			
7	1	Drain plug (0.375-16 x 0.25)	6.7	60	–
8	1	Seal			
9	1	Anodic plate			
10	1	Screw (0.437-14 x 1.75)	54	–	40
11	1	Retainer	135.5	–	100
12	1	Fitting	2.8	25	–
13	1	Cover assembly (design I and II)			
14	1	Oil seal			
15	1	O-ring (0.799 x 0.103) (design I and II)			
16	1	Retaining ring (design II)			
17	4	Screw (M6 x 20)	6.7	60	–
18	1	Washer			
19	1	Gasket			
20	1	Lower shift shaft			
21	1	Pinion gear (13 teeth)			
22	1	Nut (5/8-18)	101.7	–	75
23	1	Washer			
24	1	Roller bearing			
25	1	Driveshaft (Long)			
		Driveshaft (X-Long)			
		Driveshaft (XX-Long)			
26	1	Spacer/bearing assembly (1B792549 and below)			
27	AR	Shim (0.002–0.050)			
28	1	Roller bearing assembly (1B792549 and below)			
29	1	Cup (1B792549 and below)			
30	1	Cup/roller bearing assembly (1B792549 and below)			
31	1	Roller bearing (1B792549 and below)			
32	1	Water pump housing			
33	1	Face seal			
34	4	Screw (M6 x 20)	6.7	60	–
35	1	Impeller			
36	1	Face plate			
37	1	Retaining ring			
38	1	Oil seal carrier			

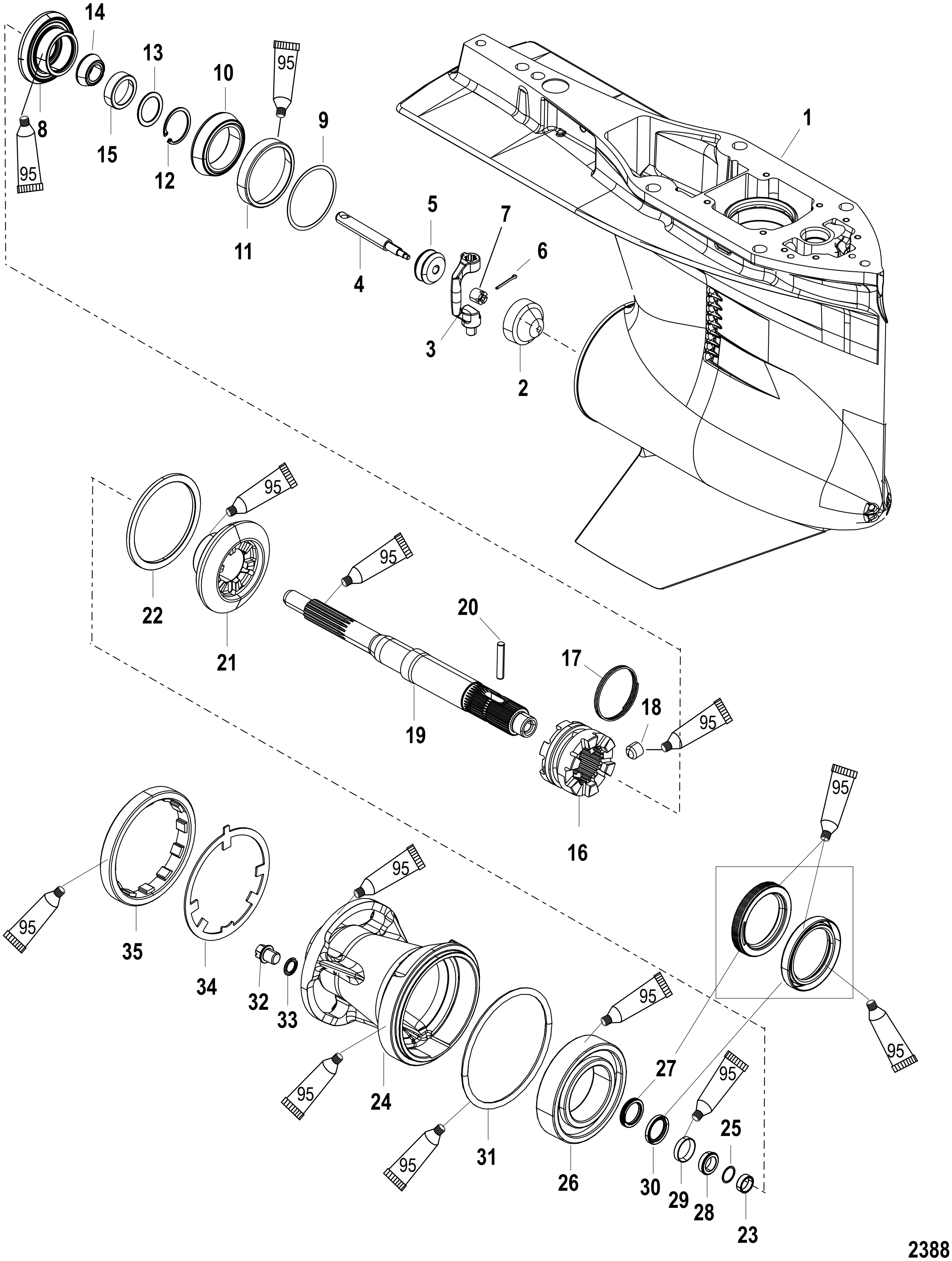
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
39	1	O-ring (2.175 x 0.103)			
40	1	Oil seal			
41	1	Oil seal			
42	1	Key			
43	1	Gasket			
44	1	Gasket			
45	1	Coupling			
46	1	Cup/roller bearing assembly (1B792550 and above)			
47	1	Roller bearing (1B792550 and above)			
48	1	Shim set (1B792550 and above)			
49	1	Tapered roller bearing assembly (1B792550 and above)			
50	1	Cup (1B792550 and above)			

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift cover assembly screws	92-809819
91	Engine Coupler Spline Grease	Driveshaft splines	8M0071842
95	2-4-C with PTFE	Shift shaft splines, retainer threads, O-rings, oil seal lips, pinion needle bearing, water pump housing, driveshaft roller bearing	92-802859A 1

Gear Housing (Driveshaft)



Gear Housing (Propeller Shaft) (Standard Rotation)



Gear Housing (Propeller Shaft) (Standard Rotation)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Plug	135.5		100
3	1	Shift crank			
4	1	Shift shaft spool			
5	1	Spool			
6	1	Cotter pin			
7	1	Castle nut			
8	1	Forward gear			
9	AR	Shim (0.002–0.050 in.)			
10	1	Roller bearing			
11	1	Cup			
12	1	Retaining ring			
13	1	Thrust washer			
14	1	Roller bearing assembly			
15	1	Cup			
16	1	Clutch			
17	1	Spring			
18	1	Detent pin			
19	1	Propeller shaft			
20	1	Cross pin			
21	1	Reverse gear			
22	1	Thrust ring			
23	1	Spacer			
24	1	Bearing carrier			
25	AR	Shim (0.002–0.070 in.)			
26	1	Ball bearing			
27	1	Oil seal			
28	1	Roller bearing			
29	1	Cup			
30	1	Oil seal			
31	1	O-ring			
32	1	Screw	6.7	60	
33	1	Seal			
34	1	Keyed washer			
35	1	Bearing carrier retainer	285[1.]		210[1.]

1. Torque retainer to 135.5 Nm (100 lb-ft), then check rolling torque on propeller shaft. If torque is within specification, torque retainer to 285 Nm (210 lb-ft).

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Forward gear, forward gear race, reverse gear, propeller shaft splines, clutch detent pin, propeller shaft seals, bearing carrier O-ring, bearing carrier contact surfaces, bearing carrier retainer	92-802859A 1

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part. It is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

Disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** to find the correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel, one that will contact only the bearing race, when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean the bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin the bearing with compressed air, as this may cause the bearing to score from lack of lubrication. After cleaning, lubricate the bearings with High Performance Gear Lubricant. Do not lubricate the tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work the inner bearing race in and out, while holding the outer race, to check for side wear.

When inspecting the tapered bearings, determine the condition of the rollers and the inner bearing race by inspecting the bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles, and/or discoloration from overheating. Always replace the tapered bearing and race as a set.

Inspect the gear housing for bearing races that have spun in their respective bores. If the race has spun, the gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check the shaft surface for pitting, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced if the conditions described are found.

Shims

Keep a record of all shim amounts and their location during disassembly to aid in reassembly. Be sure to follow the shimming instructions during reassembly, as gears must be installed to the correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 Threadlocker to the outer diameter of all metal case oil seals. When using Loctite on seals or threads, the surfaces must be clean and dry. To ease installation, apply 2-4-C with PTFE on all O-rings. To prevent wear, apply 2-4-C with PTFE onto the I.D. of the oil seals.

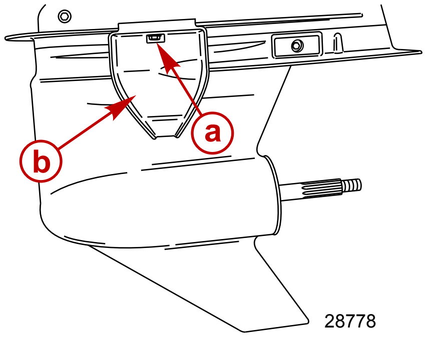
Gearcase Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Verify the position of the shift switch. The gearcase must be in the same position when reinstalling the gearcase to the driveshaft housing.

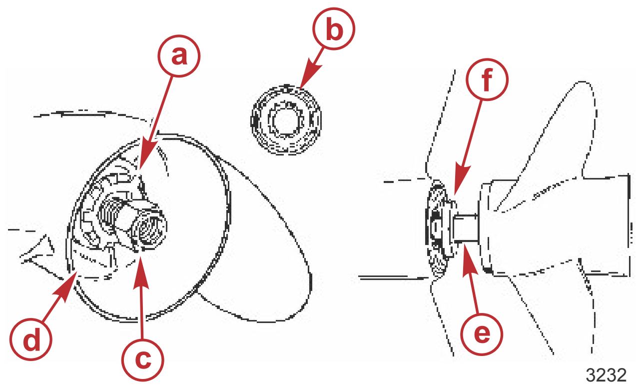
2. Drain the engine oil pan of oil. Failure to drain the oil prior to removing the gearcase will result in approximately 0.9463 liter (1 US qt) of oil leakage when the gearcase is removed.



a - Drain plug/seal washer
b - Oil drain funnel

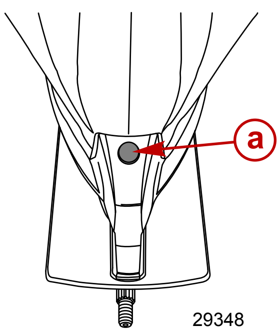
Oil Drain Funnel	91-892866A01

3. Tilt the outboard to the trailer full up position and engage the tilt lock lever.
4. Bend the tabs of the propeller tab washer away from the rear thrust hub. Remove the propeller locknut, tab washer, rear thrust hub, propeller, and forward thrust hub from the propeller shaft.



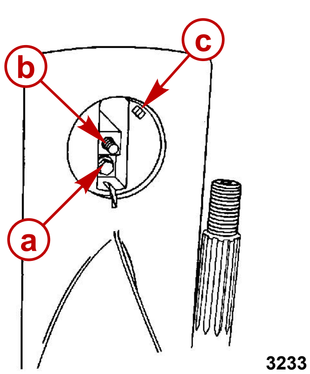
a - Tab washer
b - Continuity washer (if equipped)
c - Propeller nut
d - Rear thrust hub
e - Propeller shaft
f - Forward thrust hub

5. Remove the rubber plug at the rear edge of the driveshaft housing. Remove the screw (13 mm) that secures the anodic plate. Remove the plate from the gear housing.



a - Rubber plug

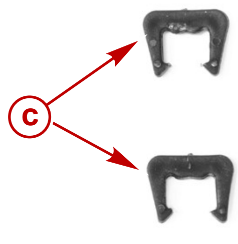
6. Once the plate is removed, remove the screw (14 mm) from inside of the cavity.



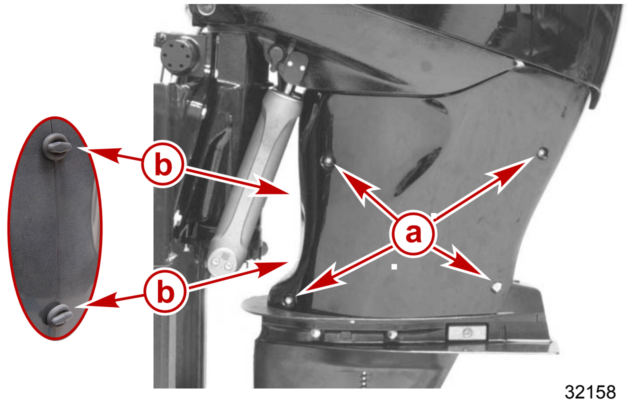
a - Screw (inside cavity)
b - Screw (secures anodic plate)
c - Ribs

7. Remove the clips or O-rings securing the front of the driveshaft housing chaps.

8. Remove the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing and remove the chap.



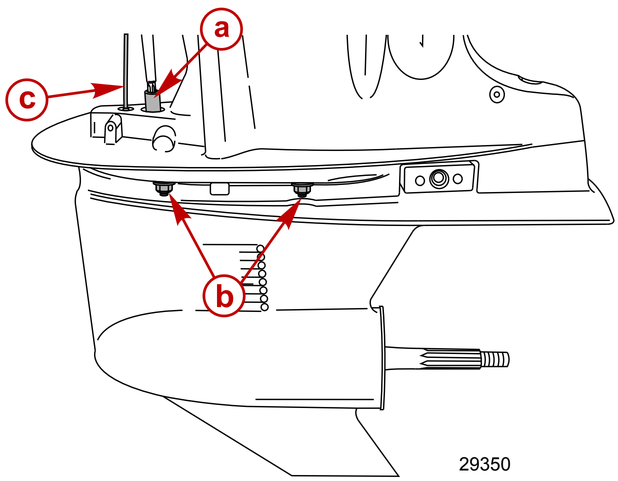
32157



32158

- **a -** Chap mounting screw (M6)
- **b -** O-ring
- **c -** Clips (used on later models in place of O-rings)

9. While pressing in on the speedometer tube junction, pull out on the tube to disconnect.
10. Loosen the side mounting locknuts. Do not attempt to remove one nut before the opposite side is loosened sufficiently or the gear housing could be damaged.
11. Pull the gear housing away from the driveshaft housing as far as the loosened nuts will allow, then remove the loosened nuts. Do not allow the gear housing to fall, as it is now free.



29350

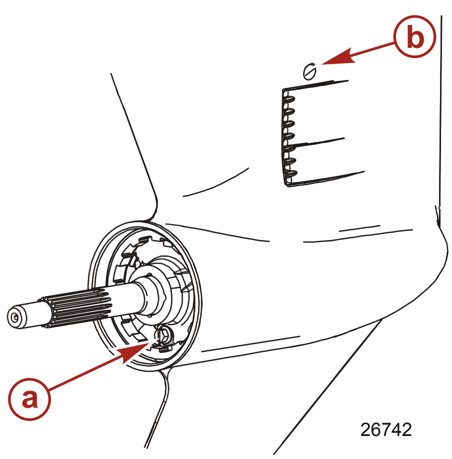
- **a -** Shift shaft coupler
- **b -** Nuts and washers (2 each side)
- **c -** Speedometer tube

12. Pull the gear housing from the driveshaft housing.

Gearcase Serviceability Inspection

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.
2. Position a clean drain pan under the gear housing and remove the fill and vent screws from the gear housing with a 10 mm socket or slot screwdriver.



26742

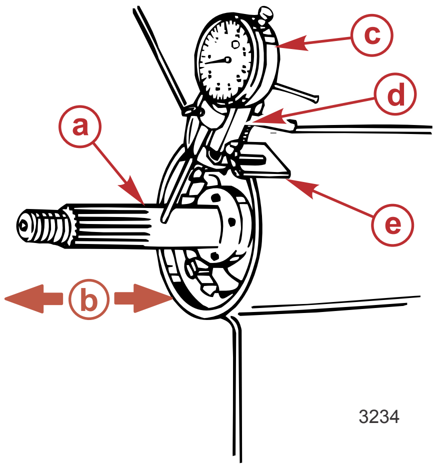
- **a -** Fill screw
- **b -** Vent screw

3. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles, or a large quantity of fine particles, indicates the need for gear housing disassembly and component inspection.
4. Check the color of the gear lubricant. White or cream color indicates presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly and inspection of oil seals, seal surfaces, O-rings, and gear housing components.

Propeller Shaft Inspection

Check for a bent propeller shaft as follows:

1. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.23 mm (0.009 in.), a bent propeller shaft is indicated.
2. Check for propeller shaft end play. There should be no end play. If end play exists, excessive wear has occurred and the gear housing must be disassembled for inspection.



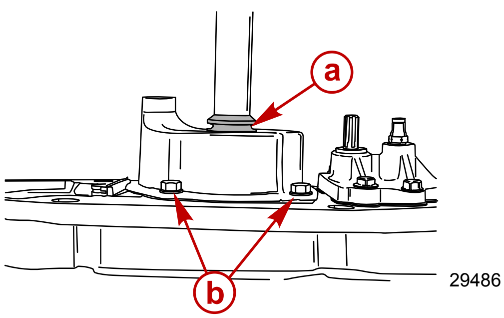
a - Propeller shaft runout
b - Propeller shaft end play
c - Dial indicator
d - Dial indicator holding tool
e - Dial indicator adapter

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Dial Indicator Holding Tool	91- 89897

Water Pump

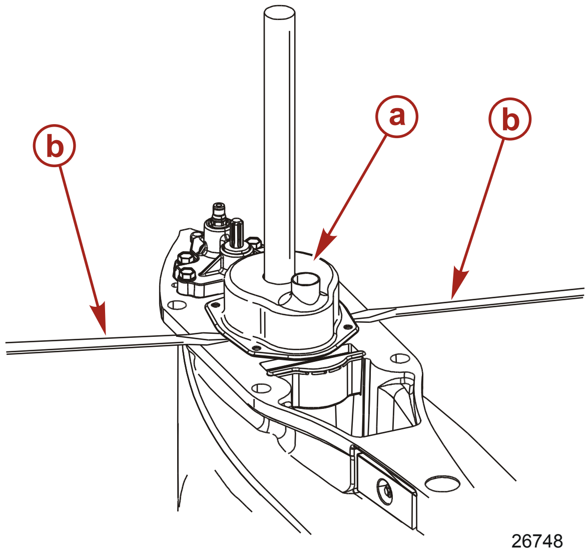
Removal and Disassembly

1. Remove the water seal and water pump screws.



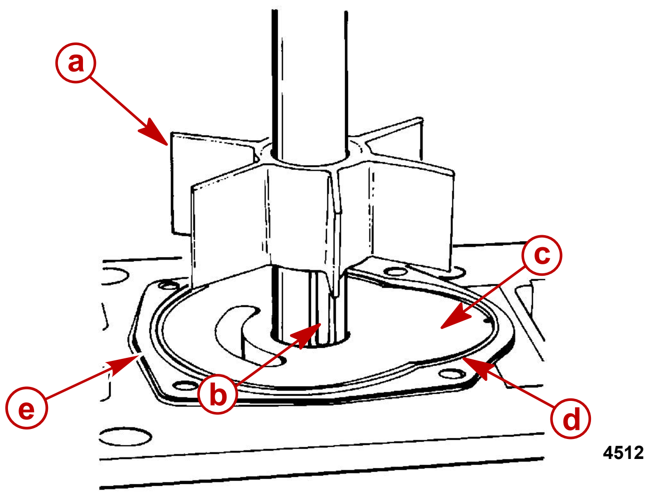
a - Water seal
b - Screws (2 each side)

2. Carefully slide the water pump straight up off of the driveshaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with screwdrivers.



a - Water pump body
b - Screwdrivers

3. Remove the impeller, impeller key, face plate, pump cover gasket, and pump base gasket.



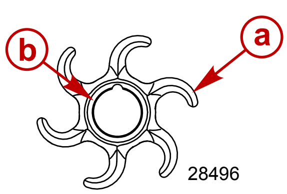
a - Impeller
b - Key
c - Face plate
d - Pump cover gasket (gray bead faces up)
e - Pump cover base gasket

Cleaning and Inspection

NOTE: With the gearcase removed, inspect the water tube coupling assembly inside the driveshaft housing for wear or damage. If necessary, replace the worn or damaged components as required.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting the liner and plate. The depth of the groove will not affect water pump output.

1. Inspect face plate and water pump liner for grooves and/or rough surfaces.
2. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears, and wear. Replace impeller if any of these conditions are found.
3. Inspect impeller bonding to impeller hub.



a - Impeller
b - Hub

4. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

IMPORTANT: When completing gear housing repairs that require removal of water pump impeller, it is recommended the impeller be replaced. If it is necessary, however, to reuse impeller, do not install in reverse to original rotation, or premature impeller failure will occur.

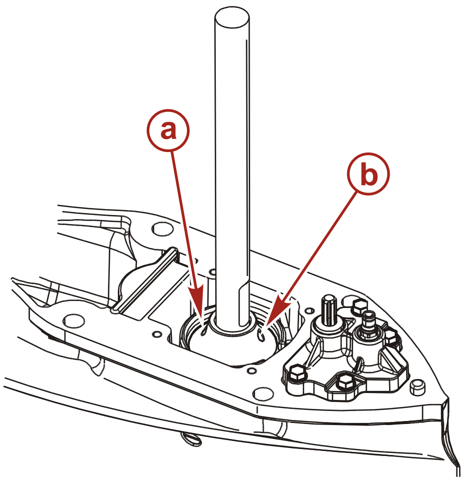
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

Removal

NOTE: Pushing down on the seal carrier may aid in the removal of the retaining ring above the seal carrier.

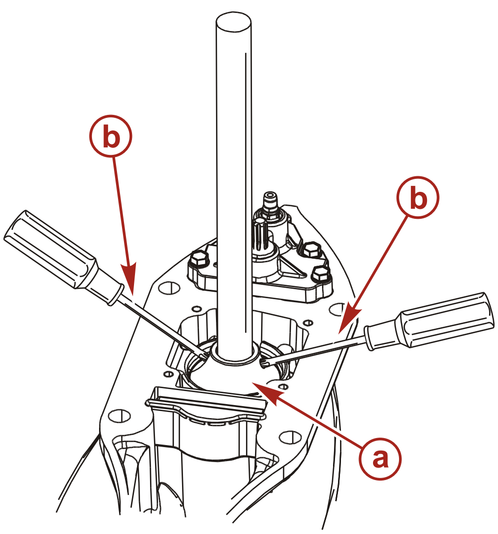
1. While pushing down on the seal carrier, use a flat tip screwdriver to aid in the removal of the retaining ring above the oil seal carrier.



26749

a - Retaining ring
b - Seal carrier

2. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



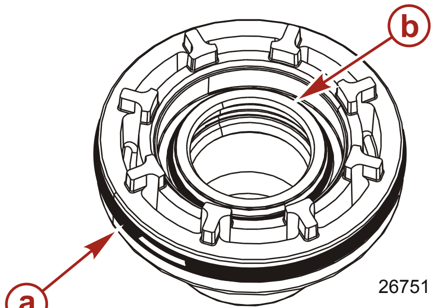
26750

a - Oil seal carrier
b - Screwdrivers

Disassembly

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

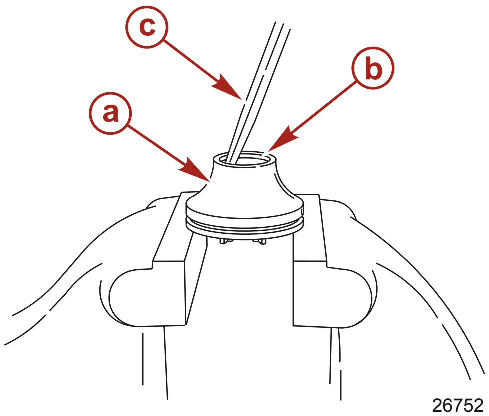
1. Remove the O-ring.



a - O-ring
b - Oil seals (2)

IMPORTANT: Use caution when removing carrier oil seals to avoid nicking or scratching the plastic surface the seals contact in the carrier, as water leakage into the gearcase could result.

2. Remove oil seals with a screwdriver or punch.

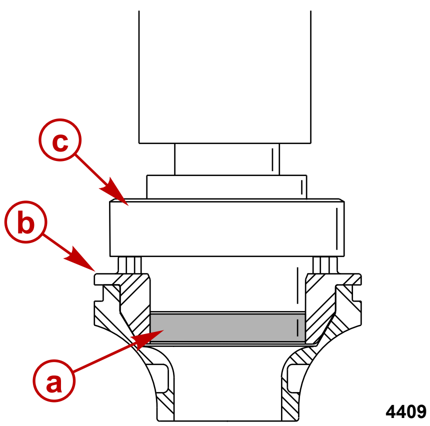


a - Oil seal carrier
b - Oil seals
c - Screwdriver

Reassembly

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C with PTFE to seal lips and between seals. Apply Loctite 380 to outer diameter of both seals.

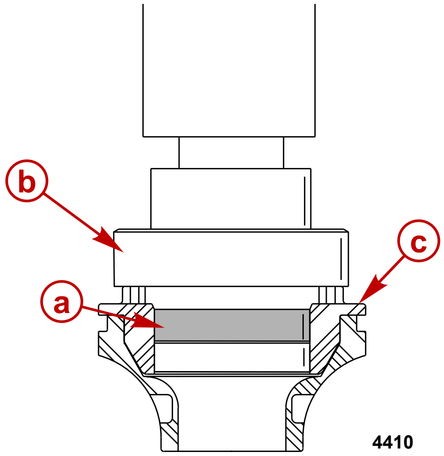
1. Press first seal into carrier with oil seal driver, using long side of seal driver.



a - First seal installed (lip faces away from driver)
b - Seal carrier
c - Oil seal driver

Oil Seal Driver	91-889844T

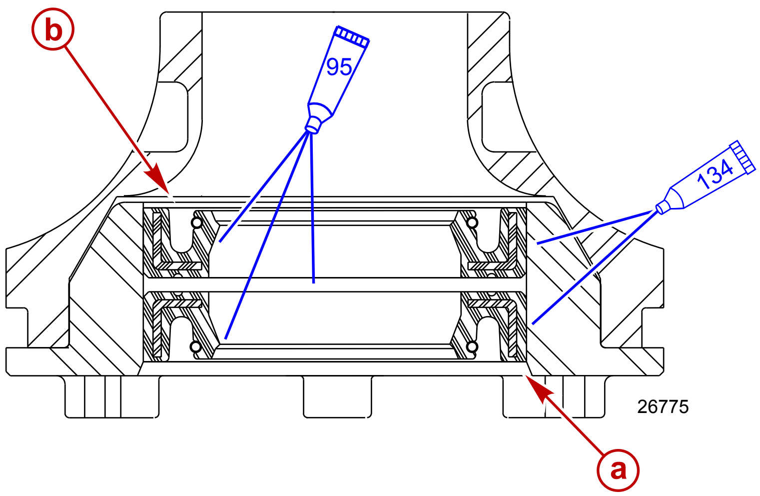
2. Reverse the seal driver and using the short side of driver, press the second seal in until the seal driver is flush with the carrier surface.



a - Second seal installed (lip faces towards driver)
b - Oil seal driver
c - Seal carrier

Oil Seal Driver	91-889844T

3. Apply 2-4-C with PTFE to seal lips.



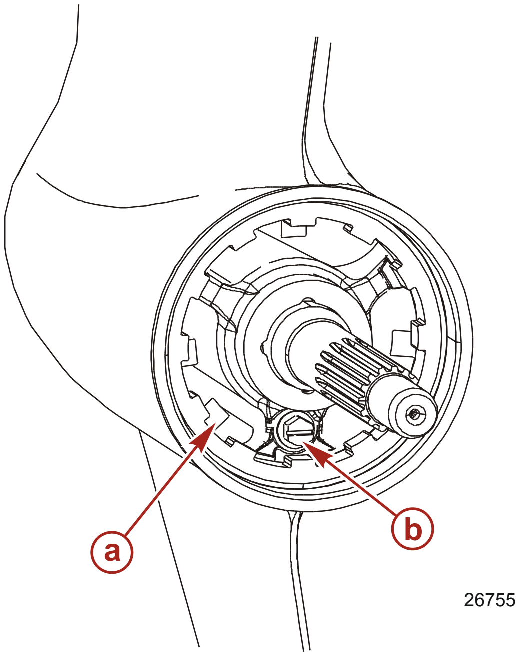
a - Second seal installed (lip faces down)
b - First seal installed (lip faces up)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1
134	Loctite 380	Outer diameter of oil seals	Obtain Locally

Bearing Carrier and Propeller Shaft

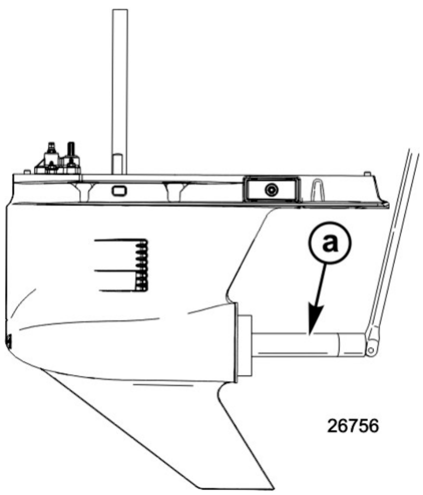
1. Straighten any lock tabs on the tab washer.

NOTE: *The drain plug in the bearing carrier must be removed before using the bearing carrier retainer nut wrench to remove the bearing carrier retainer.*



a - Tab
b - Drain plug

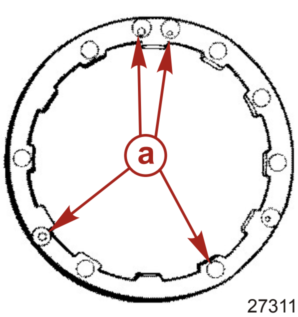
2. Remove the bearing carrier retainer following step "a" or "b," as follows:
   IMPORTANT: Drilling into the bearing carrier retainer can potentially damage the gearcase. Ensure that you do not drill into the gearcase when removing a seized retainer.
   a. Remove the bearing carrier retainer by turning the retainer counterclockwise using a bearing carrier retainer nut wrench.



a - Bearing carrier retainer nut wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

   b. If the retainer is corroded in place, drill four holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.

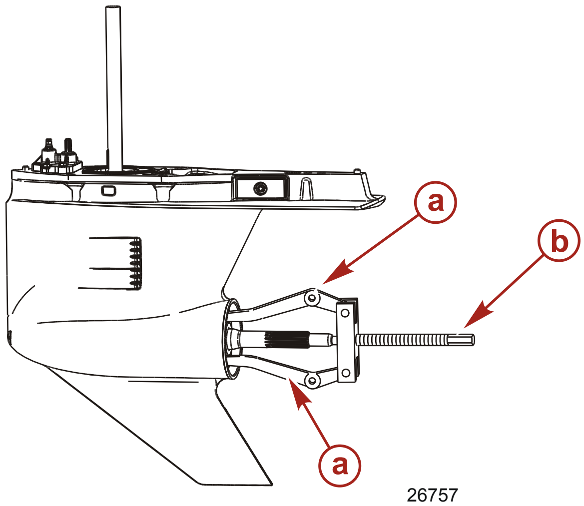


a - Drilled holes

c. Remove the tab washer.

3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. Position the puller jaws close to the bosses in the carrier.

   NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

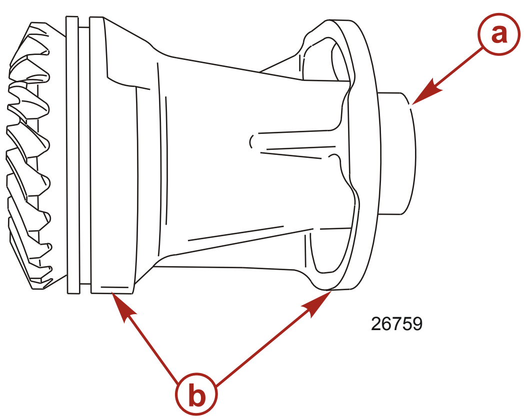
Cleaning/Inspection

IMPORTANT: It is recommended that all seals and O-rings be replaced, as a normal repair procedure, to assure effective repair.

1. Clean the bearing carrier with solvent and dry with compressed air.

⚠ WARNING
Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

2. Inspect the bearing carrier for signs of excessive corrosion, especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident, replace the carrier.

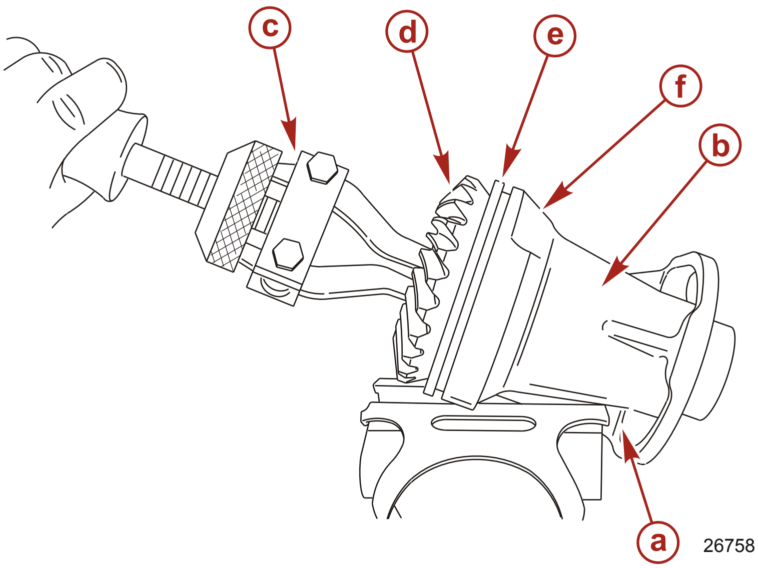


a - Bearing carrier
b - Inspect for corrosion

3. The propeller shaft utilizes a tapered roller bearing and cup for shaft support just forward of the bearing carrier seals. The reverse gear and bearing assembly must be removed from the bearing carrier to gain access to the propeller shaft tapered bearing for inspection.
4. Inspect the reverse gear to pinion gear wear pattern. It should be even and smooth. If not, replace the reverse gear, pinion gear, and forward gear.
5. Check the clutch jaws on the reverse gear for damage. Replace the reverse gear if damage is found on the clutch jaws.
6. Apply light oil to the reverse gear bearing. Rotate the reverse gear bearing while checking the bearing for rough spots and/or catches. Push in and pull out on the reverse gear to check for bearing side wear. Replace the bearing if any of the listed conditions exist.

Disassembly

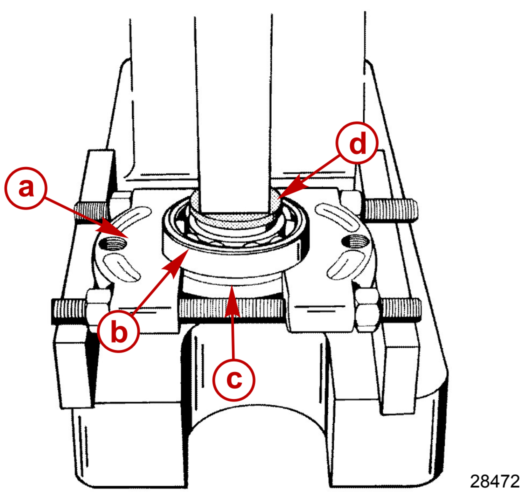
1. Remove and discard the O-ring between the bearing carrier and the thrust washer.
   IMPORTANT: Clamping the bearing carrier in a vise can damage the carrier. Clamp onto the reinforcing rib only.
2. Place the bearing carrier in a vise. Clamp only on the bearing carrier reinforcing rib.
3. Remove the reverse gear, thrust ring, and bearing as an assembly using a slide hammer puller.



a - Bearing carrier reinforcing rib
b - Bearing carrier
c - Slide hammer puller
d - Reverse gear
e - Thrust ring
f - Bearing (not seen) - located inside carrier

Slide Hammer	91-34569A 1

4. Remove the thrust washer from the reverse gear assembly.
5. Using a suitable mandrel and the universal puller plate to support the bearing, press the bearing from the reverse gear as shown.

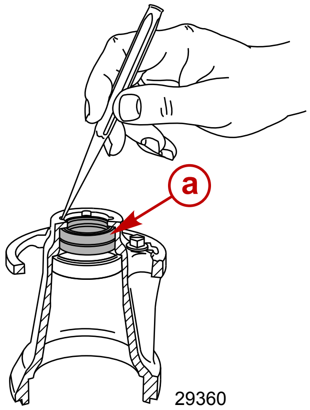


a - Universal puller plate
b - Bearing
c - Gear
d - Mandrel

Universal Puller Plate	91-37241

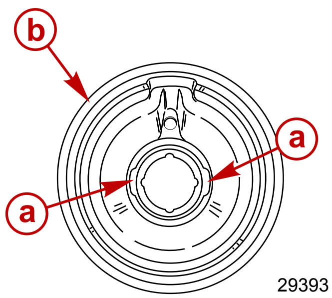
6. Inspect the gear and thrust ring for excessive wear, cracks, or damage. Replace the appropriate components if any of these conditions are found.
   NOTE: Inspect the aft propeller shaft tapered roller bearing for pits, scoring, discoloration, or excessive looseness. Replace the bearing and bearing race inside of the carrier if these conditions exist.
7. Perform the following step "a" or "b," as necessary.

a. **If replacing the seals only:** Remove the oil seals with a suitable punch, being careful not to damage the bore of the bearing carrier. Discard both of the seals.



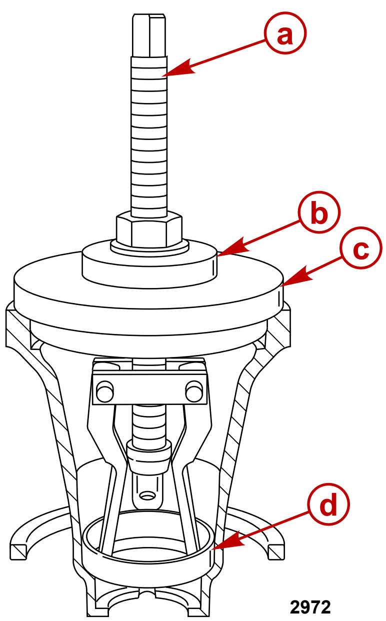
a - Seals

b. **If replacing the tapered roller bearing and seals:** Remove the seals with a punch as noted above. There are slots cast into the carrier to aid in the removal of the bearing race with puller jaws.



a - Slots
b - Bearing carrier

c. Remove the tapered bearing race from the carrier using a bearing puller assembly, pilot washer, and seal driver guide. Discard the bearing, race, and both seals.



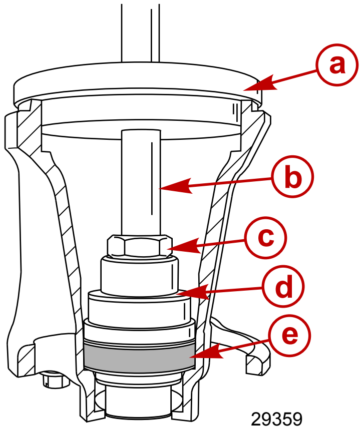
a - Bearing puller assembly
b - Pilot washer
c - Seal driver guide
d - Race

Bearing Puller Assembly	91- 83165T
Pilot Washer	91-36571T
Seal Driver Guide	91-889845

Assembly

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air.
2. Lubricate the bore that the tapered bearing race is pressed into with High Performance Gear Lubricant.

3. Assemble the bearing race onto the driver.
4. Press the bearing race into the bearing carrier until the race bottoms out in the bearing carrier.

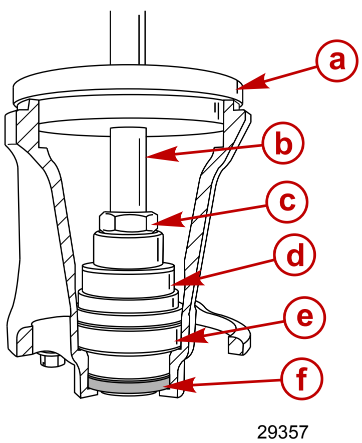


- a - Seal driver guide
- b - Driver rod
- c - Hex nut
- d - Bearing cup driver/oil seal installer
- e - Tapered bearing race

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Tapered bearing race bore	92-858064K01

5. Thoroughly clean the bore in which the first seal is to be pressed.
6. Assemble the first seal, with the lips of the seal facing away from the driver shoulder, onto the long end of the oil seal driver.
7. Apply Loctite 380 to the outside diameter of the oil seal.
8. Press on the oil seal driver until the driver bottoms out on the bearing race.



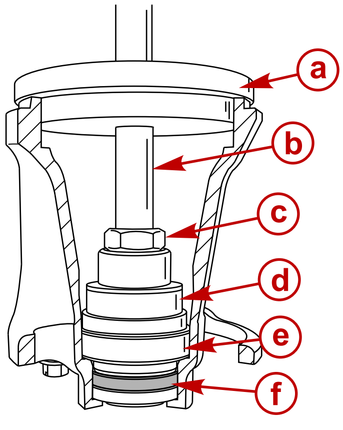
- a - Seal driver guide
- b - Driver rod
- c - Hex nut
- d - Bearing cup driver/oil seal installer
- e - Bearing race
- f - Oil seal (first)

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T

Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outer diameter of bearing carrier oil seal	Obtain Locally

9. Assemble the second seal, with the lips of the seal facing the driver shoulder, onto the short end of the driver seal.
10. Apply Loctite 380 to the outside diameter of the seal.

11. Press on the oil seal with the driver until the driver bottoms out on the bearing race.



29358

a - Seal driver guide
b - Driver rod
c - Hex nut
d - Bearing cup driver/oil seal installer
e - Bearing race
f - Oil seal (second)

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T

Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outer diameter of oil seals	Obtain Locally

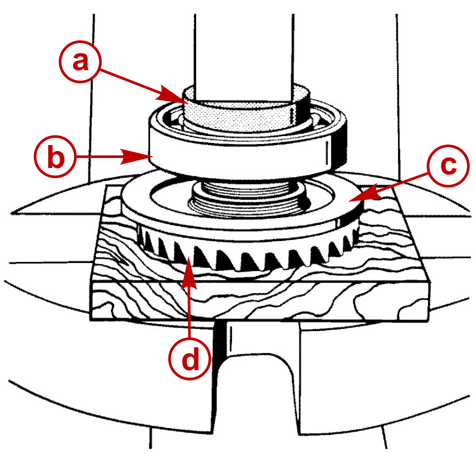
12. Lubricate the seal lips and fill the area between the seals with 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1

13. Install the propeller shaft tapered roller bearing into the carrier bearing race.

    NOTE: The reverse gear bearing is not fully seated until the reverse gear/bearing assembly is pressed into the bearing carrier.

14. Install the thrust washer and a new ball bearing onto the reverse gear. Press on the inner race of the ball bearing using the pilot washer until the pilot washer bottoms out on the gear.



28473

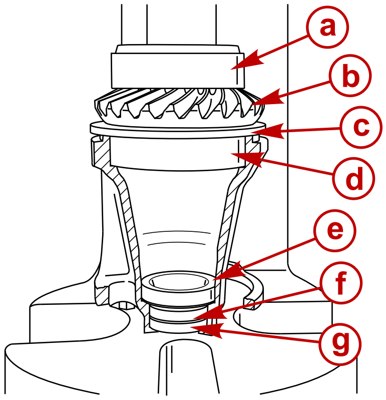
a - Pilot washer
b - Ball bearing
c - Thrust washer
d - Reverse gear

Pilot Washer	91-36571T

15. Lubricate the bore that the bearing is pressed into with High Performance Gear Lubricant.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearing bore in carrier	92-858064K01

16. Press the reverse gear assembly into the bearing carrier until the bearing bottoms out in the bearing carrier.

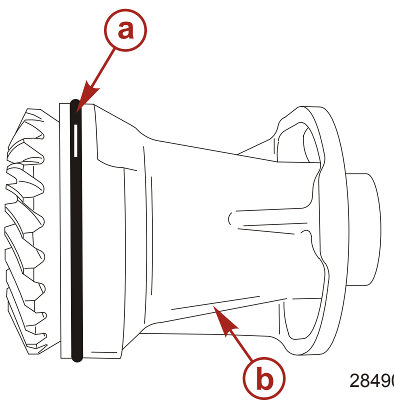


29354

a - Bearing cup driver
b - Reverse gear
c - Thrust washer
d - Ball bearing
e - Tapered bearing
f - Seal
g - Seal

Bearing Cup Driver	91-885592T

17. Lubricate the O-ring with 2-4-C with PTFE and install the O-ring onto the bearing carrier.



28490

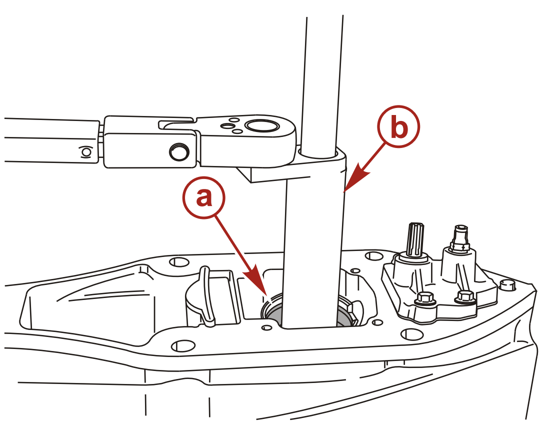
a - O-ring
b - Bearing carrier

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier O-ring	92-802859A 1

Driveshaft Assembly

Removal

1. Remove the driveshaft pinion nut as follows:
   a. Remove the upper driveshaft tapered bearing retainer.

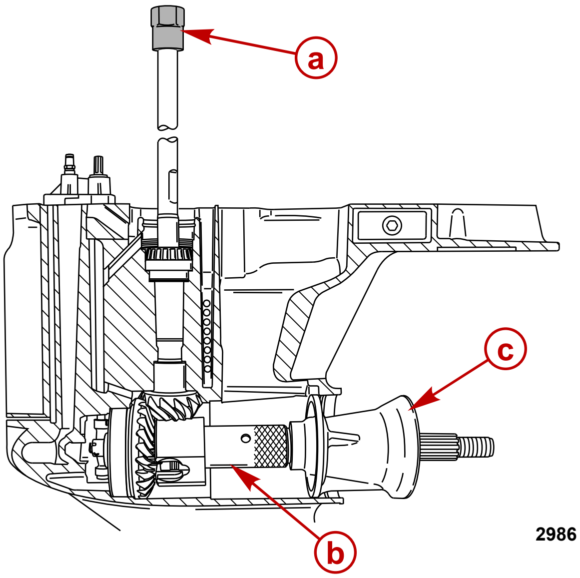


29353

a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

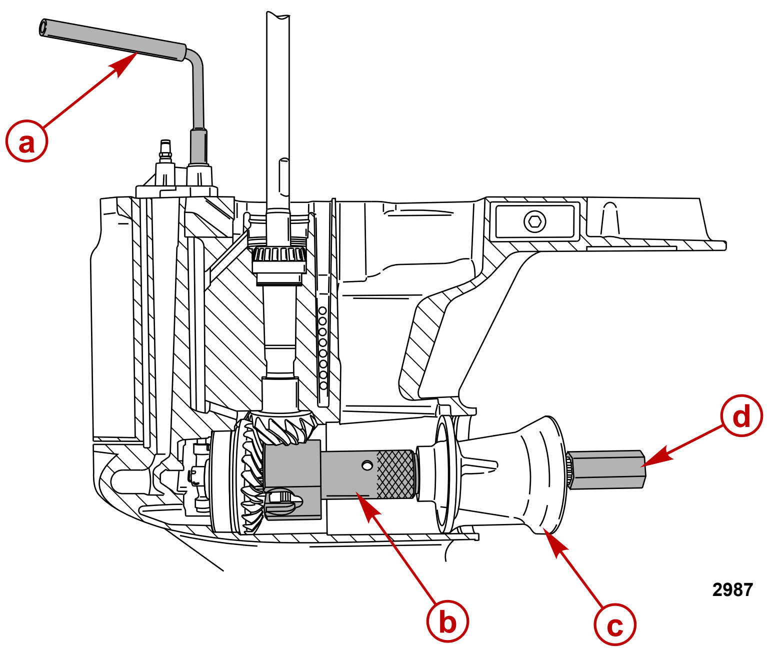
b. Place the driveshaft holding tool onto the driveshaft.
c. Insert the pinion nut wrench with the MC1 slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the driveshaft to align the pinion gear nut into the pinion nut wrench slot.
d. Install the bearing carrier into the gear housing backwards to support the propeller shaft and to keep the pinion nut wrench aligned.
e. Using the driveshaft holding tool, loosen the pinion nut by rotating the driveshaft counterclockwise.



a - Driveshaft holding tool
b - Pinion nut wrench
c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91- 61067T03

f. If the driveshaft is broken, place the propeller shaft adapter onto the propeller shaft splines. Hold the shift shaft in forward gear and loosen the pinion nut by rotating propeller shaft counterclockwise to turn the gears, thus loosening the pinion nut.

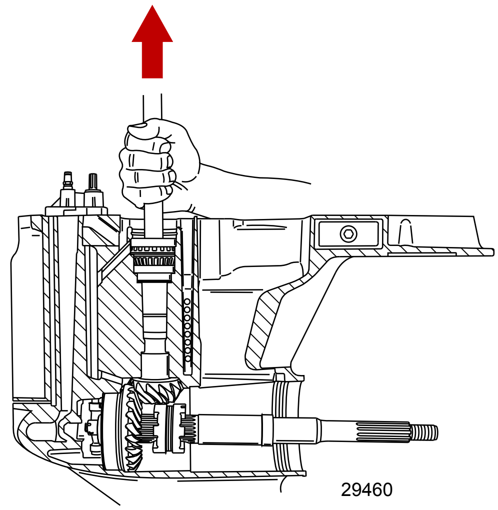


a - Shift shaft tool (fabricate from old shift shaft)
b - Pinion nut wrench
c - Bearing carrier (installed backwards)
d - Propeller shaft adapter

Pinion Nut Wrench	91- 61067T03
Propeller Shaft/Driveshaft Adapter	91-61077T

g. Remove the pinion nut by rotating the driveshaft, or the propeller shaft, in a counterclockwise direction.
h. Remove all tools.

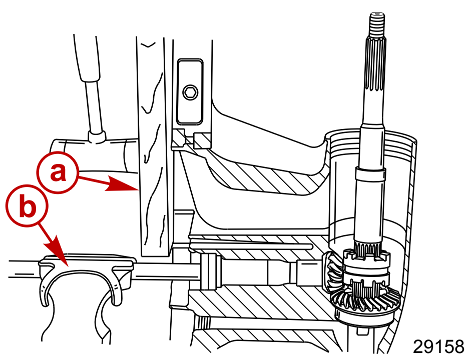
2. Remove the driveshaft and all components by pulling the driveshaft straight out of the gear housing, as shown.



IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the driveshaft is removed. Be careful not to lose the 18 rollers.

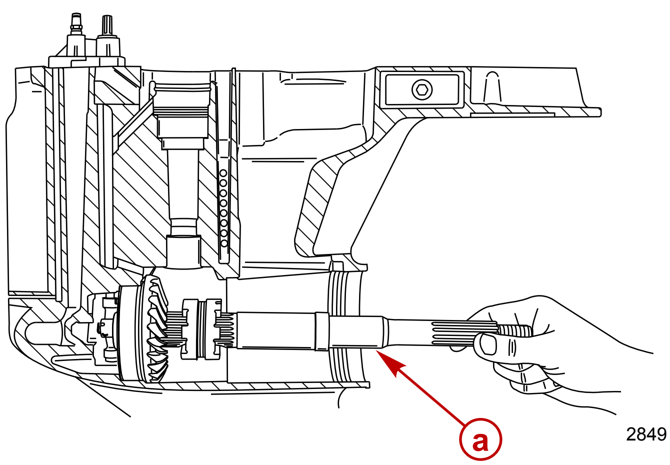
NOTE: If the pinion gear is seized onto the driveshaft, place the gearcase in a vise using soft jaw vise covers. Place a block of wood on the gear housing mating surface. Use a mallet and carefully tap the gear housing away from the driveshaft.

IMPORTANT: Striking a gear housing directly with a mallet, or dropping the gear housing, could distort the gear housing resulting in gear housing failure.



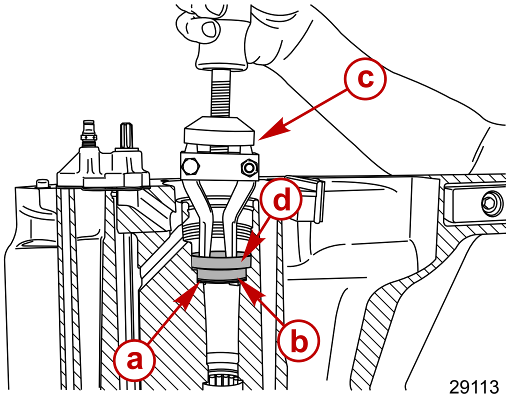
a - Wood block
b - Driveshaft in soft jaw vise

3. Move the propeller shaft downward to retrieve the pinion gear, washer, and nut from inside the gear housing.
4. Raise the propeller shaft back up until it is centered in the gear housing and then move the propeller shaft to the starboard side of the housing.



a - Propeller shaft

5. Remove the lower driveshaft bearing cup and shims using a slide hammer puller. Retain the shims for reinstallation.



a - Shims
b - Bearing race
c - Slide hammer puller
d - Driveshaft bearing cup

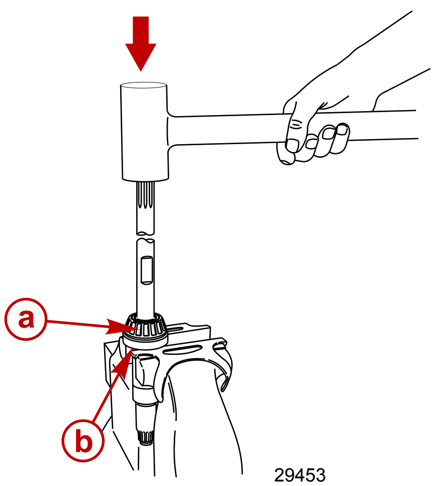
Slide Hammer	91-34569A 1

Disassembly

NOTE: Do not remove the upper and lower tapered roller bearings from the driveshaft unless replacement is indicated. Bearings cannot be reused after removal from the driveshaft.

NOTE: If one driveshaft tapered roller bearing is damaged, both tapered bearings and spacer must be replaced as a set.

1. Both the upper and lower tapered roller bearings can be removed from the driveshaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the driveshaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a dead blow hammer until the bearings are free. Do not drop the shaft when performing this operation.

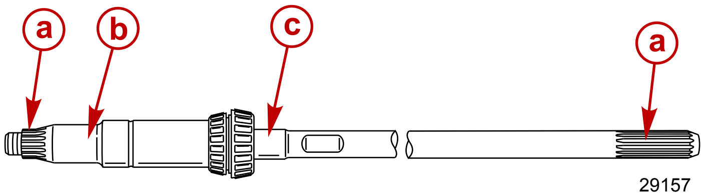


a - Driveshaft with both upper and lower bearings
b - Lower bearing cup removed from gearcase

Inspection

1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air. Do not spin the bearings.
2. The condition of the upper and lower driveshaft bearing cups is an indication of the condition of each of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. Replace the pinion bearing and the driveshaft if the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the driveshaft for a worn or twisted condition. Replace the driveshaft if either condition exists.

5. Inspect the driveshaft for grooves where the water pump base oil seals contact the shaft. Replace the driveshaft if grooves are found.



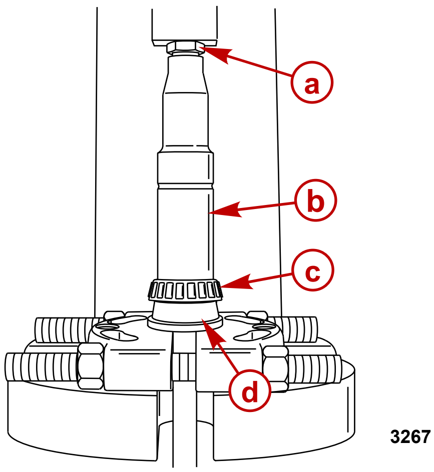
a - Splines
b - Pinion bearing surface
c - Seal surface

6. Inspect the pinion gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the pinion gear and the forward gear as a set if any defects are found.

Assembly

NOTE: Complete the instructions in this section only if the components have been disassembled.

1. Apply a light coat of High Performance Gear Lubricant on the I.D. of the driveshaft tapered bearing.
2. Assemble a new lower tapered roller bearing to the driveshaft, with the small O.D. of the bearing facing the pinion gear end of the driveshaft.
3. Thread a used pinion nut onto the end of the driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond the nut or thread damage could result while pressing.
4. Press the lower tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, or an old tapered roller bearing inner race.



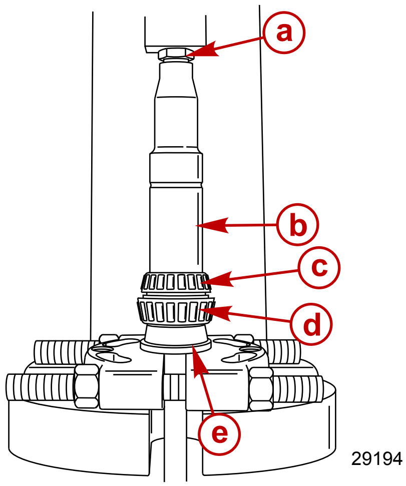
a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Old tapered roller bearing inner race

Universal Puller Plate	91-37241

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of driveshaft tapered bearing	92-858064K01

5. Apply a light coat of High Performance Gear Lubricant on the I.D. of the driveshaft tapered bearing.
6. Assemble a new upper tapered roller bearing to the driveshaft with the large O.D. of the bearing facing the pinion gear end of the driveshaft.
7. Thread a used pinion nut onto the end of the driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond the nut or thread damage could result while pressing.

8. Press the new upper tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, or an old tapered roller bearing inner race.



a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Upper driveshaft tapered bearing
e - Old tapered roller bearing inner race

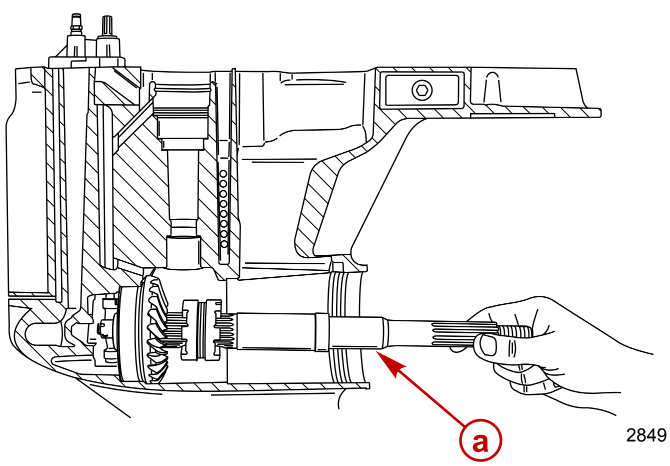
Universal Puller Plate	91-37241

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of the driveshaft tapered bearing	92-858064K01

Propeller Shaft Assembly and Forward Gear Bearing Cup

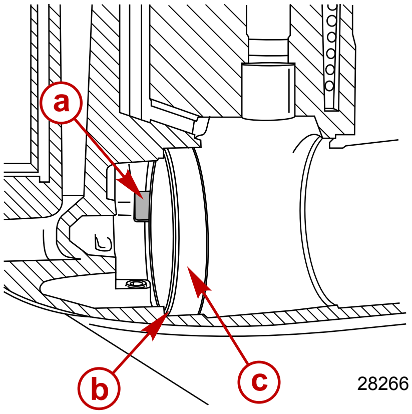
Removal

1. Tilt the propeller shaft to the starboard side of the gear housing and remove the shaft.



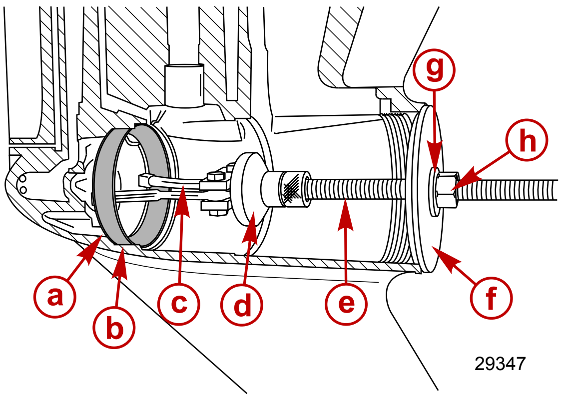
a - Propeller shaft

2. Two notches are provided in the gear housing just forward of the forward gear bearing cup, to position the puller jaws for easier removal of the bearing cup and shims.



a - Notches
b - Shims
c - Forward gear bearing cup

3. Remove forward gear bearing cup and shims. Measure and make note of the shim thickness. If shims are not damaged, they may be reused.



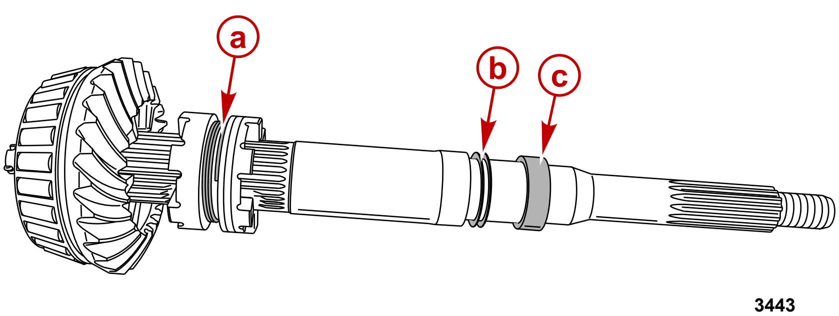
a - Shims
b - Bearing cup
c - Jaws (from slide hammer puller kit)
d - Puller head (from slide hammer puller kit)
e - Puller shaft
f - Guide plate
g - Washer
h - Nut

Slide Hammer	91-34569A 1
Bearing Removal and Installation Kit	91- 31229A 7
Guide Plate	91-816243

Component Disassembly

NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a workbench to ensure the parts are not dropped or damaged, and to avoid personal injury.

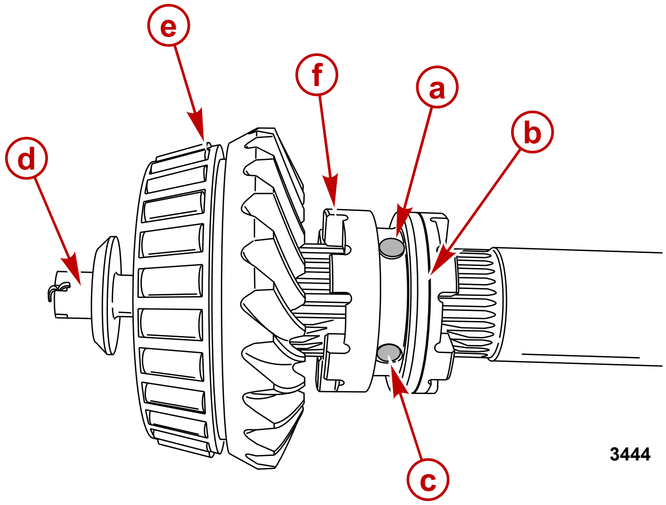
1. Remove the propeller shaft preload spacer and shims.
2. Remove the spring around the clutch, being careful not to overstretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.



a - Spring
b - Shims
c - Preload spacer

3. Remove the detent pin.
4. Remove the cross pin that goes through the clutch.

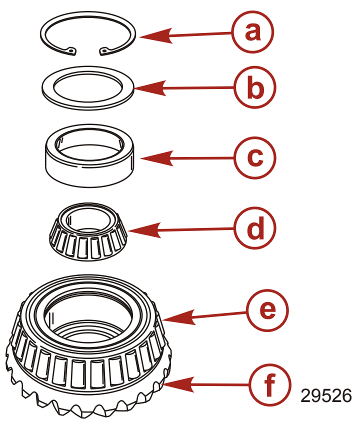
5. Remove the remainder of the components.



a - Detent pin
b - Clutch band (faces toward reverse gear)
c - Cross pin
d - Spool and actuating shaft assembly
e - Forward gear assembly
f - Clutch

Inspection

1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.
3. The propeller shaft utilizes two tapered roller bearing and cup assemblies for propeller shaft support. One tapered bearing is just forward of the bearing carrier seals. The reverse gear assembly must be removed from the bearing carrier to gain access to this bearing for inspection. The other tapered bearing is located inside the forward gear assembly. The forward gear assembly must be removed from the propeller shaft and a snap ring retainer and flat washer removed from the forward gear assembly to gain access to this tapered bearing for inspection.

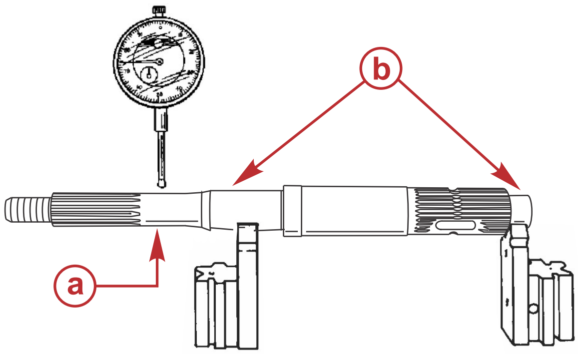


a - Snap ring
b - Flat washer
c - Tapered bearing race
d - Tapered bearing
e - Forward gear bearing
f - Forward gear

NOTE: *The forward gear bearing should not be removed from the forward gear unless replacement is necessary. The bearing is not reusable if the bearing is removed.*

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exist.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.
6. Inspect the propeller shaft for a bent condition using V-blocks and a dial indicator.
   a. Position the propeller shaft bearing surfaces on the V-blocks.
   b. Adjust the height of the V-blocks to level the propeller shaft.
   c. Position the dial indicator tip just forward of the propeller shaft splines.

7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.23 mm (0.009 in.), replace the propeller shaft.



29505

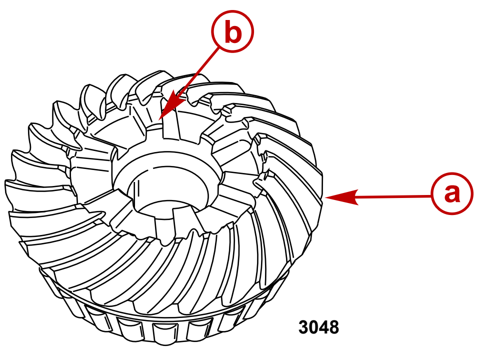
a - Check movement with dial indicator here
b - Seal surface area

Dial Indicator	91- 58222A 1

Forward Gear Assembly

Component Inspection

1. Clean the forward gear assembly and the forward gear bearing cup with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pits, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the forward gear and the pinion gear as a set if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. Replace both the forward and pinion gear as a set if any of these conditions exist.



3048

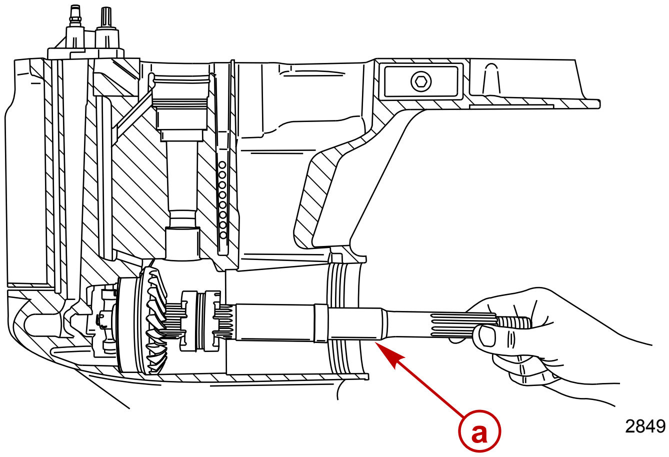
a - Forward gear teeth
b - Clutch jaws

4. Inspect the propeller shaft tapered roller bearing on the inside of the forward gear and its respective bearing cup. If either the bearing or the bearing cup surface is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, remove and replace the tapered roller bearing assembly in the forward gear.
5. Inspect the tapered roller bearing pressed onto the forward gear and the bearing surface on the forward gear bearing cup. If either the roller bearing or the bearing surface of the forward gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the forward gear bearing cup and remove and replace the tapered roller bearing.

Disassembly

NOTE: The forward gear and propeller shaft assembly can only be removed from the gear housing after the driveshaft and pinion gear have been removed.

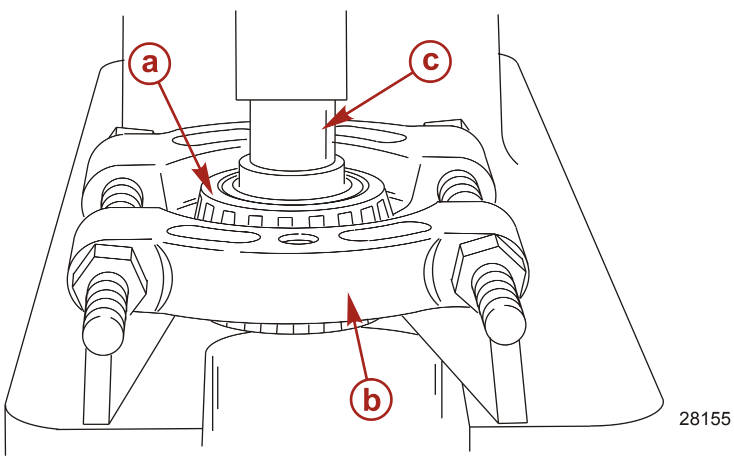
1. Tilt the propeller shaft to the starboard side of the gear housing and remove the propeller shaft and gear assembly.



a - Propeller shaft

IMPORTANT: Do not remove the pressed on tapered roller bearing from the forward gear unless replacement of the bearing is required. The bearing cannot be used after it has been removed.

2. If inspection determines that replacement of the forward gear tapered bearing is required, separate the gear from the bearing as follows:
   a. Press the universal puller plate between the forward gear and the tapered bearing.
   b. Place the assembly on a press and press the gear out of the bearing with a suitable mandrel.
   NOTE: The tapered bearing and race must be replaced as a set.

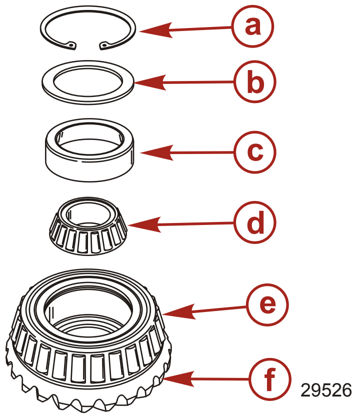


a - Forward gear bearing
b - Universal puller plate
c - Mandrel

Universal Puller Plate	91-37241

3. If inspection determines that replacement of the propeller shaft tapered roller bearing is required, remove the bearing as follows:
   a. Clamp the forward gear securely in a soft jaw vise.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.

b. Use snap ring pliers to remove the snap ring. Push the tapered roller bearing assembly out of the inside of the forward gear.

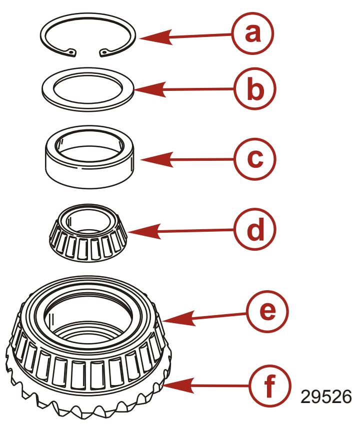


a - Snap ring
b - Flat washer
c - Tapered bearing race
d - Tapered bearing
e - Forward gear bearing
f - Forward gear

Assembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Apply High Performance Gear Lubricant to the I.D. of the forward gear. Push the tapered roller bearing assembly into the forward gear until the bearing seats.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.
2. Install the snap ring into the groove of the forward gear to secure the tapered roller bearing assembly.



a - Snap ring
b - Flat washer
c - Tapered bearing race
d - Tapered bearing
e - Forward gear bearing
f - Forward gear

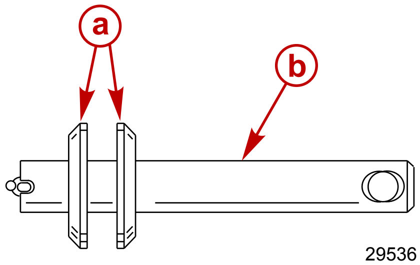
Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of forward gear	92-858064K01

Shift Spool Assembly

Inspection

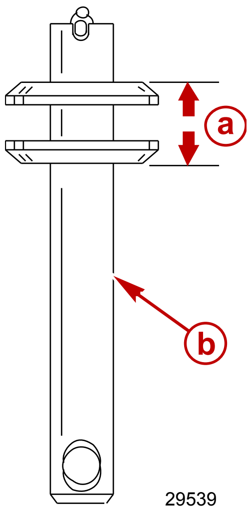
1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.

3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



a - Contact area
b - Nonratcheting shift spool

4. Inspect to ensure the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).
5. Inspect to ensure the spool has end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



a - End play
b - Shift spool

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

Disassembly

NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

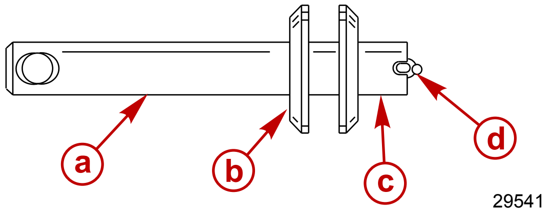
NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.

Reassembly

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the spool and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If the castle nut is threaded down and the cotter pin slot is already aligned at the hole in the shift spool shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend the ends of the cotter pin in opposite directions.

5. Verify the spool has end play. If it does not, adjust the castle nut again.



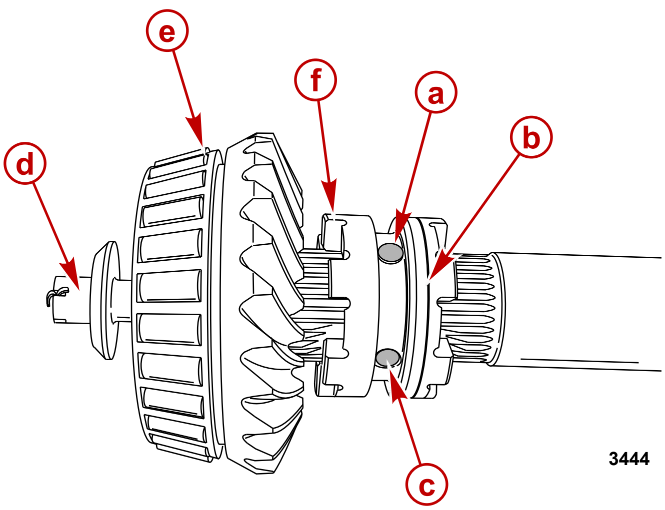
a - Shift shaft
b - Spool
c - Castle nut
d - Cotter pin

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

6. If this adjustment did not produce the desired results, it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned, it will be necessary to replace the shift spool assembly.

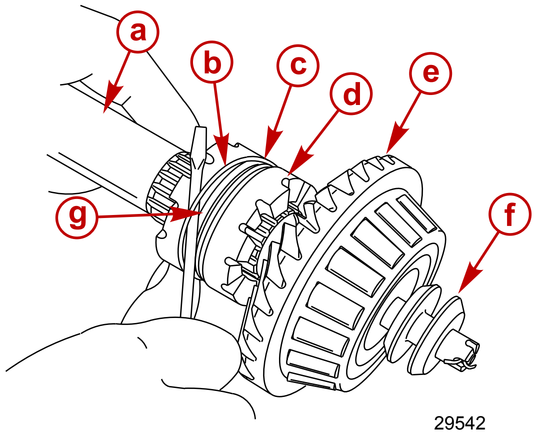
Propeller Shaft Reassembly

1. Install the sliding clutch (with band on clutch facing aft) onto the propeller shaft. Align the cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the forward gear assembly to the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft, making sure the cross pin hole of the shift spool shaft is aligned with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft, and through the shift spool shaft hole.
5. Install detent pin in third hole in clutch.



a - Detent pin
b - Clutch band (faces aft)
c - Cross pin
d - Shift spool and actuating shaft assembly
e - Forward gear assembly
f - Clutch

6. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Verify the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.**



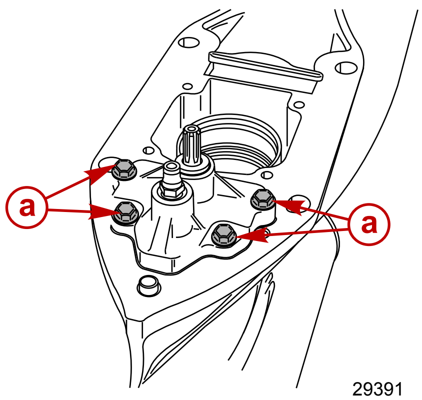
a - Propeller shaft
b - Cross pin retaining spring
c - Cross pin (hidden)
d - Sliding clutch
e - Forward gear assembly
f - Spool and actuating shaft assembly
g - Detent pin (hidden)

Shift Shaft Assembly

Removal

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gearcase) without removing any of the internal components of the gear housing.

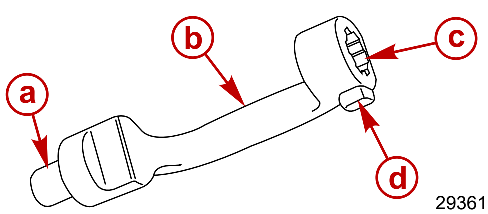
1. Remove the shift shaft cover assembly screws. Remove the shift shaft and cover assembly by pulling both straight out of the gear housing.



a - Shift shaft cover screws (M6 x 20)

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the pivot pin for damage or wear.

   NOTE: The shift crank has a locating tab. On right-hand rotation gearcases, the tab faces toward the forward gear bearing assembly. On left-hand rotation gearcases, the tab faces away from the reverse gear bearing assembly.

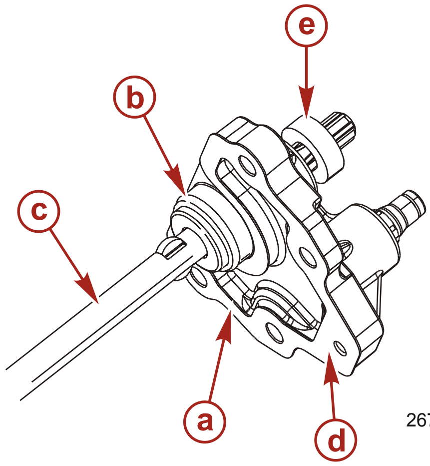


a - Pivot pin
b - Contact area
c - Splines
d - Locating tab

Disassembly and Inspection

1. Remove the rubber washer from the shift shaft.

2. Slide the cover assembly off the shift shaft.

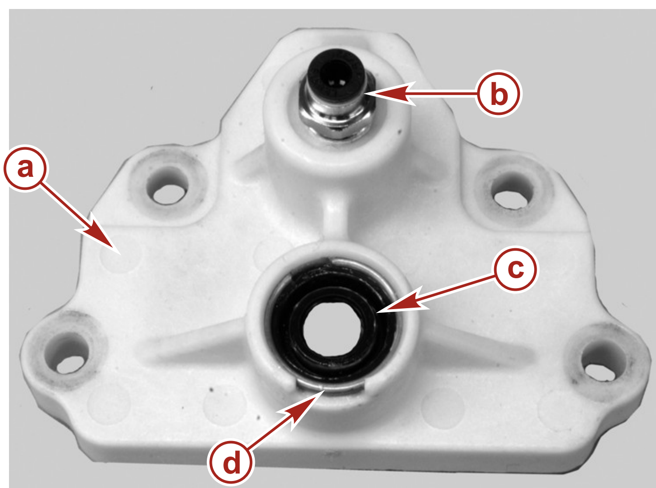


26760

- a - Shift shaft cover assembly
- b - O-ring
- c - Shift shaft
- d - Gasket
- e - Rubber washer

3. Clean all components with a suitable solvent and dry thoroughly with compressed air.
   a. Inspect the shift shaft cover for cracking, damage, or excessive wear.
   b. Inspect the oil seal inside the cover, the sleeve, and the O-ring on the outside of the cover for damage or excessive wear. Remove the retaining ring, if equipped, to remove the seal.
   c. Inspect the speedometer connector for damage or blockage.
   d. Inspect the speedometer passage through the shift shaft cover for debris.

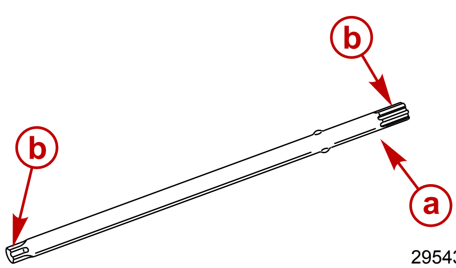
   NOTE: If any of these conditions exist, replace the appropriate components.



46075

- a - Shift shaft cover (design I and design II)
- b - Speedometer tube connector
- c - Oil seal (seal is replaceable)
- d - Retaining ring (design II)

4. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either of these conditions are found.



29543

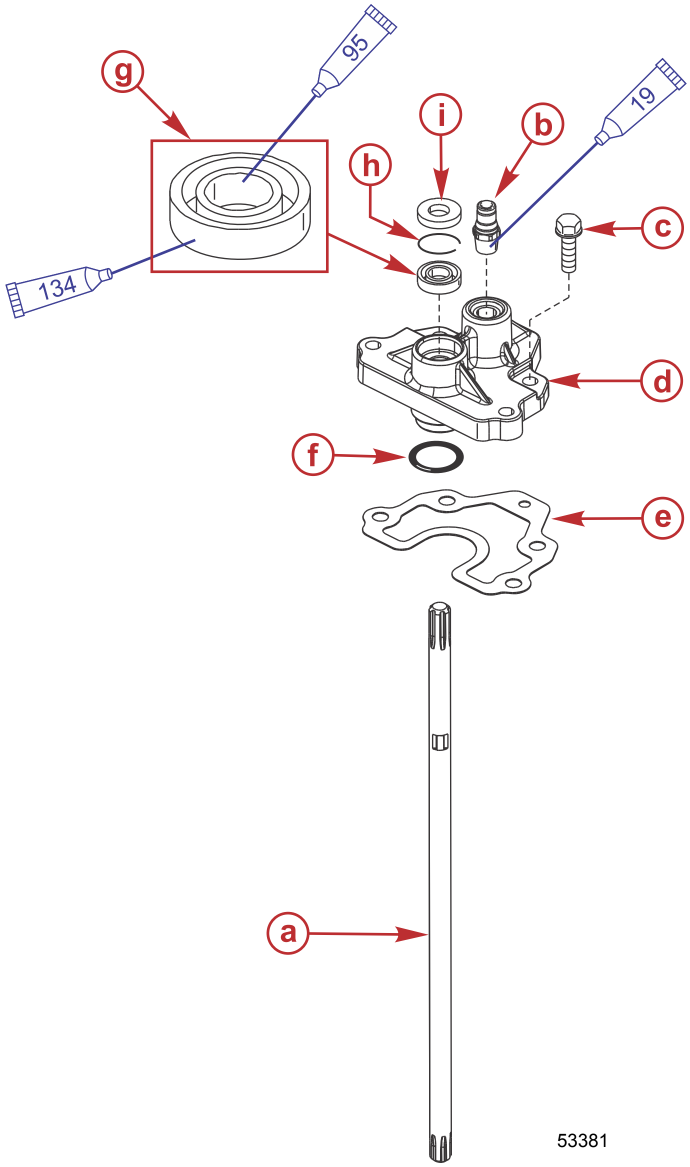
- a - Oil seal surface
- b - Splines

Assembly

1. Lightly lubricate the seat of the O-ring diameter on the cover and the lip of the oil seal with 2-4-C with PTFE.
2. Apply Loctite 380 to the outside diameter of the oil seal. Wipe off any excess Loctite.
3. If the speedometer connector was removed and/or replaced, lightly coat the threads of the connector with Perfect Seal. Assemble the speedometer connector into the cover and tighten the connector to the specified torque.

4. Assemble all components, as shown below. Be sure to position the O-ring onto the cover before installing the cover assembly into the gear housing.

   NOTE: Design II utilizes a retaining ring to secure the oil seal.



a - Shift shaft
b - Speedometer hose connector
c - Screws (M6 x 20) (4)
d - Cover assembly (design I and design II)
e - Gasket
f - O-ring
g - Oil seal (lip faces up)
h - Retaining ring (design II)
i - Rubber washer

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Speedometer connector threads	92-34227Q02
95	2-4-C with PTFE	Seat of the shift shaft cover assembly O-ring diameter and lip of the oil seal	92-802859A 1
134	Loctite 380	Outside diameter of the oil seal	Obtain Locally

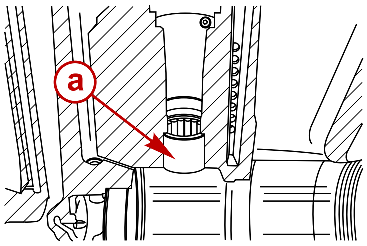
Description	Nm	lb-in.	lb-ft
Speedometer connector	2.8	25	–
Cover assembly screws (M6 x 20) (4 each)	6.7	60	–

Pinion Bearing Removal

NOTE: Inspect the bearing surface on the driveshaft where the rollers of the lower pinion bearing roll. The condition of the driveshaft at this location gives an indication of the condition of the roller bearing. Replace lower pinion bearing (rollers and race as a set) if the driveshaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.

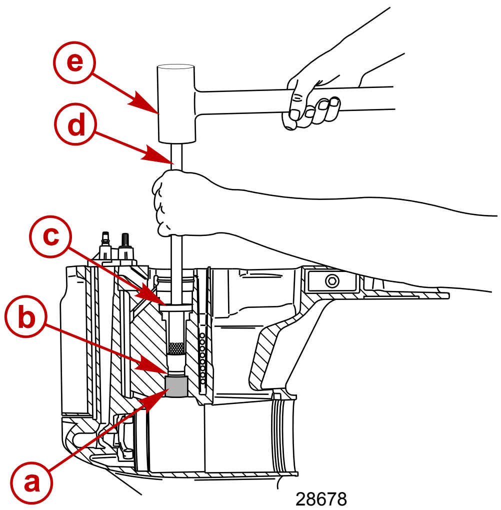
IMPORTANT: All the roller bearings (18) must be in place inside the bearing race while driving the pinion bearing from the gear housing. It is recommended that the cardboard tube provided with a new pinion bearing be used to keep the bearings in place while driving out the old pinion bearing.

IMPORTANT: Do not use the bearing (race or rollers) once it has been removed.



a - Pinion bearing

Remove and discard the pinion bearing (race and rollers) using the tools as shown.



a - Pinion bearing
b - Driver head
c - Pilot washer
d - Driver rod
e - Dead blow hammer

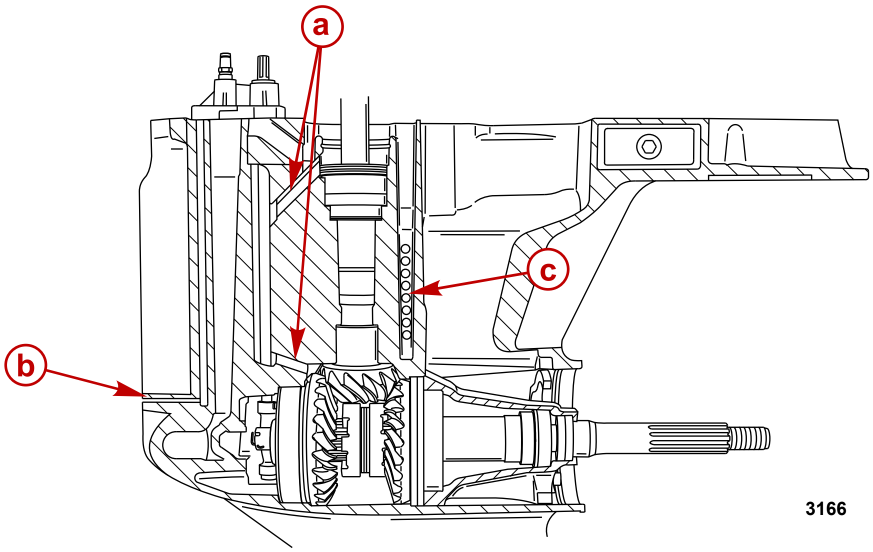
Driver Head	91- 36569T
Pilot Washer	91-36571T
Driver Rod	91- 37323

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Ensure all sealants, locking agents, and debris are removed.
2. Verify the two oil circulation holes in the driveshaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact, or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.

   NOTE: The upper driveshaft bearing cup is a slip fit within the driveshaft bore and may show signs of movement. All other bearing cups are press fit and should not show any signs of movement.
5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. A press fit type bearing bore in which the race/cup is loose will require replacement of the gear housing.

6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole, as this could cause erroneous speedometer readings.



3166

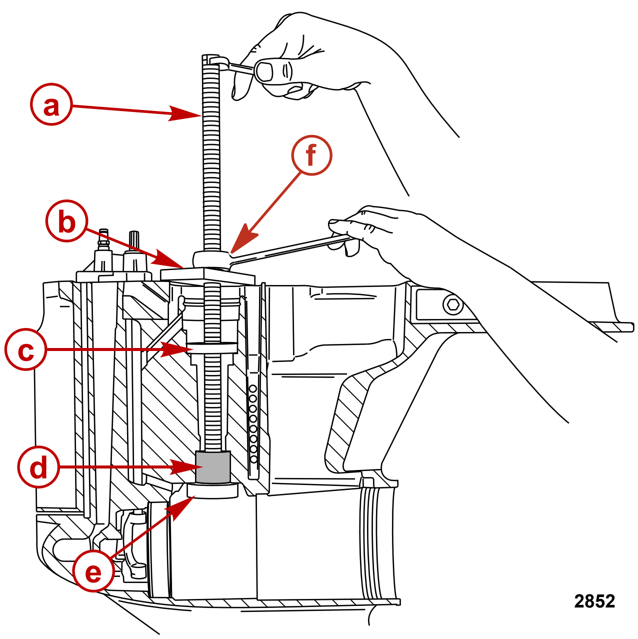
- a - Oil circulation holes
- b - Speedometer hole
- c - Water inlet holes

7. Verify the locating pins are in place in the gear housing and the corresponding holes in the driveshaft housing are not elongated. The driveshaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing Installation

IMPORTANT: Install only a new pinion bearing. Do not install a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with High Performance Gear Lubricant.
2. Position the new pinion bearing, with the cardboard shipping sleeve in place, onto the driver head with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly into position, by way of the propeller shaft bore, at the driveshaft bore, as shown.
4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.



2852

- a - Puller rod
- b - Puller plate
- c - Pilot
- d - Pinion bearing
- e - Mandrel
- f - Hex nut

Bearing Removal and Installation Kit	91- 31229A 7

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Pinion bearing bore	92-858064K01

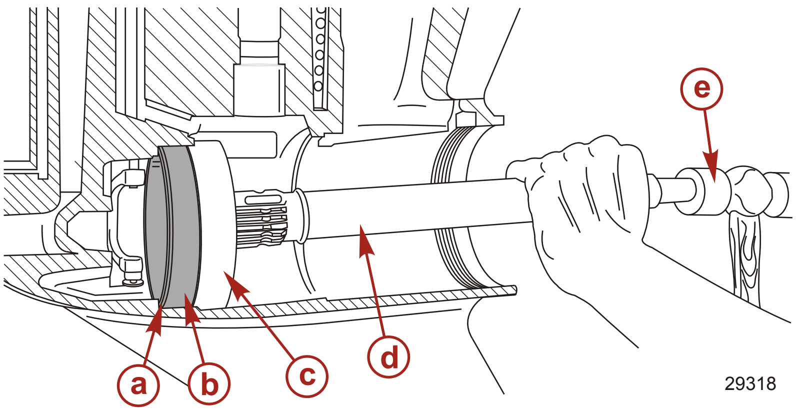
Forward Bearing Cup

Installation

Forward Gear	
Backlash	0.482–0.660 mm (0.019–0.026 in.)

NOTE: If the forward gear, forward gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when cup was removed. If the forward gear, forward gear bearing and cup, or gear housing were replaced, install 0.762 mm (0.030 in.) of shims.

1. Lubricate the bore into which the forward gear bearing cup is to be installed with High Performance Gear Lubricant.
2. Place the shim into forward bore of gear housing.
3. Press the bearing cup into the gear housing using the installation tool.
   IMPORTANT: Verify that the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.



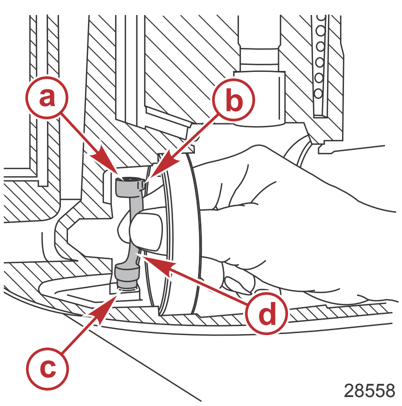
- a - Shims
- b - Race
- c - Bearing cup driver
- d - Propeller shaft (old nonserviceable)
- e - Mallet

Bearing Cup Driver	91-885592T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Forward gear bearing cup bore	92-858064K01

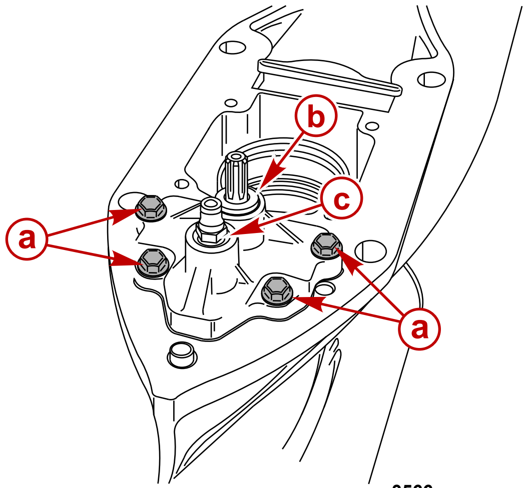
Shift Shaft Installation

1. Place the shift crank into the pivot pin hole in the forward section of the gear housing. Ensure that the shift crank faces towards the right (starboard) side of the gear housing.
   NOTE: The shift crank has a locating tab. On right-hand rotation gearcases, the locating tab faces toward the forward gear bearing assembly. On left-hand rotation gearcases, the locating tab faces away from the reverse gear bearing assembly.



- a - Shift shaft splines
- b - Locating tab
- c - Pivot pin
- d - Shift crank

2. Install the shift shaft assembly into the gear housing, as shown. Engage the splined end of the shift shaft with the shift crank. Verify the O-ring is positioned properly on the bushing and lubricated with 2-4-C with PTFE. Secure the shift shaft bushing with four screws. Tighten the screws and the speedometer fitting to specification.
3. Install the rubber washer onto the shift shaft and slide the washer down until it just touches the oil seal in the bushing.



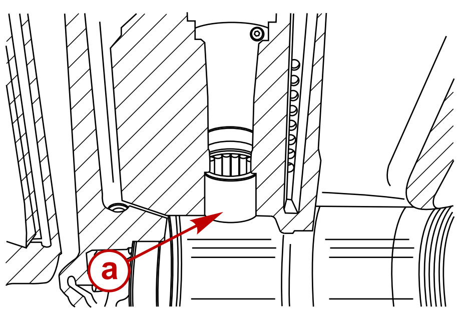
3566

a - Screw (4)
b - Rubber washer
c - Speedometer fitting

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring	92-802859A 1

Description	Nm	lb-in.	lb-ft
Shift shaft bushing screws (M6 x 20)	6.7	60	–
Speedometer fitting	2.8	25	–

NOTE: If the pinion bearing needle bearings have fallen out, install the 18 needles into the needle bearing outer race. Use 2-4-C with PTFE to help hold needles in place.



29114

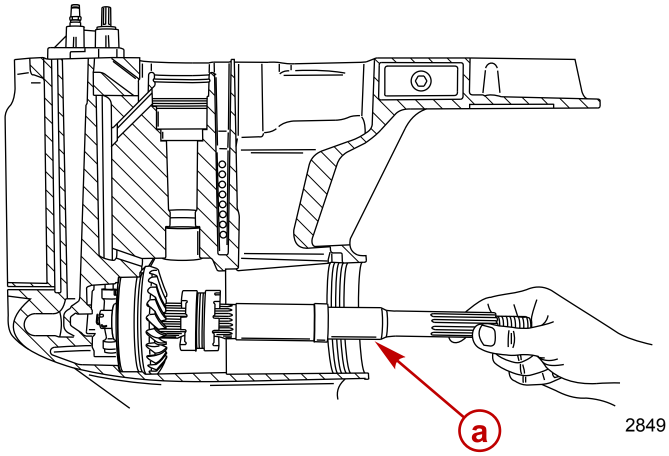
a - Pinion bearing

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Pinion needle bearings	92-802859A 1

Propeller Shaft Installation

NOTE: The shift/clutch assembly should be in the neutral detent position when installing the propeller shaft.

1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the right (starboard) side of gear housing and hold the shift shaft in neutral while installing the shaft.



a - Propeller shaft

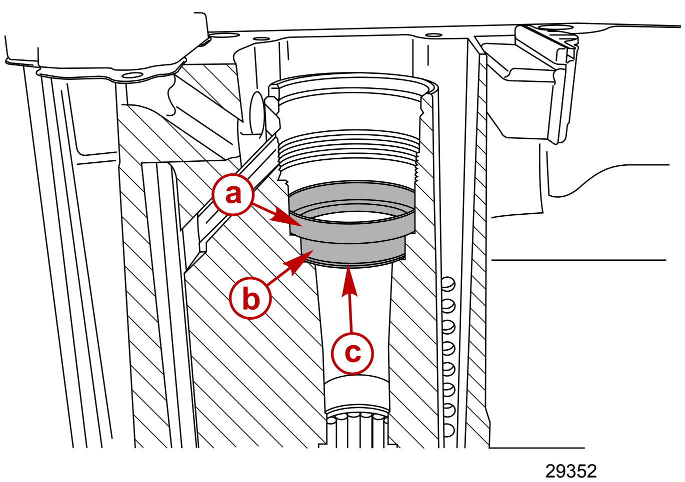
2. Operate the shift shaft to ensure it has been properly installed. The sliding clutch should move forward when the shift shaft is turned counterclockwise, and should move aft when the shift shaft is turned clockwise.

Driveshaft and Pinion Gear Installation

NOTE: If the original shims were not retained or if the pinion gear, driveshaft, driveshaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.508 mm (0.020 in.) shim, for the lower tapered roller bearing.

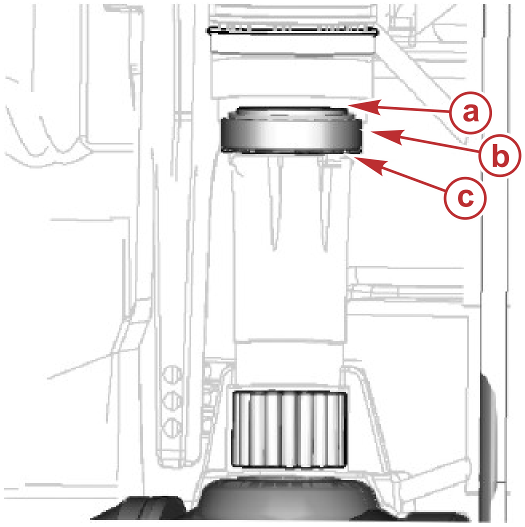
NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, install the same shims or same amount of shims.

1. Place the lower tapered bearing shims into the driveshaft housing bore.
2. Install the lower tapered bearing race into the driveshaft housing bore.
3. Depending on the design:
   a. **Design I**: Install the spacer (flanged end faces down).



Design I
a - Spacer
b - Tapered bearing race
c - Shims

b. **Design II**: Install the shims.



Design II
a - Shims
b - Tapered bearing race
c - Shims

4. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

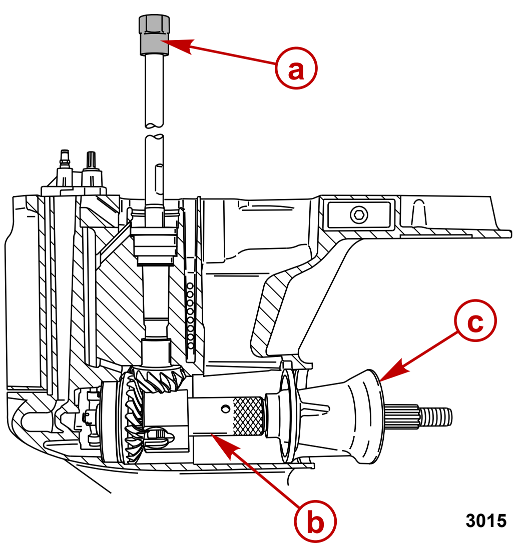
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

***NOTE:** Install the pinion gear nut with the flat side of the nut away from the pinion gear.*

***NOTE:** For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, or Bellows Adhesive, or equivalent.*

***NOTE:** If the backlash has to be changed, it is recommended that Loctite 271 Threadlocker not be applied to the pinion nut until the backlash setting is finalized. Do not reuse the old pinion nut. Install a new pinion nut after backlash is finalized.*

5. Place the pinion gear and washer into the gear housing.
6. With the propeller shaft horizontal, insert the pinion nut holding tool (with the nut) into the gear housing.
7. Insert the driveshaft into the gear housing driveshaft bore. It may be necessary to rotate the driveshaft to engage the driveshaft splines into the pinion gear splines.
8. Start the pinion nut onto the driveshaft threads by rotating the driveshaft until the nut is snug.
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut holding tool in position.
10. Tighten the pinion nut to the specified torque by turning the driveshaft using the driveshaft holding tool and torque wrench.



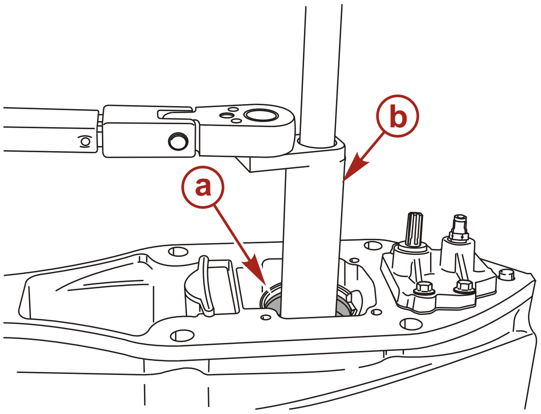
a - Driveshaft holding tool
b - Pinion nut wrench
c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T

Pinion Nut Wrench	91- 61067T03

Description	Nm	lb-in.	lb-ft
Pinion nut	101.7	–	75

11. Install the upper driveshaft tapered roller bearing cup. Apply 2-4-C with PTFE to the retainer threads and install the retainer. Tighten the retainer to the specified torque.



a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Retainer threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Retainer	135.5	–	100

12. Remove the bearing carrier, pinion nut wrench, and driveshaft bearing retainer wrench.

NOTE: Units correctly assembled to this point would show a driveshaft rolling torque of 0.2–0.9 Nm (2–8 lb-in.).

Pinion Gear Height

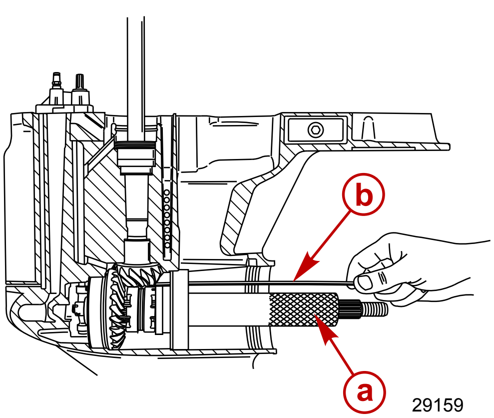
Checking and Adjusting Using Pinion Gear Locating Tool 91-56048001

NOTE: The prop shaft and forward gear can be installed when checking pinion height if pinion gear locating tool (91-56048001) is used.

1. Place the pinion gear locating tool into the gear housing aligning window in tool with pinion gear.

   NOTE: Take the following measurements at 3 locations, rotating the driveshaft 120 degrees between each reading.

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and the high point of the shimming tool.



a - Pinion gear locating tool
b - Feeler gauge

Pinion Gear Locating Tool	91- 56048001

3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the 3 readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

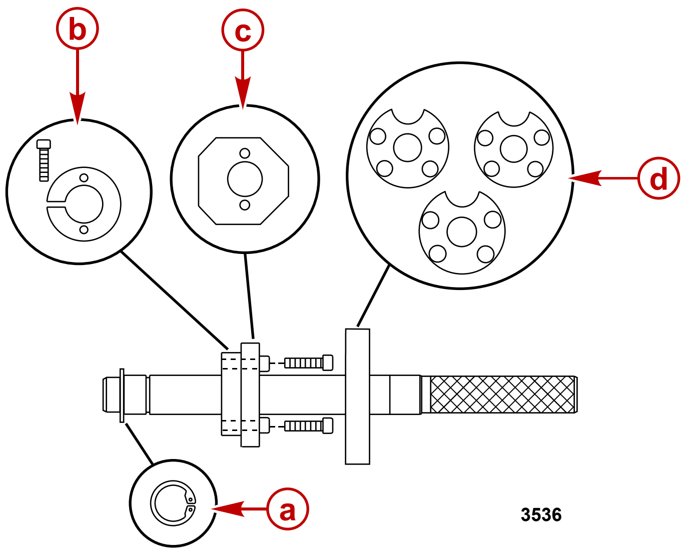
Pinion Gear	
Height	0.635 mm (0.025 in.)

6. If the average pinion gear height is not correct, add shims (to increase pinion height) or subtract shims (to lower pinion height) beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and retorque retainer to specifications.

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Checking and Adjusting using Pinion Gear Locating Tool 91-12349A05

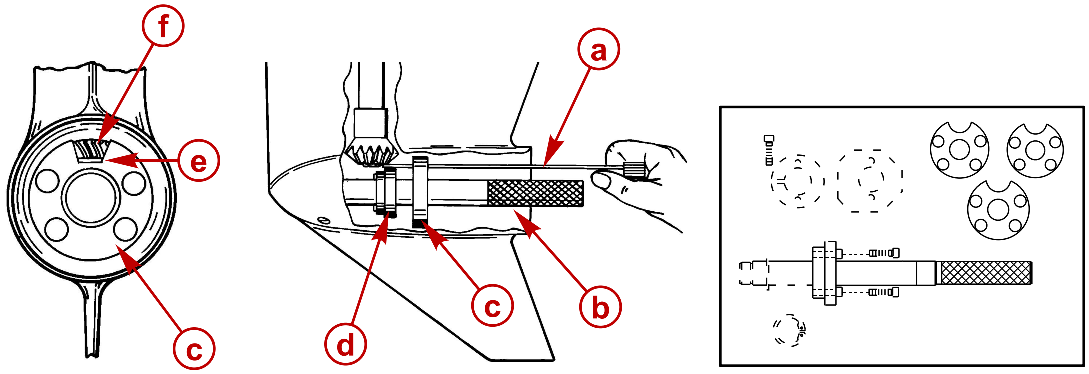


a - Retaining ring - relocate to first groove for 2.6 liter gearcase
b - Split collar
c - Gauging block - use flat #4 for 2.6 liter gearcase
d - Locating disc - use disc #2 for 2.6 liter gearcase

NOTE: The forward gear assembly must be installed when using pinion gear locating tool 91-12349A05.

1. Install retaining ring on pinion height tool into first groove of arbor.

2. Using disc #2 and flat #4, install pinion gear locating tool into gearcase.



3174

a - Feeler gauge
b - Pinion gear locating tool
c - Disc #2
d - Flat #4
e - 0.635 mm (0.025 in.)
f - Pinion gear

Pinion Gear Locating Tool	91- 12349A05

NOTE: Take the following measurements at three locations, rotating the driveshaft 120 degrees between each reading (always rotate the driveshaft in a clockwise direction).

3. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
4. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
5. Repeat this process until three readings have been taken.
6. Add the three readings together and divide the sum by three to get the average pinion gear height. Make note of this average measurement.

Pinion Gear	
Height	0.635 mm (0.025 in.)

7. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
8. Reinstall removed components and retorque retainer to specifications.

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

9. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Forward Gear Backlash

Forward Gear	
Backlash	0.482–0.660 mm (0.019–0.026 in.)

NOTE: If backlash has already been checked and it was determined that it needs to be adjusted, adding or subtracting 0.03 mm (0.001 in.) shims will change the gear backlash by the same amount.

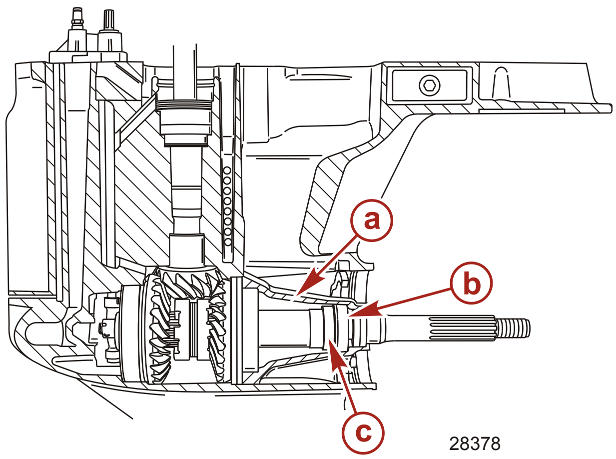
Example 1 (if backlash is too high)	
If forward backlash checks:	1.02 mm (0.040 in.)
(Subtract):	0.56 mm (0.022 in.)
Add this quantity of shims:	0.46 mm (0.018 in.)

Example 1 (if backlash is too high)	
Provides backlash of:	0.56 mm (0.022 in.)

Example 2 (if backlash is too low)	
Backlash checks:	0.25 mm (0.010 in.)
Subtract this quantity of shims:	0.31 mm (0.012 in.)
Provides backlash of:	0.56 mm (0.022 in.)

1. Install propeller shaft preload spacer onto propeller shaft.

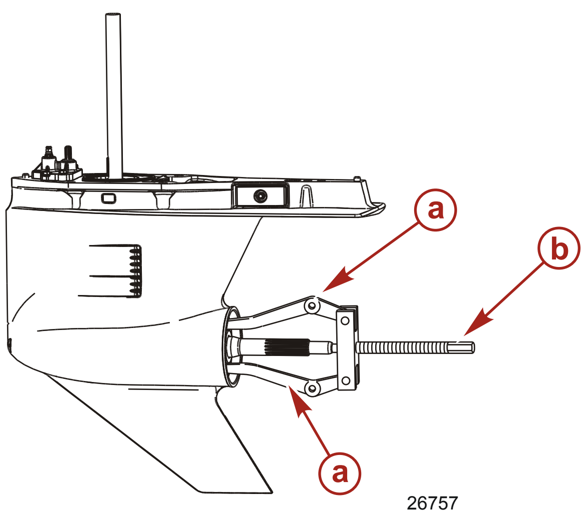
   NOTE: *Propeller shaft preload shims will be installed when checking propeller shaft preload, following.*
2. Place the bearing carrier assembly into the gear housing being careful to align the rear propeller shaft bearing with the propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion and reverse gears.
3. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with PTFE. Start the retainer into the gear housing threads and screw it down fully by hand.



a - Bearing carrier assembly
b - Propeller shaft bearing
c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer nut threads and corresponding gear housing threads, bearing carrier O-ring, upper driveshaft bearing retainer threads	92-802859A 1

4. Apply forward pressure to propeller shaft as follows:
   a. Attach puller jaws assembly onto bearing carrier bosses and propeller shaft.
   b. Torque the puller bolt to specification. Rotate driveshaft three full turns clockwise and retorque the bolt to specification.

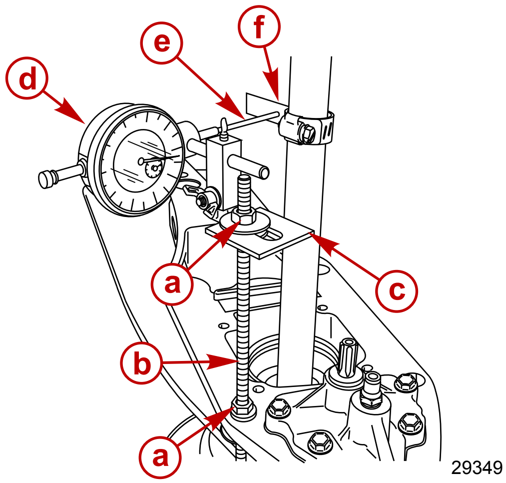


a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

Description	Nm	lb. in.	lb. ft.
Propeller shaft torque	5.5	50	

5. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.) obtain locally
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator Adapter	91-83155
Dial Indicator	91- 58222A 1
Backlash Indicator Rod	91- 78473

6. Take the backlash readings by lightly turning the driveshaft back and forth. No movement should be noticed at the propeller shaft.
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
   c. Repeat step **b** above and take and record another reading. Repeat step **6** until a total of four backlash readings have been taken.
7. Add the four readings together and divide the sum by four. This is your average backlash.

Forward Gear	
Average backlash	0.482–0.660 mm (0.019–0.026 in.)

8. If the backlash is less than the specified minimum, remove the shims from in front of the forward gear bearing race to obtain the correct backlash. When reinstalling the pinion nut, apply Loctite 271 to the threads of the nut.
9. If the backlash is more than the specified maximum, add shims in front of the forward gear bearing race to obtain the correct backlash. When reinstalling the pinion nut, apply Loctite 271 to the threads of the nut.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Threads of pinion nut	92-809819

NOTE: By adding or subtracting 0.025 mm (0.001 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).

10. Remove the bearing carrier removal tool and puller bolt.

Reverse Gear Backlash

Reverse Gear	
Backlash	1.27–1.47 mm (0.050–0.058 in.)

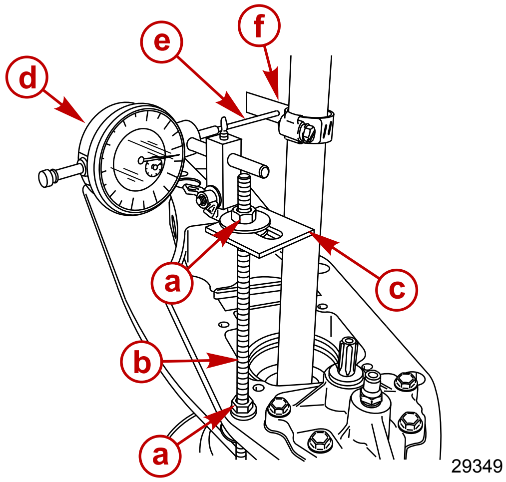
Although reverse gear backlash is not adjustable, it may be checked as follows:

NOTE: Pinion height must be set before checking reverse gear backlash.

NOTE: Tighten the bearing carrier retainer nut to specification.

Description	Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	285[1.]		210[1.]

1. Apply backward pressure on the propeller shaft by holding shift crank against the reverse gear.
2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.) obtain locally
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator Adapter	91-83155
Dial Indicator	91- 58222A 1
Backlash Indicator Rod	91- 78473

3. Take the backlash readings by lightly turning the driveshaft back and forth, so as to feel the backlash between the gears. No movement should be noticed at the propeller shaft.
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
   c. Repeat step **b** above and take and record another reading. Repeat step 3 until a total of four backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash. If backlash is not as indicated, gearcase is not properly assembled or parts are excessively worn and must be replaced before returning the gearcase to service.

Reverse Gear	
Average backlash	1.27–1.47 mm (0.050–0.058 in.)

5. Remove the backlash indicator tool. Remove the dial indicator and all its mounting components.

Propeller Shaft Bearing Preload

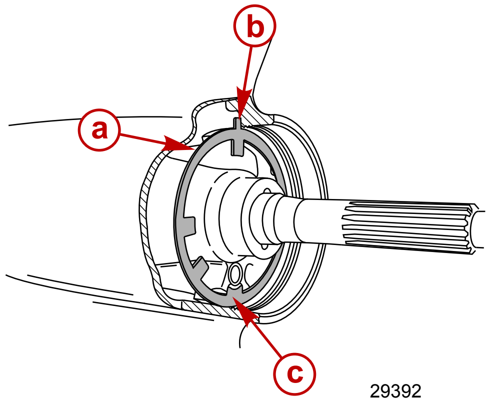
NOTE: All gear housing components must be installed and correctly shimmed before checking propeller shaft bearing preload. The propeller shaft tapered roller bearing must be properly seated in the race during installation. The driveshaft retainer should be torqued to specification.

Description	Nm	lb-in.	lb-ft
Driveshaft retainer	135.5	–	100

1. Remove the bearing carrier.
2. Slide the preload spacer off of propeller shaft.
3. Install the (retained) propeller shaft preload shims onto the propeller shaft. If any shims were lost, start with 0.9 mm (0.035 in.) shim thickness.
4. Install the preload spacer onto the propeller shaft.
5. Install the bearing carrier, aligning the rear propeller shaft bearing with the propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion with the reverse gear.

1. Torque retainer to 135.5 Nm (100 lb-ft), then check rolling torque on propeller shaft. If torque is within specification, torque retainer to 285 Nm (210 lb-ft).

6. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the U-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab
c - U-shaped tab

7. With the gear housing in neutral, torque the bearing carrier retainer nut to initial specification.
8. Rotate the propeller shaft several times to seat the propeller shaft tapered roller bearings in their races.
9. Torque the bearing carrier retainer nut to final specification.

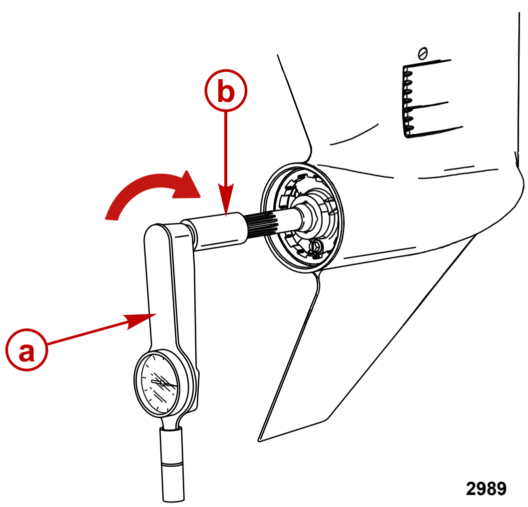
Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5	–	100
	Final	285	–	210

10. Install propeller shaft adapter and using a torque wrench, rotate propeller shaft in the direction of normal rotation with a slow steady motion.
11. Verify rolling torque is within specification for new or used bearings.

Description	Nm	lb-in.	lb-ft
Bearing rolling torque (new bearings)	1.1–1.8	10–16	–
Bearing rolling torque (used bearings)	0.45–1.1	4–10	–

NOTE: Preload will change approximately 0.056 Nm (1/2 lb-in.) of rolling torque per 0.025 mm (0.001 in.) of shim change.

12. If rolling torque is too high, remove shims from propeller shaft ahead of tapered bearing/spacer in bearing carrier. If torque is too low, add shims.



a - Torque wrench
b - Propeller shaft adapter

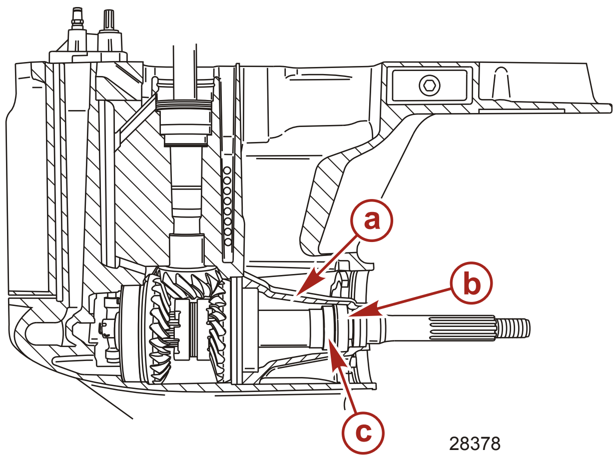
Propeller Shaft/Driveshaft Adapter	91-61077T

NOTE: If shims are changed, torque bearing carrier to initial specification. Rotate propeller shaft several times to seat propeller shaft tapered bearing. Tighten the retainer nut to final specification. Use torque wrench to check rolling torque. Repeat this procedure each time shims are changed.

Description		Nm	lb-in.	lb-ft
Bearing carrier	**First**	135.5	–	100
	Final	285	–	210

Bearing Carrier Final Installation

1. Remove the bearing carrier and lubricate the following as specified:
   a. Lubricate the carrier O-ring with 2-4-C with PTFE.
   b. Lubricate both the forward and aft outer diameters of the bearing carrier and gearcase area where the carrier will seat with 2-4-C with PTFE.
   c. Fill the space between the carrier oil seals with 2-4-C with PTFE.

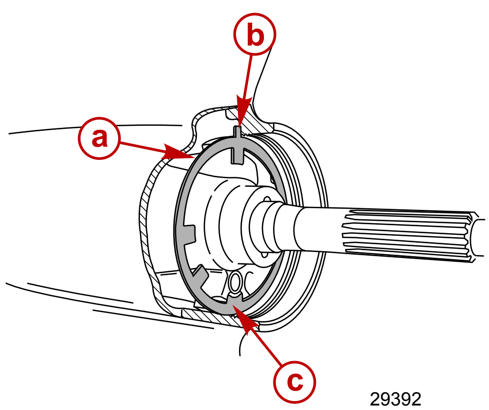


28378

a - Bearing carrier
b - Propeller shaft bearing
c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	92-802859A 1

2. Place the bearing carrier assembly into the gear housing, being careful to align the rear propeller shaft bearing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the reverse gears.
3. Lubricant fill screw in the bearing carrier should be located at the 6 o'clock position.
4. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the U-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



29392

a - Tab washer
b - Rectangular tab
c - U-shaped tab

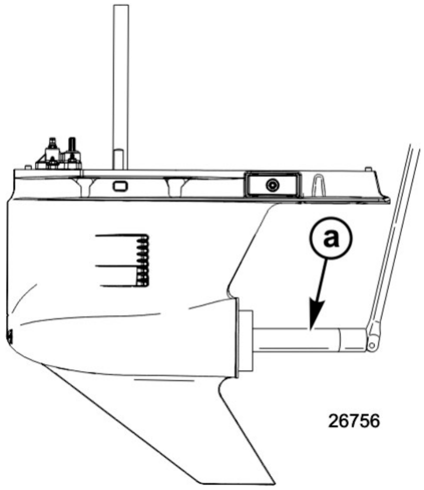
5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with PTFE. Start the retainer into the gear housing threads and screw it down fully by hand.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer nut threads and corresponding gear housing threads	92-802859A 1

IMPORTANT: Before torquing the bearing carrier retainer, the gearcase must be bolted to the driveshaft housing or securely fastened in a gearcase holding fixture to avoid possible damage to the gear housing.

NOTE: Torque retainer nut to initial specification first. Rotate propeller shaft several times to seat tapered roller bearings. Retainer nut can then be torqued to final specification.

6. Torque the bearing carrier retainer to specification. If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. Do not loosen retainer to achieve alignment.



a - Bearing carrier retainer nut wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5		100
	Final	285		210

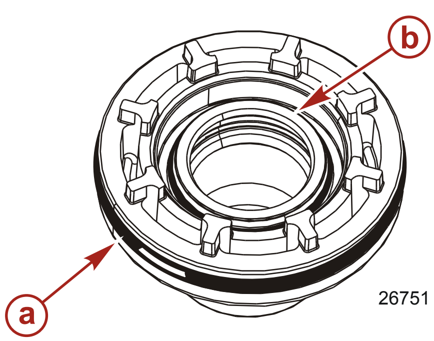
7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).

Oil Seal Carrier Installation

NOTE: The oil seal carrier may be lightly tapped into position by sliding the driveshaft bearing retainer wrench over the driveshaft.

Driveshaft Bearing Retainer Wrench	91-43506T

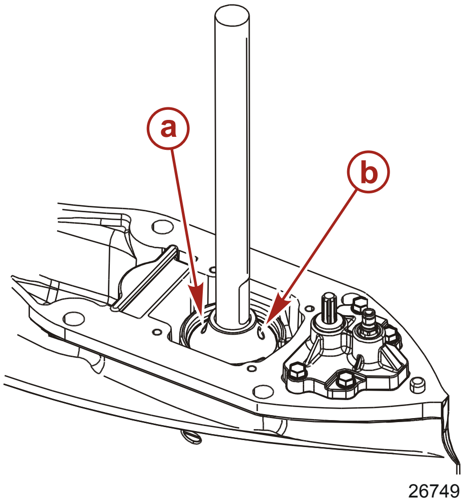
1. Lubricate the oil seal carrier oil seal lips, space between the seals, and the O-ring with 2-4-C with PTFE. Install the oil seal carrier over the driveshaft and into the gearcase.



a - O-ring
b - Oil seal lips

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal carrier seal lips, space between oil seals, O-ring	92-802859A 1

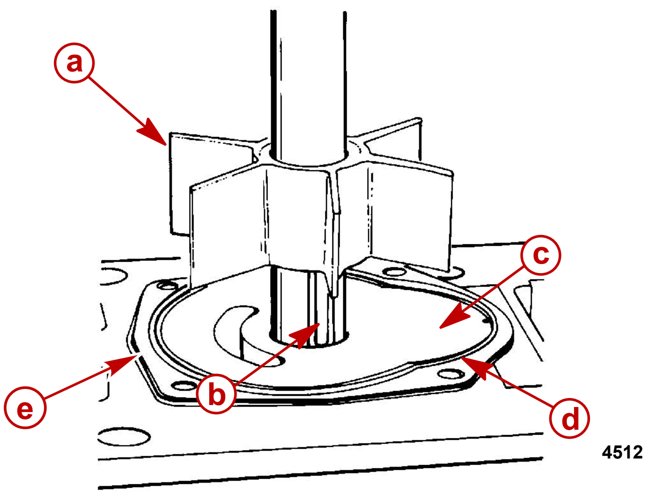
2. Install the retaining ring above the oil seal carrier.



a - Retaining ring
b - Oil seal carrier

Water Pump Installation

1. Install water pump base gasket.
2. Install water pump face plate.
3. Install water pump cover gasket.
4. Place a small amount of 2-4-C with PTFE on the flat surface of the impeller key and install the key onto the driveshaft keyway.
   IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.
5. Assemble the water pump impeller onto the driveshaft and down over the key.

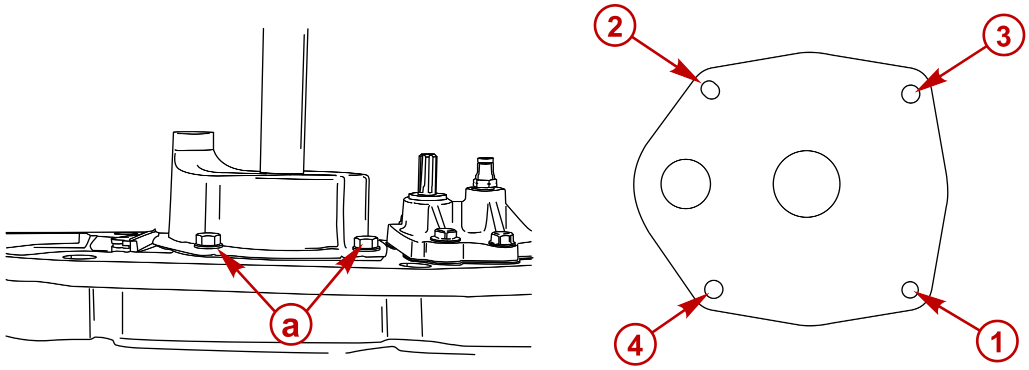


a - Impeller
b - Key
c - Face plate
d - Pump cover gasket (gray seal bead faces up)
e - Pump base gasket

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Flat surface of the impeller key	92-802859A 1

6. Apply a light coat of 2-4-C with PTFE to the inside of the pump cover. Rotate the driveshaft in a clockwise direction, while pushing down on the water pump cover to ease the water pump cover over the impeller blades.

7. Hand start starboard front fastener first into the water pump assembly. Install the remaining three fasteners. Run all fasteners down and torque in sequence to specification.



3599

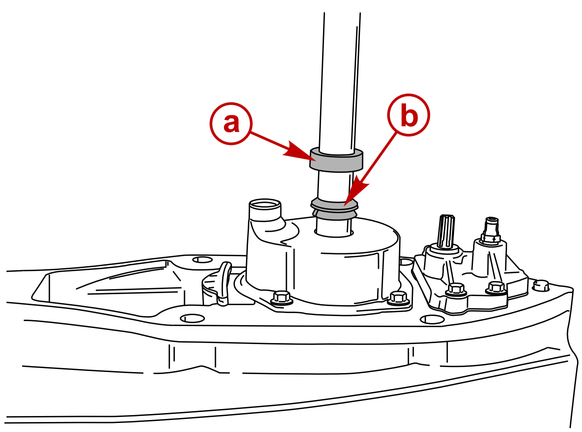
a - Water pump cover screws (4)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside of water pump cover	92-802859A 1

Description	Nm	lb-in.	lb-ft
Water pump cover screws (4)	6.7	60	

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

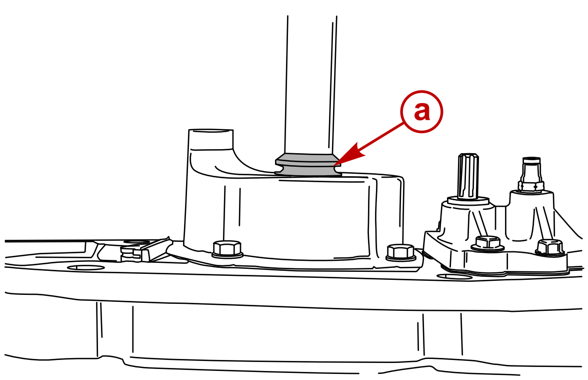
8. Using tool provided in seal kit or water pump kit, press seal down over driveshaft (do not grease driveshaft) until tool seats against pump housing.



29356

a - Tool
b - Seal

NOTE: *If tool is not available, lightly press seal against housing until specified height is obtained.*



29355

a - Seal

Water Pump Cover	
Seal height	8.9 mm ± 0.76 mm (0.350 in. ± 0.030 in.)

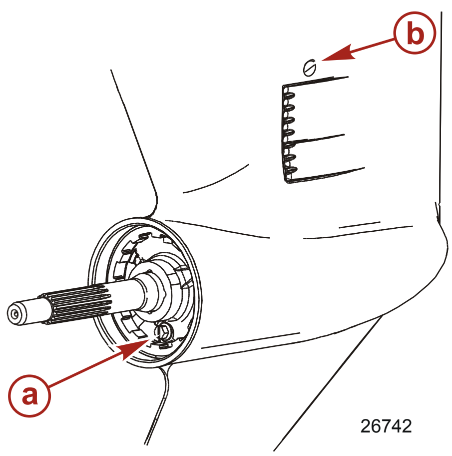
Checking Gearcase Operation

Prior to filling the gearcase with lubricant, check the gearcase for proper shift operation, as follows:

1. Rotate the shift shaft counterclockwise to the forward gear position. The propeller shaft should rotate clockwise and then lock (no ratcheting motion).
2. Rotate the shift shaft to the neutral position. The propeller shaft should rotate freely both clockwise and counterclockwise.
3. Rotate the shift shaft clockwise to the reverse gear position. The propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).
   IMPORTANT: If the shifting operation is not as described, the gear housing must be disassembled and the cause corrected.

Gear Lubricant Filling Instructions

1. Inspect the fill and vent sealing washers for cuts or abrasions. Replace the washers if necessary.
   IMPORTANT: Never apply lubricant to the gear housing without first removing the vent screw, or the gear housing cannot be filled because of trapped air. Fill the gear housing only when the housing is in a vertical position.
2. Slowly fill the housing through the fill hole with High Performance Gear Lubricant until the lubricant flows out of the vent hole and no air bubbles are visible.
3. Install the vent screw into the vent hole.
   IMPORTANT: Do not lose more than 30 cc (1 fl oz) of gear lubricant while reinstalling the fill screw.
4. Remove the grease tube (or hose) from the fill hole and quickly install the fill screw into the fill hole. Torque the fill and vent screws to specification.



a - Fill screw
b - Vent screw

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear housing	92-858064K01

Description	Nm	lb. in.	lb. ft.
Fill and vent screws	6.7	60	

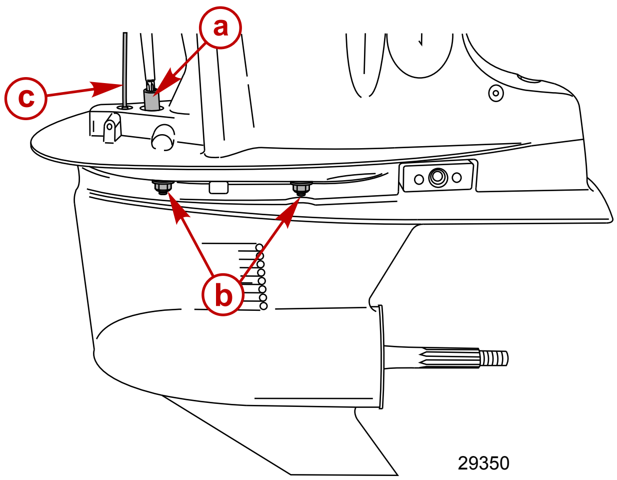
Installing Gear Housing to Driveshaft Housing

⚠ WARNING
Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

1. Tilt the engine to the full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C with PTFE onto the driveshaft splines. Do not allow lubricant on top of the driveshaft.
3. Apply a light coat of 2-4-C with PTFE onto the shift shaft splines. Do not allow lubricant on top of the shift shaft.

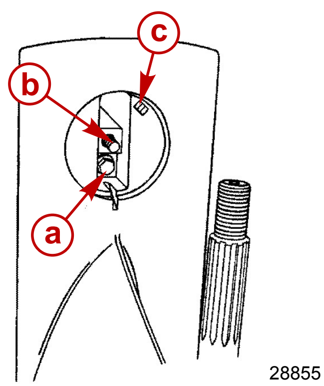
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft splines; shift shaft splines	92-802859A 1

4. Insert the anodic plate screw into the hole in the rear of the gear housing to the driveshaft housing machined surface.
5. Verify the neutral position switch is in the neutral position. Verify that the gearcase is in the neutral position.
6. Position the gear housing so that the driveshaft is protruding into the driveshaft housing. If, while performing Step 7, the driveshaft splines will not align with crankshaft splines, lower the gearcase and turn the driveshaft slightly in a clockwise direction. Repeat until the driveshaft splines match with the crankshaft splines.
7. Move the gear housing up toward the driveshaft housing while aligning the shift shaft splines with the shift shaft coupler and the water tube outlet on the water pump cover with the water tube coupler in the driveshaft housing.
8. Place the flat washers onto the studs located on either side of the driveshaft housing. Start a nut on these studs and tighten finger-tight.
9. Insert the speedometer tube into the speedometer tube coupler.



a - Shift shaft coupler
b - Nuts and flat washers (2 each side)
c - Speedometer tube

10. Start the screw at the rear of the gear housing inside the trim tab recess. Do not tighten the screw at this time.



a - Screw
b - Anodic plate attaching bolt
c - Ribs (align carefully with anodic plate)

IMPORTANT: Do not force gearcase up into place with attaching nuts.

11. Evenly tighten the two nuts which were started in Step 8. Tighten to specification.

Description	Nm	lb. in.	lb. ft.
Nuts (2 each side)	75		55

12. Install the remaining washers and nuts onto the driveshaft studs and tighten to specification.

Description	Nm	lb. in.	lb. ft.
Gearcase attaching nut (2 each side)	75		55

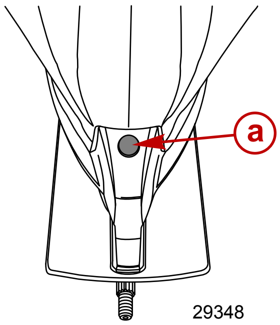
13. Tighten the screw started in Step 10 to specification.

Description	Nm	lb. in.	lb. ft.
Screw (M12 x 35)	75		55

14. Position the trim tab or anodic plate in the gear housing. Align the grooves of the trim tab with the ribs in the trim tab pocket. Adjust to the position in which it had previously been installed and, while holding the trim tab, tighten the screw to specification.

Description	Nm	lb. in.	lb. ft.
Screw (0.437-14 x 1.75 in.)	54		40

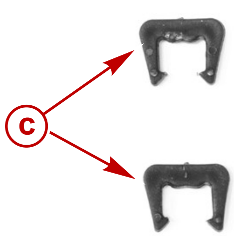
15. Install the rubber plug into the trim tab bolt opening at the rear edge of the driveshaft housing.



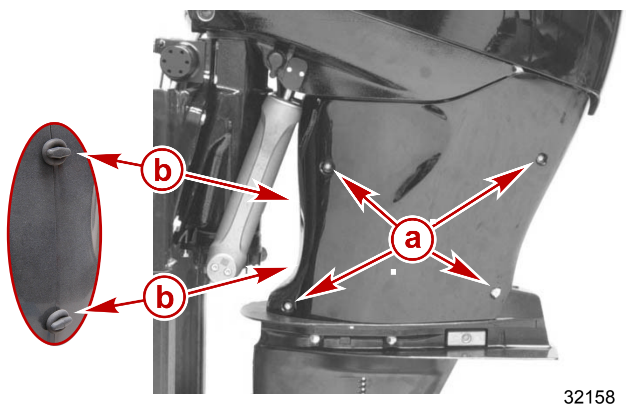
29348

a - Rubber plug

16. Install the clips or O-rings securing the front of the driveshaft housing chaps.
17. Install the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing. Tighten the screws to specification.



32157



32158

a - Chap mounting screw (M6)
b - O-ring
c - Clips (used on later models in place of O-rings)

Description	Nm	lb. in.	lb. ft.
Driveshaft housing chap screws (4 or 6 each side)	6	53	

Gear Housing

Section 6B - Left-Hand Rotation (4.8 in. Diameter)

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6
B

Gear Housing Specifications (Counter Rotation)

Gear Housing Specifications (Counter Rotation)	
Gear ratio	
Model 200/225/250/275	1.85:1 (13/24 teeth)
Model 300	1.75:1 (12/21 teeth)
Gearcase capacity	970 ml (32.8 fl oz)
Gear lubricant type	High Performance Gear Lubricant
Pinion height	0.635 mm (0.025 in.)
Forward gear backlash	0.482–0.660 mm (0.019–0.026 in.)
Reverse gear backlash	1.27–1.47 mm (0.050–0.058 in.)
Water pressure at RPM	
at 550 RPM (idle)	15.2 kPa (2.2 psi)
at 6000 RPM (WOT) warm water fast boat	60 kPa (8.7 psi)
at 6000 RPM (WOT) cold water fast boat	260 kPa (37.8 psi)
Gear housing pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)
Propeller shaft runout	0.23 mm (0.009 in.)

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift cover assembly screws	92-809819
		Pinion gear nut threads	
19	Perfect Seal	Speedometer connector threads	92-34227Q02
87	High Performance Gear Lubricant	Bore that roller bearing race is pressed into	92-858064K01
		Bearing bore in carrier	
		Inside diameter of driveshaft tapered bearings	
		Inside diameter of the reverse gear	
		Pinion bearing bore	
		Reverse gear bearing cup bore	
		Gear housing	
91	Engine Coupler Spline Grease	Driveshaft splines	8M0071842

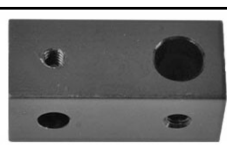
Tube Ref No.	Description	Where Used	Part No.
	2-4-C with PTFE	Shift shaft splines, retainer threads, O-rings, oil seal lips, pinion needle bearing, water pump housing, driveshaft roller bearing	92-802859A 1
		Bearing cup, reverse gear bearing surface, detent pin, propeller shaft splines, bearing carrier retainer, bearing carrier surfaces, seal lips, O-ring, bearing adapter	
		Oil seal lips and between oil seals	
		Bore that roller bearing is pressed into	
		Bearing carrier O-ring	
		Seat of the shift shaft cover assembly O-ring diameter and lip of the oil seal	
		Shift shaft bushing O-ring	
		Hold pinion needle bearings in place	
		Retainer threads	
		Bearing carrier retainer threads, corresponding gear housing threads, and upper driveshaft bearing retainer threads	
		Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	
		Bearing carrier retainer nut threads and corresponding gear housing threads	
		Oil seal carrier seal lips, space between oil seals, O-ring	
		Flat surface of the impeller key	
		Inside of water pump cover	
		Driveshaft splines; shift shaft splines	
	Loctite 380	Outer diameter of oil seals	Obtain Locally
		Outer diameter of oil seal	
		Outside diameter of the oil seal	

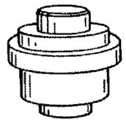
Special Tools

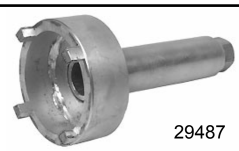
Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates

Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

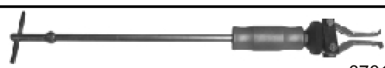
Dial Indicator Adapter	91-83155
 2999	Dial indicator holding fixture.

Dial Indicator Holding Tool	91- 89897
 29496	Secures the dial indicator to gear housing when checking backlash.

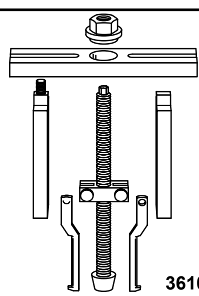
Oil Seal Driver	91-889844T
 29498	Installs seals in driveshaft seal carrier.

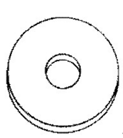
Bearing Carrier Retainer Nut Wrench	91-61069T
 29487	Installs and removes the bearing carrier retainer nut

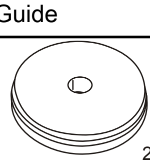
Puller Jaws Assembly	91-46086A1
 9514	Removes bearing carrier and bearing races; use with puller bolt (91- 85716)

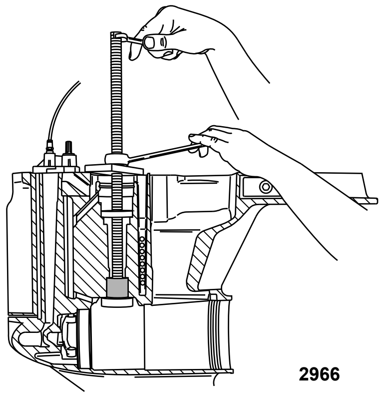
Slide Hammer	91-34569A 1
 6761	Used with puller jaws to remove various engine components

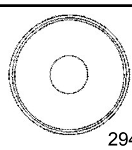
Needle Bearing Removal Tool	91-816245
 10793	Removes the needle bearings from the back adapter of a counter rotating gearcase.

Bearing Puller Assembly	91- 83165T
 **3610**	Removes bearings, races, and bearing carriers

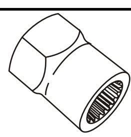
Pilot Washer	91-36571T
 29490	Used in pinion gear and pinion bearing installation.

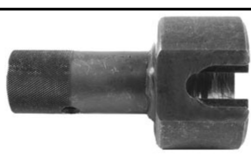
Seal Driver Guide	91-889845
 29590	Aids in the installation of bearing carrier seals.

Bearing Removal and Installation Kit	91- 31229A 7
 2966	Installs and removes the bearings in all gearcases 91-31229A7 tool assembly includes the following components: 11-24156 Hex Nut 12-34961 Washer 91-15755T Bearing Carrier 91-29310 Plate 91-29610 Pilot Plate 91-30366T1 Mandrel 91-31229 Puller Shaft 91-32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91-36569T Driver Head 91-36571T Pilot Washer 91-37292 Roller Bearing 91-37311 Driver Head 91-37312 Driver Head 91-37323 Driver Head Rod 91-37324 Pilot Washer 91-38628T Puller/Driver Head 91-52393 Driver Needle Bearing 91-52394 Head Pull Rod

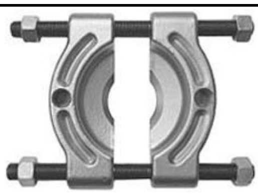
Bearing Cup Driver	91-885592T
 29492	Installs reverse gear bearing cup

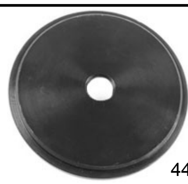
Driveshaft Bearing Retainer Wrench	91-43506T
 9520	Removes and installs the threaded bearing retainer

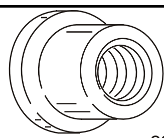
Driveshaft Holding Tool	91-889958T
 28677	Holds driveshaft during pinion nut removal on the Verado models

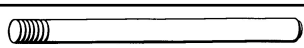
Pinion Nut Wrench	91- 61067T03
 29501	Holds the pinion nut when removing the pinion gear and driveshaft

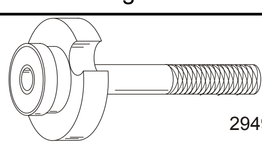
Propeller Shaft/Driveshaft Adapter	91-61077T
 10805	Provides a wrench surface to turn the propeller shaft or the driveshaft

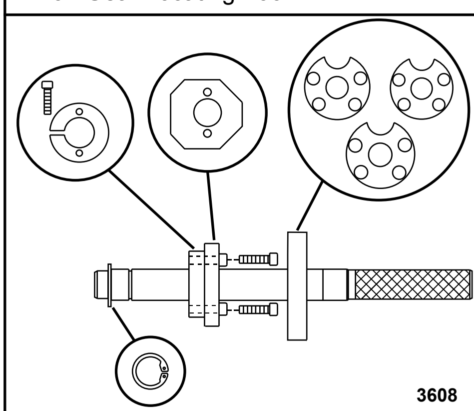
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft

Guide Plate	91-816243
 4481	Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase

Driver Head	91- 36569T
 29499	Used in pinion gear and bearing installation.

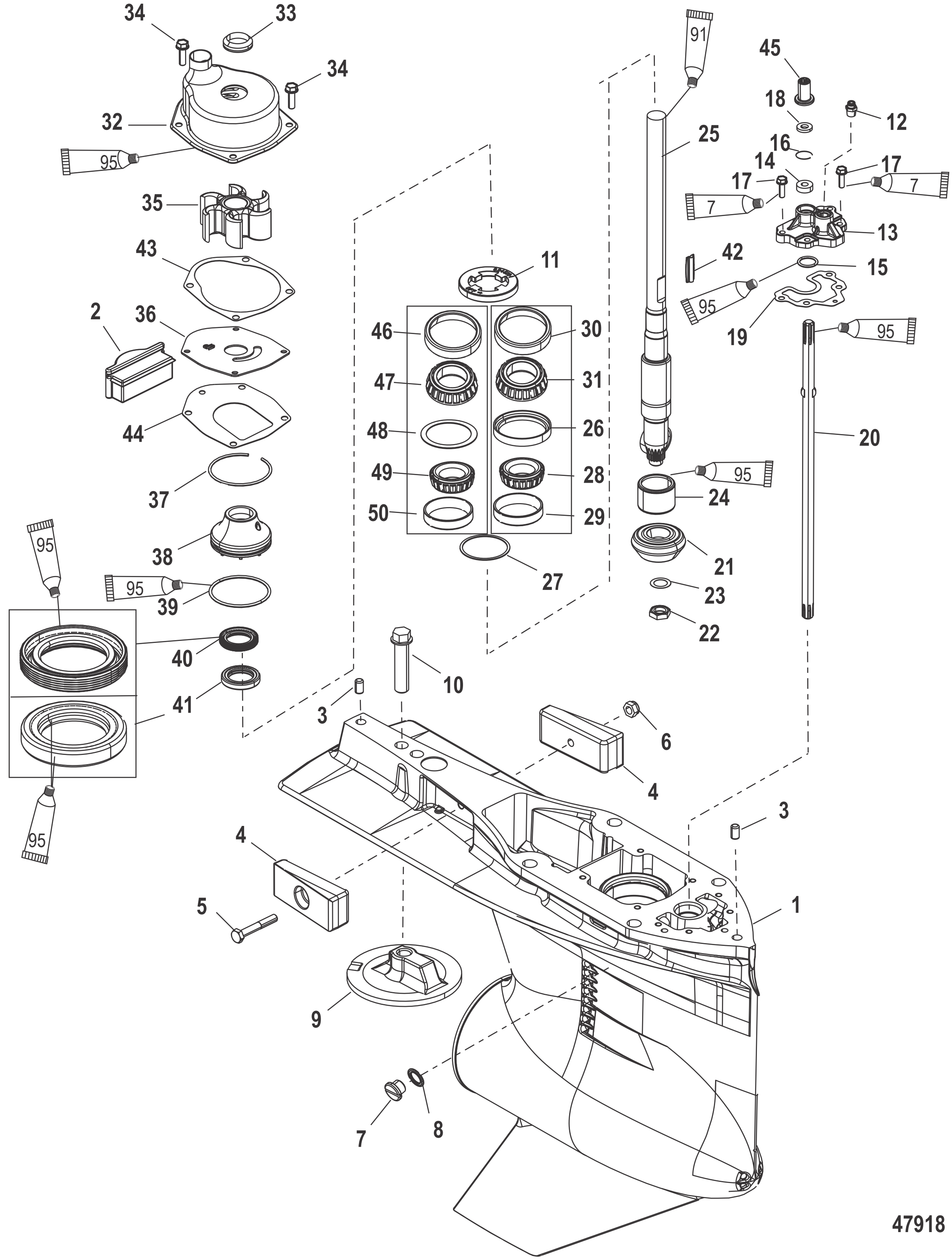
Driver Rod	91- 37323
 25431	Aids in the removal and installation of various bearings and bearing races

Pinion Gear Locating Tool	91- 56048001
 29493	Measures pinion gear height.

Pinion Gear Locating Tool	91- 12349A05
 3608	Measures pinion gear height.

Backlash Indicator Rod	91- 78473
 9450	Aids in checking gear backlash

Gear Housing (Driveshaft)



Gear Housing (Driveshaft)

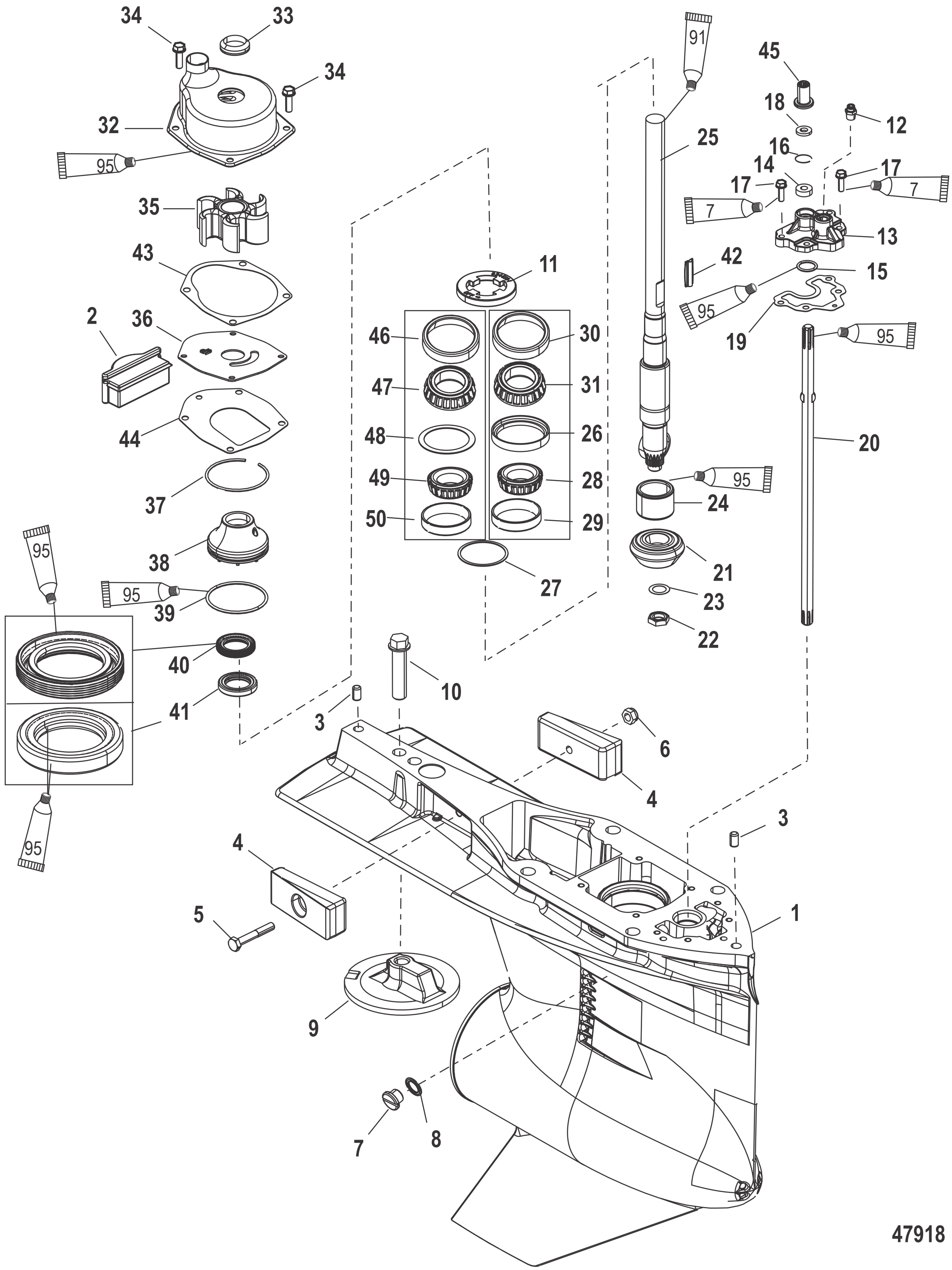
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	1	Filler block			
3	2	Dowel pin			
4	2	Anode			
5	1	Screw (M6 x 40)			
6	1	Nut			
7	1	Drain plug (0.375-16 x 0.25)	6.7	60	–
8	1	Seal			
9	1	Anodic plate			
10	1	Screw (0.437-14 x 1.75)	54	–	40
11	1	Retainer	135.5	–	100
12	1	Fitting	2.8	25	–
13	1	Cover assembly (design I and II)			
14	1	Oil seal			
15	1	O-ring (0.799 x 0.103) (design I and II)			
16	1	Retaining ring (design II)			
17	4	Screw (M6 x 20)	6.7	60	–
18	1	Washer			
19	1	Gasket			
20	1	Lower shift shaft			
21	1	Pinion gear (13 teeth)			
22	1	Nut (5/8-18)	101.7	–	75
23	1	Washer			
24	1	Roller bearing			
25	1	Driveshaft (Long)			
		Driveshaft (X-Long)			
		Driveshaft (XX-Long)			
26	1	Spacer/bearing assembly (1B792549 and below)			
27	AR	Shim (0.002–0.050)			
28	1	Roller bearing assembly (1B792549 and below)			
29	1	Cup (1B792549 and below)			
30	1	Cup/roller bearing assembly (1B792549 and below)			
31	1	Roller bearing (1B792549 and below)			
32	1	Water pump housing			
33	1	Face seal			
34	4	Screw (M6 x 20)	6.7	60	–
35	1	Impeller			
36	1	Face plate			
37	1	Retaining ring			
38	1	Oil seal carrier			

Left-Hand Rotation (4.8 in. Diameter)

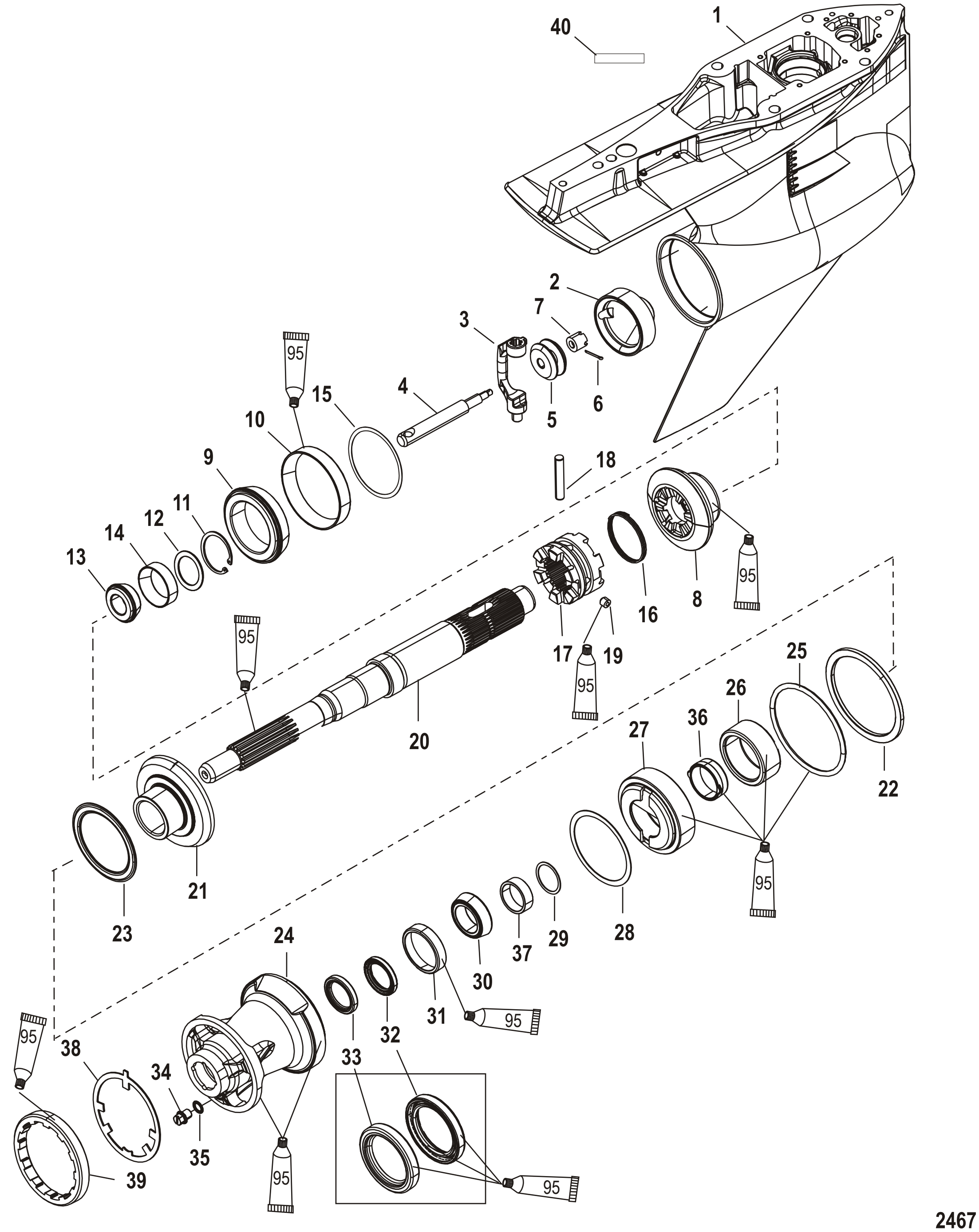
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
39	1	O-ring (2.175 x 0.103)			
40	1	Oil seal			
41	1	Oil seal			
42	1	Key			
43	1	Gasket			
44	1	Gasket			
45	1	Coupling			
46	1	Cup/roller bearing assembly (1B792550 and above)			
47	1	Roller bearing (1B792550 and above)			
48	1	Shim set (1B792550 and above)			
49	1	Tapered roller bearing assembly (1B792550 and above)			
50	1	Cup (1B792550 and above)			

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift cover assembly screws	92-809819
91	Engine Coupler Spline Grease	Driveshaft splines	8M0071842
95	2-4-C with PTFE	Shift shaft splines, retainer threads, O-rings, oil seal lips, pinion needle bearing, water pump housing, driveshaft roller bearing	92-802859A 1

Gear Housing (Driveshaft)



Gear Housing (Propeller Shaft) (Counter Rotation)



Gear Housing (Propeller Shaft) (Counter Rotation)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Plug	135.5		100
3	1	Shift crank			
4	1	Shift shaft spool			
5	1	Spool			
6	1	Cotter pin			
7	1	Adjusting sleeve			
8	1	Reverse gear			
9	1	Roller bearing			
10	1	Cup			
11	1	Retaining ring			
12	1	Thrust washer			
13	1	Roller bearing assembly			
14	1	Cup			
15	AR	Shim (0.002–0.050 in.)			
16	1	Spring			
17	1	Clutch			
18	1	Cross pin			
19	1	Detent pin			
20	1	Propeller shaft			
21	1	Forward gear			
22	1	Thrust ring			
23	1	Thrust bearing			
24	1	Bearing carrier			
25	1	O-ring			
26	1	Needle roller bearing			
27	1	Bearing adapter			
28	AR	Shim (0.002–0.045 in.)			
29	AR	Shim (0.030–0.070 in.)			
30	1	Roller bearing assembly			
31	1	Cup			
32	1	Oil seal			
33	1	Oil seal			
34	1	Screw	6.7	60	
35	1	Seal			
36	1	Adapter			
37	1	Spacer			
38	1	Keyed washer			
39	1	Retainer			
40	1	Counter rotation decal			

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing cup, reverse gear bearing surface, detent pin, propeller shaft splines, bearing carrier retainer, bearing carrier surfaces, seal lips, O-ring, bearing adapter	92-802859A 1

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part. It is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

Disassembly of a subassembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** to find the correct page number.

Threaded parts are right-hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel that will contact only the bearing race when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in the air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean the bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin the bearing with compressed air, as this may cause the bearing to score from lack of lubrication. After cleaning, lubricate the bearings with High Performance Gear Lubricant. Do not lubricate the tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work the inner bearing race in and out, while holding the outer race, to check for side wear.

When inspecting the tapered bearings, determine the condition of the rollers and the inner bearing race by inspecting the bearing cup for pits, scoring, grooves, uneven wear, imbedded particles, and/or discoloration from overheating. Always replace the tapered bearing and race as a set.

Inspect the gear housing for bearing races that have spun in their respective bores. If the race has spun, the gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check the shaft surface for pits, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced if the conditions described are found.

Shims

Keep a record of all shim amounts and their location during disassembly to aid in reassembly. Be sure to follow the shimming instructions during reassembly, as gears must be installed to the correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

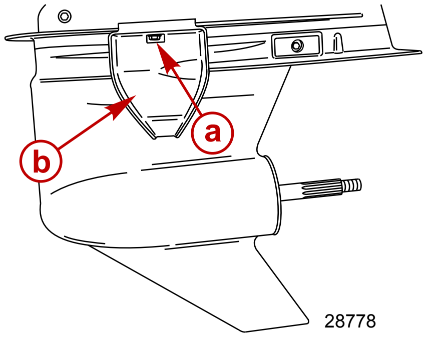
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 Threadlocker to the outer diameter of all metal case oil seals. When using Loctite on seals or threads, the surfaces must be clean and dry. To ease installation, apply 2-4-C with PTFE on all O-rings. To prevent wear, apply 2-4-C with PTFE on the I.D. of oil seals.

Gearcase Removal

⚠ WARNING
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Verify the position of the shift switch. The gearcase must be in the same position when reinstalling the gearcase to the driveshaft housing.

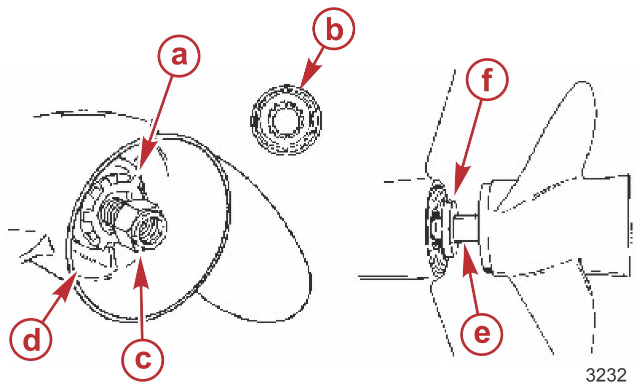
2. Drain the engine oil pan of oil. Failure to drain the oil prior to removing the gearcase will result in approximately 0.9463 liter (1 US qt) of oil leakage when the gearcase is removed.



a - Drain plug/seal washer
b - Oil drain funnel

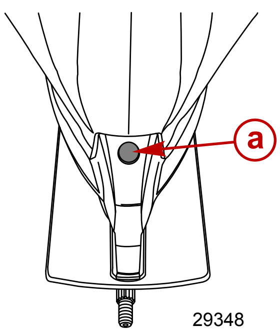
Oil Drain Funnel	91-892866A01

3. Tilt the outboard to the trailer full up position and engage the tilt lock lever.
4. Bend the tabs of the propeller tab washer away from the rear thrust hub. Remove the propeller locknut, tab washer, rear thrust hub, propeller, and forward thrust hub from the propeller shaft.



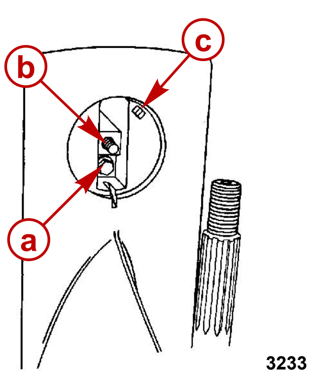
a - Tab washer
b - Continuity washer (if equipped)
c - Propeller nut
d - Rear thrust hub
e - Propeller shaft
f - Forward thrust hub

5. Remove the rubber plug at the rear edge of the driveshaft housing. Remove the screw that secures the anodic plate. Remove the plate from the gear housing.



a - Rubber plug

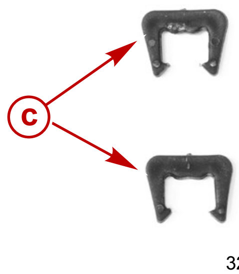
6. Once the plate is removed, remove the screw from inside of the cavity.

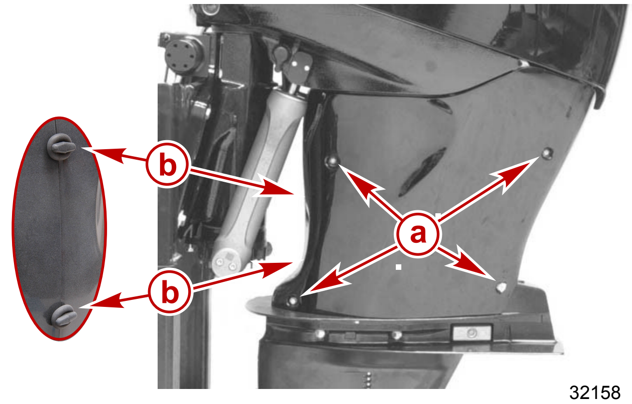


a - Screw (inside cavity) (14 mm)
b - Screw (secures anodic plate) (13 mm)
c - Ribs

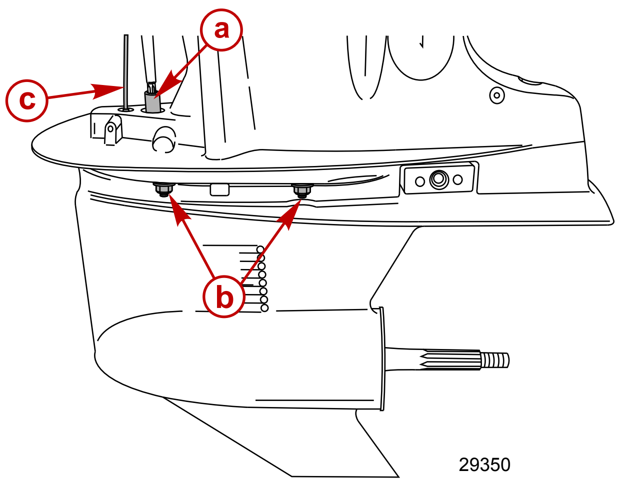
7. Remove the clips or O-rings securing the front of the driveshaft housing chaps.

8. Remove the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing and remove the chap.





9. While pressing in on the speedometer tube junction, pull out on the tube to disconnect.
10. Loosen the side mounting locknuts. Do not attempt to remove one nut before the opposite side is loosened sufficiently or the gear housing could be damaged.
11. Pull the gear housing away from the driveshaft housing as far as the loosened nuts will allow, then remove the loosened nuts. Do not allow the gear housing to fall.



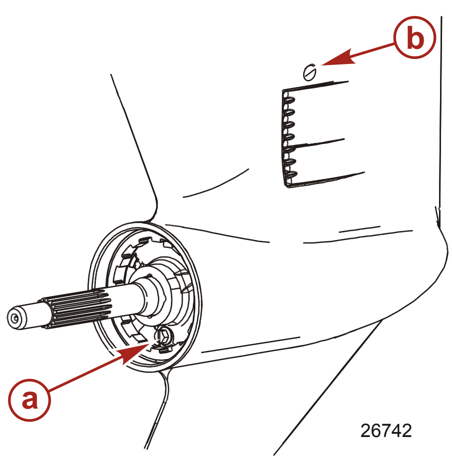
a - Shift shaft coupler
b - Nuts and washers (2 each side)
c - Speedometer tube

12. Pull the gear housing from the driveshaft housing.

Gearcase Serviceability Inspection

Draining and Inspecting Gear Housing Lubricant

1. Place the gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.
2. Position a clean drain pan under the gear housing and remove the fill and vent screws from the gear housing with a 10 mm socket or slot screwdriver.



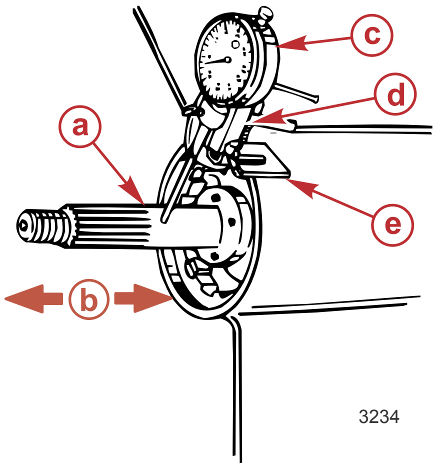
a - Fill screw
b - Vent screw

3. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates the need for gear housing disassembly and component inspection.
4. Check the color of the gear lubricant. White or cream color indicates presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly and inspection of oil seals, seal surfaces, O-rings, and gear housing components.

Propeller Shaft Inspection

Check for a bent propeller shaft as follows:

1. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.23 mm (0.009 in.), a bent propeller shaft is indicated.
2. Check for propeller shaft end play. There should be no end play. If end play exists, excessive wear has occurred and the gear housing must be disassembled for inspection.



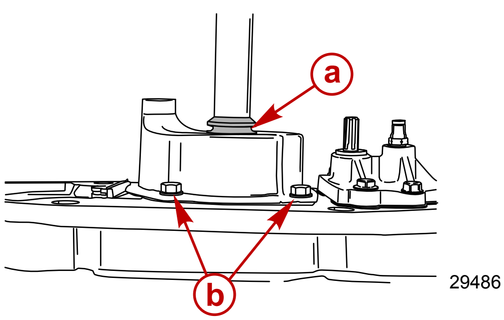
a - Propeller shaft runout
b - Propeller shaft end play
c - Dial indicator
d - Dial indicator holding tool
e - Dial indicator adapter

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Dial Indicator Holding Tool	91- 89897

Water Pump

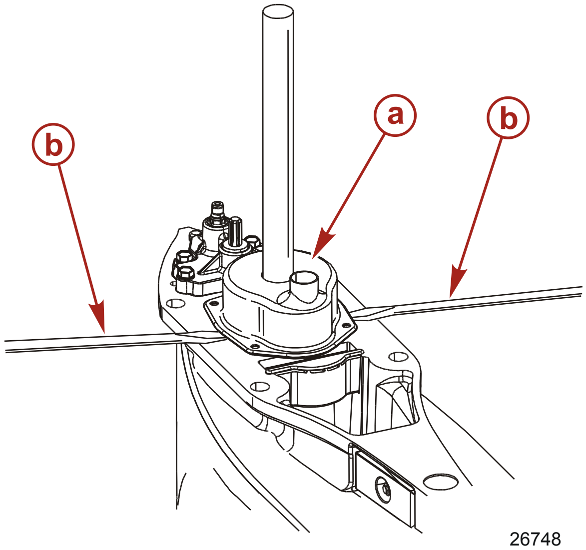
Removal and Disassembly

1. Remove the water seal and water pump screws.



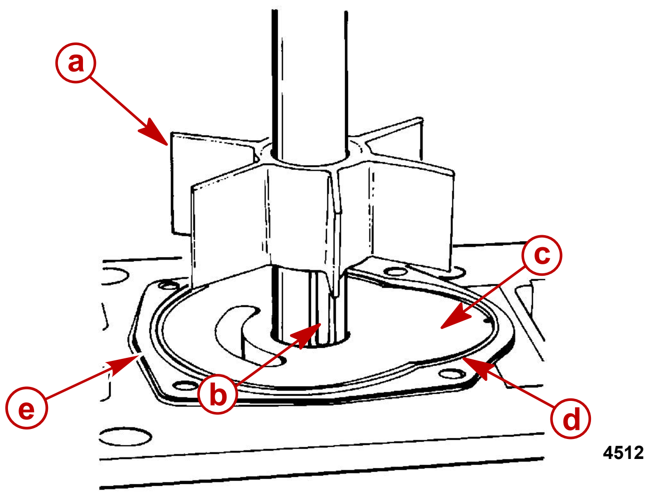
a - Water seal
b - Screws (2 each side)

2. Carefully slide the water pump straight up off of the driveshaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with screwdrivers.



- a - Water pump body
- b - Screwdrivers

3. Remove the impeller, impeller key, face plate, pump cover gasket, and pump base gasket.



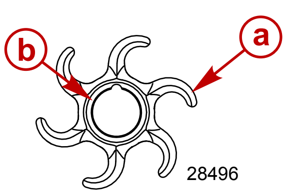
- a - Impeller
- b - Key
- c - Face plate
- d - Pump cover gasket (gray bead faces up)
- e - Pump cover base gasket

Cleaning and Inspection

NOTE: With the gearcase removed, inspect the water tube coupling assembly inside the driveshaft housing for wear or damage. If necessary, replace the worn or damaged components as required.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting the liner and plate. The depth of the groove will not affect water pump output.

1. Inspect face plate and water pump liner for grooves and/or rough surfaces.
2. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears, and wear. Replace impeller if any of these conditions are found.
3. Inspect impeller bonding to impeller hub.



- a - Impeller
- b - Hub

4. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

IMPORTANT: When completing gear housing repairs that require removal of water pump impeller, it is recommended the impeller be replaced. If it is necessary, however, to reuse impeller, do not install in reverse to original rotation, or premature impeller failure will occur.

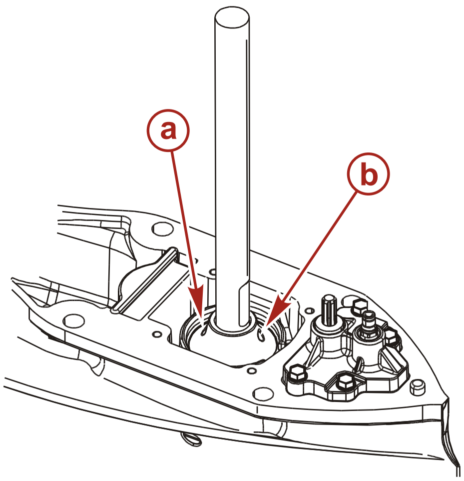
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

Removal

NOTE: Pushing down on the seal carrier may aid in the removal of the retaining ring above the seal carrier.

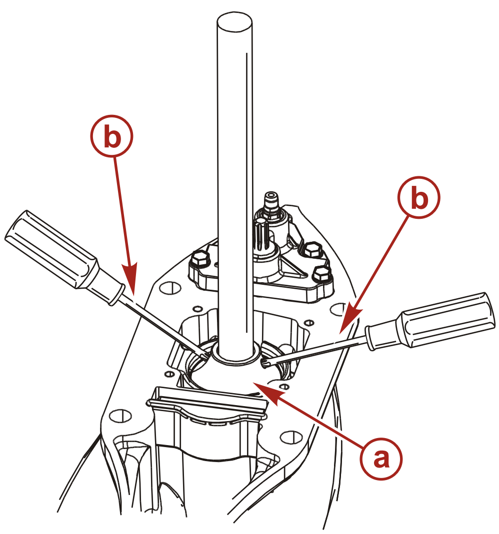
1. While pushing down on the seal carrier, use a flat tip screwdriver to aid in the removal of the retaining ring above the oil seal carrier.



26749

a - Retaining ring
b - Seal carrier

2. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



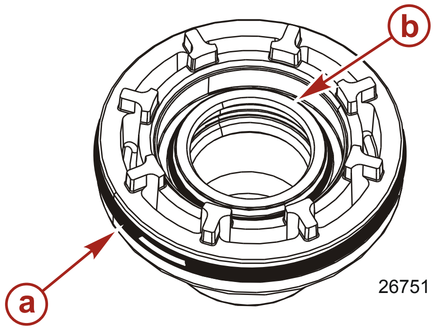
26750

a - Oil seal carrier
b - Screwdrivers

Disassembly

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

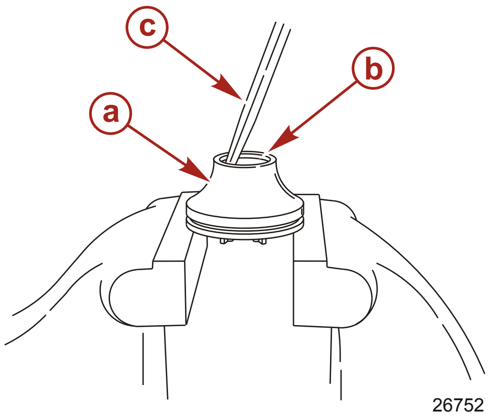
1. Remove the O-ring.



a - O-ring
b - Oil seals (2)

IMPORTANT: Use caution when removing carrier oil seals to avoid nicking or scratching the plastic surface the seals contact in the carrier, as water leakage into the gearcase could result.

2. Remove oil seals with a screwdriver or punch.

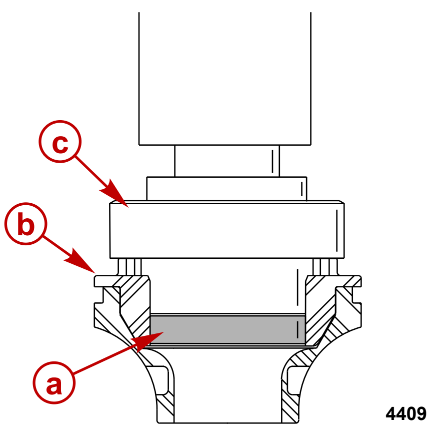


a - Oil seal carrier
b - Oil seals
c - Screwdriver

Reassembly

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C with PTFE to seal lips and between seals. Apply Loctite 380 to outer diameter of both seals.

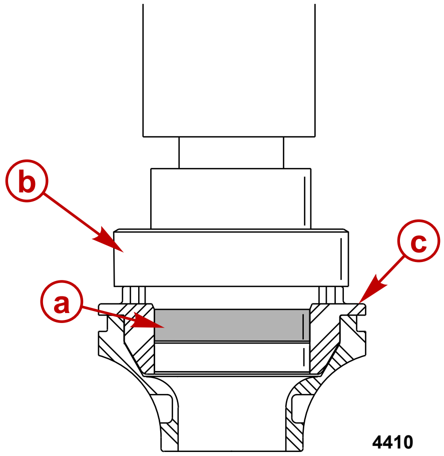
1. Press first seal into carrier with oil seal driver, using long side of seal driver.



a - First seal installed (lip faces away from driver)
b - Seal carrier
c - Oil seal driver

Oil Seal Driver	91-889844T

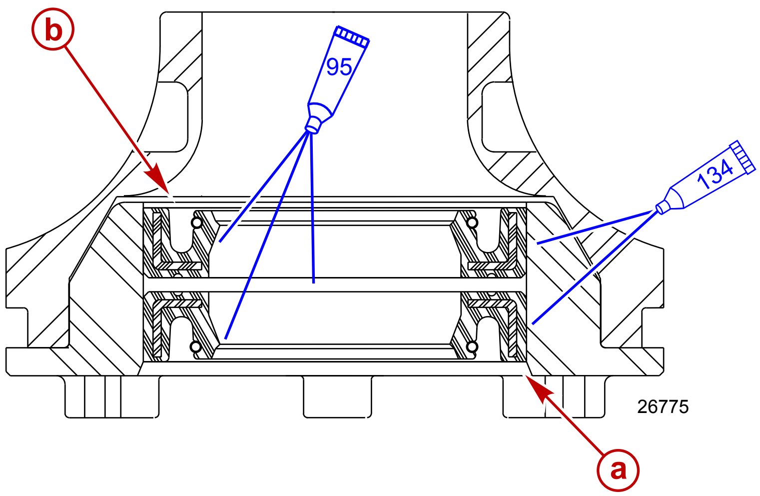
2. Reverse the seal driver and using the short side of driver, press the second seal in until the seal driver is flush with the carrier surface.



- a - Second seal installed (lip faces towards driver)
- b - Oil seal driver
- c - Seal carrier

Oil Seal Driver	91-889844T

3. Apply 2-4-C with PTFE to seal lips.



- a - Second seal installed (lip faces down)
- b - First seal installed (lip faces up)

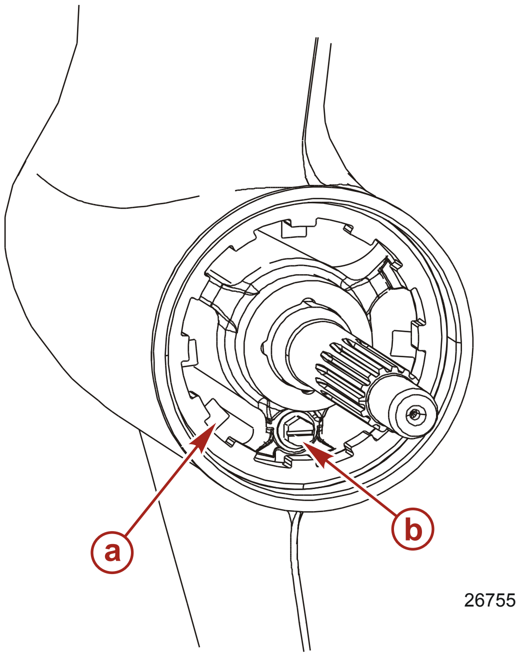
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1
134	Loctite 380	Outer diameter of oil seals	Obtain Locally

Bearing Carrier and Propeller Shaft

Removal

1. Straighten any lock tabs on the tab washer.

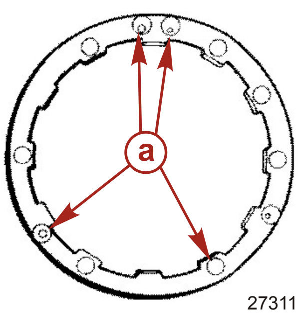
NOTE: *The drain screw in the bearing carrier must be removed before using the bearing carrier retainer nut wrench to remove the bearing carrier retainer.*



a - Tab
b - Drain screw

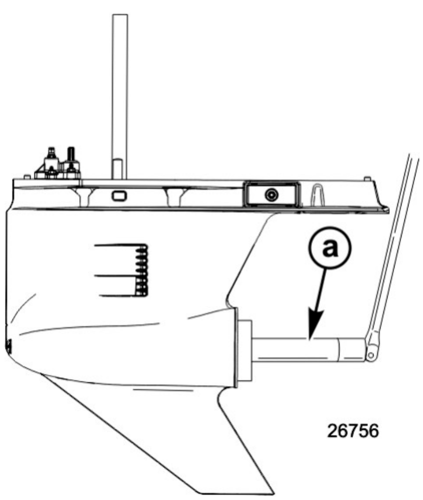
Bearing Carrier Retainer Nut Wrench	91-61069T

2. Remove the bearing carrier retainer following step "a" or "b," as follows:
IMPORTANT: Drilling into the bearing carrier retainer can potentially damage the gearcase. Ensure that you do not drill into the gearcase when removing a seized retainer.
    a. If the retainer is corroded in place, drill four holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



a - Drilled holes

    b. Remove the bearing carrier retainer using a bearing carrier retainer nut wrench. Remove the tab washer.

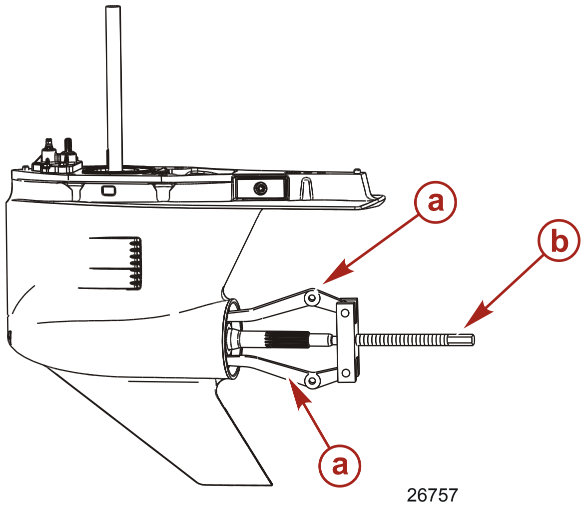


a - Bearing carrier retainer nut wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. Position the puller jaws close to the bosses in the carrier.

   NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

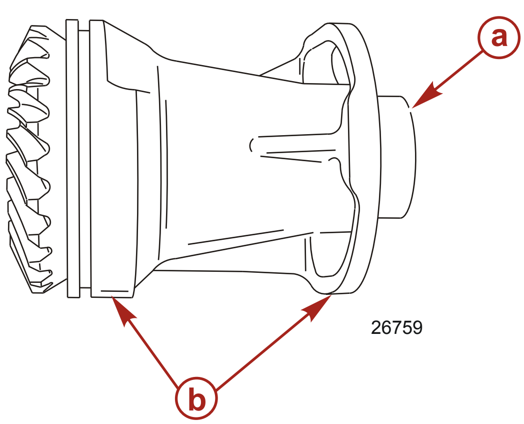
Cleaning/Inspection

IMPORTANT: It is recommended that all seals and O-rings be replaced, as a normal repair procedure, to assure effective repair.

1. Clean the bearing carrier with solvent and dry with compressed air.

⚠ WARNING
Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

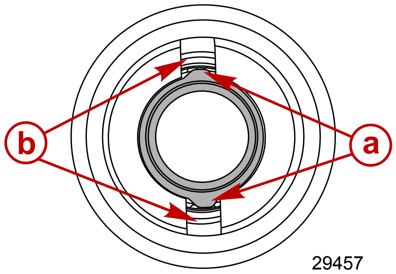
2. Inspect the bearing carrier for signs of excessive corrosion, especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident, replace the carrier.



a - Bearing carrier
b - Inspect for corrosion

3. The propeller shaft utilizes a tapered roller bearing and cup for shaft support just forward of the bearing carrier seals. The forward gear and bearing adapter assembly must be removed from the bearing carrier to gain access to the propeller shaft tapered bearing for inspection.

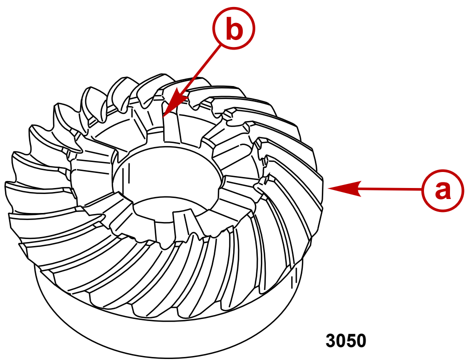
4. The forward gear can be removed from the adapter/bearing carrier assembly by rotating the gear until the forward gear sleeve tabs align with the slots in the adapter. The forward gear can then be removed from the adapter/bearing carrier assembly.



29457

a - Forward gear sleeve tabs
b - Bearing adapter slots

5. Inspect the forward gear for pits, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the forward gear and the pinion gear if any defects are found.
6. Check the clutch jaws on the forward gear for damage. Replace the forward gear if damage is found on the clutch jaws.

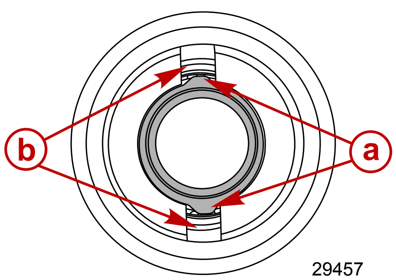


3050

a - Forward gear
b - Clutch jaws

Disassembly

1. Remove and discard the O-ring between the bearing carrier and the thrust washer.
2. Remove the forward gear assembly by rotating the forward gear sleeve tabs to align with the bearing adapter slots. Remove the gear.



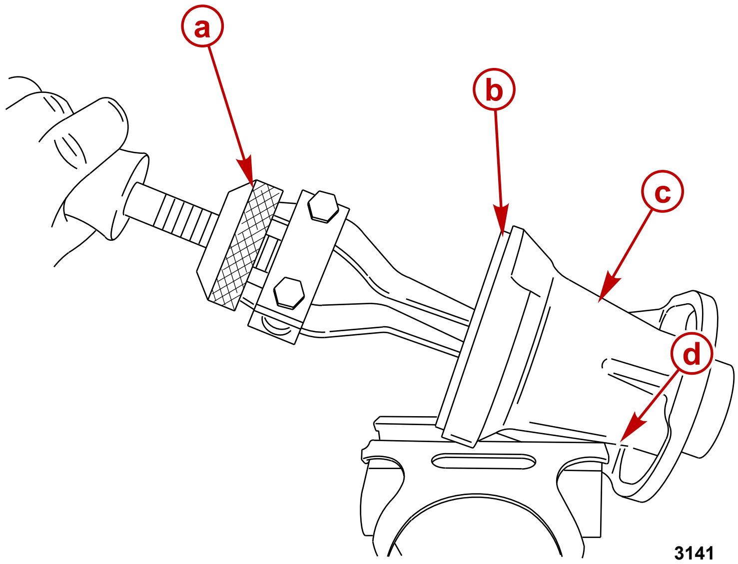
29457

a - Forward gear sleeve tabs
b - Bearing adapter slots

IMPORTANT: Clamping the bearing carrier in a vise can damage the carrier. Clamp onto the reinforcing rib only.

3. Remove the forward gear bearing adapter by placing the bearing carrier in a vise. Clamp only on the reinforcing rib.

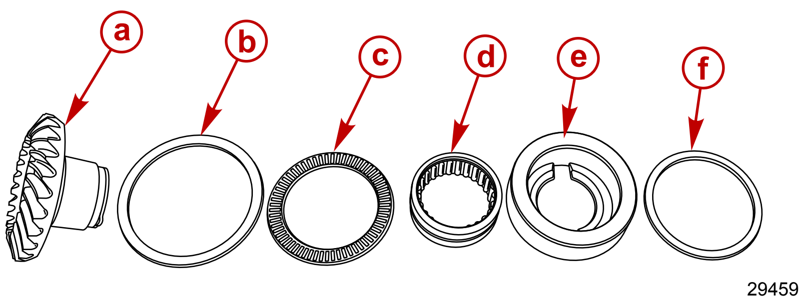
4. Remove the bearing adapter as an assembly using a slide hammer puller.



a - Slide hammer puller
b - Bearing adapter
c - Bearing carrier
d - Bearing carrier reinforcing rib

Slide Hammer	91-34569A 1

5. Clean the forward gear bearing adapter assembly with a suitable solvent and dry it using compressed air.

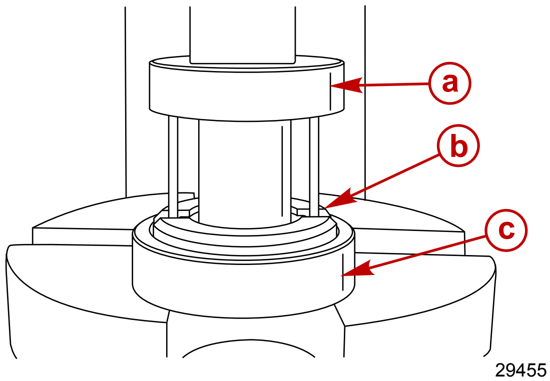


a - Forward gear
b - Thrust washer
c - Thrust bearing
d - Roller bearing
e - Bearing adapter
f - Shim

NOTE: The condition of the bearing surfaces on the forward gear in the areas that the bearings of the bearing adapter and the thrust bearing rides, is an indication of the condition of the respective bearings. Replace the bearings if the surface of the gear and/or thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded metal particles.

IMPORTANT: Do not remove the roller bearing from the bearing adapter unless replacement is necessary. The bearing should not be used after it has been removed from the bearing adapter.

6. If the roller bearing in the bearing adapter must be replaced, remove the bearing from the adapter using a bearing removal tool. Align the pins of the tool with the slots of the adapter and apply force to the center of the tool so the pressure is equal on both of the pins. Discard the bearing after removal.

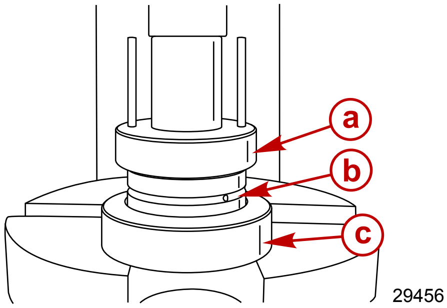


a - Bearing removal tool
b - Roller bearing
c - Bearing adapter

Needle Bearing Removal Tool	91-816245

7. Assemble the adapter as follows:
   a. Lubricate the bore that the roller bearing is pressed into with 2-4-C with PTFE.

b. Install the roller bearing into the adapter with the numbered end of the bearing facing the driver shoulder.
c. Press the roller bearing into the adapter using a bearing removal tool until the tool contacts the adapter.

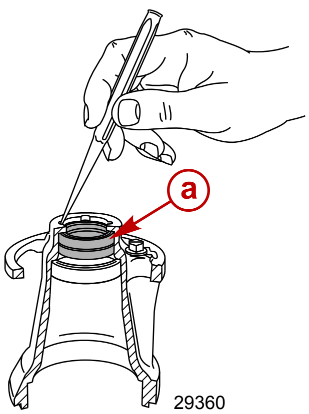


a - Bearing removal tool
b - Roller bearing (numbers/letters face driver)
c - Bearing adapter

Needle Bearing Removal Tool	91-816245

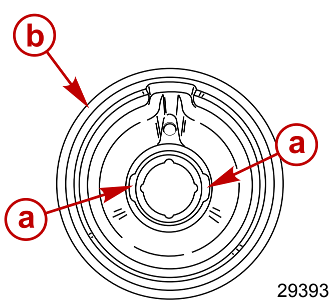
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bore that roller bearing is pressed into	92-802859A 1

8. Perform the following step "a" or "b," as necessary.
   a. **If replacing the seals only:** Remove the oil seals with a suitable punch, being careful not to damage the bore of the bearing carrier. Discard both of the seals.



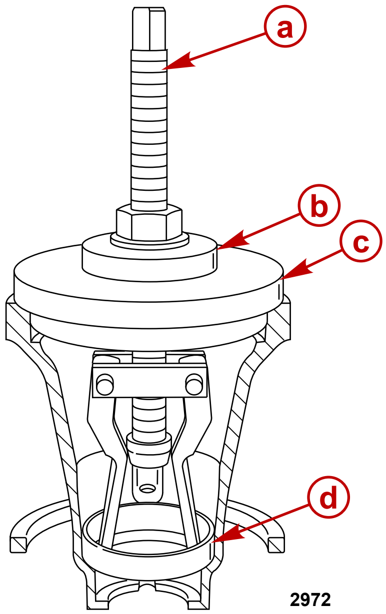
a - Seals

   b. **If replacing the tapered roller bearing and seals:** Remove the seals with a punch as noted above. There are slots cast into the carrier to aid in the removal of the bearing race with puller jaws.



a - Slots
b - Bearing carrier

c. Remove the tapered bearing race from the carrier using a bearing puller assembly, pilot washer, and seal driver guide. Discard the bearing, race, and both seals.



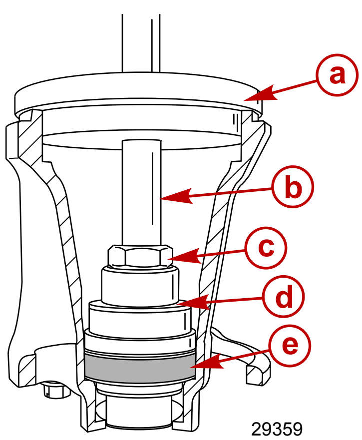
a - Bearing puller assembly
b - Pilot washer
c - Seal driver guide
d - Race

Bearing Puller Assembly	91- 83165T
Pilot Washer	91-36571T
Seal Driver Guide	91-889845

Assembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air.
2. Lubricate the bore that the roller bearing race is pressed into with High Performance Gear Lubricant.
3. Assemble the bearing race onto the driver.
4. Press the bearing race into the bearing carrier until the race bottoms out in the bearing carrier.

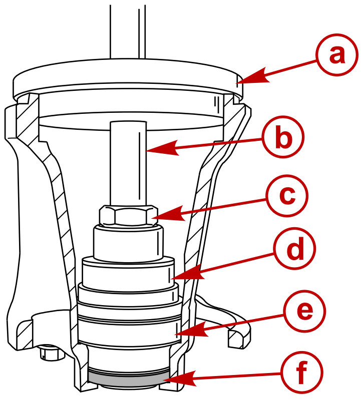


a - Seal driver guide
b - Driver rod
c - Hex nut
d - Bearing cup driver/oil seal installer
e - Tapered bearing race

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing cup driver/oil seal installer	91-889844T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bore that roller bearing race is pressed into	92-858064K01

5. Thoroughly clean the bore in which the first seal is to be pressed.
6. Assemble the first seal, with the lips of the seal facing away from the driver shoulder, onto the long end of the oil seal driver.
7. Apply Loctite 380 to the outside diameter of the oil seal.
8. Press on the oil seal driver until the driver bottoms out on the bearing race.



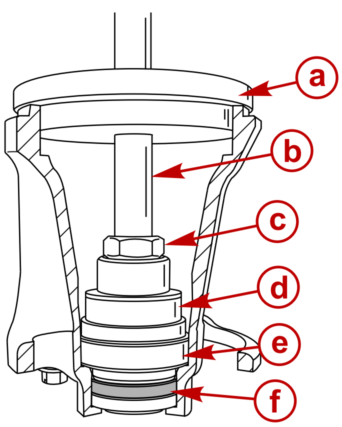
29357

a - Seal driver guide
b - Driver rod
c - Hex nut
d - Bearing cup driver/oil seal installer
e - Bearing race
f - Oil seal (first)

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing Cup Driver/Oil Seal Installer	91-889844T

Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outer diameter of oil seal	Obtain Locally

9. Assemble the second seal, with the lips of the seal facing the driver shoulder, onto the short end of the driver.
10. Apply Loctite 380 to the outside diameter of the seal.
11. Press on the oil seal with the driver until the driver bottoms out on the bearing race.



29358

a - Seal driver guide
b - Driver rod
c - Hex nut
d - Bearing cup driver/oil seal installer
e - Bearing race
f - Oil seal (second)

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91- 31229A 7
Bearing Cup Driver/Oil Seal Installer	91-889844T

Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outer diameter of oil seal	Obtain Locally

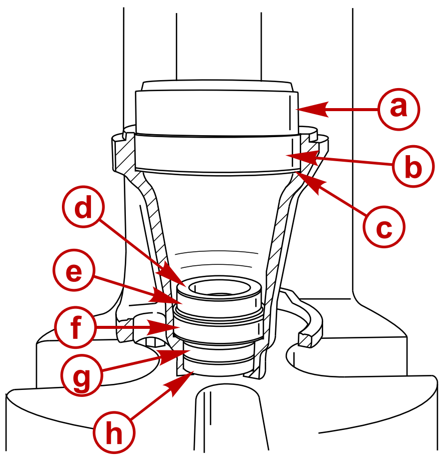
12. Lubricate the seal lips and fill the area between the seals with 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1

13. Install the propeller shaft tapered roller bearing into the carrier bearing race.
14. Lubricate the bore that the bearing is pressed into with High Performance Gear Lubricant.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearing bore in carrier	92-858064K01

15. Install the bearing adapter shim into the bearing carrier.
16. Press the bearing adapter into the bearing carrier until the adapter bottoms out in the bearing carrier.



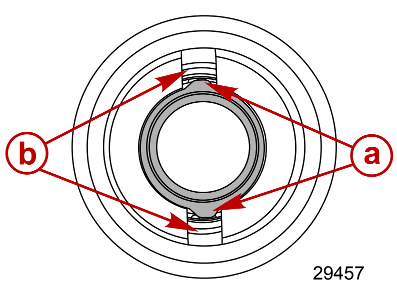
3157

a - Bearing cup driver
b - Bearing adapter
c - Bearing adapter shim
d - Shim
e - Spacer
f - Tapered bearing
g - Seal
h - Seal

Bearing Cup Driver	91-885592T

NOTE: The shim and spacer above the tapered bearing may be installed before the propeller shaft, or both placed on the propeller shaft, and installed into the carrier with the propeller shaft. However, without the propeller shaft installed in the bearing carrier, the shim, spacer, and tapered bearing may fall out of alignment.

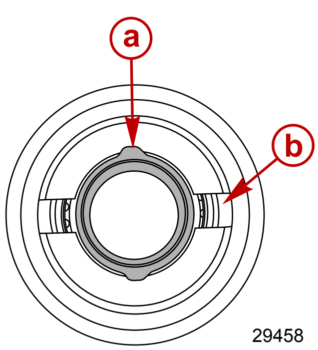
17. Install the thrust bearing onto the bearing adapter.
18. Install the thrust washer onto the bearing adapter.
19. Install the forward gear into the bearing adapter by aligning the forward gear adapter sleeve tabs with the slots in the bearing adapter.



29457

a - Forward gear sleeve tabs
b - Bearing adapter slots

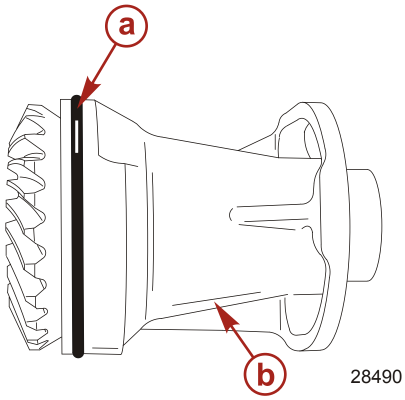
20. Rotate the forward gear 90 degrees after installing the gear into the bearing adapter.



29458

a - Forward gear sleeve tabs
b - Bearing adapter slots

21. Lubricate the O-ring with 2-4-C with PTFE and install the O-ring onto the bearing carrier.



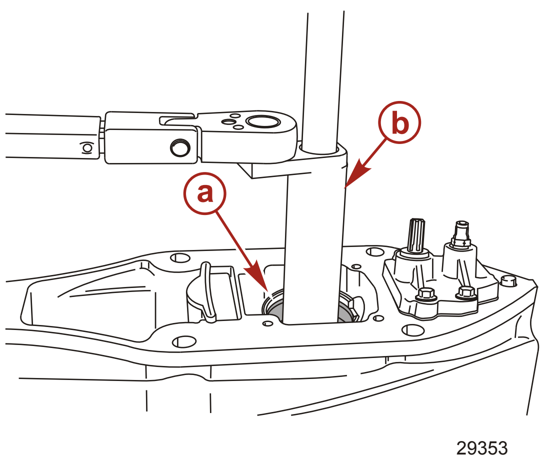
a - O-ring
b - Bearing carrier

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier O-ring	92-802859A 1

Driveshaft Assembly

Removal

1. Remove the driveshaft pinion nut as follows:
   a. Remove the upper driveshaft tapered bearing retainer.

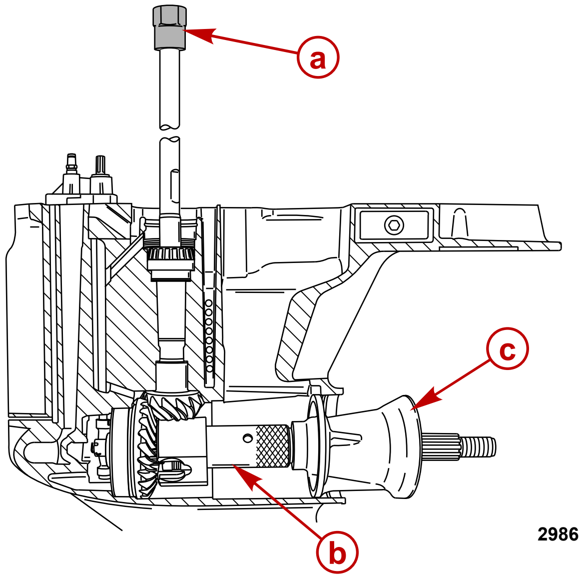


a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

   b. Place the driveshaft holding tool onto the driveshaft.
   c. Insert the pinion nut wrench with the MR slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the driveshaft to align the pinion gear nut into the pinion nut wrench slot.
   d. Install the bearing carrier into the gear housing backwards to support the propeller shaft and to keep the pinion nut wrench aligned.

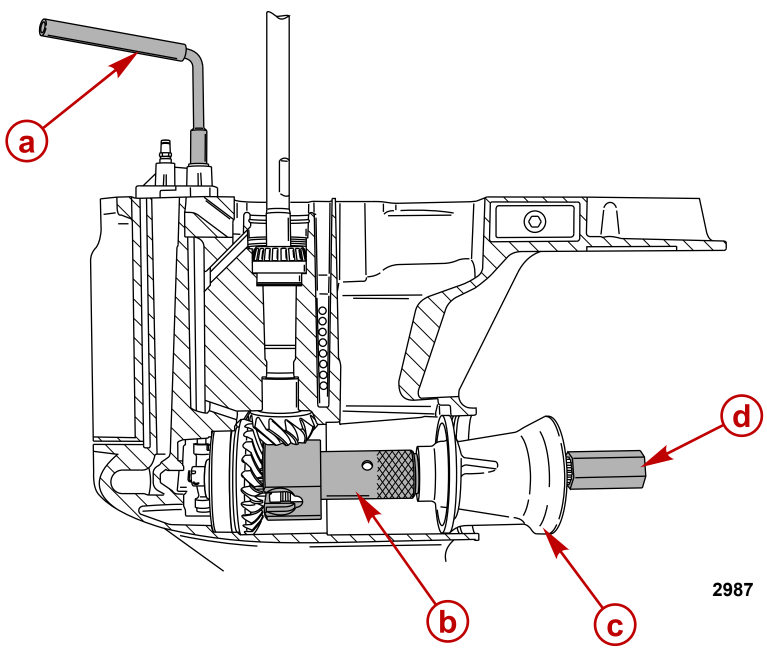
e. Rotate the driveshaft counterclockwise and loosen the pinion nut.



a - Driveshaft holding tool
b - Pinion nut wrench
c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91- 61067T03

f. If the driveshaft is broken, place the propeller shaft adapter onto the propeller shaft splines. Hold the shift shaft in forward gear and loosen the pinion nut by rotating propeller shaft counterclockwise to turn the gears, thus loosening the pinion nut.



a - Shift shaft tool (fabricate from old shift shaft)
b - Pinion nut wrench
c - Bearing carrier (installed backwards)
d - Propeller shaft adapter

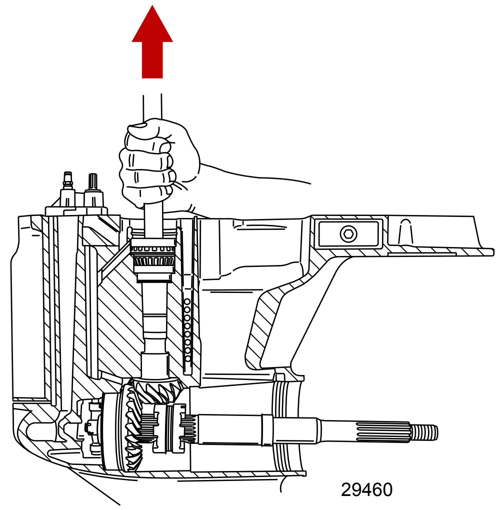
Pinion Nut Wrench	91- 61067T03
Propeller Shaft/Driveshaft Adapter	91-61077T

g. Completely unscrew the driveshaft bearing retainer.

h. Completely unscrew the pinion nut by rotating the driveshaft or the propeller shaft in a counterclockwise direction.

i. Remove all tools.

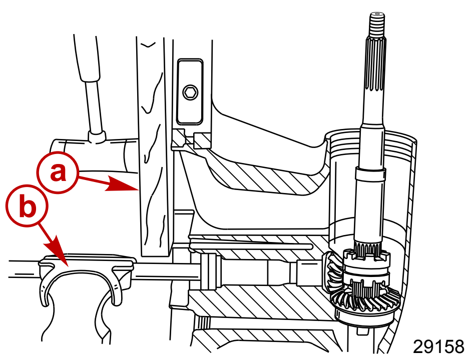
2. Remove the driveshaft and all components by pulling the driveshaft straight out of the gear housing, as shown.



IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the driveshaft is removed. Be careful not to lose the 18 rollers.

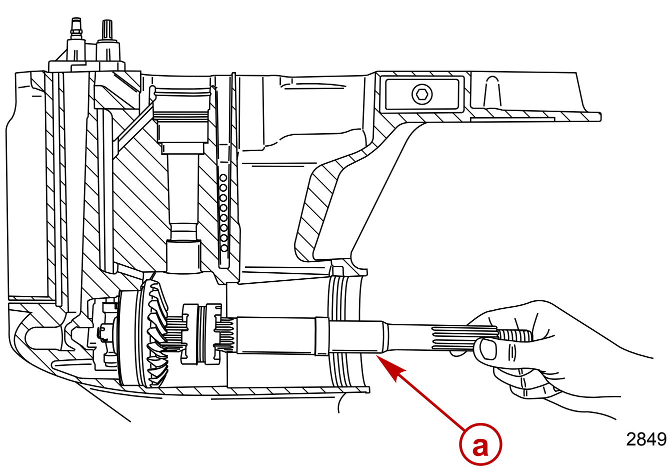
NOTE: *If the pinion gear is seized onto the driveshaft, place the gearcase in a vise using soft jaw vise covers. Place a block of wood on the gear housing mating surface. Use a mallet and carefully tap the gear housing away from the driveshaft.*

IMPORTANT: Striking a gear housing directly with a mallet, or dropping the gear housing, could distort the gear housing resulting in gear housing failure.



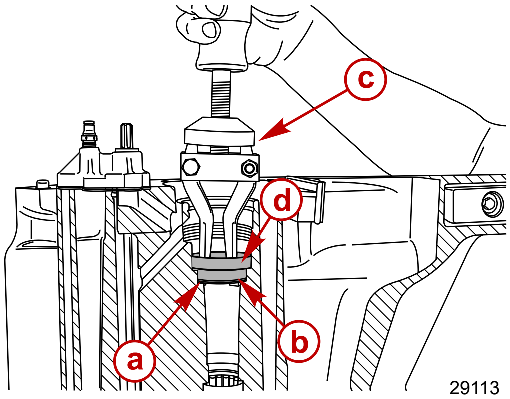
a - Wood block
b - Driveshaft in soft jaw vise

3. Retrieve the pinion gear, the washer, and the nut from the inside of the gear housing.
4. Move the propeller shaft to the port side of the gearcase to disengage the propeller shaft assembly from the shift crank. Remove the propeller shaft.



a - Propeller shaft

5. Remove the spacer, lower driveshaft bearing cup, and shims using the slide hammer puller. Retain the shims and spacer for reinstallation.



a - Shims
b - Bearing race
c - Slide hammer puller
d - Spacer

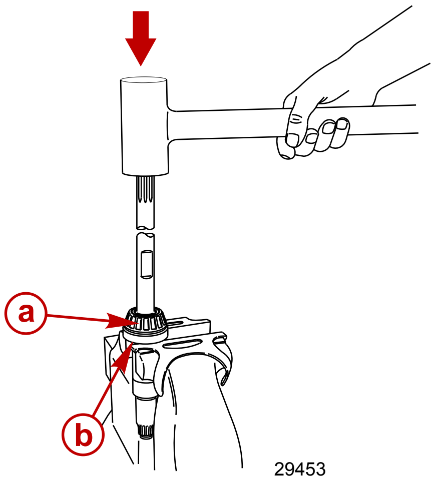
Slide Hammer	91-34569A 1

Disassembly

NOTE: Do not remove the upper and lower tapered roller bearings from the driveshaft unless replacement is indicated. Bearings cannot be reused after removal from the driveshaft.

NOTE: If one driveshaft tapered roller bearing is damaged, both tapered bearings and spacer must be replaced as a set.

1. Both the upper and lower tapered roller bearings can be removed from the driveshaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the driveshaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a dead blow hammer until the bearings are free. Do not drop the shaft when performing this operation.

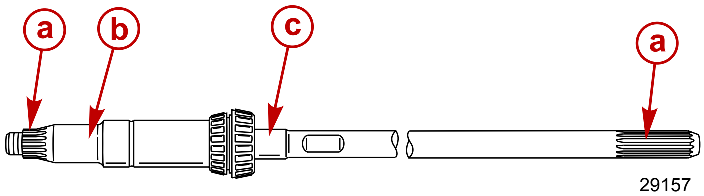


a - Driveshaft with both upper and lower bearings
b - Lower bearing cup removed from gearcase

Inspection

1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air. Do not spin the bearings.
2. The condition of the upper and lower driveshaft bearing cups is an indication of the condition of each of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. Replace the pinion bearing and driveshaft if the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the driveshaft for a worn or twisted condition. Replace the driveshaft if either condition exists.

5. Inspect the driveshaft for grooves where the water pump base oil seals contact the shaft. Replace the driveshaft if grooves are found.



29157

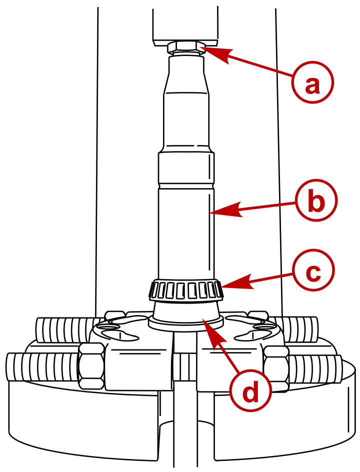
a - Splines
b - Pinion bearing surface
c - Seal surface

6. Inspect the pinion gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the pinion gear and the forward gear as a set if any defects are found.

Reassembly

NOTE: Complete the instructions in this section only if the components have been disassembled.

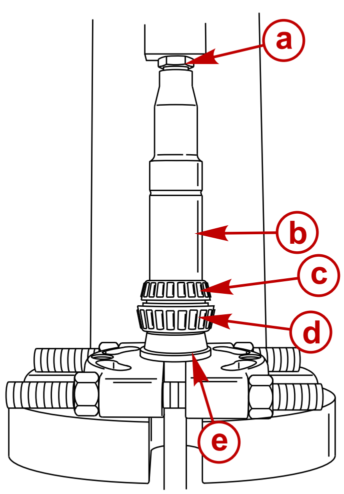
1. Apply a light coat of High Performance Gear Lubricant on the I.D. of the driveshaft tapered bearing.
2. Assemble a new lower tapered roller bearing to the driveshaft, with the large O.D. of the bearing facing the pinion gear end of the driveshaft.
3. Thread a used pinion nut onto the end of the driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond the nut or thread damage could result while pressing.
4. Press the lower tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, or an old tapered roller bearing inner race.



3267

a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Old tapered roller bearing inner race

5. Press the new upper tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, or an old tapered roller bearing inner race.



29194

a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Upper driveshaft tapered bearing
e - Old tapered roller bearing inner race

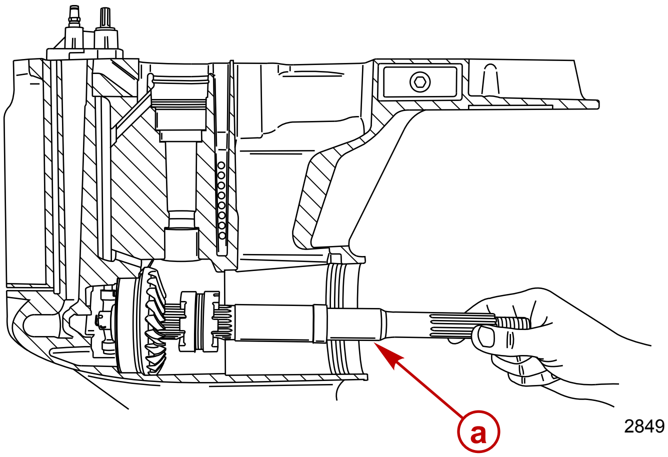
Universal Puller Plate	91-37241

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of driveshaft tapered bearings	92-858064K01

Propeller Shaft Assembly and Reverse Gear Bearing Cup

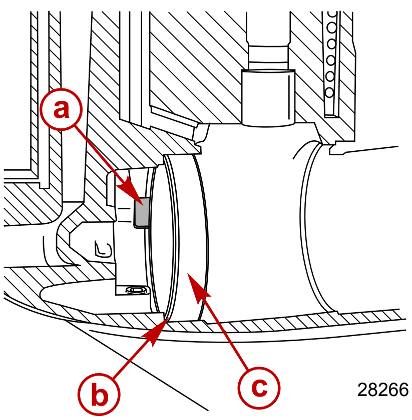
Removal

1. Tilt the propeller shaft to the port side of the gear housing and remove the shaft.



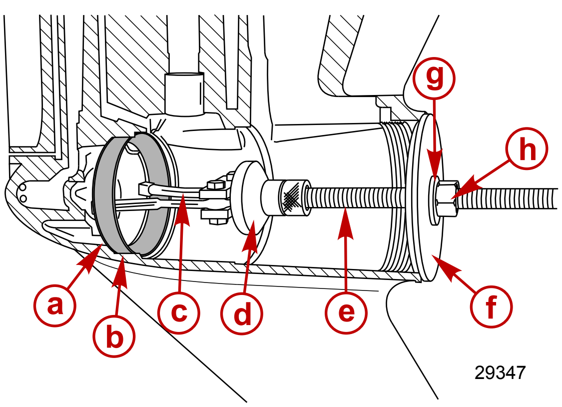
a - Propeller shaft

2. Two notches are provided in the gear housing just forward of the reverse gear bearing cup, to position the puller jaws for easier removal of the bearing cup and shims.



a - Notches
b - Shims
c - Reverse gear bearing cup

3. Remove the reverse gear bearing cup and shims. Measure and make note of the shim thickness. If the shims are not damaged, they may be used.



a - Shims
b - Bearing cup
c - Jaws (from slide hammer puller kit)
d - Puller head (from slide hammer puller kit)
e - Puller shaft
f - Guide plate
g - Washer
h - Hex nut

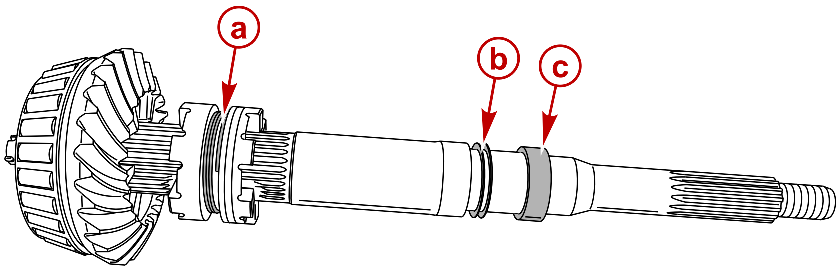
Guide Plate	91-816243
Slide Hammer	91-34569A 1

Bearing Removal and Installation Kit	91- 31229A 7

Disassembly

NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a workbench to ensure the parts are not dropped or damaged and to avoid personal injury.

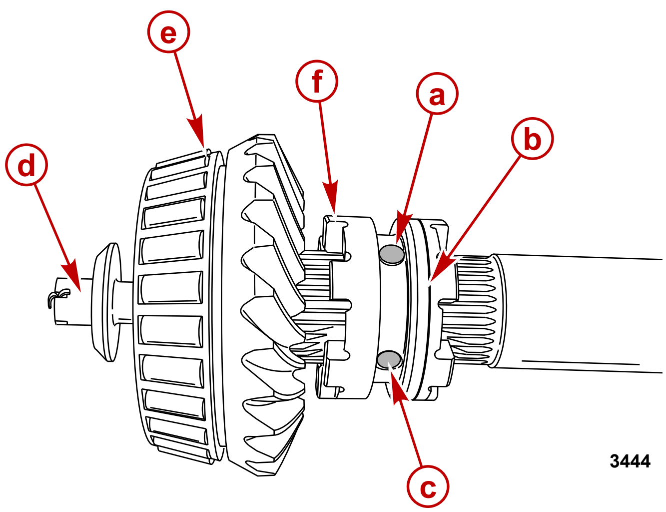
1. Remove the spring around the clutch, being careful not to overstretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.



3443

a - Spring
b - Shims
c - Preload spacer

2. Remove the detent pin.
3. Remove the cross pin that goes through the clutch.
4. Remove the remainder of the components.



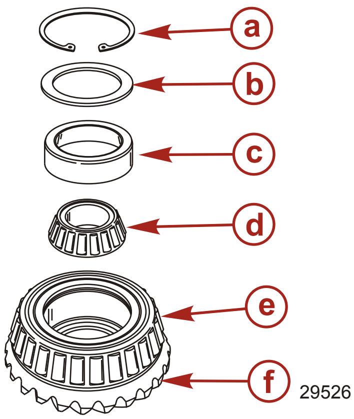
3444

a - Detent pin
b - Clutch band (faces forward gear)
c - Cross pin
d - Spool and actuating shaft assembly
e - Reverse gear assembly
f - Clutch

Inspection

1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air. Do not spin the bearings.
2. Inspect the sliding clutch jaws for damage. If the jaws are chipped or rounded off, replace the clutch.

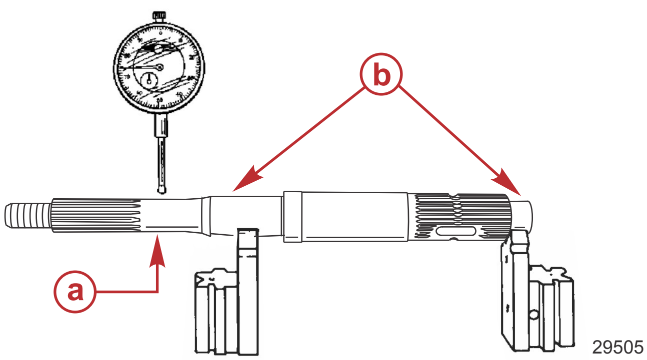
3. The propeller shaft utilizes two tapered roller bearing and cup assemblies for propeller shaft support. One tapered bearing is just forward of the bearing carrier seals. The forward gear assembly and bearing adapter must be removed from the bearing carrier to gain access to this bearing for inspection. The other tapered bearing is located inside the reverse gear assembly. The reverse gear assembly must be removed from the propeller shaft and a snap ring retainer and flat washer removed from the reverse gear assembly to gain access to this tapered bearing for inspection.



a - Snap ring
b - Flat washer
c - Tapered bearing race
d - Tapered bearing
e - Reverse gear bearing
f - Reverse gear

NOTE: The reverse gear bearing should not be removed from the reverse gear unless replacement is necessary. The bearing is not usable if the bearing is removed.

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exist.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.
6. Inspect the propeller shaft for a bent condition using V-blocks and a dial indicator.
   a. Position the propeller shaft bearing surfaces on the V-blocks.
   b. Adjust the height of the V-blocks to level the propeller shaft.
   c. Position the dial indicator tip just forward of the propeller shaft splines.
7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.23 mm (0.009 in.), replace the propeller shaft.



a - Check movement with dial indicator here
b - Seal surface area

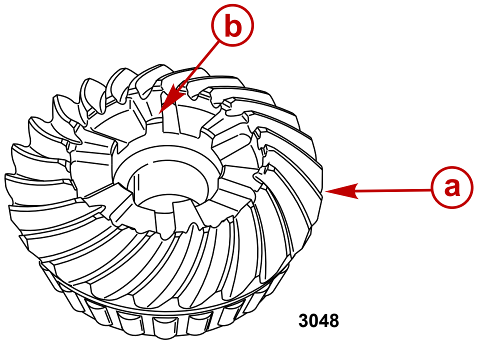
Dial Indicator	91- 58222A 1

Reverse Gear Assembly

Inspection

1. Clean the reverse gear assembly and the reverse gear bearing cup with a suitable solvent and dry with compressed air. Do not spin the bearings.
2. Inspect the gear for pits, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the reverse gear and the pinion gear as a set if any defects are found.

3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. Replace both the reverse and pinion gear as a set if any of these conditions exist.



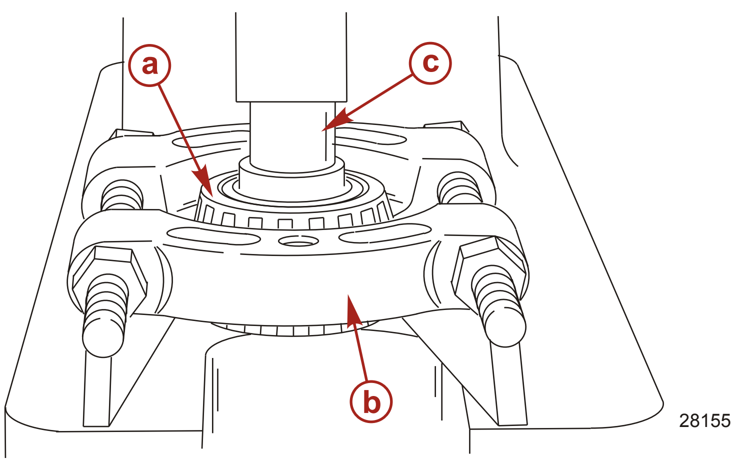
a - Reverse gear teeth
b - Clutch jaws

4. Inspect the propeller shaft tapered roller bearing on the inside of the reverse gear and its respective bearing cup. If either the bearing or the bearing cup surface is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, remove and replace the tapered roller bearing assembly in the reverse gear.
5. Inspect the tapered roller bearing pressed onto the reverse gear and the bearing surface on the reverse gear bearing cup. If either the roller bearing or the bearing surface of the reverse gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the reverse gear bearing cup and remove and replace the tapered roller bearings.

Disassembly

NOTE: The reverse gear and propeller shaft assembly can only be removed from the gear housing after the driveshaft and pinion gear have been removed.

1. Tilt the propeller shaft to the port side of the gear housing and remove the propeller shaft and gear assembly.
   IMPORTANT: Do not remove the pressed on tapered roller bearing from the reverse gear unless replacement of the bearing is required. The bearing cannot be reused after it has been removed.
2. If inspection determines that replacement of the reverse gear tapered bearing is required, separate the gear from the bearing as follows:
   a. Press the universal puller plate between the reverse gear and the tapered bearing.
   b. Place the assembly on a press and press the gear out of the bearing with a suitable mandrel.
   NOTE: The tapered bearing and race must be replaced as a set.

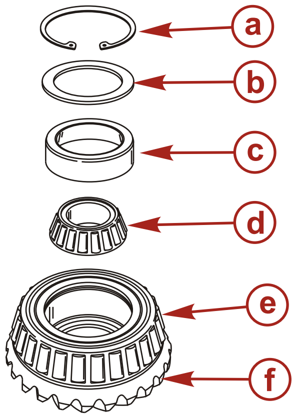


a - Reverse gear bearing
b - Universal puller plate
c - Mandrel

Universal Puller Plate	91-37241

3. If inspection determines that replacement of the propeller shaft tapered roller bearing is required, remove the bearing as follows:
   a. Clamp the reverse gear securely in a soft jaw vise.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.

b. Use snap ring pliers to remove the snap ring. Push the tapered roller bearing assembly out of the inside of the reverse gear.



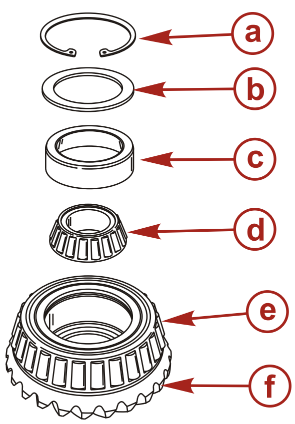
29526

- a - Snap ring
- b - Flat washer
- c - Tapered bearing race
- d - Tapered bearing
- e - Reverse gear bearing
- f - Reverse gear

Assembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled, repaired, or replaced.

1. Apply High Performance Gear Lubricant to the I.D. of the reverse gear. Using a suitable mandrel that contacts only the inner portion of the race, press the tapered roller bearing assembly onto the reverse gear until the bearing seats.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.
2. Install the snap ring into the groove of the reverse gear to secure the tapered roller bearing assembly.



29526

- a - Snap ring
- b - Flat washer
- c - Tapered bearing race
- d - Tapered bearing
- e - Reverse gear bearing
- f - Reverse gear

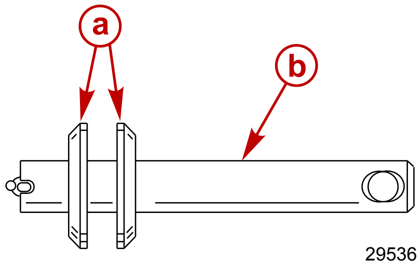
Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of the reverse gear	92-858064K01

Shift Spool Assembly

Inspection

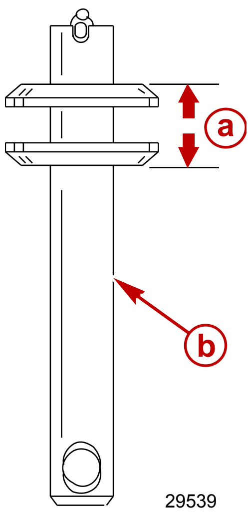
1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.

3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



a - Contact area
b - Nonratcheting shift spool

4. Inspect to ensure the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).
5. Inspect to ensure the spool has end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



a - End play
b - Shift spool

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

Disassembly

NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

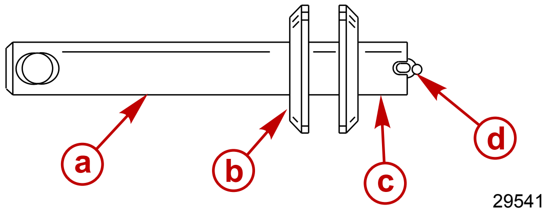
NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.

Reassembly

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the spool and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If the castle nut is threaded down and the cotter pin slot is already aligned at the hole in the shift spool shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend the ends of the cotter pin in opposite directions.

5. Verify the spool has end play. If it does not, adjust the castle nut again.



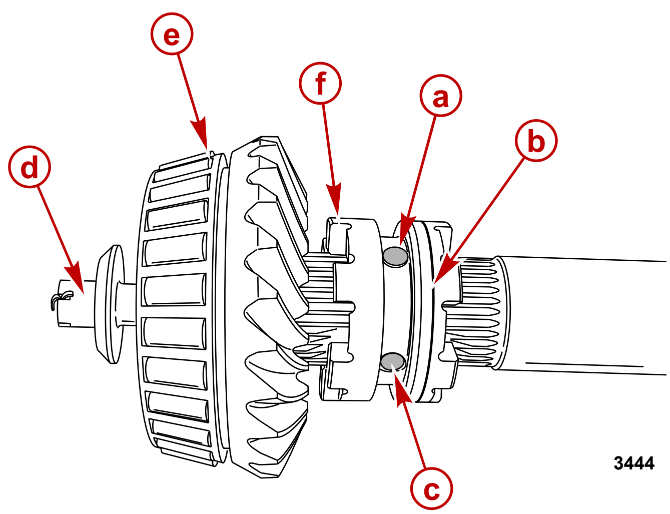
a - Shift shaft
b - Spool
c - Castle nut
d - Cotter pin

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

6. If this adjustment did not produce the desired results, it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned, it will be necessary to replace the shift spool assembly.

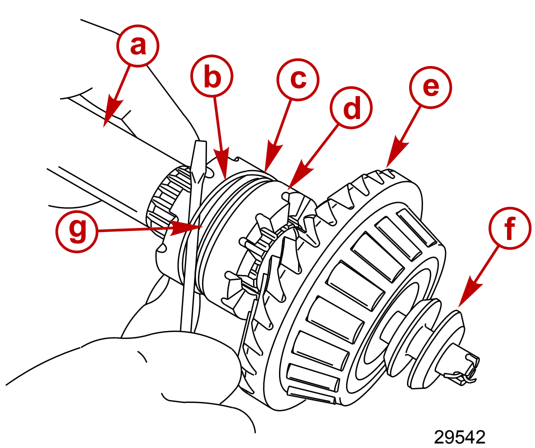
Propeller Shaft Reassembly

1. Install the sliding clutch onto the propeller shaft. Align the cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the reverse gear assembly to the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft, making sure to align the cross pin hole of the shift spool shaft with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft, and through the shift spool shaft hole.
5. Install detent pin in third hole in clutch.



a - Detent pin
b - Clutch band (faces aft)
c - Cross pin
d - Shift spool and actuating shaft
e - Reverse gear assembly
f - Clutch

6. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it.
IMPORTANT: Verify the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.



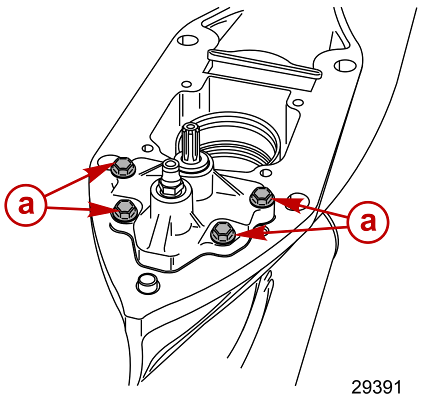
a - Propeller shaft
b - Cross pin retaining spring
c - Cross pin (hidden)
d - Sliding clutch
e - Reverse gear assembly
f - Spool and actuating shaft assembly
g - Detent pin (hidden)

Shift Shaft Assembly

Removal

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gearcase) without removing any of the internal components of the gear housing.

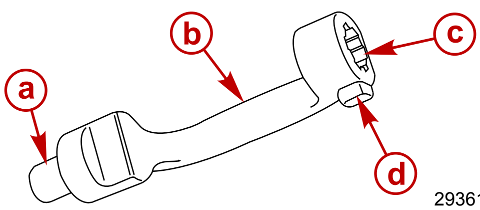
1. Remove the shift shaft cover assembly screws. Remove the shift shaft and cover assembly by pulling both straight out of the gear housing.



a - Shift shaft cover screws (M6 x 20)

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the pivot pin for damage or wear.

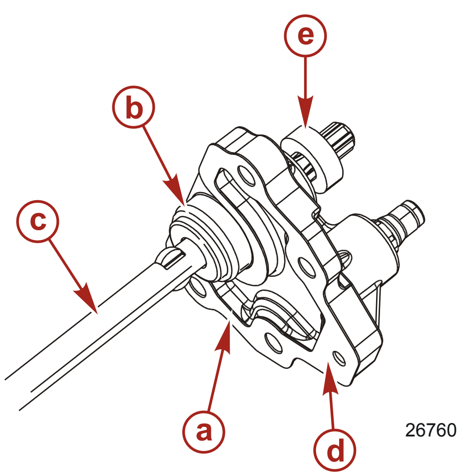
   NOTE: The shift crank has a locating tab. On right-hand rotation gearcases, the tab faces toward the forward gear bearing assembly. On left-hand rotation gearcases, the tab faces away from the reverse gear bearing assembly.



a - Pivot pin
b - Contact area
c - Splines
d - Locating tab

Disassembly and Inspection

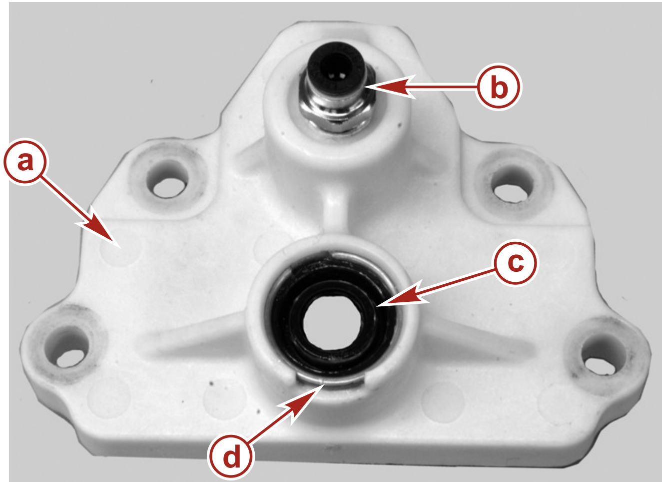
1. Remove the rubber washer from the shift shaft.
2. Slide the cover assembly off the shift shaft.



a - Shift shaft cover assembly
b - O-ring
c - Shift shaft
d - Gasket
e - Rubber washer

3. Clean all components with a suitable solvent and dry thoroughly with compressed air.
   a. Inspect the shift shaft cover for cracking, damage, or excessive wear.
   b. Inspect the oil seal inside the cover, the sleeve, and the O-ring on the outside of the cover for damage or excessive wear. Remove the retaining ring, if equipped, to remove the seal.
   c. Inspect the speedometer connector for damage or blockage.
   d. Inspect the speedometer passage through the shift shaft cover for debris.

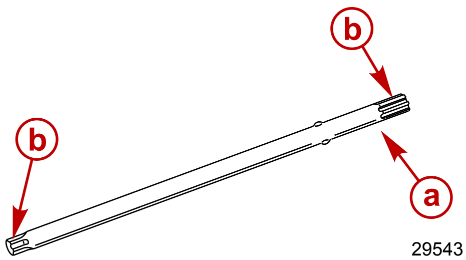
NOTE: If any of these conditions exist, replace the appropriate components.



46075

- a - Shift shaft cover (design I and design II)
- b - Speedometer tube connector
- c - Oil seal (seal is replaceable)
- d - Retaining ring (design II)

4. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either of these conditions are found.



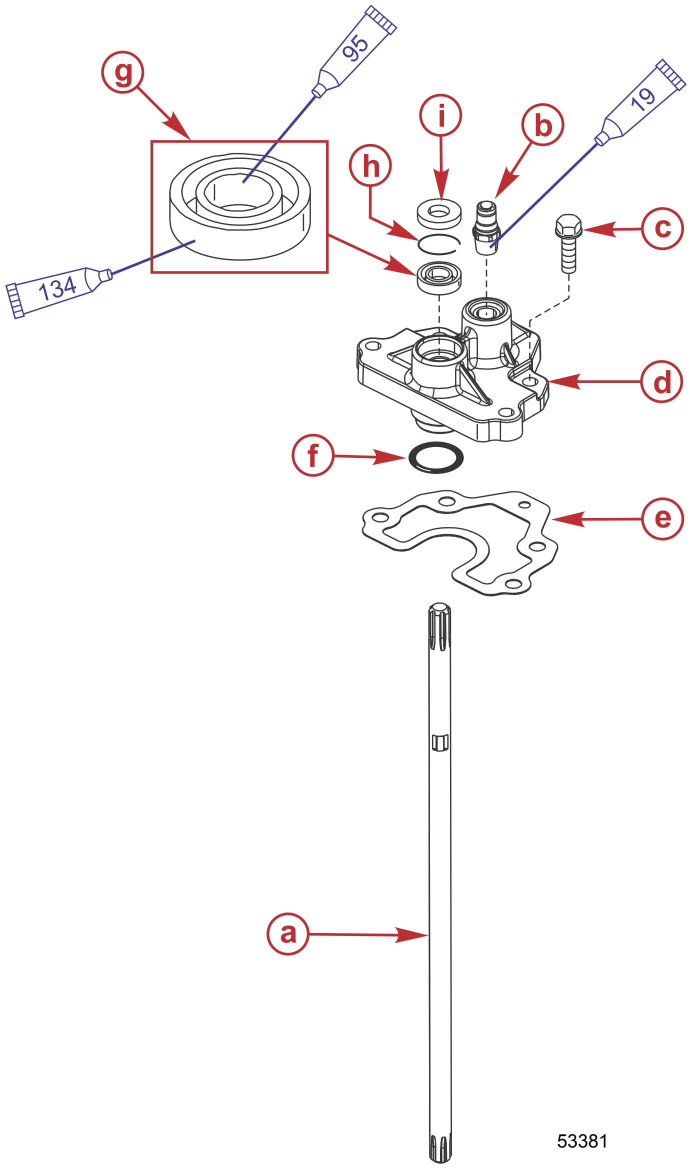
29543

- a - Oil seal surface
- b - Splines

Assembly

1. Lightly lubricate the seat of the O-ring diameter on the cover and the lip of the oil seal with 2-4-C with PTFE.
2. Apply Loctite 380 to the outside diameter of the oil seal. Wipe off any excess Loctite.
3. If the speedometer connector was removed and/or replaced, lightly coat the threads of the connector with Perfect Seal. Assemble the speedometer connector into the cover and tighten the connector to the specified torque.
4. Assemble all components, as shown below. Be sure to position the O-ring onto the cover before installing the cover assembly into the gear housing.

***NOTE:** Design II utilizes a retaining ring to secure the oil seal.*



- **a -** Shift shaft
- **b -** Speedometer hose connector
- **c -** Screws (M6 x 20) (4)
- **d -** Cover assembly (design I and design II)
- **e -** Gasket
- **f -** O-ring
- **g -** Oil seal (lip faces up)
- **h -** Retaining ring (design II)
- **i -** Rubber washer

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Speedometer connector threads	92-34227Q02
95	2-4-C with PTFE	Seat of the shift shaft cover assembly O-ring diameter and lip of the oil seal	92-802859A 1
134	Loctite 380	Outside diameter of the oil seal	Obtain Locally

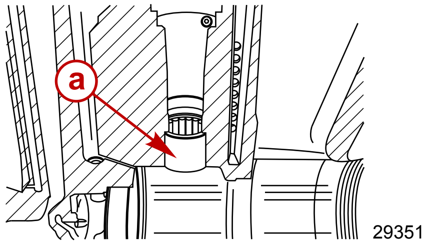
Description	Nm	lb-in.	lb-ft
Speedometer connector	2.8	25	–
Cover assembly screws (M6 x 20) (4 each)	6.7	60	–

Pinion Bearing Removal

***NOTE:** Inspect the bearing surface on the driveshaft where the rollers of the lower pinion bearing roll. The condition of the driveshaft at this location gives an indication of the condition of the roller bearing. Replace lower pinion bearing (rollers and race as a set) if the driveshaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.*

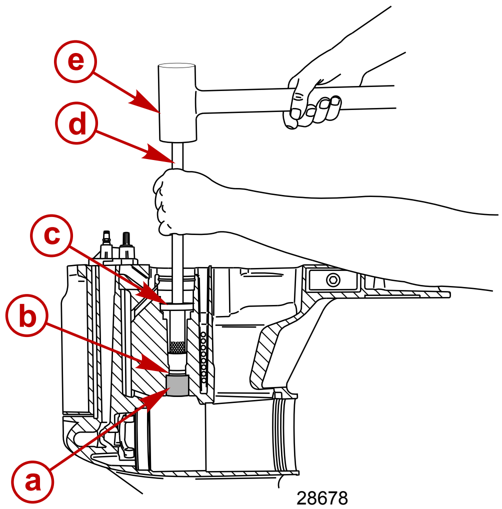
IMPORTANT: All the roller bearings (18) must be in place inside the bearing race while driving the pinion bearing from the gear housing. It is recommended that the cardboard tube provided with a new pinion bearing be used to keep the bearings in place while driving out the old pinion bearing.

IMPORTANT: Do not use the bearing (race or rollers) once it has been removed.



a - Pinion bearing

Remove and discard the pinion bearing (race and rollers) using the tools as shown.



a - Pinion bearing
b - Driver head
c - Pilot washer
d - Driver rod
e - Dead blow hammer

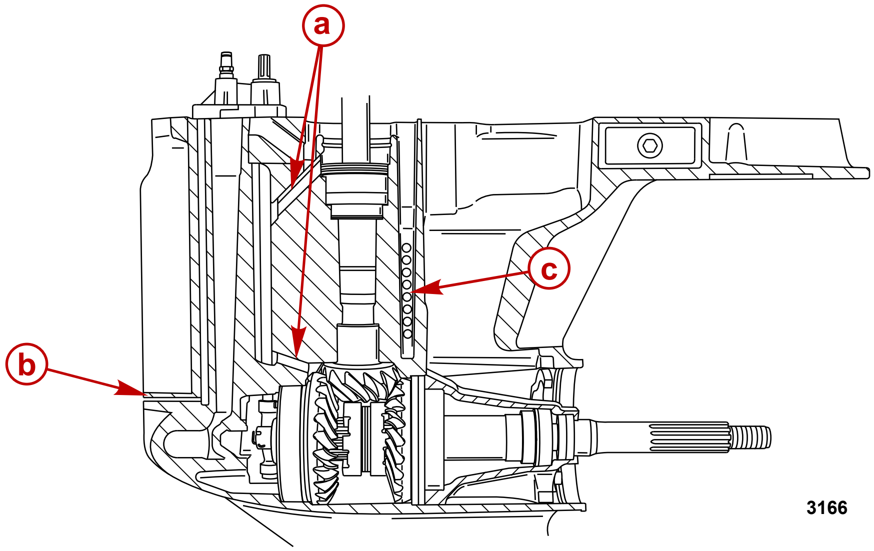
Driver Head	91- 36569T
Pilot Washer	91-36571T
Driver Rod	91- 37323

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Ensure all sealants, locking agents, and debris are removed.
2. Verify the two oil circulation holes in the driveshaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact, or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.

   NOTE: The upper driveshaft bearing cup is a slip fit within the driveshaft bore and may show signs of movement. All other bearing cups are press fit and should not show any signs of movement.
5. Inspect bearing race/cup contact areas for evidence of the bearing cup spinning. Check that bearing cups are not loose in bearing bores. A press fit type bearing bore in which the race/cup is loose will require replacement of the gear housing.

6. Inspect for blockage in the water inlet holes and the speedometer hole. Clean as necessary. Be careful not to enlarge the speedometer hole, as this could cause erroneous speedometer readings.



3166

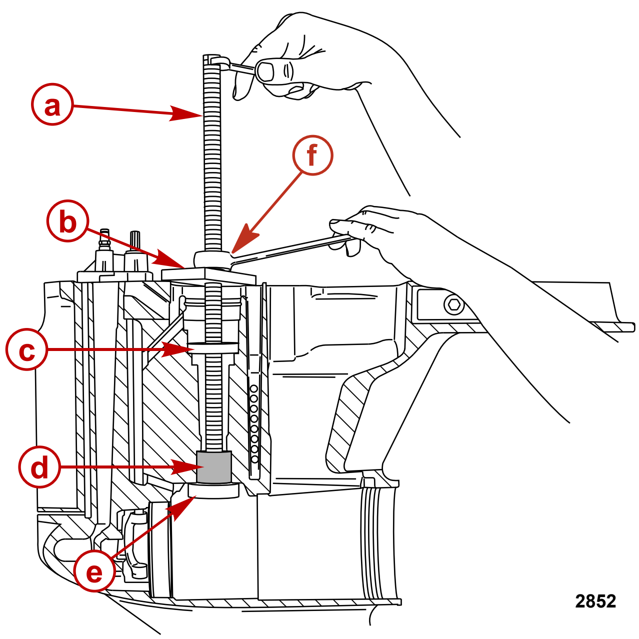
a - Oil circulation holes
b - Speedometer hole
c - Water inlet holes

7. Verify the locating pins are in place in the gear housing and the corresponding holes in the driveshaft housing are not elongated. The driveshaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing Installation

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with High Perfomance Gear Lubricant.
2. Position the new pinion bearing, with the cardboard shipping sleeve in place, onto the driver head with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly into position, by way of the propeller shaft bore, at the driveshaft bore, as shown.
4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.



2852

a - Puller rod
b - Puller plate
c - Pilot
d - Pinion bearing
e - Mandrel
f - Hex nut

Bearing Removal and Installation Kit	91- 31229A 7

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Pinion bearing bore	92-858064K01

Reverse Gear Bearing Cup

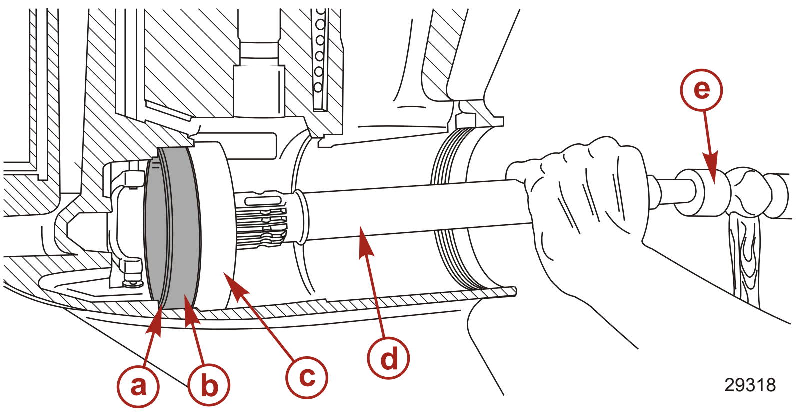
Installation

Reverse Gear	
Backlash	1.27–1.47 mm (0.050–0.058 in.)

NOTE: If the reverse gear, reverse gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when the cup was removed. If the reverse gear, reverse gear bearing and cup, or gear housing were replaced, install 0.51 mm (0.020 in.) of shims.

NOTE: If backlash has already been checked and it was determined that it needs to be adjusted (see ***Checking Reverse Gear Backlash****), adding or subtracting 0.025 mm (0.001 in.) shims will change the gear backlash by the same amount.*

1. Lubricate the bore into which the reverse gear bearing cup is to be installed with High Performance Gear Lubricant.
2. Place the shim into the reverse bore of the gear housing.
3. Press the bearing cup into the gear housing using the installation tool.
   IMPORTANT: Verify the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.



a - Shims
b - Race
c - Bearing cup driver
d - Propeller shaft (old nonserviceable)
e - Mallet

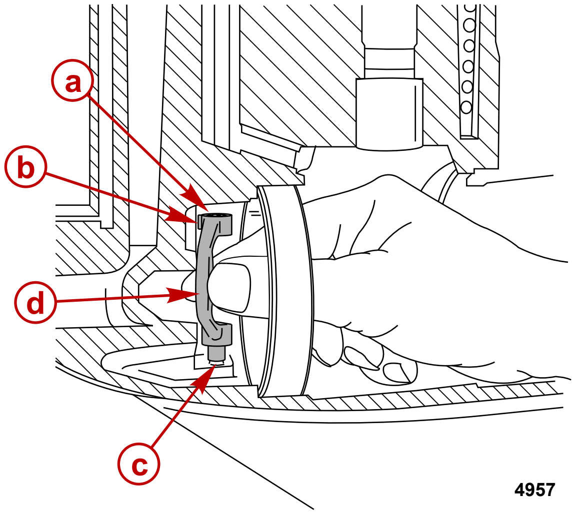
Bearing Cup Driver	91-885592T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Reverse gear bearing cup bore	92-858064K01

Shift Shaft Installation

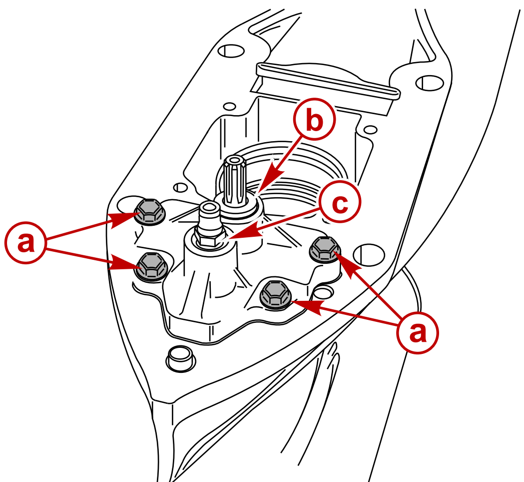
1. Place the shift crank into the pivot pin hole in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.

***NOTE:** The shift crank locating tab on right hand rotation gearcases face toward the forward gear bearing assembly. On left hand rotation gearcases, the locating tab faces away from the reverse gear bearing assembly.*



a - Shift shaft splines
b - Locating tab
c - Pivot pin
d - Shift crank

2. Install the shift shaft assembly into the gear housing, as shown. Engage the splined end of the shift shaft with the shift crank. Verify the O-ring is positioned properly on the bushing and lubricated with 2-4-C with PTFE. Secure the shift shaft bushing with four screws. Tighten the screws and the speedometer fitting to specification.
3. Install the rubber washer onto the shift shaft and slide the washer down until it just touches the oil seal in the bushing.

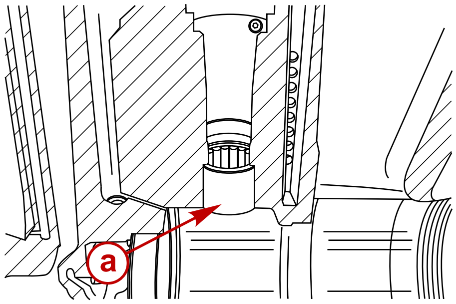


a - Screw (4)
b - Rubber washer
c - Speedometer fitting

Description	Nm	lb-in.	lb-ft
Screw (4)	6.7	60	
Speedometer fitting	2.8	25	

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft bushing O-ring	92-802859A 1

NOTE: If the pinion bearing needle bearings have fallen out, install the 18 needles into the needle bearing outer race. Use 2-4-C with PTFE to help hold the needles in place.



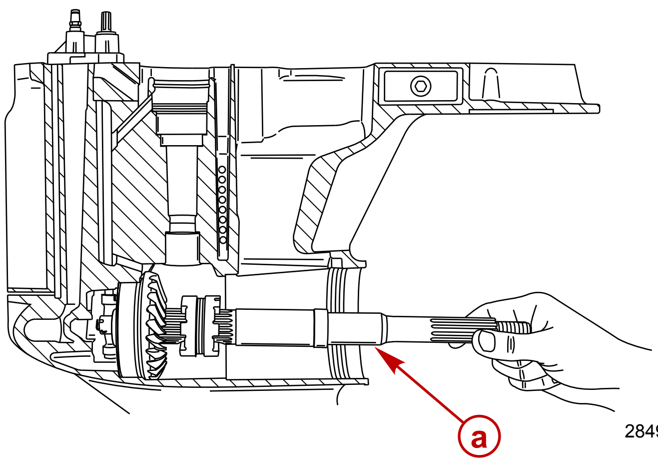
a - Pinion bearing

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Hold pinion needle bearings in place	92-802859A 1

Propeller Shaft Installation

NOTE: The shift/clutch assembly should be in the neutral detent position when installing the propeller shaft.

1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of the gear housing and rotate the shift shaft from reverse to neutral while installing the shaft.



a - Propeller shaft

2. Operate the shift shaft to ensure it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.

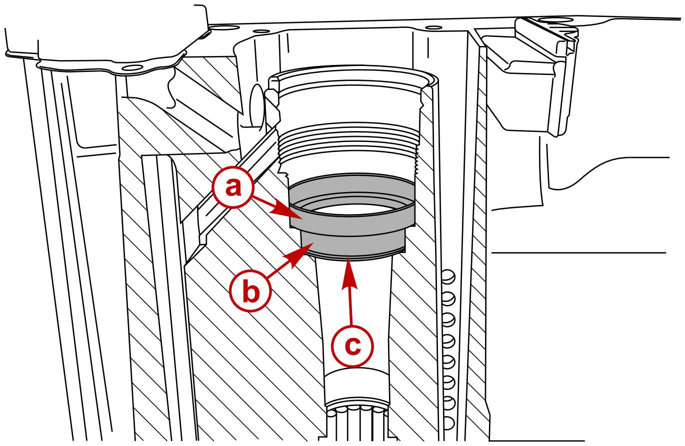
Driveshaft and Pinion Gear Installation

NOTE: If the original shims were not retained or if the pinion gear, driveshaft, driveshaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.508 mm (0.020 in.) shim, for the lower tapered roller bearing.

NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, install the same shims or same amount of shims.

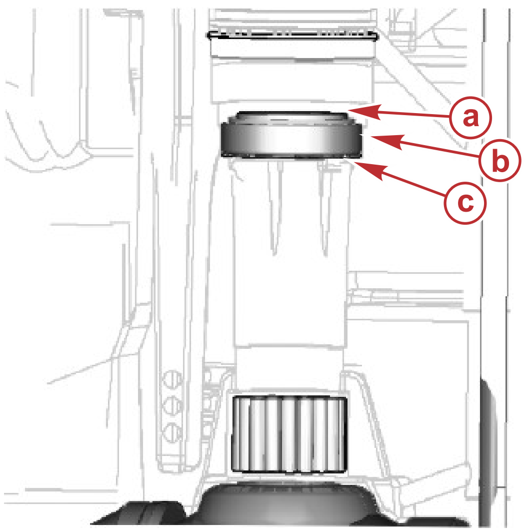
1. Place the lower tapered bearing shims into the driveshaft housing bore.
2. Install the lower tapered bearing race into the driveshaft housing bore.
3. Depending on the design:

a. **Design I**: Install the spacer (flanged end faces down).



Design I
- a - Spacer
- b - Tapered bearing race
- c - Shims

b. **Design II**: Install the shims.



Design II
- a - Shims
- b - Tapered bearing race
- c - Shims

4. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

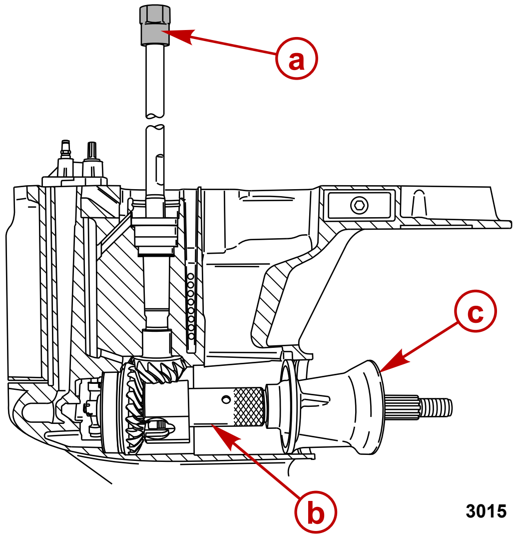
NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, or Bellows Adhesive, or equivalent.

NOTE: If the backlash has to be changed, it is recommended that Loctite 271 Threadlocker not be applied to the pinion nut until the backlash setting is finalized. Do not reuse the old pinion nut. Install a new pinion nut after backlash is finalized.

5. Place the pinion gear and washer into the gear housing.
6. With the propeller shaft horizontal, insert the pinion nut holding tool (with the nut) into the gear housing.
7. Insert the driveshaft into the gear housing driveshaft bore. It may be necessary to rotate the driveshaft to engage the driveshaft splines into the pinion gear splines.
8. Start the pinion nut onto the driveshaft threads by rotating the driveshaft until the nut is snug.
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut holding tool in position.

10. Tighten the pinion nut to the specified torque by turning the driveshaft using the driveshaft holding tool and torque wrench.

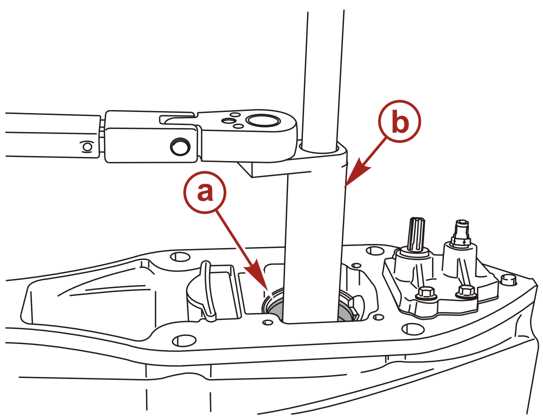


a - Driveshaft holding tool
b - Pinion nut wrench
c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91- 61067T03

Description	Nm	lb-in.	lb-ft
Pinion nut	101.7	–	75

11. Install the upper driveshaft tapered roller bearing cup. Apply 2-4-C with PTFE to the retainer threads and install the retainer. Tighten the retainer to the specified torque.



29353

a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Retainer threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Retainer	135.5	–	100

12. Remove the bearing carrier, pinion nut wrench, and driveshaft bearing retainer wrench.

NOTE: Units correctly assembled to this point would show a driveshaft rolling torque of 0.2–0.9 Nm (2–8 lb-in.).

Pinion Gear Height

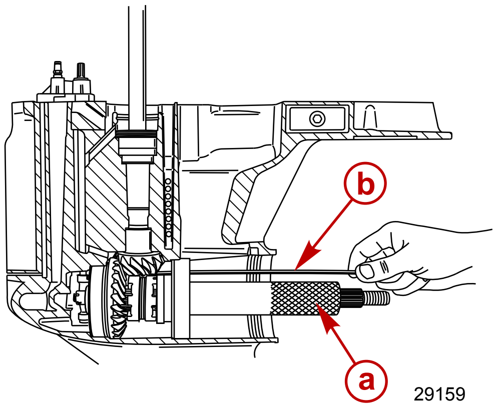
Checking and Adjusting using Pinion Height Tool 91-56048001

NOTE: The prop shaft and reverse gear can be installed when checking pinion height if pinion gear locating tool (91-56048001) is used.

1. Place the pinion gear shimming tool into the gear housing.

   NOTE: Take the following measurements at 3 locations, rotating the driveshaft 120 degrees between each reading.

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and the high point of the shimming tool.



a - Pinion gear locating tool
b - Feeler gauge

Pinion Gear Locating Tool	91- 56048001

3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the 3 readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

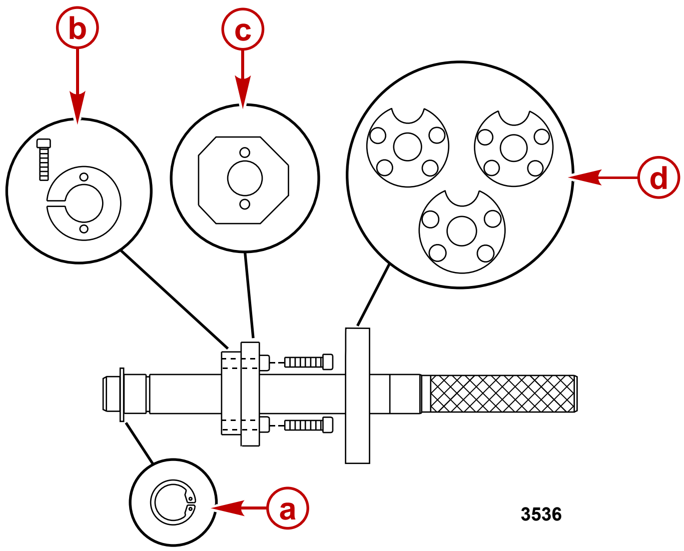
Pinion Gear	
Height	0.635 mm (0.025 in.)

6. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and retorque retainer to specifications.

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

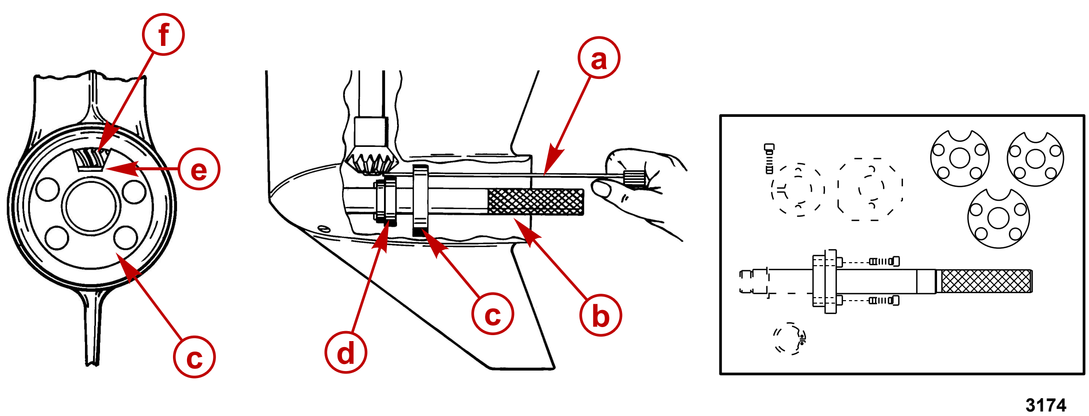
Checking and Adjusting using Pinion Gear Locating Tool 91-12349A05



- **a -** Retaining ring
- **b -** Split collar
- **c -** Gauging block
- **d -** Locating disc

NOTE: The reverse gear assembly must be installed when using pinion height tool (91-12349A05).

1. Using disc #2 and flat #4, install pinion gear locating tool into gearcase.



- **a -** Feeler gauge
- **b -** Pinion gear locating tool
- **c -** Disc #2
- **d -** Flat #4
- **e -** 0.635 mm (0.025 in.)
- **f -** Pinion gear

Pinion Gear Locating Tool	91- 12349A05

NOTE: Take the following measurements at three locations, rotating the driveshaft 120 degrees between each reading (always rotate the driveshaft in a clockwise direction).

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until three readings have been taken.
5. Add the three readings together and divide the sum by three to get the average pinion gear height. Make note of this average measurement.

Pinion Gear	
Height	0.635 mm (0.025 in.)

6. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and retorque retainer to specifications.

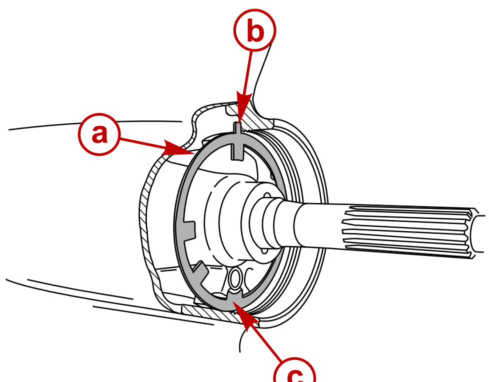
Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Bearing Carrier Installation

NOTE: If backlashes have already been checked and they are to specification, proceed to ***Bearing Carrier Final Installation*** *section.*

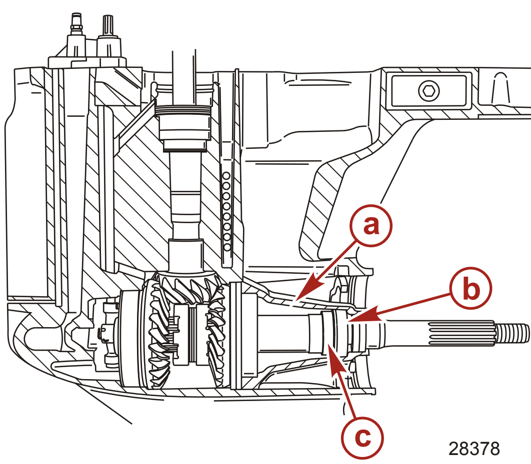
1. Place the bearing carrier assembly into the gear housing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the forward gears.
2. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the U-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



29392

a - Tab washer
b - Rectangular tab
c - U-shaped tab

3. Lubricate the bearing carrier retainer threads and corresponding gear housing threads with 2-4-C with PTFE. Start the retainer into the gear housing threads and screw it down fully by hand.



28378

a - Bearing carrier assembly
b - Propeller shaft bearing
c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer threads, corresponding gear housing threads, and upper driveshaft bearing retainer threads	92-802859A 1

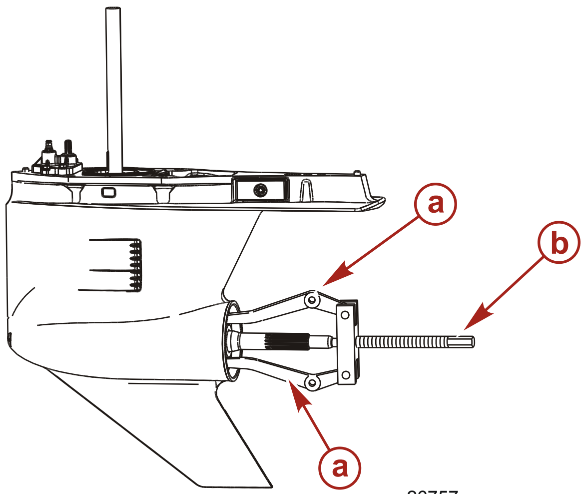
Reverse Gear Backlash

Reverse Gear	
Backlash	1.27–1.47 mm (0.050–0.058 in.)

NOTE: Pinion height must be set before checking the reverse gear backlash.

1. Apply forward pressure on the propeller shaft as follows:

a. Attach the puller jaws assembly onto the bearing carrier bosses and propeller shaft.
b. Torque the propeller nut to specification. Rotate the driveshaft three full turns in a clockwise direction and retorque the propeller nut.

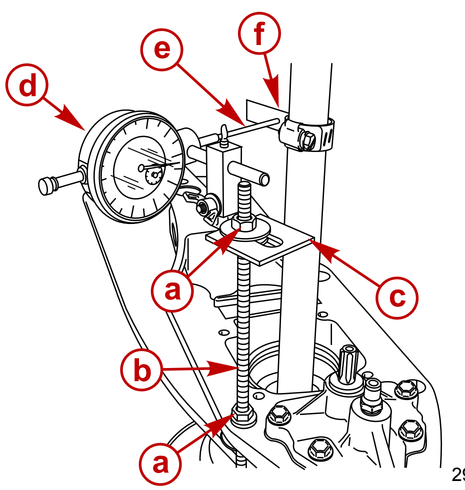


a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

Description	Nm	lb. in.	lb. ft.
Propeller nut	5	45	

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.) obtain locally
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Backlash Indicator Rod	91- 78473

3. Take the backlash readings by lightly turning the driveshaft back and forth, so as to feel the backlash between the gears. No movement should be noticed at the propeller shaft.
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
   c. Repeat step **b** above and take and record another reading. Repeat step 3 until a total of four backlash readings have been taken.
4. Add the four readings together and divide the sum by four. The result is the average backlash.

Reverse Gear	
Average backlash (1.86:1) (1.75:1)	1.27–1.47 mm (0.050–0.058 in.)

5. If the backlash is less than the specified minimum, remove shims from in front of the reverse bearing race to obtain the correct backlash. When reinstalling pinion nut, apply Loctite 271 Threadlocker to the threads of the nut.
6. If backlash is more than the specified maximum, add shims in front of the reverse gear bearing race to obtain the correct backlash. When reinstalling pinion nut, apply Loctite 271 Threadlocker to the threads of the nut.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

NOTE: By adding or subtracting 0.025 mm (0.001 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).

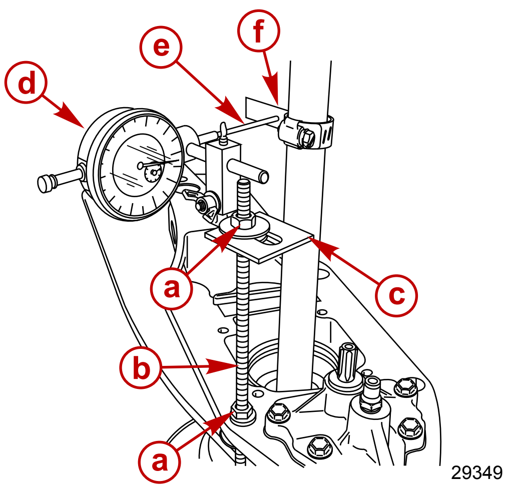
Forward Gear Backlash

Forward Gear	
Backlash	0.482–0.660 mm (0.019–0.026 in.)

NOTE: Pinion height must be set before checking forward gear backlash.

NOTE: Propeller shaft shims must be removed from propeller shaft to check forward gear backlash.

1. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.) obtain locally
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator Adapter	91-83155
Dial Indicator	91- 58222A 1
Backlash Indicator Rod	91- 78473

2. Apply backward pressure on the propeller shaft by holding the shift crank against the forward gear.
3. Take the backlash readings by lightly turning the driveshaft back and forth. No movement should be noticed at the propeller shaft.
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
   c. Repeat step **b** above and take and record another reading. Repeat step 3 until a total of four backlash readings have been taken.
4. Add the four readings together and divide the sum by four. The result is the average backlash.

Forward Gear	
Average backlash (1.86:1) (1.75:1)	0.482–0.660 mm (0.019–0.026 in.)

5. If the backlash is less than the specified minimum, remove the shims from behind the forward gear bearing adapter to obtain the correct backlash.
6. If the backlash is more than the specified maximum, add shims behind the forward gear bearing adapter to obtain the correct backlash.

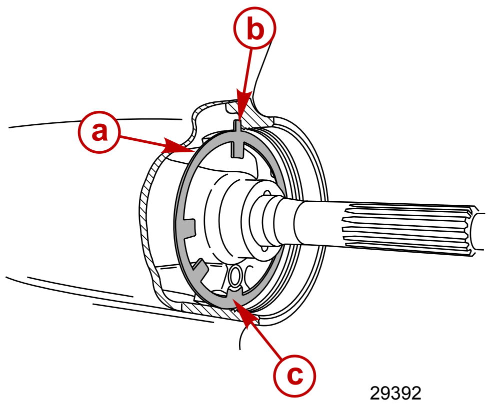
   NOTE: By adding or subtracting 0.025 mm (0.001 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.). Recheck the backlash after making shim adjustments.

Propeller Shaft Bearing Preload

NOTE: All gear housing components must be installed and correctly shimmed before checking propeller shaft bearing preload. The propeller shaft tapered roller bearing must be properly seated in the race during installation. The driveshaft retainer should be torqued to specification.

Description	Nm	lb-in.	lb-ft
Driveshaft retainer	135.5	–	100

1. Remove the bearing carrier.
2. Slide the preload spacer off of propeller shaft.
3. Install the (retained) propeller shaft preload shims onto the propeller shaft. If any shims were lost, start with 0.9 mm (0.035 in.) shim thickness.
4. Install the preload spacer onto the propeller shaft.
5. Install the bearing carrier, aligning the rear propeller shaft bearing with the propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion with the reverse gear.
6. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the U-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab
c - U-shaped tab

7. With the gear housing in neutral, torque the bearing carrier retainer nut to initial specification.
8. Rotate the propeller shaft several times to seat the propeller shaft tapered roller bearings in their races.
9. Torque the bearing carrier retainer nut to final specification.

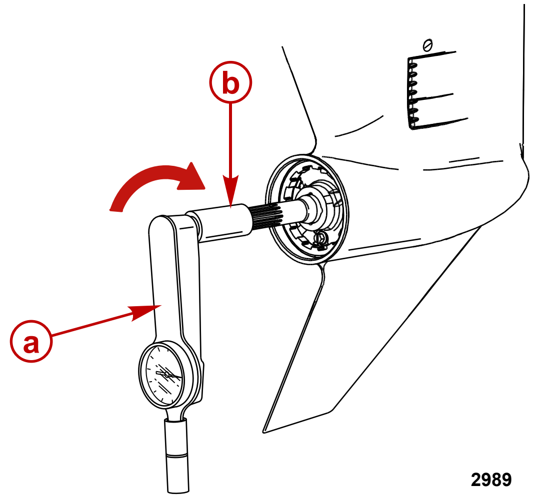
Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5	–	100
	Final	285	–	210

10. Install propeller shaft adapter and using a torque wrench, rotate propeller shaft in the direction of normal rotation with a slow steady motion.
11. Verify rolling torque is within specification for new or used bearings.

Description	Nm	lb-in.	lb-ft
Bearing rolling torque (new bearings)	1.1–1.8	10–16	–
Bearing rolling torque (used bearings)	0.45–1.1	4–10	–

NOTE: Preload will change approximately 0.056 Nm (1/2 lb-in.) of rolling torque per 0.025 mm (0.001 in.) of shim change.

12. If rolling torque is too high, remove shims from propeller shaft ahead of tapered bearing/spacer in bearing carrier. If torque is too low, add shims.



2989

a - Torque wrench
b - Propeller shaft adapter

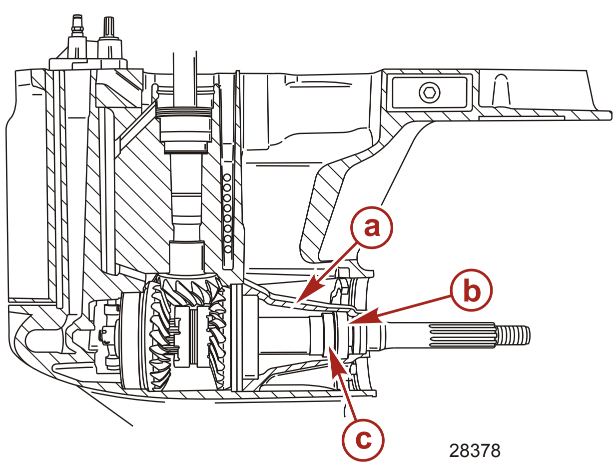
Propeller Shaft/Driveshaft Adapter	91-61077T

NOTE: If shims are changed, torque bearing carrier to initial specification. Rotate propeller shaft several times to seat propeller shaft tapered bearing. Tighten the retainer nut to final specification. Use torque wrench to check rolling torque. Repeat this procedure each time shims are changed.

Description		Nm	lb-in.	lb-ft
Bearing carrier	**First**	135.5	–	100
	Final	285	–	210

Bearing Carrier Final Installation

1. Remove the bearing carrier and lubricate the following as specified:
   a. Lubricate the carrier O-ring with 2-4-C with PTFE.
   b. Lubricate both the forward and aft outer diameters of the bearing carrier and gearcase area where the carrier will seat with 2-4-C with PTFE.
   c. Fill the space between the carrier oil seals with 2-4-C with PTFE.



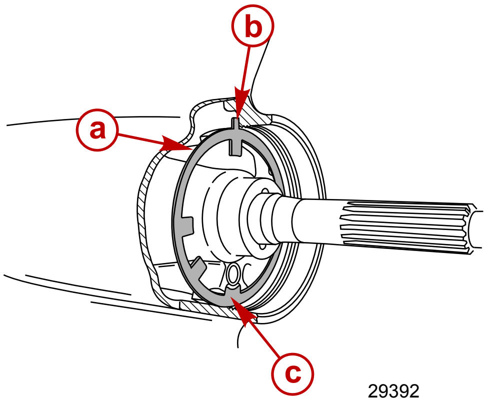
28378

a - Bearing carrier
b - Propeller shaft bearing
c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	92-802859A 1

2. Place the bearing carrier assembly into the gear housing, being careful to align the rear propeller shaft bearing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the reverse gears.
3. Lubricant fill screw in the bearing carrier should be located at the 6 o'clock position.

4. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the U-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab
c - U-shaped tab

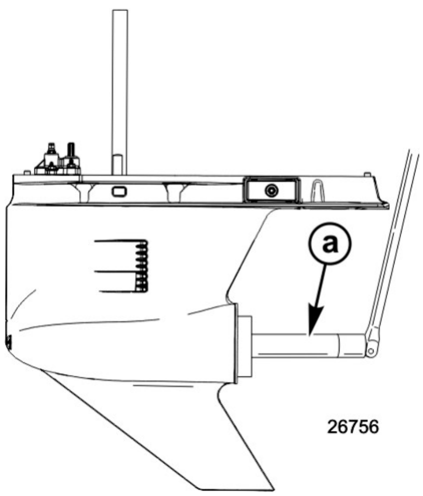
5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with PTFE. Start the retainer into the gear housing threads and screw it down fully by hand.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer nut threads and corresponding gear housing threads	92-802859A 1

IMPORTANT: Before torquing the bearing carrier retainer, the gearcase must be bolted to the driveshaft housing or securely fastened in a gearcase holding fixture to avoid possible damage to the gear housing.

NOTE: Torque retainer nut to initial specification first. Rotate propeller shaft several times to seat tapered roller bearings. Retainer nut can then be torqued to final specification.

6. Torque the bearing carrier retainer to specification. If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. Do not loosen retainer to achieve alignment.



a - Bearing carrier retainer nut wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5		100
	Final	285		210

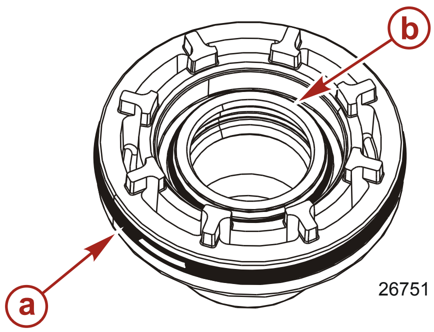
7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).

Oil Seal Carrier Installation

NOTE: The oil seal carrier may be lightly tapped into position by sliding the driveshaft bearing retainer wrench over the driveshaft.

Driveshaft Bearing Retainer Wrench	91-43506T

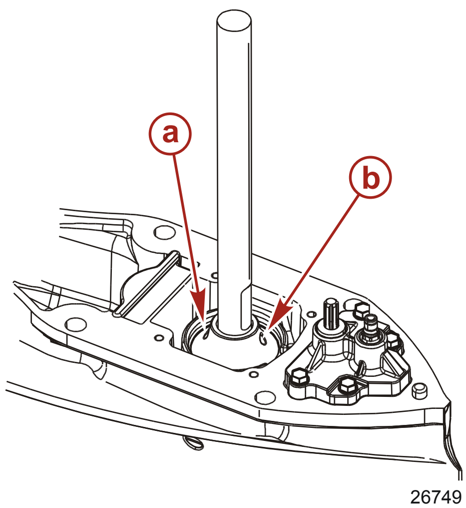
1. Lubricate the oil seal carrier oil seal lips, space between the seals, and the O-ring with 2-4-C with PTFE. Install the oil seal carrier over the driveshaft and into the gearcase.



a - O-ring
b - Oil seal lips

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal carrier seal lips, space between oil seals, O-ring	92-802859A 1

2. Install the retaining ring above the oil seal carrier.

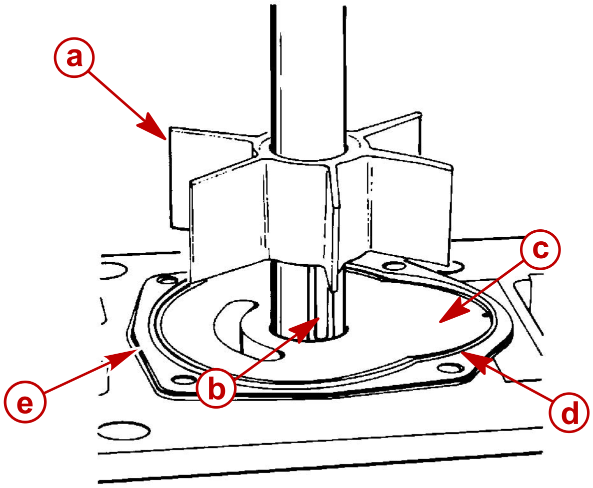


a - Retaining ring
b - Oil seal carrier

Water Pump Installation

1. Install water pump base gasket.
2. Install water pump face plate.
3. Install water pump cover gasket.
4. Place a small amount of 2-4-C with PTFE on the flat surface of the impeller key and install the key onto the driveshaft keyway.
   IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

5. Assemble the water pump impeller onto the driveshaft and down over the key.

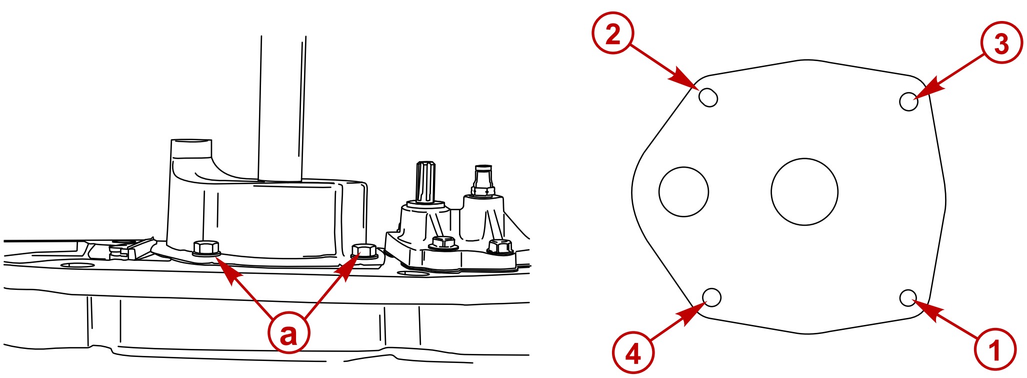


4512

a - Impeller
b - Key
c - Face plate
d - Pump cover gasket (gray seal bead faces up)
e - Pump base gasket

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Flat surface of the impeller key	92-802859A 1

6. Apply a light coat of 2-4-C with PTFE to the inside of the pump cover. Rotate the driveshaft in a clockwise direction, while pushing down on the water pump cover to ease the water pump cover over the impeller blades.
7. Hand start starboard front fastener first into the water pump assembly. Install the remaining three fasteners. Run all fasteners down and torque in sequence to specification.



3599

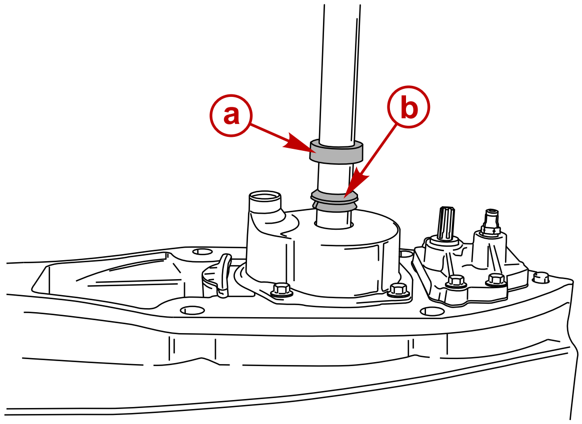
a - Water pump cover screws (4)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside of water pump cover	92-802859A 1

Description	Nm	lb-in.	lb-ft
Water pump cover screws (4)	6.7	60	

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

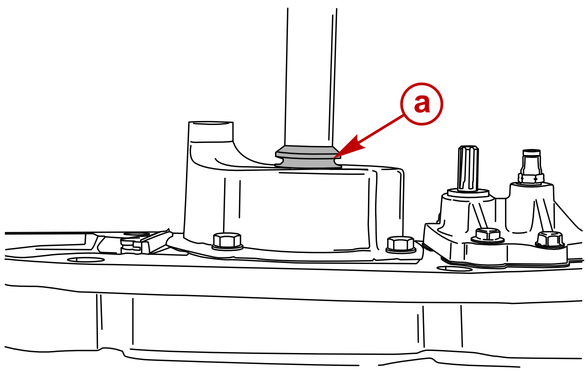
8. Using tool provided in seal kit or water pump kit, press seal down over driveshaft (do not grease driveshaft) until tool seats against pump housing.



a - Tool
b - Seal

29356

NOTE: If tool is not available, lightly press seal against housing until specified height is obtained.



a - Seal

29355

Water Pump Cover	
Seal height	8.9 mm ± 0.76 mm (0.350 in. ± 0.030 in.)

Checking Gearcase Operation

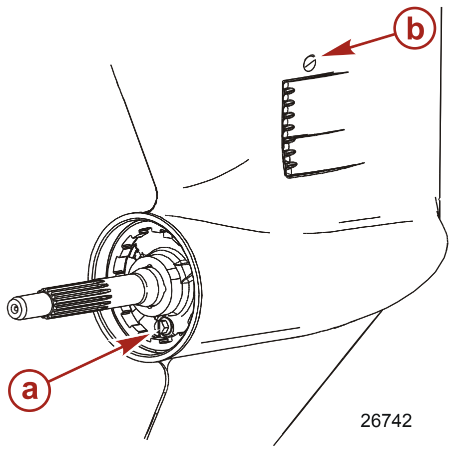
Prior to filling the gearcase with lubricant, check the gearcase for proper shift operation, as follows:

1. Rotate the shift shaft counterclockwise to the forward gear position. The propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).
2. Rotate the shift shaft to the neutral position. The propeller shaft should rotate freely both clockwise and counterclockwise.
3. Rotate the shift shaft clockwise to the reverse gear position. The propeller shaft should rotate clockwise and then lock (no ratcheting motion).
   IMPORTANT: If the shifting operation is not as described, the gear housing must be disassembled and the cause corrected.

Gear Lubricant Filling Instructions

1. Inspect the fill and vent sealing washers for cuts or abrasions. Replace the washers if necessary.
   IMPORTANT: Never apply lubricant to the gear housing without first removing the vent screw, or the gear housing cannot be filled because of trapped air. Fill the gear housing only when the housing is in a vertical position.
2. Slowly fill the housing through the fill hole with High Performance Gear Lubricant until the lubricant flows out of the vent hole and no air bubbles are visible.
3. Install the vent screw into the vent hole.
   IMPORTANT: Do not lose more than 30 cc (1 fl oz) of gear lubricant while reinstalling the fill screw.

4. Remove the grease tube (or hose) from the fill hole and quickly install the fill screw into the fill hole. Tighten the fill and vent screws to specification.



a - Fill screw
b - Vent screw

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear housing	92-858064K01

Description	Nm	lb. in.	lb. ft.
Fill and vent screws	6.7	60	

Installing Gear Housing to Driveshaft Housing

⚠ WARNING

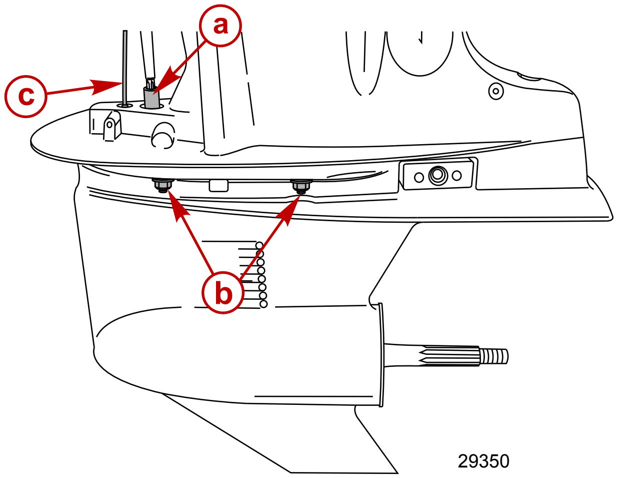
Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

1. Tilt the engine to the full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C with PTFE onto the driveshaft splines. Do not allow lubricant on top of the driveshaft.
3. Apply a light coat of 2-4-C with PTFE onto the shift shaft splines. Do not allow lubricant on top of the shift shaft.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft splines; shift shaft splines	92-802859A 1

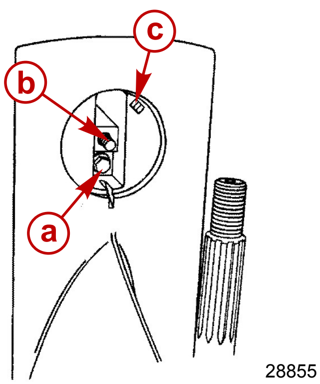
4. Insert the anodic plate screw into the hole in the rear of the gear housing to the driveshaft housing machined surface.
5. Verify the neutral position switch is in the neutral position. Verify that the gearcase is in the neutral position.
6. Position the gear housing so that the driveshaft is protruding into the driveshaft housing. If, while performing Step 7, the driveshaft splines will not align with crankshaft splines, lower the gearcase and turn the driveshaft slightly in a clockwise direction. Repeat until the driveshaft splines match with the crankshaft splines.
7. Move the gear housing up toward the driveshaft housing while aligning the shift shaft splines with the shift shaft coupler and the water tube outlet on the water pump cover with the water tube coupler in the driveshaft housing.
8. Place the flat washers onto the studs located on either side of the driveshaft housing. Start a nut on these studs and tighten finger-tight.

9. Insert the speedometer tube into the speedometer tube coupler.



- a - Shift shaft coupler
- b - Nuts and flat washers (2 each side)
- c - Speedometer tube

10. Start the screw at the rear of the gear housing inside the trim tab recess. Do not tighten the screw at this time.



- a - Screw
- b - Anodic plate attaching bolt
- c - Ribs (align carefully with anodic plate)

IMPORTANT: Do not force the gearcase up into place with the attaching nuts.

11. Evenly tighten the two nuts which were started in Step 8. Tighten to specification.

Description	Nm	lb. in.	lb. ft.
Nuts (2 each side)	75		55

12. After the two nuts located on either side of the driveshaft housing are tightened, check the shift operation as follows:
    a. Turn the ignition switch to the "ON" position and move the remote control to the forward gear position. The propeller shaft should rotate clockwise and then lock (no ratcheting motion).
    b. Move the remote control into the neutral position. The propeller shaft should rotate freely clockwise/counterclockwise.
    c. Move the remote control into the reverse gear position. The propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).
    IMPORTANT: If the shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

13. Install the remaining washers and nuts onto the driveshaft studs and tighten to specification.

Description	Nm	lb. in.	lb. ft.
Gearcase attaching nut (2 each side)	75		55

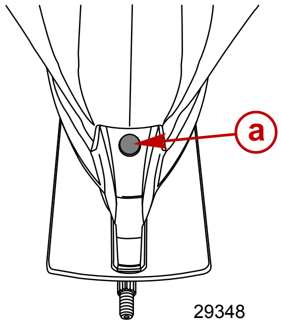
14. Tighten the screw started in Step 10 to specification.

Description	Nm	lb. in.	lb. ft.
Screw (M12 x 35)	75		55

15. Position the trim tab or anodic plate in the gear housing. Align the grooves of the trim tab with the ribs in the trim tab pocket. Adjust to the position in which it had previously been installed and, while holding the trim tab, tighten the screw to specification.

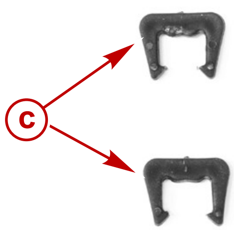
Description	Nm	lb. in.	lb. ft.
Screw (0.437-14 x 1.75 in.)	54		40

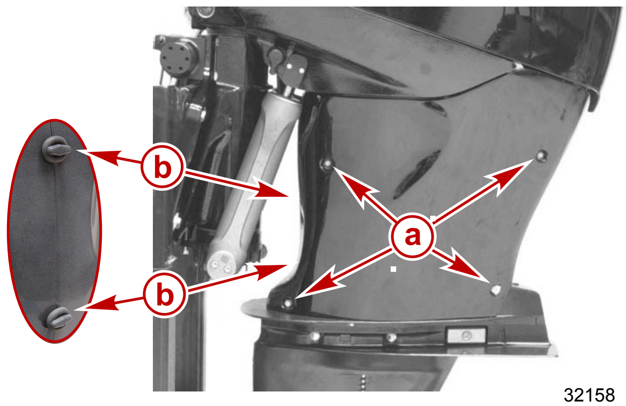
16. Install the rubber plug into the trim tab screw opening at the rear edge of the driveshaft housing.



a - Rubber plug

17. Install the clips or O-rings securing the front of the driveshaft housing chaps.
18. Install the screws (four or six for XXL shaft) securing the port chap to the driveshaft housing. Tighten the screws to specification.





a - Chap mounting screw (M6)
b - O-ring
c - Clips (used on later models in place of O-rings)

Description	Nm	lb. in.	lb. ft.
Driveshaft housing chap screws (4 or 6 each side)	6	53	

Gear Housing

Section 6C - Right-Hand and Left-Hand Rotation (5.44 in. Diameter)

Table of Contents

Gear Housing Specifications

Gear Housing Specifications		
Gear ratio		
Model 225/250/300		1.85:1 (13/24 teeth)
Model 300 HD/350 SCi		1.75:1 (12/21 teeth)
Gear housing capacity	All models	850 ml (28.7 fl oz)
Propeller shaft runout	All models	0.23 mm (0.009 in.)
Pinion height	All models	0.635 mm (0.025 in.)
Front gear backlash (right-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.533 mm (0.021 in.)
	1.85:1 ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.584 mm (0.023 in.)
Front gear backlash (left-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.838 mm (0.033 in.)
	1.85:1 ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.914 mm (0.036 in.)
Rear gear backlash (right-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.864 mm (0.034 in.)
	1.85: ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.939 mm (0.037 in.)
Rear gear backlash (left-hand rotation)	1.75:1 ratio, 31.75 mm (1.25 in.) diameter propeller shaft	0.533 mm (0.021 in.)
	1.85: ratio, 25.4 mm (1.0 in.) diameter propeller shaft	0.584 mm (0.023 in.)
Water pressure at 550 RPM	All models	6.9–20.5 kPa (1–3 psi)
Water pressure at 6000 RPM (warm water)	All models	60 kPa (8.7 psi)
Water pressure at 6000 RPM (cold water)	All models	260 kPa (37.8 psi)
Leak test (for 5 minutes)	All models	103.4 kPa (15 psi)
Poppet valve open pressure	All models	27.6–62.0 kPa (4–9 psi)

Lubricants, Sealants, Adhesives

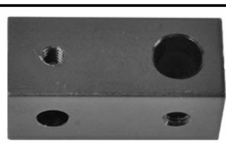
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion gear nut threads Threads of pinion nut	92-809819
19	Perfect Seal	Speedometer connector threads	92-34227Q02
27	Bellows Adhesive	Driveshaft pinion gear washer	92-86166Q1

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Tapered bearing cup bore	92-858064K01
		Outside surface of the rear gear roller bearing and the rear gear bearing bore in the carrier	
		Inside diameter of the driveshaft tapered bearings	
		Inside diameter of front gear	
		Pinion bearing bore	
		Front gear bearing cup bore	
		Gear housing	
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1
		O-ring	
		Shift shaft bushing O-ring and lip of the oil seal	
		Retainer threads	
		Bearing carrier retainer threads	
		Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier oil seals	
		Bearing carrier retainer nut threads and corresponding gear housing threads	
		Torpedo ring threads	
		Oil seal carrier oil seal lips, space between the seals, and the O-ring	
		Flat surface of impeller key	
		Inside of the water pump housing	
		Water tube coupling O-rings	
		Shift shaft splines and driveshaft splines	
134	Loctite 380	Outside diameter of bearing carrier oil seal	Obtain Locally
		Outside diameter of oil seals	
		Outside diameter of the oil seal	

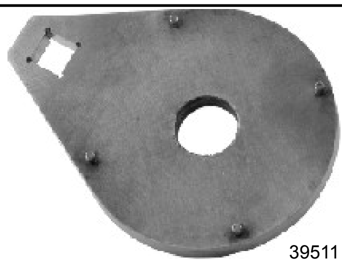
Special Tools

Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

Dial Indicator Adapter	91-83155
 2999	Dial indicator holding fixture.

Dial Indicator Holding Tool	91- 89897
 29496	Secures the dial indicator to gear housing when checking backlash.

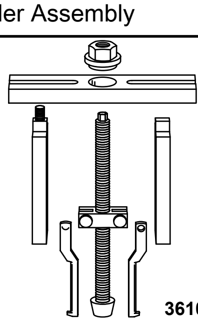
Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates

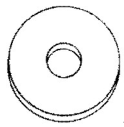
Torpedo Ring Installation Tool	91-8M0039309
 39511	Installs torpedo ring

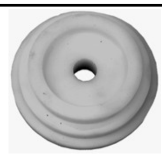
Bearing Carrier Retainer Nut Tool	91-8M0046632
 46139	Aids in the removal and installation of the bearing carrier retainer

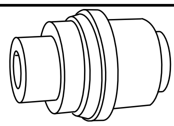
Puller Jaws Assembly	91-46086A1
 9514	Removes bearing carrier and bearing races; use with Puller Bolt (91-85716)

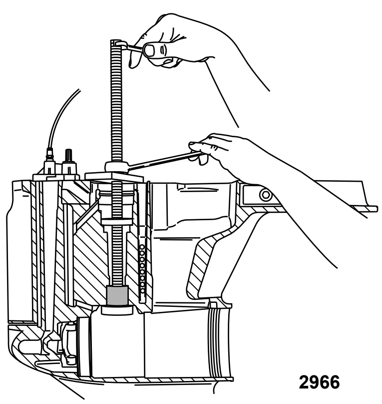
Torch Lamp	91- 63209
 8776	Heats surfaces to aid in the removal and installation of interference fit engine components.

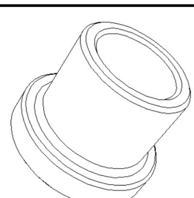
Bearing Puller Assembly	91- 83165T
 3610	Removes bearings, races and bearing carriers

Pilot Washer	91-36571T
 29490	Used in pinion gear and pinion bearing installation

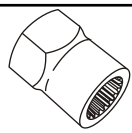
Bearing Carrier Guide Plate	91-8M0053084
 46141	Aids in the installation of bearing carrier seals and propeller shaft tapered bearing race

Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
 6229	Installs bearing carrier cup and seals.

Bearing Removal and Installation Kit	91- 31229A 7
 2966	Installs and removes the bearings in all gearcases 91- 31229A 7 tool assembly includes the following components: 11- 24156 Hex Nut 12- 34961 Washer 91- 15755T Bearing Carrier 91- 29310 Plate 91- 30366T 1 Mandrel 91- 31229 Puller Shaft 91- 32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91- 36569T Driver Head 91- 36571T Pilot Washer 91-37292 Roller Bearing 91- 37311 Driver Head 91- 37312T Driver Head 91- 37323 Driver Head Rod 91- 37324T Pilot Washer 91- 37350T Pilot Mandrel 91- 38628T Puller/Driver Head 91-52393T Driver Needle Bearing 91-52394 Head Pull Rod

Retaining Ring Installation Tool	91-8M0053153
 47520	Aids in the installation of the rear gear retaining ring

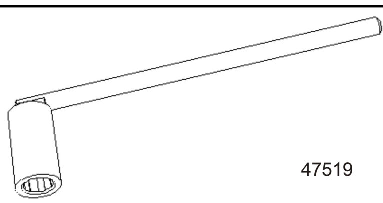
Driveshaft Bearing Retainer Wrench	91-43506T
 9520	Removes and installs the threaded bearing retainer

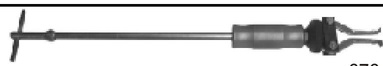
Driveshaft Holding Tool	91-889958T
 28677	Holds driveshaft during pinion nut removal on the Verado models

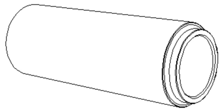
Pinion Nut Holding Tool	91-8M0036288
 39509	For torquing pinion nut.

Propeller Shaft Holder	91-8M0035594
 39510	Stabilizes propshaft

Propeller Shaft/Driveshaft Adapter	91-61077T
 **10805**	Provides a hex surface to turn the propeller shaft

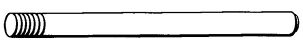
Shift Shaft Handle Tool	91-8M0050615
 47519	Used to rotate gearcase shift shaft

Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components. Use with puller jaws.

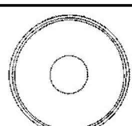
Driveshaft Bearing Installation Tool	91-8M0052590
 47416	Install upper and lower driveshaft bearings

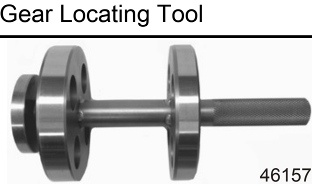
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft.

Pinion Bearing Removal Tool	91-8M0046348
 46152	Removes pinion bearing

Driver Rod	91- 37323
 25431	Aids in the removal and installation of various bearings and bearing races

Pinion Bearing Installation Tool	91-8M0046360
 46153	Installs pinion bearing

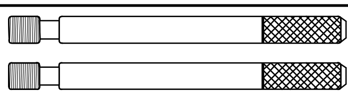
Bearing Cup Driver	91-885592T
 29492	Installs front gear bearing cup

Pinion Gear Locating Tool	91-8M0046443
 46157	Sets pinion location

Bearing Carrier Installation Tool	91-840388
 9518	Protects the seals when installing the bearing carrier on 19 spline (1-1/4 inch) propeller shaft. (Part of assembly 91-840393A1)

Backlash Indicator Rod	91-8M0053505
 46158	Aids in checking gear backlash

Bearing Carrier Installation Tool	91-8M0059911
 9518	Protects the seals when installing the bearing carrier on 19 spline (1-1/4 inch) propeller shaft (part of assembly 91-840393A1)

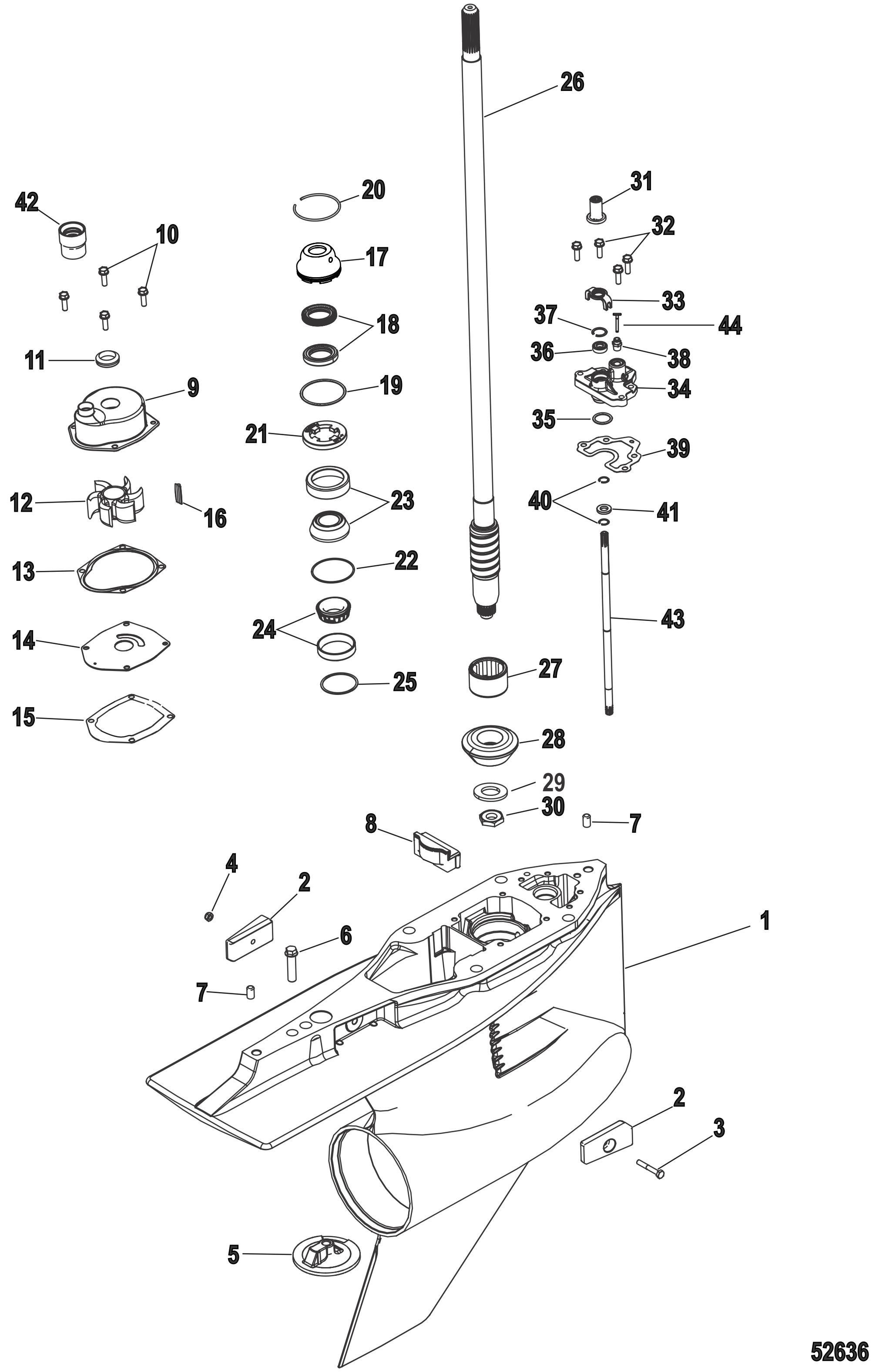
Water Pump Alignment Pins	91-821571A 1
 9482	Aligns the water pump during installation

Driveshaft Seal Installation Tool	91-818769
 47536	Sets driveshaft seal height

Notes:

Gear Housing Components

Gear Housing (Driveshaft)

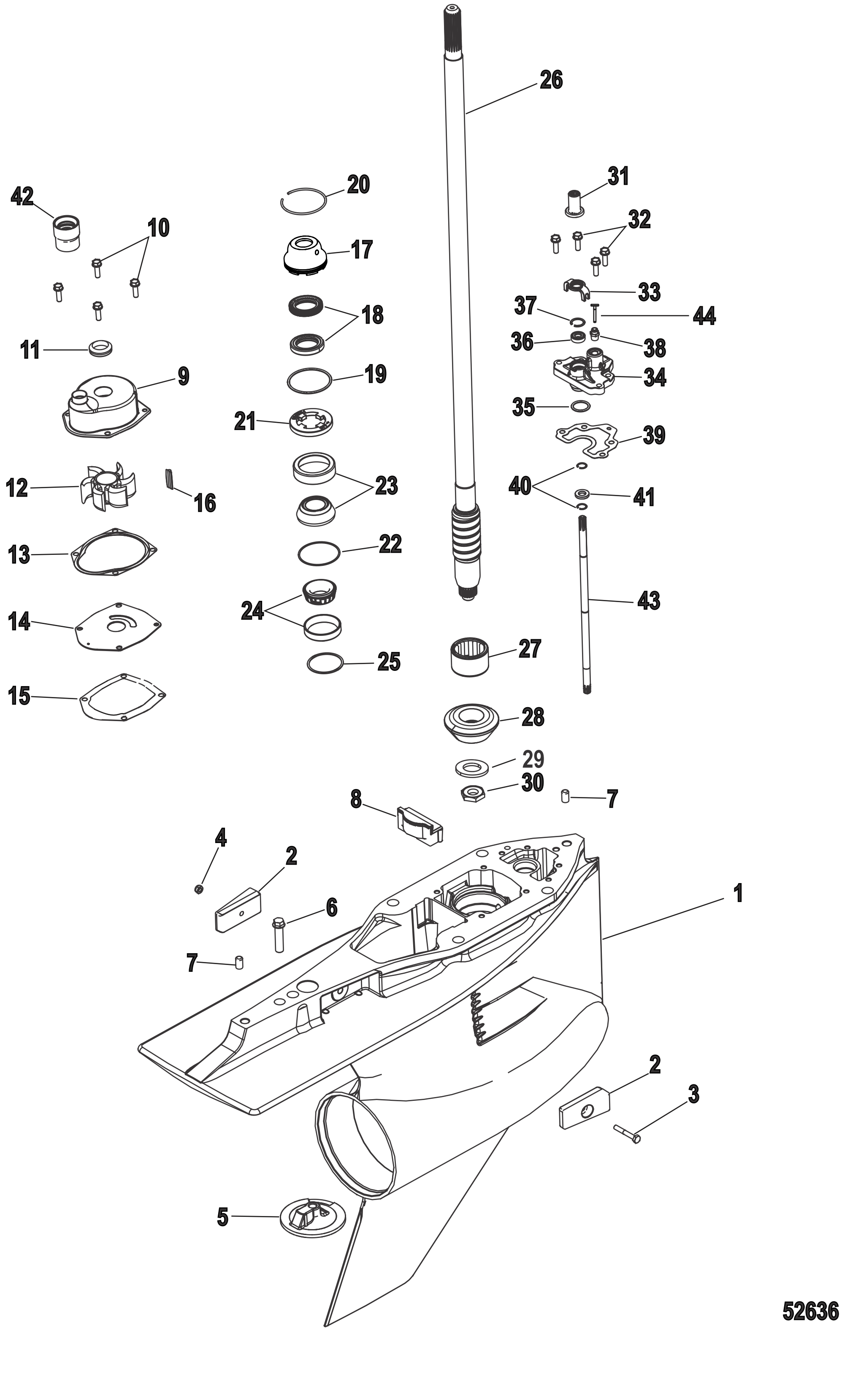


Gear Housing (Driveshaft)

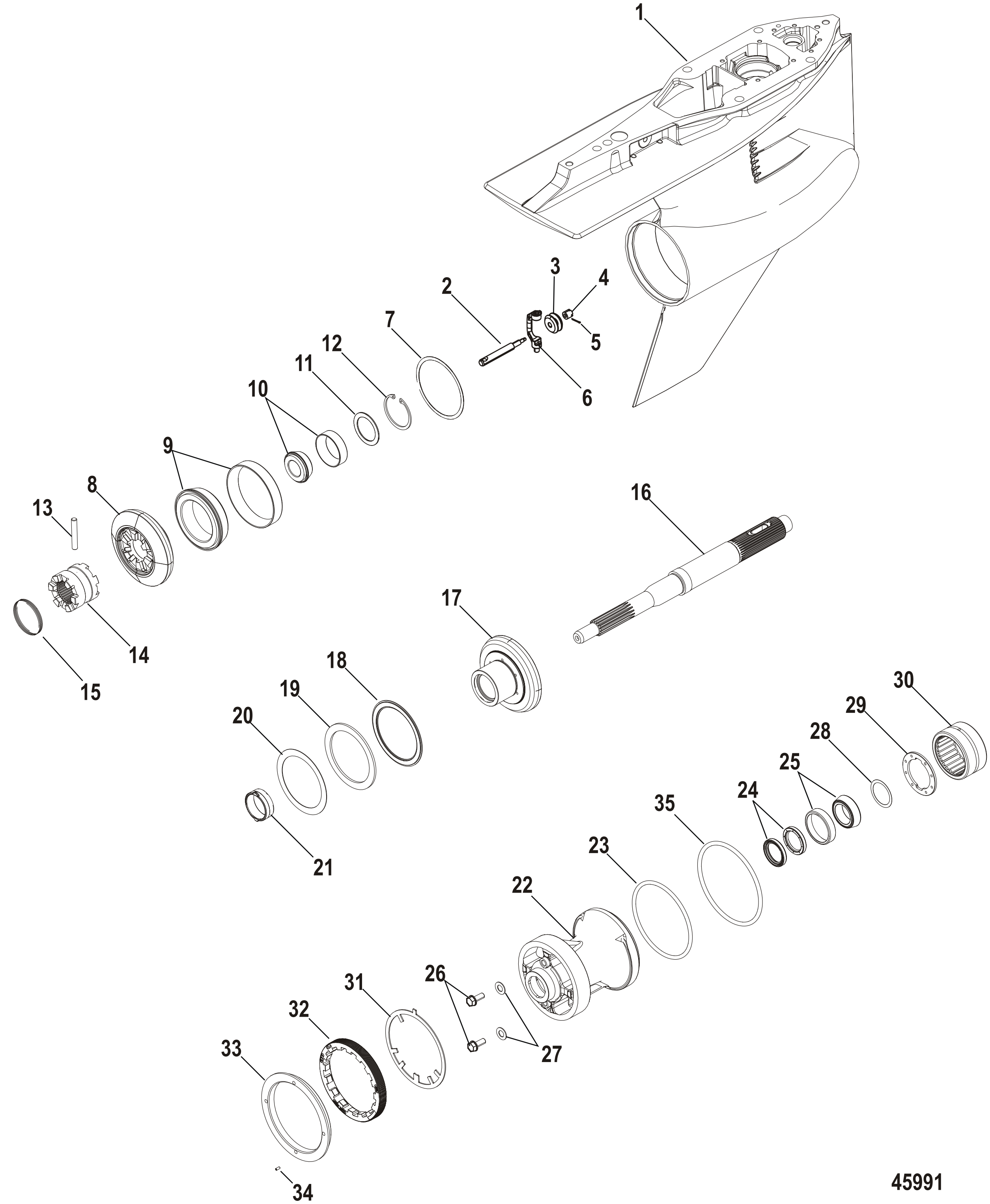
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	2	Anode			
3	1	Screw (M6 x 40)			
4	1	Nut (M6), stainless steel			
5	1	Anode kit			
6	1	Screw (0.437-14 x 1.750)	54	–	40
7	2	Dowel pin (0.375 x 0.625) without hole			
8	1	Filler block			
9	1	Water pump housing kit			
10	4	Screw (M6 x 20)	6.8	60	–
11	1	Face seal			
12	1	Impeller			
13	1	Gasket			
14	1	Faceplate			
15	1	Gasket			
16	1	Key			
17	1	Oil seal assembly			
18	2	Seal (not sold separately)			
19	1	O-ring (2.175 x 0.103)			
20	1	Retaining ring			
21	1	Retainer	135.5	–	100
22	1	Shim set			
23	1	Roller bearing			
24	1	Tapered roller bearing			
25	1	Shim assembly			
26	1	Driveshaft			
27	1	Roller bearing			
28	1	Gear set 13/24 (1.85:1) forward and pinion			
		Gear set 12/21 (1.75:1) forward and pinion			
29	1	Pinion nut washer (design II)			
30	1	Pinion nut (design II, with washer)	169.5	–	125
		Pinion nut (design I, no washer)	101.7	–	75
31	1	Coupling			
32	4	Screw (M6 x 20)	6.8	60	–
33	1	Grommet assembly			
34	1	Cover assembly			
35	1	O-ring (0.799 x 0.103)			
36	1	Oil seal			
37	1	Retaining ring			
38	1	Fitting			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
39	1	Gasket			
40	2	E-ring			
41	1	Magnet			
42	1	Water tube coupling			
43	1	Shift shaft			
44	1	Plug (1.75:1 ratio gearcase)			

Gear Housing (Driveshaft)



Gear Housing (Propeller Shaft)



Gear Housing (Propeller Shaft)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	1	Spool assembly			
3	1	Spool			
4	1	Castle nut			
5	1	Cotter pin			
6	1	Crank			
7	1	Shim			
8	1	Forward gear (RH) 13/24 (1.85:1), 12/21 (1.75:1)			
	1	Reverse gear (LH) 13/24 (1.85:1), 12/21 (1.75:1)			
9	1	Roller bearing assembly			
10	1	Tapered roller bearing assembly			
11	1	Thrust washer			
12	1	Retaining ring			
13	1	Pin			
14	1	Clutch			
15	1	Spring			
16	1	Propeller shaft - 25.4 mm (1.0 in.), 1.85:1 ratio			
	1	Propeller shaft - 31.75 mm (1.25 in.), 1.75:1 ratio			
17	1	Reverse gear (RH) 13/24 (1.85:1), 12/21 (1.75:1)			
	1	Forward gear (LH) 13/24 (1.85:1), 12/21 (1.75:1)			
18	1	Bearing			
19	1	Washer			
20	AR	Shim			
21	1	Adapter			
22	1	Carrier assembly			
23	1	O-ring (4.475 x 0.210)			
24	2	Oil seal			
25	1	Tapered bearing assembly			
26	2	Plug	22.6	200	16.5
27	2	Seal			
28	AR	Shim			
29	1	Retaining ring			
30	1	Needle bearing			
31	1	Tab washer			
32	1	Retainer nut	433.9[1.]		320[1.]
33	1	Torpedo cover	68		50
34	1	Set screw (10-32)	2.8	25	
35	1	Washer			

1. Torque retainer to 135.5 Nm (100 lb-ft), then check rolling torque on propeller shaft. If torque is within specification, torque retainer to 285 Nm (210 lb-ft) and then rotate retainer an additional 3.8 cm (1.5 in.).

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part. It is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

Disassembly of a subassembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** to find the correct page number.

Threaded parts are right-hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel that will contact only the bearing race when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in the air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean the bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin the bearing with compressed air, as this may cause the bearing to score from lack of lubrication. After cleaning, lubricate the bearings with High Performance Gear Lubricant. Do not lubricate the tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work the inner bearing race in and out, while holding the outer race, to check for side wear.

When inspecting the tapered bearings, determine the condition of the rollers and the inner bearing race by inspecting the bearing cup for pits, scoring, grooves, uneven wear, imbedded particles, and/or discoloration from overheating. Always replace the tapered bearing and race as a set.

Inspect the gear housing for bearing races that have spun in their respective bores. If the race has spun, the gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check the shaft surface for pits, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced if the conditions described are found.

Shims

Keep a record of all shim amounts and their location during disassembly to aid in reassembly. Be sure to follow the shimming instructions during reassembly, as gears must be installed to the correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

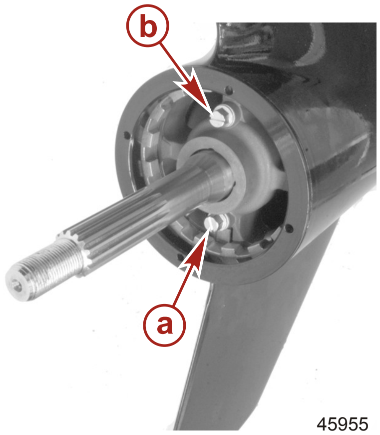
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 Threadlocker to the outer diameter of all metal case oil seals. When using Loctite on seals or threads, the surfaces must be clean and dry. To ease installation, apply 2-4-C with PTFE on all O-rings. To prevent wear, apply 2-4-C with PTFE on the I.D. of oil seals.

Gearcase Serviceability Inspection

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.

2. Position a clean drain pan under the gear housing and remove the fill and vent plugs from the gear housing with a 10 mm socket or slot screwdriver.



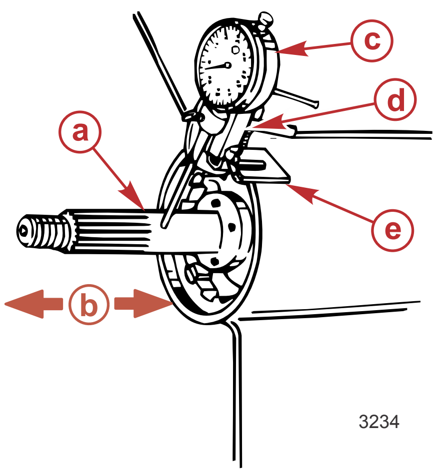
a - Fill plug
b - Vent plug

3. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles, or a large quantity of fine particles, indicates the need for gear housing disassembly and component inspection.
4. Check the color of the gear lubricant. White or cream color indicates presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly and inspection of oil seals, seal surfaces, O-rings, and gear housing components.

Propeller Shaft Inspection

Check for a bent propeller shaft as follows:

1. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.23 mm (0.009 in.), a bent propeller shaft is indicated.
2. Check for propeller shaft end play. There should be no end play. If end play exists, excessive wear has occurred and the gear housing must be disassembled for inspection.



a - Propeller shaft runout
b - Propeller shaft end play
c - Dial indicator
d - Dial indicator holding tool
e - Dial indicator adapter

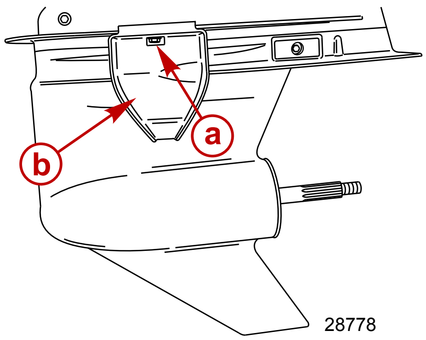
Propeller Shaft	
Runout	0.23 mm (0.009 in.)

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Dial Indicator Holding Tool	91- 89897

Gearcase Removal

> **⚠ WARNING**
>
> **Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.**

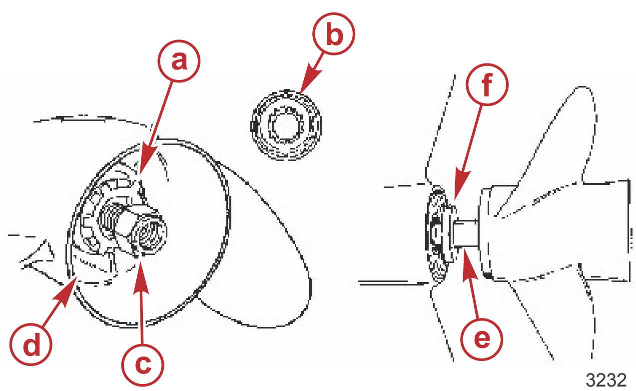
1. Verify the position of the shift switch. The gearcase must be in the same position when installing the gearcase to the driveshaft housing.
2. Drain the engine oil pan of oil. Failure to drain the oil prior to removing the gearcase will result in approximately 0.9463 liter (1 US qt) of oil leakage when the gearcase is removed.



a - Drain plug/seal washer
b - Oil drain funnel

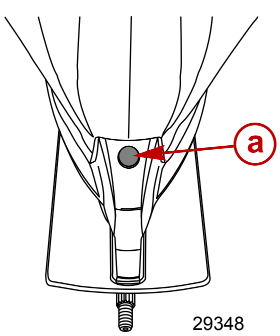
Oil Drain Funnel	91-892866A01

3. Tilt the outboard to the trailer full up position and engage the tilt lock lever.
4. Bend the tabs of the propeller tab washer away from the rear thrust hub. Remove the propeller locknut, tab washer, rear thrust hub, propeller, and forward thrust hub from the propeller shaft.



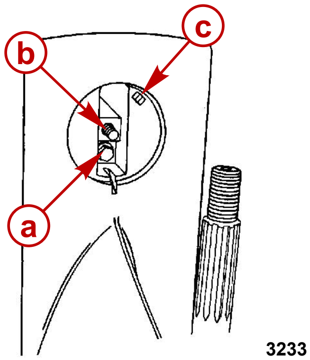
a - Tab washer
b - Continuity washer (if equipped)
c - Propeller nut
d - Rear thrust hub
e - Propeller shaft
f - Forward thrust hub

5. Remove the rubber plug at the rear edge of the driveshaft housing. Remove the screw (13 mm) that secures the anodic plate. Remove the plate from the gear housing.



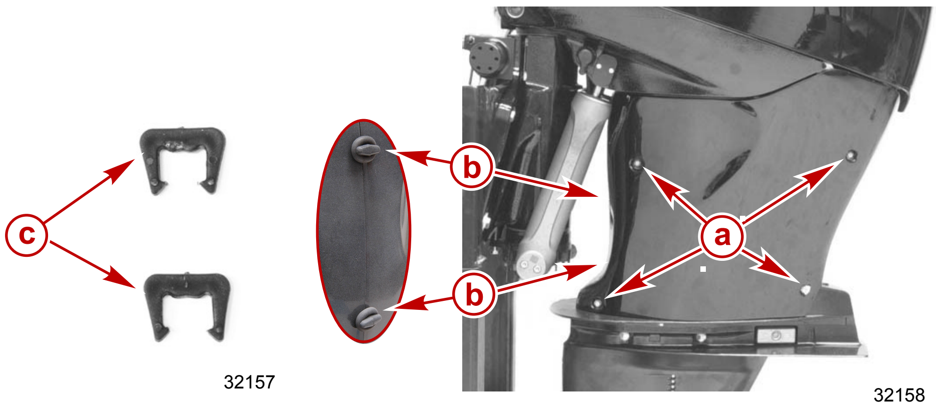
a - Rubber plug

6. Once the plate is removed, remove the screw from inside the cavity.



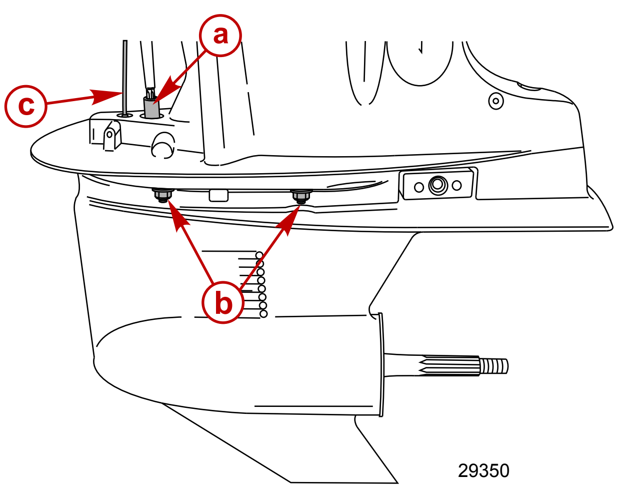
a - Screw (inside cavity)
b - Screw (secures anodic plate)
c - Ribs

7. Remove the clips or O-rings securing the front of the driveshaft housing chaps.
8. Remove the four screws (six for XXL shaft) securing the port chap to the driveshaft housing and remove the chap.



a - Chap mounting screw (M6)
b - O-ring
c - Clips (used on later models in place of O-rings)

9. While pressing in on the speedometer tube junction, pull out on the tube to disconnect.
10. Loosen the side mounting locknuts. Do not attempt to remove one nut before the opposite side is loosened sufficiently or the gear housing could be damaged.
11. Pull the gear housing away from the driveshaft housing as far as the loosened nuts will allow, then remove the loosened nuts. Do not allow the gear housing to fall, as it is now free.



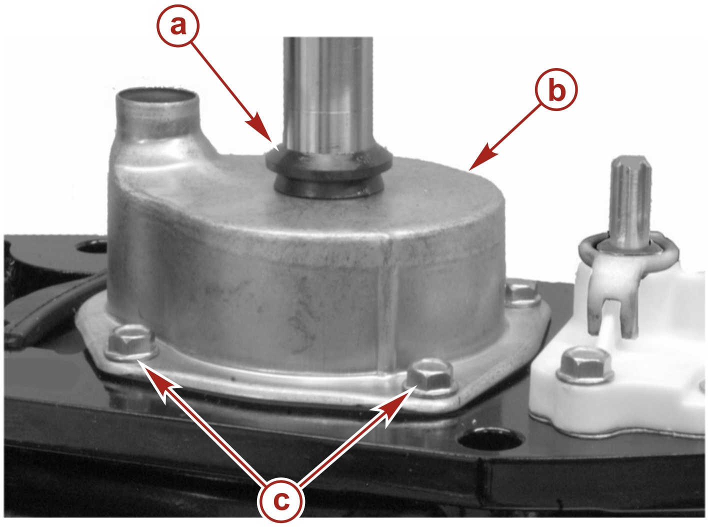
a - Shift shaft coupler
b - Nuts and washers (2 each side)
c - Speedometer tube (if equipped)

12. Pull the gear housing from the driveshaft housing.

Water Pump Removal

Removal and Disassembly

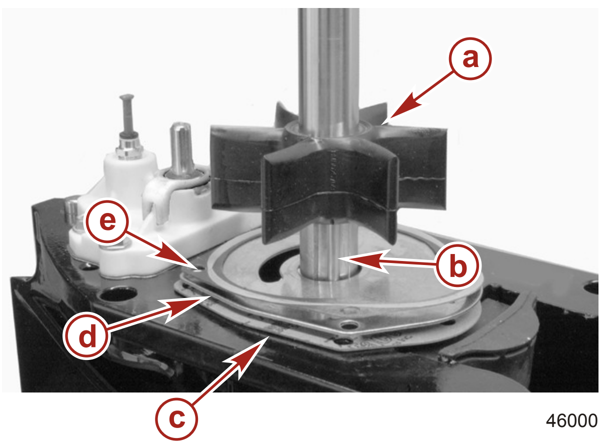
1. Remove the driveshaft seal and water pump screws.



45998

a - Driveshaft seal
b - Water pump cover
c - Screw (two each side)

2. Lift the water pump cover straight up and off the driveshaft.
3. Remove the impeller, impeller key, gaskets, and face plate.



46000

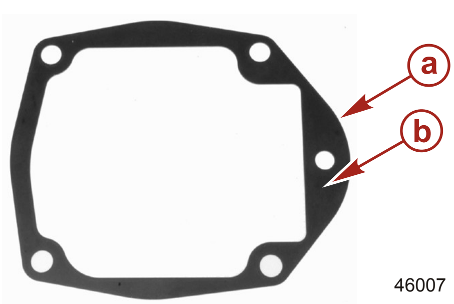
a - Impeller
b - Impeller key
c - Large hole gasket
d - Face plate
e - Stainless steel gasket

Cleaning and Inspection

NOTE: With the gear housing removed, inspect the water tube coupling assembly inside the driveshaft housing for wear or damage. Replace worn or damaged components.

IMPORTANT: The circular groove formed by the impeller will not affect water pump output.

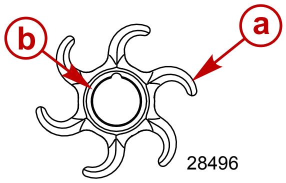
1. Inspect the face plate and water pump liner for grooves or rough surfaces.
2. Inspect the stainless steel gasket coated surface for scratches or damage. If the coating is scratched or damaged, replace the stainless steel gasket.



46007

a - Stainless steel gasket
b - Coating

3. Inspect the impeller seal surfaces and ends of the impeller blades for cracks, tears, and wear. Replace the impeller if any of these conditions are found.
4. Inspect the impeller bonding to the impeller hub.



a - Impeller
b - Hub

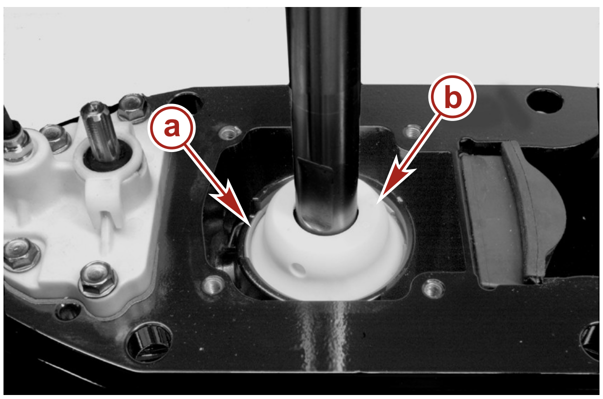
5. Inspect the impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace the impeller if any of these conditions exist.
   IMPORTANT: When completing gear housing repairs that require removal of the water pump impeller, it is recommended the impeller be replaced. However, if the impeller must be used, do not install in reverse to original rotation; premature impeller failure will occur.

Oil Seal Carrier Assembly

Removal

NOTE: Push down on the seal carrier to aid in the removal of the retaining ring above the seal carrier.

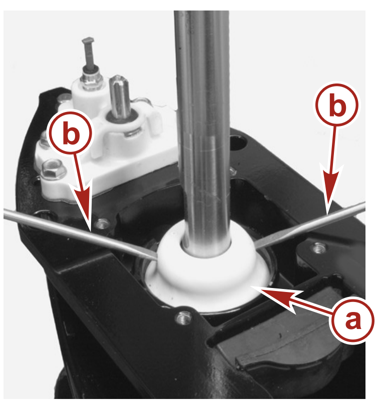
1. While pushing down on the seal carrier, use a flat tip screwdriver to aid in the removal of the retaining ring above the oil seal carrier.



46008

a - Retaining ring
b - Seal carrier

2. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



46009

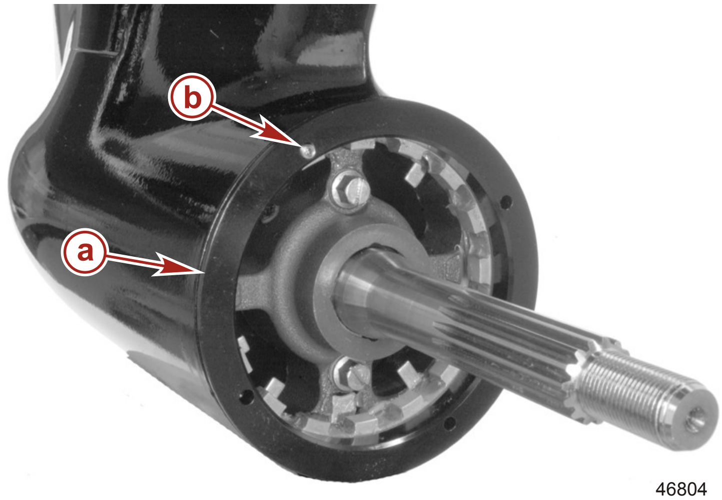
a - Oil seal carrier
b - Screwdrivers

Disassembly

NOTE: The oil seals within the oil seal carrier are not individually replaceable. If the oil seals require replacement, the oil seal carrier must be replaced as an assembly.

Bearing Carrier and Propeller Shaft

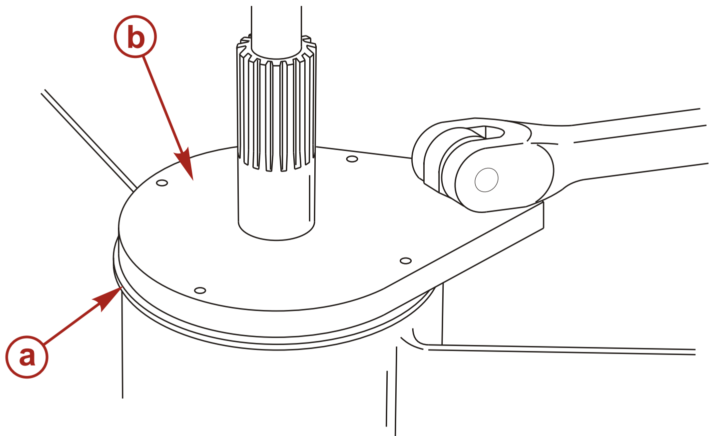
1. Remove the set screw from the torpedo ring using a 3/32 inch allen wrench.



46804

a - Torpedo ring
b - Set screw

2. Remove the torpedo ring using a torpedo ring installation tool.



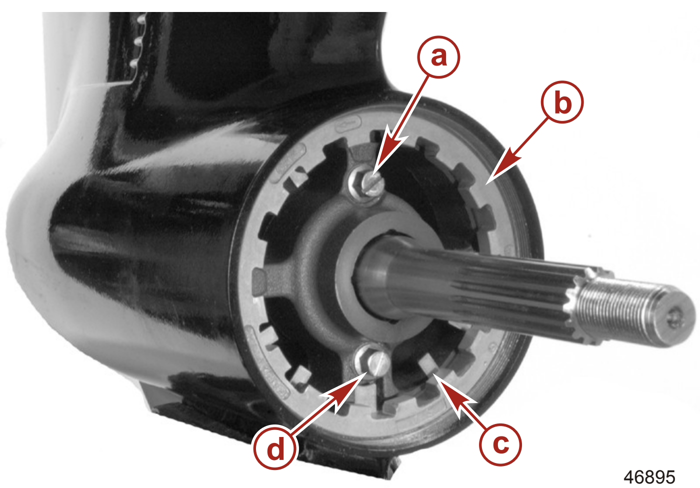
40888

a - Torpedo ring
b - Torpedo ring installation tool

Torpedo Ring Installation Tool	91-8M0039309

3. Straighten any lock tabs on the tab washer.

NOTE: The drain plug in the bearing carrier must be removed before using the bearing carrier retainer nut wrench to remove the bearing carrier retainer.



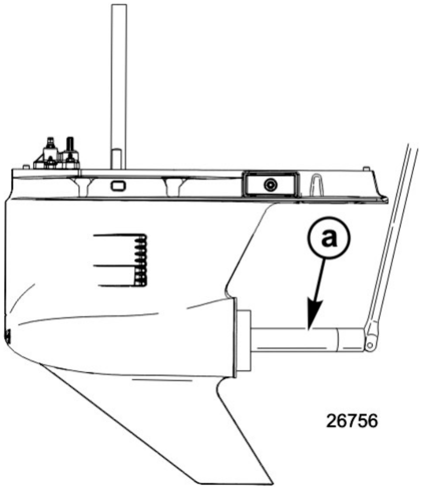
46895

a - Vent plug
b - Bearing carrier retainer
c - Lock tab
d - Drain plug

4. Remove the bearing carrier retainer following step "a" or "b," as follows:

IMPORTANT: Drilling into the bearing carrier retainer can potentially damage the gearcase. Ensure that you do not drill into the gearcase when removing a seized retainer.

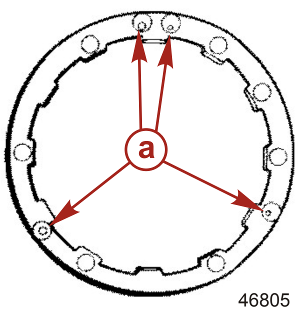
a. Remove the bearing carrier retainer by turning the retainer counterclockwise using a bearing carrier retainer nut wrench.



a - Bearing carrier retainer nut wrench

Bearing Carrier Retainer Nut Tool	91-8M0046632

b. If the retainer is corroded in place, drill four holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



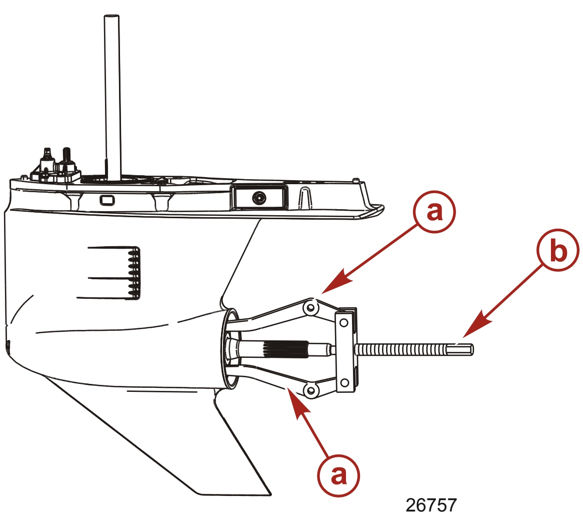
a - Drilled holes

c. Remove the tab washer.

5. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. Position the puller jaws close to the bosses in the carrier.

NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.

NOTE: The rear propeller shaft bearing shim may remain on the propeller shaft or fall out of the bearing carrier when the bearing carrier is removed from the gear housing.



a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

Cleaning/Inspection

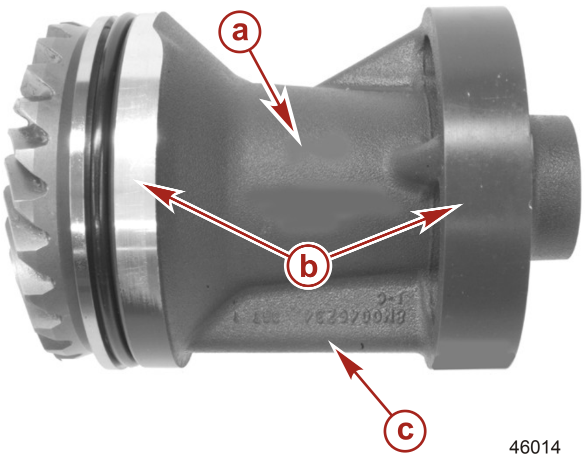
IMPORTANT: It is recommended that all seals and O-rings be replaced to assure effective repair.

1. Clean the bearing carrier with solvent and dry with compressed air.

⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

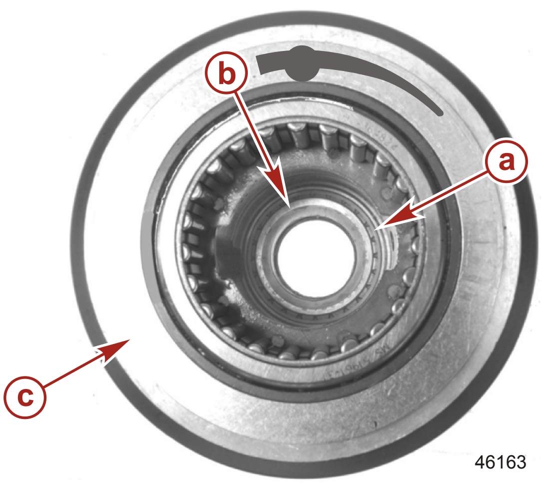
2. Inspect the bearing carrier for signs of excessive corrosion, especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident, replace the carrier.



46014

a - Bearing carrier
b - Inspect for corrosion
c - Reinforcing rib

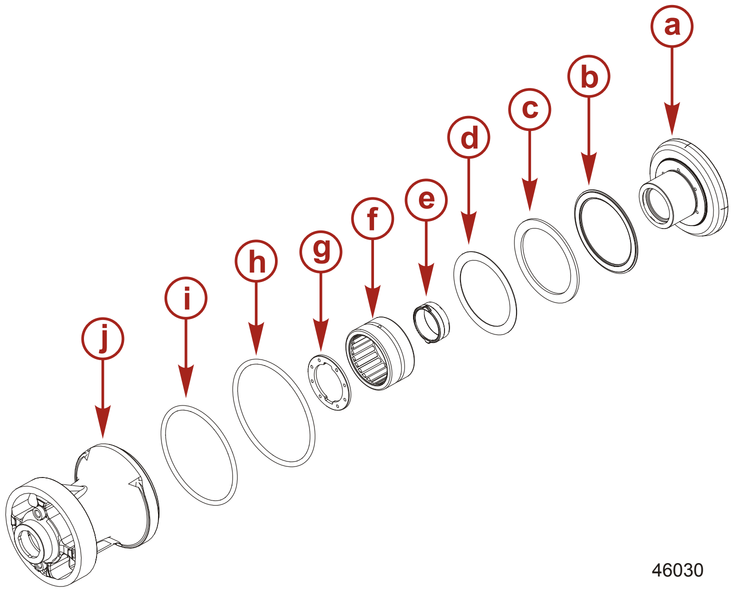
3. The propeller shaft utilizes a tapered roller bearing cone and cup for shaft support just forward of the bearing carrier seals. The rear gear and bearing assembly must be removed from the bearing carrier to gain access to the propeller shaft tapered bearing cone for inspection.



46163

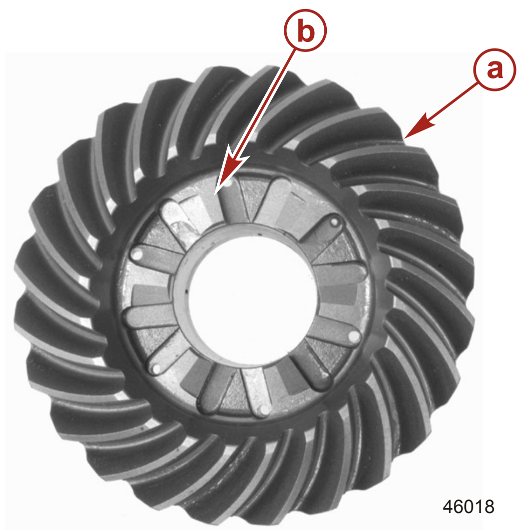
a - Tapered roller bearing cone (cup hidden under bearing)
b - Shim (on top of bearing)
c - Bearing carrier (rear gear removed)

4. The rear gear can be removed from the bearing carrier assembly by rotating the gear until the rear gear adapter tabs align with the slots in the retaining ring. The rear gear can then be lifted out of the bearing carrier assembly.



- a - Rear gear
- b - Thrust bearing
- c - Race - thrust bearing
- d - Shim
- e - Adapter (pressed into rear gear)
- f - Rear gear roller bearing (pressed into bearing carrier)
- g - Retaining ring
- h - Bearing carrier thrust ring
- i - O-ring (4.475 x 0.210)
- j - Bearing carrier

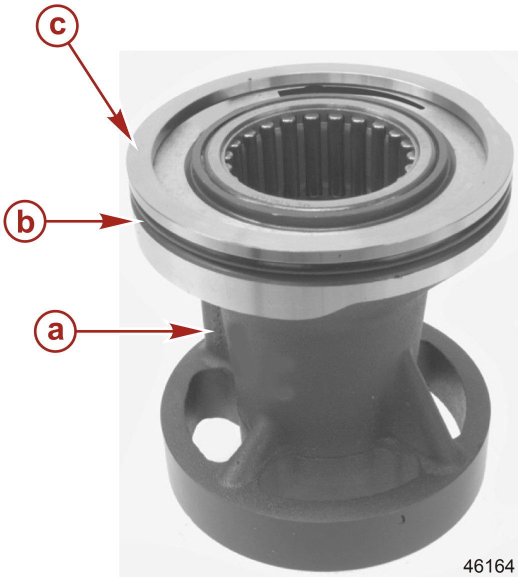
5. Inspect the rear gear to pinion gear wear pattern. It should be even and smooth. If not, replace the rear gear, pinion gear, and front gear.
6. Inspect the rear gear for pitted, chipped or broken teeth, and hairline fractures. Replace the rear gear and the pinion gear if any defects are found.
7. Check the clutch jaws on the rear gear for damage. Replace the rear gear if damage is found on the clutch jaws.



- a - Rear gear
- b - Clutch jaws

Disassembly

1. Remove and discard the O-ring between the bearing carrier and the bearing carrier thrust ring.



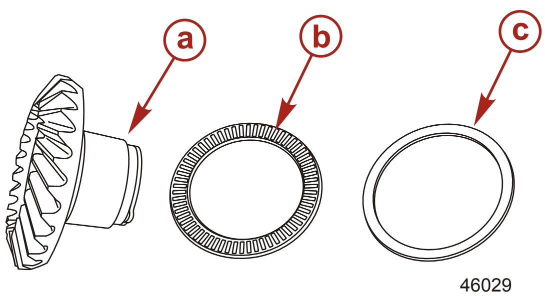
a - Bearing carrier
b - O-ring
c - Bearing carrier thrust ring

IMPORTANT: If it is necessary to place the bearing carrier in a vise for servicing procedures, clamp onto the reinforcing rib only. Clamping on any other location may damage the bearing carrier.

2. To remove the rear gear roller bearing, use a torch lamp to heat the bearing carrier area surrounding the roller bearing. Use a suitable mandrel and driver rod to press against the retaining ring behind the roller bearing. A hydraulic press or arbor press is recommended to apply force to the driver rod. Do not reuse the retaining ring or roller bearing after removal from the bearing carrier.

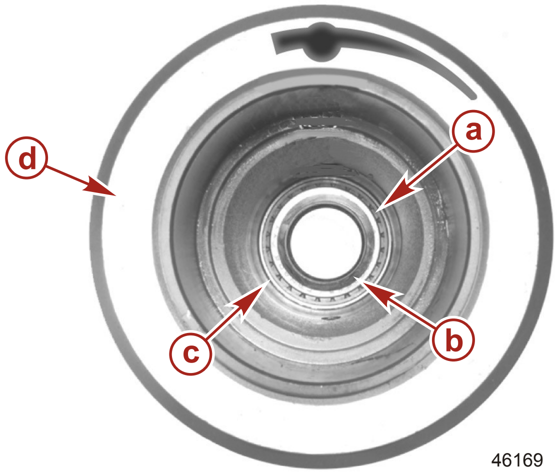
Torch Lamp	91- 63209

3. Inspect the rear gear, thrust bearing, and race for excessive wear, cracks, or damage. Replace the appropriate components if any of these conditions are found.



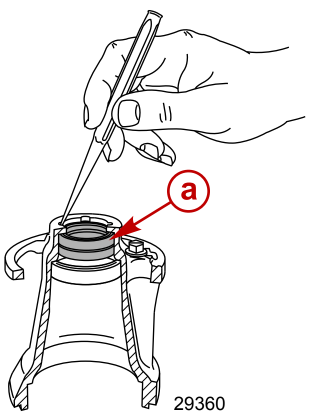
a - Rear gear
b - Thrust bearing
c - Race - thrust bearing

NOTE: *Inspect the aft propeller shaft tapered bearing cone for pits, scoring, discoloration, or excessive looseness. Replace the bearing and bearing cup inside of the carrier if these conditions exist.*



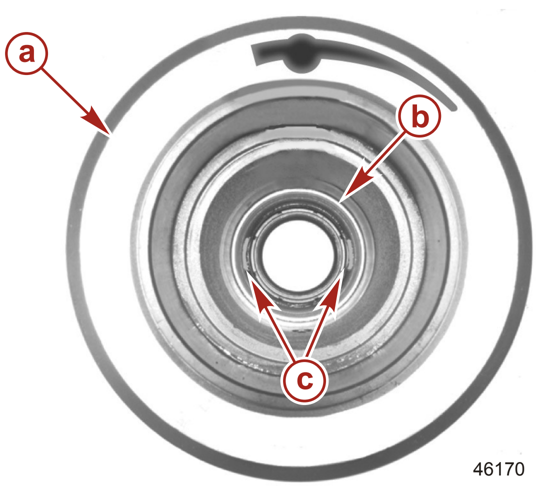
a - Tapered bearing cone
b - Shim
c - Bearing cup
d - Bearing carrier

4. Perform the following step "a" or "b," as necessary.
   a. **If replacing the seals only:** Remove the oil seals with a suitable punch, being careful not to damage the bore of the bearing carrier. Discard both of the seals.



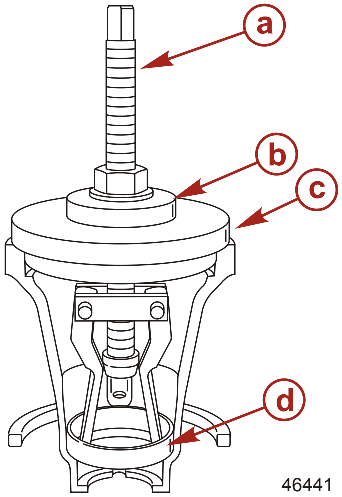
a - Seals

   b. **If replacing the tapered roller bearing and seals:** Remove the seals with a punch as noted above. There are slots cast into the carrier to aid in the removal of the bearing cup with puller jaws.



a - Bearing carrier
b - Bearing cup
c - Slots

c. Remove the tapered bearing cup from the carrier using a bearing puller assembly, pilot washer, and bearing carrier guide plate. Discard the bearing, cup, and both seals.

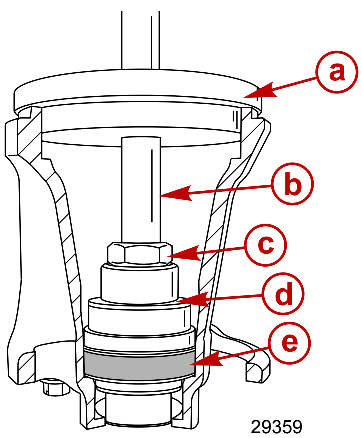


a - Bearing puller assembly
b - Pilot washer
c - Bearing carrier guide plate
d - Bearing cup

Bearing Puller Assembly	91- 83165T
Pilot Washer	91-36571T
Bearing Carrier Guide Plate	91-8M0053084

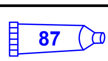
Assembly

1. Clean the components with a suitable solvent and dry the parts thoroughly using compressed air.
2. Lubricate the tapered bearing cup bore with High Performance Gear Lubricant.
3. Assemble the bearing cup onto the driver.
4. Press the bearing cup into the bearing carrier until the cup bottoms out in the bearing carrier.



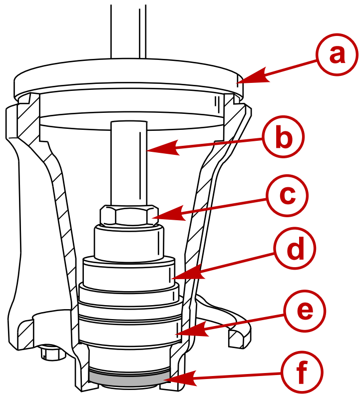
a - Bearing carrier guide plate
b - Driver rod
c - Hex nut
d - Bearing cup driver/oil seal installer
e - Tapered bearing cup

Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
Bearing Carrier Guide Plate	91-8M0053084
Bearing Removal and Installation Kit	91- 31229A 7

Tube Ref No.	Description	Where Used	Part No.
 87	High Performance Gear Lubricant	Tapered bearing cup bore	92-858064K01

5. Thoroughly clean the bore in which the first seal is to be pressed.
6. Assemble the first seal, with the lips of the seal facing away from the driver shoulder, onto the long end of the oil seal driver.
7. Apply Loctite 380 to the outside diameter of the oil seal.

8. Press on the oil seal with the driver until the driver bottoms out on the bearing cup.



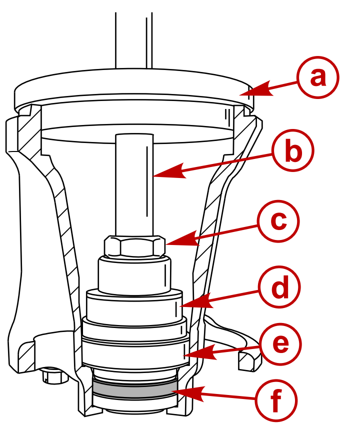
29357

- a - Bearing carrier guide plate
- b - Driver rod
- c - Hex nut
- d - Bearing cup driver/oil seal installer
- e - Bearing cup
- f - Oil seal (first)

Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
Bearing Carrier Guide Plate	91-8M0053084
Bearing Removal and Installation Kit	91- 31229A 7

Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outside diameter of bearing carrier oil seal	Obtain Locally

9. Assemble the second seal, with the lips of the seal facing the driver shoulder, onto the short end of the driver seal.
10. Apply Loctite 380 to the outside diameter of the seal.
11. Press on the oil seal with the driver until the driver bottoms out on the bearing cup.



29358

- a - Bearing carrier guide plate
- b - Driver rod
- c - Hex nut
- d - Bearing cup driver/oil seal installer
- e - Bearing cup
- f - Oil seal (second)

Bearing Carrier Guide Plate	91-8M0053084
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
Bearing Removal and Installation Kit	91- 31229A 7

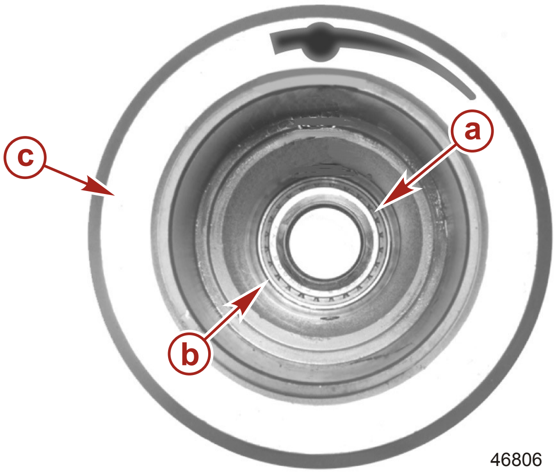
Tube Ref No.	Description	Where Used	Part No.
134	Loctite 380	Outside diameter of oil seals	Obtain Locally

12. Lubricate the seal lips and fill the area between the seals with 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal lips and between oil seals	92-802859A 1

NOTE: The shim above the tapered bearing cone should be installed on the propeller shaft to prevent loss. However, without the propeller shaft installed in the bearing carrier, the tapered bearing cone may fall out of alignment.

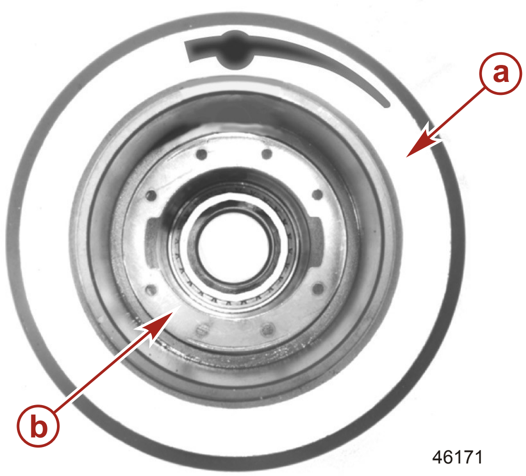
13. Install the propeller shaft tapered bearing cone into the bearing carrier.



a - Tapered roller bearing cone
b - Bearing cup
c - Bearing carrier

IMPORTANT: Do not install a retaining ring that is bent or distorted.

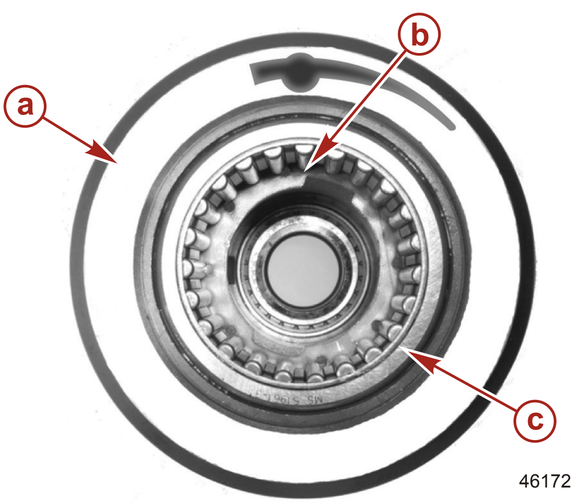
14. Press the retaining ring into the bearing carrier using a retaining ring installation tool.



a - Bearing carrier
b - Retaining ring

Retaining Ring Installation Tool	91-8M0053153

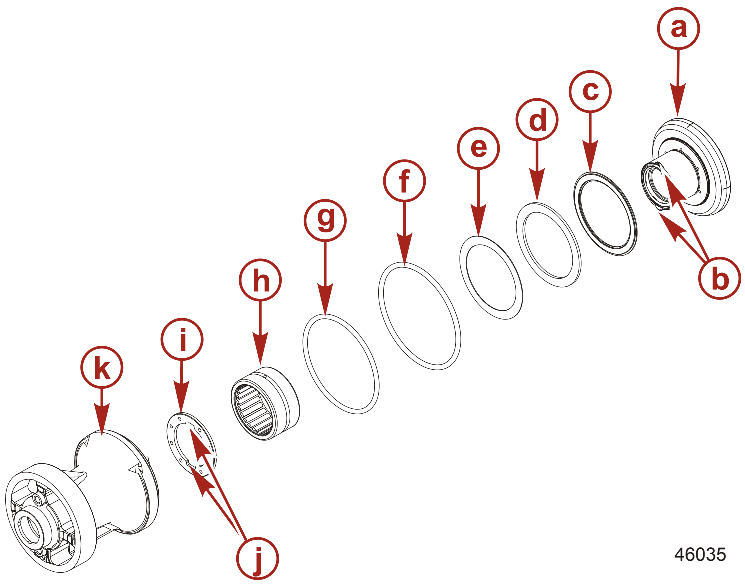
15. Apply High Performance Gear Lubricant to the outside surface of a new rear gear roller bearing. Lubricate the bore that the bearing is pressed into with High Performance Gear Lubricant.
16. Use a mandrel to press the new roller bearing with numbers/letters facing up into the bearing carrier. The bearing should be flush with the bearing carrier surface when properly seated.



a - Bearing carrier
b - Retaining ring
c - Roller bearing

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Outside surface of the rear gear roller bearing and the rear gear bearing bore in the carrier	92-858064K01

17. Lubricate the O-ring with 2-4-C with PTFE.
18. Install the O-ring, thrust ring, shim, thrust bearing race, and thrust bearing onto the bearing carrier. Install the rear gear into the bearing carrier by aligning the tabs on the rear gear with the slots in the retaining ring.



46035

a - Rear gear
b - Tabs
c - Thrust bearing
d - Thrust bearing race
e - Shim
f - Thrust ring
g - O-ring
h - Rear gear roller bearing (previously pressed into bearing carrier)
i - Retaining ring (previously installed into bearing carrier)
j - Slots
k - Bearing carrier

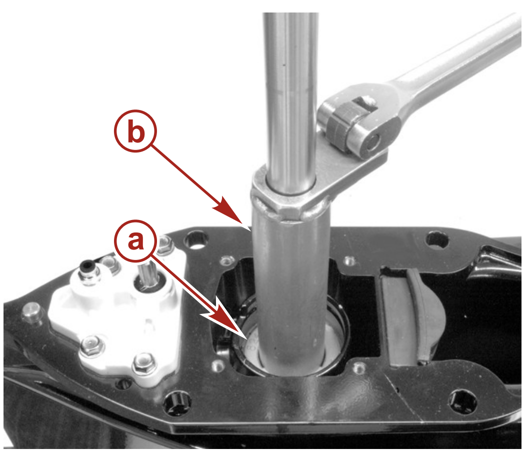
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring	92-802859A 1

19. Rotate the rear gear 90° after installing the gear into the retaining ring.

Driveshaft Removal, Inspection, Disassembly, and Assembly

Driveshaft Removal

1. Remove the driveshaft bearing retainer with the driveshaft bearing retainer wrench.



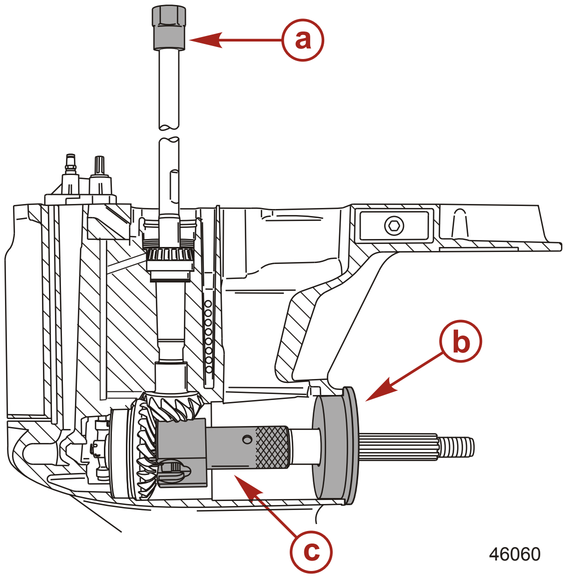
46049

a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

2. Install the driveshaft holding tool onto the driveshaft.
3. Insert the pinion nut wrench into the gear housing with the slot facing the pinion gear. It may be necessary to lift and rotate the driveshaft to align the pinion gear nut into the pinion nut wrench.
4. Install the propeller shaft holder over the propeller shaft and into the gear housing to maintain the pinion nut wrench alignment.

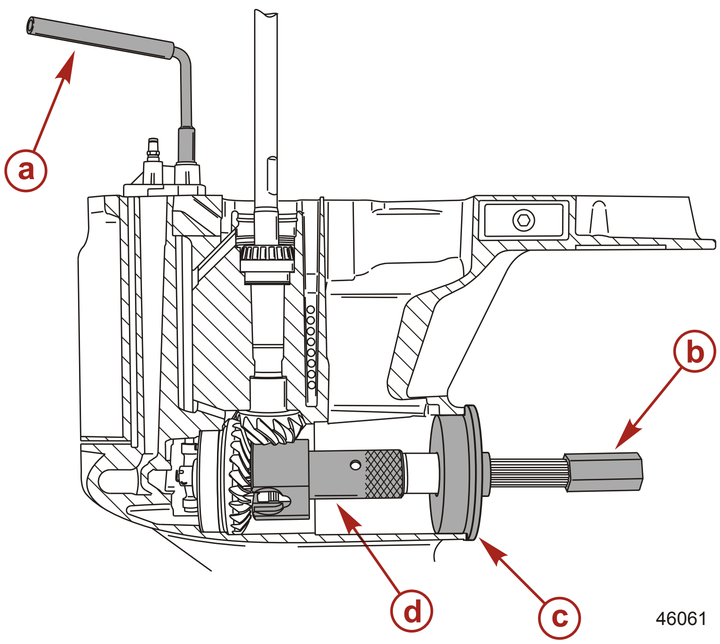
5. Use the driveshaft holding tool to loosen the pinion nut.



a - Driveshaft holding tool
b - Propeller shaft holder
c - Pinion nut holding tool

Driveshaft Holding Tool	91-889958T
Pinion Nut Holding Tool	91-8M0036288
Propeller Shaft Holder	91-8M0035594

6. If the driveshaft is broken, place the propeller shaft adapter onto the propeller shaft splines. Hold the shift shaft against the rear gear and loosen the pinion nut by rotating the propeller shaft counterclockwise.

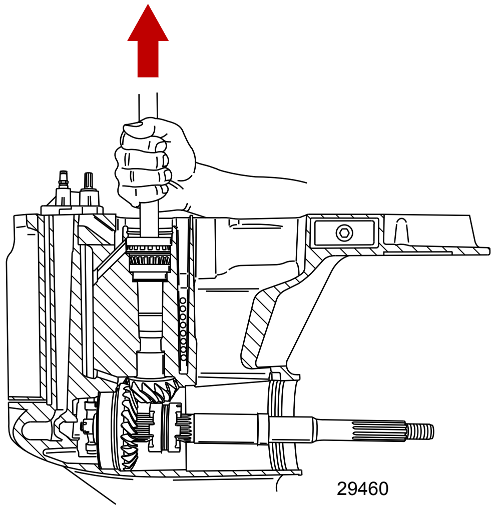


a - Shift shaft handle tool
b - Propeller shaft adapter
c - Propeller shaft holder
d - Pinion nut holding tool

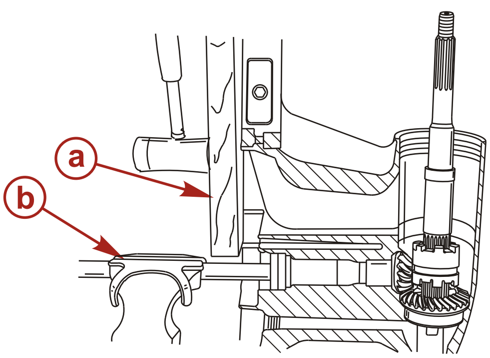
Pinion Nut Holding Tool	91-8M0036288
Propeller Shaft/Driveshaft Adapter	91-61077T
Shift Shaft Handle Tool	91-8M0050615
Propeller Shaft Holder	91-8M0035594

7. Remove all of the tools.

8. Remove the driveshaft by pulling the driveshaft straight out of the gear housing.



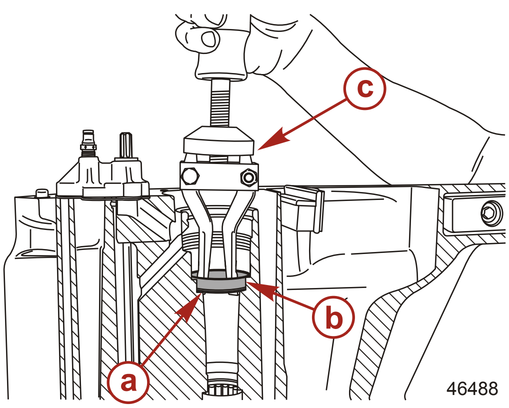
9. If the pinion gear is seized onto the driveshaft, clamp the driveshaft in a soft jaw vise. Place a block of wood on the gear housing mating surface. Use a mallet and carefully tap the gear housing away from the driveshaft.
   IMPORTANT: Striking a gear housing directly with a mallet can distort the gear housing causing gear housing failure.
   IMPORTANT: The pinion bearing rollers can fall out of the pinion bearing race after the driveshaft is removed. Do not lose the 18 rollers.



46161

a - Wood block
b - Driveshaft in soft jaw vise

10. Move the propeller shaft downward to retrieve the pinion gear and nut from inside the gear housing.
11. Remove the driveshaft bearing cup and shims with a slide hammer. Retain the shims for installation.



a - Shims
b - Bearing race
c - Slide hammer puller

Slide Hammer	91-34569A 1

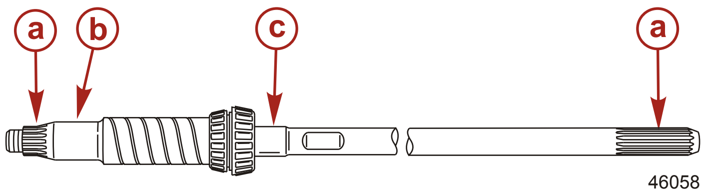
Driveshaft Inspection

1. Clean all parts with a suitable solvent and dry with compressed air. Do not spin the bearings.

⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

2. Inspect the driveshaft bearing cups for pits, grooves, uneven wear, discoloration, or embedded particles. Replace the bearings and bearing cups if any of these conditions are found.
3. Inspect the pinion bearing surface on the driveshaft for pits, grooves, uneven wear, discoloration, or embedded particles. Replace the pinion bearing and the driveshaft if any of these conditions are found.
4. Inspect the splines at both ends of the driveshaft for a worn or twisted condition. Replace the driveshaft if any of these conditions are found.
5. Inspect the water pump base oil seals contact of the driveshaft for grooves. Replace the driveshaft if grooves are found.



a - Splines
b - Pinion bearing surface
c - Seal surface

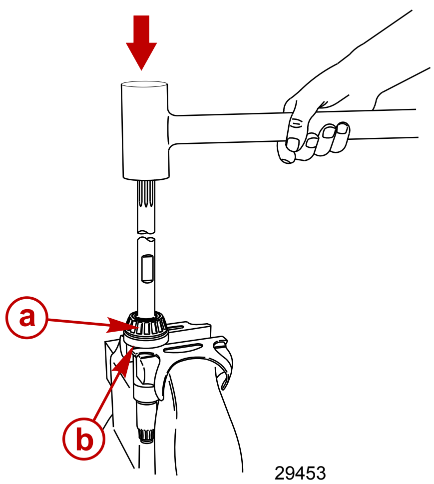
6. Inspect the pinion gear for pits, chipped or broken teeth, fractures, and excessive or uneven wear. Replace the pinion gear and the forward gear as a set if any of these conditions are found.

Driveshaft Disassembly

NOTE: Do not remove the tapered roller bearings from the driveshaft unless replacement is required. The bearings cannot be reused after removal.

NOTE: If one of the driveshaft tapered roller bearings is damaged, both tapered bearings must be replaced as a set.

1. Use the lower bearing cup removed from the gear housing and place the cup on top of a vise, leaving the vise jaws open to allow the driveshaft to slide through.
2. Hold onto the driveshaft and tap on the top of the shaft with a dead blow hammer. Do not drop the driveshaft.

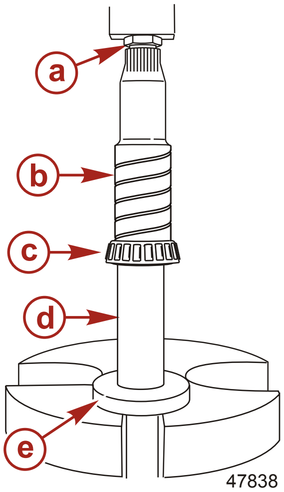


a - Upper and lower bearings
b - Lower bearing cup

Driveshaft Assembly

1. Apply High Performance Gear Lubricant on the inside diameter of the driveshaft bearings.
2. Install the lower tapered roller bearing to the driveshaft, with the small outside diameter of the bearing facing towards the pinion gear end of the driveshaft.
3. Thread a used pinion nut onto the end of the driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. The driveshaft threads must not extend beyond the nut or thread damage will result when pressing the bearing on.

4. Press the lower bearing onto the driveshaft with the driveshaft bearing installation tool.



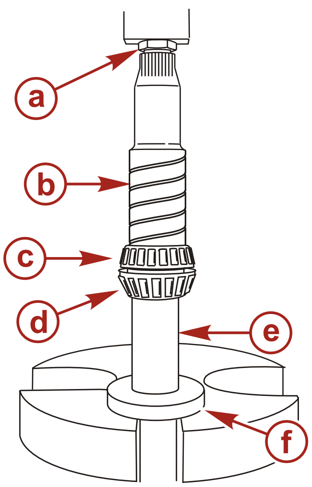
47838

a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Driveshaft bearing installation tool
e - Flat washer (obtain locally)

Driveshaft Bearing Installation Tool	91-8M0052590

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of the driveshaft tapered bearings	92-858064K01

5. Install the upper bearing onto the driveshaft, with the large outside diameter of the bearing facing the pinion gear end of the driveshaft.
6. Press the upper bearing onto the driveshaft with the driveshaft bearing installation tool.



47836

a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing
d - Upper driveshaft tapered bearing
e - Driveshaft bearing installation tool
f - Flat washer (obtain locally)

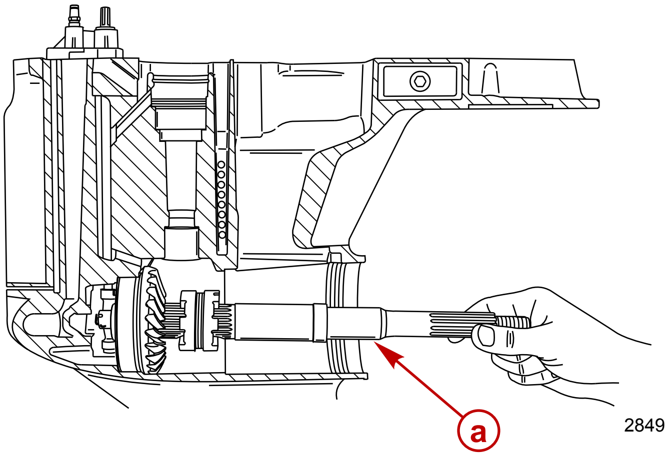
Driveshaft Bearing Installation Tool	91-8M0052590

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of the driveshaft tapered bearings	92-858064K01

Propeller Shaft Assembly and Front Gear Bearing Cup

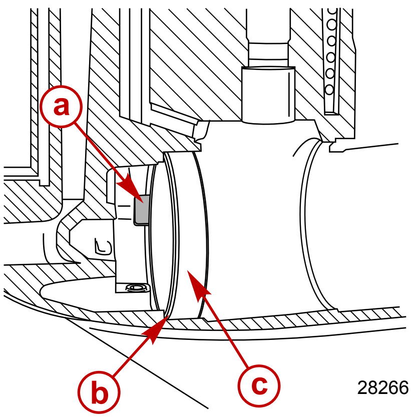
Removal

1. On right-hand rotation gear housings, tilt the propeller shaft to the starboard side of the gear housing and remove the shaft. On left-hand rotation gear housings, tilt the propeller shaft to the port side of the gear housing and remove the shaft.



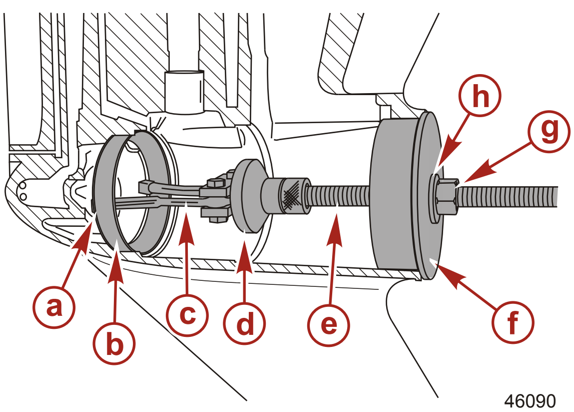
a - Propeller shaft

2. Two notches are provided, in the gear housing just forward of the front gear bearing cup, to position the puller jaws for easier removal of the bearing cup and shims.



a - Notches
b - Shims
c - Front gear bearing cup

3. Remove the front gear bearing cup and shims. Measure and make note of the shim thickness. If shims are not damaged, they may be reused.



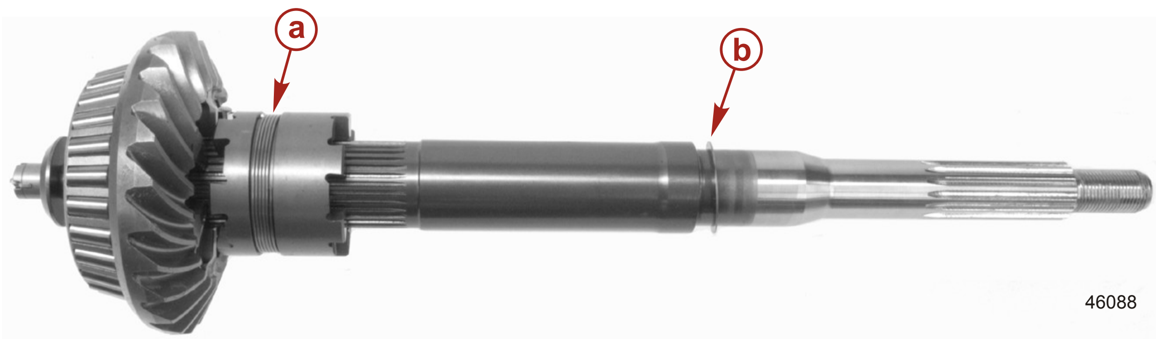
a - Shims
b - Bearing cup
c - Jaws (from slide hammer puller kit)
d - Puller head (from slide hammer puller kit)
e - Puller shaft
f - Propeller shaft holder
g - Nut
h - Washer

Slide Hammer	91-34569A 1
Bearing Removal and Installation Kit	91- 31229A 7
Propeller Shaft Holder	91-8M0035594

Component Disassembly

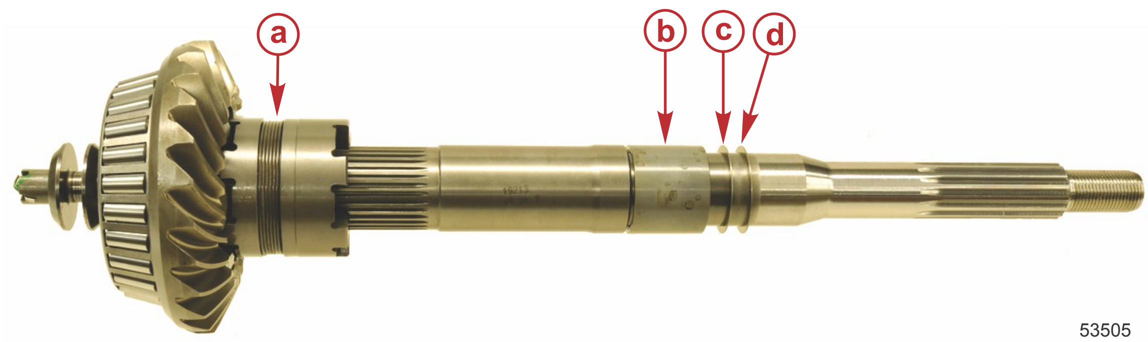
NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a workbench to ensure the parts are not dropped or damaged, and to avoid personal injury.

1. Remove the propeller shaft shims and thrust spacer (design II.)
2. Remove the spring around the clutch, being careful not to overstretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.



Design I

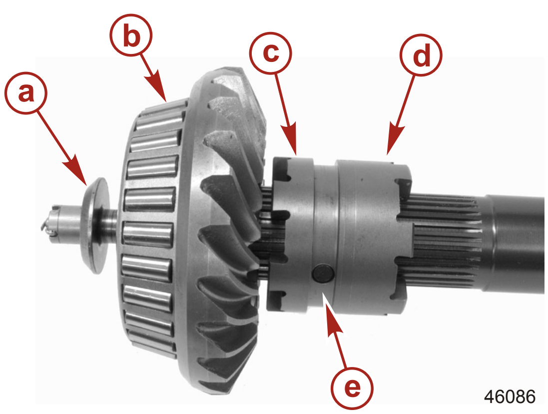
a - Spring
b - Shim



Design II

a - Spring
b - Thrust spacer
c - Shim
d - Thin shim (if required)

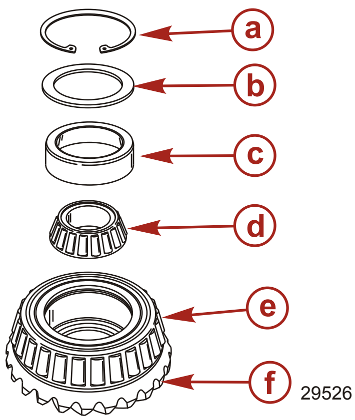
3. Remove the cross pin that goes through the clutch.
4. Remove the remainder of the components.



a - Shift spool and actuating shaft assembly
b - Front gear assembly
c - Clutch
d - Long end of clutch (faces toward rear gear)
e - Cross pin

Inspection

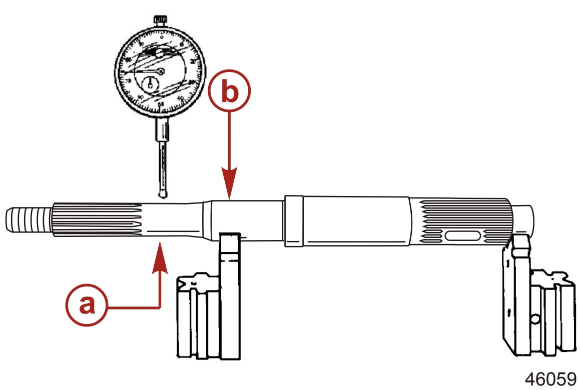
1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.
3. The propeller shaft utilizes two tapered roller bearing and cup assemblies for propeller shaft support. One tapered bearing is just forward of the bearing carrier seals. The rear gear assembly must be removed from the bearing carrier to gain access to this bearing for inspection. The other tapered bearing is located inside the front gear assembly. The front gear assembly must be removed from the propeller shaft and a snap ring retainer and flat washer removed from the front gear assembly to gain access to this tapered bearing for inspection.



a - Snap ring
b - Flat washer
c - Tapered bearing cup
d - Tapered bearing cone
e - Front gear bearing cone
f - Front gear

NOTE: The front gear bearing should not be removed from the front gear unless replacement is necessary. The bearing is not reusable if the bearing is removed.

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exist.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.
6. Inspect the propeller shaft for a bent condition using V-blocks and a dial indicator.
   a. Position the propeller shaft bearing surfaces on the V-blocks.
   b. Adjust the height of the V-blocks to level the propeller shaft.
   c. Position the dial indicator tip just forward of the propeller shaft splines.
7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.23 mm (0.009 in.), replace the propeller shaft.



a - Check movement with dial indicator here
b - Seal surface area

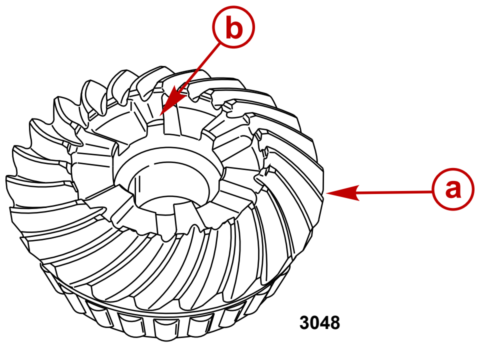
Propeller Shaft	
Runout	0.23 mm (0.009 in.)

Dial Indicator	91- 58222A 1

Front Gear Assembly

Component Inspection

1. Clean the front gear assembly and the front gear bearing cup with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pits, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the front gear and the pinion gear as a set if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. Replace both the front gear and pinion gear as a set if any of these conditions exist.



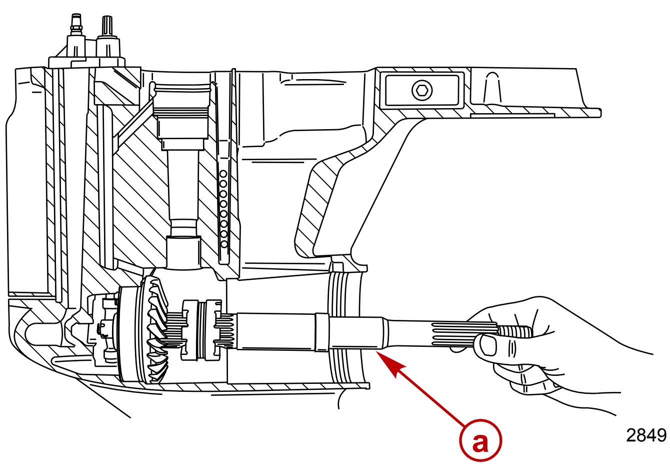
a - Front gear teeth
b - Clutch jaws

4. Inspect the propeller shaft tapered roller bearing on the inside of the front gear and its respective bearing cup. If either the bearing or the bearing cup surface is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, remove and replace the tapered roller bearing assembly.
5. Inspect the tapered roller bearing pressed onto the front gear and the bearing surface on the front gear bearing cup. If either the roller bearing or the bearing surface of the front gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the front gear bearing cup and remove and replace the tapered roller bearing.

Disassembly

NOTE: The front gear and propeller shaft assembly can only be removed from the gear housing after the driveshaft and pinion gear have been removed.

1. On right-hand rotation gear housings, tilt the propeller shaft to the starboard side of the gear housing and remove the propeller shaft and gear assembly. On left-hand rotation gear housings, tilt the propeller shaft to the port side of the gear housing and remove the propeller shaft and gear assembly.

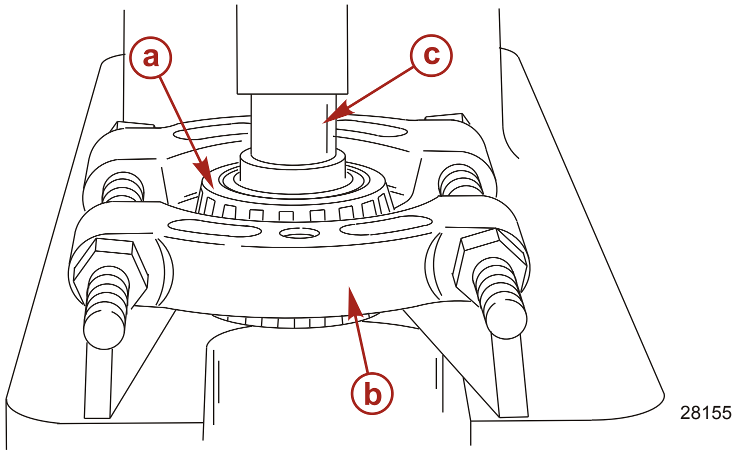


a - Propeller shaft

IMPORTANT: Do not remove the pressed on tapered roller bearing from the front gear unless replacement of the bearing is required. The bearing cannot be reused after it has been removed.

2. If inspection determines that replacement of the front gear tapered bearing is required, separate the gear from the bearing as follows:
   a. Install the universal puller plate between the front gear and the tapered bearing.
   b. Place the assembly on a press and press the gear out of the bearing with a suitable mandrel.

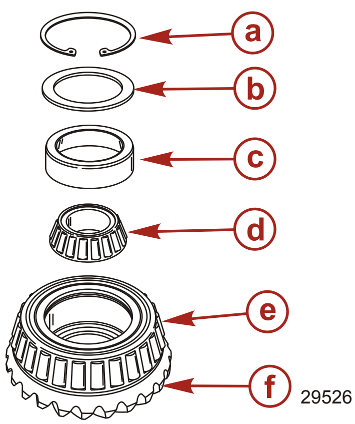
NOTE: The tapered bearing and race must be replaced as a set.



a - Front gear bearing
b - Universal puller plate
c - Mandrel

Universal Puller Plate	91-37241

3. If inspection determines that replacement of the propeller shaft tapered roller bearing is required, remove the bearing as follows:
   a. Clamp the front gear securely in a soft jaw vise.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.
   b. Use snap ring pliers to remove the snap ring. Remove the tapered roller bearing assembly out of the inside of the front gear.



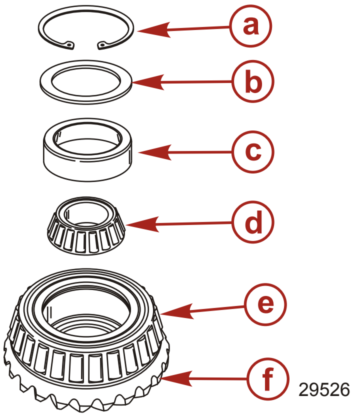
a - Snap ring
b - Flat washer
c - Tapered bearing cup
d - Tapered bearing cone
e - Front gear bearing cone
f - Front gear

Assembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Apply High Performance Gear Lubricant to the I.D. of the front gear. Push the tapered roller bearing assembly into the front gear until the bearing seats.
   IMPORTANT: Use suitable eye protection when removing or installing the snap ring.

2. Install the snap ring into the groove of the front gear to secure the tapered roller bearing assembly.



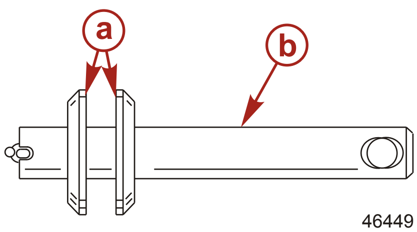
a - Snap ring
b - Flat washer
c - Tapered bearing cup
d - Tapered bearing cone
e - Front gear bearing cone
f - Front gear

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of front gear	92-858064K01

Shift Spool Assembly

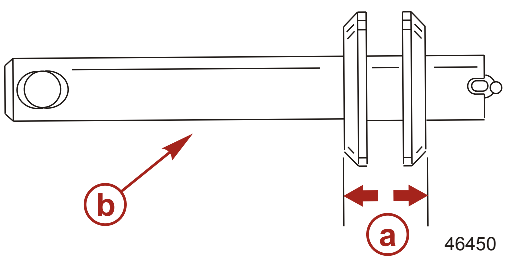
Inspection

1. Clean the assembly with solvent and dry all parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, replace the complete shift spool assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



a - Contact area
b - Nonratcheting shift spool

4. Verify the spool spins freely.
5. Verify the spool has end play. The end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



a - End play
b - Shift spool

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

Disassembly

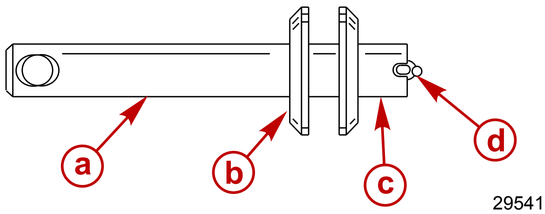
NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, replace the shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.

Reassembly

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the spool and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If the castle nut is threaded down and the cotter pin slot is already aligned at the hole in the shift spool shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend the ends of the cotter pin in opposite directions.
5. Verify the spool has end play. If it does not, adjust the castle nut again.



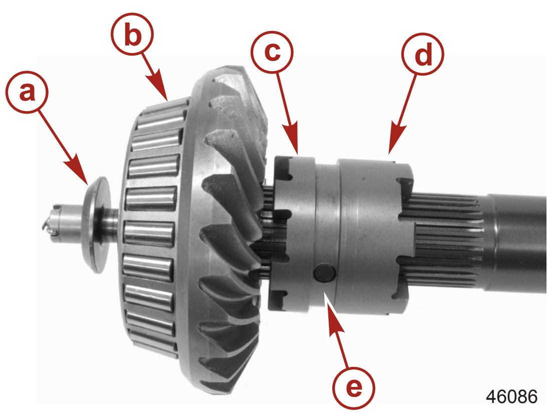
a - Shift shaft
b - Spool
c - Castle nut
d - Cotter pin

Shift Spool	
End play	0.05–0.25 mm (0.002–0.010 in.)

6. If this adjustment did not produce the desired results, it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned, replace the shift spool assembly.

Propeller Shaft Assembly

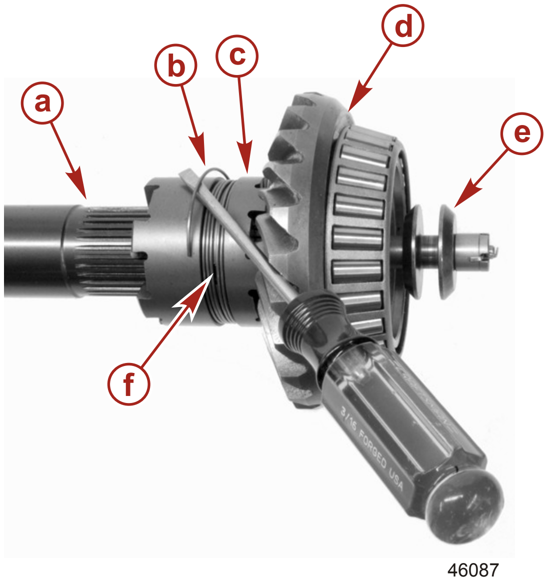
1. Install the sliding clutch, with the long end of the clutch facing toward the rear gear, onto the propeller shaft. Align the cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the front gear assembly to the propeller shaft.
3. Assemble the shift spool assembly into the propeller shaft, making sure the cross pin hole of the shift spool shaft is aligned with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft, and through the shift spool shaft hole.



a - Shift spool and actuating shaft assembly
b - Front gear assembly
c - Clutch
d - Long end of clutch (facing toward the rear gear)
e - Cross pin

5. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort or stretch the spring while assembling it.

IMPORTANT: Verify the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.



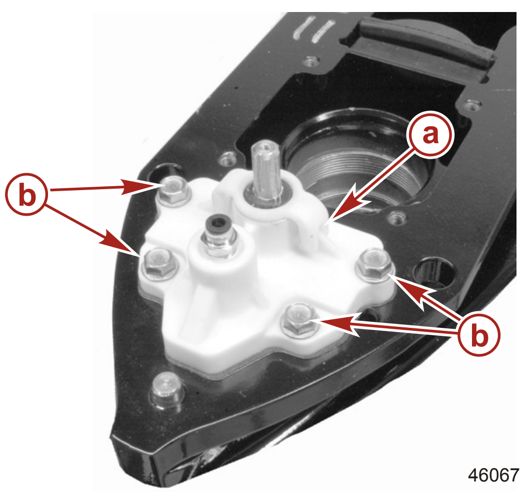
a - Propeller shaft
b - Cross pin retaining spring
c - Sliding clutch
d - Front gear assembly
e - Shift spool and actuating shaft assembly
f - Cross pin (hidden)

Shift Shaft Cover Assembly

Removal

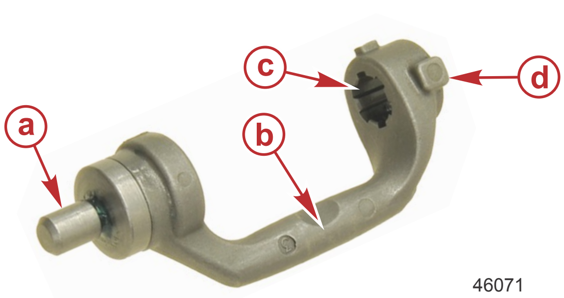
NOTE: It is possible to remove and service the shift shaft assembly without removing any of the internal components of the gear housing.

1. Remove the shift shaft cover screws. Remove the shift shaft and cover assembly from the gear housing.



a - Shift shaft cover assembly
b - Shift shaft cover screws

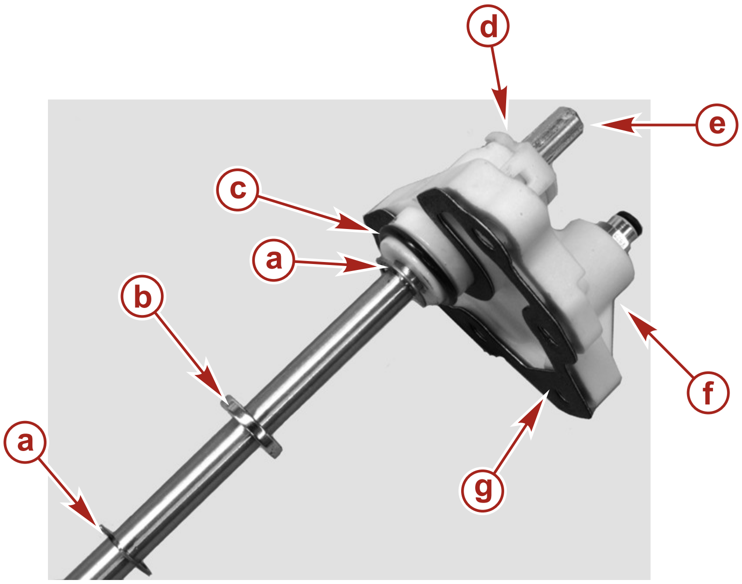
2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect for wear in the areas that contact the shift spool and inspect the splines and the pivot pin for damage or wear.



a - Pivot pin
b - Contact area
c - Splines
d - Locating tab

Disassembly and Inspection

1. Slide the cover assembly off the shift shaft.

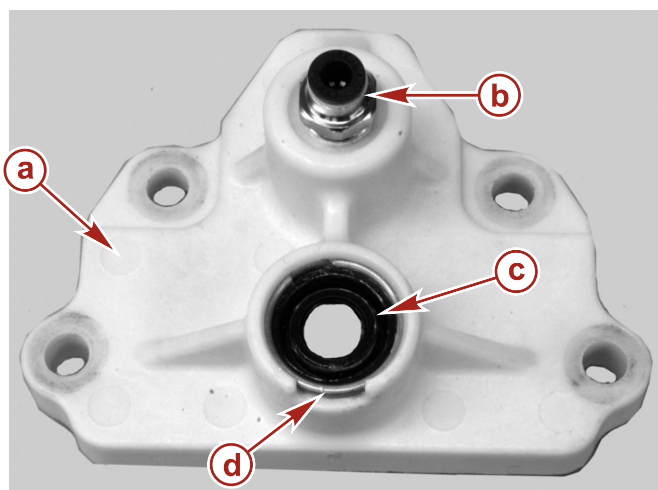


46074

a - E-ring
b - Magnet
c - O-ring
d - Grommet assembly
e - Shift shaft
f - Shift shaft cover
g - Gasket

2. Clean all components with a suitable solvent and dry with compressed air.
   a. Inspect the shift shaft cover for cracking, damage, or excessive wear.
   b. Inspect the oil seal inside the cover and the O-ring on the outside of the bushing for damage or excessive wear.
   c. Inspect the speedometer connector for damage or blockage.
   d. Inspect the speedometer passage through the shift shaft cover for debris.

   NOTE: If any of these conditions exist, replace the appropriate components.

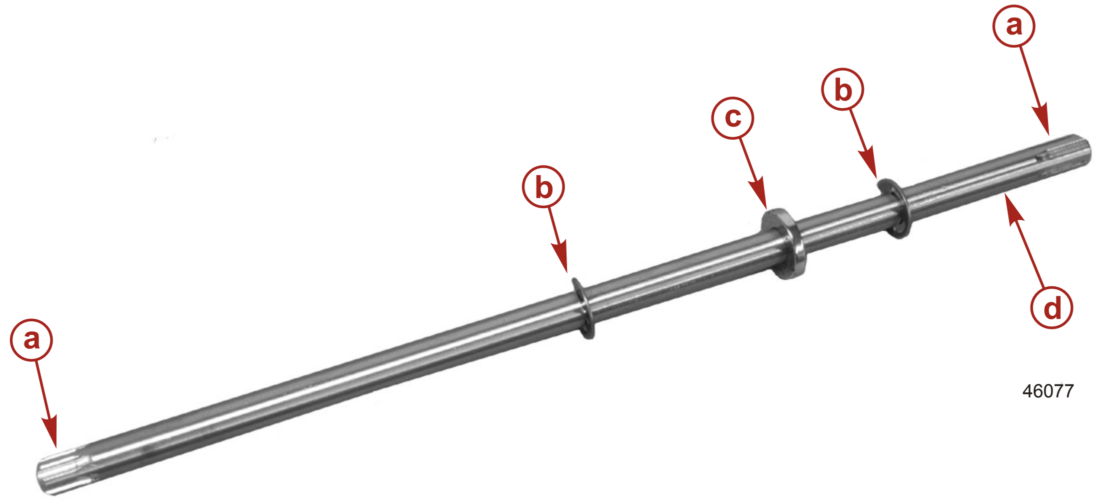


46075

a - Shift shaft cover
b - Speedometer tube connector
c - Oil seal (seal is replaceable)
d - Oil seal retainer ring

3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either of these conditions are found.
4. Inspect the magnet for large metal particles. Small amounts of fine particles is normal. Clean off any metal debris attached to the magnet. The presence of large particles indicates abnormal wear and will require the disassembly and inspection of the gear housing.

NOTE: *The shift shaft magnet will rest against the lower E-ring when the shift shaft is installed in the gear housing.*

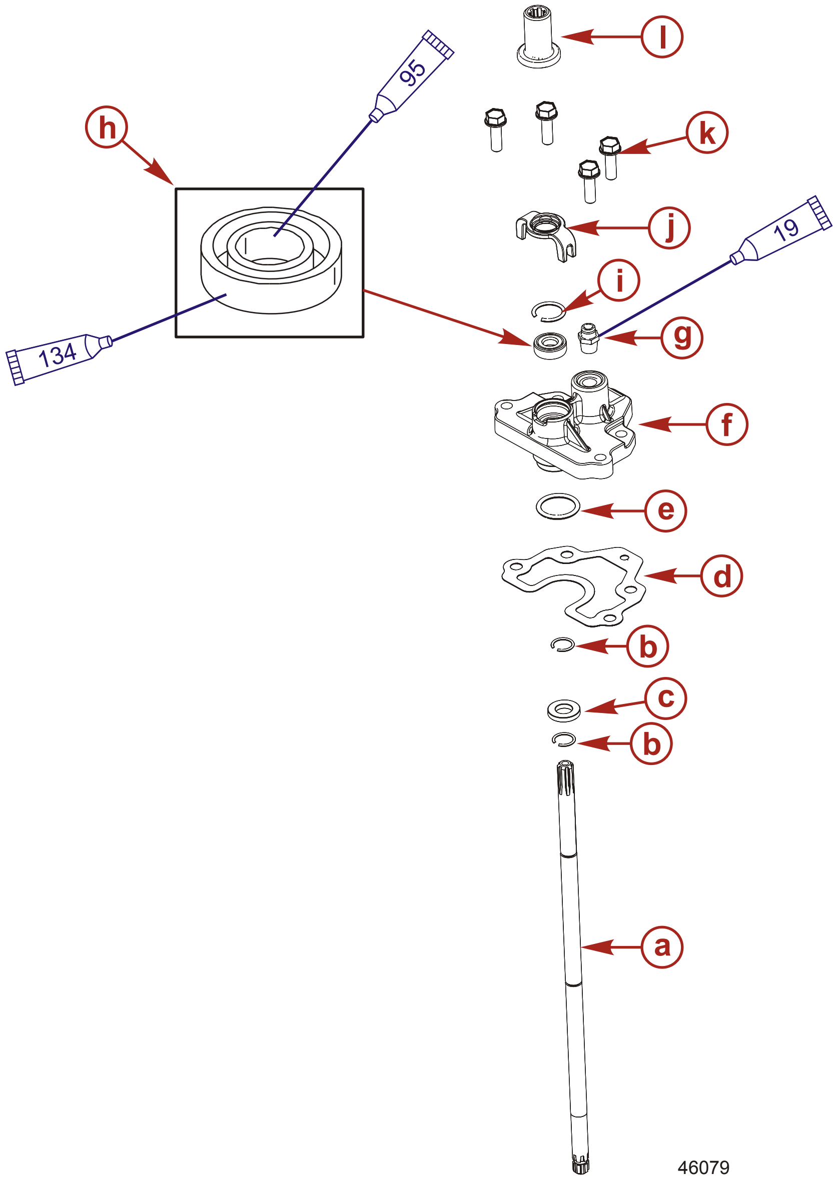


a - Splines
b - E-ring
c - Magnet
d - Seal surface

Assembly

1. Lubricate the O-ring with 2-4-C with PTFE and install onto the shift shaft cover.
2. Apply Loctite 380 to the outside diameter of the oil seal.
3. Install the oil seal with the lips of the seal facing out. Wipe off any excess Loctite after installation.
4. Lubricate the oil seal lips with 2-4-C with PTFE.

5. If the speedometer connector was removed and/or replaced, lightly coat the threads of the connector with Perfect Seal. Assemble the speedometer connector to the cover and torque the connector to specification.



a - Shift shaft
b - E-ring (2)
c - Magnet
d - Gasket
e - O-ring
f - Shift shaft cover
g - Speedometer hose connector
h - Seal (lip faces up)
i - Retaining ring
j - Grommet assembly
k - Screws (4)
l - Coupling

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Speedometer connector threads	92-34227Q02
95	2-4-C with PTFE	Shift shaft bushing O-ring and lip of the oil seal	92-802859A 1
134	Loctite 380	Outside diameter of the oil seal	Obtain Locally

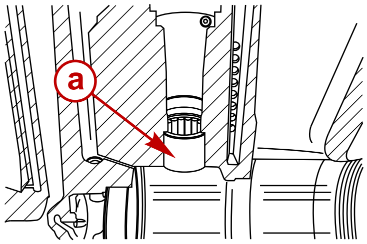
Description	Nm	lb-in.	lb-ft
Speedometer connector	2.8	25	
Shift shaft cover screws (M6 x 20) (4)	6.8	60	

Pinion Bearing Removal

NOTE: Inspect the bearing surface on the driveshaft where the rollers of the lower pinion bearing roll. The condition of the driveshaft at this location gives an indication of the condition of the roller bearing. Replace lower pinion bearing (rollers and race as a set) if the driveshaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.

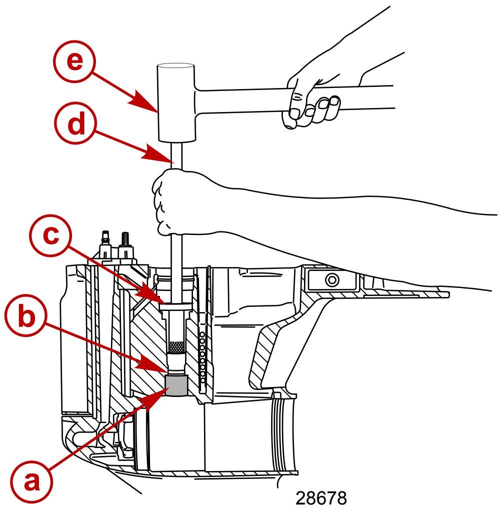
IMPORTANT: All the roller bearings (18) must be in place inside the bearing race while driving the pinion bearing from the gear housing. It is recommended that the cardboard tube provided with a new pinion bearing be used to keep the bearings in place while driving out the old pinion bearing.

IMPORTANT: Do not reuse the bearing race or rollers once they have been removed.



a - Pinion bearing

Remove and discard the pinion bearing race and rollers using the tools as shown.



a - Pinion bearing
b - Driver head
c - Pilot washer
d - Driver rod
e - Dead blow hammer

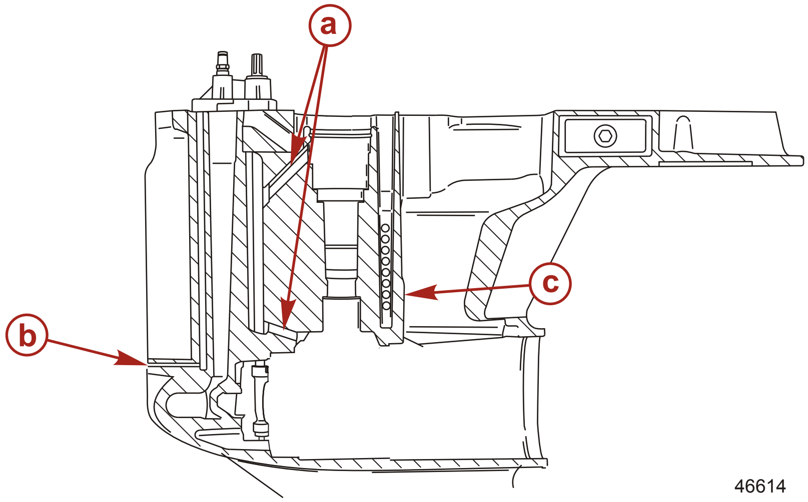
Pinion Bearing Removal Tool	91-8M0046348
Pilot Washer	91-36571T
Driver Rod	91- 37323

Gear Housing Inspection

1. Clean the gear housing with a suitable solvent and a hard bristle brush. Dry the gear housing using compressed air. Ensure all sealants, locking agents, and debris are removed.
2. Verify the two oil circulation holes in the driveshaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact, or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.

   NOTE: The driveshaft bearing cups are a slip fit within the driveshaft bore and may show signs of movement. All other bearing cups are press fit and should not show any signs of movement.
5. Inspect the bearing race/cup contact areas for evidence of the bearing cup spinning. Check that the bearing cups are not loose in the bearing bores. A press fit type bearing bore in which the race/cup is loose will require replacement of the gear housing.

6. Inspect for blockage in the water inlet holes and the speedometer hole and clean as necessary. Be careful not to enlarge the speedometer hole, as this could cause erroneous speedometer readings.



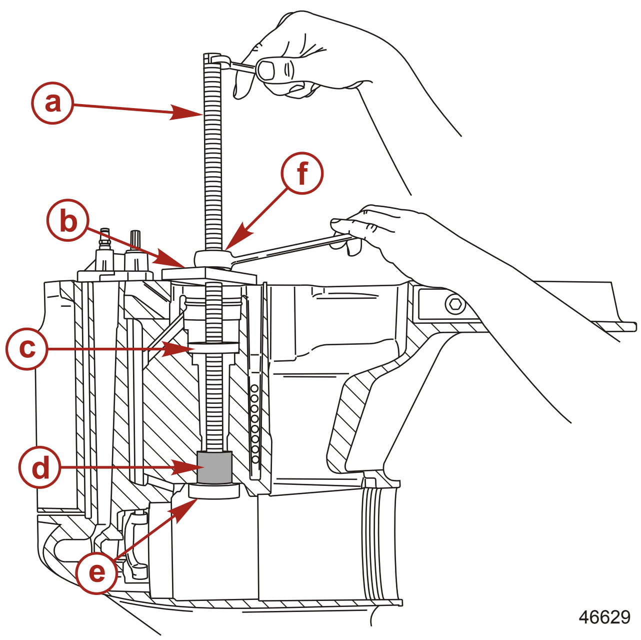
a - Oil circulation holes
b - Speedometer hole
c - Water inlet holes

7. Verify the locating pins are in place in the gear housing and the corresponding holes in the driveshaft housing are not elongated. The driveshaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing Installation

IMPORTANT: Never install a pinion bearing that was removed from a gear housing. Always install a new pinion bearing.

1. Lubricate the gearcase pinion bearing bore with High Performance Gear Lubricant.
2. Install the pinion bearing onto the mandrel so the letter and number side of the bearing faces up.
3. Insert the mandrel and bearing into the gearcase pinion bearing bore.
4. Install the puller plate onto the puller rod and insert the puller rod into the gearcase driveshaft bore. Thread the puller rod into the mandrel.
5. Secure the puller rod and tighten the nut until the mandrel contacts the gearcase.



a - Puller rod
b - Puller plate
c - Pilot
d - Pinion bearing
e - Pinion bearing installation tool
f - Hex nut

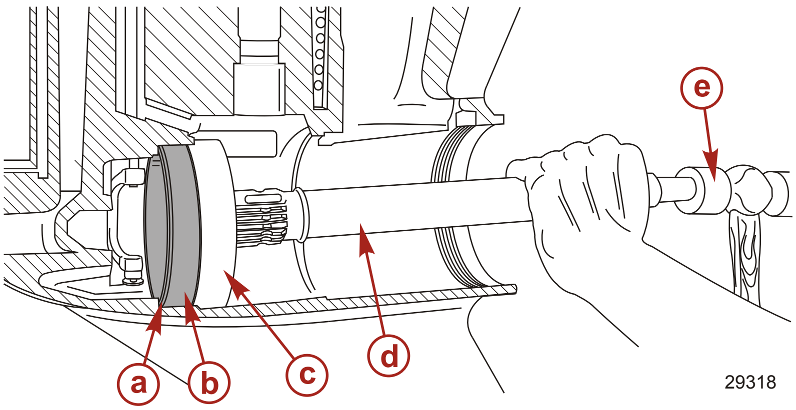
Bearing Removal and Installation Kit	91- 31229A 7
Pinion Bearing Installation Tool	91-8M0046360

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Pinion bearing bore	92-858064K01

Front Gear Bearing Cup Installation

NOTE: If the front gear, front gear bearing and cup, or gear housing were not replaced, install the same measurement of shims that were removed. If the front gear, front gear bearing and cup, or gear housing were replaced, install 0.762 mm (0.030 in.) shims.

1. Lubricate the front gear bearing cup bore with High Performance Gear Lubricant.
2. Install the shims into the front gear bearing cup bore.
   IMPORTANT: Verify the bearing cup is positioned as straight as possible to avoid damaging the bore while pressing the bearing cup in.



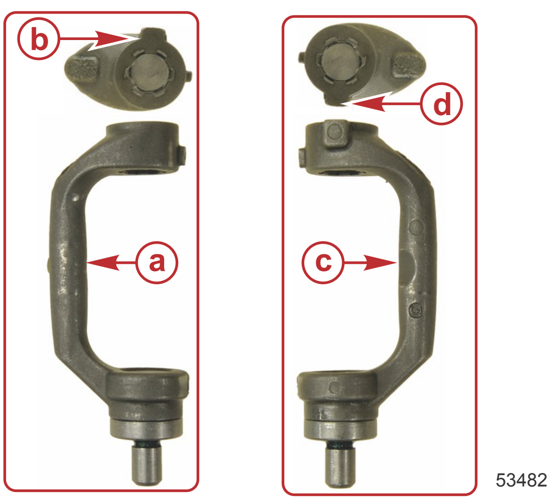
a - Shims
b - Front gear bearing cup
c - Bearing cup driver
d - Propeller shaft (old nonserviceable)
e - Mallet

Bearing Cup Driver	91-885592T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Front gear bearing cup bore	92-858064K01

Shift Shaft Installation

NOTE: The shift crank has a locating tab on it. The locating tab faces aft in right-hand rotation gear housings. The locating tab faces forward in left-hand rotation gear housings.

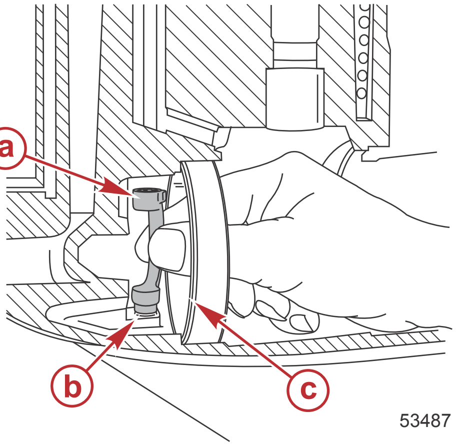


Verado shift crank

a - Left-hand rotation aft view - shift crank toward port
b - Left-hand rotation top view - locating tab facing forward
c - Right-hand rotation aft view - shift crank toward starboard
d - Right-hand rotation top view - locating tab facing aft

Right-Hand and Left-Hand Rotation (5.44 in. Diameter)

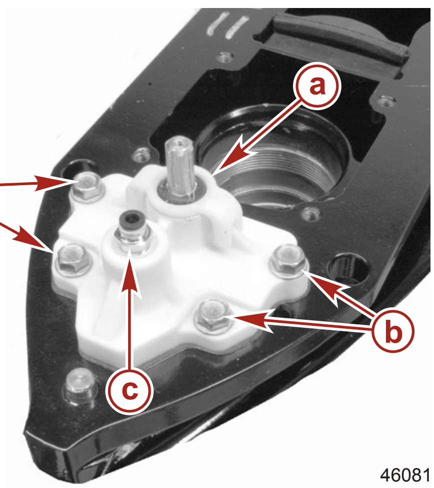
1. Place the shift crank into the pivot pin hole in the forward section of the gear housing. Ensure that the shift crank faces towards the starboard side of the gear housing for right-hand rotation gearcases. Ensure that the shift crank faces toward the port side of the gear housing for left-hand rotation gearcases.



Right-hand rotation shown

a - Shift crank
b - Pivot pin
c - Front gear bearing cup

2. Verify that the O-ring is on the cover and lubricated with 2-4-C with PTFE.
3. Install the shift shaft assembly into the gear housing. Engage the splined end of the shift shaft with the shift crank.
4. Secure the shift shaft cover with four screws. Tighten the screws and the speedometer fitting to the specified torque.
5. Install the retainer assembly onto the shift shaft and slide the retainer assembly down until it touches the oil seal in the cover.



a - Retainer assembly
b - Screws (M6 x 20)
c - Speedometer fitting

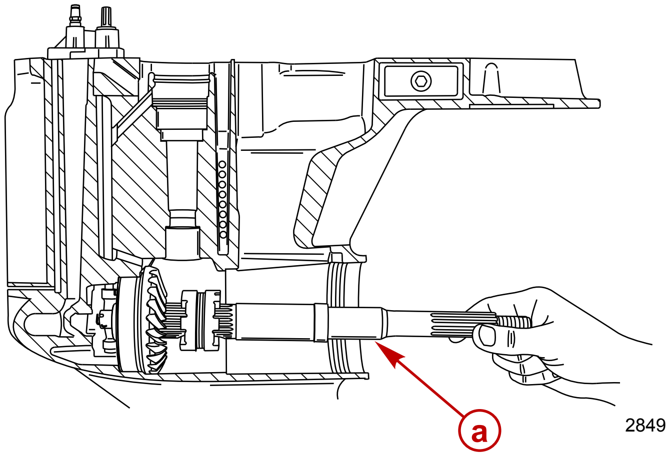
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring	92-802859A 1

Description	Nm	lb-in.	lb-ft
Shift shaft cover screws (M6 x 20)	6.8	60	–
Speedometer fitting	2.8	25	–

Propeller Shaft Installation

NOTE: The shift/clutch assembly should be in the neutral position when installing the propeller shaft.

1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the starboard side of gear housing for right-hand rotation gear housings and to the port side of the gear housing for left-hand rotation gear housings. Hold the shift shaft in neutral while installing the shaft.



a - Propeller shaft

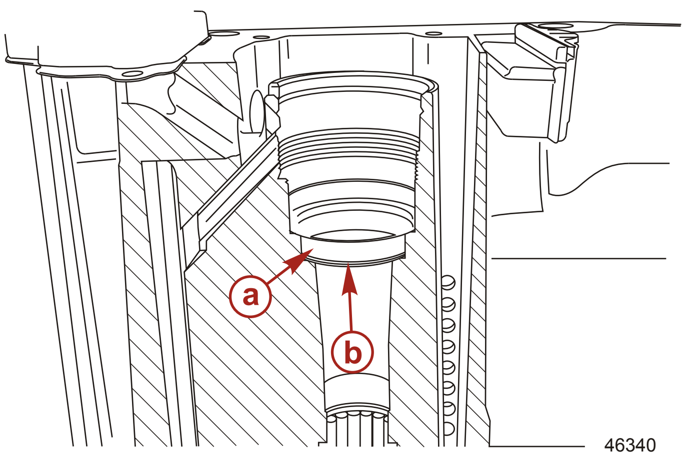
2. Operate the shift shaft to ensure it has been properly installed. The sliding clutch should move forward when the shift shaft is turned counterclockwise. The sliding clutch should move aft when the shift shaft is turned clockwise.

Driveshaft and Pinion Gear Installation

NOTE: If the original shims were not retained, or if the pinion gear, driveshaft, driveshaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.508 mm (0.020 in.) shim for the lower tapered roller bearing.

NOTE: If the original shims were retained or measurement known, and none of the above listed parts were replaced, install the same shims or same amount of shims.

1. Place the lower tapered bearing shims into the driveshaft housing bore.
2. Install the lower tapered bearing cup into the driveshaft housing bore.



a - Tapered bearing cup
b - Shims

3. Apply Loctite 271 Threadlocker to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

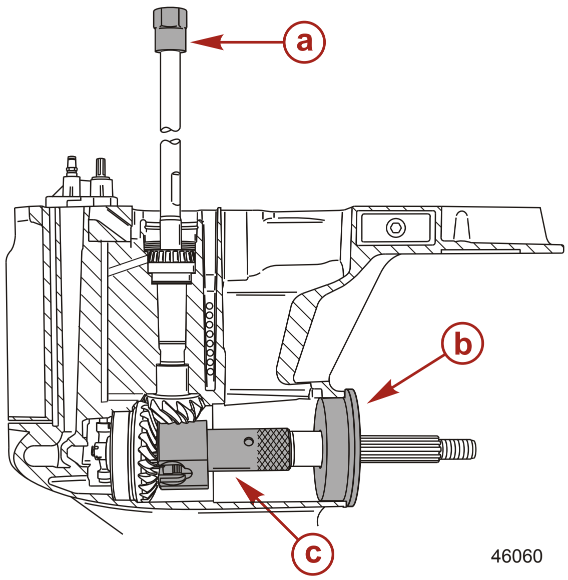
NOTE: For ease of installation, glue the washer (design II only) to the pinion gear using 3M Adhesive, or Bellows Adhesive, or equivalent.

Tube Ref No.	Description	Where Used	Part No.
27	Bellows Adhesive	Driveshaft pinion gear washer	92-86166Q1

***NOTE:** If the backlash has to be changed, it is recommended that Loctite 271 Threadlocker not be applied to the pinion nut until the backlash setting is finalized. Do not reuse the old pinion nut. Install a new pinion nut after backlash is finalized.*

a. Design II: Place the pinion gear and washer into the gear housing.
b. Design I: Place the pinion gear into the gear housing.

4. With the propeller shaft horizontal, insert the pinion nut holding tool with the nut into the gear housing.
5. Insert the driveshaft into the gear housing driveshaft bore. It may be necessary to rotate the driveshaft to engage the driveshaft splines into the pinion gear splines.
6. Start the pinion nut onto the driveshaft threads by rotating the driveshaft until the nut is snug.
7. Install the propeller shaft holder into the gear housing to hold the propeller shaft and the pinion nut holding tool in position.
8. Tighten the pinion nut to the specified torque by turning the driveshaft using the driveshaft holder and torque wrench.



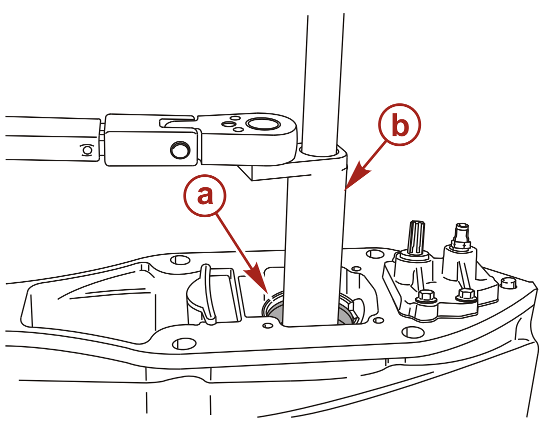
46060

a - Driveshaft holding tool
b - Propeller shaft holder
c - Pinion nut holding tool

Driveshaft Holding Tool	91-889958T
Pinion Nut Holding Tool	91-8M0036288
Propeller Shaft Holder	91-8M0035594

Description	Nm	lb-in.	lb-ft
Pinion nut (design II, with washer)	169.5	–	125
Pinion nut (design I, no washer)	101.7	–	75

9. Install the upper driveshaft tapered roller bearing shim.
10. Install the upper driveshaft tapered roller bearing cup. Apply 2-4-C with PTFE to the retainer threads and install the retainer. Tighten the retainer to the specified torque.



29353

a - Retainer
b - Driveshaft bearing retainer wrench

Driveshaft Bearing Retainer Wrench	91-43506T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Retainer threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Retainer	135.5	–	100

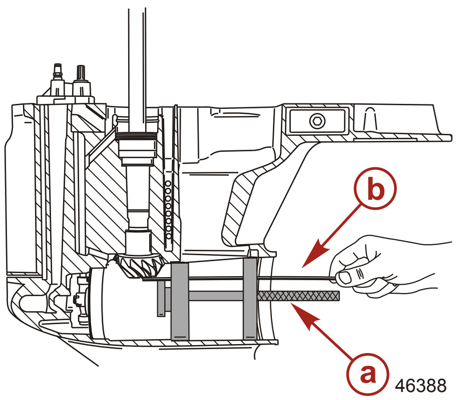
11. Remove the propeller shaft holder, pinion nut holding tool, and driveshaft bearing retainer wrench.
12. Check the driveshaft rolling torque. Units correctly assembled to this point would show a driveshaft rolling torque of 0.3–0.9 Nm (3–8 lb-in.). If the driveshaft rolling torque is not within specification, the shim under the upper tapered roller bearing cup will need to be changed and the driveshaft rolling torque rechecked. If the driveshaft rolling torque is too high, add shims under the upper bearing cup. If the driveshaft rolling torque is too low, remove shims from under the upper bearing cup.

Pinion Gear Height

Checking and Adjusting using Pinion Gear Locating Tool 91-8M0046443

NOTE: The front gear assembly, propeller shaft, and bearing carrier must be removed from the gear housing prior to checking the pinion gear height.

1. Place the pinion gear locating tool into the gear housing, aligning the window in the tool with the pinion gear.
2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and the high point of the shimming tool.



a - Pinion gear locating tool
b - Feeler gauge

Pinion Gear Locating Tool	91-8M0046443

3. Rotate the driveshaft 120° in a clockwise direction and measure the clearance.
4. Repeat this process until three measurements have been taken.
5. Add the three measurements together and divide the sum by three to get the average pinion gear clearance. Make note of this average measurement.

Pinion Gear Specification	
Clearance	0.635 mm (0.025 in.)

6. If the average pinion gear clearance is not within specification, add or subtract shims below the lower driveshaft tapered bearing cup.
   IMPORTANT: If the pinion height needs to be adjusted, the driveshaft rolling torque will be affected. The amount of shims added or subtracted to obtain the correct pinion height will correspond to the amount of shims required to obtain the correct driveshaft rolling torque.
7. Install the removed components and tighten the retainer to the specified torque.

Description	Nm	lb-in.	lb-ft
Retainer	135.5		100

8. Rotate the driveshaft three turns in a clockwise direction and check the pinion gear clearance. If the pinion gear clearance is not within specification, adjust the shim thickness and repeat this process until the average pinion gear clearance is within specification.

Front Gear Backlash

Front Gear Backlash Specification Right-Hand Rotation	
1.75:1 ratio	0.533 mm (0.021 in.)
1.85:1 ratio	0.584 mm (0.023 in.)

Front Gear Backlash Specification Left-Hand Rotation	
1.75:1 ratio	0.838 mm (0.033 in.)
1.85:1 ratio	0.914 mm (0.036 in.)

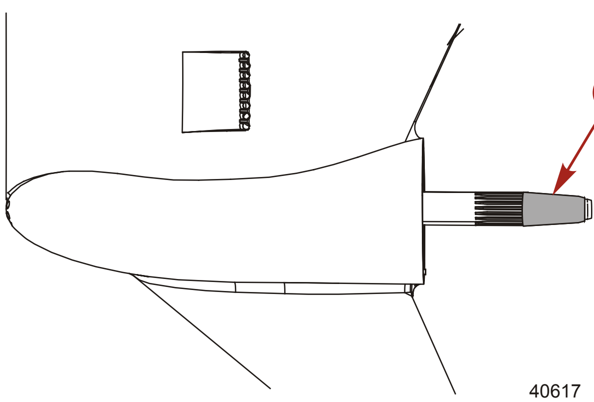
The following tables show examples of adjusting the backlash.

Example 1 (if backlash is too high)	
Front gear backlash measurement:	1.02 mm (0.040 in.)
Subtract the front gear backlash specification:	0.56 mm (0.022 in.)
Add this quantity of shims:	0.46 mm (0.018 in.)
Provides backlash of:	0.56 mm (0.022 in.)

Example 2 (if backlash is too low)	
Front gear backlash specification:	0.56 mm (0.022 in.)
Subtract the front gear backlash measurement:	0.25 mm (0.010 in.)
Remove this quantity of shims:	0.31 mm (0.012 in.)
Provides backlash of:	0.56 mm (0.022 in.)

NOTE: The pinion gear clearance must be within specifications before checking front gear backlash.

1. Install the propeller shaft tapered roller bearing shim onto the propeller shaft.
   IMPORTANT: Prior to installing the bearing carrier into a gearcase utilizing the heavy-duty 31.75 mm (1.25 in.) diameter propeller shaft, install the bearing carrier installation tool over the propeller shaft. This tool will protect the bearing carrier seal lips from being damaged by the propeller shaft splines. Remove the tool after the bearing carrier is installed.

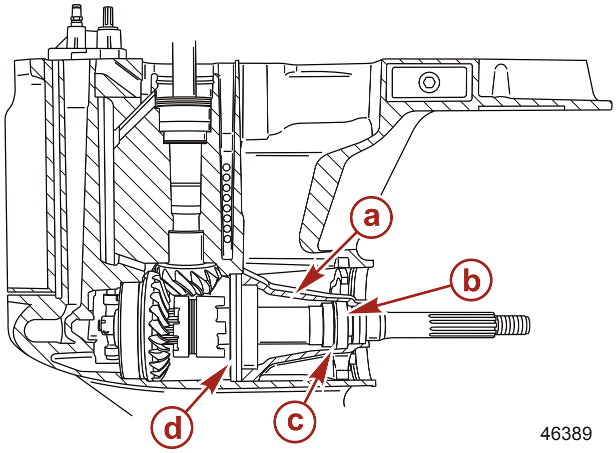


a - Bearing carrier installation tool

Bearing Carrier Installation Tool	91-840388

2. Place the bearing carrier assembly into the gear housing. Carefully align the rear propeller shaft bearing with the propeller shaft.

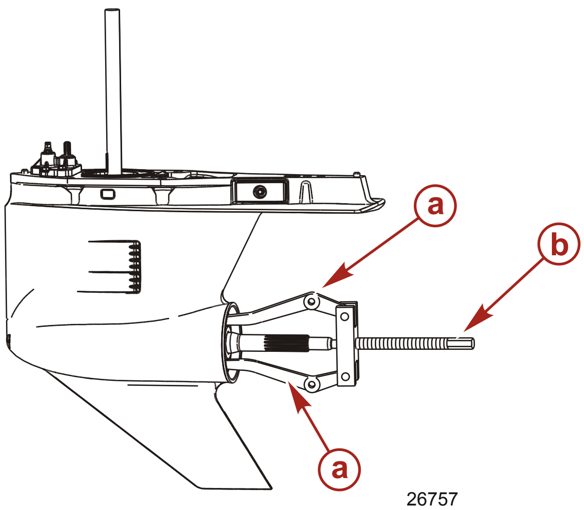
3. Lubricate the bearing carrier retainer threads with 2-4-C with PTFE. Install the retainer and the locking tab washer into the gear housing and thread the retainer down fully by hand.



a - Bearing carrier assembly
b - Propeller shaft tapered bearing
c - Shim
d - Washer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer threads	92-802859A 1

4. Install the puller jaws assembly onto the bearing carrier bosses and propeller shaft.
5. Tighten the puller bolt to the specified torque. Rotate the driveshaft three turns clockwise and check the puller bolt torque.

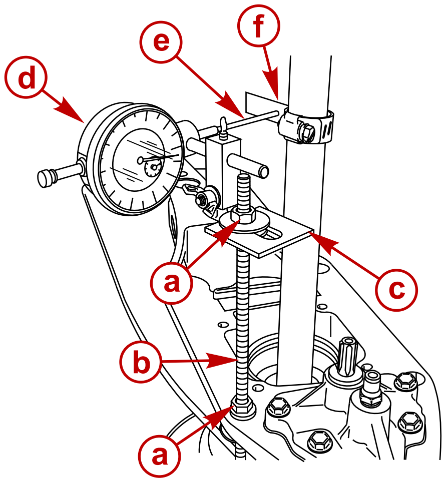


a - Puller jaws assembly
b - Puller bolt

Puller Jaws Assembly	91-46086A1

Description	Nm	lb-in.	lb-ft
Puller bolt	5.5	50	

6. Install a dial indicator and align the pointer so it is perpendicular to the "5" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so the dial indicator needle makes one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (obtain locally)
b - Threaded rod (obtain locally)
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator Adapter	91-83155
Dial Indicator	91- 58222A 1
Backlash Indicator Rod	91-8M0053505

7. Lightly turn the driveshaft back and forth. This is the amount of backlash. No movement should be noticed at the propeller shaft. Record the amount of backlash.
8. Loosen the indicator tool and rotate the driveshaft 120° in a clockwise direction.
9. Lightly turn the driveshaft back and forth. No movement should be noticed at the propeller shaft. Record the amount of backlash. Repeat this for a total of three backlash measurements.
10. Add the three measurements together and divide the sum by three. This is the average front gear backlash.

Front Gear Backlash Specification Right-Hand Rotation	
1.75:1 ratio	0.533 mm (0.021 in.)
1.85:1 ratio	0.584 mm (0.023 in.)

Front Gear Backlash Specification Left-Hand Rotation	
1.75:1 ratio	0.838 mm (0.033 in.)
1.85:1 ratio	0.914 mm (0.036 in.)

11. If the backlash is less than the specification, remove shims in front of the front gear bearing cup to obtain the correct backlash.
12. If the backlash is more than the specification, add shims in front of the front gear bearing cup to obtain the correct backlash.

    NOTE: *By adding or subtracting 0.025 mm (0.001 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).*
13. When the backlash is within specification, apply Loctite 271 Threadlocker to the threads of the pinion nut and tighten to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Threads of pinion nut	92-809819

Description	Nm	lb-in.	lb-ft
Pinion nut	101.7		75

Rear Gear Backlash

Rear Gear Backlash Specification Right-Hand Rotation	
1.75:1 ratio	0.864 mm (0.034 in.)
1.85:1 ratio	0.939 mm (0.037 in.)

Rear Gear Backlash Specification Left-Hand Rotation	
1.75:1 ratio	0.533 mm (0.021 in.)
1.85:1 ratio	0.584 mm (0.023 in.)

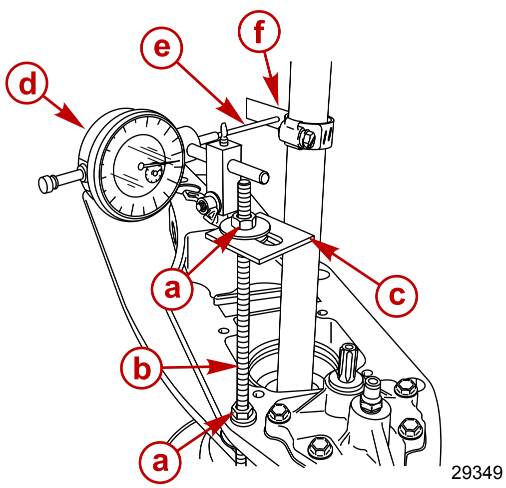
NOTE: *The pinion gear clearance must be within specifications before checking reverse gear backlash.*

NOTE: *Propeller shaft shims must be removed from the propeller shaft to check the rear gear backlash.*

1. Tighten the bearing carrier retainer nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Bearing carrier retainer nut	285[1.]		210[1.]

2. Install a dial indicator and align the pointer so it is perpendicular to the "5" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so the dial indicator needle makes one full revolution and comes to "0" on the dial indicator scale.
3. Apply pressure on the propeller shaft by holding the shift crank against the reverse gear.



a - Nuts (4) (obtain locally)
b - Threaded rod (obtain locally)
c - Dial indicator adapter
d - Dial indicator
e - Indicator pointer
f - Backlash indicator rod

Dial Indicator Adapter	91-83155
Dial Indicator	91- 58222A 1
Backlash Indicator Rod	91-8M0053505

4. Lightly turn the driveshaft back and forth. This is the amount of backlash. No movement should be noticed at the propeller shaft. Record the amount of backlash.
5. Loosen the indicator tool and rotate the driveshaft 120° in a clockwise direction.
6. Lightly turn the driveshaft back and forth. No movement should be noticed at the propeller shaft. Record the amount of backlash. Repeat this for a total of three backlash measurements.
7. Add the three measurements together and divide the sum by three. This is your average rear gear backlash. If rear gear backlash is not within specification, the gear housing is not properly assembled or the parts are excessively worn and must be replaced.

Rear Gear Backlash Specification Right-Hand Rotation	
1.75:1 ratio	0.864 mm (0.034 in.)
1.85:1 ratio	0.939 mm (0.037 in.)

1. Torque retainer to 135.5 Nm (100 lb-ft), then check rolling torque on propeller shaft. If torque is within specification, torque retainer to 285 Nm (210 lb-ft). Then rotate the retainer an additional 3.8 cm (1.5 in.).

Rear Gear Backlash Specification Left-Hand Rotation	
1.75:1 ratio	0.533 mm (0.021 in.)
1.85:1 ratio	0.584 mm (0.023 in.)

Propeller Shaft Bearing Preload (Design I and Design II)

NOTE: All gear housing components must be installed and correctly shimmed before checking propeller shaft bearing preload. The propeller shaft tapered roller bearing must be properly seated in the race during installation. The driveshaft retainer must be tightened to the specified torque.

Description	Nm	lb-in.	lb-ft
Driveshaft retainer	135.5	–	100

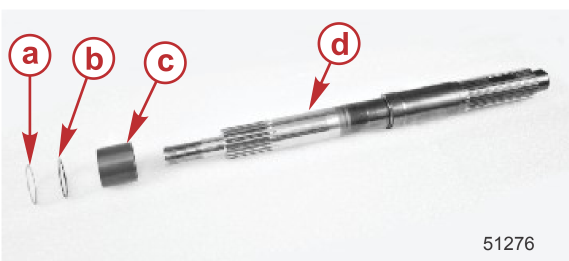
Propeller Shaft Assembly - Design I

1. Remove the bearing carrier.
2. Install the retained propeller shaft preload shims onto the propeller shaft. If the shims were lost, start with 0.9 mm (0.035 in.) shim thickness.

Propeller Shaft Assembly - Design II

IMPORTANT: Install a maximum of two shims on the propeller shaft to obtain the specified propeller shaft rolling torque. To obtain the specified rolling torque, shims of different thicknesses may have to be interchanged. Do not use a shim smaller than 0.51 mm (0.020 in.).

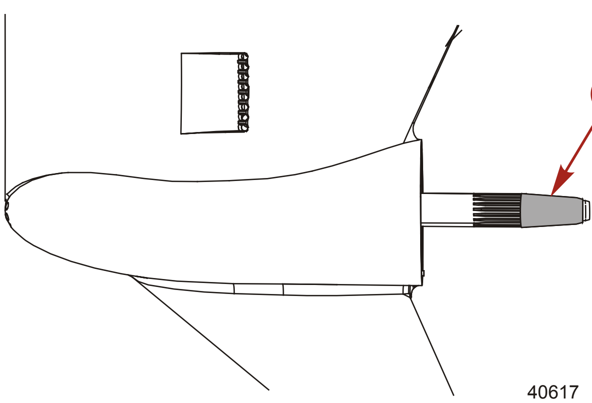
1. Remove the bearing carrier.
2. Install the new thrust spacer onto the new propeller shaft.
3. Install a shim onto the propeller shaft. Do not use a shim smaller than 0.51 mm (0.020 in.) shim thickness. A maximum of two shims may be installed on the shaft to obtain the specified rolling torque. If two shims are required, install the thinner shim last.



Installation order of components
- a - Thin shim if required
- b - Shim
- c - Thrust spacer
- d - Propeller shaft

Preload Procedure

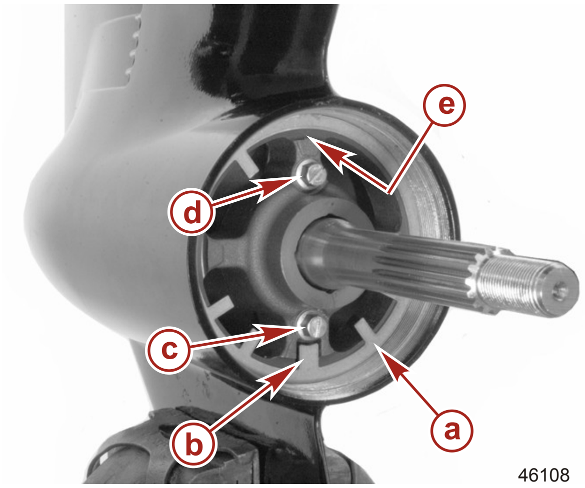
1. Install the propeller shaft into the gear housing.
2. Install the bearing carrier installation tool onto the propeller shaft.
   IMPORTANT: Prior to installing the bearing carrier into a gear housing utilizing the heavy-duty 31.75 mm (1.25 in.) diameter propeller shaft, install the bearing carrier installation tool over the propeller shaft. This tool will protect the bearing carrier seal lips from being damaged by the propeller shaft splines. Remove the tool after the bearing carrier is installed.



- a - Bearing carrier installation tool

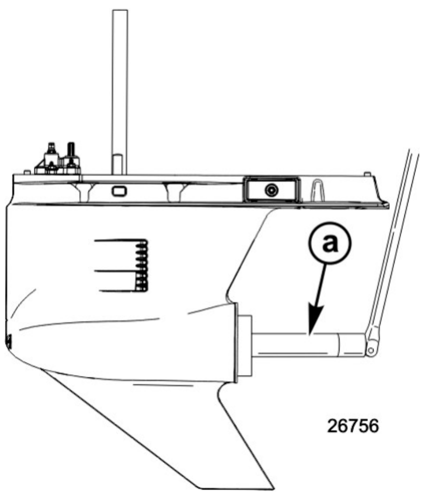
Bearing Carrier Installation Tool	91-8M0059911

3. Install the bearing carrier aligning the rear propeller shaft bearing with the propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion with the rear gear.
4. Insert the small rectangular tab of the tab washer into its corresponding slot in the gear housing at the 12 o'clock position above the bearing carrier while aligning the large rectangular tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - U-shaped tab
c - Fill plug
d - Vent plug
e - Rectangular tab (hidden)

5. With the gear housing in neutral, tighten the bearing carrier retainer nut to the initial specified torque.
6. Rotate the propeller shaft several times to seat the propeller shaft tapered roller bearings in their races.
7. Tighten the bearing carrier retainer nut to the final specified torque.



a - Bearing carrier retainer nut tool

Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5	–	100
	Final	285	–	210

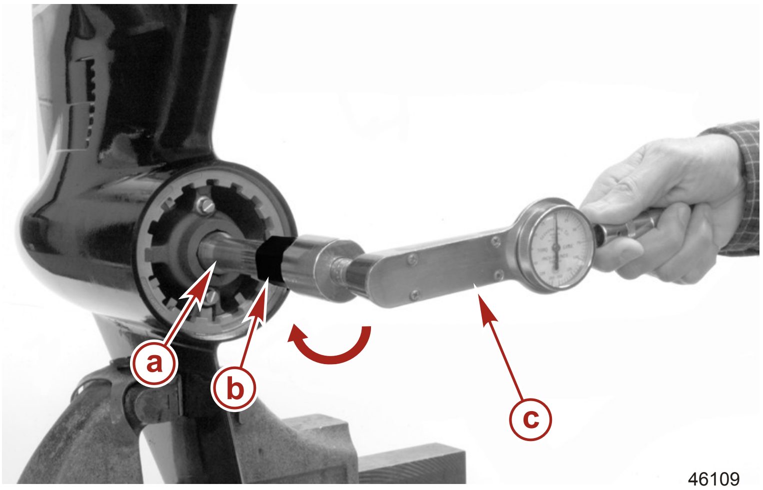
Bearing Carrier Retainer Nut Tool	91-8M0046632

8. Remove the bearing carrier installation tool from the propeller shaft.
9. Install the propeller shaft adapter and using a torque wrench, rotate the propeller shaft in the direction of normal rotation with a slow steady motion.
10. Verify the rolling torque is within specification for new or used bearings.

Description	Nm	lb-in.	lb-ft
Bearing rolling torque (new bearings)	1.1–1.8	10–16	–
Bearing rolling torque (used bearings)	0.45–1.1	4–10	–

NOTE: *Preload will change approximately 0.056 Nm (½ lb-in.) of rolling torque per 0.025 mm (0.001 in.) of shim change.*

11. If the rolling torque is too high, install a thinner shim on the propeller shaft aft of the thrust spacer. If the torque is too low, install a thicker shim. Be certain the shims are installed aft of the thrust spacer.
IMPORTANT: Install a maximum of two shims on the propeller shaft to obtain the specified propeller shaft rolling torque. To obtain the specified rolling torque, shims of different thicknesses may have to be interchanged. Do not use a shim smaller than 0.51 mm (0.020 in.).



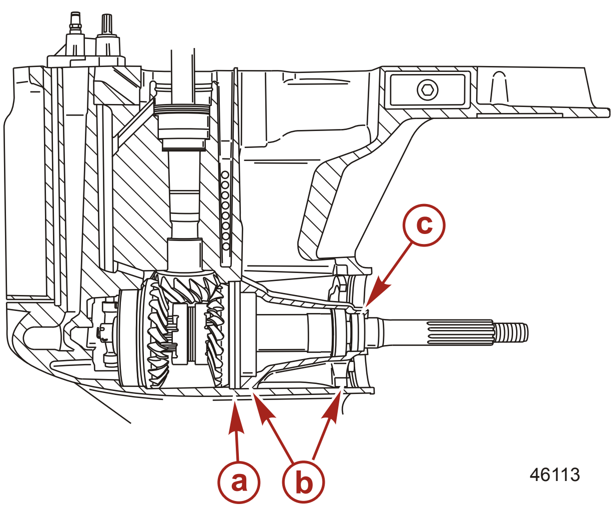
a - Propeller shaft
b - Propeller shaft adapter
c - Torque wrench

Propeller Shaft/Driveshaft Adapter	91-61077T

NOTE: If the shims are changed, tighten the bearing carrier to the initial specified torque. Rotate the propeller shaft several times to seat the propeller shaft tapered bearing. Tighten the retainer nut to the final specified torque. Use the torque wrench to check the rolling torque. Repeat this procedure each time the shims are changed.

Bearing Carrier Final Installation

1. Remove the bearing carrier and lubricate the following as specified:
   a. Lubricate the carrier O-ring with 2-4-C with PTFE.
   b. Lubricate both the forward and aft outer diameters of the bearing carrier and gearcase area where the carrier will seat with 2-4-C with PTFE.
   c. Fill the space between the carrier oil seals with 2-4-C with PTFE.

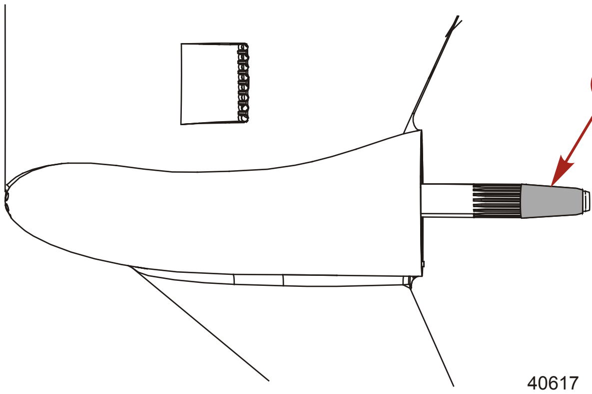


a - O-ring
b - Forward and aft outer diameters of bearing carrier
c - Propeller shaft seals

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier oil seals	92-802859A 1

NOTE: Applying a light coat of 2-4-C with PTFE to the rear gear thrust bearing, thrust washer, spacer, and shim will help keep the components in alignment when installing the bearing carrier assembly into the gearcase.

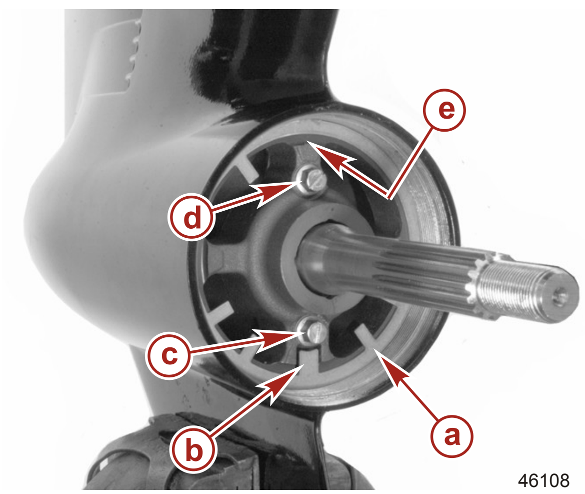
IMPORTANT: Prior to installing the bearing carrier into a gearcase utilizing the heavy-duty 31.75 mm (1.25 in.) diameter propeller shaft, install the bearing carrier installation tool over the propeller shaft. This tool will protect the bearing carrier seal lips from being damaged by the propeller shaft splines. Remove the tool after the bearing carrier is installed.



a - Bearing carrier installation tool

Bearing Carrier Installation Tool	91-840388

2. Place the bearing carrier assembly into the gear housing, being careful to align the rear propeller shaft bearing. It may be necessary to turn the driveshaft to align the teeth of the pinion gear and the rear gear.
3. The lubricant fill plug in the bearing carrier should be located at the 6 o'clock position.
4. Insert the rectangular tab of the tab washer into the slot in the gearcase above the bearing carrier vent plug while aligning the U-shaped tab of the tab washer with the slot below the fill plug.



a - Tab washer
b - U-shaped tab
c - Fill plug
d - Vent plug
e - Rectangular tab (hidden)

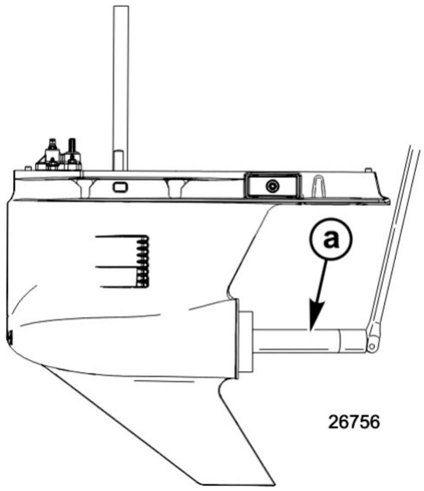
5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with PTFE. Start the retainer into the gear housing threads and screw it down fully by hand.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing carrier retainer nut threads and corresponding gear housing threads	92-802859A 1

IMPORTANT: Before torquing the bearing carrier retainer, the gearcase must be bolted to the driveshaft housing or securely fastened in a gearcase holding fixture to avoid possible damage to the gear housing.

NOTE: Torque the retainer nut to the initial specification first. Rotate the propeller shaft several times to seat the tapered roller bearings. The retainer nut can then be tightened to the final specification.

6. Tighten the bearing carrier retainer nut to the specified torque. If one tab does not align up in space between two of the notches, continue to tighten the retainer until alignment is achieved. Do not loosen the retainer to achieve alignment.

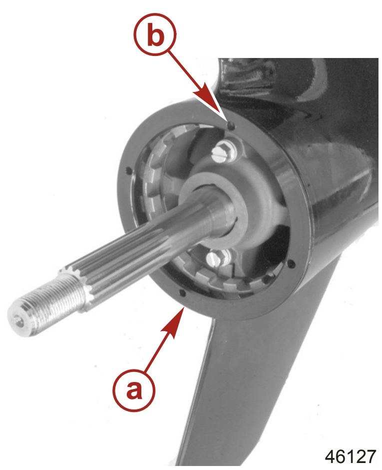


a - Bearing carrier retainer nut tool

Bearing Carrier Retainer Nut Tool	91-8M0046632

Description		Nm	lb-in.	lb-ft
Bearing carrier retainer nut	**First**	135.5		100
	Final	433.9[1.]		320[1.]

7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).
8. Apply 2-4-C with PTFE to the torpedo ring threads.
9. Install the torpedo ring onto the gear housing. Tighten the ring to the specified torque. Drive the torpedo ring set screw tight with a 3/32 inch allen wrench.



a - Torpedo ring
b - Set screw

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Torpedo ring threads	92-802859A 1

Torpedo Ring Installation Tool	91-8M0039309

Description	Nm	lb-in.	lb-ft
Torpedo ring	68		50
Set screw	2.8	25	

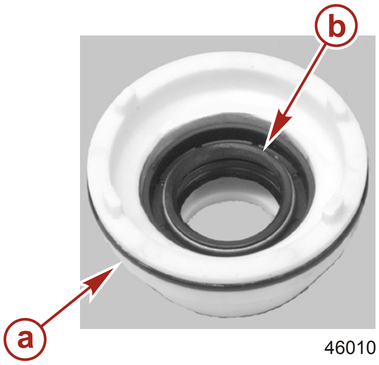
1. Torque the retainer nut to 285 Nm (210 lb-ft) and then rotate the retainer nut an additional 3.8 cm (1.5 in.) and align the tab washer with the nearest slot in the retainer.

Oil Seal Carrier Installation

NOTE: The oil seal carrier may be lightly tapped into position by sliding the driveshaft bearing retainer wrench over the driveshaft.

Driveshaft Bearing Retainer Wrench	91-43506T

1. Lubricate the oil seal carrier oil seal lips, space between the seals, and the O-ring with 2-4-C with PTFE.

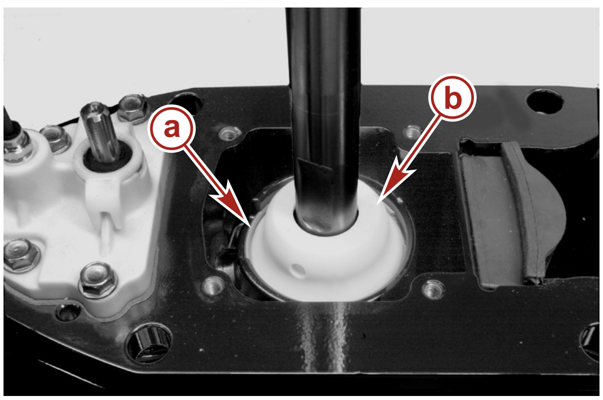


46010

a - O-ring
b - Oil seal lips

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Oil seal carrier oil seal lips, space between the seals, and the O-ring	92-802859A 1

2. Install the oil seal carrier over the driveshaft and into the gearcase.
3. Install the retaining ring above the oil seal carrier.



46008

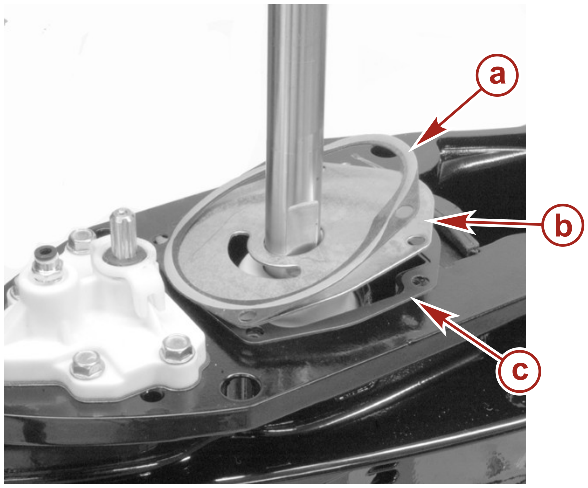
a - Retaining ring
b - Oil seal carrier

Water Pump Installation

NOTE: The gaskets and the faceplate hole pattern are not symmetrical. If the holes of the gaskets and face plate do not align with the screw holes of the gear housing or each other, one or more of the parts are installed incorrectly.

1. Install the coated metal gasket, the faceplate, and then the fiber gasket with the neoprene bead onto the gear housing.

NOTE: *The neoprene bead on the fiber gasket faces up towards the pump cover.*



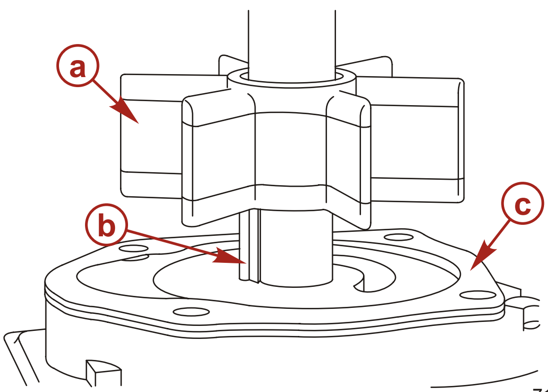
46117

- **a -** Fiber gasket with neoprene bead
- **b -** Faceplate
- **c -** Coated metal gasket

2. Apply a small amount of 2-4-C with PTFE onto the flat surface of the impeller key and install the key onto the driveshaft keyway.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Flat surface of impeller key	92-802859A 1

3. Install the water pump impeller onto the driveshaft and water pump key.
   IMPORTANT: Do not install a used impeller with the blades oriented in a reversed direction from the original rotation. Premature impeller failure will occur.



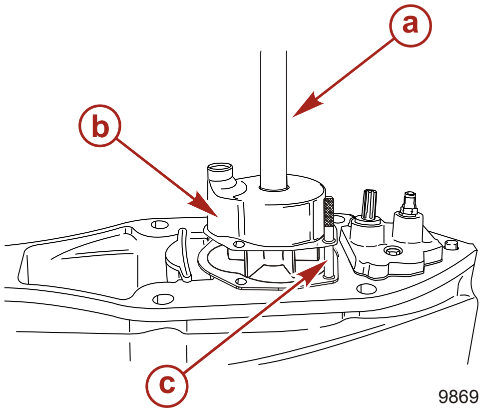
7153

- **a -** Impeller
- **b -** Key
- **c -** Water pump faceplate and gaskets (one gasket on each side of the faceplate)

4. Install the two water pump alignment pins through the gaskets and faceplate.

Water Pump Alignment Pins	91-821571A 1

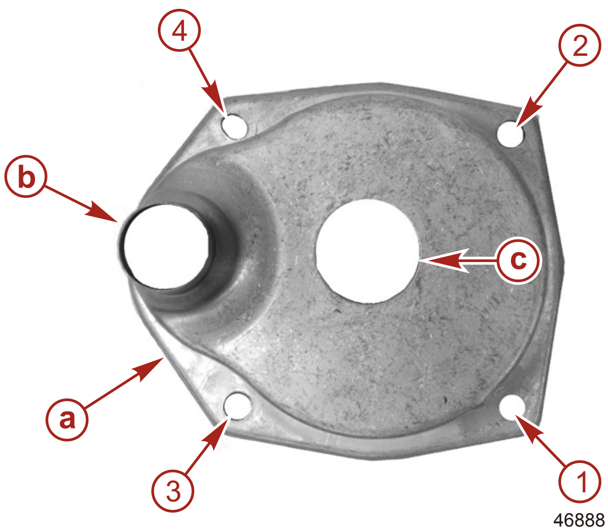
5. Apply a light coat of 2-4-C with PTFE to the inside of the water pump housing. Position the water pump housing over the driveshaft and water pump alignment pins. Rotate the driveshaft in a clockwise direction while pushing down on the water pump housing.



a - Rotate driveshaft clockwise
b - Water pump housing
c - Water pump alignment pins

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside of the water pump housing	92-802859A 1

6. Install two screws into the water pump housing and remove the water pump alignment pins. Install the remaining two screws. Tighten the screws in the sequence shown to the specified torque.



a - Water pump cover
b - Water outlet
c - Driveshaft access hole

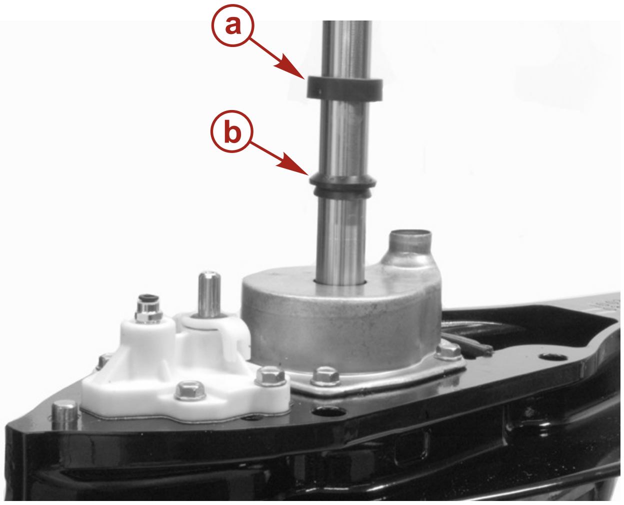
Description	Nm	lb-in.	lb-ft
Screws	6.8	60	

7. Lubricate the water tube coupling O-rings with 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Water tube coupling O-rings	92-802859A 1

8. Install the water tube coupling assembly onto the water pump housing.
9. Install the driveshaft seal and use the tool provided in the seal kit or the water pump kit to press the seal down.

IMPORTANT: If the driveshaft seal is not installed at the proper height, air will be drawn into the water pump causing the engine to overheat.

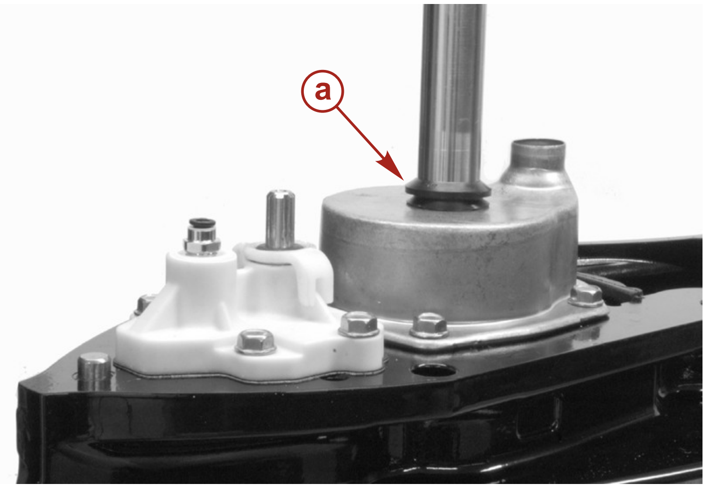


46120

a - Driveshaft seal installation tool
b - Driveshaft seal

Driveshaft Seal Installation Tool	91-818769

10. If the tool is not available, press the seal against the water pump housing until the height of the seal is 8.9 ± 0.76 mm (0.350 ± 0.030 in.).



46122

a - Driveshaft seal

Checking Gear Housing Operation

Prior to filling the gear housing with lubricant, check the gear housing for proper shift operation, as follows:

Standard Rotation

1. Rotate the shift shaft counterclockwise to the forward motion position. The propeller shaft should rotate clockwise and then lock (no ratcheting motion).
2. Rotate the shift shaft clockwise to the reverse motion position. The propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).
3. Rotate the shift shaft to a point halfway between the forward and reverse motion position. This should be the neutral position. The propeller shaft should rotate freely both clockwise and counterclockwise.
   IMPORTANT: If the shifting operation is not as described, the gear housing must be disassembled and the cause corrected.

Counterrotation

1. Rotate the shift shaft counterclockwise to the forward motion position. The propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).

2. Rotate the shift shaft clockwise to the reverse motion position. The propeller shaft should rotate clockwise and then lock (no ratcheting motion).
3. Rotate the shift shaft to a point halfway between the forward and reverse motion position. This should be the neutral position. The propeller shaft should rotate freely both clockwise and counterclockwise.
   IMPORTANT: If the shifting operation is not as described, the gear housing must be disassembled and the cause corrected.

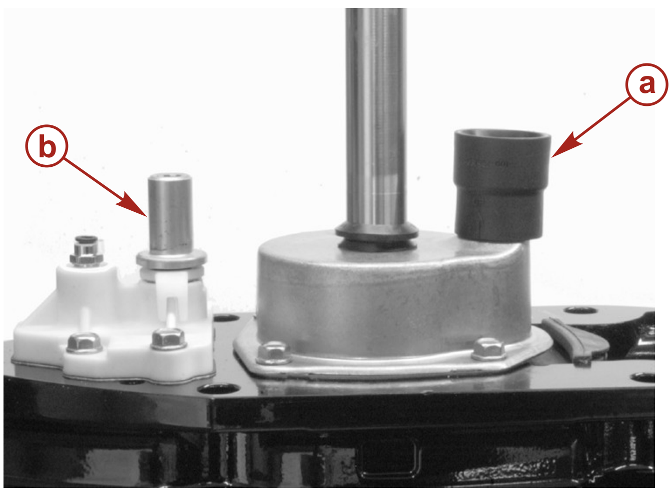
Gear Housing Installation

1. Lubricate the splines of the shift shaft and driveshaft with 2-4-C with PTFE. Do not allow lubricant on top of the shift shaft or driveshaft.

NOTICE
Installing the gear housing to the powerhead without adequately cleaning the top of the driveshaft can result in severe product damage. Any lubricant trapped in the space between the driveshaft and the crankshaft prevent the two from properly engaging. Always clean the top of the driveshaft before installing the gear housing.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft splines and driveshaft splines	92-802859A 1

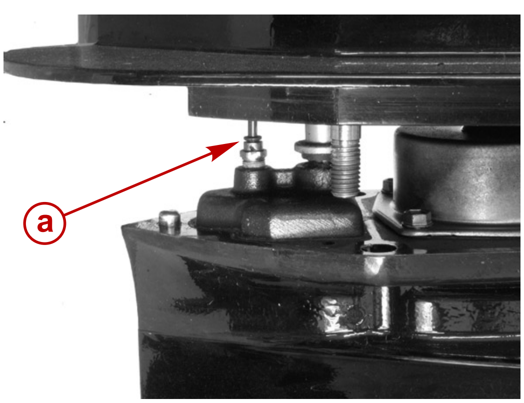
2. Verify the gear housing is in neutral.
3. Install the water pump coupler.
4. Install the shift shaft coupler.



46124

a - Water pump coupler
b - Shift shaft coupler

5. Verify the anode screw is in the rear hole of the gear housing.
6. Verify the upper shift shaft is in neutral.
7. Position the gear housing so the driveshaft is protruding into the driveshaft housing.
8. Push the speedometer tubing into the Legris fitting on the gear housing.



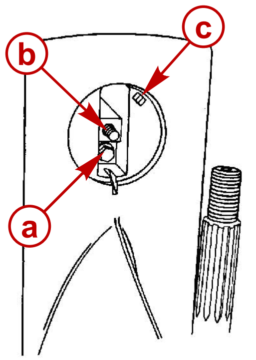
40278

a - Legris fitting

9. Move the gear housing up toward the driveshaft housing while aligning the shift shaft splines and water tube.

NOTE: If the driveshaft splines will not align with the crankshaft splines, rotate the flywheel slightly to reposition the splines.

10. Secure the gear housing assembly with four nuts and washers. Do not tighten the nuts at this time.
11. Start the screw at the rear of the gear housing inside the anode recess. Do not tighten the screw at this time.



3233

a - Screw (inside cavity)
b - Screw (secures anodic plate)
c - Ribs

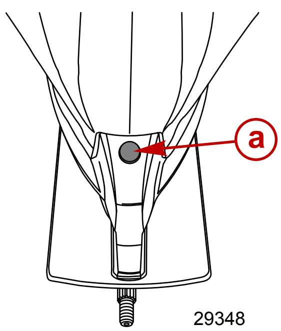
12. Check the shift shaft spline engagement and correct if necessary.
13. Tighten the nuts to the specified torque.
IMPORTANT: Do not force the gear housing up into place with the attaching nuts and screw.
14. Tighten the screw to the specified torque located at the rear of the gear housing inside the anode recess.

Description	Nm	lb-in.	lb-ft
Nuts	61		45
Screw	74.6		55

15. Install the anode plate and secure with the screw. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Anode plate screw	54		40

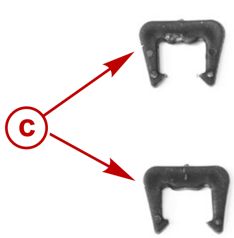
16. Install the rubber plug onto the driveshaft housing.



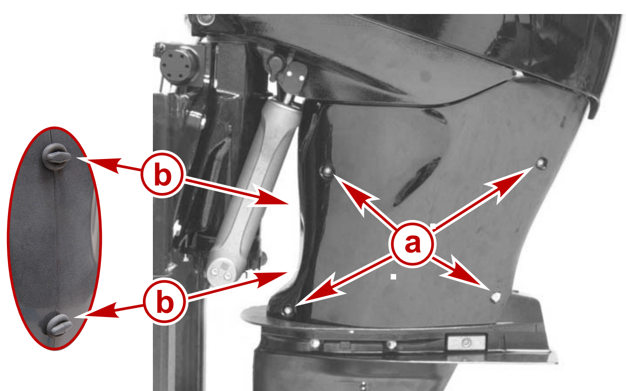
29348

a - Rubber plug

17. Install the clips or O-rings securing the front of the driveshaft housing chaps.
18. Install the four screws (six for XXL shaft) securing the port chap to the driveshaft housing. Tighten the screws to the specified torque.



32157



32158

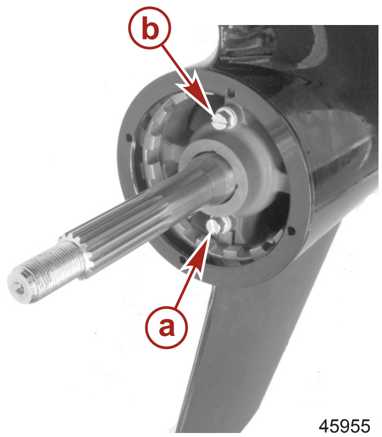
a - Chap mounting screw (M6)
b - O-ring
c - Clips (used on later models in place of O-rings)

Description	Nm	lb-in.	lb-ft
Driveshaft housing chap screws (4 or 6 each side)	6	53	

IMPORTANT: After installing the gearcase and prior to returning the outboard to service, the powerhead crankcase should be refilled with the recommended engine lubricant.

Gear Lubricant Filling Instructions

1. Inspect the fill and vent sealing washers for cuts or abrasions. Replace the washers if necessary.
   IMPORTANT: Never add lubricant to the gear housing without removing the vent plug. The gear housing cannot be filled if the vent plug is not removed because of trapped air. Fill the gear housing only when the housing is in a vertical position.
2. Slowly fill the housing through the fill hole with High Performance Gear Lubricant until the lubricant flows out of the vent hole and no air bubbles are visible.
3. Install the vent plug into the vent hole.
   IMPORTANT: Do not lose more than 30 cc (1 fl oz) of gear lubricant while installing the fill plug.
4. Remove the fill tube or hose from the fill hole and quickly install the fill plug into the fill hole. Tighten the fill and vent plugs to the specified torque.



45955

a - Fill plug
b - Vent plug

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear housing	92-858064K01

Description	Nm	lb-in.	lb-ft
Fill and vent plugs	22.6	200	16.5

Notes:

Attachments

Section 7A - Attachments

Table of Contents

7
A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	First four threads of tie bar attaching screw First four threads of special screw (10-896555025)	92-809819
95	2-4-C with PTFE	Clevis attaching screw shoulder Clevis/tie bar arm attaching screw shoulder	92-802859A 1
116	RTV 587 Ultra Blue Silicone Sealer	Rudder sensor autopilot tube	92-809825

Special Tools

Power Steering Module Primer Kit	91-895040K01
 5547	Bleeds power steering system without running engine.

Dual Tie Bar

Installation

Dual Outboard Steering Tie Bar Kit	
892722A03	66–71 cm (26–28 in.)
899156A02	71–76 cm (28–30 in.)
892724A03	76–81 cm (30–32 in.)
899157A02	81–86 cm (32–34 in.)
899158A02	86–91 cm (34–36 in.)

IMPORTANT: The tie bar arms must be fastened to each engine using special screws (10-896555025). The use of any other unauthorized fastener may result in the tie bar arm disconnecting from the engine.

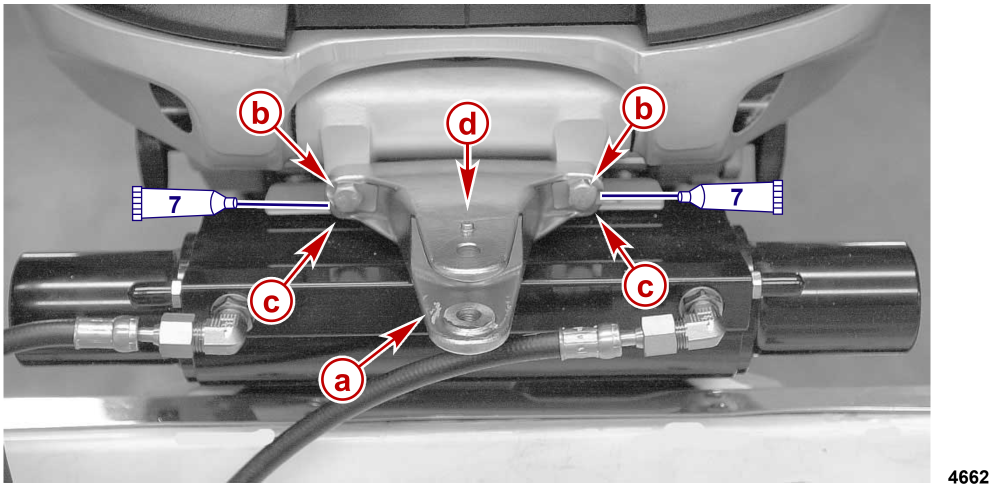
⚠ WARNING

Improper fasteners or improper installation procedures can result in loosening or disengagement of the tie bar. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow all tie bar installation instructions and torque procedures.

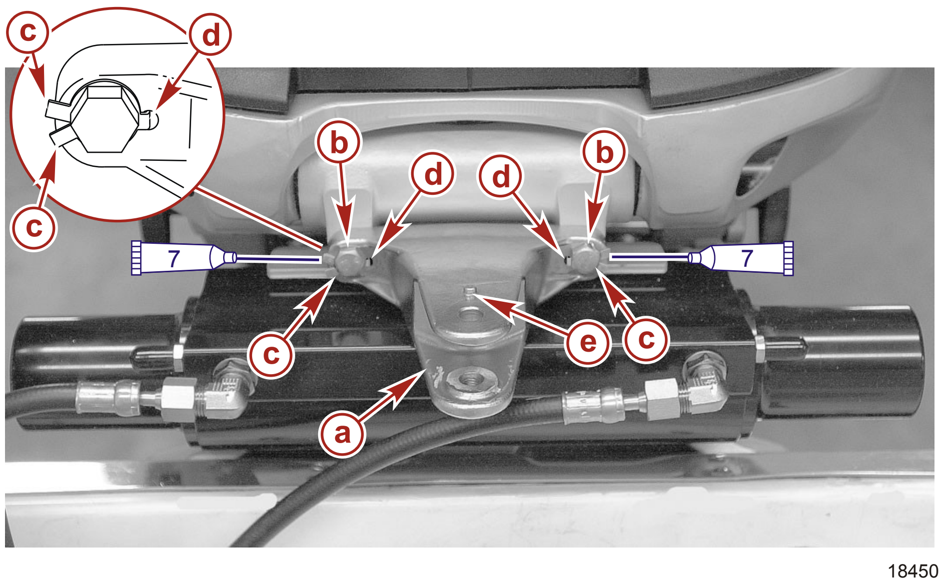
1. Install the tie bar arm to each engine with two screws and two locking retainers. Apply Loctite 271 Threadlocker to the first four threads of the screws. Position the tie bar arm on each engine with the locating tab facing up.

   NOTE: The design 1 tie bar arm utilizes a locking retainer that bends against the attaching screw. The design 2 tie bar arm has locating holes which a finger of the locking retainer is inserted into before the other fingers are bent against the attaching screw.

2. While holding the locking retainer in position, tighten the screws to specification. Bend one corner of the locking retainer against the flat of each screw.



Design 1
- a - Tie bar arm
- b - Attaching screw
- c - Locking retainers
- d - Locating tab



Design 2
- a - Tie bar arm
- b - Attaching screw
- c - Locking finger
- d - Locating hole
- e - Locating tab

Description	Nm	lb. in.	lb. ft.
Tie bar arm attaching screw (M8 x 25 mm)	55		40.5

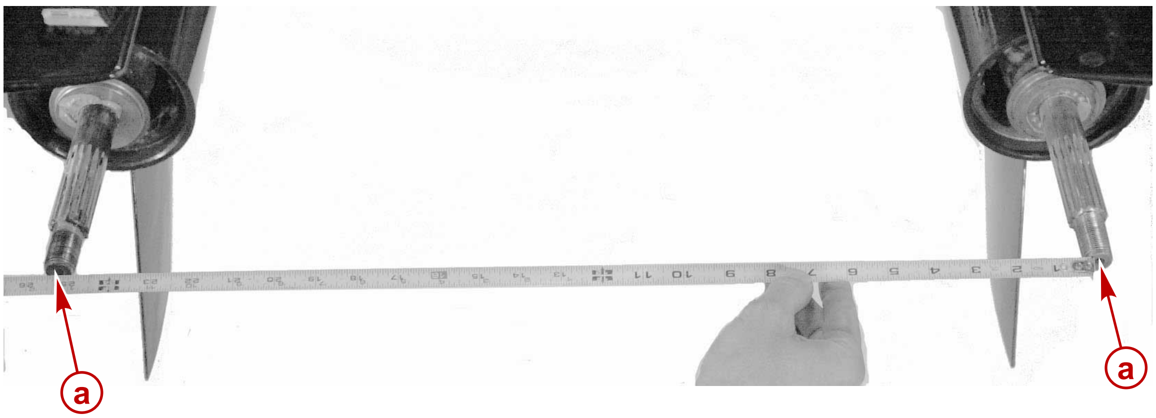
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	First four threads of tie bar attaching screw	92-809819

3. Measure the distance between the tie bar arm centers. Record the distance.

4664

a - Tie bar arm centers

4. Measure the distance between the propeller shaft centers. Record the distance.



4666

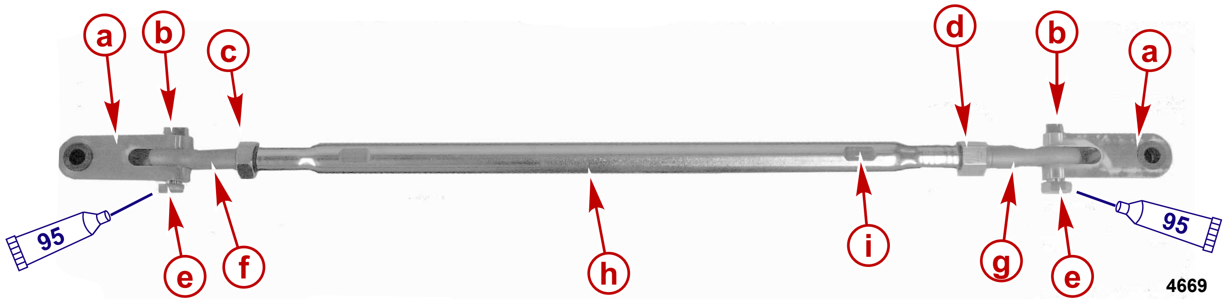
a - Propeller shaft centers

5. Adjust the engines to equalize both measurements.
   IMPORTANT: Both tie rod ends must be threaded into the coupler 19 mm (0.75 in.) minimum and the attaching nut tightened against the coupler to prevent the coupler from turning. Insufficient engagement of the tie rod threads could result in the tie rods pulling out of the coupler and disengaging the steering tie rod.

⚠ WARNING
Improper fasteners or improper installation procedures can result in loosening or disengagement of the tie bar. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow all tie bar installation instructions and torque procedures.

6. Assemble each tie rod end to the tie rod coupler with the corresponding attaching nut.
   NOTE: The tie rod couplers are threaded for left hand (LH) and right hand (RH) tie rod ends respectively. Assemble the corresponding tie rod end to the correct end of the coupler. Do not tighten the tie rod end/coupler attaching nuts at this time.

7. Install the clevis assembly onto each tie rod end. Secure the clevis with a screw and nut. Apply 2-4-C with PTFE to the screw shoulder. Tighten the screw and nut to specification.



a - Clevis
b - Clevis attaching nut (M8 x 1.25)
c - Tie rod end/coupler attaching nut (M14 x 200 RH)
d - Tie rod end/coupler attaching nut (M14 x 200 LH [marked "L"])
e - Clevis attaching screw (M8 x 35.3 mm)
f - Tie rod end RH
g - Tie rod end (marked "L")
h - Coupler
i - Flat with "L" imprinted (left hand threads)

Description	Nm	lb. in.	lb. ft.
Clevis attaching nut (M8 x 1.25)	25		18.4
Clevis attaching screw (M8 x 35.3 mm)	25		18.4

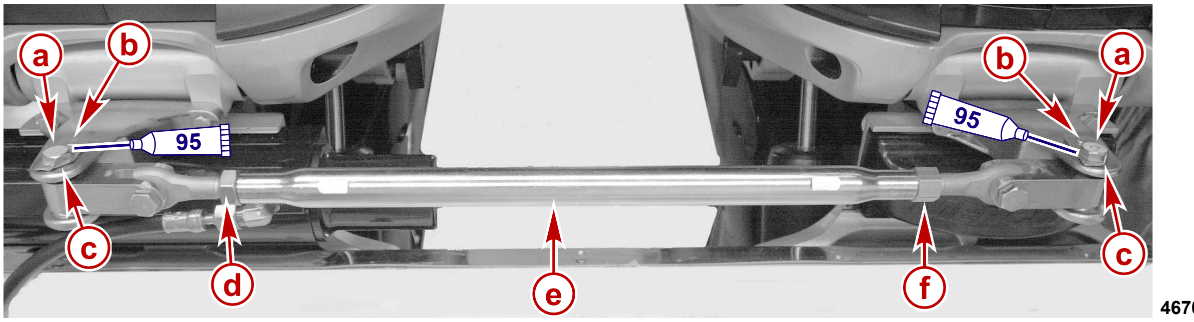
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Clevis attaching screw shoulder	92-802859A 1

8. Adjust the tie bar ends equally so that the clevis mounting screw holes match the engine centerline distance previously noted. Do not tighten the attaching nuts at this time.

   NOTE: To aid in the installation of the second tie bar mount screw, turn the tie bar coupler to help align the mounting screw holes between the tie bar arms and the tie bar clevises.

9. Install the tie bar assembly onto the tie bar arms. Secure the tie bar assembly with a screw and locking retainer. Apply 2-4-C with PTFE to the screw shoulder. Align the locking retainer with the alignment tab on the tie bar arm.
10. Tighten the screws to specification. Bend one corner of the locking retainer against the flat of each screw.
11. Turn the tie bar coupler to equalize the distance between the tie bar arm centers and the propeller shaft centers.

12. When the engines are centered, tighten the attaching nuts against the coupler to specification.



- **a -** Clevis/tie bar arm attaching screw (M8 x 46.75 mm)
- **b -** Locating tab
- **c -** Locking retainer
- **d -** Tie rod end/coupler attaching nut (M14 x 200 RH thread)
- **e -** Coupler
- **f -** Tie rod end/coupler attaching nut (M14 x 200 LH thread [marked "L"])

Description	Nm	lb. in.	lb. ft.
Clevis/tie bar arm attaching screw (M8 x 46.75 mm)	25		18.4
Tie rod end/coupler attaching nut (M14 x 200 RH thread)	35		25.8
Tie rod end/coupler attaching nut (M14 x 200 LH thread [marked "L"])	35		25.8

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Clevis/tie bar arm attaching screw shoulder	92-802859A 1

IMPORTANT: After the installation is complete and before operating the outboards, check that the boat will turn right when the steering wheel is turned right and that the boat will turn left when the steering wheel is turned left. Check the steering through the full range (left and right) at all trim and tilt angles to ensure interference-free movement.

Maintenance Instructions

Maintenance inspection is the owner's responsibility and must be performed at the specific intervals.

Normal service - Every 50 hours of operation or 60 days (whichever comes first).

Severe service - Every 25 hours of operation or 30 days (whichever comes first).

NOTE: Operation in saltwater is considered severe service.

1. Check steering system components for wear. Replace any worn parts.
2. Check steering system fasteners to ensure they are torqued to correct specifications.
3. Refer to operating and maintenance instructions for power steering system.

Plus One Tie Bar

Installation

Plus One Outboard Tie Bar Kit	
892726A03	66–71 cm (26–28 in.)
899159A02	71–76 cm (28–30 in.)
892728A03	76–81 cm (30–32 in.)
899160A02	81–86 cm (32–34 in.)
899161A02	86–91 cm (34–36 in.)

IMPORTANT: The tie bar arms must be fastened to each engine using special screws (10-896555025). The use of any other unauthorized fastener may result in the tie bar arm disconnecting from the engine.

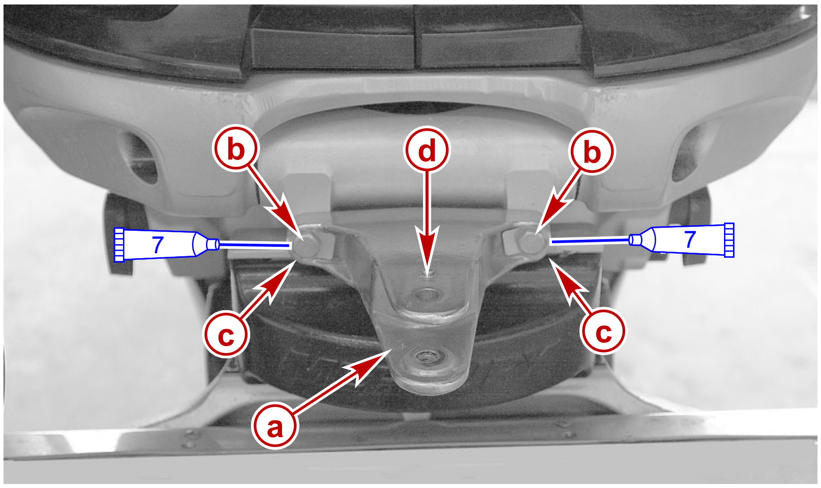
⚠ WARNING

Improper fasteners or improper installation procedures can result in loosening or disengagement of the tie bar. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow all tie bar installation instructions and torque procedures.

1. Install the tie bar arm to each engine with two screws and two locking retainers. Apply Loctite 271 Threadlocker to the first four threads of the screws. Position the tie bar arm on the engine with the locating tab facing up.

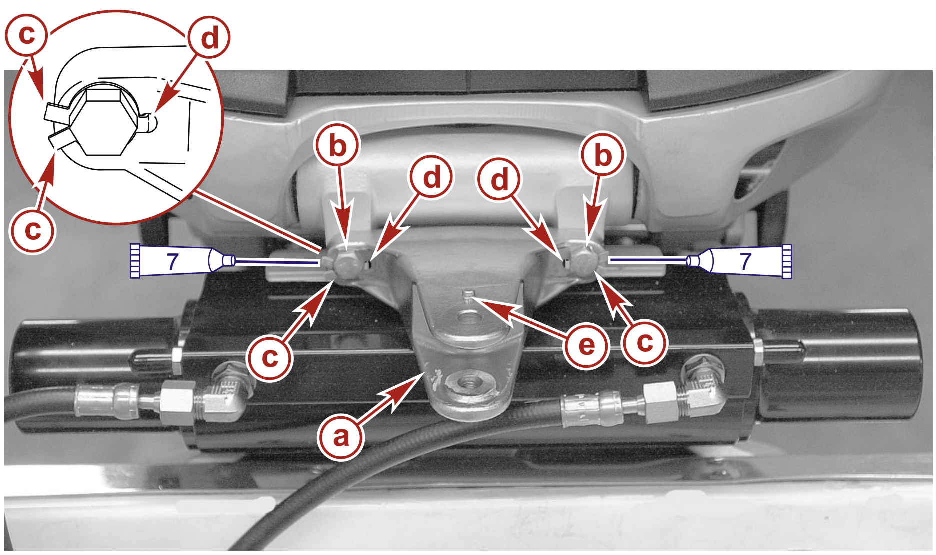
   NOTE: *The design 1 tie bar utilizes a locking retainer that bends against the attaching screw. The design 2 tie bar arm has locating hole which a finger of the locking retainer is inserted into before the other fingers are bent against the attaching screw.*

2. While holding the locking retainers in position, tighten the screws to specification. Bend one corner of the locking retainer against the flat of each screw.



5082

Design 1
- a - Tie bar arm
- b - Attaching screw
- c - Locking retainer
- d - Locating tab



18450

Design 2
- a - Tie bar arm
- b - Tie bar arm attaching screw
- c - Locking finger
- d - Retainer locating hole
- e - Locating tab (facing up)

Description	Nm	lb. in.	lb. ft.
Tie bar arm attaching screw (M8 x 25)	55		40.5

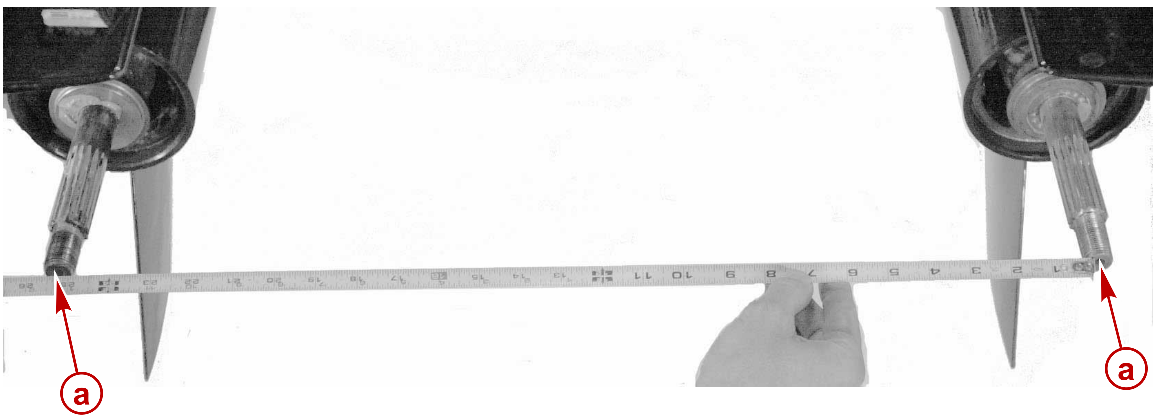
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	First four threads of tie bar attaching screw	92-809819

3. Measure the distance between the tie bar arm centers. Record the distance.

4664

a - Tie bar arm centers

4. Measure the distance between the propeller shaft centers. Record the distance.



4666

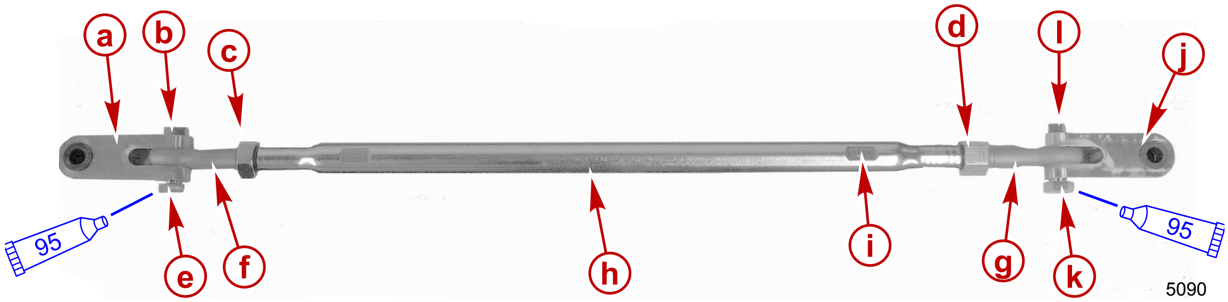
a - Propeller shaft centers

5. Adjust the engines to equalize both measurements.
   IMPORTANT: Both tie rod ends must be threaded into the coupler 19 mm (0.75 in.) minimum and the attaching nut tightened against the coupler to prevent the coupler from turning. Insufficient engagement of the tie rod threads could result in the tie rod ends pulling out of the coupler and disengaging the steering tie rod.

⚠ WARNING
Improper fasteners or improper installation procedures can result in loosening or disengagement of the tie bar. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow all tie bar installation instructions and torque procedures.

6. Assemble each tie rod end to the tie rod coupler with the corresponding attaching nut.
   NOTE: *The tie rod couplers are threaded for left hand (LH) and right hand (RH) tie rod ends respectively. Assemble the corresponding tie rod end to the correct end of the coupler. Do not tighten the tie rod end/coupler attaching nuts at this time.*

7. Install the clevis assembly onto each tie rod end. Secure the clevis with a screw and nut. Apply 2-4-C with PTFE to the screw shoulder. Tighten the screw and nut to specification.



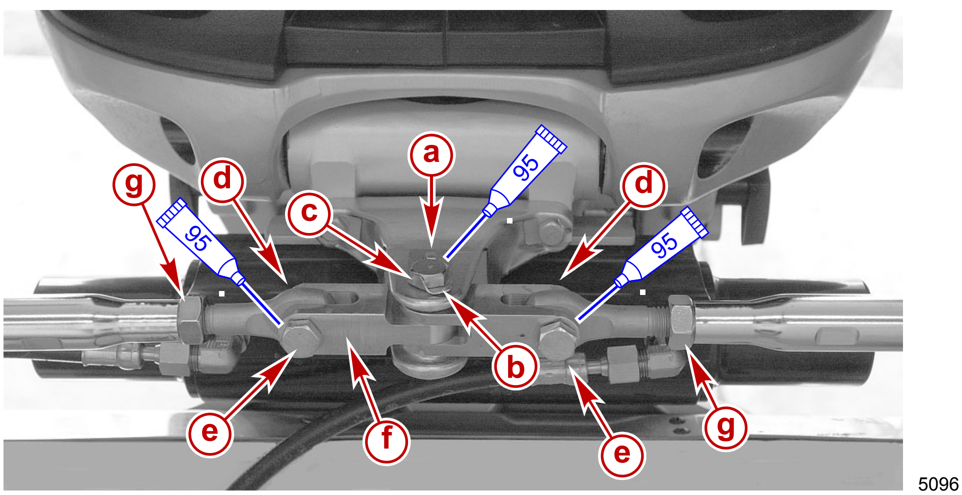
a - Clevis (892469A01)
b - Clevis attaching nut (M8 x 1.25)
c - Tie rod end/coupler attaching nut (M14 x 2.00 RH)
d - Tie rod end/coupler attaching nut (M14 x 2.00 LH [marked "L"])
e - Clevis attaching screw (M8 x 35.3 mm)
f - Tie rod end (RH)
g - Tie rod end (marked "L")
h - Coupler
i - Flat with "L" imprinted (left hand threads)
j - Clevis (from dual tie bar kit)
k - Clevis attaching screw (M8 x 35.3 mm) (from dual tie bar kit)
l - Clevis attaching nut (M8 x 1.25) (from dual tie bar kit)

Description	Nm	lb. in.	lb. ft.
Clevis attaching screw (M8 x 35.3 mm)	25		18.5
Clevis attaching nut (M8 x 1.25)	25		18.5

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Clevis attaching screw shoulder	92-802859A 1

NOTE: On triple engine installations, install the double clevis assembly on the center engine. On quadruple engine installations, install the double clevis assemblies on the center engines. Single clevis assemblies are always used on the outside engines.

8. Install the double clevis/tie bar assembly to the center/inner engine. Secure the tie bar assembly with a screw and locking retainer. Apply 2-4-C with PTFE to the screw shoulder. Align the locking retainer with the alignment tab on the tie bar arm.
9. Tighten the screws and nuts to specification. Bend one corner of the locking retainer against the flat of each screw.

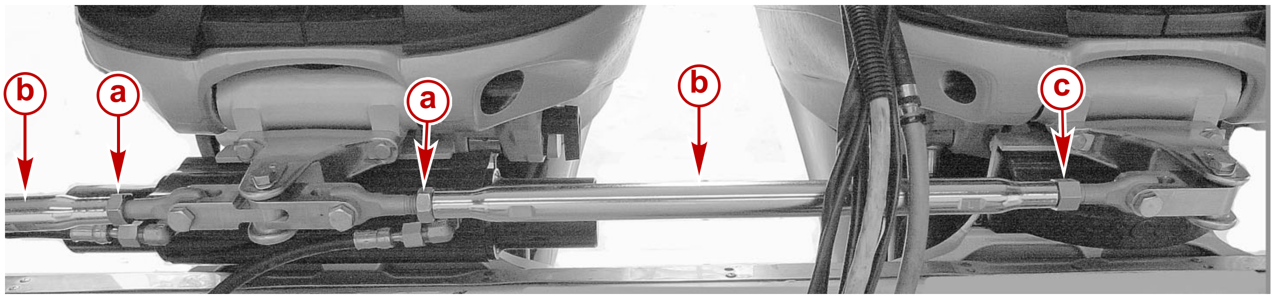


a - Alignment tab
b - Clevis/tie bar arm attaching screw (M8 x 46.75 mm)
c - Locking retainer
d - Nut (M8 x 1.25) (hidden)
e - Clevis attaching screw (M8 x 35.3 mm)
f - Clevis (892468A01)
g - Nut (M14 x 2.00) (do not tighten yet)

Description	Nm	lb. in.	lb. ft.
Clevis/tie bar arm attaching screw (M8 x 46.75 mm)	25		18.5
Clevis attaching screw (M8 x 35.3 mm)	25		18.5
Nut (M8 x 1.25) (hidden)	25		18.5

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Clevis/tie bar arm attaching screw shoulder	92-802859A 1

10. Turn the tie bar coupler to equalize the distance between the tie bar arm centers and the propeller shaft centers.
11. When the engines are centered, tighten the attaching nuts against the coupler to specification.



5099

a - Nuts (M14 x 2.00 RH thread)
b - Coupler
c - Nut (M14 x 2.00 LH thread)

Description	Nm	lb. in.	lb. ft.
Nut (M14 x 2.00 RH thread)	35		26
Nut (M14 x 2.00 LH thread)	35		26

IMPORTANT: After the installation is complete and before operating the outboards, check that the boat will turn right when the steering wheel is turned right and that the boat will turn left when the steering wheel is turned left. Check the steering through the full range (left and right) at all trim and tilt angles to ensure interference-free movement.

Maintenance Instructions

Maintenance inspection is the owner's responsibility and must be performed at the specific intervals.

Normal service - Every 50 hours of operation or 60 days (whichever comes first).

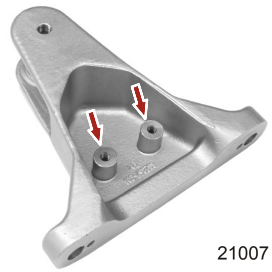
Severe service - Every 25 hours of operation or 30 days (whichever comes first).

NOTE: Operation in saltwater is considered severe service.

1. Check steering system components for wear. Replace any worn parts.
2. Check steering system fasteners to ensure they are torqued to correct specifications.
3. Refer to operating and maintenance instructions for power steering system.

Rudder Sensor Installation Instructions

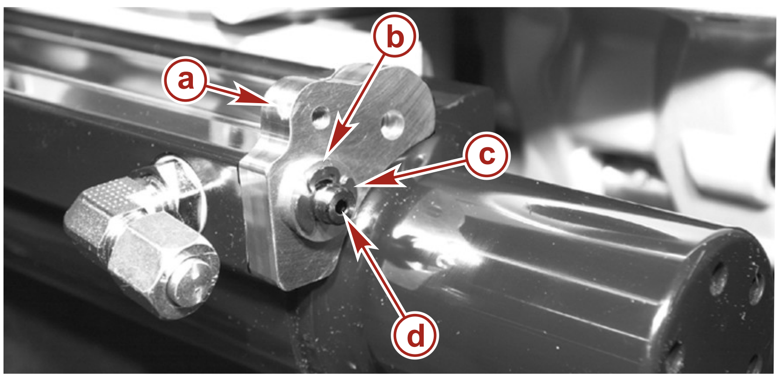
NOTICE
Inspect the steering arm on the outboard. If the steering arm does not have two mounting bosses for the rudder sensor magnet, order steering arm P/N 892367T02.



21007

Rudder Sensor Installation

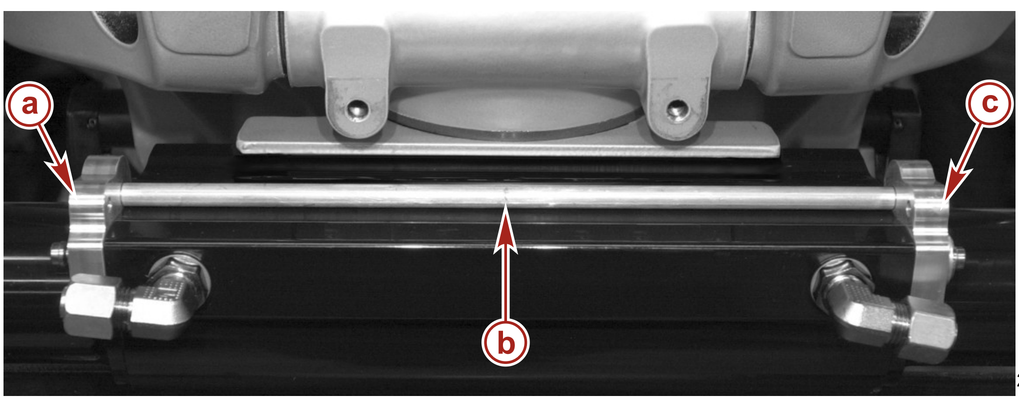
1. Install a bushing in one of the brackets.
2. Attach the bracket to the steering cylinder port end cap.
3. Install a retaining ring over the groove on the port bleed valve.



20306

a - Bracket
b - Bushing
c - Retaining ring
d - Bleed valve

4. Insert the autopilot tube in the hole in the port bracket.
5. Install a bushing in the starboard bracket.
6. Assemble the starboard bracket to the autopilot tube and the steering cylinder end cap.

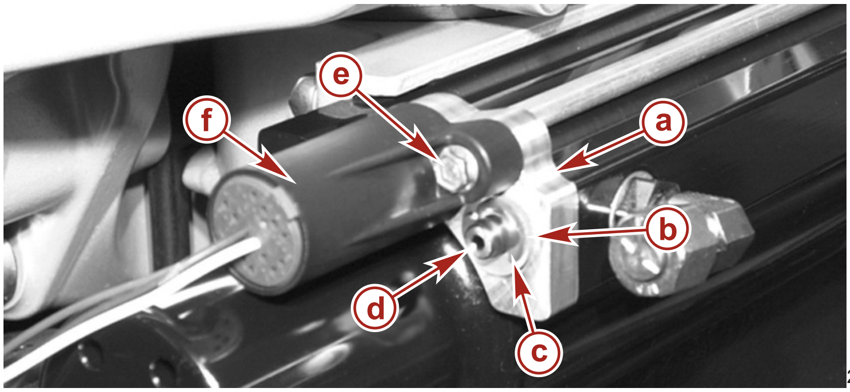


20307

a - Starboard side bracket
b - Autopilot tube
c - Port side bracket

7. Install a retaining ring over the groove on the starboard bleed valve.
8. Insert the rudder sensor into one end of the autopilot tube. Ensure that the rudder sensor is flush with the bracket before tightening the screw.

9. Secure the rudder sensor with a (M5 x 25) screw. Tighten the screw to the specified torque.



20308

a - Starboard side bracket
b - Bushing
c - Retaining ring
d - Bleed valve
e - Screw (M5 x 25)
f - Rudder sensor

Description	Nm	lb. in.	lb. ft.
Rudder sensor attaching screw (M5 x 25)	4	35	

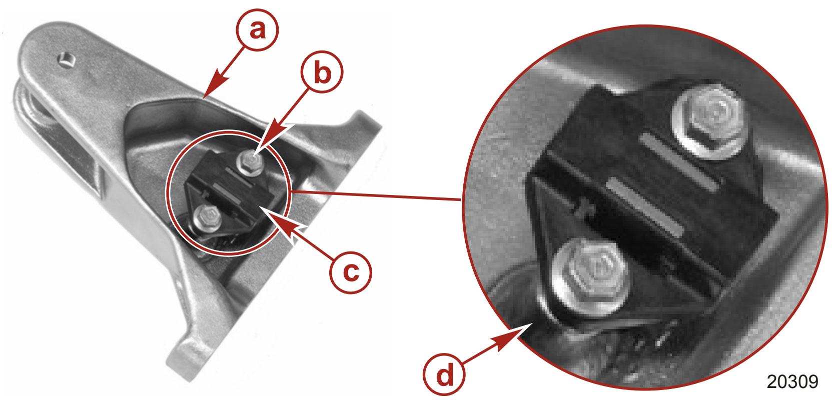
10. Seal the opposite end of the autopilot tube with RTV 587 Silicone Sealer.

Tube Ref No.	Description	Where Used	Part No.
116	RTV 587 Ultra Blue Silicone Sealer	Rudder sensor autopilot tube	92-809825

Magnet Installation

1. Attach the magnet assembly to the underside of the steering arm using two (M5 x 12) screws. Tighten the screws to the specified torque.

   NOTE: *The magnet assembly must be installed as shown.*



20309

a - Steering arm
b - Screw (M5 x 12) (2)
c - Magnet
d - Mounting boss (2)

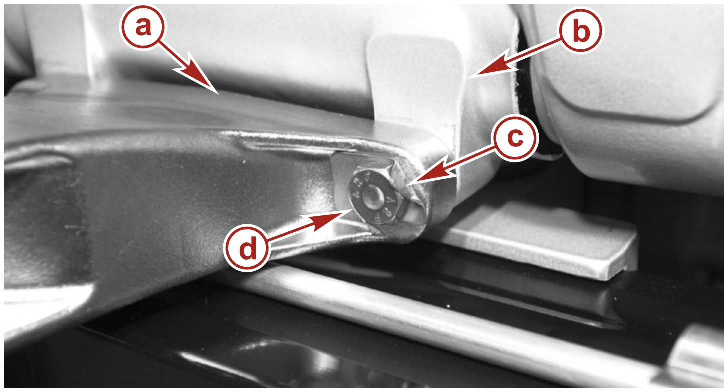
Description	Nm	lb. in.	lb. ft.
Rudder magnet attaching screw (M5 x 12)	4	35	

IMPORTANT: The steering arm must be fastened to the engine using special screws. The use of any other unauthorized fastener may result in the steering arm disconnecting from the engine.

2. Install the steering arm to the steering head with two special screws and two locking retainers with the locking tabs facing up. Apply Loctite 271 Threadlocker to the first four threads of the screws.

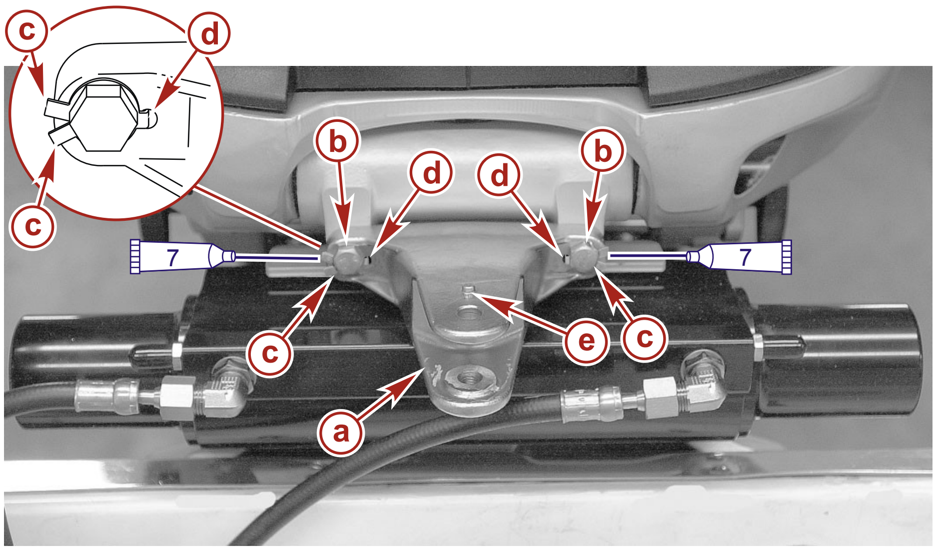
   NOTE: *The design tie bar arm utilizes a locking retainer that bends against the attaching screw. The design 2 tie bar arm has locating holes which a finger of the locking retainer is inserted into before the other fingers are bent against the attaching screw.*

3. While holding the locking retainer in position, torque the screws to specification. Bend one locking tab of each retainer against a flat of each screw.



20310

Design 1
- a - Steering arm
- b - Steering head
- c - Locking tab bent against screw (2)
- d - Special screw (10-896555025) (2)



18450

Design 2
- a - Tie bar arm
- b - Tie bar arm attaching screw
- c - Locking finger
- d - Retainer locating hole
- e - Locating tab

Description	Nm	lb. in.	lb. ft.
Steering arm attaching screw (M8 x 25)	55		40.5

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	First four threads of special screw (10-896555025)	92-809819

Wire Connections

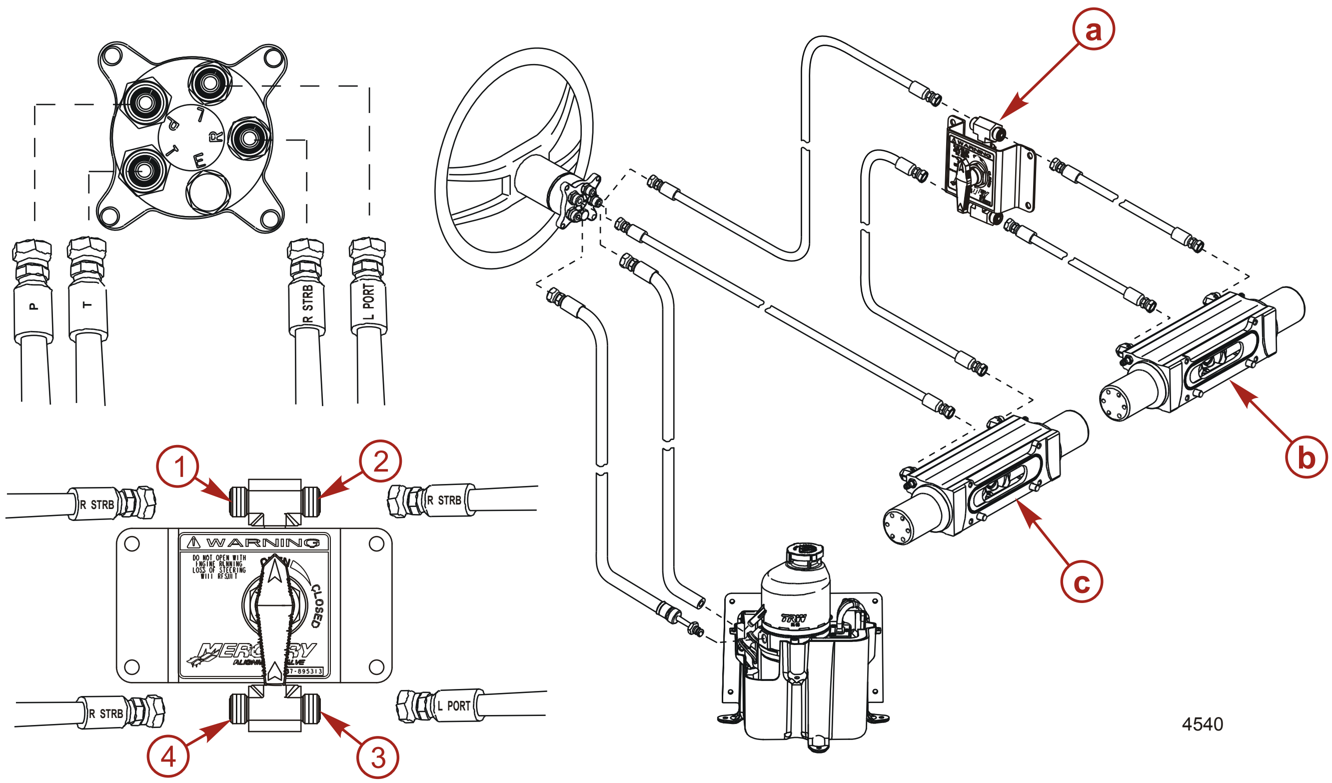
Rudder Sensor Wire Color	Description
Green	Output
Brown	Supply
White	Ground

Liquid Tie Bar

Liquid Tie Bar Installation

1. Mount the tie bar valve in an area where the valve will be accessible for making periodic realignments.
2. Install steering cylinder (896500A01) to left hand rotation outboard (XL, XXL). Follow installations instructions which are provided with steering cylinder.
3. Refer to **Mercury Precision Parts Accessories Guide** and order the hydraulic hoses in the required length.

4. Connect hydraulic hoses to the steering helm and power steering pump following instructions which accompany the steering helm and pump.
5. Connect hydraulic hoses between tie bar valve and steering cylinders.



a - Tie bar valve
b - Steering cylinder, starboard outboard
c - Steering cylinder, port outboard

Steering Helm Fitting ID Mark	Hose ID Mark	Description
P	P	Pressure from pump to helm
T	T	Tank low pressure return to pump
R	R-STRB	Hose connects to tie bar valve
L	L-PORT	Hose connects to port side fitting on port steering cylinder

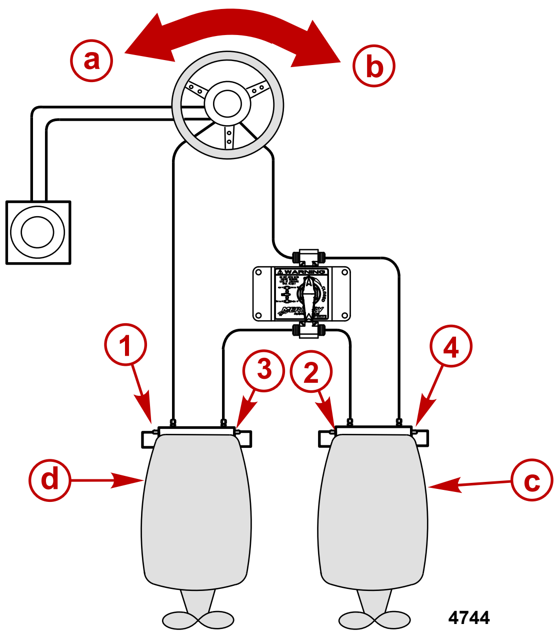
Tie Bar Valve Fitting ID	Hose ID Mark	Description
1	R-STRB	Hose connects to R fitting on steering helm
2	R-STRB	Hose connects to starboard side fitting on starboard steering cylinder
3	L-PORT	Hose connects to port side fitting on starboard steering cylinder
4	R-STRB	Hose connects to starboard side fitting on port steering cylinder

6. Open tie bar valve.
7. Fill steering system with SAE 0W-30 Full Synthetic Power Steering Fluid. Follow filling instructions provided with the power steering pump. Complete the bleeding instructions following.

Bleeding Instructions

1. Have the engines running, or electrically operate the power steering pump using the power steering module primer kit (90-895040K01).

2. Open the tie bar valve.



a - Port steering wheel direction
b - Starboard steering wheel direction
c - Starboard outboard
d - Port outboard

Power Steering Module Primer Kit	91-895040K01

NOTE: Attach an 8 mm (5/16 in.) transparent bleed hose to the bleed fitting being opened. Route the other end of the bleed hose back into the steering pump tank. Do not bleed the power steering fluid into a different container. This will pump fluid out of the system that was just filled up.

3. Turn the steering wheel to starboard until the port outboard is facing bleed fitting 1 and contacting the full steering stop. Do not allow the outboard to move from this position. Open bleed fitting 1 until an air-free stream of fluid comes from the fitting. Close bleed fitting 1.
4. Take hold of the starboard outboard and turn it so it is facing bleed fitting 2 and contacting the full steering stop. Do not allow the outboard to move from this position. Open bleed fitting 2 until an air-free stream of fluid comes from the fitting. Close bleed fitting 2.
5. Open bleed fitting 3. Take hold of the port outboard and turn it so it is facing bleed fitting 3 and contacting the full steering stop. Do not allow the outboard to move from this position. Leave the bleed fitting open until an air-free stream of fluid comes from the fitting. Close bleed fitting 3.
6. Open bleed fitting 4. Take hold of the starboard outboard and turn it so it is facing bleed fitting 4 and contacting the full steering stop. Do not allow the outboard to move from this position. Leave the bleed fitting open until an air-free stream of fluid comes from the fitting. Close bleed fitting 4.
7. Close the tie bar valve.
8. Turn the steering wheel from full stop to full stop a few times.
9. Refer to realignment instructions (following) to ensure the outboards are set straight.

Realignment Instructions

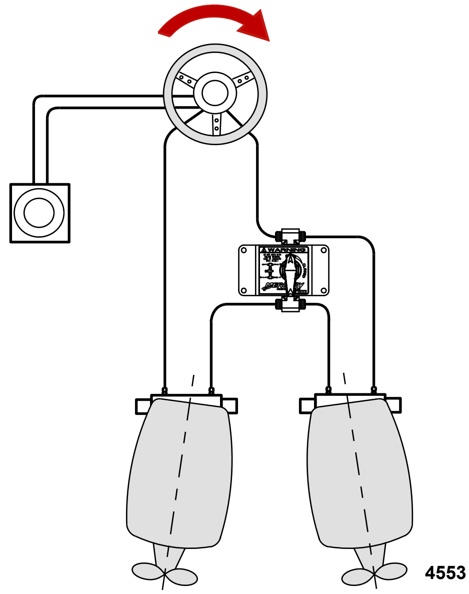
During normal usage, it is possible for the outboards to become misaligned. Outboard alignment should be checked before each use.

If misalignment occurs, complete the following steps to realign.

Propellers too Far Apart

1. Have the engines running, or electrically operate the power steering pump using the power steering module primer kit (90-895040K01).
2. Turn the steering wheel to full starboard. Both outboards will move. Starboard outboard will contact its full steering stop first.
3. After the starboard outboard contacts its full steering stop, open the tie bar valve.
4. Continue to turn the steering wheel to full starboard until the port outboard contacts its full steering stop.

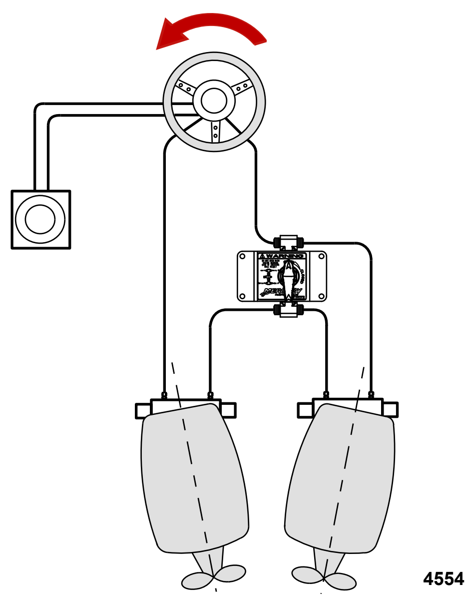
5. Close the tie bar valve.



Power Steering Module Primer Kit	91-895040K01

Propellers too Close Together

1. Have the engines running, or electrically operate the power steering pump using the power steering module primer kit (90-895040K01).
2. Turn the steering wheel to full port. Both outboards will move. The starboard outboard will contact its full steering stop first.
3. After the starboard outboard contacts its full steering stop, open the tie bar valve.
4. Continue to turn the steering wheel to full port until the port outboard contacts its full steering stop.
5. Close the tie bar valve.



Power Steering Module Primer Kit	91-895040K01

Power Steering

Power Steering Primer Module

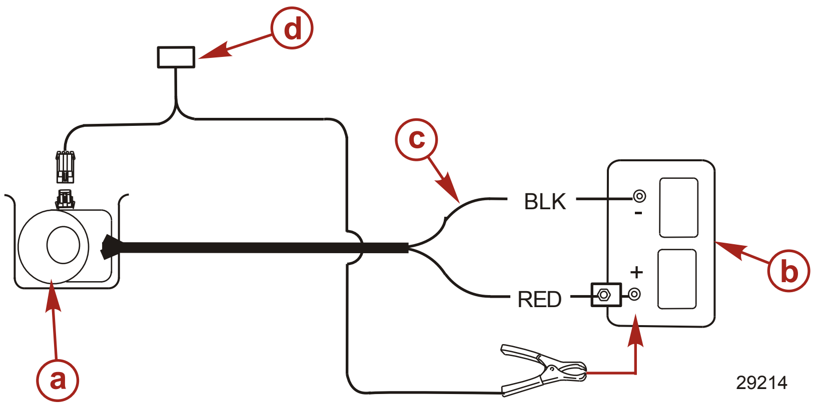
This power steering primer module is intended for bleeding the power steering system of Verado models, after initial installation or after servicing of the power steering system, without the need to run the engine.

Filling Power Steering System with Engine Not Running

Use SAE 0W-30 Full Synthetic Power Steering Fluid in the power steering system. In an emergency, if recommended power steering fluid is not available, the use of any full synthetic engine oil can be temporarily used. The power steering fluid should then be drained and replaced with SAE 0W-30 Full Synthetic Power Steering Fluid as soon as possible, to avoid loss of performance in power steering system.

Fluid Type	Capacity	Mercury Part Number
SAE 0W-30 Full Synthetic Power Steering Fluid	1–2 liters (1–2 US quarts) depending on length of steering hoses	92-858077K01

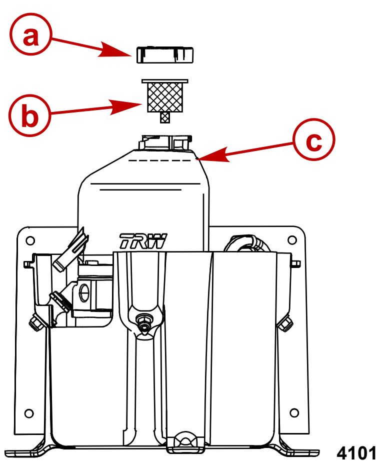
1. Disconnect power steering signal harness from engine signal harness.
2. Connect the power steering module primer kit to the power steering pump and 12 volt positive power source, as shown.



a - Power steering pump
b - Primary battery
c - Battery leads
d - Power steering module primer

Power Steering Module Primer Kit	91-895040K01

3. Remove the filler cap and filter from the power steering pump.
4. Fill the pump tank with the recommended power steering fluid.



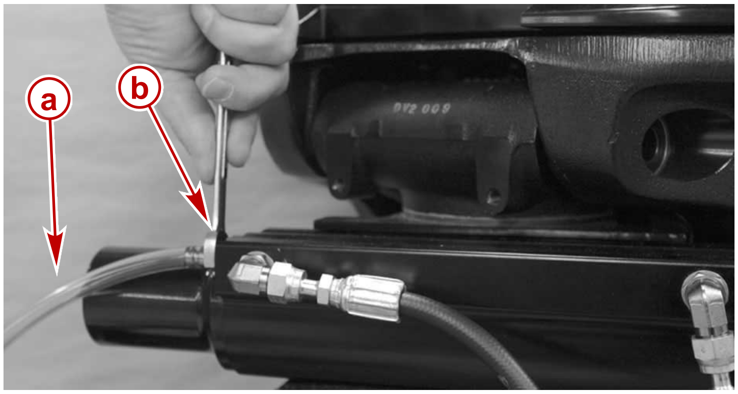
a - Fill cap
b - Filter
c - Full level

IMPORTANT: The power steering module primer has two switches, "POWER" - "ON" and "OFF," and "PUMP" - "ON" and "OFF." To power up and activate the power steering pump, there are two steps: 1) turn the "POWER" switch to the "ON" position to power up the pump, wait for two seconds, then, 2) turn the "PUMP" switch to the "ON" position to activate the pump.

IMPORTANT: Do not run the pump out of fluid. If the pump draws air during bleeding, the resulting rebleeding will take two to three times longer than the initial bleeding.

5. Power up and activate the pump until the fluid drops halfway. Turn off both switches on the power steering module primer and refill the pump tank. Repeat this operation until the pump tank stays full.
6. Power up and activate the pump while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until the fluid drops halfway. Stop turning the steering wheel and refill the pump tank. Repeat this operation turning the steering wheel from full lock to full lock 10 times until the pump tank stays full.
7. For bleeding any air left in the steering system, power up and activate the pump. Turn the steering wheel in one direction until the full lock position is met.

8. Attach an 8 mm ID (5/16 in. ID) transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route the bleed hose into the pump tank. Do not bleed the power steering fluid into a different container. This will pump fluid out of the system that was just filled up.
9. Open the bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from the system. Tighten the bleed valve securely and remove the bleed hose.



3640

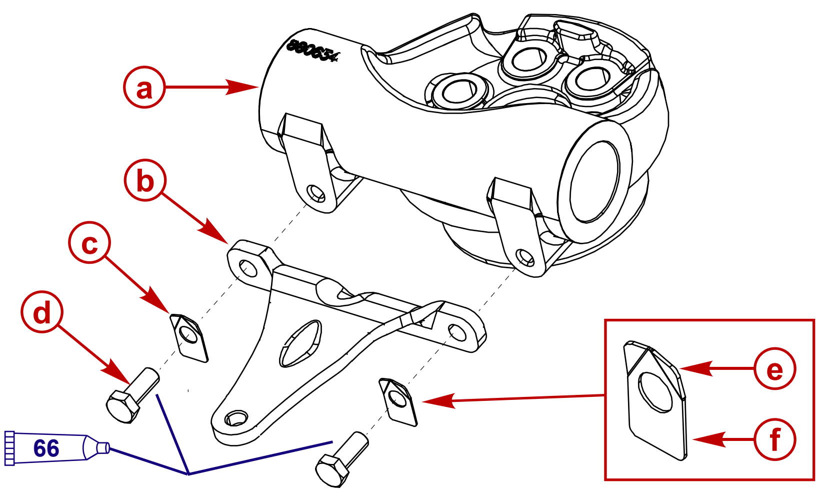
a - Bleed hose
b - Bleed valve in steering cylinder

10. Turn the steering wheel to the opposite full lock position and repeat steps 8 and 9.
11. Replace the filter and fill cap on the power steering pump.
12. The power steering system can be rechecked after sitting overnight to remove any air that may be left in the system. Repeat the steps for bleeding steering system, preceding.
13. Turn off both switches, remove the power steering module primer, and reconnect the power steering signal harness from the engine to the pump.

Adapter Steering Arm - Kicker Engine

Installation Instructions

1. Clean threaded holes in steering head.
2. Apply a small amount of Loctite 242 Threadlocker to screw threads.
3. Attach kicker bracket to steering head with locking retainers and screws.
4. Tighten screws to specified torque.



4034

a - Steering head
b - Kicker bracket
c - Locking retainer
d - Mounting screw
e - Top ear of retainer
f - Bottom of retainer

Description	Nm	lb. in.	lb. ft.
Mounting screw (2)	25		18.4

Tube Ref. No.	Description	Where Used	Part Number
66	Loctite 242 Threadlocker	Mounting screws	92-809821

5. Bend top ear of retainer over screw head to lock.
6. Bend bottom of retainer down over bracket.

7. Connect (accessory) steering tie bar between steering arm bracket of main power outboard and steering bracket of kicker outboard, following instructions supplied with steering tie bar.

Analog Gauge Interface (AGI)

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

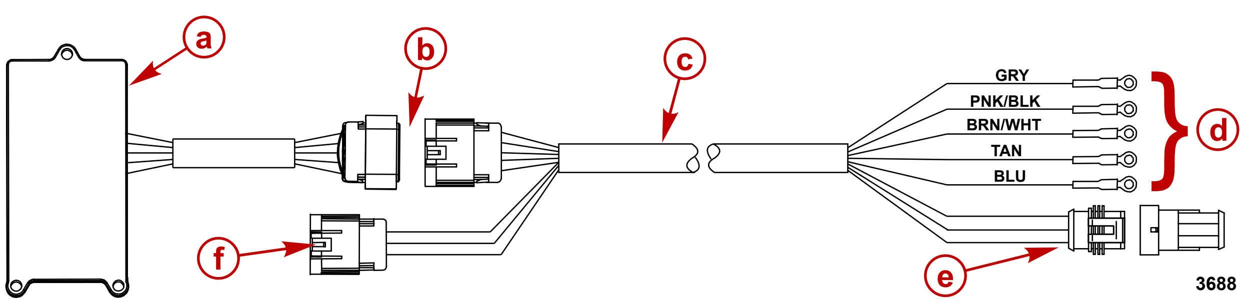
Analog Gauge Interface (AGI) Installation

NOTE: This analog gauge interface (AGI) can only be used with the 14 pin digital throttle and shift (DTS) system to drive analog and/or SmartCraft System Link gauges. For analog gauges, use ring terminals on AGI harness to connect to analog sender inputs on gauge backs, and tape back any unused terminals. For SmartCraft System Link gauges, use 3 pin System Link connection on AGI harness. The AGI system can support ten System Link gauges per helm, two helms maximum.

IMPORTANT: Mount AGI module with wires coming out of potting facing downward to prevent moisture from collecting at base of wires and wicking into module. Route and secure all wires and harnesses away from hot or moving parts.

1. With screws and washers supplied in kit, mount the AGI module securely under the dash or helm in close proximity to the gauges being used.
2. Refer to the following table for AGI harness wire color/analog gauge sender input connections. Tape back any unused terminals. Secure the connections per the gauge manufacturer's specifications.

Analog Gauge Type	AGI Harness Wire Color
Tachometer	Gray
Oil pressure/oil level	Blue
Water temperature	Tan
Trim positions	Brown/white
Fuel level	Pink/black

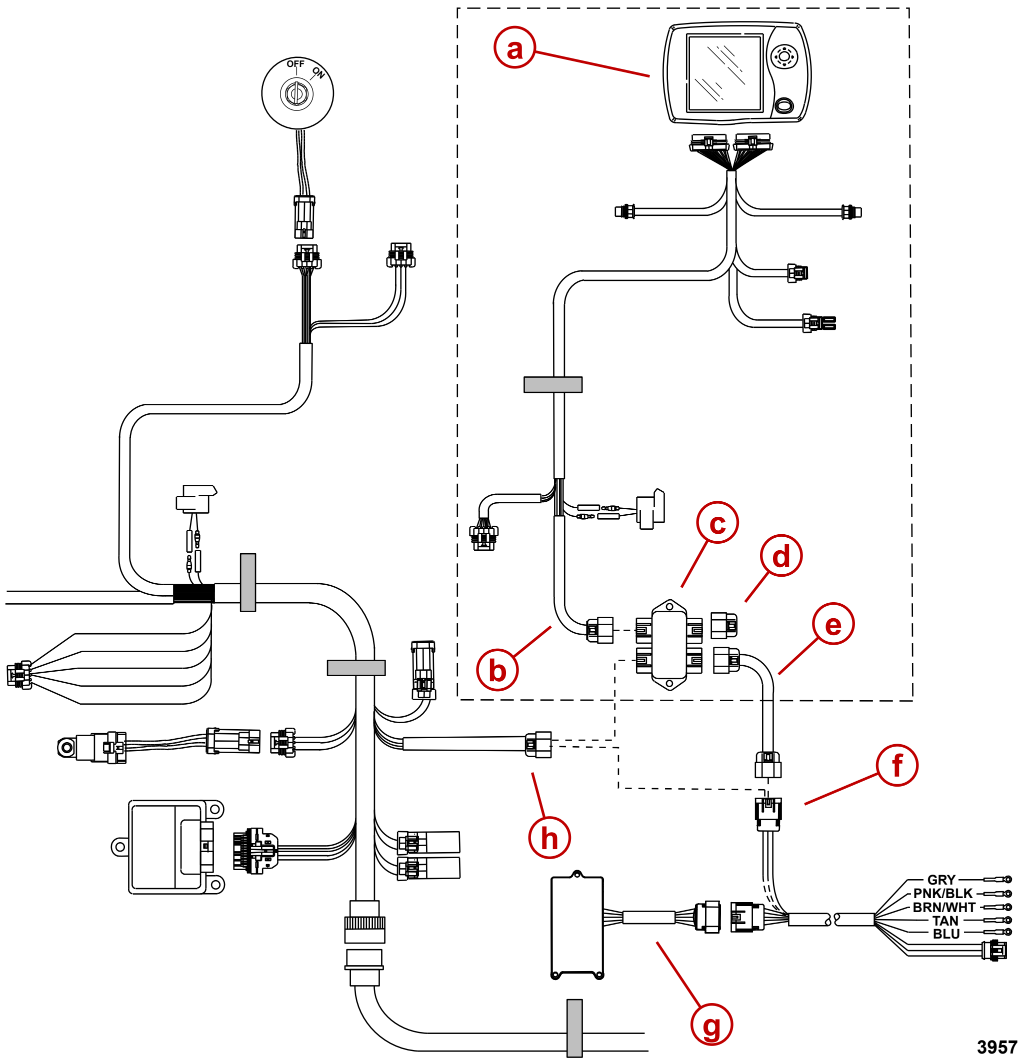


a - AGI module
b - 14 pin connection
c - AGI harness
d - Analog gauge terminal connections
e - System Link 3 pin connection
f - 10 pin CAN data connection

3. Route and connect the wire from the key switched 12 volt positive power source to the analog gauges. Secure the connections per the gauge manufacturer's specifications.

4. Route and connect the ground wire from the analog gauges to a common ground. Secure the connections per the gauge manufacturer's specifications.
5. Connect any SmartCraft System Link gauges to the System Link 3 pin connection. The AGI system can support ten System Link gauges per helm, two helms maximum.
6. Plug the 14 pin AGI harness connection into the AGI module.
7. Connect the 10 pin CAN data harness connection on the command module harness to the AGI harness.
    a. If the SmartCraft System View is not being used, plug the 10 pin CAN data connection on the AGI harness directly into the 10 pin CAN data connection on the command module harness.
    b. If the SmartCraft System View is being used, a junction box and harness adapter will be required. Plug the 10 pin CAN data connection on the command module harness, 10 pin CAN data connection on the System View harness, and one end of the harness adapter into the junction box. Plug the 10 pin CAN data connection on the AGI harness into the other end of the harness adapter. Insulate any unused connection ports on the junction box with weather caps.

Typical AGI Application with System View



a - System View display
b - 10 pin CAN data connection on System View harness
c - SmartCraft junction box
d - Weather cap
e - Harness adapter
f - 10 pin CAN data connection on AGI harness
g - AGI module
h - 10 pin CAN data connection on command module harness

Configuring Analog/Digital Tachometer Signal through PCM

IMPORTANT: The engine propulsion control module (PCM) tachometer configuration factory default has been set to an analog. This will allow the operation of one analog tachometer. Depending on the desired use of analog/digital gauges, the PCM set-up may have to be configured from analog to a digital.

Following are optional uses of analog and digital gauges and the setting for the tachometer configuration in the PCM necessary to run them.

Gauge Configuration	Analog	Digital
Analog tachometer only	**X**	
System Link gauges used with System View, System Monitor, or System Tach	-	-
System Link gauges used in conjunction with System Link adapter harness and command module harness without the use of System View, System Monitor, or System Tach		**X**
AGI used with or without System View, System Monitor, or System Tach, to run analog and System Link gauges		**X**

The computer diagnostic system (CDS) can be used to select analog or digital PCM tachometer configuration.

PCM Configuration with CDS

1. Attach the CDS to the engine. Refer to the on-line help if needed.
2. From the "Logon" screen, navigate to the "Engine Select" screen.
3. From the "Engine Select" screen, fill in the engine type information and select "Tool Box."
4. From the "Tool Box" screen, select "Active Diagnostics."
5. From the "Active Diagnostics" screen, scroll down and select "Tach Link Config."
6. To change the PCM configuration from the default of analog to digital, select "Enable" and then select "Run."
7. To change the PCM configuration from the digital to analog, select "Disable" and then select "Run."

Notes:

Power Steering

Section 8A - Power Steering

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A

Power Steering Specifications

Power Steering Specifications	
Fluid type	SAE 0W-30 Synthetic Power Steering Fluid
Capacity	Typical 1–2 liters (1–2 US qt)
Current draw	Shall not exceed 75 amps
Steering ratio (40 cc helm and single steering cylinder, lock to lock)	4.1 turns
Steering ratio (50 cc helm with dual steering cylinders, lock to lock)	6.5 turns

Lubricant, Sealant, Adhesives

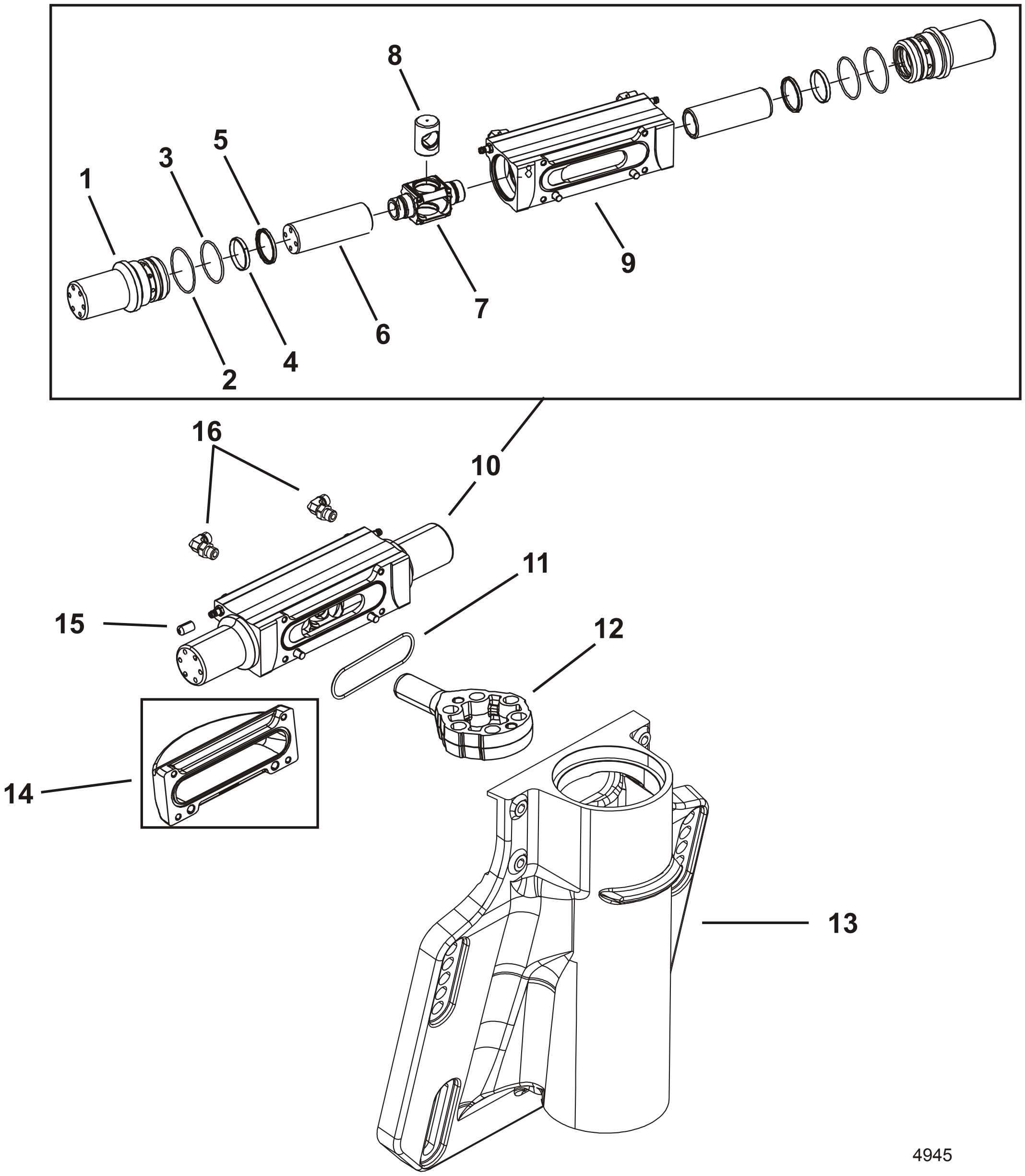
Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Steering cylinder housing O-ring	92-858076K01

Special Tools

Power Steering Module Primer Kit	91-895040K01
 5547	Bleeds power steering system without running engine.

Notes:

Power Steering Cylinder Components

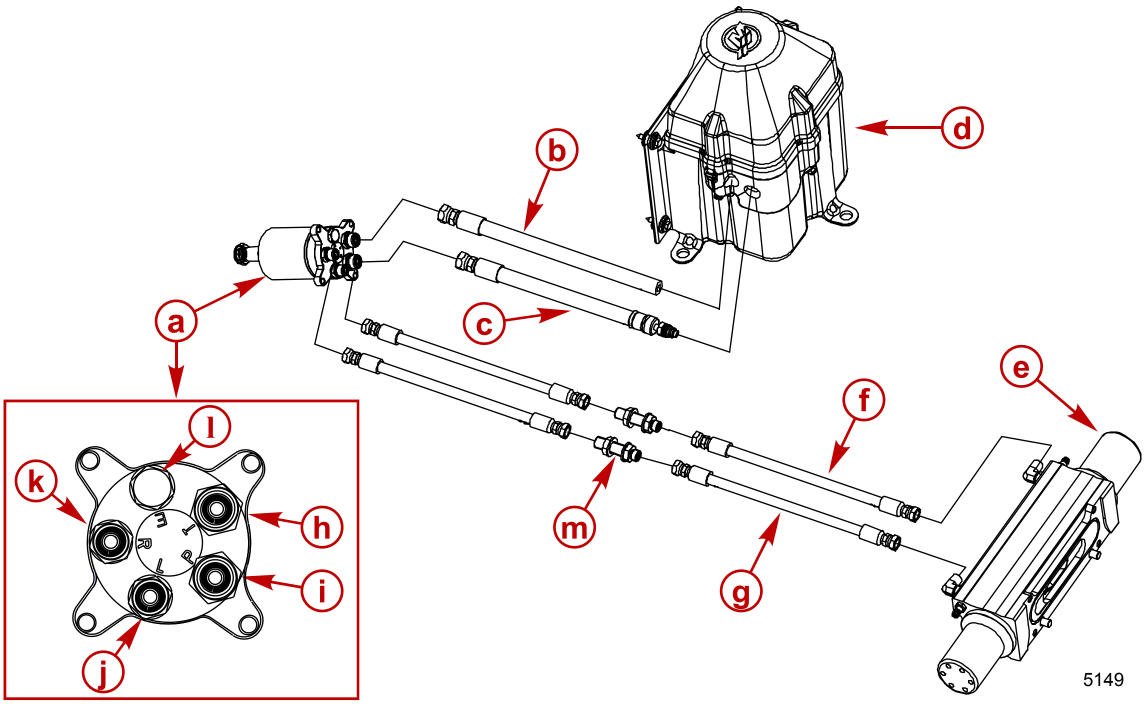


Power Steering Cylinder Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	2	End cap	271		200
2	2	O-ring			
3	2	O-ring			
4	2	Wear ring			
5	2	Seal			
6	2	Piston			
7	1	Center union assembly			
8	1	Pivot pin assembly			
9	1	Steering housing			
10	1	Steering cylinder assembly			
11	1	Seal			
12	1	Steering arm			
13	1	Pedestal			
14	1	Cover counter rotation			
15	1	Cap bleeder			
16	2	Elbow			

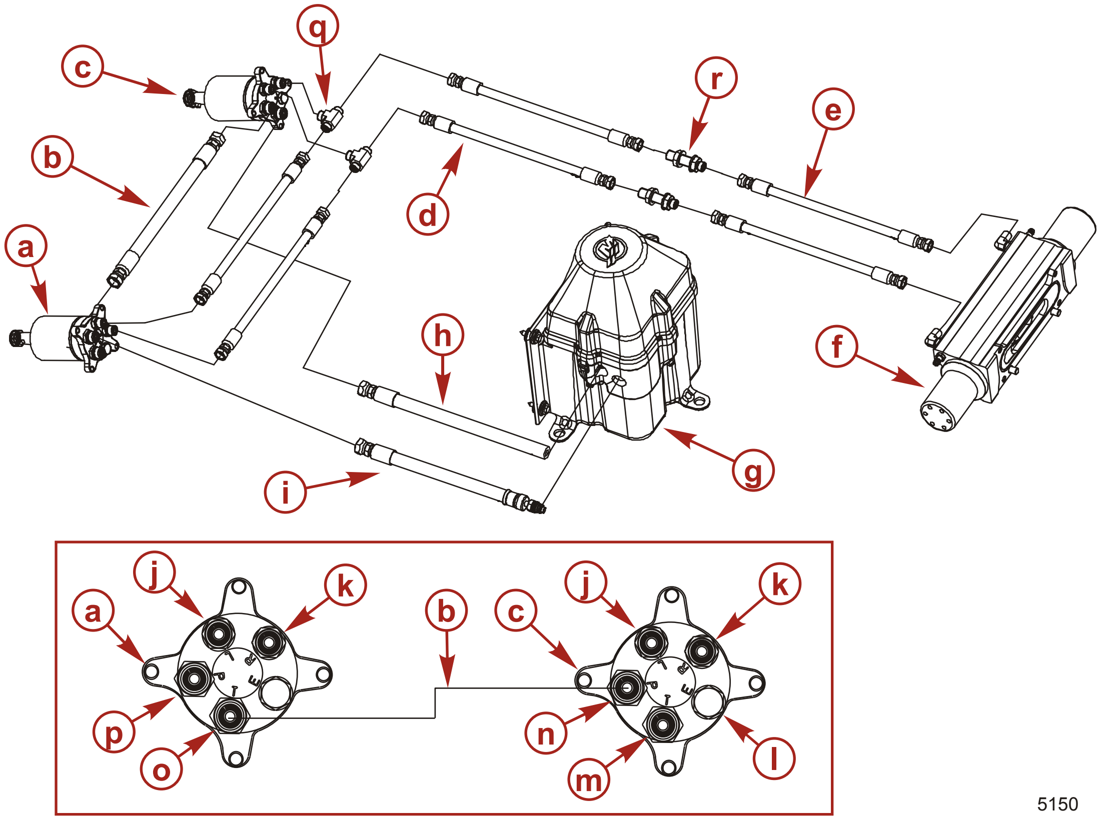
Power Steering Systems

Single Helm - Single Cylinder



- a - Helm
- b - Tank hose (T)
- c - Pressure hose (P)
- d - Power steering pump module
- e - Power steering cylinder
- f - Starboard steering hose (R-STAR)
- g - Port steering hose (L-PORT)
- h - "T" - Tank connection
- i - "P" - Pressure connection
- j - "L" - Port connection
- k - "R" - Starboard connection
- l - Plug
- m - Bulkhead fitting (2) (optional)

Dual Helm - Single Cylinder

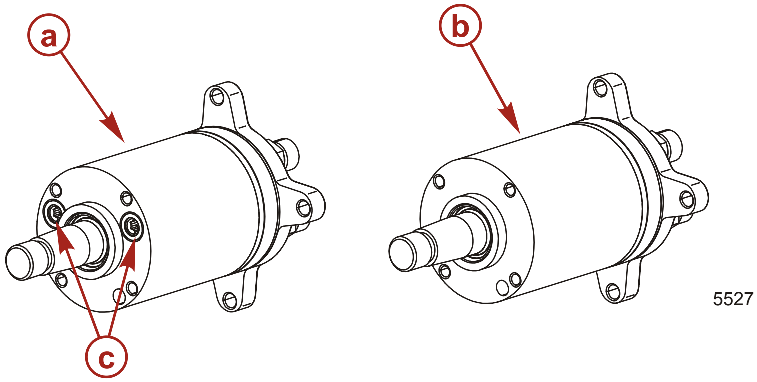


- **a -** Dual helm 1
- **b -** Tank 1 to pressure 2 hose
- **c -** Standard helm 2
- **d -** Port steering hose (L PORT)
- **e -** Starboard steering hose (R STAR)
- **f -** Power steering cylinder
- **g -** Power steering pump module
- **h -** Tank hose (T)
- **i -** Pressure hose (P)
- **j -** "L" - Port connection
- **k -** "R" - Starboard connection
- **l -** Plug
- **m -** "T" - Tank 2 connection
- **n -** "P" - Pressure 2 connection
- **o -** "T" - Tank 1 connection (to "P" 2)
- **p -** "P" - Pressure 1 connection
- **q -** T-fitting (2)
- **r -** Bulkhead fitting (2)

Dual Station Steering Helm Identification

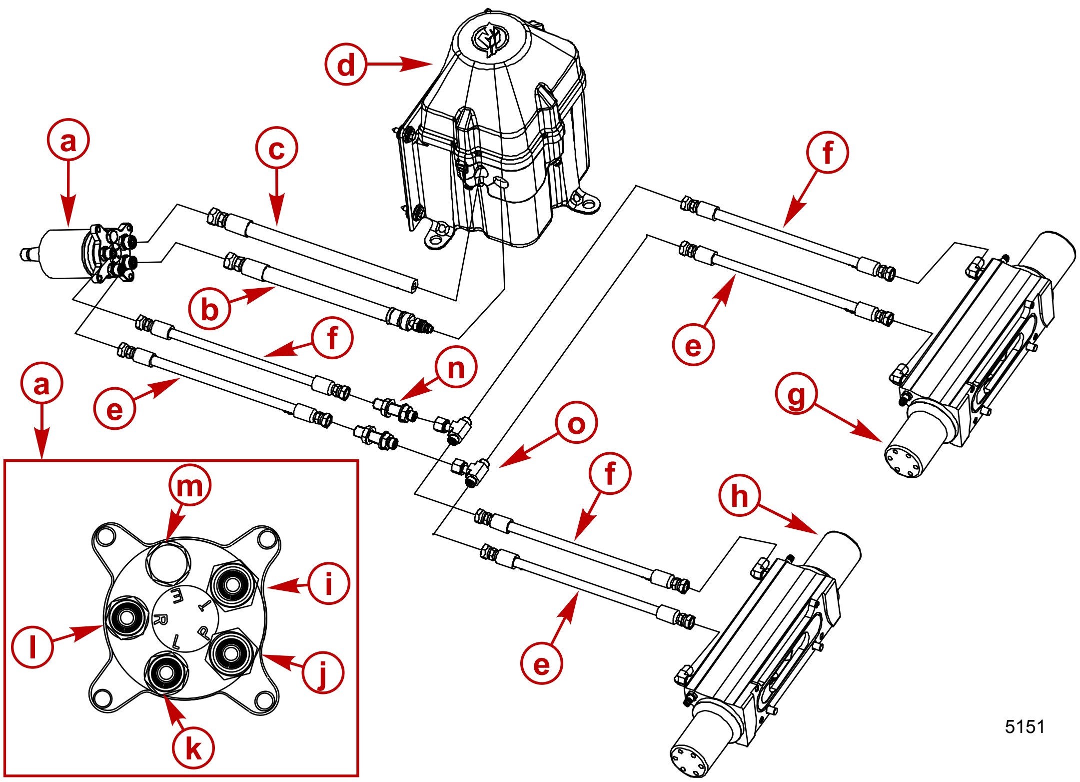
IMPORTANT: The dual station steering helm must be mounted as the primary helm (first in-line from the pump).

The external appearance of the dual station steering helm is very similar to a standard steering helm. The only external difference between helms is that the standard steering helm has two plugs located in the front end of the helm.



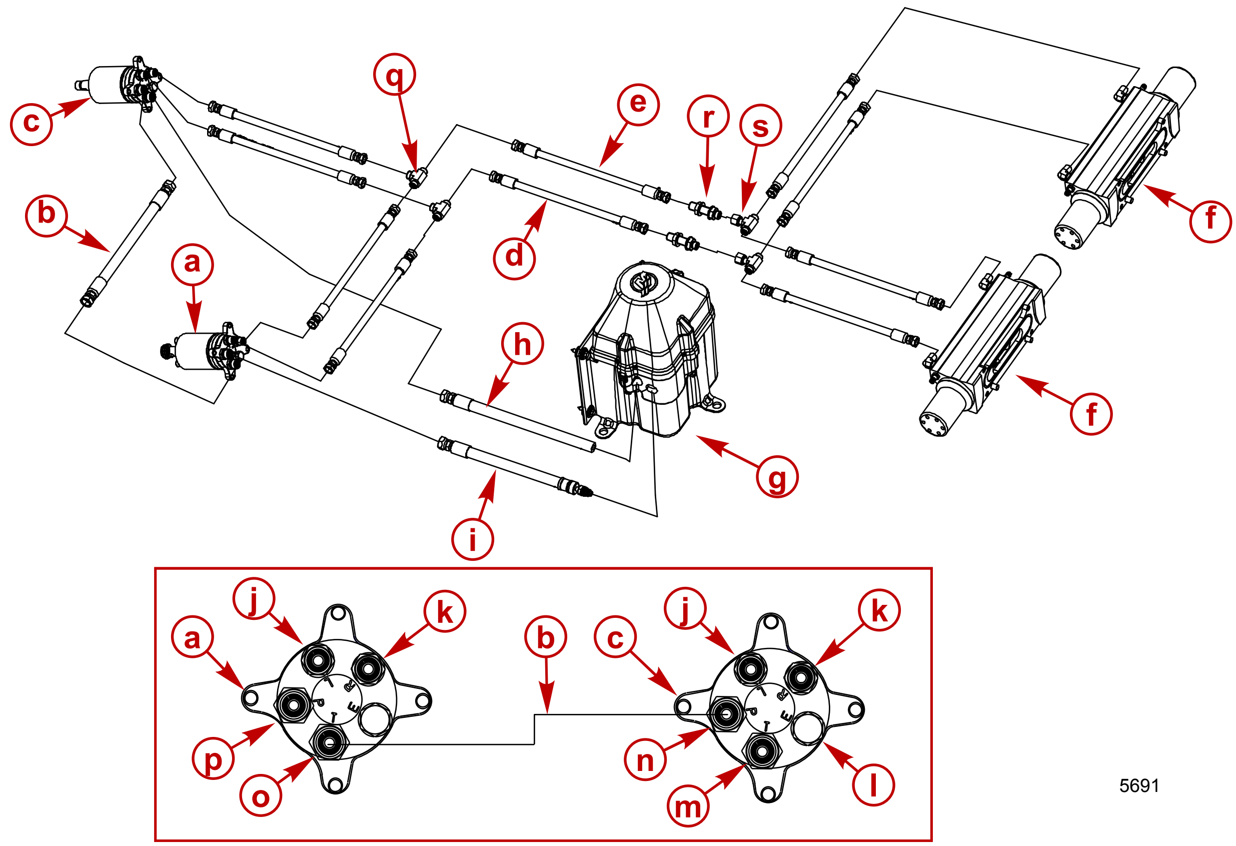
- a - Standard steering helm 2
- b - Dual station helm 1
- c - Plugs

Single Helm - Dual Cylinder



- a - Helm
- b - Pressure hose (P)
- c - Tank hose (T)
- d - Power steering pump module
- e - Port steering hose (L PORT)
- f - Starboard steering hose (R STAR)
- g - Power steering cylinder 1
- h - Power steering cylinder 2
- i - "T" - Tank connection
- j - "P" - Pressure connection
- k - "L" - Port connection
- l - "R" - Starboard connection
- m - Plug
- n - Bulkhead fitting (2)
- o - Swivel t-fitting (2)

Dual Helm - Dual Cylinder

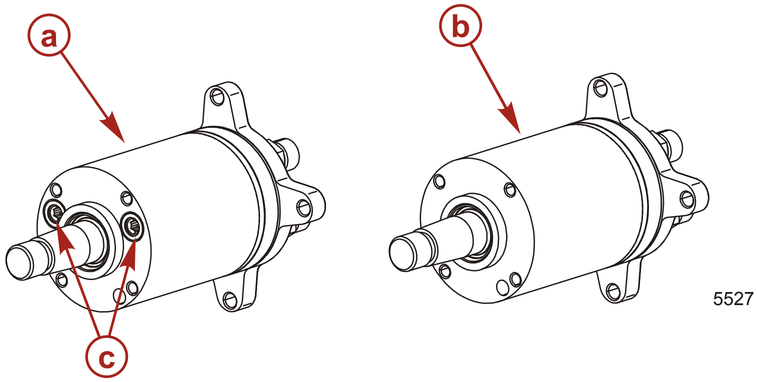


a - Dual helm 1
b - Tank 1 to pressure 2 hose
c - Standard helm 2
d - Port steering hose
e - Starboard steering hose
f - Power steering cylinder
g - Power steering pump module
h - Tank hose
i - Pressure hose
j - "L" - Port connection
k - "R" - Starboard connection
l - Plug
m - "T" - Tank 2 connection
n - "P" - Pressure 2 connection
o - "T" - Tank 1 connection (to "P" 2)
p - "P" - Pressure 1 connection
q - T-fitting (2)
r - Bulkhead fitting (2)
s - Swivel T-fitting (2)

Dual Station Steering Helm Identification

IMPORTANT: The dual station steering helm must be mounted as the primary helm (first in-line from the pump).

The external appearance of the dual station steering helm is very similar to a standard steering helm. The only external difference between helms is that the standard steering helm has two plugs located in the front end of the helm.



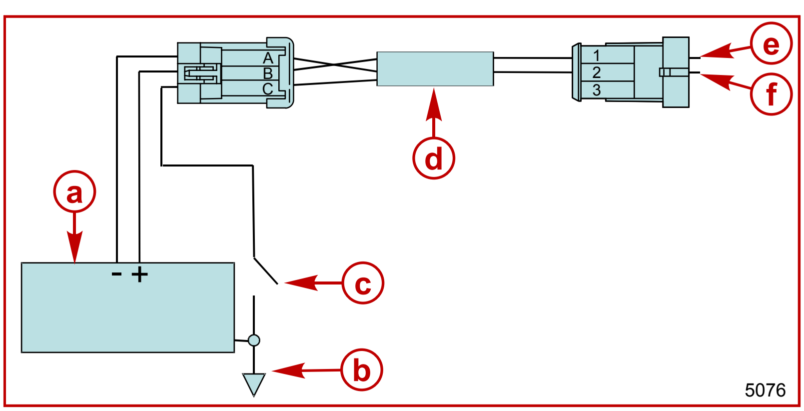
a - Standard steering helm 2
b - Dual station helm 1
c - Plugs

Troubleshooting the Power Steering System

Problem	Possible Cause	Remedy
Power steering system operates (pump runs), but the outboard does not steer.	Hose connections.	Check pressure and tank hoses for correct connections at helm.
Power steering system operates (pump runs), but the outboard does not steer, steers slowly, or erratic. Hose connections are correct.	Air in system.	Bleed the power steering system. Refer to **Filling Power Steering System with Engine Running.**
Power steering pump does not operate (pump does not run).	Blown fuse.	1. Check fuse at power steering pump. Replace if blown. 2. Check battery connection.
Power steering pump does not operate (pump does not run). Fuse is good.	Driver module.	1. Check pin connections. Refer to **Testing the Power Steering Driver Module.** Replace if defective. 2. Start pump with primer module. If pump starts, replace driver module. Refer to **Filling Power Steering System with Engine Not Running.**
Power steering pump does not operate (pump does not run). Fuse is good. Driver module is good.	Driver module harness.	Check driver module harness connections. Replace if defective.
Power steering pump does not operate (pump does not run). Fuse is good. Driver module is good. Signal harness is good.	Outboard PCM.	Test PCM. Refer to **Section 2A - Troubleshooting with the Computer Diagnostic System (CDS).**

Testing the Power Steering Driver Module

1. Use the following circuit to test the power steering driver module.



a - 12.0 volt DC power supply
b - Ground
c - Switch
d - Power Steering Driver Module (PSDM)
e - Test output pin 1
f - Test output pin 2

2. The PSDM input connects to the engine's main harness via a 3-way waterproof connector.
   a. Pin A provides system ground
   b. Pin B provides key switch battery voltage
   c. Pin C provides engine run signal
3. The PSDM output connects to the Electric Power Hydraulic Steering (EPHS) unit via a second 3-way waterproof connector.
   a. Pin 1 provides conditioned engine run signal
   b. Pin 2 provides key switch battery voltage
   c. Pin 3 is empty
4. Test the following power steering driver module functional characteristics.

Input Conditions	Output Results	With Respect to :
Pin A = ground Pin B = 12.0 V Pin C = open	Pin 1 = 0 V (ground) Pin 2 = 12.0 V	Pin A
Pin A = ground Pin B = 12.0 V Pin C = ground	Pin 1 = 11.5 - 12.5 V Pin 2 = 12.0 V	Pin A

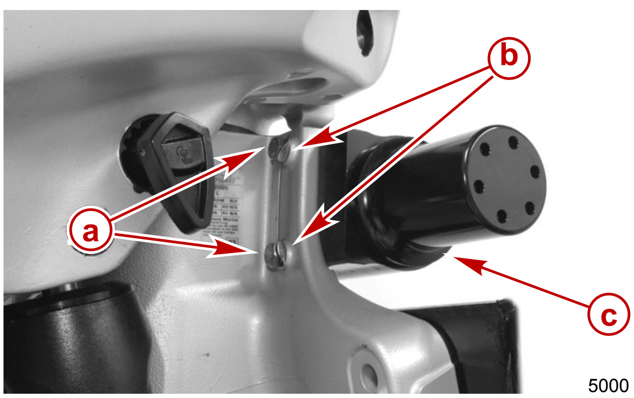
5. Check driver module for cracks, corrosion, separation of material and broken or partially separated leads.
6. If the driver module does not pass the test specifications or material defects are found, discard the driver module. The power steering driver module is not a repairable component.

Power Steering Cylinder

Steering Cylinder

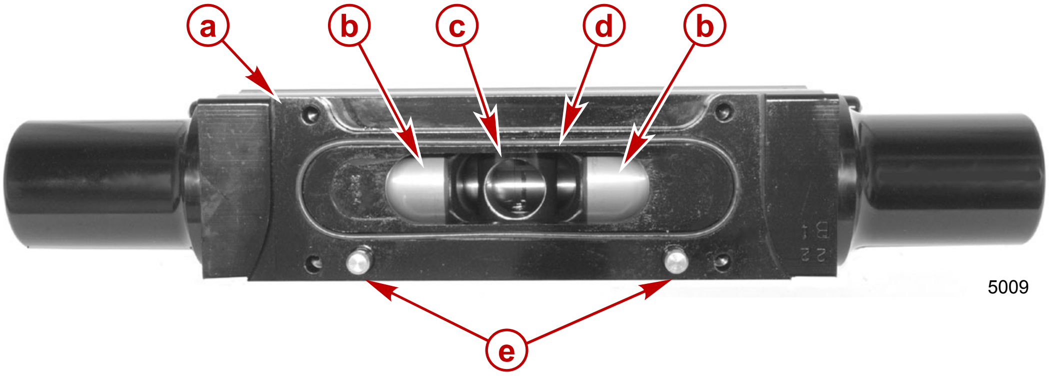
Removal

1. Disconnect the port and starboard hoses from steering cylinder. Label port and starboard hoses for reference. Cap and plug steering cylinder and hose end fittings.
2. Plug hose ends and cap the elbow fittings on the steering cylinder.
3. Flatten lock tabs on the steering cylinder mounting screw retainer.
4. Remove 2 mounting screws on each side of the outboard pedestal. Remove steering cylinder from pedestal.



a - Steering cylinder mounting screws (4) M8 x 30
b - Retainer lock tab
c - Steering cylinder

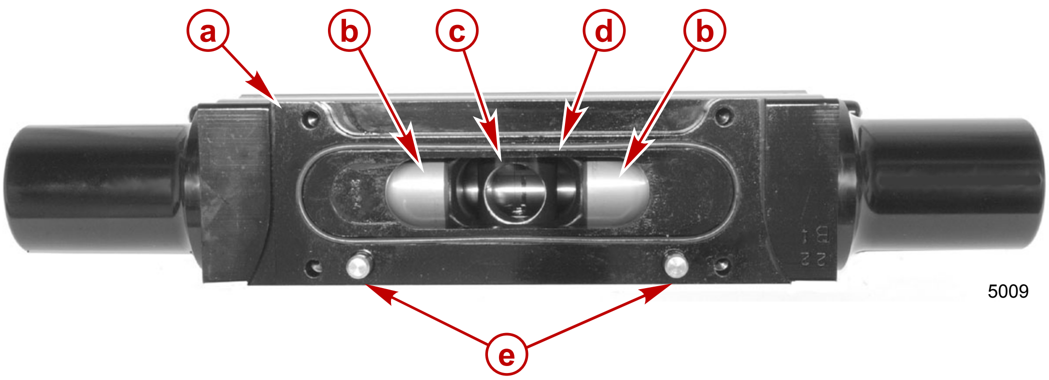
5. Remove O-ring from steering cylinder housing.



a - Steering cylinder housing
b - Steering cylinder piston
c - Pivot pin assembly and center union assembly
d - O-ring
e - Dowel pin (2)

Installation

1. Ensure mounting surface of the steering cylinder housing and pedestal are free of nicks and burrs.
2. Install new lubricated O-ring seal on steering cylinder mounting surface.

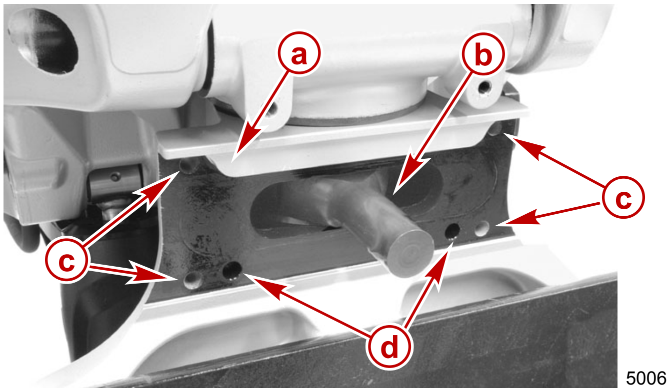


a - Steering cylinder housing
b - Steering cylinder piston
c - Pivot pin assembly and center union assembly
d - Steering cylinder housing O-ring
e - Dowel pin (2)

Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Steering cylinder housing O-ring	92-858076K01

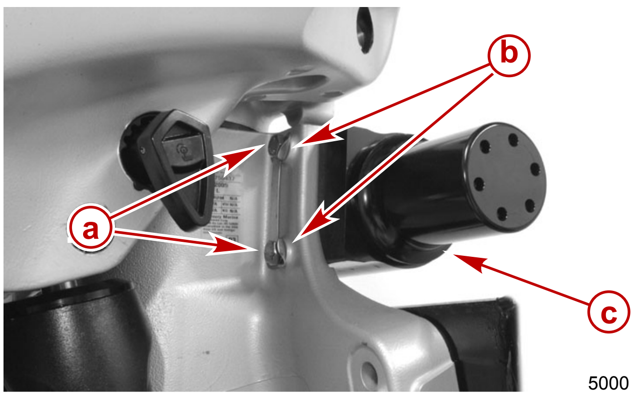
3. Align steering arm to center position.

4. Install steering cylinder on pedestal.



a - Pedestal
b - Steering arm
c - Through holes for mounting screws
d - Dowel pin holes

5. Secure steering cylinder with 4 screws and 2 retainers.
6. Tighten mounting screws to specified torque.
7. Bend retainer lock tab over a flat of each mounting screw.



a - Steering cylinder mounting screws (4) M8 x 30
b - Retainer lock tab
c - Steering cylinder

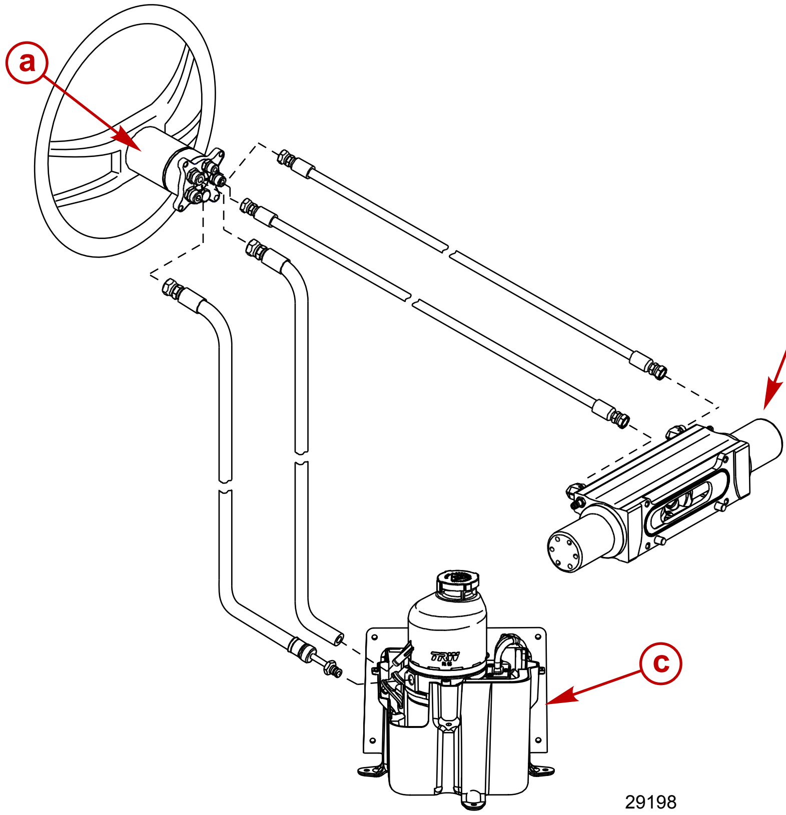
Description	Nm	lb-in.	lb-ft
Steering cylinder mounting screw	24.9		18.3

Steering Cylinder Service

The Verado steering cylinder is not serviceable. Order a new steering cylinder if service is required.

Power Steering Installation

Power Steering System



a - Steering helm
b - Steering cylinder on outboard
c - Power steering pump

Installation Procedure

NOTE: On some large/heavy dual outboard boats the steering forces generated in extreme maneuvers may create loads that exceed the pump's pressure capacity. The operator may feel intermittent periods of load feedback at the steering wheel. The steering wheel may feel hard to turn for brief periods during these extreme maneuvers. If steering performance is deemed unacceptable for the application, a second accessory cylinder may be rigged. When using a second steering cylinder, the 40 cc helm should be replaced with a 50 cc helm.

Selecting Location for the Power Steering Pump

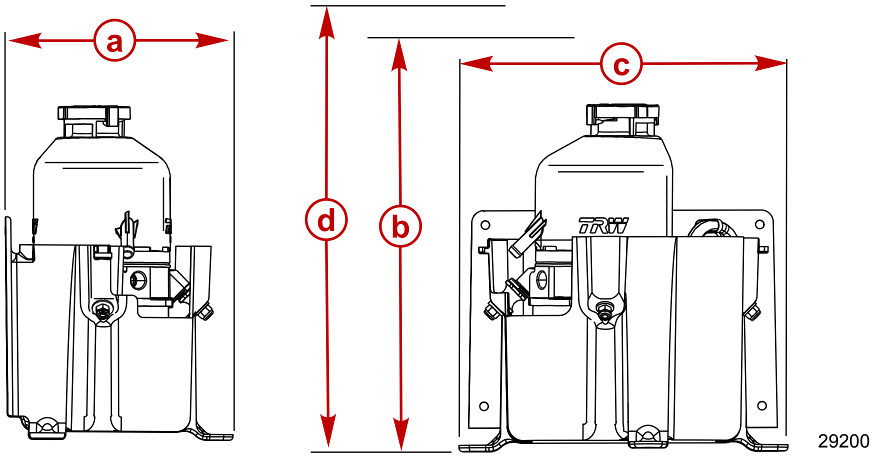
⚠ WARNING

Dirt or contaminants in the hydraulic steering system can damage the steering system's internal components. Damaged components can lead to serious injury or death due to loss of boat control. Do not allow dirt or contamination to enter the helm, lines, or cylinder of this steering system and perform all hydraulic inspections, service, or assembly procedures in a clean work area.

Select a mounting location (floor or side of internal bulkhead) for the installation of the power steering pump that meets the following requirements:

- To reduce noise on aluminum or metal hulls, isolate the steering hoses from the hull with suitable nonabrasive hangers.
- Steering hoses from the steering wheel helm must be free of twists or stress. Gently secure the hose bundle together with a cable tie located approximately 25.4 cm (10 in.) from the steering wheel helm.
- Do not mount the pump on an angle greater than 15° from the vertical position.
- The pump electrical wiring must be within reach of the auxiliary battery.
- Pump should be mounted in an area that allows sound enclosure, cover removal, and easy access to the fill cap.
- Install the pump in an area where the bilge water will not contaminate the pump.
- To reduce transmitted noise, mount the pump on a wood or fiberglass surface. Avoid mounting the pump on aluminum or steel surfaces.

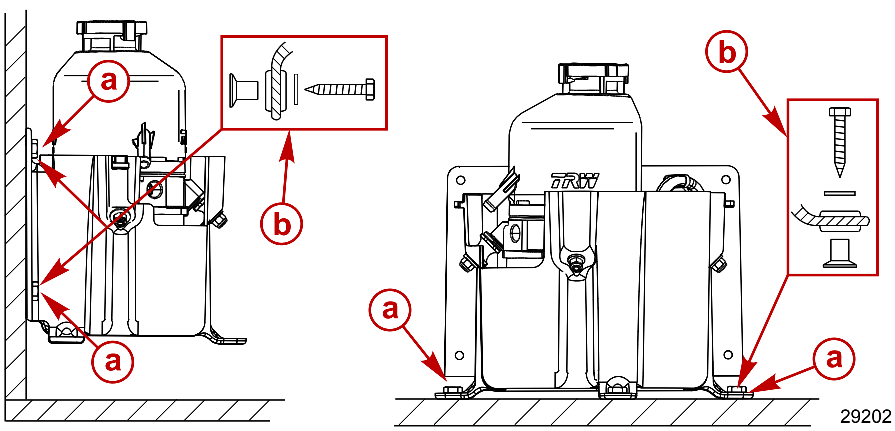
Required Mounting Clearances for the Power Steering Pump



a - 21.5 cm (8-1/2 in.)
b - 31.0 cm (12-7/32 in.) to top cover (not shown)
c - 28.5 cm (11-1/4 in.)
d - 43.2 cm (17 in.) clearance required for cover removal

Installing Power Steering Pump

1. The power steering pump can be mounted two ways:
   - On the side of the internal bulkhead
   - Mounted on the floor
2. Mount the power steering pump at the selected location using appropriate fastening hardware suitable for the type of material and thickness of the mounting surface.



Mounted on internal bulkhead

Mounted on floor

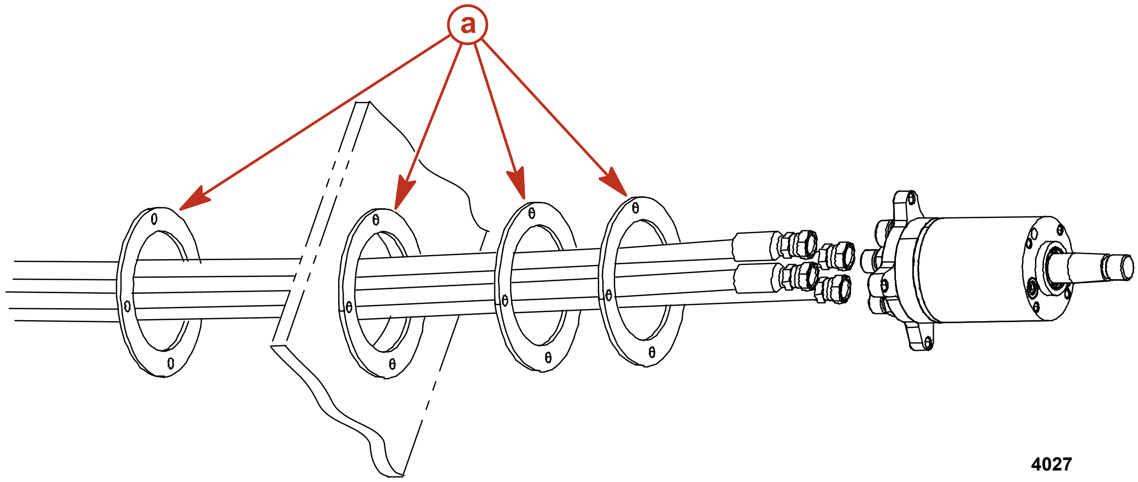
a - Lag screws or through bolts (3 or 4)
b - Mounting hardware

Connection of the Hydraulic Hoses to the Steering Helm

NOTE: Hoses must be routed up through the steering helm opening in the dash and secured to the helm fittings prior to mounting the steering helm.

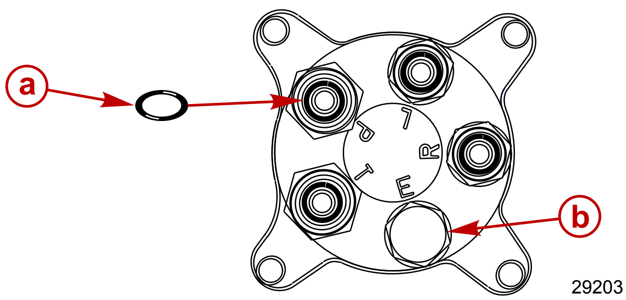
1. Place the steering hoses through one backing plate on the internal side of the dashboard. Route the steering hoses through the drilled opening, and place the required amount of backing plates on the hoses on the external side of the dashboard.

NOTE: The number of backing plates varies depending on helm displacement.



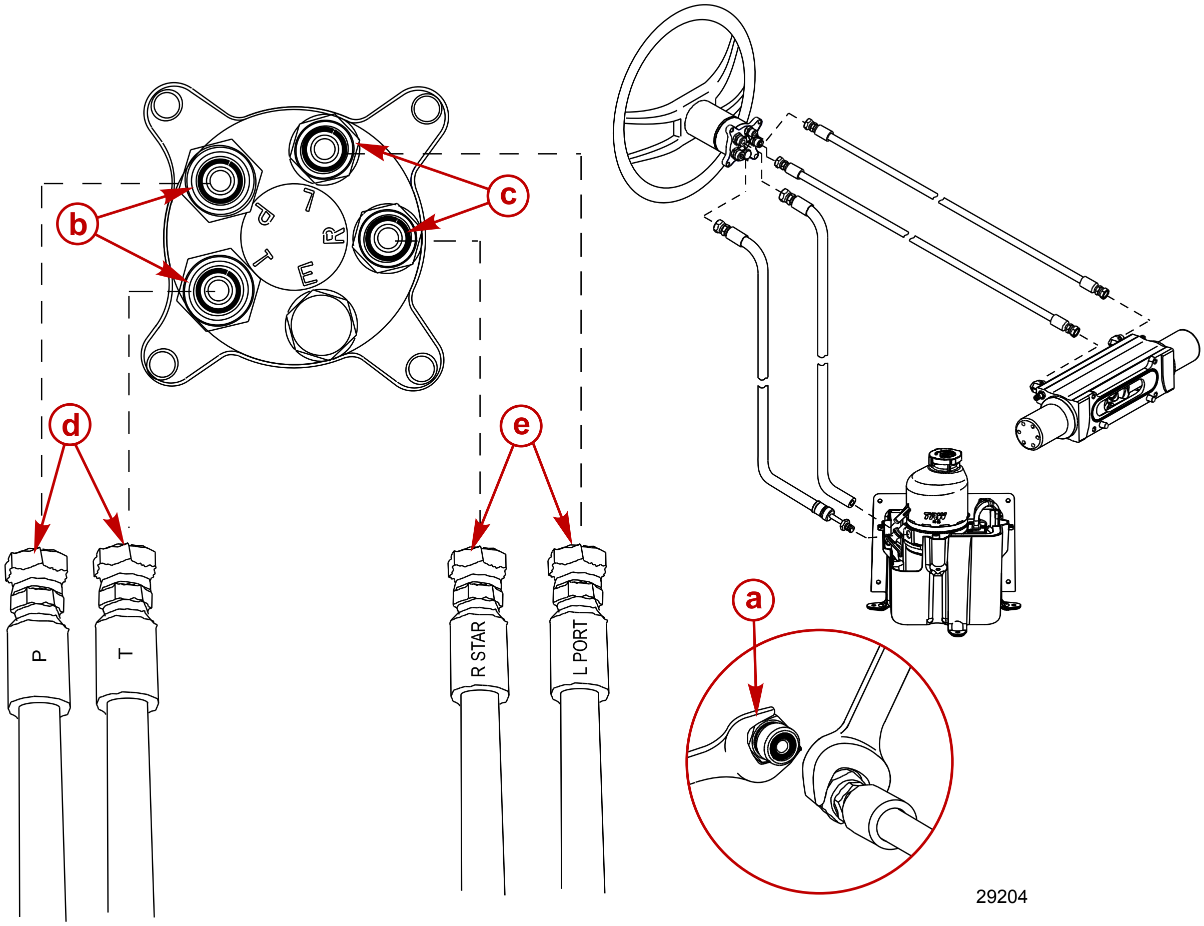
a - Backing plates

2. Remove and discard the shipping caps from the ends of the four fittings on the steering helm. Ensure the O-ring seals did not lift off with the shipping caps.
3. Ensure the O-ring seals are in place on the end of the steering helm fittings.



a - O-ring seals (4)
b - Plug - not used

4. Make the hose connections to the steering helm as shown. Use a thin wrench and hold the helm fittings from turning while tightening hoses. Do not overtighten the hose connections.



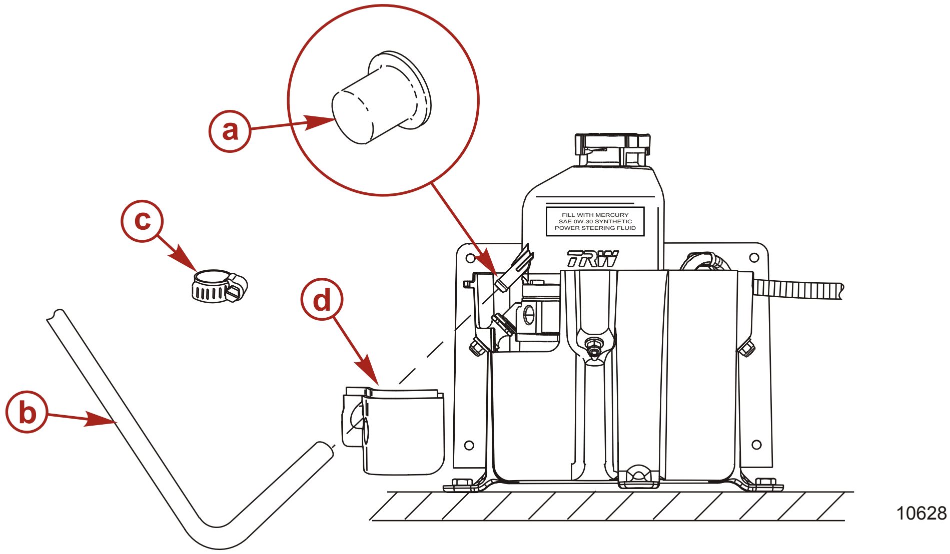
a - Thin wrench
b - Helm hex fitting wrench size (P and T) - 19 mm (3/4 in.)
c - Helm hex fitting wrench size (R and L) - 16 mm (5/8 in.)
d - Hydraulic hose hex fitting wrench size (P and T) - 21 mm (13/16 in.)
e - Hydraulic hose hex fitting wrench size (R STAR and L PORT) - 18 mm (11/16 in.)

Helm Fitting ID Mark	Hose ID Mark	Description
P	P	Pressure from pump to helm
T	T	Tank low pressure return to pump
R	R STAR	Hose connects to starboard side of steering cylinder
L	L PORT	Hose connects to port side of steering cylinder

Connection of the Hydraulic Hoses to the Power Steering Pump

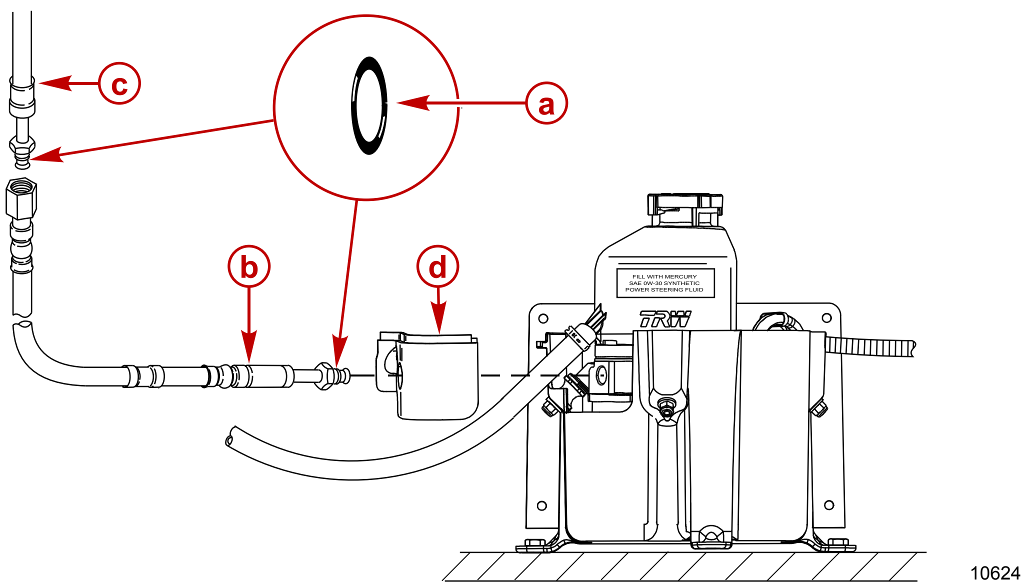
1. Remove and discard the yellow protector cap from the reservoir.

2. Connect the low-pressure hydraulic hose from the steering helm to the low-pressure fitting on the pump reservoir as shown. Fasten hose to fitting with a hose clamp.



- a - Yellow protector cap (remove and discard)
- b - Low-pressure hydraulic hose from steering helm
- c - Hose clamp
- d - Grommet

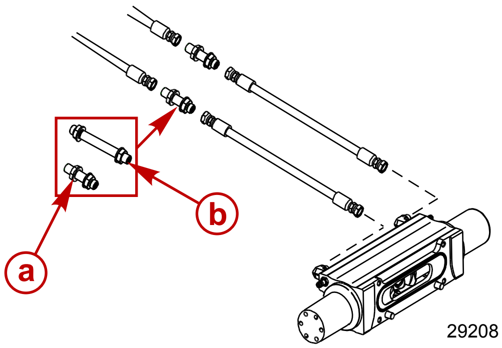
3. Remove and discard cap and plug from the ends of the dampening hose.
4. Ensure that the O-ring seal is on the end of the dampening hose fitting.
5. Connect the high-pressure dampening hose to the power steering pump.
6. Ensure that the O-ring seal is on the end of a high-pressure hydraulic steering hose fitting.
7. Connect the high-pressure hydraulic hose from the steering helm to the dampening hose.
8. Install the grommet onto the power steering pump enclosure.



- a - O-ring
- b - Dampening hose
- c - High-pressure hydraulic steering hose
- d - Grommet

Connection of the Hydraulic Hoses to the Steering Cylinder

1. Route the hydraulic hoses to the outboard steering cylinder. Bulkhead fittings are available if an opening does not exist in the engine well.

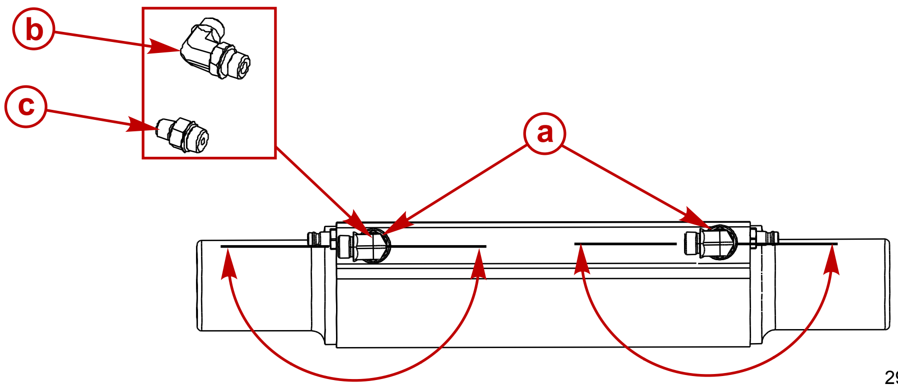


29208

a - Bulkhead fitting - bulkhead thickness up to 1.9 cm (0.75 in.) (22-892517)
b - Bulkhead fitting - bulkhead thickness up to 7.62 cm (3 in.) (22-892518)

***NOTE:** The 90° hose fittings on the steering cylinder can be rotated to align with the hose routing. Straight hose fittings (22-892519) are also available.*

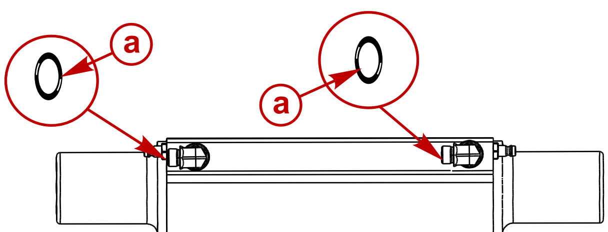
2. Position the 90° hose fittings to the desired direction. Loosen the fastening nuts in order to rotate. Position the fittings and tighten the fastening nuts.



29209

a - Position fittings
b - 90° fitting
c - Straight fitting

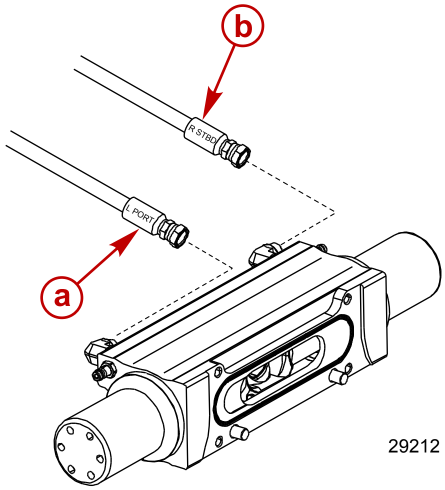
3. Remove and discard the shipping caps from the two fittings on the steering cylinder. Ensure the O-ring seals did not lift off with the shipping caps.
4. Ensure the O-ring seals are in place on the end of each fitting.



29211

a - O-rings

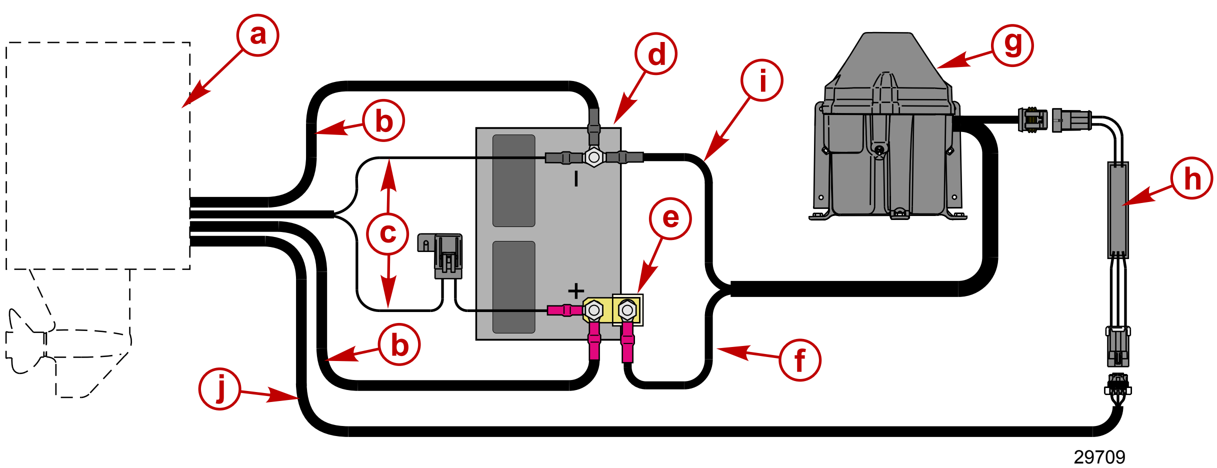
5. Make the hydraulic steering hose connections to the steering cylinder as shown.



a - Port fitting (L PORT)
b - Starboard fitting (R STBD)

Electrical Connections to the Steering Pump

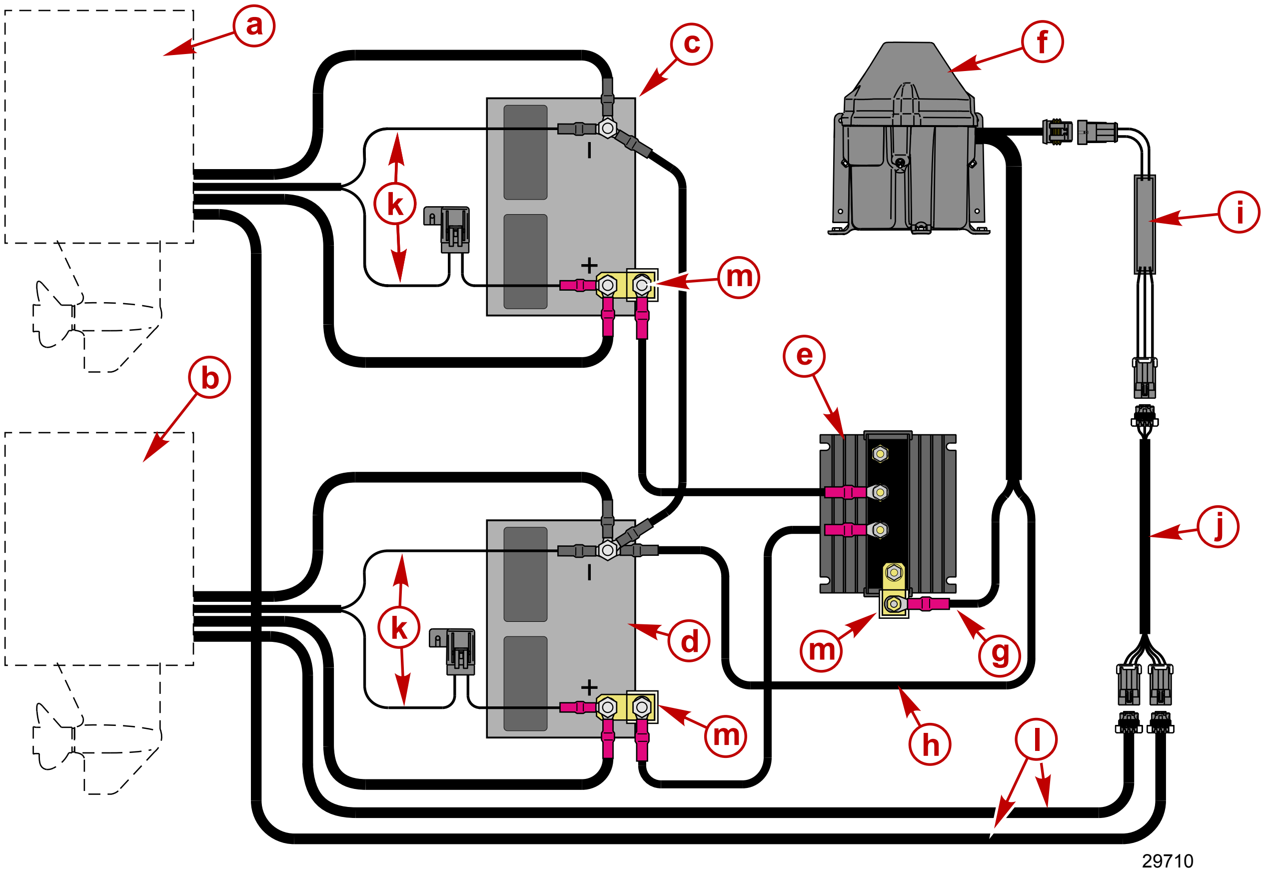
NOTE: For single engine installation, the power steering pump battery cables should be connected directly to the outboard starting battery.



Single engine application

a - Engine
b - Battery cable
c - DTS power harness
d - Battery
e - Power steering fuse - 90 amp
f - Power steering pump 12 V positive harness
g - Power steering pump
h - Power steering pump driver module harness
i - Power steering pump ground harness
j - Power steering signal harness

NOTE: *On multiple installations, the automatic power switch (APS) (87-895091K01) must be used to connect all outboard starting batteries to the power steering pump. The APS allows battery voltage to be drawn from the starting battery with the highest state of charge.*



Dual engine application

- a - Port engine
- b - Starboard engine
- c - Port engine cranking battery
- d - Starboard engine cranking battery
- e - Automatic power switch (APS)
- f - Power steering pump
- g - Power steering pump to APS output terminal
- h - Power steering pump to cranking battery negative
- i - Power steering pump driver module harness
- j - Dual engine power steering adapter
- k - DTS power harness
- l - Power steering signal harness
- m - Fuse - 90 amp

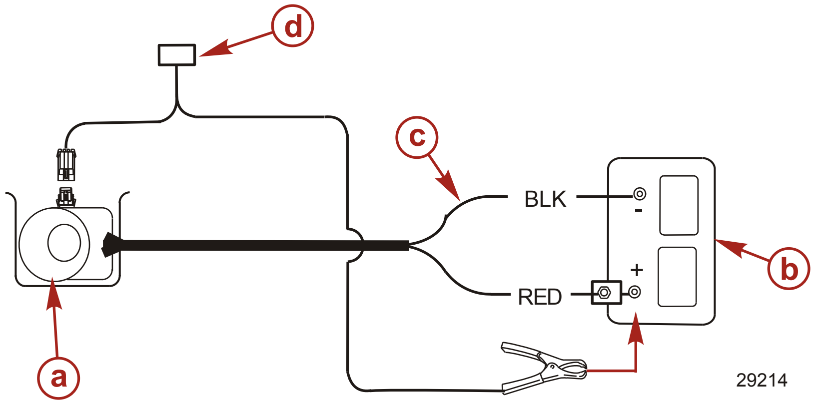
Filling Power Steering System with Engine Not Running

Use SAE 0W-30 Full Synthetic Power Steering Fluid in the power steering system. In an emergency, if recommended power steering fluid is not available, the use of any full synthetic engine oil can be temporarily used. The power steering fluid should then be drained and replaced with SAE 0W-30 Full Synthetic Power Steering Fluid as soon as possible, to avoid loss of performance in power steering system.

Fluid Type	Capacity	Mercury Part Number
SAE 0W-30 Full Synthetic Power Steering Fluid	1–2 liters (1–2 quarts) depending on length of steering hoses	92-858002K01

1. Disconnect power steering signal harness from engine signal harness.

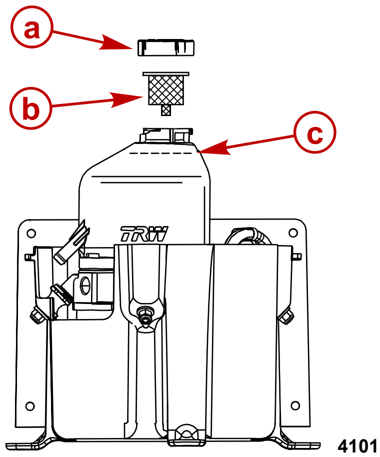
2. Connect the power steering module primer kit to the power steering pump and 12 volt positive power source, as shown.



- a - Power steering pump
- b - Primary battery
- c - Battery leads
- d - Power steering primer module

Power Steering Module Primer Kit	91-895040K01

3. Remove the filler cap and filter from the power steering pump.
4. Fill the pump tank with recommended power steering fluid.



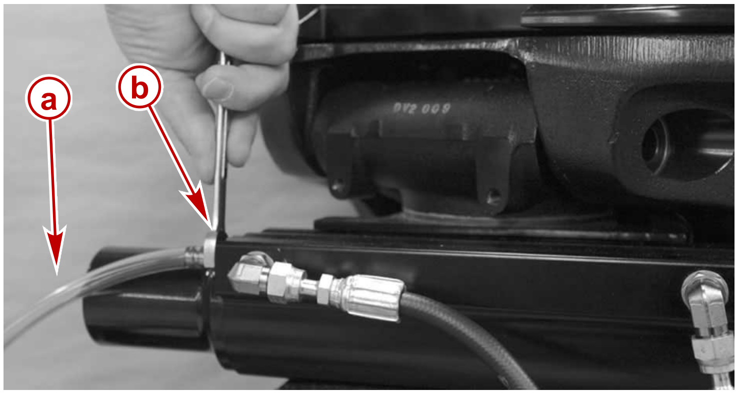
- a - Fill cap
- b - Filter
- c - Full level

IMPORTANT: The power steering module primer has two switches, "POWER" - "ON" and "OFF," and "PUMP" - "ON" and "OFF." To power up and activate the power steering pump, there are two steps: 1) turn the "POWER" switch to the "ON" position to power up pump, wait for two seconds, then, 2) turn the "PUMP" switch to the "ON" position to activate pump.

IMPORTANT: Do not run pump out of fluid. If pump draws air during bleeding, the resulting rebleeding will take two to three times longer than initial bleeding.

5. Power up and activate the pump until fluid drops halfway. Turn off both switches on the power steering primer module and refill the pump tank. Repeat this operation until pump tank stays full.
6. Power up and activate the pump while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until fluid drops halfway, stop turning the steering wheel and refill the pump tank. Repeat this operation turning the steering wheel from full lock to full lock 10 times until pump tank stays full.
7. For bleeding any air left in the steering system, power up and activate the pump. Turn the steering wheel in one direction until the full lock position is met.
8. Attach an 8 mm (5/16 in.) I.D. transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route bleed hose into pump tank (do not bleed power steering fluid into a different container, this will only be pumping fluid out of the system that was just filled).

9. Open bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from system. Tighten bleed valve securely and remove bleed hose.



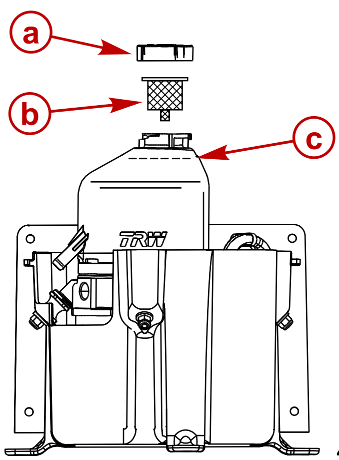
3640

a - Bleed hose
b - Bleed valve in steering cylinder

10. Turn the steering wheel to opposite full lock position, and repeat steps 8 and 9.
11. Replace the filter and fill cap on the power steering pump.
12. If desired, the power steering system can be rechecked after sitting overnight to remove any air that may possibly be left in the system. Repeat steps for bleeding steering system, preceding.
13. Turn off both switches, remove the power steering primer module and reconnect the power steering signal harness from the engine to the pump.

Filling Power Steering System with Engine Running

1. Remove the filler cap and filter from the power steering pump.
2. Fill the pump tank with recommended power steering fluid.

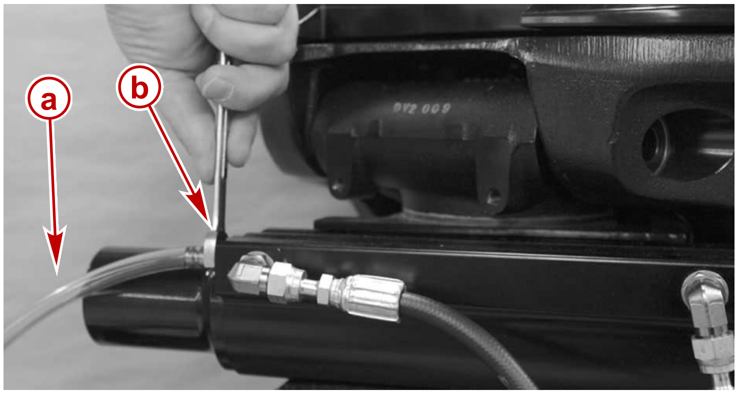


4101

a - Cap
b - Filter
c - Full level

3. Start and run the engine until the steering pump fluid drops halfway. Turn off the engine and refill the pump. Repeat this operation until pump stays full.
4. Start and run the engine while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until fluid drops halfway. Stop turning wheel, turn off engine, and refill the pump tank. Repeat this operation turning the steering wheel to full lock to full lock 10 times until pump tank stays full.
5. For bleeding any air left in the steering system, start and run the engine, and turn the steering wheel in one direction until the full lock position is met.
6. Attach an 8 mm (5/16 in.) I.D. transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route bleed hose into pump tank (do not bleed power steering fluid into a different container, as this will only be pumping fluid out of the system that was just filled).

7. Open bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from system. Tighten bleed valve securely and remove bleed hose.



a - Bleed hose
b - Bleed valve in steering cylinder

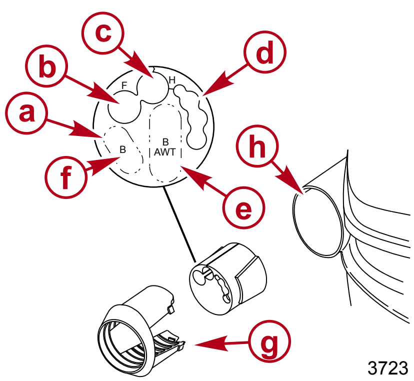
8. Turn the steering wheel to opposite full lock position, and repeat procedure for bleeding steering system.
9. Replace the filter and filler cap on the power steering pump.
10. If desired, the power steering system can be rechecked after sitting overnight to remove any air that may possibly be left in the system. Repeat steps for bleeding steering system, preceding.

Routing Connections Through the Cowl

IMPORTANT: Ensure that sufficient excess exists in the wiring harness and battery cables routed between the cowl fitting and the engine attachment point to relieve stress and prevent hoses from being kinked or pinched. Ensure that excess exists in all hoses and cables in full left and right turns and full tilt position.

NOTE: Mercury Marine suggests routing the wiring, cables and fuel hose through a rigging hose or flexible sleeve from the engine to the boat's gunnel or motor well. Follow the installation instructions included with the Rigging Hose or Flexible Sleeve Kit.

1. Pull out the grommet fitting from the front cowl opening. Route the wiring harnesses, battery cables, and fuel hose through the correct openings in the rubber grommet as shown.



a - Rubber grommet
b - Fuel hose
c - 14 pin data harness
d - DTS power harness, vessel sensor harness, power steering pump harness
e - Large diameter battery cables
f - Small diameter battery cables
g - Grommet fitting
h - Front cowl opening

2. Insert rubber grommet into fitting and secure fitting in front cowl opening.

Color Diagrams

Section 9A - Color Diagrams

Table of Contents

9
A

Notes:

Notes:

200/225/250/275 Verado Engine Harness S/N 0T980000–1B229688

1 - Propulsion control module (PCM)
2 - Splice saver SP3
3 - Ignition pencil coil #6
4 - Ignition pencil coil #5
5 - Ignition pencil coil #4
6 - Ignition pencil coil #3
7 - Ignition pencil coil #2
8 - Ignition pencil coil #1
9 - Camshaft position sensor
10 - Splice saver SP2
11 - Fuel injector #5
12 - Fuel injector #3
13 - Fuel injector #1
14 - Fuel injector #2
15 - Fuel injector #4
16 - Fuel injector #6
17 - Splice saver SP4
18 - Electronic boost control (EBC)
19 - Oil pressure sensor
20 - Splice saver SP5
21 - Upper knock sensor
22 - Resistor (upper knock sensor)
23 - Lower knock sensor
24 - Resistor (lower knock sensor)
25 - Manifold absolute pressure (MAP) sensor
26 - Block water pressure sensor
27 - Water in fuel (WIF) sensor connector
28 - Shift position switch
29 - Block coolant temperature sensor
30 - Cylinder head coolant temperature sensor
31 - Pitot pressure sensor
32 - Crank position sensor (CPS)
33 - Engine control module (ECM) - 20 amp fuse
34 - Ignition coils (IGN. COILS) - 20 amp fuse
35 - Fuel system (FUEL) - 20 amp fuse
36 - Injector power (INJ. PWR.) - 20 amp fuse
37 - Spare fuses - 20 amp
38 - Power steering signal harness
39 - Oil temperature sensor
40 - Supercharger outlet air temperature sensor
41 - Positive connection terminal
42 - Negative battery cable
43 - Starter solenoid
44 - Starter motor
45 - 150 amp fusible link
46 - 70 amp alternator
47 - Manifold air temperature (MAT) sensor
48 - Main power relay (MPR)
49 - Splice saver SP1
50 - Splice saver SP6
51 - Electronic throttle control (ETC)
52 - Starter relay
53 - Electronic shift control (ESC)
54 - Cowl tilt switch
55 - Vent canister purge valve (VCPV)
56 - Vent canister float switch (VCFS)
57 - Trim down relay
58 - Trim up relay
59 - To trim pump
60 - Trim position sensor
61 - To fuel supply module (FSM)
62 - DTS power harness - 5 amp fuse
63 - CAN 1 terminator resistor
64 - Boat sensor harness
65 - CAN 2 terminator resistor
66 - Diagnostic terminal
67 - 14 pin engine harness connector

200/225/250/275 Verado Engine Harness
S/N 0T980000–1B229688

Notes:

200/225/250/275/300 Verado Engine Harness S/N 1B229689 and above

1 - Propulsion control module (PCM)
2 - Ignition pencil coil #6
3 - Ignition pencil coil #5
4 - Ignition pencil coil #4
5 - Ignition pencil coil #3
6 - Ignition pencil coil #2
7 - Ignition pencil coil #1
8 - Camshaft position sensor
9 - Fuel injector #5
10 - Fuel injector #3
11 - Fuel injector #1
12 - Fuel injector #2
13 - Fuel injector #4
14 - Fuel injector #6
15 - Splice saver 4
16 - Electronic boost control (EBC)
17 - Oil pressure sensor
18 - Splice saver 5
19 - Upper knock sensor
20 - Resistor (upper knock sensor)
21 - Lower knock sensor
22 - Resistor (lower knock sensor)
23 - Manifold absolute pressure (MAP) sensor
24 - Block water pressure sensor
25 - Water in fuel (WIF) sensor connector
26 - Shift position switch
27 - Block coolant temperature sensor
28 - Cylinder head coolant temperature sensor (s/n 1B51733 and below)
29 - Pitot pressure sensor
30 - Crank position sensor (CPS)
31 - Propulsion control module (ECM) - ATDC 20 ampere fuse
32 - Ignition coils (IGN. COILS) - ATDC 20 ampere fuse
33 - Fuel delivery (FUEL) - ATDC 20 ampere fuse
34 - Injector power (INJ. PWR) - ATDC 20 ampere fuse
35 - Diagnostics - ATDC 2 ampere fuse
36 - Spare fuses - ATDC 20 ampere
37 - Joystick piloting models only TVM MPR - ATDC 20 ampere fuse
38 - Power steering signal harness
39 - Oil temperature sensor
40 - Supercharger outlet air temperature sensor
41 - Positive cable terminal
42 - Negative battery cable
43 - Starter solenoid
44 - Starter motor
45 - 150 ampere fusible link
46 - 70 ampere alternator
47 - Manifold air temperature (MAT) sensor
48 - Main power relay (MPR)
49 - Splice saver 1
50 - Splice saver 6
51 - Electronic throttle control (ETC)
52 - Fuel pump relay
53 - Starter relay
54 - Electronic shift control (ESC)
55 - Cowl tilt switch
56 - Fuel vapor purge valve
57 - Vent canister switch
58 - Trim down relay
59 - Trim up relay
60 - To trim pump
61 - Trim position sensor
62 - Fuel system module (FSM)
63 - DTS power harness - SAE 5 ampere fuse
64 - CAN P (dk blu and wht) and CAN H (grn/org and org/grn) red-colored terminator resistor

__NOTE:__ Early models: CAN P (dk blu and wht) yellow-colored terminator resistor

65 - Boat sensor harness
66 - CAN X terminator resistor
67 - Diagnostic terminal
68 - Electrical data harness

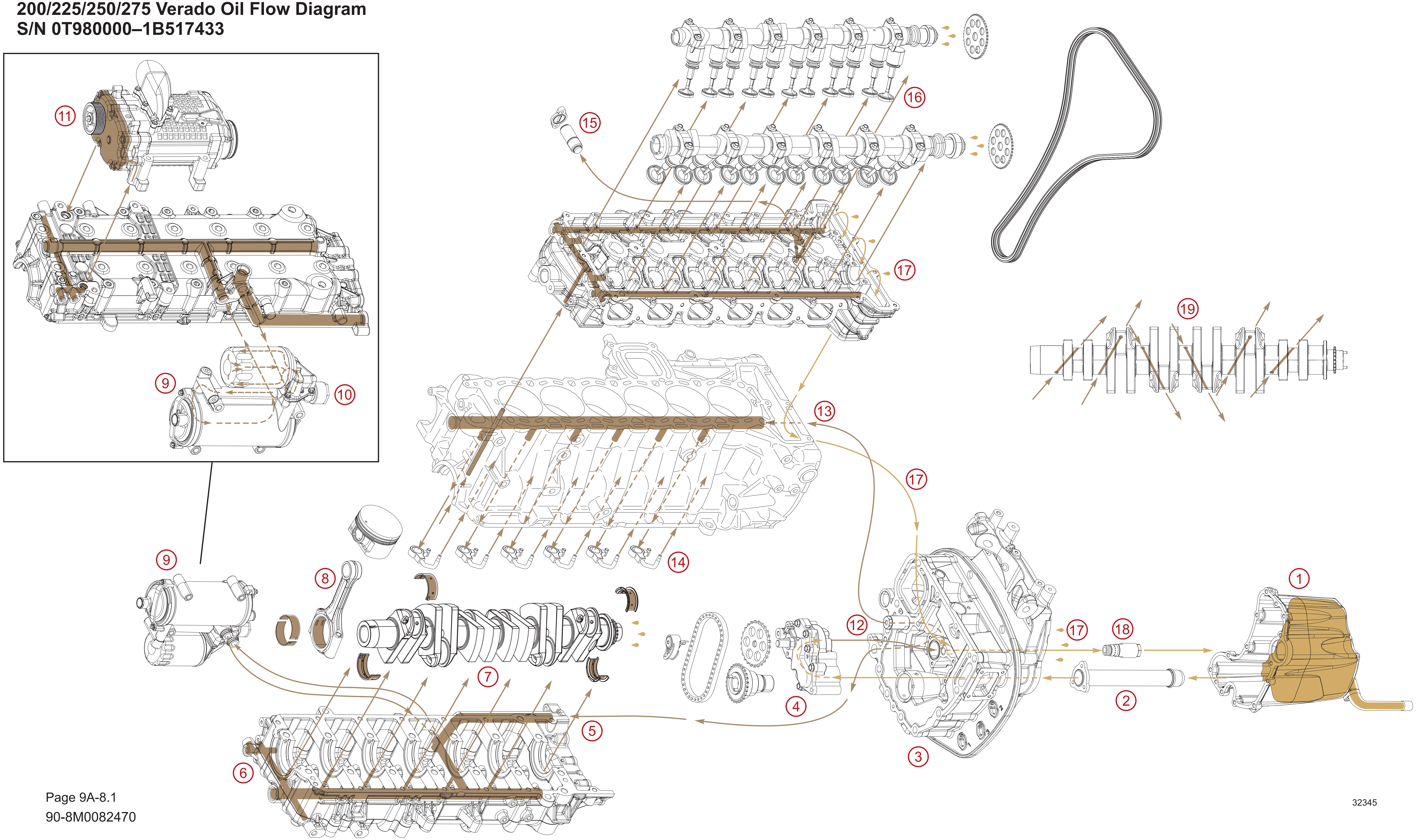
200/225/250/275/300 Verado Engine Harness
S/N 1B229689 and Above

Notes:

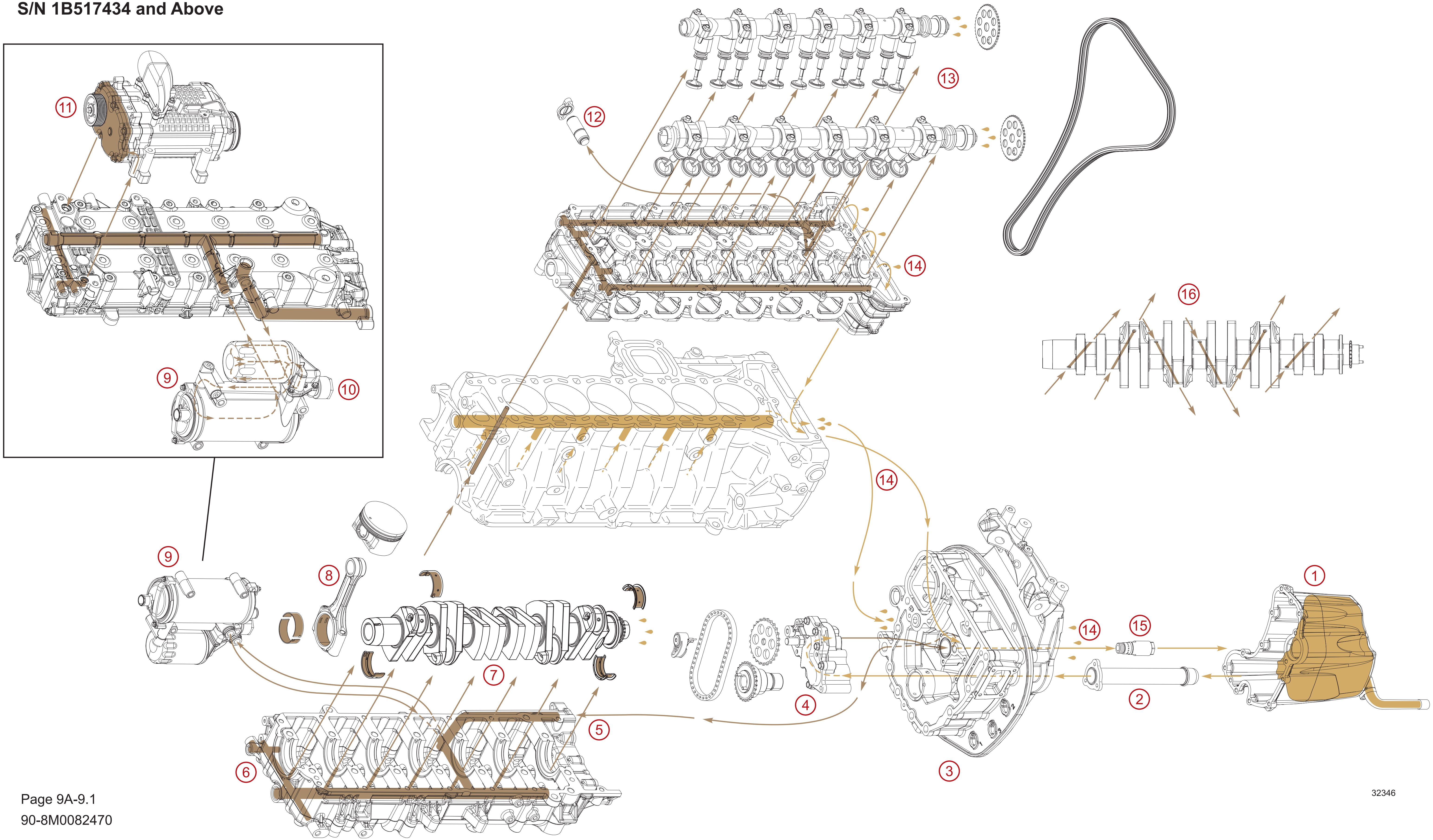
200/225/250/275 Verado Oil Flow Diagram S/N 0T980000–1B517433

1 - Oil sump
2 - Oil pickup tube
3 - Adapter plate
4 - Oil pump
5 - Oil passage to main gallery
6 - Main gallery
7 - Crankshaft/main bearings
8 - Piston rod/wrist pin
9 - Integrated oil module (IOM)
10 - Thermostat
11 - Supercharger
12 - Check valve for piston cooling jet gallery
13 - Piston cooling jet gallery
14 - Piston cooling jets
15 - Timing chain tensioner
16 - Camshaft/bearings
17 - Oil return
18 - Oil pressure relief valve
19 - Crankshaft main bearing to connecting rod bearing oiling

200/225/250/275 Verado Oil Flow Diagram
S/N 0T980000–1B517433



200/225/250/275/300 Verado Oil Flow Diagram
S/N 1B517434 and Above



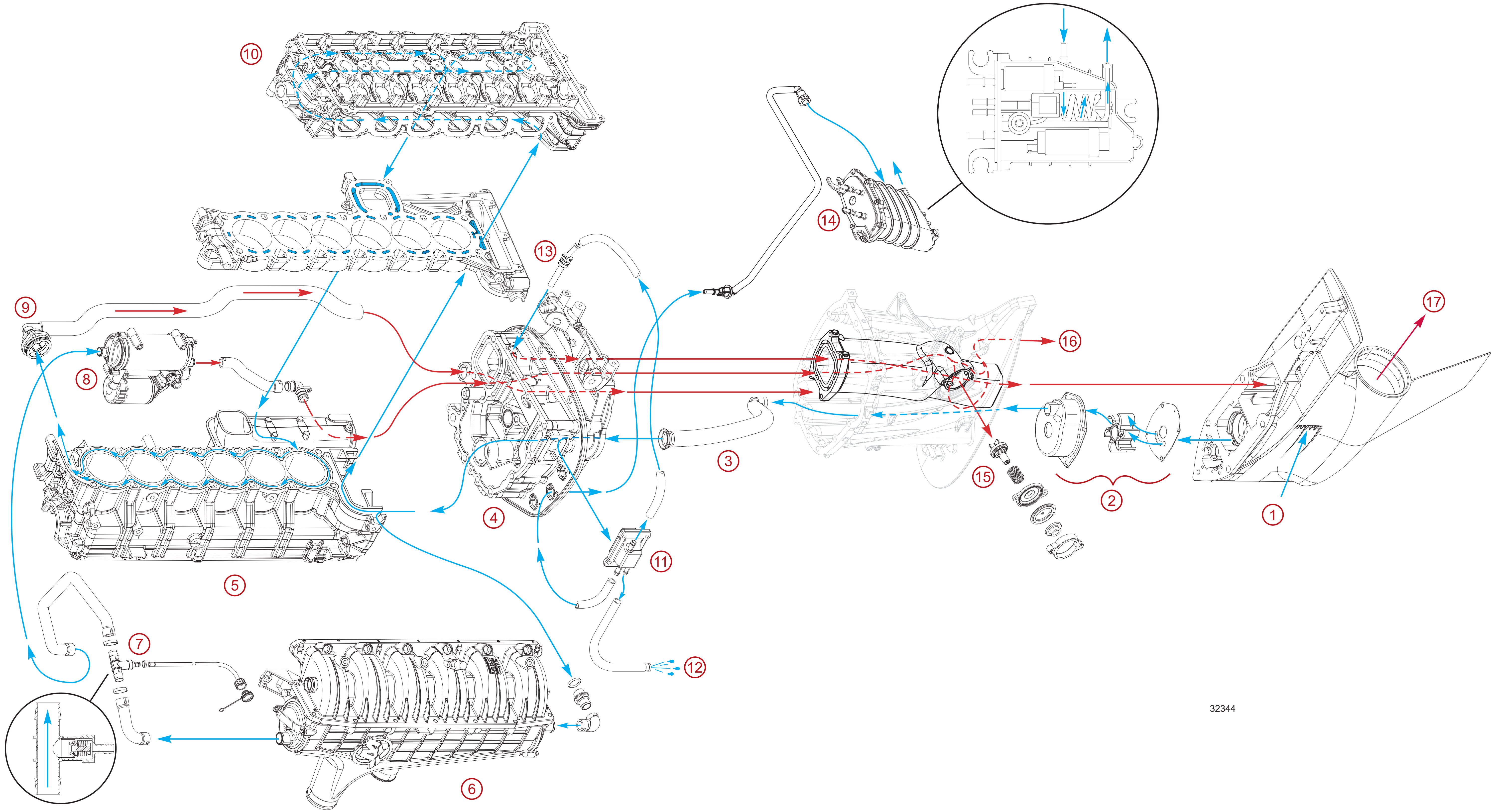
200/225/250/275/300 Verado Oil Flow Diagram S/N 1B517434 and Above

1 - Oil sump
2 - Oil pickup tube
3 - Adapter plate
4 - Oil pump
5 - Oil passage to main gallery
6 - Main gallery
7 - Crankshaft/main bearings
8 - Piston rod/wrist pin
9 - Integrated oil module (IOM)
10 - Thermostat
11 - Supercharger
12 - Timing chain tensioner
13 - Camshaft/bearings
14 - Oil return
15 - Oil pressure relief valve
16 - Crankshaft main bearing to connecting rod bearing oiling

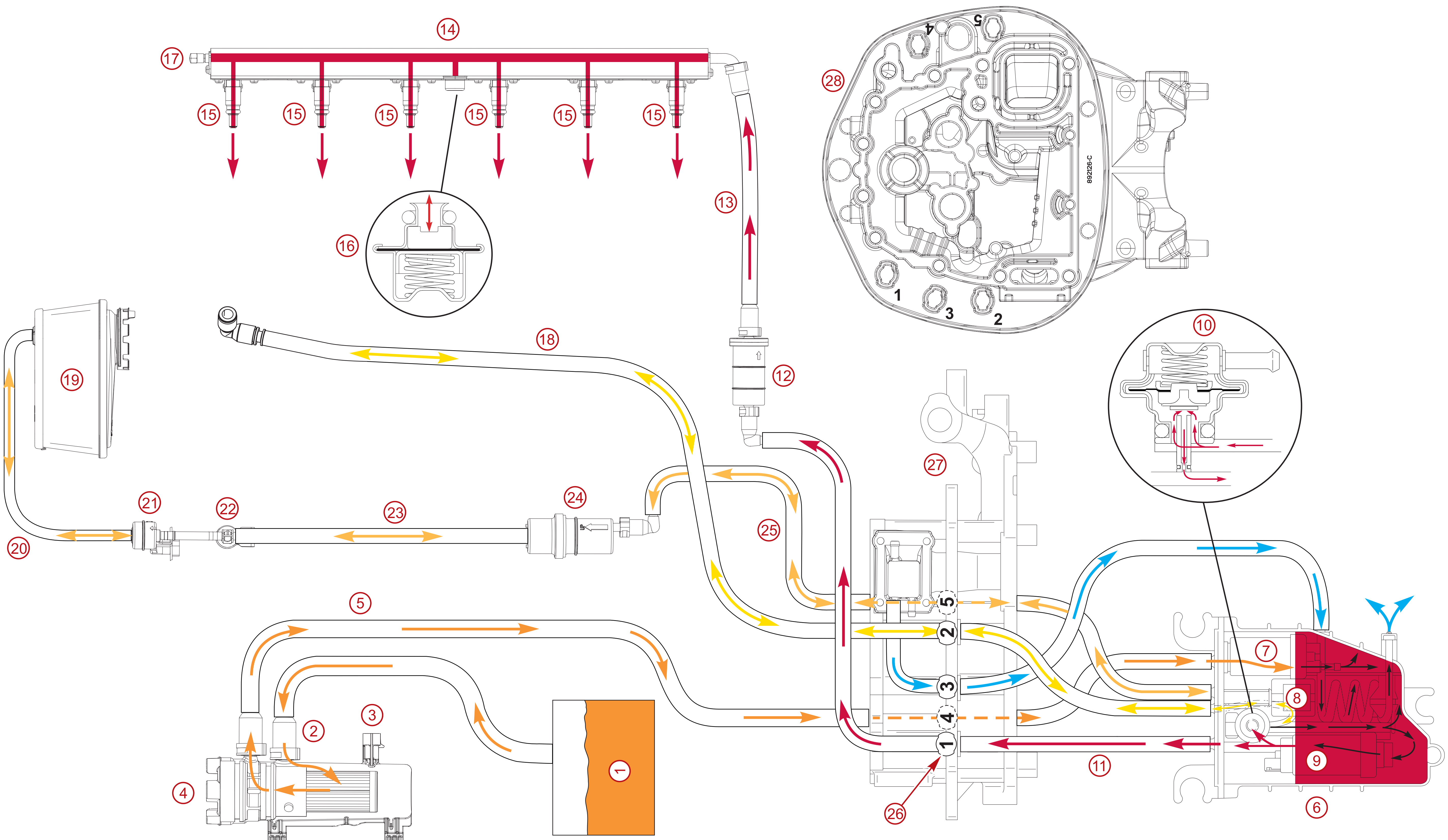
200/225/250/275/300 Verado Water Flow Diagram S/N 0T980000 and Above

1 - Cooling water inlet
2 - Water pump
3 - Water tube
4 - Adapter plate
5 - Cylinder block
6 - Charge air cooler (CAC)
7 - Flush T-fitting
8 - Integrated oil module (IOM)
9 - Thermostat
10 - Cylinder head
11 - Manifold housing water strainer
12 - Tell-tale
13 - Evaporative cooler
14 - Fuel supply module (FSM) cooling coil
15 - Poppet valve
16 - Water discharge
17 - Water discharge from evaporative cooler

200/225/250/275/300 Verado Water Flow Diagram
S/N 0T980000 and Above



200/225/250/275/300 Verado Fuel Flow Diagram
S/N 0T980000 and Above



200/225/250/275/300 Verado Fuel Flow Diagram S/N 0T980000 and Above

1 - Fuel tank
2 - Fuel inlet
3 - Water in fuel (WIF) sensor
4 - Water separating fuel filter (2 micron)
5 - Fuel inlet line to FSM
6 - Fuel supply module (FSM)
7 - Fuel pump (lift)
8 - Float switch
9 - Fuel pump (high-pressure)
10 - Fuel pressure regulator
11 - Fuel line (high-pressure) FSM to inline filter
12 - Fuel filter (20 micron) (high-pressure)
13 - Fuel line (high-pressure) inline filter to fuel rail
14 - Fuel rail
15 - Fuel injectors
16 - Damper
17 - Fuel pressure test port (Schrader valve)
18 - Manifold reference line
19 - Air filter
20 - Fuel vapor purge line (upper)
21 - Fuel vapor purge valve
22 - Fuel vapor purge relief valve
23 - Fuel vapor purge line (lower)
24 - Vent canister
25 - FSM to vent canister line
26 - Hose routing through adapter plate (1 - 5)
27 - Adapter plate (port side view)
28 - Adapter plate (top view)

Notes: