Product Applications Manual - Gasoline Inboard Models

MERCURY
MerCruiser

Product Applications Manual

Gasoline Inboard Models

www.mercurymarine.com.au
Private Bag 1420
Dandenong South 3175
Victoria, Australia

www.mercurymarine.com
P.O. Box 1939
Fond du Lac, WI 54936-1939 USA

www.marinepower.com
(Parc Industriel de Petit-Rechain)
B-4822 Verviers/Belgium

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NOTICE

Details for specific product installation are located in the Power Package Installation Manual that accompanies each product.

Manual Introduction and Overview

This Product Applications Manual has been written and published by Mercury Marine and is targeted to the boat manufacturer's engineers and designers. It is intended to aid you, the boat manufacturer, in the proper integration of our power packages in your boats. Proper integration is critical to extract the full potential from your boat and engine packages and to deliver our mutual customers the reliability, durability, and performance that exceed their expectations.

The manual includes important information, recommendations, and requirements for designing your boats and setting up your assembly process to optimize the installation of our products. Laid out by system (i.e. fuel system, exhaust system), the manual allows the user to quickly locate important information about the systems that comprise the power package installation. It is not intended to replace the installation manuals (provided with the engines), which cover step-by-step installation procedures for the power package hardware. Your installers should still use the installation manuals when installing the power packages to ensure that no steps are missed and all cautions and warnings are understood.

We cannot anticipate all conceivable installations and their possible hazards or results. Therefore, any manufacturer or person who applies or installs the product in a manner that does not fulfill the requirements listed herein must first be completely satisfied that neither their safety nor the product will be endangered by the application or installation procedure selected.

The boat manufacturer or installing dealer is responsible for selecting the appropriate power package (including correct gear ratio and propeller) for a given boat. Making an appropriate selection requires knowledge of the boat (weight, length, hull design, intended use and duty cycle, desired speed, etc.) that is uniquely in the possession of the boat manufacturer or installing dealer. While Mercury employs people capable of assisting on such issues, the final decision on the application of the product rests with the boat manufacturer or installing dealer. Mercury recommends that any new or modified hull–power package combination be thoroughly tested prior to sale to verify that the boat performs as desired, handles safely, and that the engine runs in the specified RPM range.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. Mercury MerCruiser reserves the right to make changes at any time without obligation. As required, revisions to this manual will be made available. Any suggested improvements to this manual are welcome and should be directed to:

Mercury MerCruiser, Technical Communication Department
3003 N. Perkins Road,
Stillwater, OK 74075
405-377-1200
Fax 405-743-6537

Safety Alerts and Notices

Throughout this publication, "Warnings" and "Cautions," accompanied by the international HAZARD symbol  , are used to alert the technician to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe these safety alerts carefully.

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

⚠ WARNING

WARNING—indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION—indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or property damage. It may also be used to alert against unsafe practices.

IMPORTANT: Indicates information or instructions that are necessary for a particular step or action.

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

Related Bulletin List

Use the following table to record any future bulletins that affect or add to the information in this manual. List the bulletin numbers and affected sections or pages in this manual for your reference.

Bulletin Type	Bulletin Number	Bulletin Description/Title	Section/Page Affected

Copyright and Trademark Information

Manual Outline

Important Information

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A

Section 1A - Important Information

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Sales and Technical Assistance

Mercury MerCruiser employs a staff of highly trained specialists to assist you with any sales or technical issues that you might have. This includes a group of Product Application Engineers (PAEs) who specialize in the application of our product and are recognized throughout the industry for their expertise in this area. If you have an issue with the application of our product that cannot be resolved over the telephone, an PAE can be scheduled to assist you at your facility. All requests for assistance should be directed to:

Inside the U.S.A.

Mercury MerCruiser
3003 N. Perkins Rd.
Stillwater,, OK 74075

Quality/Service Support

,
(405) 743-6555
Fax (405) 743-6570

Sales or Field Sales Technical Support

,
(405) 743-6505
Fax (405) 743-6560

Outside the U.S.A.

Contact your Distribution Center or Distributor.

Mercury MerCruiser Service Offices

For assistance, call, fax, or write. Please include your daytime telephone number with mail and fax corresponce.

United States		
Telephone	(405) 743-6555	Mercury MerCruiser 3003 N. Perkins Road Stillwater, OK 74074
Fax	(405) 743-6570	
Website	www.mercurymarine.com	

Canada		
Telephone	(905) 567-6372	Mercury Marine Ltd. 2395 Meadowpine Blvd. Mississauga, Ontario L5N 7W6 Canada
Fax	(905) 567-8515	

Australia, Pacific		
Telephone	(61) (3) 9791-5822	Mercury Marine Australia 132–140 Frankston Road Dandenong, Victoria 3164 Australia
Fax	(61) (3) 9793-5880	

Europe, Middle East, Africa		
Telephone	(32) (87) 32 • 32 • 11	Marine Power — Europe, Inc. Parc Industriel de Petit-Rechain B-4800 Verviers, Belgium
Fax	(32) (87) 31 • 19 • 65	

Mexico, Central America, South America, Caribbean		
Telephone	(954) 744-3513	Mercury Marine 11650 Interchange Circle North Miramar, FL 33025 U.S.A.
Fax	(954) 744-3535	

Japan		
Telephone	81-053-423-2500	Mercury Marine — Japan Anshin-cho 283-1 Hamamatsu Shizuoka-ken, Japan 435-0005 Japan
Fax	81-053-423-2510	

Asia, Singapore		
Telephone	5466160	Mercury Marine Singapore 72 Loyang Way Singapore, 508762
Fax	5467789	

Mercury Precision Parts / Quicksilver Products

A complete line of Quicksilver Accessories (remote controls, instrumentation, exhaust and cooling system components, etc.) are available from Mercury Precision Parts to meet your boat rigging needs. These accessories have been carefully designed for compatibility with Mercury MerCruiser products, providing unsurpassed quality and performance. Any warranty problems that may occur will be quickly and conveniently handled, using the same warranty system as used for standard Mercury products. A complete listing of all of the latest accessories can be found in the Mercury Precision Parts and Accessories Guide. Many of these accessories are covered under the related system sub-sections following.

The following address and telephone numbers can be contacted for ordering parts or obtaining technical assistance:

Inside the U.S.A.
Mercury Marine
Attn. Parts Department
W6250 W. Pioneer Road
P.O. Box 1939
Fond du Lac, WI 54935-1939
U.S.A.
(920) 929-5589 or (800) 487-6372

Outside the U.S.A

Contact your Distribution Center or Distributor.

Factory Installed Options

Several accessories are also available as factory installed options from Mercury MerCruiser, including (but not limited to) those listed. These factory options avoid the problems and costs associated with installing them in your facility. Contact your sales representative for a list of the latest options.

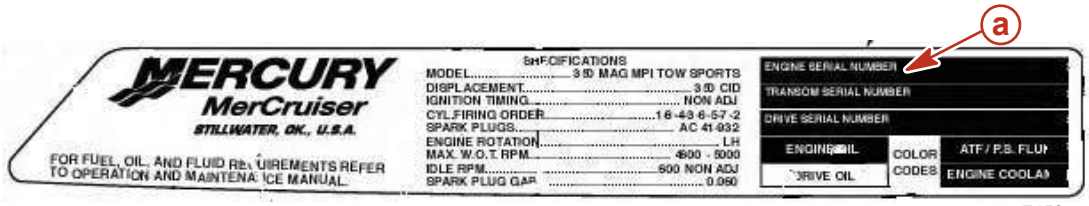
- Closed Cooling
- Exhaust Risers
- Propeller Shaft Couplings
- Remote Oil Filter
- Air-Actuated Drain

Serial Number Decal Placement—Inboard and Tow Sports

There are three engine serial number decal strips provided with each power package. One should be used for each of the following:

- Engine Specification Decal
- Warranty Registration Card
- Operation, Maintenance and Warranty Manual identification page

Affix engine serial number decal to Engine Specification Decal.



7450

Typical

a - Engine serial number location

11543

a - Engine serial number location

California Regulations for 2007—Low Permeation Fuel Hose

California Regulations for New 2007 and Later Spark-Ignition Inboard/Sterndrive Pleasurecraft

(3) Requirements of engine manufacturers and boat manufacturers under Option 2 and using Low Permeation Fuel Line Hose:

(A) Each manufacturer that chooses Option 2 must provide written instructions, as part of the installation materials provided to purchasers of the engine, to use Low Permeation fuel Line Hose for the primary Fuel line connecting the fuel tank to the engine of any boat that is manufactured for sale, sold, or offered for sale in California, or that is introduced, delivered or imported into California for introduction into commerce.

(B) Each boat manufactured must install Low Permeation Fuel Line Hose for the primary Fuel line connecting the fuel tank to the engine of any boat that is manufactured for sale, sold, or offered for sale in California that uses an engine from a manufacturer that chooses Option 2.

Low Permeation Fuel Line Hose is defined as not exceeding 15 g/m²/24 h with CE10 fuel at 23° C as specified in SAE J 1527—Marine Fuel Hoses.

Emission Control Information

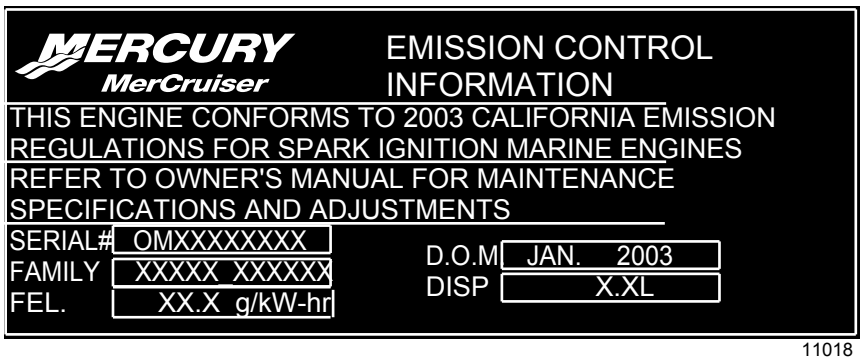
International Regulations Compliance

In an effort to support your international business, MerCruiser spends considerable resources each year keeping our products in compliance with international regulations. A dedicated Regulations Group at MerCruiser is devoted to ensuring that our products meet the host of regulatory requirements that cover our product throughout the world. This includes compliance with the following regulations and standards:

- ABYC (American Boat and Yacht Council).
- USCG (U.S. Coast Guard).
- SAE (Society of Automotive Engineers).
- ISO (International Standards Organization).
- CARB (California Air Resources Board).
- EU (European Union).
- SAV (Schweizer Abgas Vorschriften—Swiss Gas Regulations).
- JCI (Japanese Craft Inspection).

Emission Control Information Label

A tamper-resistant Emission Control Information label is affixed in a visible location to the engine at time of manufacture by Mercury MerCruiser. In addition to the required emissions statement, the label lists the engine serial number, family, FEL (emission level), date of manufacture (month, year), and the engine displacement. Please note that the low emissions certification will not affect the fit, function, or performance of the engines. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding.



Emission control label — non-CE marked

"SERIAL#" - Engine serial number

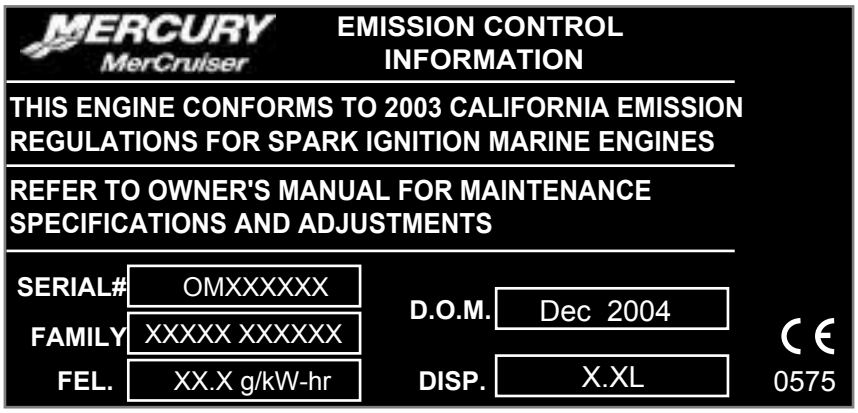
"FAMILY" - Engine family

"FEL." - Family emission limit

"D.O.M." - Date of manufacture

"DISP" - Piston displacement

IMPORTANT: 5.0L, and 5.7L models are not CE certified at the time of this publication. Contact the appropriate Mercury MerCruiser Product Application Engineers (PAE), or Mercury MerCruiser Technical Service for information on CE certified product.



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Emission control label — CE marked

"SERIAL#" - Engine serial number

"FAMILY" - Engine family

"FEL." - Family emission limit

"D.O.M." - Date of manufacture

"DISP" - Piston displacement

CE - When this mark is present in the lower right corner of the Emission Control Information Label, on the engine, the Declaration of Conformance applies.

NOTE: *The following applies to CE marked products only.*

DECLARATION OF CONFORMANCE – MERCURY MERCRUISER

This sterndrive or inboard engine when installed in accordance to Mercury MerCruisers' instructions complies with the requirements of the following directives by meeting the associated standards, as amended:

Recreational Craft Directive 94/25/EC; 2003/44/EC

Applicable Requirement	Standards Applied
Owner's manual (A.2.5)	ISO 10240
Openings in Hull, Deck and superstructure (A.3.4)	ISO 9093-1; ISO 9093-2
Handling characteristics (A.4)	ISO 8665
Inboard Engine (A.5.1.1)	ISO 15584; ISO 10088; ISO 7840; ISO 10133
Fuel System (A.5.2)	ISO 10088; ISO 7840; ISO 8469
Electrical System (A.5.3)	ISO 10133; ISO 8846
Steering system (A.5.4)	Applicable portions of: ISO 10592, ISO 8848 and ABYC P-17
Exhaust emission requirements (B.2)	ISO 8178
Owner's manual (B.4)	ISO 8665
Noise emission levels (C.1)	ISO 14509
Ignition-protected equipment (Annex II)	ISO 8846; SAE J1171; SAE J1191; SAE J 2031

Mercury MerCruiser declares that our sterndrive or inboard engines without integral exhaust, when installed in a recreational craft, in accordance with the manufacturers supplied instructions, will meet the exhaust emissions requirements of the directive mentioned above. This engine must not be put into service until the recreational craft in which it is to be installed has been declared in conformity, if so required, with the relevant provision of the directive.

Electromagnetic Compatibility Directive 89/336/EC, 92/31/EEC and 93/68/EEC

Generic emission standard	EN 50081-1
Generic immunity standard	EN 50082-1
Vehicles, boats and internal combustion engine driven devices - Radio disturbance characteristics	SAE J551 (CISPR 12)
Electrostatic discharge testing	EN 61000-6-2; EN 61000-4-2; EN61000-4-3

The notified body responsible for surveillance of the quality system under Full Quality Assurance Module H of Directive 2003/44/EC is:

Det Norske Veritas
Norway
Notified Body Number: 0575

This declaration is issued under the sole responsibility of Mercury Marine and Mercury MerCruiser.

Patrick C. Mackey

President - Mercury Marine, Fond du Lac, WI USA

Regulatory contact:
Engineering - Regulatory
MerCruiser
3003 N. Perkins Rd
Stillwater, Oklahoma 74075
USA
(405) 377-1200

RECREATIONAL CRAFT DIRECTIVES—EU

REQUIREMENTS FOR BOAT COMPANIES

- Craft requirements as stated in Annex I of the Recreational Craft Directives require adding the CE marking to the builder's plate (capacity plate), not the HIN plate.
- Adherence to all component requirements as stated in Annex II of the Recreational Craft Directives.

Mercury Marine will meet the amended Recreational Craft Directives for all Mercury Outboard and Mercruiser product equipped with integral exhaust.

Boats that are equipped with non integral exhaust (after market exhaust) must be tested and certified by the boat manufacturer for conformance with requirements as stated in Annex I of the Recreational Craft Directives. The boat must be equipped with the intended exhaust system at the time of testing.

Boats produced in the US must clear customs on EU soil by 12/31/2005 at the latest to be exempt from 2006 requirements.

OWNER RESPONSIBILITY

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

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

Star Label

Beginning January 1, 2003, one Three-Star label will be included with each factory-certified Mercury MerCruiser engine.

All Mercury MerCruiser engines (500 hp and below) will have a Three-Star Ultra Low Emission rating. The Three-Star label identifies that these engines meet the California Air Resources Board's Sterndrive and Inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One-Star - Low Emissions engines.

The Three-Star label will be affixed on the left side of the hull as shown.

a - Recommended location **b -** Secondary location

One Star - Low emission	
 mc79569-1	The one-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted two-stroke engines. These engines are equivalent to the U.S. EPA's 2006 standards for marine engines.
Two Stars - Very Low emission	
 mc79570-1	The two-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low-Emission engines.
Three Stars - Ultra Low emission	
 mc79571-1	The three-star label identifies engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2008 exhaust emission standards or the Sterndrive and Inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.
Four Stars - Super Ultra Low emission	
 mc79572-1	The Four Star label identifies engines that meet the Air Resources Board's Sterndrive and Inboard marine engine 2009 exhaust emission standards. Personal Watercraft and Outboard marine engines may also comply with these standards. Engines meeting these standards have 90% lower emissions than One Star - Low Emission engines.

Specifications

Engine Specifications

TOW SPORTS MODELS

	5.7L	350 MAG MPI	Black Scorpion	MX 6.2L MPI	MX 6.2 Black Scorpion
Propshaft Power	201 kw (270 hp)	235 kw (315 hp)	246 kw (330 hp)	239 kw (320 hp)	254 kw (340 hp)
Displacement	5.7 liter (350 cid)			6.2 liter (377 cid)	
Configuration / Cylinders	V-8				
Bore x Stroke	102 x 88.4 mm (4.00 x 3.48 in.)			102 x 95.3 mm (4.00 x 3.75 in.)	
Compression Ratio	9.4:1			9.0:1	
Fuel System	2 Bbl. Carb (TKS)	MPI			
Ignition System	Digital Thunderbolt 5	ECM 555			
Alternator Amp. Cold/Hot	72 amp. / 65 amp.				
Maximum RPM @ WOT	4400–4800	4600–5000	4800–5200		
Rev Limiter RPM	4950	5150	5350		
Idle RPM	650				
Oil Pressure @ 2000 RPM	207–483 kPa (30–70 psi)				
Minimum Oil Pressure @ Idle	28 kPa (4 psi)		41 kPa (6 psi)	28 kPa (4 psi)	41 kPa (6 psi)
Thermostat Temperature	71 °C (160 °F) (Seawater Cooled)				
Timing (Degrees)	10° BTDC	8° BTDC			
Firing Order	1-8-4-3-6-5-7-2				
Weight	375 kg (833 lb.)	365 kg (813 lb.)	373 kg (821 lb.)	373 kg (821 lb.)	373 kg (821 lb.)
Closed Cooling	N/A				
Remote Oil Line			Optional		Optional
Audio Warning System	Standard				
Water Drain System	Multi-point Manual		Air Actuated Water Drain optional	Multi-point Manual	Air Actuated Water Drain optional
50 Amp Circuit Breaker	Standard				
Minimum Battery Rating	375 cca / 475 mca / 90 Ah	750 cca / 950 mca / 180 Ah			
Flush System	Kit				
S Pipe Exhaust	N/A	Optional	N/A	Optional	N/A
Optional Riser Kits	43 mm (1.7 in.)		N/A	43 mm (1.7 in.)	N/A

INBOARD MODELS BELOW 239 KW (320 HP)

	5.7L	350 MAG MPI	350 MAG MPI Horizon
Propshaft Power	194 kw (260 hp)	224 kw (300 hp)	224 kw (300 hp)
Displacement	5.7 liter (350 cid)		
Configuration / Cylinders	V-8		
Bore x Stroke	102 x 88.4 mm (4.00 x 3.48 in.)		
Compression Ratio	9.4:1		
Fuel System	2 Bbl. Carb.	MPI	
Ignition System	Thunderbolt 5 Digital	Digital	
Alternator Amp. (Cold/Hot)	72 amp / 65 amp		
Maximum RPM at WOT	4200–4600	4600–5000	
Rev Limiter RPM	4750	5150	
Idle RPM	650	600	
Oil Pressure @ 2000 RPM	30-70 psi / 207-483 kPa		
Min. Oil Pressure @ Idle	4 psi / 28 kPa		
Thermostat Temperature	71°C (160°F) (Seawater Cooled)		
Thermostat Temperature	77°C (170°F) (Closed Cooled)		
Timing	10° BTDC	8° BTDC	
Firing Order	1-8-4-3-6-5-7-2		
Transmission Offerings	Refer to SECTION 2-Transmission and Drive Line		
Weight	400 kg (888 lb.)	390 kg (860 lb.)	427 kg (948 lb.)
Remote Oil	Not Available	Standard	
Closed Cooling	Kit	Optional	Standard
Audio Warning System	Standard		
Water Drain System	Multipoint Drain System	Multipoint Drain System standard Air Actuated Water Drain is optional for Closed Cooling models	Air Actuated Water Drain
50 Amp Circuit Breaker	Standard		
Flush System	Kit	Standard	
Exhaust Elbows	Cast Iron w/Ceramic, EDP and Paint		
Optional Riser Kits	43 mm (1.7 in.) 76 mm (3 in.), 152 mm (6 in)		
Battery rating	375 cca / 475 mca / 90 Ah	750 cca / 950 mca / 180 Ah (Minimum rating)	
Battery rating for DTS models	N/A	800 cca / 1000 mca / 190 Ah (Minimum rating)	

INBOARD MODELS OVER 224 KW (300 HP)

	MX 6.2 MPI	MX 6.2 MPI Horizon	8.1S HO	8.1S Horizon
Propshaft Power	239 kw (320 hp)		313 kw (420 hp)	276 kw (370 hp)
Displacement	6.2 liter (377 cid)		8.1 liter (496 cid)	
Configuration / Cylinders	V-8			
Bore x Stroke	102 - 95.3 mm (4.00 x 3.75 in.)		108 x 111 mm (4.25 x 4.38 in.)	
Compression Ratio	9.0:1		9.1:1	
Fuel System	MPI			
Ignition System	Digital		Distributorless	
Alternator Amp. (Cold/Hot)	72 amp / 65 amp			
Maximum RPM at WOT	4600–5000		4400–4800	4200–4600
Rev Limiter RPM	5150		4950	4750
Idle RPM	600		650	
Oil Pressure @ 2000 RPM	207–483 kPa (30–70 psi)		413 kPa (60 psi)	
Minimum Oil Pressure @ Idle	28 kPa (4 psi)		207 kPa (30 psi)	
Thermostat Temperature	71°C (160°F) (Seawater Cooled)		N/A	
Thermostat Temperature	77°C (170°F) (Closed Cooling)		71°C (160°F) (Closed Cooling)	
Timing	8° BTDC		N/A	
Firing Order	1-8-4-3-6-5-7-2		1-8-7-2-6-5-4-3	
Transmission Offerings	Refer to SECTION 2-Transmission and Drive Line			
Dimensions	Refer to Installation CD			
Weight	390 kg (860 lb.) (with down angle transmission)		513 kg (1130 lb.) (with down angle transmission)	
Remote Oil	Standard			
Closed Cooling	Optional	Standard		
Audio Warning System	Standard			
Water Drain System	Multipoint Drain System Standard Air Actuated Water Drain is optional with Closed Cooling	Air Actuated Water Drain		
50 Amp Circuit Breaker	Standard			
Flush System	Standard		Kit	Kit
Optional Riser Kits	43 mm (1.7 in.) 76 mm (3 in.) 152 mm (6 in.)		51 mm (2 in.) 152 mm (6 in.) 203 mm (8 in.)	
Battery rating	750 cca / 950 mca / 180 Ah (Minimum rating)			
Battery rating for DTS models	800 cca / 1000 mca / 190 Ah (Minimum rating)			

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb. in.	lb. ft.
Engine mount bracket screws	64		47
Trunnion clamping screws and nuts	68		50
Thermostat housing attaching screws	41		30
Propeller shaft coupling screws and nuts	68		50
Shift and throttle cable fasteners	Tighten securely, then loosen ½ turn to allow pivot points to rotate		
Fuel inlet fitting (water separator)	Apply #567 loctite pipe sealant with teflon to threads. Do not use teflon tape. 1¾ to 2¼ turns past finger tight.		

Notes:

Transmission and Drive Line

Section 2A - Transmission and Drive Line

2 A

Table of Contents

General Information

Gear Ratio Selection

The transmission gear ratio and propeller must provide the optimum match between the engine and the boat application. Gear ratio and propeller selection are affected by numerous factors including engine horsepower, WOT RPM, hull design, propeller clearance, boat weight, and other factors. Several computer programs are available to assist in analyzing all of these variables and selecting the proper propeller and gear ratio. Typically, a higher reduction transmission coupled with a slower turning, larger diameter propeller provides the best efficiency for larger, heavier boats. Conversely, a lower reduction transmission and a smaller diameter, faster turning propeller will generally provide superior performance on lighter, faster applications (35 mph and above).

Engine and Propeller Shaft Installation Angle

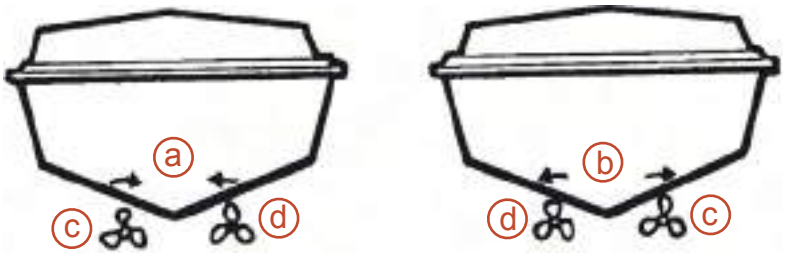
The transmission and engine should be mounted so that the angle relative to horizontal is within the range shown on the installation drawings. As a general rule, the propeller shaft angle should position a properly sized propeller at least one propeller diameter below the waterline.

Installing the engine with the front end too high can cause aeration of the transmission fluid and engine oil. Special care must be taken on 350 cid/5.7L and 377 cid/6.2L V-drive applications with propeller shaft angles of less than 9° to avoid water reversion problems through the exhaust system (See **Exhaust System**). The exhaust elbow outlets will have less than their prescribed amount of downward slope with the exhaust elbows installed in their normal orientation. On these applications, reverse the exhaust elbows to get the proper slope. The engine can be obtained from the factory with this orientation.

NOTE: *5.7L, 6.2L, and 8.1L models have an increased slope in the exhaust elbow outlets and can accommodate any propeller shaft angle (within the specified range) in V-Drive applications without the need to reverse the elbow.*

Propeller Shaft Rotation and Spacing on Dual Installations

Best all-around performance is typically obtained by installing the engines so that the propellers turn outboard (looking from the stern). As a general rule, the centerline to centerline spacing between the propellers should be a minimum of 2.5 times the propeller diameter. Insufficient spacing will reduce efficiency and increase vibration. Shaft spacing must provide the minimum distances between engines as specified in the table following to allow for servicing.



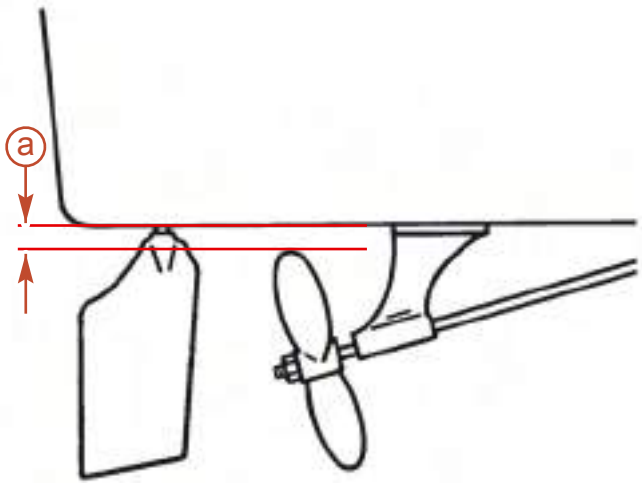
14884

a - Inboard propeller rotation
b - Outboard propeller rotation
c - RH rotation
d - LH rotation

Minimum Distance Between Engine Centerlines	
Model	**Measurement**
All Except 8.1S	838 mm (33 in.)
8.1S	927 mm (37½ in.)

Propeller Blade Tip Clearance

Sufficient clearance is required between the propeller blade tips and the boat bottom to prevent a water-hammering action against the hull. Insufficient clearance will contribute to excessive noise and vibration and could result in cavitation problems. A clearance of 10–15% of the propeller diameter is typical for most boats.



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a - 10–15% of propeller diameter minimum

Propeller Shaft Coupling

Since the engine has flexible mounts, some provision must be provided in the propeller shaft and coupling to accommodate for slight engine movement. On recreational boats, this is typically provided by the use of a flexible stuffing box and a single strut bearing. In these cases, a rigid propeller shaft coupling can be used. Rigid propeller shaft couplings can be ordered with the engine or purchased through *Mercury Precision Parts and Accessories.* Alignment with these couplings is critical; See **Section 3 — Engine.**

Typically, a minimum distance of 20 times the propeller shaft diameter should be provided between the transmission output flange and the first fixed bearing to minimize vibration. If this distance is not available, a flexible coupling can be used. Flexible couplings provide vibration isolation and are more tolerant to engine misalignment. They also reduce the need for periodic realignment of the engine.

If an aftermarket coupling is to be used, the flange must conform with the specifications on the installation drawing. The transmission output flanges comply with:

- Velvet Drive 71C and ZF 45C—SAE J756 Type 410.
- All other transmissions—SAE J756 Type 5.

All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the coupler and transmission output flange. All coupler bolts must be torqued.

Description	Nm	lb. in.	lb. ft.
Coupler bolts	68		50

Propeller Shaft

The required propeller shaft diameter can vary significantly depending on the material used, strut and bearing design, engine horsepower, and shaft RPM. Information is available from the propeller shaft manufacturer and in marine handbooks for selecting the proper diameter. Sufficient shaft diameter is critical for durability and minimizing vibration. As a guideline, the propeller shaft should be a minimum of 1/14 the diameter of the propeller.

Propeller Shaft Log Seal Connections

⚠ CAUTION

Avoid overheating damage. Mercury MerCruiser is not responsible for engine damage caused by improper cooling system connections for the propeller shaft log seal.

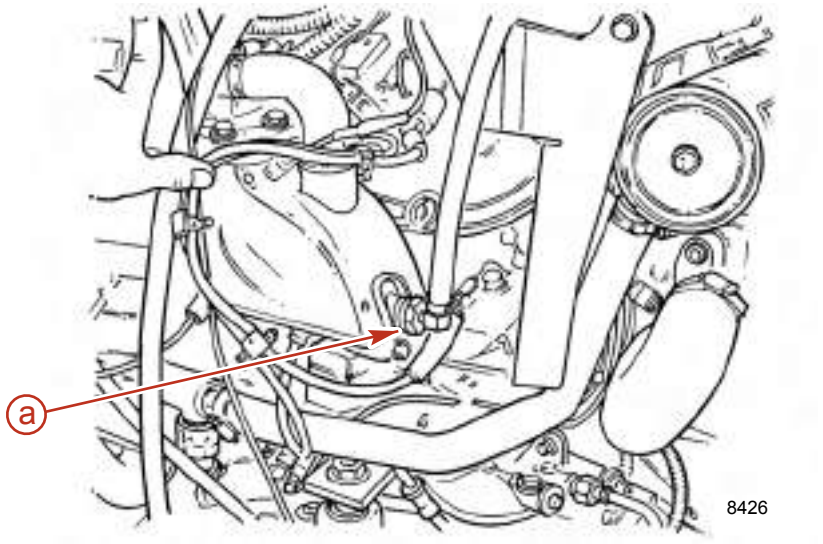
The propeller shaft log seal hose should be routed so that a portion of the hose extends above the top of the engine exhaust elbows to prevent a siphoning action when the engine is not running. Securely fasten the hose to maintain its proper position.

⚠ CAUTION

Engine damage may result from failure to route propeller shaft log seal hose properly. This could cause increased exhaust system corrosion, submersion damage or freeze damage to engine.

8.1S MODELS

Connect the shaft log seal hose to the reducer fitting on the end of the starboard exhaust manifold. The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system and must not be removed.

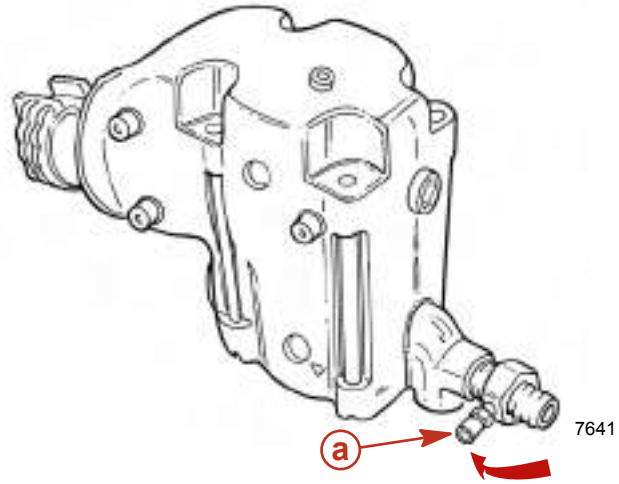


Propeller shaft log seal connection — 8.1S models

a - Reducer fitting

5.7 LITER (350 CID) AND 6.2 LITER (377 CID) MODELS

A fitting is installed at the factory into the proper port on the port exhaust elbow.

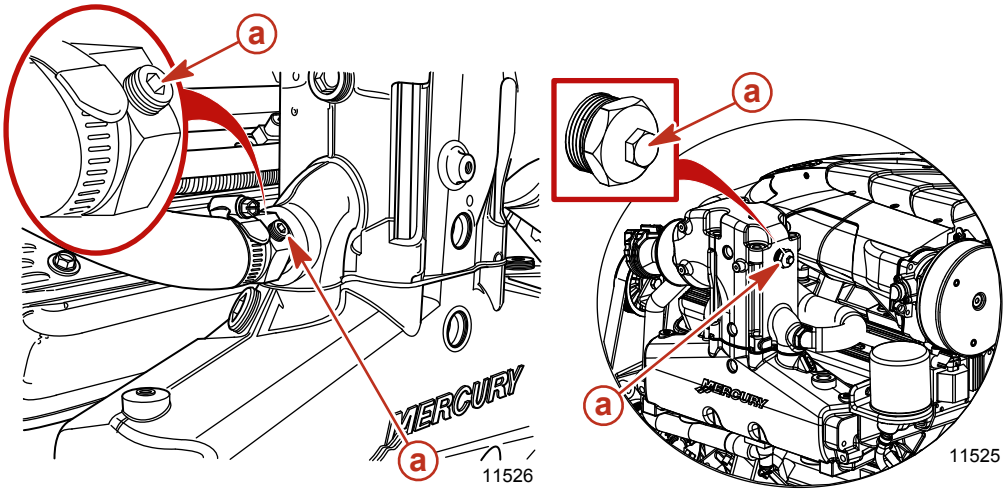


Propeller shaft log seal connection — 5.7L and 6.2L models

a - Shaft log seal fitting

SCORPION MODELS

A brass plug is installed at the factory into the proper port on the port exhaust elbow.



In-line models **V-Drive models**

a - Brass plug

IMPORTANT: If not using a shaft log seal, this fitting must remain plugged.

Transmissions

Gear Ratios

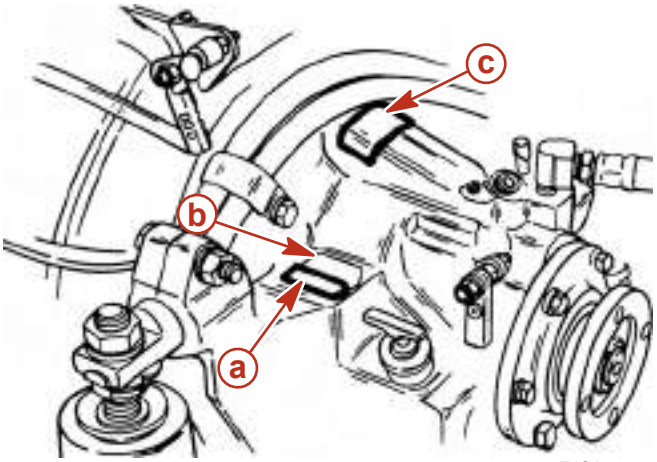
	Velvet Drive Gear Ratios				Walter V-Drive Gear Ratios		ZF Marine Gear Ratios			
	71C	72C	5000A	5000V	45C	71C	45C	63A	63IV	80A
Tow Sports										
5.7L	1.0:1						1.0:1			
350 MAG MPI	1.0:1	1.5:1					1.0:1			
Black Scorpion	1.0:1				1.46:1	1.46:1	1.0:1			
MX6.2L Black Scorpion	1.0:1				1.46:1	1.46:1	1.0:1			
Inboard										
5.7L	1.0:1	1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	
350 MAG MPI	1.0:1	1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	
350 MAG MPI Horizon	1.0:1	1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	
6.2L MX MPI		1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	
6.2L MX MPI Horizon		1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	
8.1S HO		1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	2.8:1
8.1S Horizon		1.0:1	1.25:1 1.5:1 2.0:1 2.5:1 2.8:1	1.5:1 2.0:1 2.5:1				1.5:1 2.0:1 2.5:1 2.7:1	1.5:1 2.0:1 2.5:1	2.8:1

IMPORTANT: 8.1S HO, and 8.1S Horizon Models using Velvet Drive 72C 1.0:1R—V-Drive installation only, used with level mounted engine coupled to a drive shaft with forward-facing exhaust elbows.

Model Offerings and Identification

VELVET DRIVE 71C AND 72C TRANSMISSIONS

On all Velvet Drive In-Line 71C and 72C series transmissions, the gear ratio in FORWARD gear is marked on the identification plate. Transmission output flange rotation in FORWARD gear is indicated on a decal on the transmission case. Transmission rotation is described when viewed from the rear of transmission.



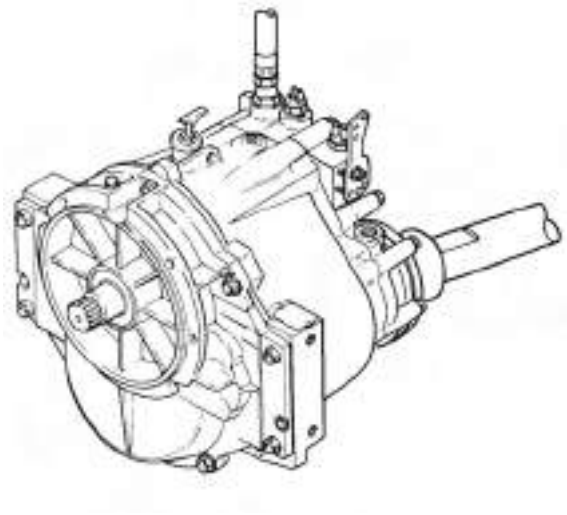
7424

Velvet Drive 71C and 72C transmissions

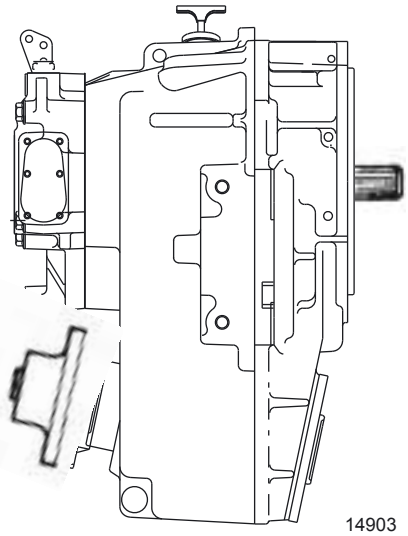
a - Identification plate
b - Gear ratio (in FORWARD gear)
c - Output flange rotation decal (in FORWARD gear)

VELVET DRIVE 5000 SERIES TRANSMISSIONS

On the Velvet Drive 5000A and 5000V transmissions, the identification plate indicates gear ratio, serial number, and model.

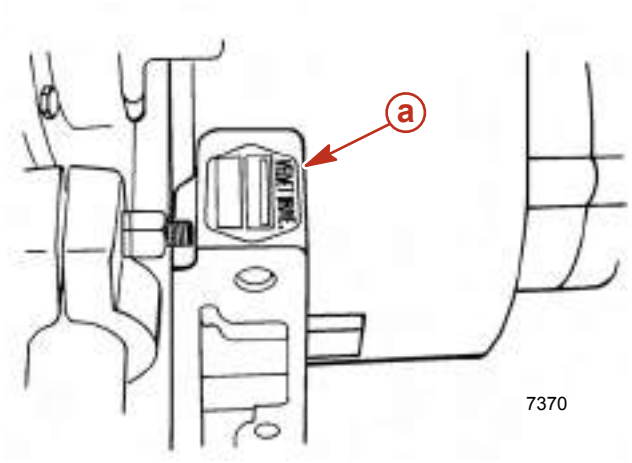


5000A 8° down angle



14903

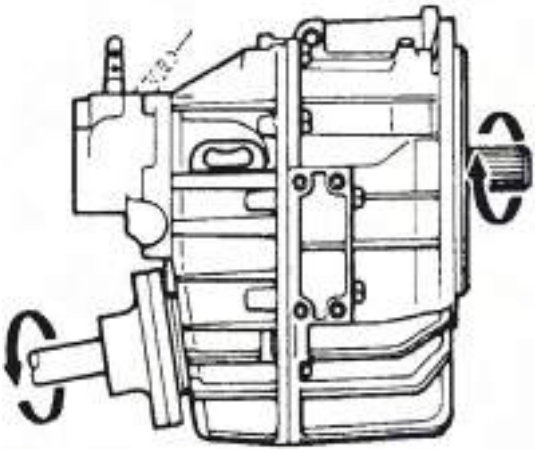
5000V 12° V-drive



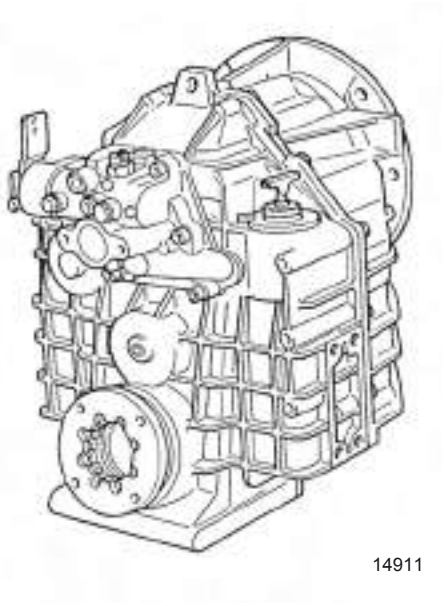
a - Identification plate

ZF MARINE 630 AND 800 SERIES TRANSMISSIONS

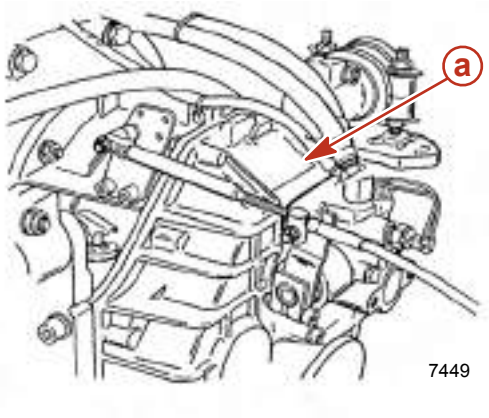
On the ZF Marine Down-Angle and V-Drive transmissions, the identification plate indicates gear ratio, serial number, and model.



8° down angle



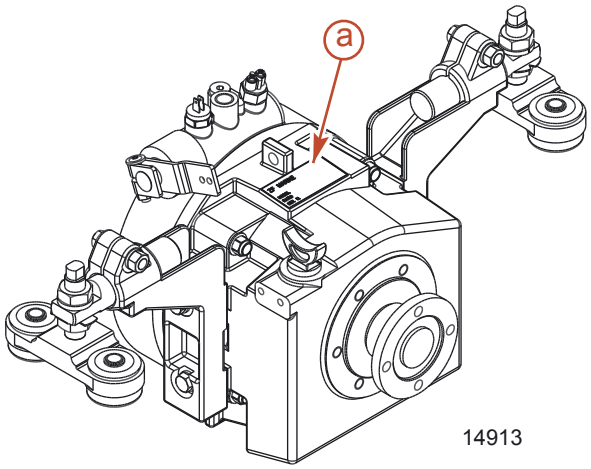
12° V-drive



a - Identification plate

ZF MARINE/HURTH 45C

The transmission identification plate is located on the top rear of the transmission.

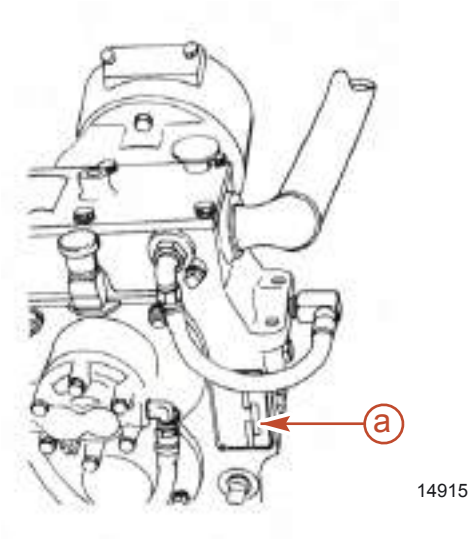


ZF Marine/Hurth 45C

a - Identification plate

WALTER V-DRIVE TRANSMISSIONS

On the Walter V-Drive transmissions, the identification plate indicates gear ratio, serial number, and model.



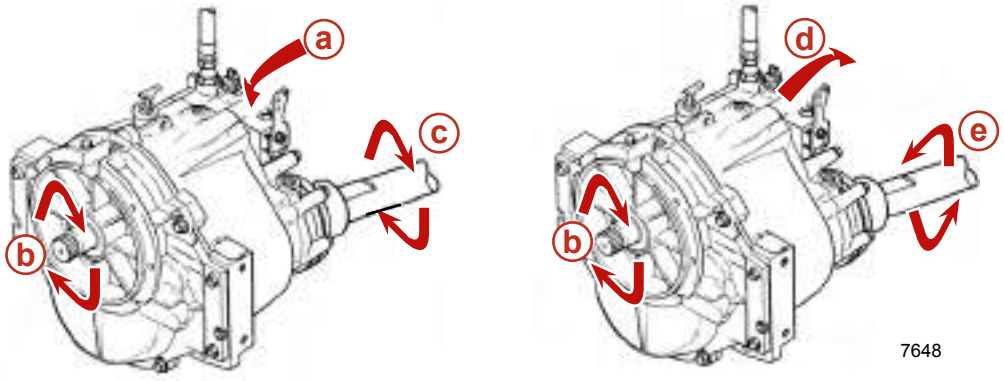
Walter RV-36 V-Drive

a - Identification plate

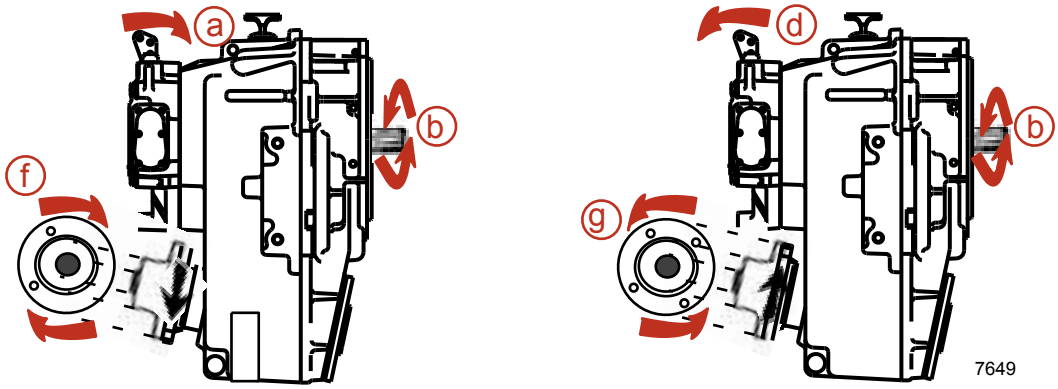
Propeller Rotation

ZF MARINE 630 AND 800 AND VELVET DRIVE 5000 SERIES TRANSMISSION

The ZF Marine 630 and 800 and Velvet Drive 5000 Series transmissions are full power reversing transmissions, allowing a standard LH rotation engine (viewed from flywheel end) to be used for both propeller rotations. Propeller rotation (output flange rotation) is determined by shift cable attachment at the remote control.



Velvet Drive 5000A — 8° down-angle



Velvet Drive 5000V — V-Drive

a - Direction of shift lever engagement (toward flywheel)

b - Engine/transmission input shift rotation direction (LH)

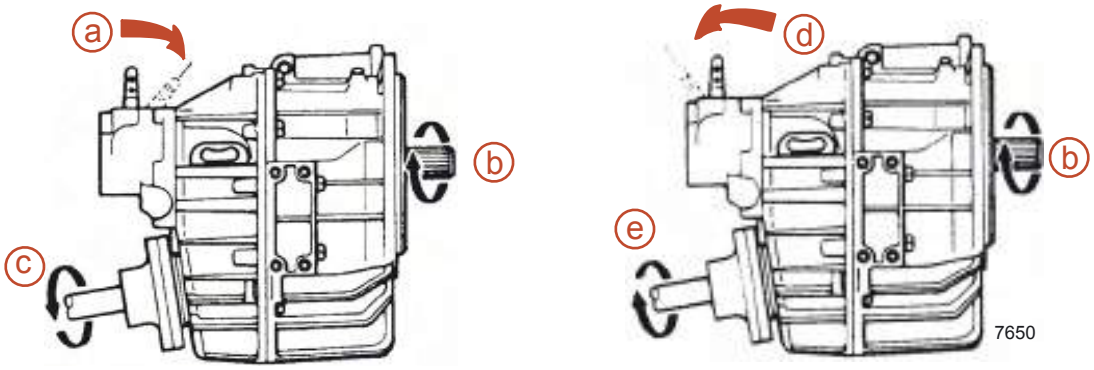
c - Transmission output/propeller shaft rotation direction (LH as viewed at propeller)

d - Direction of shift lever engagement (away from flywheel)

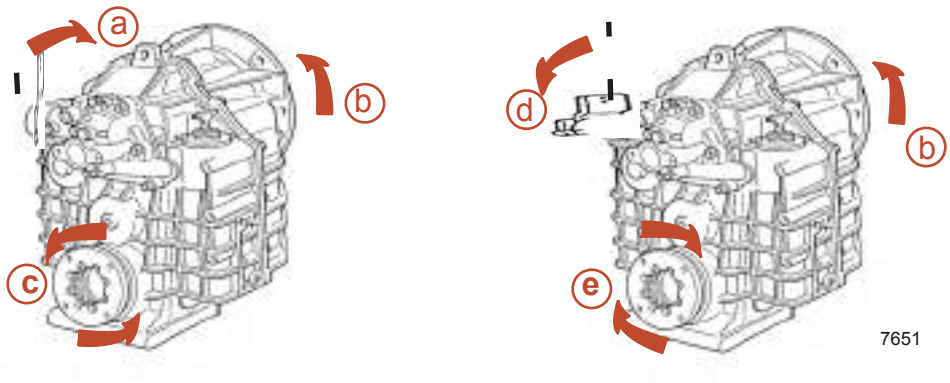
e - Transmission output/propeller shaft rotation direction (RH as viewed at propeller)

f - Transmission output/propeller shaft rotation direction (LH as viewed at propeller)

g - Transmission output/propeller shaft rotation direction (RH as viewed at the propeller)



ZF Marine 630A and 800 — down-angle transmissions



ZF Marine 630V — V-drive transmissions

a - Direction of shift lever engagement (toward flywheel)

b - Engine/transmission input shift rotation direction (LH)

c - Transmission output / propeller shaft rotation direction (RH as viewed at propeller)

d - Direction of shift lever engagement (away from flywheel)

e - Transmission output / propeller shaft rotation direction (LH as viewed at propeller)

f - Transmission output / propeller shaft rotation direction (RH as viewed at propeller)

g - Transmission output / propeller shaft rotation direction (LH as viewed at the propeller)

VELVET DRIVE 71C AND 72C TRANSMISSIONS

⚠ CAUTION

Propeller rotation must match output flange rotation decal on transmission. Transmission failure will occur if incorrect rotation propeller is used

Engine

Section 3A - Engine

Table of Contents

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting	92-809822

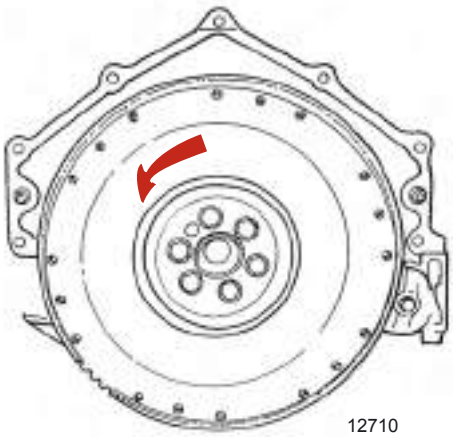
Special Tools

Alignment hook	91-863375A 1
 9190	Assists during engine alignment.

General Information

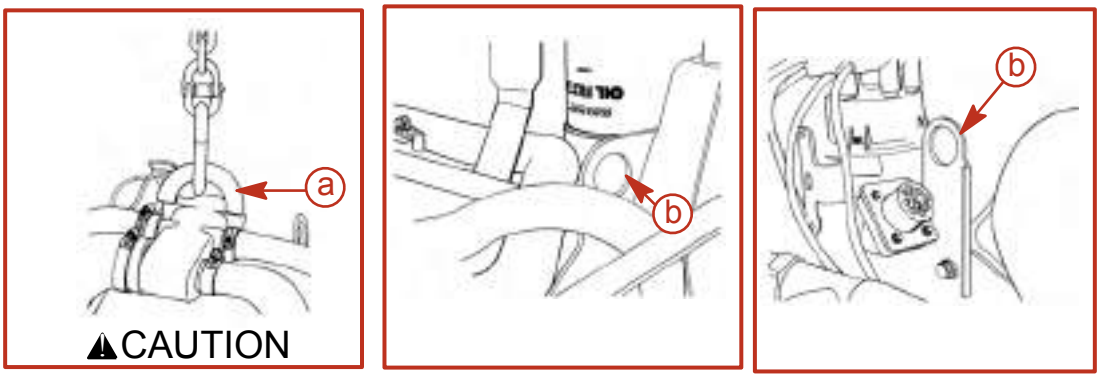
Engine Rotation

Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end). All Mercury MerCruiser engines are left hand (LH) rotation. Propeller rotation is not necessarily the same as engine rotation; See **Section 2 —Transmission and Drive Line.**


12710

Engine Lifting Provisions

Engines are equipped with a lifting eye at the front and the rear. Use a suitable sling with the proper weight rating when lifting the engine.



Typical engine

a - Center lifting eye (engine alignment only)

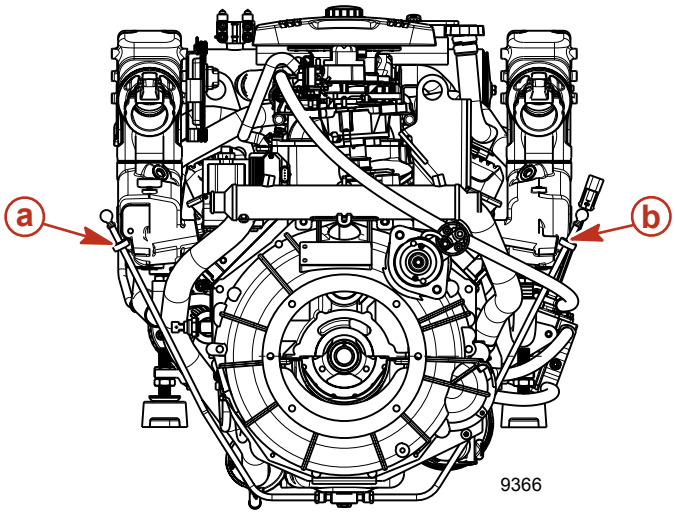
b - Lifting eye

NOTE: *8.1L (496 cid) engines require alignment hook (91-863375-1).*

Alignment hook	91-863375A 1

Engine Oil Dipstick Relocation

Some models are equipped with an oil dipstick in the port and starboard dipstick tubes. If only one dipstick is present and the engine is equipped with two dipstick tubes, you may relocate the oil dipstick.



Model shown is equipped with two oil dipsticks

a - Dipstick option 1

b - Dipstick option 2

1. To relocate the oil dipstick:
   a. Remove the rubber cap from the dipstick tube.
   b. Remove the oil dipstick and insert it into the opposite dipstick tube.
   c. Place the rubber cap over the dipstick tube that is not being used.

Engine Compartment Construction

⚠ WARNING

Avoid serious injury or death and property damage due to improper boat design and construction. Always adhere to all applicable Marine Regulations (United States Coast Guard [USCG], European Union - Recreational Craft Directive [EU-RCD], and so on) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], and so on) when designing and constructing the boat and the boat components, such as the engine compartment, fuel delivery system and exhaust system.

Engine Compartment Ventilation

See **Section 4—Air Intake System.**

Engine Compartment Seams

⚠ CAUTION

Avoid engine damage. Water, that runs onto the air intake, may enter the engine and cause serious damage to internal engine and/or turbocharger parts. Engine compartment design must not allow water to run onto the air intake or air filter.

Exercise care in the design and construction of the engine compartment. Seams must be located so that rain water is directed away from the air intake system and electrical system.

Clearance

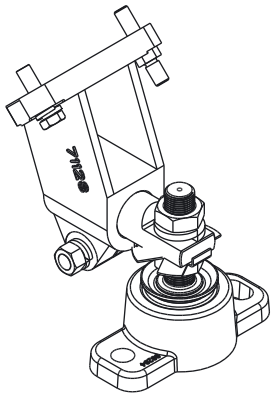
IMPORTANT: The engine compartment must provide a minimum of 13 mm (½ in.) clearance between the boat and any component on the engine (i.e. exhaust manifold, elbow, oil pan, transmission case, etc.). This allows for engine mount deflection during operation.

Engine Bed Requirements

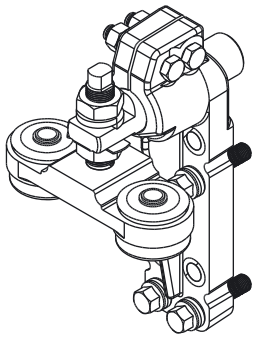
The engine bed (i.e. stringers) must be designed to support the G-forces imposed by the engine during the most severe duty. The bed must also handle the torque produced by the engine and the thrust generated by the propeller. Deflection of the engine bed could stress the engine components, causing possible engine misalignment and transmission failure. The proper design of the engine bed varies considerably from one boat design to the next. Therefore, Mercury MerCruiser makes no attempt to provide detailed engine bed design requirements to cover all possible applications. The proper design of the engine bed is left to the boat manufacturer. The following general guidelines are provided:

- The engine bed must be firmly affixed to the boat and should be made as large as possible to distribute the load evenly. Reinforcements should be used where necessary. Mount pad locations should be as large as possible.
- The engine mounts are designed for the industry standard 572 mm (22½ in.) stringer widths (center to center), but can accommodate widths up to 610 mm (24 in.).
- The engine bed must position the engine so that a minimum 6 mm (¼ in.) of up and down adjustment exists on all four mounts after performing the final engine alignment. This is necessary to allow for realignment in the future. Engine mount isolators will compress slightly over time.
- The front and rear mount locations on the engine bed should be in parallel planes. This can be checked by tying a string from the left front mount location to the right rear mount location and another string from the right front to the left rear. The strings should just touch were they cross.

- The engine mounts must rest squarely on the engine bed so that the rubber isolator is not preloaded in one direction or the other. Preloading the engine mount will cause increased vibration.



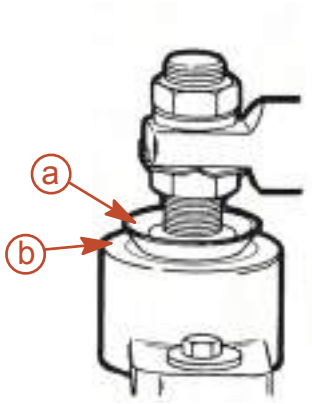
14921



14922

Typical front mount **Typical rear mount**

- The metal ring must not contact the mount base on the front mount.



15889

Typical front mount

a - Metal ring **b -** Mount base

- Engine mounts have provisions for 10 mm (3/8 in.) fasteners for securing mounts to the engine bed. Fasteners should be selected as appropriate for the type of engine bed material being used. The slot in front engine mounts should face forward. Do not install fasteners at an angle.

Serviceability

All engines require maintenance and some will require service repair within the life of the product. Considering serviceability when designing the engine compartment could have a major impact on customer and dealer satisfaction.

In addition to customer and dealer satisfaction, consider the implications of serviceability with respect to our warranty policy. **The Mercury MerCruiser warranty policy states, in part, that reasonable access must be provided to the product for warranty service.** Refer to the warranty policy in the appropriate**Operation, Maintenance, and Warranty Manuals**. It states that removal or replacement of the boat partitions or material because of boat design for necessary access to the product is not covered. Consider serviceability when designing the boat and engine compartment to avoid these types of issues.

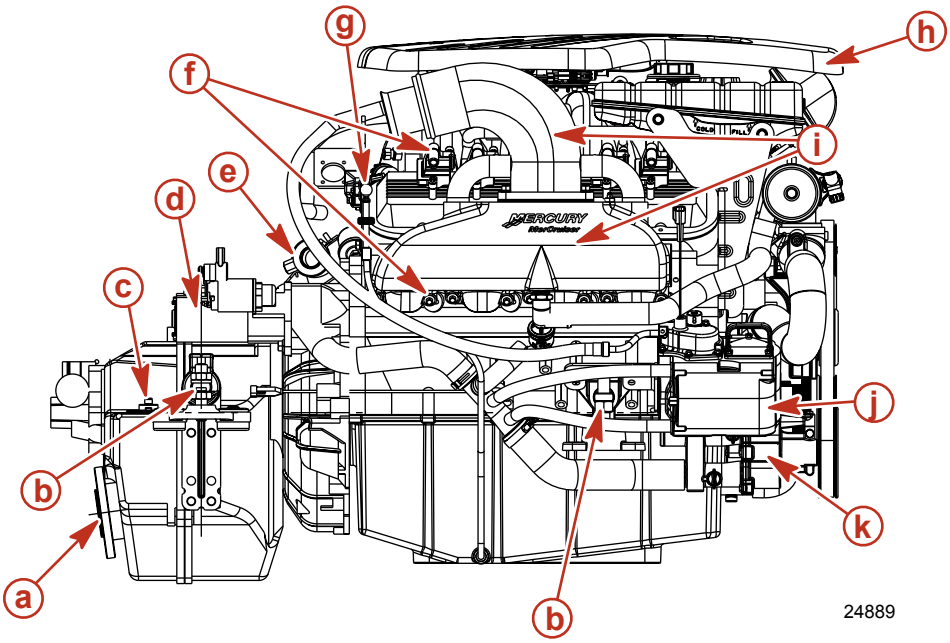
Consider all engines options used in a boat when designing the engine compartment. The engine size differences between some of the models as well as differences in service point locations may have a major effect on serviceability.

The following is a list of the major service points to consider when designing the engine compartment. Typical illustrations are shown to assist you in identifying these locations. These are typical views and may not accurately represent the model that you are working with. The specific engines, along with their installation drawings and the appropriate **Operation, Maintenance, and Warranty Manual**, should be used when doing the actual design work.

MAJOR SERVICE POINTS LIST

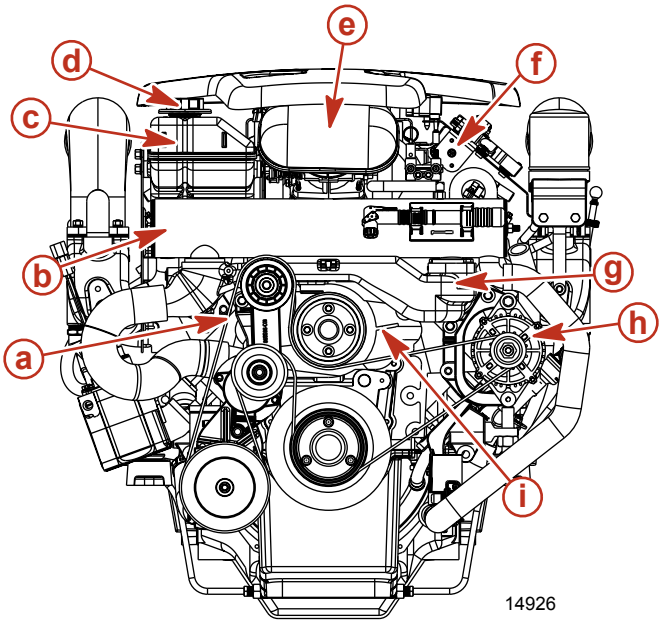
- Oil filter
- Engine oil dipstick
- Crankcase oil fill cap
- Water separating fuel filter
- Transmission fluid dipstick
- Transmission/propeller shaft coupler
- Engine mounts
- Ignition components
- Electrical components bracket
- Flame arrestor
- Starter
- Circulating pump
- Alternator
- Exhaust manifolds/elbows
- Thermostat housing
- Shift and throttle linkages
- Seawater pump
- Drive belt
- Water drains
- Flush connector (if equipped)
- Heat exchanger pressure cap and end caps (if equipped)
- Closed cooling recovery bottle (if equipped)
- Sea strainer (if equipped)
- Battery
- Transmission
- Fuel/induction system
- Fuel coolers (if equipped)
- Oil coolers
- Cylinder heads
- Complete engine removal

ENGINE VIEW



Typical 8.1L inboard side view

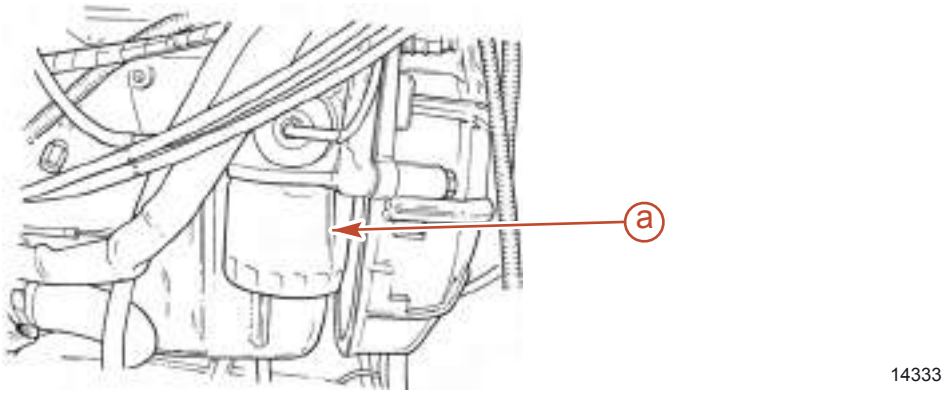
a - Transmission output flange
b - Engine mounts (4)
c - Transmission dipstick
d - Starter (inboard style)
e - Transmission fluid cooler
f - Ignition components
g - Dipstick
h - Engine cover
i - Exhaust manifold and elbow (2)
j - Gen III Cool Fuel Module (Inboard models)
k - Seawater pump



Typical 8.1L inboard front view

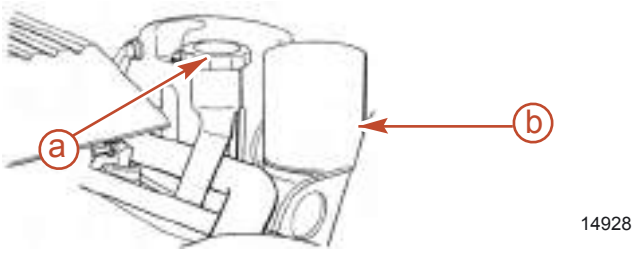
a - Drive belt
b - Heat exchanger
c - Coolant reservoir
d - Pressure cap
e - Flame arrestor
f - Electrical bracket
g - Thermostat housing
h - Alternator
i - Circulating pump

OIL FILTERS



Typical tow sports engine oil filter

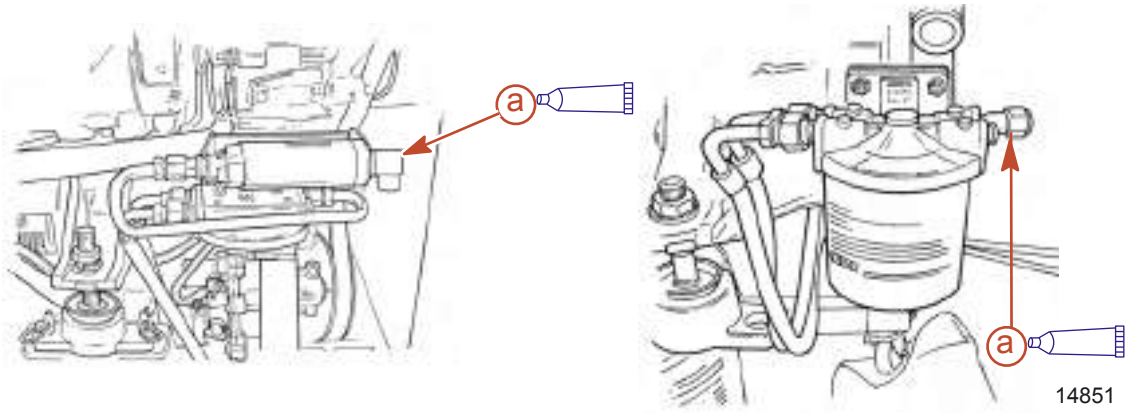
a - Engine-mounted oil filter



Typical inboard engine oil filter

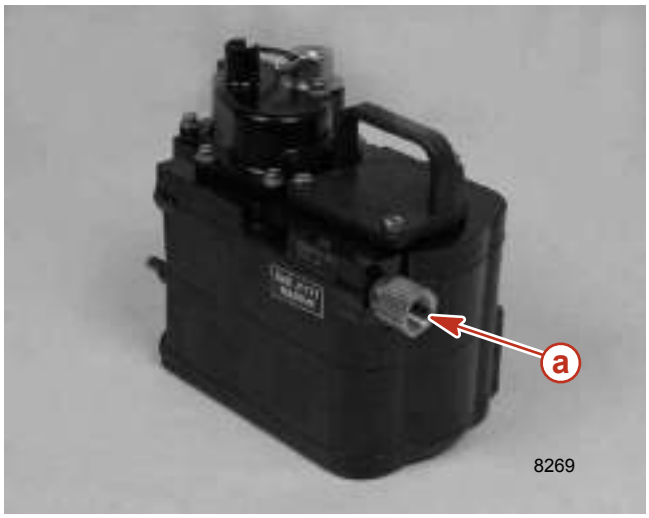
a - Engine oil fill cap
b - Remote oil filter

FUEL CONNECTIONS



Models with boost pump **Models without boost pump**

a - Fuel inlet fitting

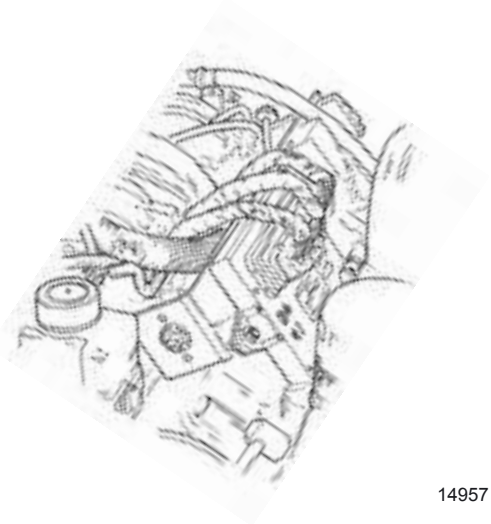


Gen III Cool Fuel Module (Inboard models)

a - Fuel inlet fitting

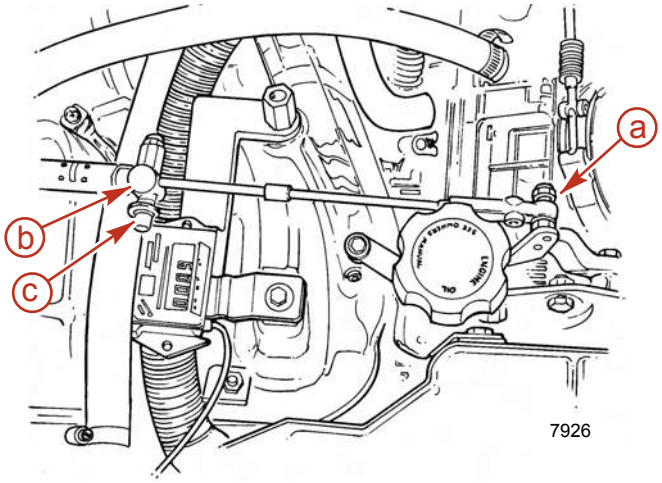
Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting	92-809822

ELECTRICAL



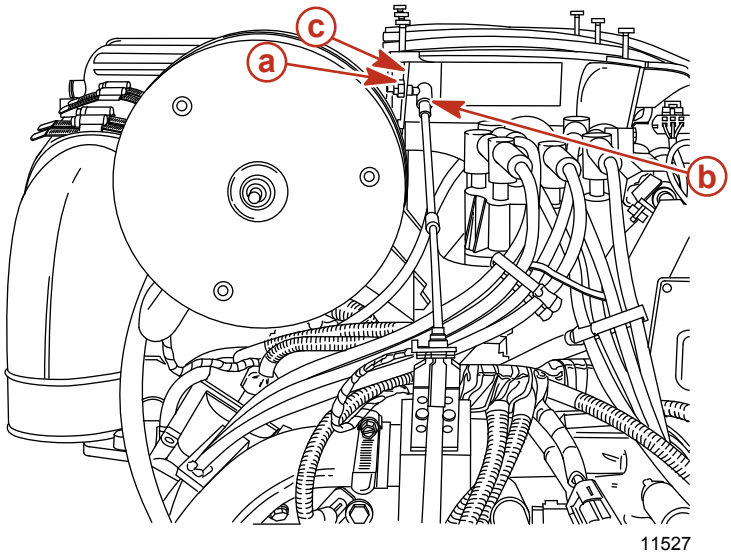
Typical electrical components bracket

THROTTLE



Typical throttle cable and linkages

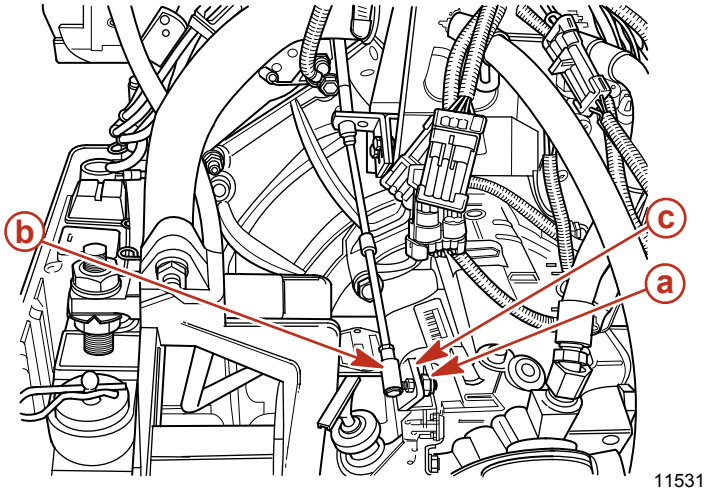
a - Flat washer and locknut
b - Cable barrel
c - Flat washer and locknut



Typical quick connect throttle cable

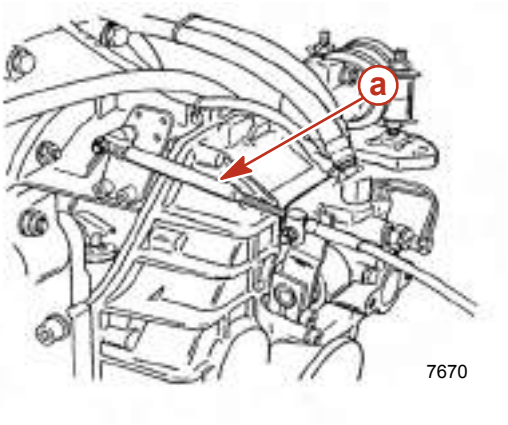
a - Jam nut
b - Cable barrel
c - Throttle body bracket

SHIFT



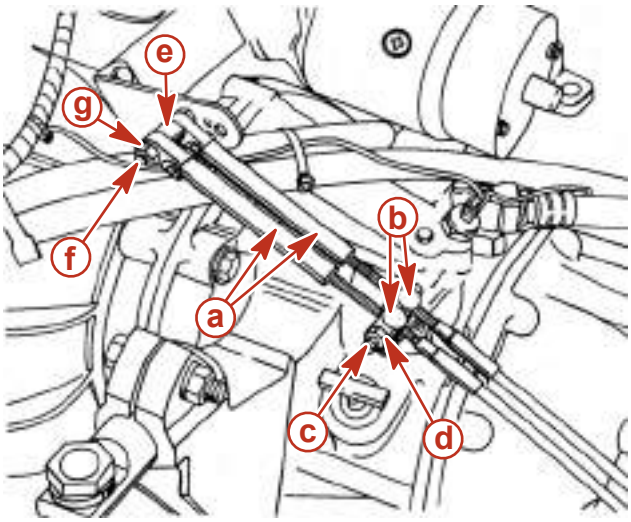
Typical quick connect shift cable

a - Jam nut
b - Cable barrel
c - Bracket



Typical transmission

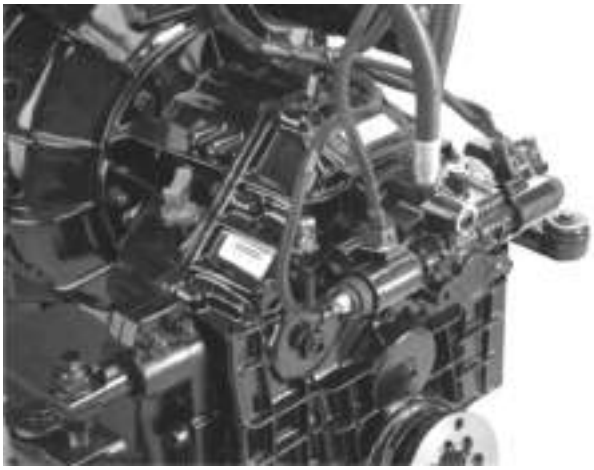
a - Shift cable



Typical dual station transmission

a - Cable end guide
b - Cable barrel
c - Cable barrel stud
d - Elastic stop nut and washer
e - Spacer
f - Cable end guide stud
g - Elastic stop nut and washer

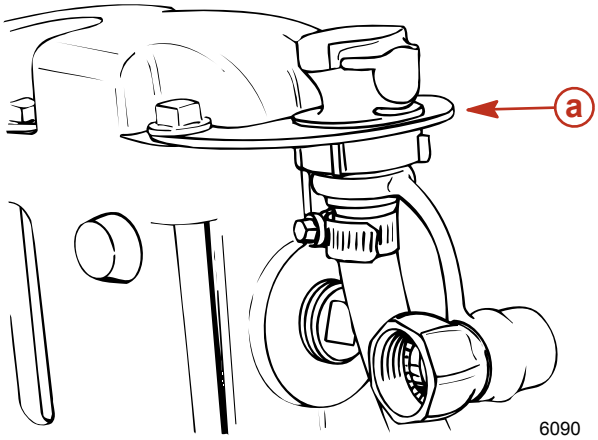
NOTE: *Shift cables are not used on DTS transmissions*



20418

ZF Marine (Hurth) transmission with electric shift— DTS models

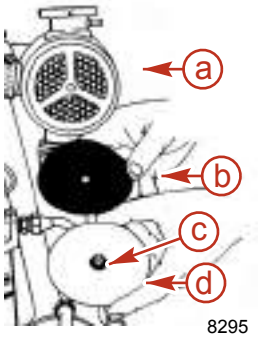
FLUSH



Typical flush connector (models so equipped)

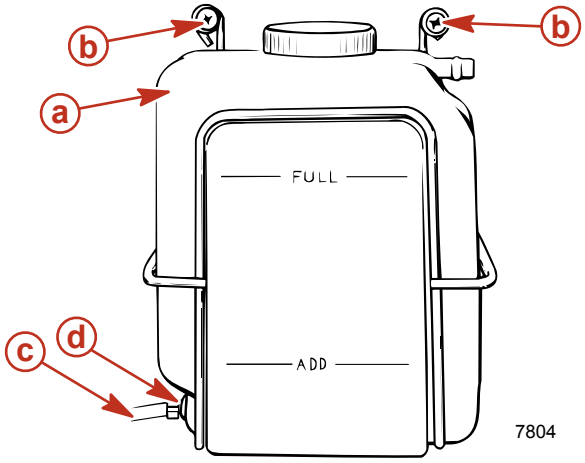
a - Flush connector

COOLANT



Typical heat exchanger (closed cooled models)

a - Heat exchanger
b - Gasket
c - Fastener
d - End cap



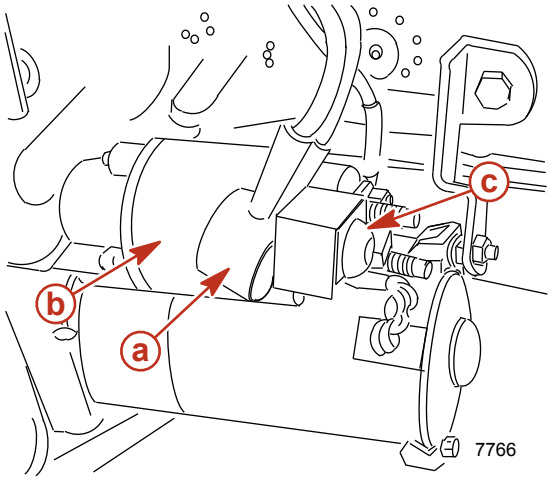
Coolant recovery bottle (closed cooled engines except 8.1S)

a - Coolant recovery bottle
b - Mounting holes
c - Hose
d - Hose clamp

SEA STRAINER

Typical sea strainer (optional)

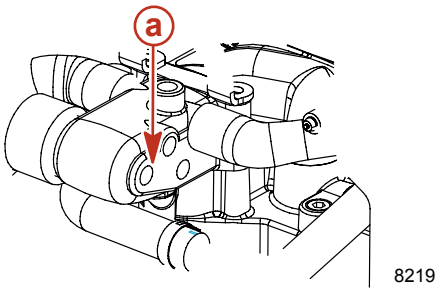
STARTER



Typical starter

a - Rubber boot
b - Starter solenoid
c - 90-amp fuse

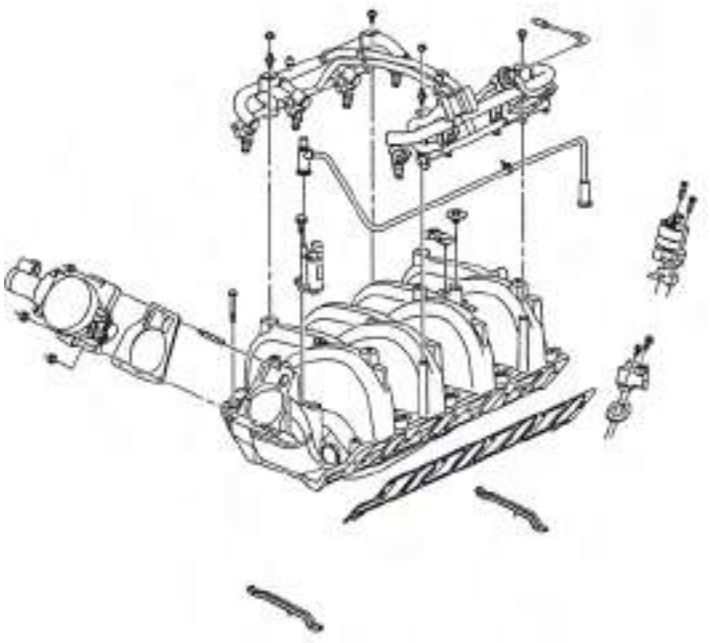
THERMOSTAT



Typical thermostat housing

a - Housing

FUEL AND AIR INDUCTION



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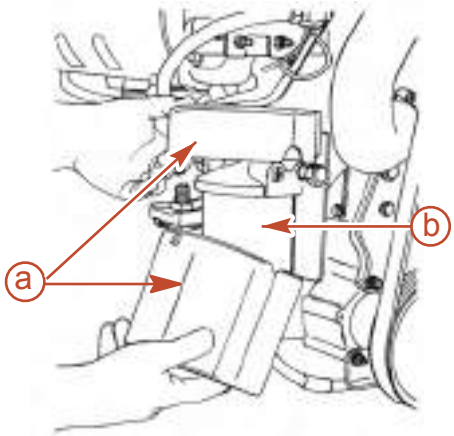
Typical Fuel/Air Induction System

FUEL SYSTEMS

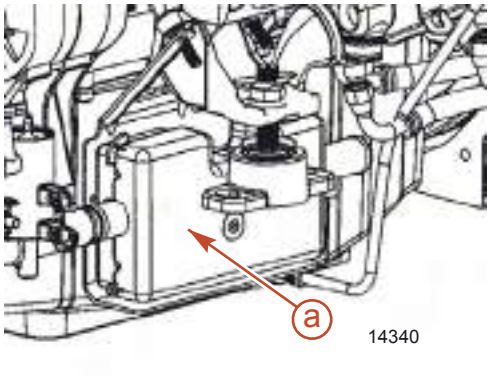


14931

Typical fuel filter

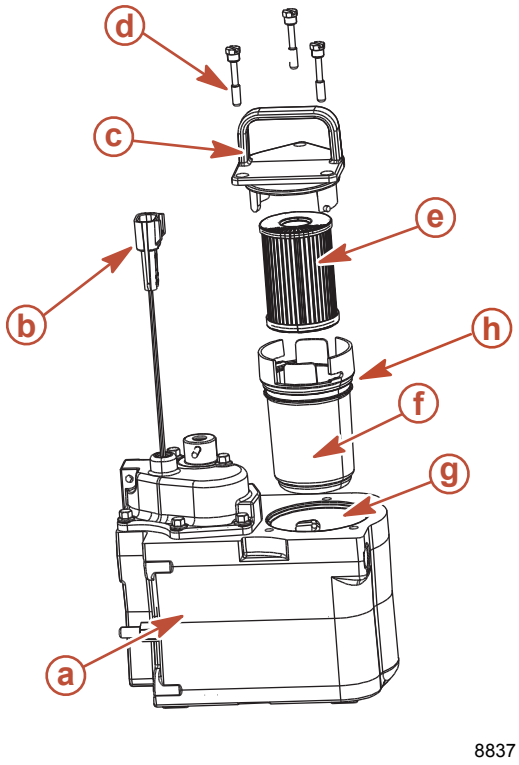
a - Water-separating fuel filter cover (MPI tow sports models only)

b - Water-separating fuel filter



Fuel cooler (Gen II)

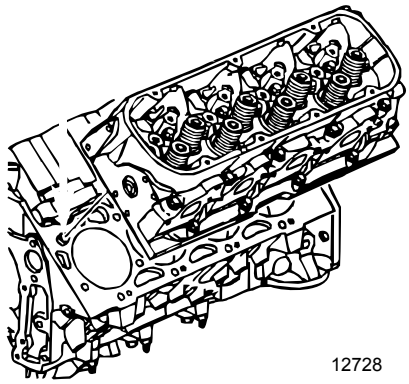
a - Fuel cooler



Gen III Cool Fuel Module

a - Cool Fuel Module
b - Cool Fuel Module harness
c - Filter cap
d - Filter assembly retaining screw
e - Fuel filter element
f - Filter cup
g - Cool Fuel Module filter reservoir
h - Filter cup seal

CYLINDER HEADS



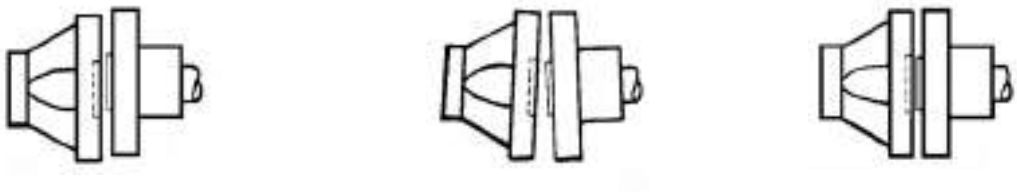
Typical cylinder head

Engine Alignment

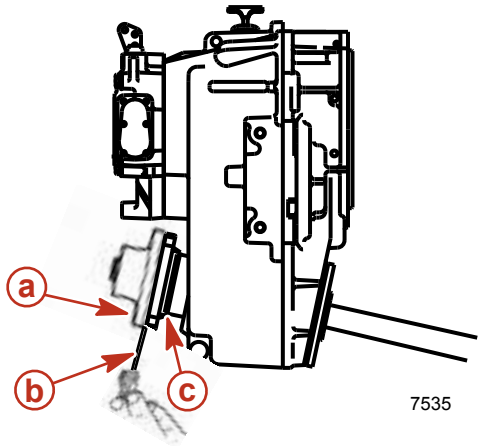
Proper alignment between the transmission, and the propeller shaft is essential to minimize noise, vibration, and power loss and to avoid overstressing the transmission and drive line components. A preliminary alignment should be performed at the time of installing the engine. The final alignment must be done after the boat is in the water to compensate for any deflection in the hull. On applications with a rigid propeller shaft coupler, the coupler should be disconnected from the transmission for shipment. The alignment should then be rechecked with the boat in the water. The requirement for checking the alignment should be clearly communicated to your dealers, along with an understanding as to who is financially responsible.

The complete alignment procedure is outlined in the installation manuals. Important elements of this process include:

- Align the engine to position the pilot on the propeller shaft coupler into the recess in the transmission output flange so that the mating surfaces of the flange and the coupler are parallel within 0.07 mm (0.003 in.).



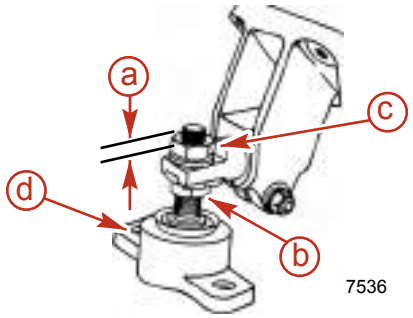
- Check alignment by holding the flange and the coupler together and checking at 90° intervals with a feeler gauge. The coupler should be rotated 180° and alignment rechecked to ensure that the coupler and flange are in alignment.



a - Propeller shaft coupler
b - Feeler gauge
c - Transmission output flange

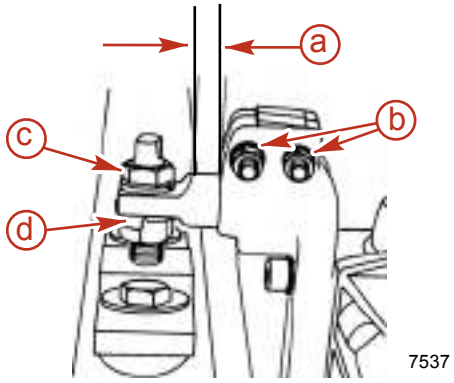
Specification	mm	in.
Transmission output flange to propeller shaft coupler alignment tolerance	0.0—0.07	0.0—0.003

- The slot on the front mounts should face forward.
- The adjusting nuts on the port and starboard mounts should be adjusted evenly.
- A minimum of 6 mm (¼ in.) of up and down adjustment must exist on all four engine mounts after final alignment to allow for realignment in the future.



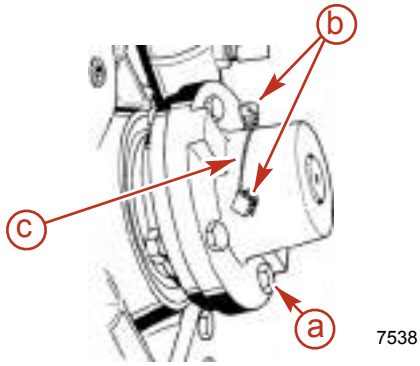
a - 6 mm (¼ in.) minimum adjustment required for future alignment
b - Adjusting nut
c - Locknut
d - Slot

- Trunnions must not extend more than 45 mm (1¾ in.) and no less than 10 mm (3/8 in.).



a - Trunnion extension 45 mm (1¾ in.). 10 mm (3/8 in.) is nominal
b - Trunnion clamping screws and nuts
c - Locknut
d - Tab washer

- Tighten mount locknuts securely. Bend the tab washer tab (that is closest to the adjacent flat on the locknut) against the flat to prevent it from loosening.
- Torque trunnion clamping screws and nuts.



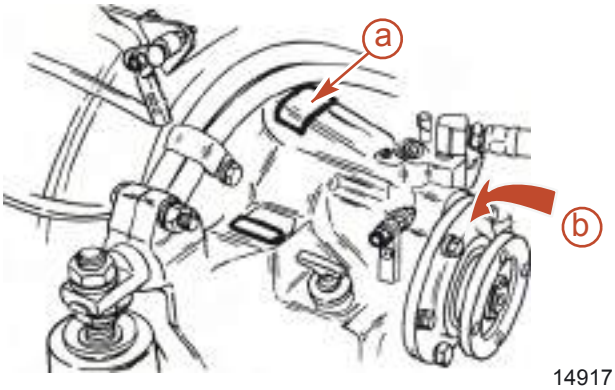
a - Coupler bolts and nuts (4)
b - Set screws
c - Safety wire

Description	Nm	lb. in.	lb. ft.
Locknuts	68		50

- Torque coupling bolts. Secure set screws if equipped with safety wire

Description	Nm	lb. in.	lb. ft.
Coupler bolts	68		50

The 1:1 and 1.5:1 gear ratio versions of these transmissions have a LH output flange rotation when in FORWARD gear. This is the same as the engine rotation and is referenced from the rear of the engine. A LH rotation propeller must be used on these applications (except a Walter V-drive application where the rotation is established by the gear box). The transmission can only be operated under full power when in the FORWARD gear position.



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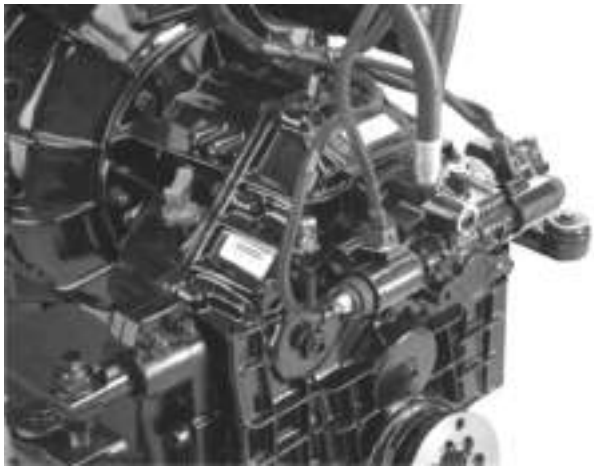
Velvet Drive 71C and 72C transmission

a - Output flange rotation decal

b - Direction of rotation in FORWARD gear

ZF Marine Transmissions—DTS

The oil temperature sensor for the ZF Marine transmissions with electronic shift is not installed at the factory. An allen plug is installed in the port for shipping. The oil temperature sensor is provided in a parts bag.



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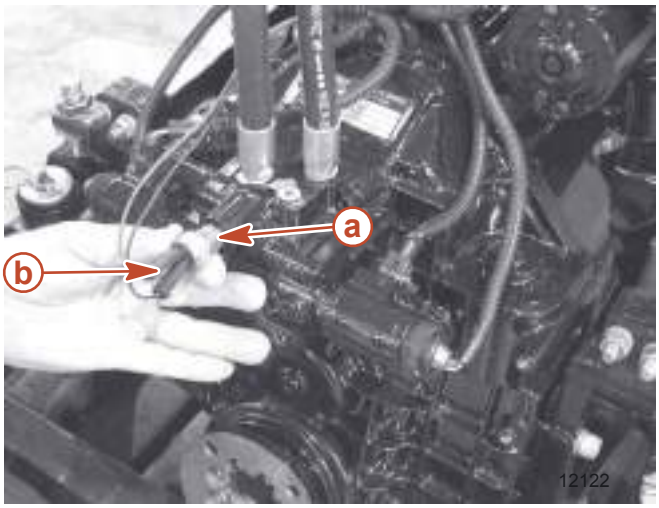
ZF Marine transmission—DTS (oil temperature sensor not installed)

Remove the allen plug and install the oil temperature sensor. Connect the wire connections, of the harness, to the oil temperature sensor.



ZF Marine transmission—DTS (oil temperature sensor installed)

a - Oil temperature sensor

b - Oil temperature sensor wire connections

Remote Control and Shift Cable

See **Section 9 — Instrumentation and Controls**

Notes:

Air Intake System

Section 4A - Air Intake System

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4
A

Engine Compartment Ventilation

Adequate ventilation is required to properly evacuate the fumes from the engine compartment and for proper engine operation. Insufficient ventilation will result in less than optimum engine performance. This is of particular concern on boats with tight engine compartments and those that use insulation to reduce engine noise. These techniques restrict the flow of air and can trap heat, which significantly increases the susceptibility to vapor locking.

IMPORTANT: This section does not cover the design of the ventilation system as it pertains to ventilation of fumes from the engine compartment. The requirements for ventilation of fumes varies considerably between boat designs and from country to country. Therefore, the boat manufacturers are responsible for ensuring their application is in compliance with the appropriate industry standards and regulations (Coast Guard, ABYC, NMMA, SAE RCD, EU, ISO and others.)

1. The ventilation system must provide compliance with the specifications for maximum pressure differential, fuel inlet temperature, and temperature at top of engine compartment as defined under the engine compartment and fuel system pressure and temperature test following.
2. The minimum air vent cross-sectional area shown in the following table can be used as a starting point for sizing the system. Keep in mind that the air inlet requirements can vary significantly from one boat design to the next, and that only performing the following test ensures compliance with the ventilation requirements.

Ventilation System Specifications

Model	Engine Air Requirements at WOT m^3/sec. (ft^3/min.)	Minimum Air Vent Cross-Sectional Area Requirements (per Engine) cm^2 (in^2)	Engine Physical Volume L (ft^3)
Ski Models			
5.7L	0.226 (486)	316 (49)	150 (5.3)
350 MAG MPI	0.239 (506)	329 (51)	
Black Scorpion			
MX6.2L	0.268 (567)	367 (57)	
MX 6.2 Black Scorpion			
Inboard Models			
5.7L	0.220 (466)	303 (47)	150 (5.3)
350 MAG MPI and 350 MAG MPI Horizon	0.229 (486)	316 (49)	
MX6.2L	0.258 (545)	355 (55)	
8.1S Horizon	0.332 (660)	426 (66)	170 (6.0)
8.1S HO	0.325 (689)	445 (69)	

3. Ventilation openings must be increased if the boat is to be equipped with a generator set.
4. On boats where more than one engine model is to be offered, size the ventilation system for the largest horsepower offering.
5. Air vent cross-sectional specifications are for engine combustion air only and do not consider the ventilation of fumes.

6. The engine physical volumes are included in the table for use in computing the volume of air in the engine compartment. This information is needed for determining the ventilation requirements for venting fumes (refer to appropriate standards).
7. Ensure that water does not enter the ducts.
8. Air inlet ducts must be located in an area where they will not pick up exhaust fumes.

Engine Compartment and Fuel System Pressure and Temperature Test

NOTE: *Due to numerous similarities, the tests for the fuel system have been incorporated into this test. All of these tests should be performed at the same time.*

These tests require the use of a precise pressure gauge (manometer) and a thermocouple temperature meter that can accurately read the ranges shown in the specifications table. These items can be obtained by purchasing a boat audit tool kit.

Description	Specification
Maximum engine compartment pressure differential @ WOT (inside vs. outside)	51 mm (2 in.) Water
Maximum temperature @ fuel inlet	44°C (110°F)
Maximum temperature @ top of engine compartment	80°C (176°F)
Maximum fuel pressure drop @ fuel inlet	6.9 kPa (1 psi)

This test is very sensitive to the ambient temperature and the Reid vapor pressure (RVP) of the fuel used during the test. Equipment is provided in the boat audit tool kit to measure the RVP if this information cannot be obtained from your fuel distributor. **This test should be performed under the highest ambient air temperatures that the boat will be subjected to in the markets where it is to be sold.**

The engine compartment must be completely closed and in a condition for normal use. Route the hose and leads from the test instruments into the engine compartment through a vent or a screw hole. If routing through a hole, ensure that it is sealed.

This test needs to be performed with the boat in the water and underway. No special loading characteristics are required, but the boat should be capable of reaching WOT. The boat tachometer should not be used due to a high level of variation.

Connections

1. Test the engine with the longest length of fuel line or the most fuel components.
2. Connect a ¼ in. NPT female brass cross fitting between the fuel inlet and the boat's fuel supply hose using appropriate hardware. Close the fuel shut off valve or clamp the hose to prevent fuel spilling into the bilge.

Equipment needed:
¼ in. NPT female brass cross and appropriate fittings
Fuel inlet connection
Thermocouple
Fuel supply hose
Pressure gauge hose

3. Install the thermocouple into the brass cross with a ¼ in. NPT thermocouple fitting. Connect the thermocouple to the meter using an extension cord.
4. Connect the pressure gauge to the brass cross with no more than 1.5 m (5 ft.) of hose. A longer hose is convenient; however, it will give unstable readings.

5. Route the manometer hose to allow reading the engine compartment differential pressure.
6. Position another thermocouple above the flame arrestor on the engine to read the peak engine compartment temperatures.
7. Be sure the hoses, thermocouples, and fittings stay away from moving parts. Use a tie strap if necessary.
8. Zero the pressure gauge before starting the engine.
9. Start the engine and check for fuel leaks.

Running Test

1. Record the ambient air and water temperature.
2. Operate the boat at WOT for 10 minutes.
3. Operate the boat at 1000, 2000, 3000, 4000 RPM, and WOT and record fuel inlet temperature and pressure.
4. Record maximum engine compartment pressure differential at WOT.
5. Bring the boat to idle (in or out of gear) and continue to idle for 15 minutes.

IMPORTANT: Do not operate generators, blowers or any other type of equipment that can displace air from the engine compartment.

IMPORTANT: Do not open the engine compartment during the test.

6. At the end of 15 minutes, record the engine compartment air temperature, fuel temperature and fuel pressure.
7. Rapidly accelerate to WOT and maintain WOT for about 30 seconds. Ensure that there is plenty of room and no danger to other boaters.
8. Do not close the throttle if a hesitation, stumble, bog or stall occurs. Allow the engine to recover (if possible) on its own.
9. Observe operating characteristics and record the highest fuel pressure drop seen during WOT run.
10. Complete heat soak test and then refer to *Interpreting Results*.

Heat Soak Test

1. Operate the boat at WOT for 10 minutes.
2. Bring the boat to an idle, anchor and shut off engine.
3. Record the fuel temperature and engine compartment air temperatures at 5 minute intervals until the highest temperature has been observed. This may take up to 2½ hours. If the temperature has remained the same for 10–15 minutes or begins to lower, the maximum has probably been reached.

IMPORTANT: Do not operate generators, blowers or any other type of equipment that can displace air from the engine compartment.

IMPORTANT: Do not open the engine compartment during the test.

4. Once the temperature has stabilized, start the engine and idle for 10 seconds. This should give time to turn the boat or clear obstacles. Rapidly accelerate to WOT and maintain WOT for about 30 seconds. Ensure that there is plenty of room and no danger to other boaters.
5. Do not close the throttle if a hesitation, stumble, bog, or stall occurs. Allow the engine to recover (if possible) on its own.
6. Observe operating characteristics and record the highest fuel pressure drop seen during the WOT run.

Interpreting Results

Changes must be made to the fuel system or ventilation system if the readings fall outside of the specifications or the engine bogs or stalls under hard acceleration. Potential causes may be:

Condition	Symptom
Hesitation	The throttle is opened and there is a 1–2 second hesitation before the engine responds and possibly a backfire. Some hesitation is acceptable in moderate to extreme conditions.
Stumble	The engine accelerates and drops 200–1000 RPM for a moment and then recovers. Backfire may occur. Some stumble is acceptable in extreme conditions.
Bog	Much more severe than a stumble. The engine drops over 2000 RPM after acceleration for 10 or more seconds. Backfire may occur. The engine barely recovers.
Stall	The engine ceases to run or fails to start.

Excessive engine compartment temperature or pressure differential

- Insufficient cross-sectional area of air vents and related hardware.
- Inlet and exhaust vents improperly located on boat (too close to one another, both in high pressure or low pressure areas).
- Vent hoses too restrictive (excessive bends, too small, laying in water).
- Vent hoses not positioned to allow good circulation of air.
- A blower may be required to get proper ventilation.

Excessive Fuel Inlet Temperature

- Same as above.
- Too much of fuel tank, lines, and related hardware exposed to engine compartment–reduce or insulate.
- Fuel line located too high in engine compartment (warmest air is at top of compartment).
- Fuel line too close to hot surface on engine.
- Refer to **Section 5—Fuel System** for more information.

Excessive Fuel Pressure Drop

- Fuel system excessively restrictive (lines too small, too many fittings).
- Auxiliary fuel filter utilized.
- Anti-siphon valve too restrictive.
- Refer to **Section 5—Fuel System** for more information.

Everything Within Specifications, But Engine Still Hesitates, Stumbles, Bogs, or Stalls.

- RVP of fuel too high.

Notes:

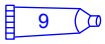
Fuel Delivery System

Section 5A - Fuel Delivery System

Table of Contents

5
A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Fuel inlet connection	92-809822

Fuel Delivery System

⚠ WARNING

Always adhere to all applicable Marine Regulations (United States Coast Guard [USCG], European Union - Recreational Craft Directive [EU-RCD], and so on) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], and so on) when installing the fuel delivery system.

The primary concern in designing the fuel system should be safety. This must be accomplished with a technically sound design and appropriate maintenance procedures.

Also, design the fuel delivery system to deliver the fuel to the engine minimizing fuel restriction and at the lowest temperature. Gasoline is extremely sensitive to vaporizing if placed under a vacuum (low pressure) and exposed to moderate or high temperatures. This is particularly true if winter blend fuels with a high Reid vapor pressure (RVP) are encountered in warmer temperature areas. Excessive restriction in the fuel delivery system may cause a condition known as vapor locking. This typically occurs after the engine has been operated at high RPM and then shut off and allowed to sit for 15 minutes to 2 hours. During this time, the engine heat soaks causing the temperature of the fuel system to increase. Upon restart, the combination of heat and vacuum in the fuel system causes the fuel to vaporize. The fuel system cannot handle this vapor, and therefore, fuel starvation results when the boater attempts to resume operation. Depending upon the degree of vapor locking, this can range from a hesitation or bog when accelerating to a complete stalling of the engine. To minimize the potential for this problem, observe the guidelines to limit fuel delivery restriction to 6.9 kPa (1 psi) vacuum or less and fuel inlet temperature to 44 °C (110 °F) or less.

The fuel delivery system is an integral part of the boat. Mercury MerCruiser makes no attempt in this manual to cover all aspects of design and integration of the fuel delivery system due to the broad range of possible configurations and the numerous regulations and standards that cover this area. Observe the applicable standards and regulations for the markets where your product will be sold, along with any information from the fuel system component manufactures. The following general guidelines are provided.

⚠ WARNING

Avoid serious injury or death and property damage due to improper boat design and construction. Always adhere to all applicable Marine Regulations (United States Coast Guard [USCG], European Union - Recreational Craft Directive [EU-RCD], and so on) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], and so on) when designing and constructing the boat and the boat components, such as the engine compartment, fuel delivery system and exhaust system.

Safety is the main concern in the design of a boat's fuel system; this must be achieved through a technically sound installation and constant inspection.

The fuel system, from the filler pipe to the fuel pump, is the same in principle for all boats.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank manufacturer.

Only a few points related to function and safety are listed here [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

- All connections should be on the upper side of the tank.
- The drain plug at the lowest point on the tank permits the removal of water and sediment.
- The tank breather pipe must have an inner diameter of at least 13 mm (½ in.)and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection-related points, applying to all engines unless otherwise stated, must be considered [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

- The fuel pickup should be at least 25 mm (1 in.) from the bottom of fuel tank to prevent picking up impurities.
- The maximum measured vacuum at the engine's fuel inlet must not exceed 6.9 kPa (1 psi) at 600, 3000, full throttle RPM, and idle RPM.

IMPORTANT: A vacuum reading higher than specified can cause vapor locking with some fuels. It can also cause poor engine performance because of fuel starvation.

- Fuel lines used must be Coast Guard approved (USCG Type A1).

Description	Specification
Minimum fuel line diameter on single-engine gasoline installations	10 mm (3/8 in.)
Minimum fuel line diameter on multi-engine gasoline installations	13 mm (½ in.) ID or larger

- **On Multi-Engine Gasoline Installations,** use a fuel pickup and fuel tank supply line for **each** engine. If a single pickup and line is used, line must be 13 mm (½ in.) ID or larger.
- Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
- Fuel lines should be installed free of stress and firmly secured to prevent vibration and/or chafing.
- Sharp bends in fuel lines should be avoided.
- A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Fuel Tank

- The fuel tank must be properly vented to allow easy filling of the tank and prevent a vacuum or pressure from being generated during normal operation. ABYC standards recommend that the vent pipe and associated hardware be 11 mm (7/16 in.) ID minimum.

- The vent and fuel fill systems must be carefully designed to inhibit water entry, a common source of engine problems. Proper location of the fill and vent fittings and the use of a good sealing fill cap is critical. A goose-neck in the vent hose can also be used to impede water entry.
- The fuel pickup tube and fittings must be at least as large as the fuel lines to minimize fuel restriction (the larger the better). A filter or sock on the end of the tube is recommended to prevent debris at the bottom of the tank from clogging the other fuel system components (especially anti-siphon valve).
- A tank with baffles or a sump is recommended for applications that will be used for aggressive boat maneuvers (i.e. ski boats) to prevent fuel aeration and starvation in turns.
- On carbureted engines, the fuel tank should be mounted below carburetor level or gravity feed may unseat the carburetor fuel inlet needle causing flooding.
- The fuel tank should be mounted as close to the level of the fuel inlet connection on the engine as possible. Excessive tank height can cause difficulties in finding a suitable anti-siphon valve. Conversely, the fuel tank distance below the fuel inlet connection has a major effect on fuel system restriction and should be kept as close as possible to the inlet (see chart).

Fuel Tank Bottom versus Fuel Inlet Height (Measured from bottom of fuel tank to height of fuel inlet fitting.)	
Less than 50.8 cm (<20 in.)	Good
50.8 cm–101.6 cm (20–40 in)	Marginal
Greater than 101.6 cm (>40 in.)	Undesirable

- The amount of fuel tank surface area that is exposed to the engine compartment can have a significant affect on fuel temperature. It may be necessary to insulate the tank if fuel inlet temperature is excessive. See **Fuel System Pressure and Temperature Test** in **Section 4.**
- Tank should be thoroughly flushed by the installer or tank supplier prior to usage to avoid getting contaminants in engine fuel system. All fuel tank openings should be sealed until fuel connections are made to avoid getting debris (fiberglass dust, etc.) in tank. Contaminants can clog the fuel filters and cause poor performance and possible engine damage, particularly on fuel injected models.

Anti-Siphon Valve

U.S. boating standards and regulations specify that an anti-siphon valve be used on any application where any portion of the fuel line falls below the top of the fuel tank. This valve serves to minimize the amount of fuel that could leak into the bilge of the boat in the event of a fuel system leak. A mechanical anti-siphon valve or an electrically operated fuel shut-off valve is acceptable for this purpose and should be installed in accordance with industry standards and the manufacturer's instructions. The mechanical valve must be carefully sized to the fuel pressure head produced in a given application (a function of the fuel level height between the lowest and highest point in the system). The valve must check the flow of fuel when the engine is not running, yet avoid excessive restriction when the engine is operating. An overall fuel system pressure drop of 6.9 kPa (1 psi) vacuum or less is desirable but may not be achievable in all cases. See **Fuel System Pressure and Temperature Test** in **Section 4.** In these cases, it is recommended that an electric fuel shut-off valve be used.

Fuel Lines and Fittings

- U.S. boating standards and regulations specify the sole use of USCG Type A1 fuel lines in the engine compartment or in any location in the boat where a break in the line could result in a discharge of 150 cc (5 oz.) of fuel in 2½ minutes.
- To meet 2007 California Air Resources Board regulations, any boat manufactured for sale, sold or offered for sale in California, or that is introduced, delivered or imported into California for introduction into commerce must use low Permeation Fuel Hose from the primary connection of the fuel tank to engine.
- Low permeation fuel hose is defined as not exceeding 15 g/m²/24 h with CE10 fuel at 23° C as specified in SAE J 1527—Marine Fuel Hoses. For more information refer to **Section 1A - California Regulations for 2007—Low Permeation Fuel Hose**
- The minimum fuel line and fitting sizes should be used. Larger sizes may be required on applications with longer fuel lines or numerous fittings.

Description	Specification
Minimum fuel line diameter on single-engine gasoline installations	10 mm (3/8 in.)
Minimum fuel line diameter on multi-engine gasoline installations	13 mm (½ in.) ID or larger

- **On Multi-Engine Gasoline Installations:** Use a fuel pickup and fuel tank supply line for **each** engine. If a single pickup and fuel tank supply line is used, the line must be 13 mm (½ in.) ID or larger.
- In addition to increasing restriction, long fuel line lengths and the use of numerous fittings can increase the fuel inlet temperature to the engine by absorbing heat from the engine compartment. Use the Fuel System Pressure and Temperature Test to determine if fuel pressure and temperature are within an acceptable range. If temperature is excessive, it will be necessary to reduce the fuel line length and/or the number of fittings or to insulate the components.
- Fuel lines should be routed as low as possible in the engine compartment to keep them in the coolest region. Temperature increases significantly with increased engine compartment height.
- The slope of the fuel line should be kept as consistent as possible to avoid high spots that can trap vapor and contribute to vapor locking problems.
- Holes where the lines run through the bulkheads should be carefully rounded off or protected with grommets to prevent damage from vibration and chafing.
- The fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing. Clamps used to secure the line should not pinch or kink the line.
- Sharp bends in the fuel line should be avoided.
- A flexible fuel line must be used to connect the fuel supply line to the fuel inlet fitting on the engine to absorb deflection between the engine and the hull structure when the engine is running.

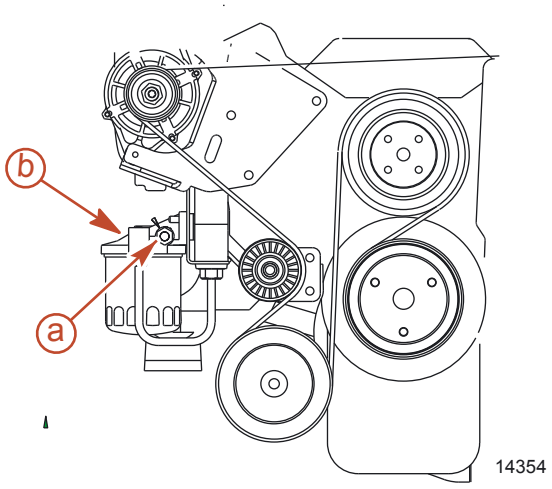
IMPORTANT: If the engine is equipped with a boost pump, an inline filter must be installed between the fuel tank and the boost pump. This filter is provided with the engine package.

Fuel Inlet Connection

Connect the flexible hose of the fuel delivery system to the locations shown using appropriate industry approved fittings and hardware. Required fitting sizes are listed below.

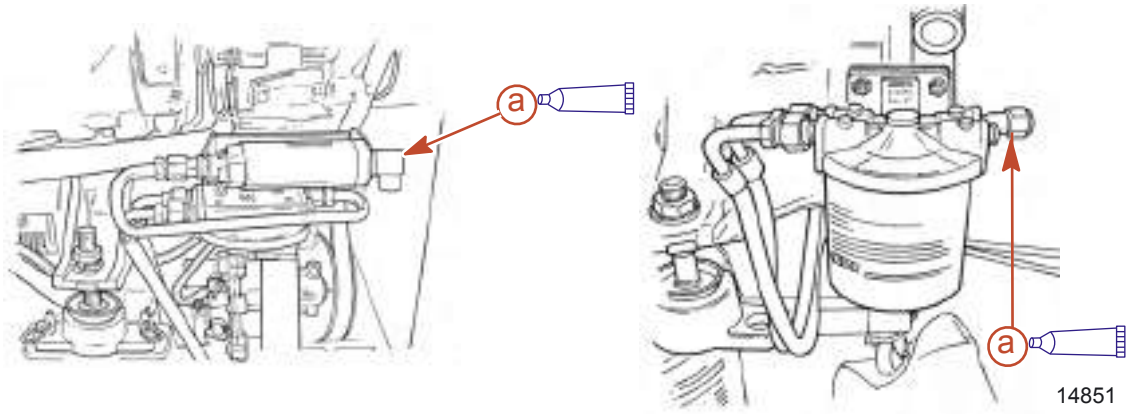
Fuel Inlet Fitting Sizes

Model	Size
All models, including 8.1S with standard fitting	3/8 in. × 18 NPSF
8.1S models with special order fitting	Compression fitting (½ in. SAE)



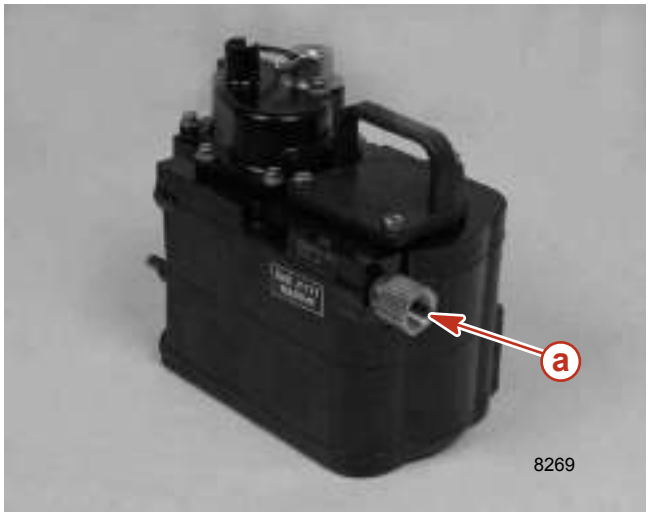
V-8 carbureted models

a - Fuel inlet **b -** Water-separating fuel filter



Typical

a - Fuel inlet fitting



Gen III Cool Fuel Module (Inboard models)

a - Fuel inlet connection

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet connection	92-809822

Inline Fuel Filter

INSTALLATION

NOTE: *Per ABYC and Coast Guard regulations, the fuel filter does not need to be grounded.*

⚠ WARNING

Avoid injury or death and power package damage from electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Install the boat fuel line from the tank to the engine.
3. With the engine installed, locate a section of the fuel line in a serviceable location, leaving enough room for filter, connections, and bracket mounting.
4. Remove 76 mm (3 in.) of fuel line in the mounting location.
5. Select the appropriate size connector for the fuel line.

IMPORTANT: Use of fittings other than those supplied by Mercury MerCruiser is acceptable as long as they do not exceed the maximum specified fuel pressure drop. Refer to the Mercury MerCruiser Applications Manual for more information on fuel pressure specifications.

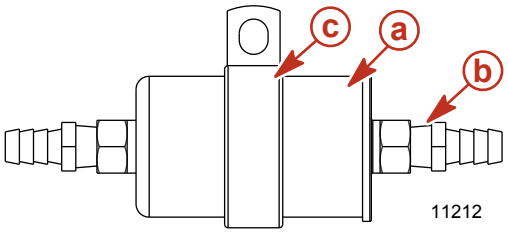
6. Apply sealant to the male pipe threads on the fuel line connectors.

Description	Where Used	Part Number
Loctite 565 PST	Fuel line connectors male pipe threads	Obtain locally

7. Install the connector on the filter.
8. Torque the fuel line connectors.

Description	Nm	lb. in.	lb. ft.
Fuel line connector	19–27		14–20

9. Insert the filter into the mounting clip.



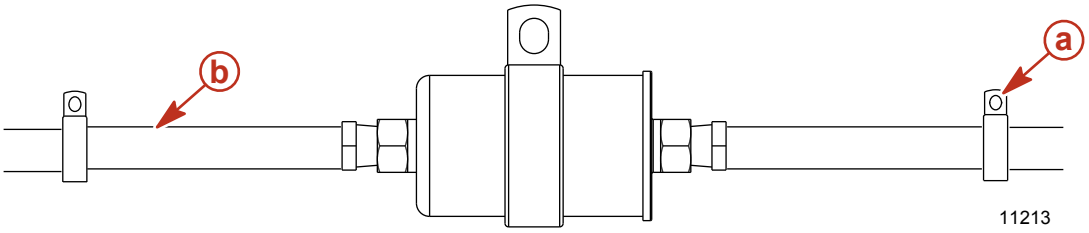
a - Inline filter
b - Connectors
c - Mounting clip

IMPORTANT: Per Coast Guard Regulation (CFD 183.570), "each fuel filter and strainer must be supported on the engine or the boat structure independent from its fuel line connections, unless the fuel filter or strainer is inside a fuel tank."

10. Install and torque the screw and washer through the fuel filter mounting clip into the stringer.

Description	Nm	lb. in.	lb. ft.
Mounting clip screw	12.2		9

11. Install the hose clamps over the hose and insert the barbs into the hose. Torque the hose clamps.
12. Inspect the fuel line mounting clips to ensure that the recommended length between clips has not been exceeded. The maximum allowable length is 46 cm (18 in.).



a - Fuel line mounting clips
b - Fuel line

Description	Nm	lb. in.	lb. ft.
Hose clamps	3.4–6.8	30–60	

13. Pressurize the fuel system and check for leaks. Relieve pressure and then check for leaks again.

Special Fitting Installation Procedure

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

The following special procedure must be used when making fuel line connection to avoid damage to fuel filter base.

CARBURETED MODELS

- Apply #565 Loctite Pipe Sealant with Teflon on threads of brass fitting. Do not use teflon tape.

Description	Where Used	Part Number
Loctite 565 PST	Fuel line connectors male pipe threads	Obtain locally

- Thread the brass fitting into the fuel filter base until finger tight, then turn the fitting an additional 1¾ to 2¼ turns with a wrench. Do not overtighten or use an air impact wrench.

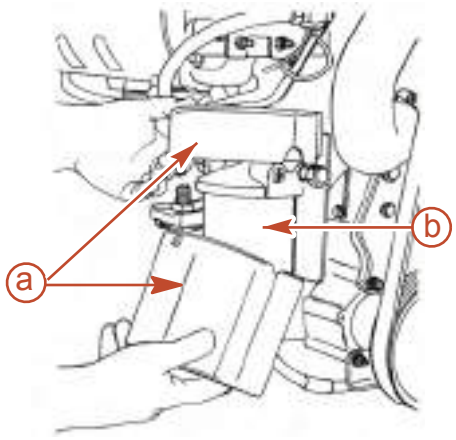
ALL MODELS

- To prevent overtightening when installing the fuel line, hold the brass fitting with a suitable wrench to prevent it from turning when the fuel line connectors are being tightened.

Cool Fuel Insulator Covers

MPI tow sports models are equipped with Mercury MerCruiser's exclusive cool fuel system for added resistance to vapor locking. On tow sports models, this includes insulator covers on the water separating fuel filter, which act as a barrier to heat transfer during a heat soak condition (engine shut off after a hard run). These covers must remain in place to derive full benefits of the system. Vapor lock problems that result from the removal of these covers are not the responsibility of Mercury MerCruiser. A space should be provided for the removal of the lower cover to allow servicing of the filter.

The fuel pump assembly is mounted low on the engine for optimum cooling and performance. While servicing of the pump is seldom required, clearance in the front of the engine should be provided to allow access.



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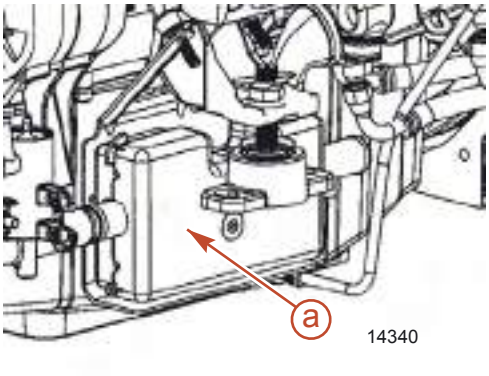
Water separating fuel filter

a - Water-separating fuel filter cover (MPI tow sports models only)

b - Water-separating fuel filter



Fuel cooler

a - Gen II fuel cooler

Exhaust System

Section 6A - Exhaust System

Table of Contents

Exhaust System

Important Information

⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Exhaust systems that are installed improperly will allow water to enter the exhaust manifolds and combustion chambers severely damaging the engine. Water Ingestion Damage to the engine will not be covered by Mercury MerCruiser Warranty unless the damage results from defective Mercury Marine parts.

The exhaust system must be installed in accordance with the specifications contained in this section. Special care must be taken as the custom designed exhaust systems used can create a tuning effect that can cause water to be forced back into the engine. The instructions in **Checking for Water Intrusion** must be performed to ensure that water intrusion is not occurring. It is the boat manufacturer's responsibility for ensuring that water intrusion does not exist with their unique exhaust system.

⚠ WARNING

Applicable boating industry standards and regulations (NMMA, ABYC, SAE, USGC, EUs, RCD, ISO) for the markets where the boat will be sold must be adhered to when designing and installing exhaust system.

Exhaust system design and installation can affect:

- Noise level.
- Performance.
- Water Intrusion.
- Carbon monoxide levels.
- Component longevity.

GLOSSARY

Water lift muffler— A muffler that exhausts above the inlet in order to muffle by lifting a column of water.

Inline muffler—A muffler that has an outlet that is parallel and level with the inlet.

Collector—A collection device that joins two exhaust banks into a perpendicular chamber without providing any noise reduction.

Carbon Monoxide Poisoning

IMPORTANT: The following important information is covered in the owner's operation, maintenance and warranty manuals. You may also want to include this information in the boat owner's manual.

Carbon monoxide is present in the exhaust fumes of all internal combustion engines including the outboards, sterndrives, and inboard engines that propel boats, as well as the generators that power various boat accessories. Carbon monoxide is a deadly gas that is odorless, colorless, and tasteless.

Early symptoms of carbon monoxide poisoning, which should not be confused with seasickness or intoxication, include headache, dizziness, drowsiness, and nausea.

⚠ WARNING

Avoid prolonged exposure to carbon monoxide. Carbon monoxide poisoning can lead to unconsciousness, brain damage or death. Ensure that the boat, while at rest or underway, is well ventilated.

GOOD VENTILATION

Ventilate passenger area, open side curtains, or forward hatches to remove fumes.

1. Example of desired air flow through the boat.

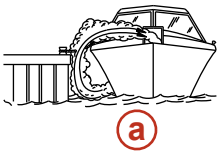
mc79553-1

POOR VENTILATION

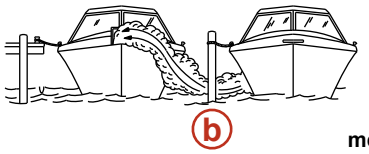
Under certain conditions, permanently enclosed or canvas enclosed cabins or cockpits with insufficient ventilation may draw in carbon monoxide. Install 1 or more carbon monoxide detectors in your boat.

Although the occurrence is rare, on a very calm day, swimmers and passengers in an open area of a stationary boat that contains or is near an operating engine may be exposed to a hazardous level of carbon monoxide.

1. Examples of poor ventilation while a boat is stationary:



a



b

mc79554-1

a - Operating the engine when the boat is moored in a confined space.

b - Mooring close to another boat with its engine operating.

2. Examples of poor ventilation while a boat is moving:

a

b

mc79556-1

a - Operating the boat with the trim angle of the bow too high.

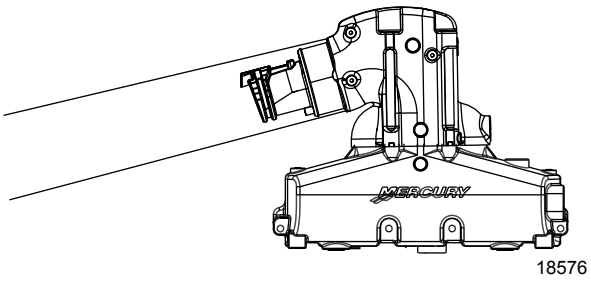
b - Operating the boat with no forward hatches open (station wagon effect).

Exhaust Connections

⚠ CAUTION

Avoid exhaust hose failure which could cause exhaust or discharge water to enter the boat. Discharge water from the exhaust elbow must flow without restriction around the entire inside diameter of the exhaust hose to avoid causing hot spots, which could eventually burn through the exhaust hose. Connect the exhaust hoses and tubes to the exhaust elbows so that they do not restrict the flow of discharge water from the exhaust elbows.

Exhaust hoses must be properly installed on exhaust elbow outlets. Discharge water from the exhaust elbow must flow around the entire inside diameter of hose to avoid causing hot spots that could burn through the hose. Exhaust hoses must be installed at the angle shown following.



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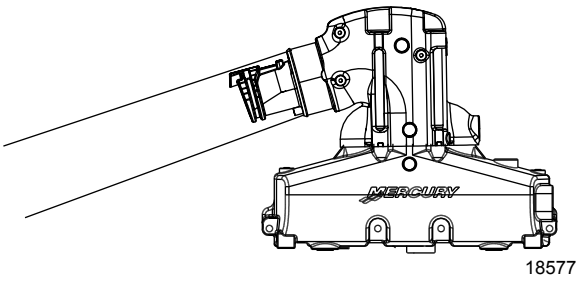

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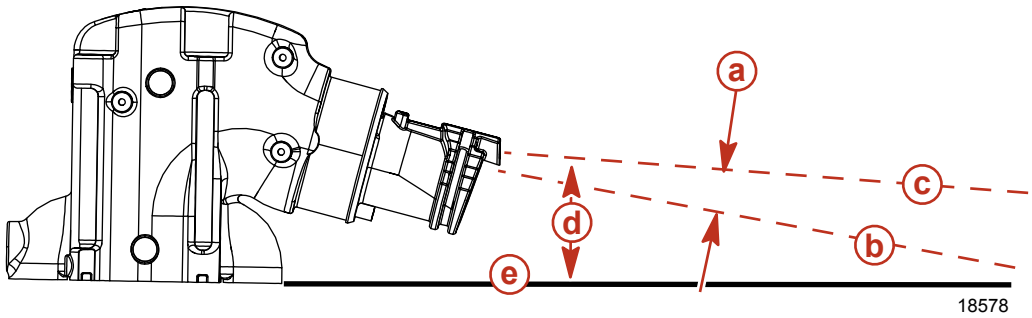
Correct **Incorrect**



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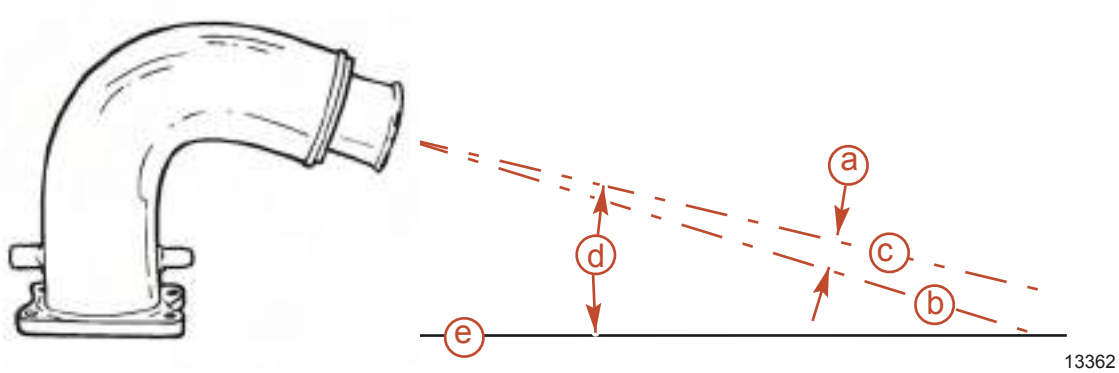
a - Maximum misalignment +/- 5 degrees
b - Exhaust outlet centerline (14° vs. crankshaft centerline)
c - Exhaust hose centerline
d - Angle vs. horizontal
e - Horizontal (level surface)



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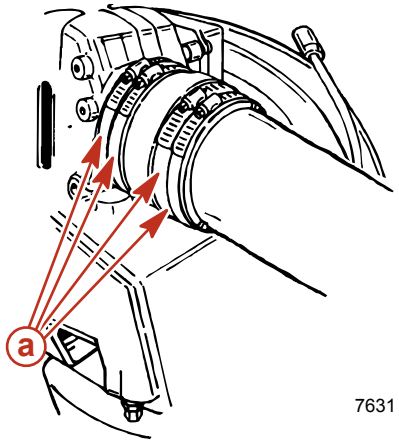
8.1 exhaust connection

a - Maximum misalignment +/- 5 degrees
b - Exhaust outlet centerline (14 degrees vs. crankshaft centerline)
c - Exhaust hose centerline
d - See chart for angle vs. horizontal
e - Horizontal (level surface)

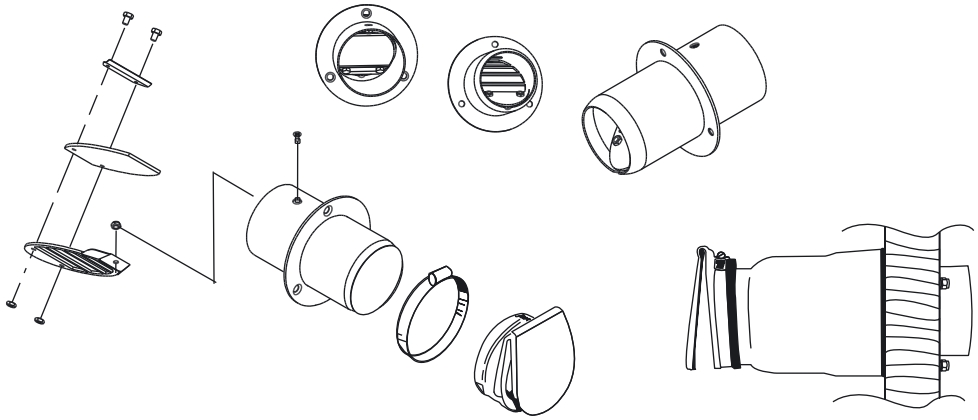
Secure all exhaust connections, including those at the exhaust elbow, with two hose clamps. ABYC standards also specify the use of stainless steel clamps with a minimum 13 mm (1/2 in.) band width. Do NOT use spring tension clamps.



a - Hose clamps

Exhaust Through-Hull Fittings

Exhaust fittings (flanges, outlets) must be equipped with an internal shutter and external flapper to prevent water intrusion problems. This is a requirement on all applications except water lift mufflers, where it is still recommended. A variety of fittings is available through Mercury Precision Parts and Accessories.



NOTE: *For exhaust accessories, refer to Section 10 — Miscellaneous Accessories.*

Exhaust Resonators

The design of the exhaust pipe and muffler system can cause a tuning effect that can contribute to a water intrusion problem. This tuning effect can be caused by a combination of factors, including but not limited to:

- Configuration of the exhaust outlets.
- Design and size of the muffler (if applicable).
- Length of exhaust hoses.
- Amount of back pressure in the system.

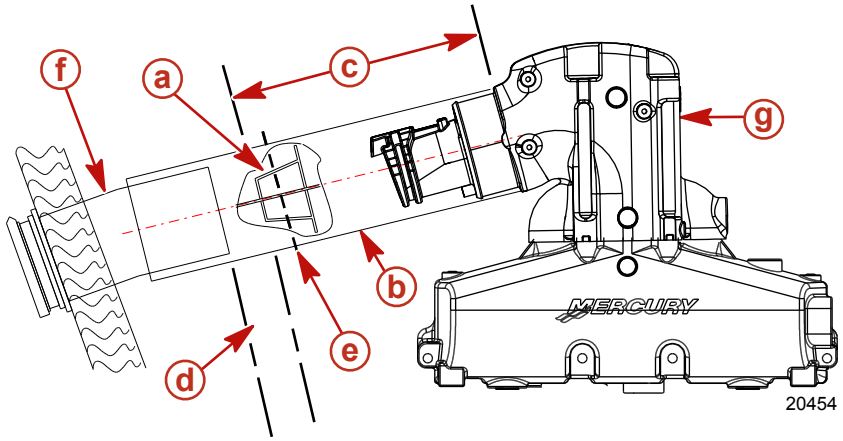
The interactive nature of these factors makes it difficult to predict which exhaust system designs will be susceptible to the tuning effect. To address this situation, Mercury MerCruiser has developed exhaust resonators that are installed aft of the exhaust elbow outlets. The resonators help to break up the reverse pulsations yet do not affect the engine performance. In some cases, a performance increase is actually realized by using the resonators.

Mercury MerCruiser recommends the use of the resonators on all models that have water present after water intrusion testing has been completed, and the exhaust system has been confirmed to meet all specifications, as outlined in this manual. Resonators are typically more beneficial for large engines, but can be used on other models as well. The kit is available through Mercury Precision Parts and Accessories.

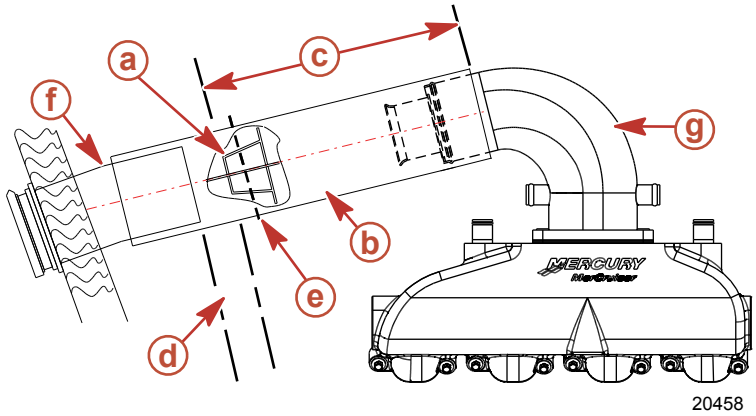
Resonators are installed as shown. Because of the critical nature of the placement of the resonator, Mercury MerCruiser will free license this technology to allow the resonator to be built into your muffler. Contact your product application engineer for details.

The exhaust resonator is positioned with the inside flat surface at the preferred distance of 43 cm (17 in.) from the front edge of the exhaust hose. The 43 cm (17 in.) dimension can be reduced, if necessary, to a minimum of 33 cm (13 in.). This dimension must be the same on both exhaust outlets. The boat builders must test to find the optimum resonator placement for each type of exhaust system.

IMPORTANT: Complete the water intrusion test to ensure that the resonators are installed properly.



a - Exhaust resonator
b - Exhaust hose
c - Dimension to inside flat surface of resonator 33–43 cm (13–17 in.)
d - No less than 51 mm (2 in.) between resonator and exhaust outlet or closest fitting
e - Hose clamp positioned around center of resonator for retention
f - Exhaust outlet
g - Exhaust elbow



a - Exhaust resonator
b - Exhaust hose
c - Dimension to inside flat surface of resonator 33-43 cm (13-17 in.)
d - No less than 51 mm (2 in.) between resonator and exhaust outlet or closest fitting
e - Hose clamp positioned around center of resonator for retention
f - Exhaust outlet
g - Exhaust elbow

Exhaust system tuning can be affected by various factors that are beyond the control of Mercury MerCruiser. Following are several factors that can affect exhaust system tuning:

- Type and configuration of exhaust outlet.
- Length of exhaust hose.
- Amount of back-pressure in exhaust system.

Exhaust System Design

Exhaust System Specifications

These engines are equipped with a wet exhaust system in which exhaust is mixed with water in the exhaust elbows. This cools the exhaust and allows the use of heat resistant rubber hose on the outlet side of the system. These specifications must be observed by the OEM and muffler manufacturer when designing, manufacturing, and installing the exhaust system:

- Exhaust elbow outlets must be a prescribed distance above the water line. Install exhaust risers if necessary. (See **Measuring Exhaust Elbow Height**).
- The riser height for systems using a water lift muffler is measured to the water line in the muffler.

Minimum Exhaust Elbow Height	
Model	**Specification**
MIE and V-drive tow sport models	38 cm (15 in.)
Tow sports inline models	33 cm (13 in.)

- A minimum of 46 cm (18 in.) of exhaust hose must be used between the exhaust elbows and the collector, Y-pipe, muffler, or first angular fitting. This portion of the exhaust hose must have a minimum of 10° downward slope. After the first 46 cm (18 in.), the exhaust system must have a minimum of 3° downward slope. (See **Measuring Exhaust Elbow Height**).
- Exhaust hoses can be installed with up to a 5° angle relative to the exhaust elbow outlets. (See **Exhaust Hose Connections**).

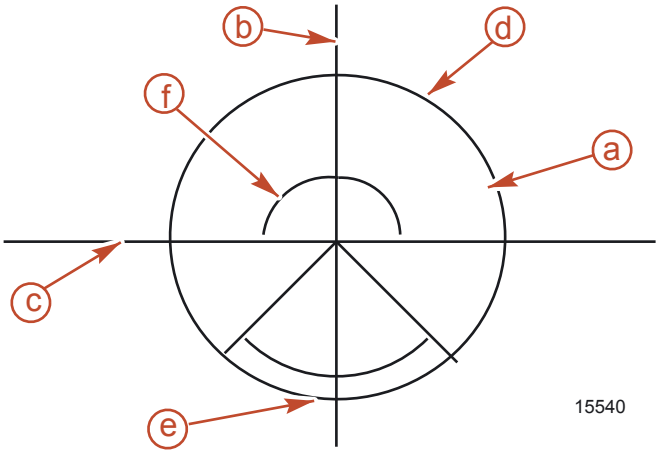
- Exhaust back pressure must meet the required specification. (See **Exhaust Back Pressure Test**)

Models	Exhaust Back Pressure
All gasoline powered engines	1 psi (7 kPa) Minimum
	2 psi (14 kPa) Optimal
	11 psi (76 kPa) Maximum

IMPORTANT: Exhaust collectors must drain sufficiently during engine shutdown and idle to provide the drainage necessary for these operational conditions. Use the following specifications when designing the collector.

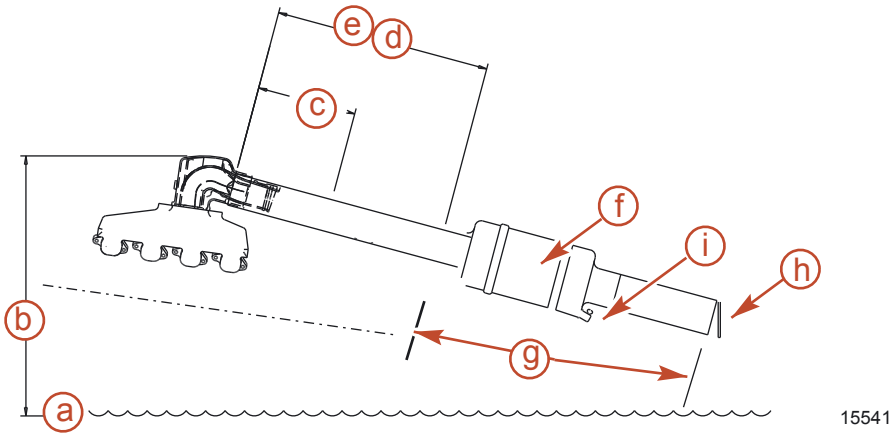
Collector Inlet and Outlet Specifications

1. The inlet hose for the collector must be placed above and within 180° of the horizontal centerline of the collector.
2. The outlet hose of the collector must be placed below the horizontal centerline of the collector and within 90° of the vertical centerline of the collector.

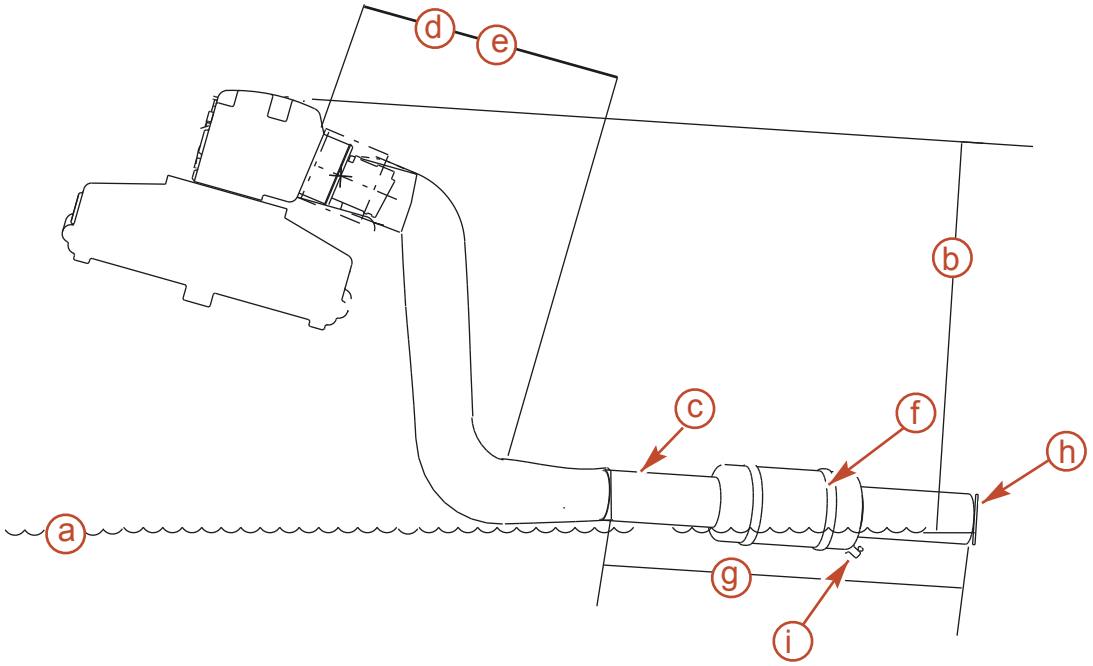


a - Collector
b - Vertical center line
c - Horizontal center line
d - Inlet side of collector
e - 90° range for placement of collector outlet
f - 180° above horizontal centerline

In-line Muffler



Typical single engine inboard without water standing in muffler



Typical single engine inboard with water standing in muffler (tow sports)

- **a -** Water line
- **b -** Minimum exhaust elbow height with maximum load
- **c -** Exhaust back pressure check point
- **d -** 46 cm (18 in.) minimum between exhaust elbow and muffler
- **e -** Minimum of 10° downward slope in the first 46 cm (18 in.)
- **f -** Muffler (must be self draining)
- **g -** 3° downward slope minimum
- **h -** External flappers
- **i -** Drain fitting

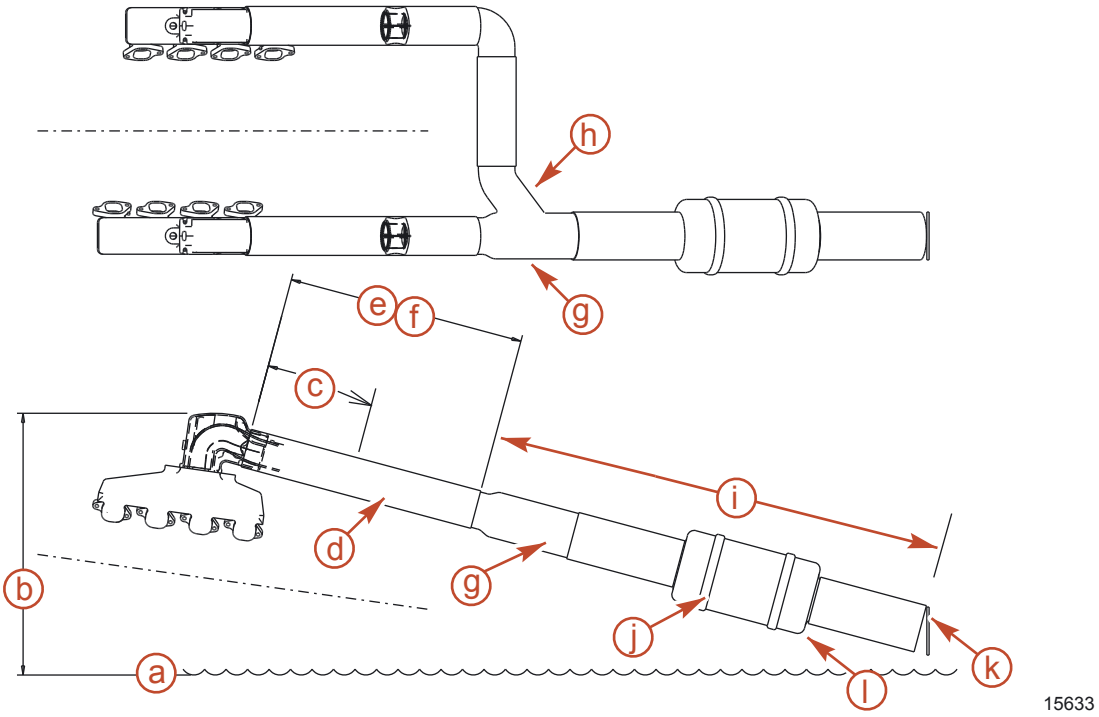
- Applications with through-transom fittings must be equipped with exhaust flappers to prevent the reverse flow of water into the engine. (See **Exhaust Through The Hull Fittings**).
- The muffler, collector, and exhaust hoses must be adequately supported for proper orientation and to prevent overstressing the exhaust manifolds and elbows. The support requirements will vary with exhaust system design and the amount of G-forces to be encountered.
- Exhaust resonators can be used on any models that may experience a water intrusion problem associated with the tuning effects of the exhaust system. (See *Exhaust Resonators*).
- Larger exhaust hoses should be used on applications with long hose runs.

Minimum Exhaust Hose Size			
Model	**Dual Outlet System**	**Single Outlet System**	
		Dual Hose Portion	**Single Hose Portion**
8.1S Models	102 mm (4 in.)	102 mm (4 in.)	127 mm (5 in.)
All others	76 mm (3 in.)	76 mm (3 in.)	102 mm (4 in.)

- A heat resistant exhaust hose that complies with specifications SAE J2006 or UL 1129 should be used (ABYC standard).

- Every exhaust hose connection must be secured with at least two hose clamps. The clamps should be stainless steel and at least 13 mm (½ in.) wide. Clamps that rely solely on spring tension should not be used. (ABYC Standard)
- The system must have the capability to be serviced, reassembled and replaced while maintaining all of the specifications. The boat builder must provide documentation such as manuals, drawings, or orientation marks on production assemblies.
- It is strongly recommended that orientation marks be used on all production exhaust system assemblies.
- In-line mufflers, collectors, and hoses must self drain after engine shutdown.

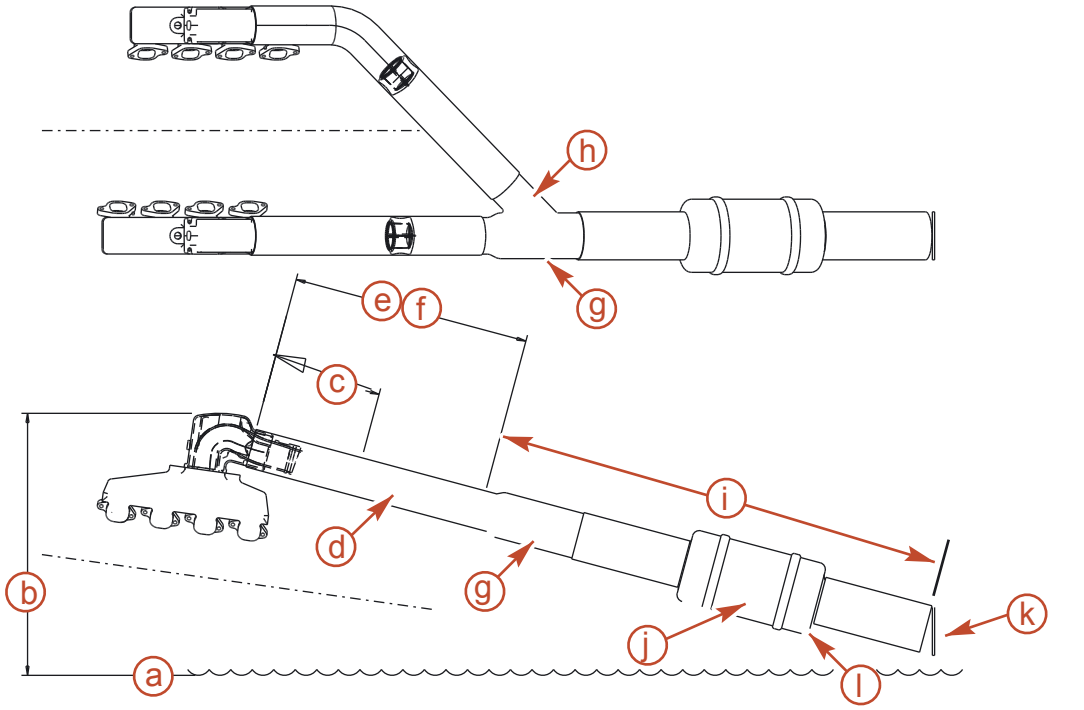
T Junction With In-Line Muffler



Typical

a - Water line
b - Minimum exhaust elbow height with maximum load
c - Exhaust back pressure check point
d - Resonator
e - 46 cm (18 in.) minimum between exhaust elbow and collector
f - 10° downward slope minimum
g - 3° downward slope minimum
h - 30°–60° degree angle at T-junction
i - 3° downward slope minimum
j - Muffler
k - External flappers
l - Drain fitting

V-Pipe and In-Line Muffler



Typical

- **a -** Water line
- **b -** Minimum exhaust elbow height with maximum load
- **c -** Exhaust back pressure check point
- **d -** Resonator
- **e -** 46 cm (18 in.) minimum between exhaust elbow and Y-pipe
- **f -** Minimum of 10° downward slope in the first 46 cm (18 in.) 46 cm (18 in.)
- **g -** Y-pipe
- **h -** 30°–60° angle at junction
- **i -** 3° downward slope minimum
- **j -** Muffler
- **k -** External flappers
- **l -** Drain fitting

Water Lift Exhaust System

These engines are equipped with a wet exhaust system in which exhaust is mixed with water in the exhaust elbows. This cools the exhaust and allows the use of heat resistant rubber hose on the outlet side of the system. These specifications must be observed by the OEM and muffler manufacturer when designing and installing the exhaust system:

- Through the prop exhaust utilizing the Y-pipe is the desired system on all models except the 496 Mag.
- Heat resistant exhaust hose that complies with specifications SAE J2006 or UL 1129 must be used (ABYC standard).
- Exhaust hoses should be no smaller than the minimum sizes. Larger hoses should be used on applications with long hose runs.

Minimum Exhaust Hose Size			
Model	Dual outlet system	Single outlet system	
		Dual hose portion	Single hose portion

Minimum Exhaust Hose Size			
496 MAG	10.2 cm (4 in.)	10.2 cm (4 in.)	12.7 cm (5 in.)
All others	10.2 cm (4 in.)	10.2 cm (4 in.)	10.2 cm (4 in.)

- Sharp bends in exhaust hoses should be avoided.
- Exhaust hoses can be installed at up to a 5° angle relative to the exhaust elbow outlets. Refer to Exhaust Hose Connections.
- Exhaust elbows must be the prescribed distance above the water line. Install risers if needed. See Measuring Exhaust Elbow Height.
- The exhaust hose attached to the exhaust elbow must have a minimum of 10° downward slope. On longer hose applications, slope can be reduced to 3° in the portion of the exhaust system that is more than 46 cm (18 in.) away from elbow.

NOTE: *Mercury MerCruiser's recommendations more stringent than ABYC recommendation of a minimum drop in the exhaust system of ½ in. per foot with an overall drop of not less than 10.2 cm (4 in.) between the exhaust elbow outlets and the boat outlets.*

Slope Conversion			
Degrees	**Drop vs. run**		**Distance from elbow**
3°	5/8 in./ft.	52 mm/m	> 18 in.
6°	1¼ in./ft.	105 mm/m	< 18 in.
7°	1-7/16 in./ft.	122 mm/m	< 18 in.
10°	2-1/8 in./ft.	176 mm/m	< 18 in.
12°	2½ in./ft.	212.5 mm/m	< 18 in.
14°	2-15/16 in./ft.	249 mm/m	< 18 in.
19°	4-1/8 in./ft.	344 mm/m	< 18 in.

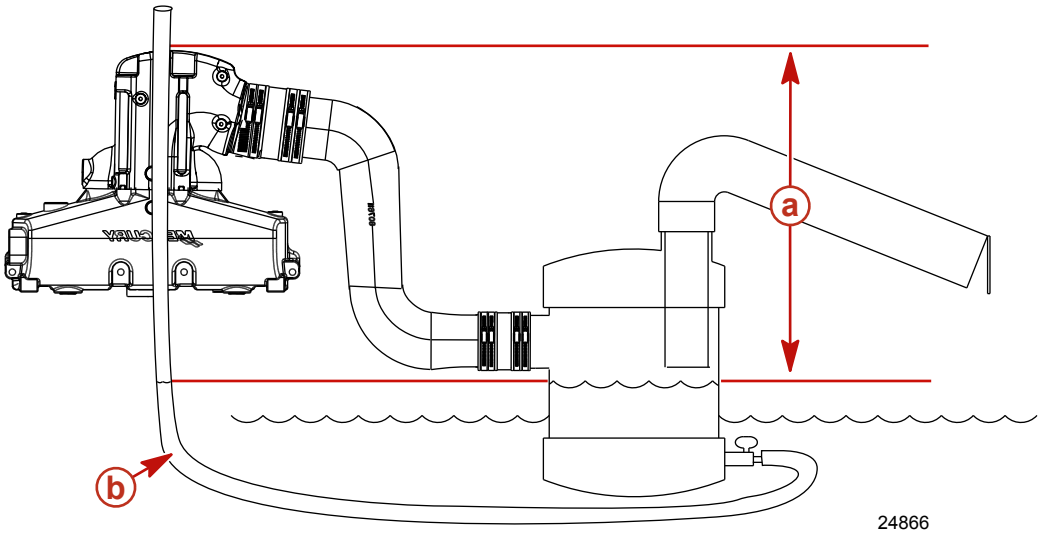
- The drop in the exhaust hose must be continuously sloping downward so that a low spot does not exist at any point.
- Exhaust resonators can be used on any models, except 3.0L models, that may experience a water intrusion problem. Refer to Exhaust Resonators.
- Through the hull exhaust fittings (flanges, outlets) must be equipped with internal shutters and external flappers to prevent the reverse flow of water into the engine. Refer to Exhaust Through The Hull Fittings.
- Exhaust outlets must be above the water line with the boat at rest in the water and a full load aboard, as well as while underway. This is necessary to minimize engine back pressure.
- Every exhaust hose connection should be secured with at least two hose clamps. The clamps should be stainless steel and at least 13 mm (½ in.) wide. Clamps which rely solely on spring tension should not be used. (ABYC Standard)
- The exhaust system must be adequately supported for proper orientation and to prevent overstressing the exhaust manifolds and elbows. The support requirements will vary with exhaust system design and the amount of G-forces to be encountered.
- The through transom exhaust system must meet the exhaust back pressure specification.
- The system must have the capability to be serviced, reassembled, and replaced while maintaining all of the specifications. The boat builder must provide documentation, such as manuals, drawings, or orientation marks on production assemblies.
- Check for absence of water intrusion and proper exhaust back pressure when finished. See Checking for Water Intrusion and Exhaust Back Pressure.

- If a waterlift/collector system is used, the waterline is defined as the waterline inside the collector. All measurements must be taken from that waterline to measure exhaust elbow weight.

WATER LIFT MUFFLER

When using water lift mufflers, Mercury MerCruiser recommends the following:

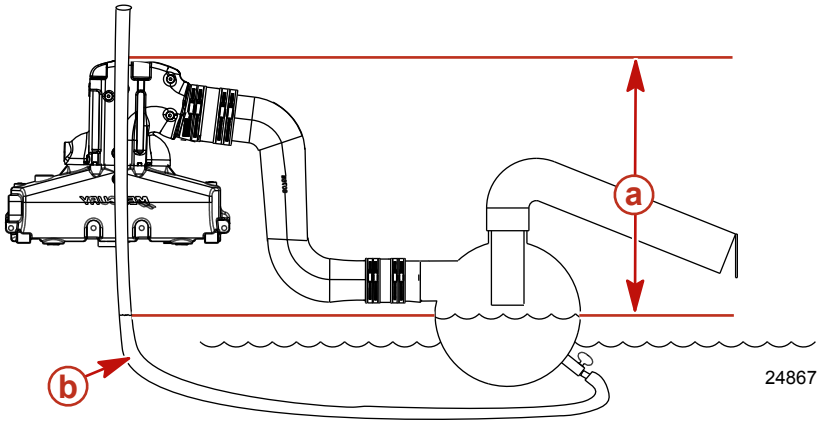
- Install mufflers per Mercury and the exhaust system manufacturer's specified distance below the top of the exhaust elbows to avoid water ingestion problems. Use the exhaust elbow risers if needed to obtain the specified distance.
- The muffler riser must also exceed both Mercury's and the exhaust system manufacturer's specified distance above the waterline to prevent the muffler from filling with water.
- Install a siphon break (vacuum valve) in the exhaust cooling water circuit if the exhaust elbows or muffler are at or below water level. Refer to Mercury's and exhaust system manufacturer's recommendations.
- Provide a drain to the drain muffler.



Typical vertical water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline



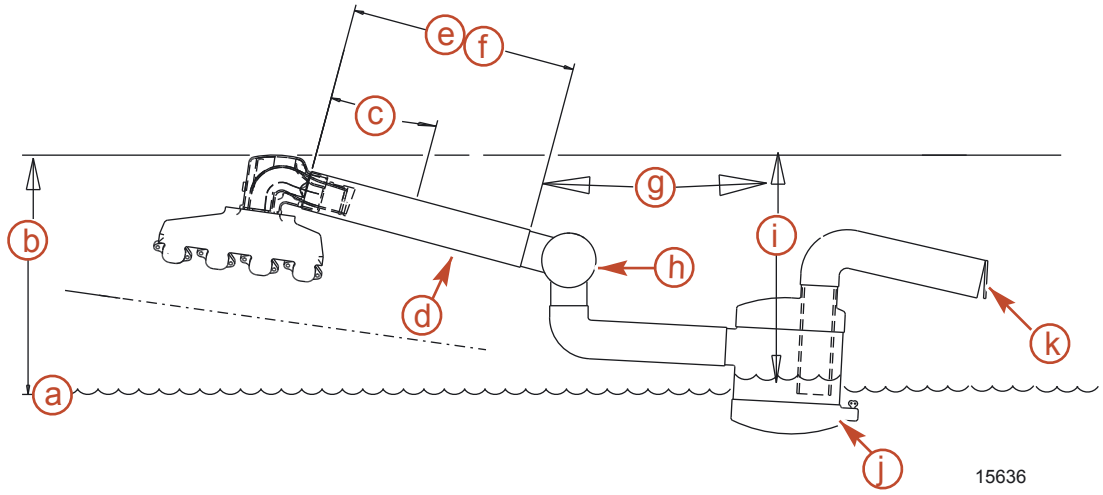
Typical horizontal water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

- Install risers or lower the muffler if necessary to meet minimum exhaust elbow height.
- The water line inside the muffler is the beginning measurement point to determine the correct elbow height.

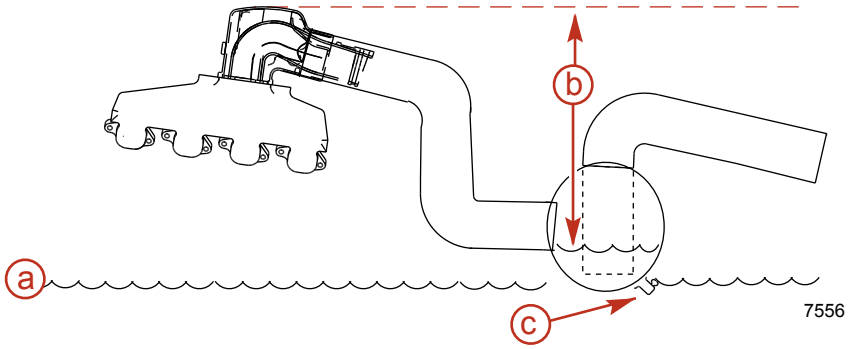
Collector and Water Lift Muffler



Typical

a - Water line
b - Siphon break (vacuum valve) Must be installed in cooling water circuit if exhaust elbows are at or below water level. Refer to muffler manufacturing recommendations.
c - Exhaust back pressure check point
d - Resonator
e - 46 cm (18 in.) minimum between exhaust elbow and collector
f - 10° downward slope minimum
g - 3° downward slope minimum
h - Collector
i - Minimum exhaust elbow height with maximum load
j - Drain fitting
k - External flappers

S-pipe Used With Water Lift Muffler



a - Water line
b - Minimum exhaust elbow height with maximum load
c - Drain plug

Measuring Exhaust Elbow Height

General Information

The height of the exhaust elbows must be within the dimensions specified to prevent water intrusion problems. Exhaust elbow risers must be installed, if needed, to obtain the proper exhaust elbow height, and exhaust angle. Risers are limited to 203.2 mm (8 in.) on 8.1L models and 152.4 mm (6 in.) on other inboard models. Measurement must be taken with the boat in the water. It is important that the boat be loaded as outlined to simulate the maximum loading conditions likely to be encountered in normal operation.

IMPORTANT: Exhaust elbow height is measured to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped. Refer to Water Lift Muffler.

IMPORTANT: Load distribution recommendations are the responsibility of the boat manufacturer. Any load distribution conditions that will affect the exhaust system must be clearly communicated to the operator in the owner's manual. For example, the number of people that can be located on the swim platform simultaneously should be included in the manual, if this could pose a problem.

Measurements under all loading conditions must be within the following specifications.

Minimum Exhaust Elbow Height	
Model	**Specification**
MIE and V-drive tow sport models	38 cm (15 in.)
Tow sports inline models	33 cm (13 in.)

Minimum Exhaust Hose Slope		
Model	**Specification**	
5.7 (350 cid), 6.2L (377 cid), 8.1L (496 cid)	Within 457 mm (18 in.) of engine	Remainder of system (if applicable)
	10°	3°

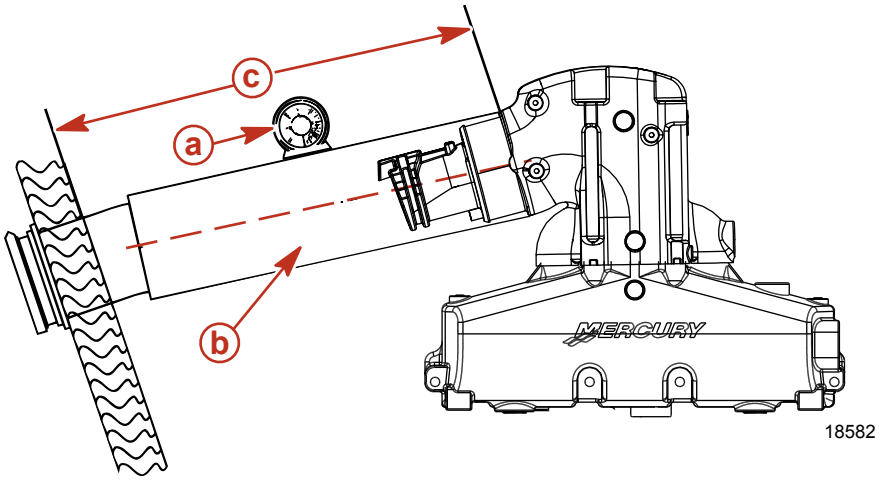
If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to the appropriate **Mercury Precision Parts and Accessory Guide** for part numbers.

The maximum exhaust riser height is specified in the table below.

Riser Options			
Model	**Low**	**Medium**	**High**
5.7 (350 cid), 6.2L (377 cid)	76 mm (3 in.) and 43 mm (1.7 in.)	76 mm (3 in.) and 119 mm (4.7 in.)	152 mm (6 in.)
8.1L (496 cid)	51 mm (2 in.)	152 mm (6 in.)	203 mm (8 in.)

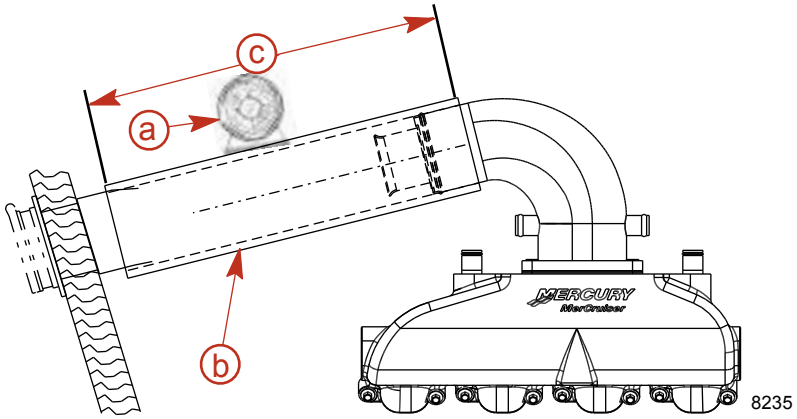
EXHAUST ANGLE MEASUREMENT

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet continuing along each section to the exhaust exit point of the boat. All exhaust angle measurements must be performed with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. See **Loading Requirements**.



Typical exhaust (except 8.1L 496 cid.)

a - Inclinometer
b - Exhaust hose or tube
c - Minimum 457 mm (18 in.)



Typical exhaust 8.1L 496 cid.

a - Inclinometer
b - Exhaust hose or tube
c - Minimum 457 mm (18 in.)

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on non-production boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**

- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**
- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boat builder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at OEM boat builders must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb.
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb.
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb.)
   - Cargo per person is equivalent to 11.34 kg (25 lb.)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft.) long, not including boats that are 8.84 m (29 ft.) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft.) long, not including boats that are 8.84 m (29 ft.) long that do not have a maximum rated swim platform weight capacity, must add181.45 Kg (400 lb.) to the swim platform .
   c. Boats 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, must add the maximum rated swim platform weight capacity to the swim platform.
   d. Boats 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that do not have a maximum rated swim platform weight capacity must add 226.80 kg (500 lb.) to the swim platform.

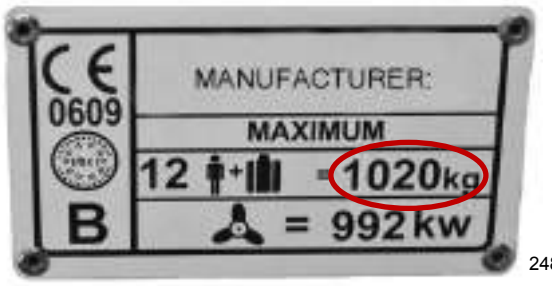
Loading the Boat with a Capacity Plate

For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lb. Persons, Gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb.) per person. This gives the whole number and remainder of 74.84 kg (165 lb.) persons to load onto the boat.
3. Put the remainder of a person in the next available seat. See **Boat loading diagram**.



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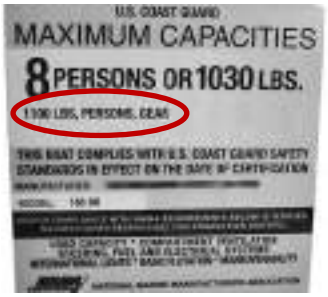
CE Capacity Plate



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USCG Capacity Plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.

IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.

8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.

9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: *The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.*

NOTE: *The following example is provided as a reference.*

EXAMPLE

NOTE: *This example uses a boat that is less than 8.84 m (29 ft.) long, not including a boat that is 8.84 m (29 ft.) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 Kg (400 lb.) to the swim platform*

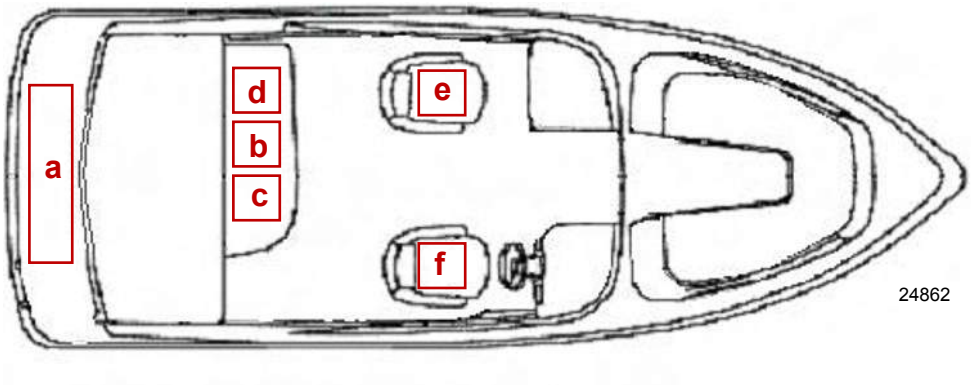
NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb. – 400 lb. = 700 lb.
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat
   - 700 lb. ÷ 165 lb. = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight
   - 0.24 × 165 lb. = 40 lb.

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.

5. Using the totals in this example, load four 165-lb. persons and one 40-lb. person onto boat seating with 400 lb. on the swim platform.

- 400 lb. + 165 lb. = 565 lb.
- 565 lb. + 165 lb. = 730 lb.
- 730 lb. + 165 lb. = 895 lb.
- 895 lb. + 165 lb. = 1060 lb.
- 1060 lb. + 40 lb. = 1100 lb.



Boat loading diagram

- **a -** Swim platform load
- **b -** MerCruiser person weight (one)
- **c -** MerCruiser person weight (two)
- **d -** MerCruiser person weight (three)
- **e -** MerCruiser person weight (four)
- **f -** Remainder MerCruiser person weight (five)

Loading the Boat—Without a Capacity Plate

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb. per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb. (MerCruiser person weight) = XXXX lb. maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb. per person. This gives the number of 165-lb. persons to load onto the boat. Round up to next whole number. See **Example 3**.

IMPORTANT: To account for cargo, add a weight of 25 lb. per person to the boat before loading passenger weight onto the boat.

4. Calculate the cargo by multiplying 25 lb. by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.

IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.

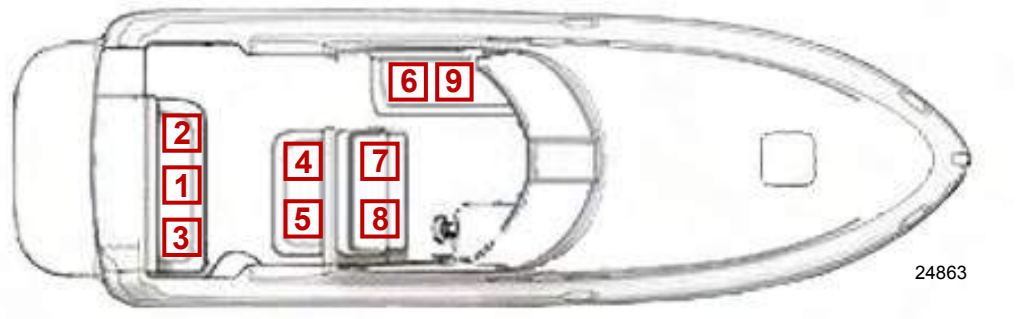
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.

10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

EXAMPLE

NOTE: *The following example is provided as a reference.*
This example uses a boat that is 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 Kg (500 lb.) to the swim platform .

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



Designated Seating Diagram

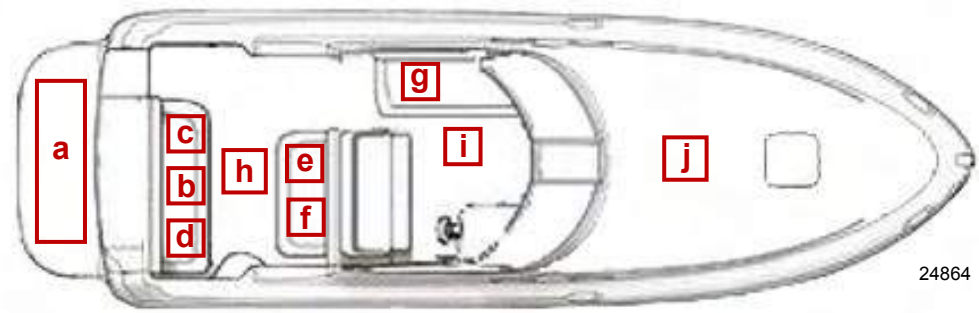
This example uses 9 persons as the maximum passenger load.

NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb. = 225 lb.
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%
   a. 225 lb. × 50% = 112.50 lb.
   b. 112.50 lb. rounded up = 113 lb.
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%
   - 225 lb. × 25% = 56.25 lb.
   - 56.25 lb. rounded down = 56 lb.
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb. (MerCruiser person weight) to get a 1485 lb. (total passenger load)
   - 9 passengers × 165 lb. = 1485 lb.
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb. – 500 lb. = 985 lb.
7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb. ÷ 165 lb. = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers

8. Using the totals in this example load 56 lb. cargo in the aft storage, 113 lb. cargo in the center storage, and 56 lb. cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb. passengers, onto the boat with 500 lb. on the swim platform.

- 500 lb. + 225 lb. = 725 lb.
- 725 lb. + 165 lb. = 890 lb.
- 890 lb. + 165 lb. = 1055 lb.
- 1055 lb. + 165 lb. = 1220 lb.
- 1220 lb. + 165 lb. = 1385 lb.
- 1385 lb. + 165 lb. = 1550 lb.
- 1550 lb. + 165 lb. = 1715 lb.

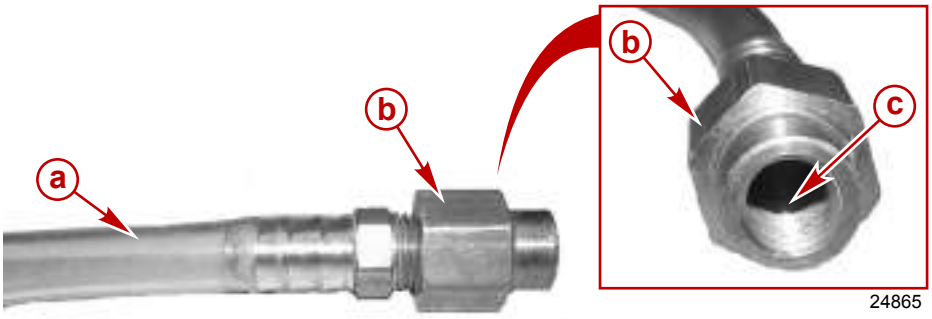


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

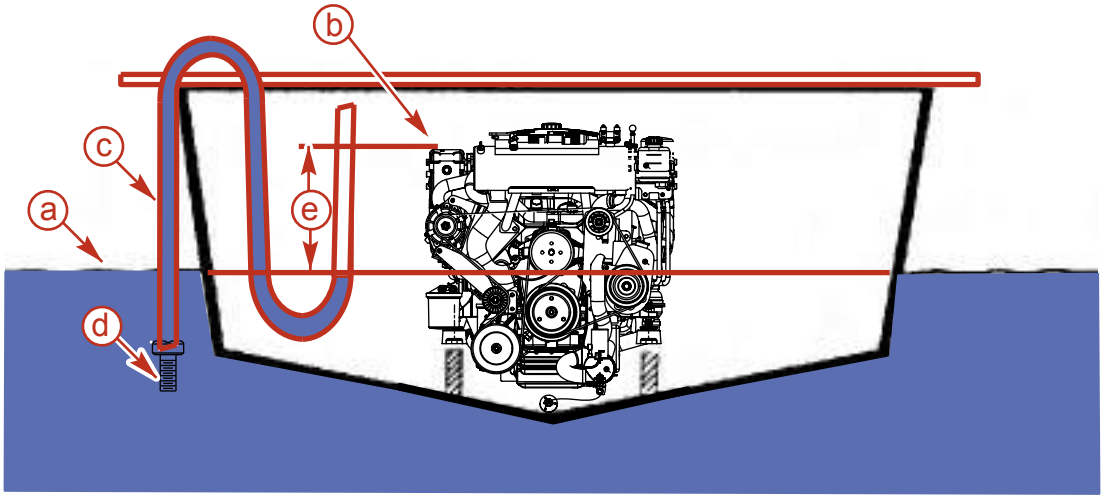
1. Obtain an 8–10 mm (5/16–3/8 in.) ID (inner diameter) clear hose approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.
4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



9142

a - Waterline
b - Top of exhaust elbow
c - Clear hose
d - Weight
e - Measurement, waterline to top of exhaust elbow

Clear Hose Measurement Method From Seacock or Muffler Drain

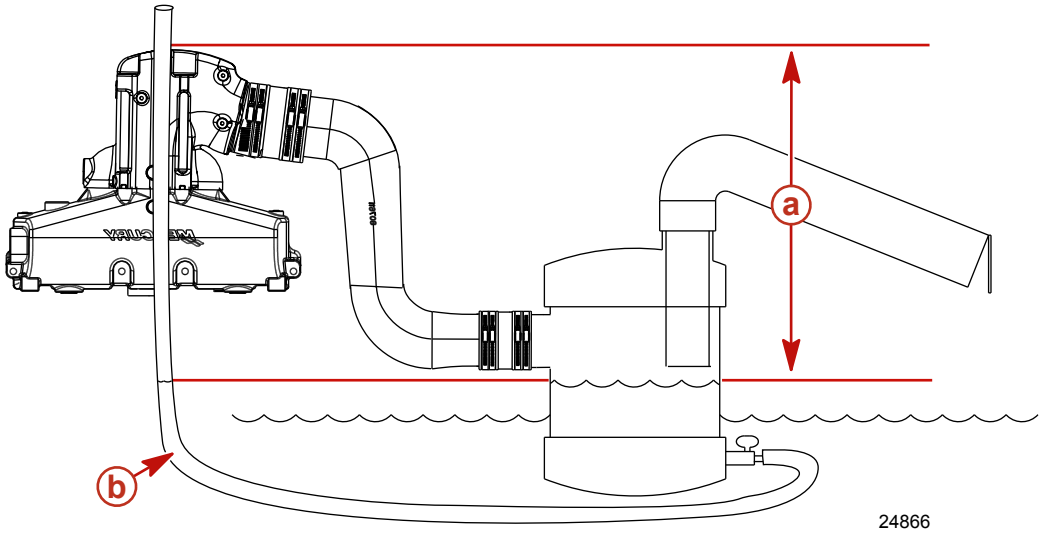
IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.

IMPORTANT: The engine must have been operated previously to fill the muffler with water.

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.

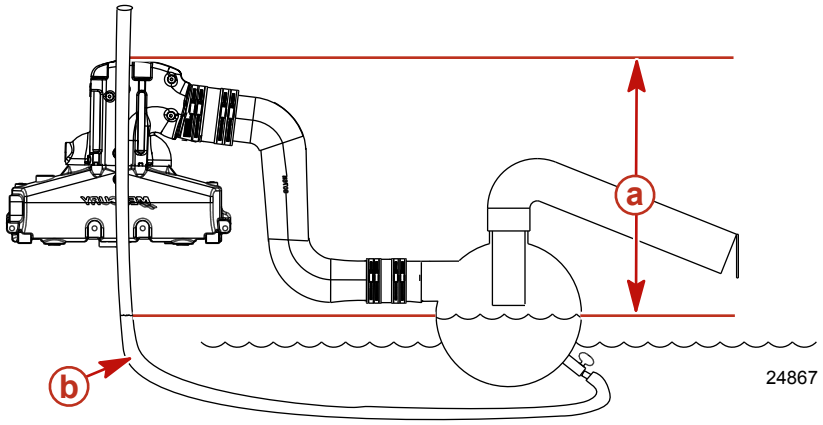
7. Slowly take the finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep the hose close to the exhaust elbow and as vertical as possible.
8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height. The maximum riser height is 20.3 cm (8 in.) on 496 models, 15.2 cm (6 in.) on all other models.



Typical vertical water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline



Typical horizontal water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

Testing the Exhaust System

Through-Transom Exhaust Back Pressure

IMPORTANT: Mercury MerCruiser recommends checking the exhaust back pressure on all new applications with through-transom or through-hull exhaust to ensure that it is within specifications.

All exhaust systems have some restriction to flow or exhaust back pressure. The power output of an engine is directly related to the amount of exhaust that can flow out of the exhaust system. For example, large displacement engines will generally lose approximately 10 horsepower for the first 7 kPa (1 psi) of exhaust back pressure. For every additional 7 kPa (1 psi) of back pressure, an engine may lose approximately 5 horsepower. Back pressure at WOT must fall within the range shown below.

Models	Exhaust Back Pressure
All gasoline powered engines	1 psi (7 kPa) Minimum
	2 psi (14 kPa) Optimal
	11 psi (76 kPa) Maximum

IMPORTANT: Some exhaust back pressure is required to prevent water intrusion in the exhaust system. Do not use more than a 10.2 cm (4 in.) inside diameter exhaust hose within the first 45.7 cm (18 in.) of each exhaust elbow.

A higher output engine will cause a greater back pressure using the same size exhaust system as an engine with less output. The boat's exhaust system should be designed and tested for the highest horsepower engine to be offered in that boat.

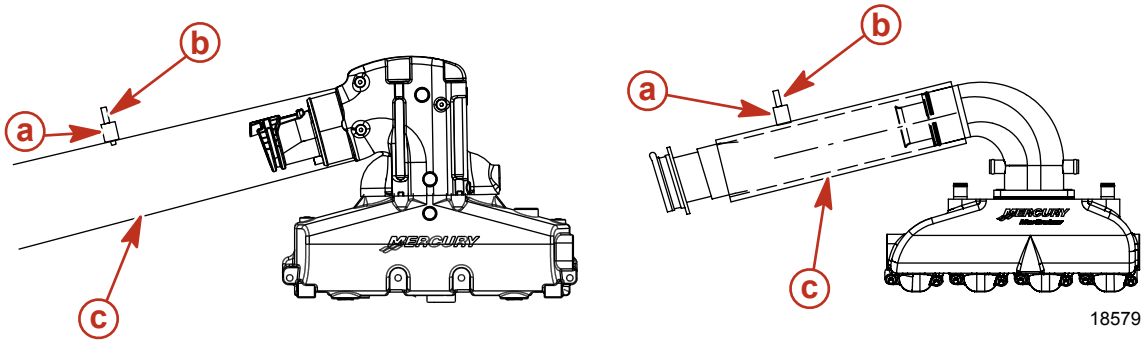
Ensure that both cylinder banks of any engine are tested. Record the highest and lowest back pressure readings. If pressure is out of specifications, changes must be made to the system to reduce the pressure. These changes include:

- Reduce exhaust system length.
- Eliminate sharp bends.
- Increase exhaust system diameter.
- Reduce muffler restriction.
- Ensure that through the transom or through the hull fittings are above water and are not restrictive while retaining internal and external flappers.

Exhaust Back Pressure Test

The boat should be in the water and underway. No special loading of the boat is necessary. The engine must be capable of reaching the specified WOT RPM as verified using an accurate service tachometer or scan tool. Both banks of each engine must be tested. Use the highest reading.

1. Drill 3/8 in. hole at the 12 o'clock position (facing up) in the exhaust hose 31–61 cm (12–24) inches from the engine exhaust elbow.
2. Assemble the Schraeder valve and brass adapter. Insert the 1/8 in. NPT male end of adapter into the hole in the exhaust hose.



Testing back pressure

a - Brass adapter
b - Schraeder valve
c - Exhaust hose

Description	Part Number
Drill and 3/8 in. drill bits or bit that match fittings	Obtain locally
Service Tachometer	Obtain locally
Schraeder valve, 2 required	22-860226
Brass 1/8 in. NPT male adapter fitting - 2 required	22-808002
Pressure gauge accurate to 7 kPa (1 psi)	Obtain locally

3. Set the pressure gauge to zero before connecting it to the engine.
4. While underway, operate the engine at 1000, 2000, 3000, 4000, and WOT RPM respectively. Record back pressure at each setting.
5. Repeat steps for the second cylinder bank and remaining engines on multiple engine applications.
6. Replace exhaust hoses.

If pressure is within specification, changes must be made to the system to reduce the pressure.

Check for Water Intrusion

IMPORTANT: A check for water intrusion must be performed on all new applications with through-transom or through-hull exhaust.

Select and perform one of the two methods to check for water in the exhaust manifolds.

The exhaust elbow removal method is the simplest and least time-consuming method to check for water in the exhaust manifolds. With this method, however, it is difficult to accurately determine the amount of water in the manifolds.

The exhaust manifold tap method provides a more accurate means to measure the water, but requires that a hole be drilled in each manifold. The manifolds must be replaced after performing this check, so the procedure is best performed by Mercury MerCruiser's product applications engineer or where repeated testing will be performed at your facility.

IMPORTANT: If there is no water in one manifold, do not assume that there is not water in the other manifold. Check each manifold.

PREPARATION

Consider hose lengths and angle, exhaust elbow height to the water line, waterlift muffler exhaust outlet angles, water lift muffler water height, idle relief angles, exhaust collector angles, air temperature, water temperature, and humidity when performing these test.

EXTENDED IDLE TEST

1. Operate the engine until it is at normal operating temperature [73°C (160 °F)].
2. Place the remote control in NEUTRAL. Increase the engine speed to 3000 RPM for 1 minute.
3. Bring the engine back to idle SLOWLY after 1 minute.
4. Shut the engine OFF.
5. Restart the engine and operate at idle speed for 15 minutes.
6. Shut the engine OFF.
7. Check for water

IMPORTANT: If this test is repeated, ensure the engine is at operating temperature and that the 3000 RPM step is repeated to clear the manifolds of water.

CHECKING BY EXHAUST ELBOW REMOVAL METHOD

NOTE: *This test is easier on seawater cooled engines but results are applicable to closed cooled engines also.*

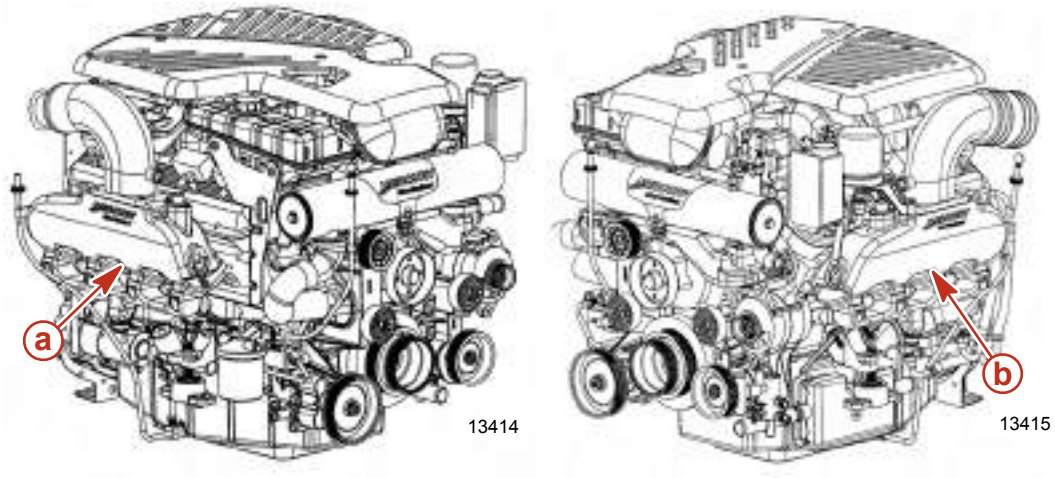
1. After the 15 minute idle preparation, drain the exhaust manifolds of water. If the engine uses a closed-cooled system, pinch or plug the hose from the heat exchanger to the exhaust elbow to prevent coolant from spilling because the heat exchanger is higher.
2. Remove the exhaust elbows.
3. Check for water in the exhaust manifold. Use a flashlight if needed to aid inspection. If water is found, measure the amount and record. See **Interpreting Results**.

NOTE: *A suction device with a rubber hose attached to the end can be used to suck the water from the manifold and discharge it into a container.*

4. Replace the elbows using new gaskets. Refer to the appropriate **Mercury MerCruiser Service Manual**.

CHECKING BY DRILLING AND TAPPING EXHAUST MANIFOLDS

1. Drill and tap a 1/8 in. NPT hole into the bottom and center of the exhaust manifold runners for cylinders numbers 4 and 5. Be sure to drill in the area that is not water-jacketed.



a - Number 4 exhaust manifold runner **b -** Number 5 exhaust manifold runner

2. Insert brass drain plugs into the holes.

Qty.	Description	Part Number
2	Brass drain plugs	22-818390

3. Run the engine as outlined in the extended idle test.
4. Drain water from the manifolds into a suitable container. Measure and record the amount of water using a graduated cylinder. An acceptable amount of condensation water is 5 ml (0.2 fl. oz.).
5. Replace the manifolds with new manifolds.

INTERPRETING RESULTS

Water vapor is a normal by-product of the combustion process, so a small amount of water [5 ml. (0.2 fl oz.)] is acceptable. This condensation has not shown to cause a problem. Water amounts in excess of this could be an indication of a water intrusion problem that requires corrective action. Some of the more common causes for this condition are:

- Insufficient exhaust riser height. See **Measuring Exhaust Elbow Height**.
- Improper exhaust hose slope.
- Failure to have at least 457 mm (18 in.) between the exhaust outlet and muffler, collector, or first angular fitting. See **Exhaust System Design**.
- Missing or mispositioned exhaust resonators. See **Exhaust Resonators**.

- Improperly sized or incorrectly installed exhaust system components.
- Leaking exhaust elbows or risers (i.e. loose screws, damaged gasket).
- Improperly designed collector or Y-pipe. See **Exhaust System Design** .
- Exhaust system causing a tuning effect. See **Exhaust Resonators**.
- Improperly functioning or missing water shutters or flappers.
- Muffler not draining.
- Engine damage.
- Poor engine running condition.

Cooling System

Section 7A - Cooling System

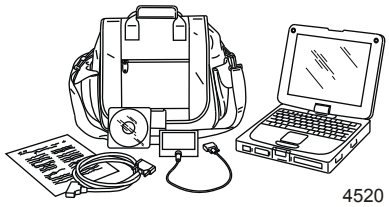
Table of Contents

7A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Special Tools

Computer Diagnostic System (CDS)	Order through 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: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

General Information

Mercury MerCruiser engines have either a seawater cooling system or a closed cooling system. Seawater cooling systems are sometimes called raw water cooling or standard cooling, while closed cooling systems are sometimes called fresh water cooling. On engines with seawater cooling, the engine is cooled entirely by the seawater in which the boat is being operated. Closed cooling systems use a combination of fresh water (antifreeze and water) and seawater for cooling. Both types of systems are designed to keep the engine operating temperature at approximately 71 degrees C (160 degrees F) for optimum performance, fuel economy and durability. (Refer to cooling system flow diagrams at end of section.)

To monitor the cooling system, a temperature switch is incorporated into the audio warning system, which alerts the operator of an abnormal condition if the temperature exceeds approximately 93 degrees C (200 degrees F). A temperature sender is also employed to operate a temperature gauge at the dash. On dual helm applications, this sender must be replaced with a dual station sender to obtain the proper temperature reading at both stations. Refer to the **Instrumentation and Controls** section for more information.

The cooling system must receive a sufficient amount of seawater under all operating conditions to operate properly. The design and installation of the seawater supply system is the boat manufacturer's responsibility. Cooling system components must be constructed, sized, and installed in accordance with the following guidelines.

⚠ CAUTION

Do not operate engine without water flowing through the seawater pickup pump, damage to the pump impeller and subsequent overheating damage to the engine or sterndrive unit may result.

Seawater Supply System

Specifications

SEAWATER SUPPLY HOSE

Seawater Supply Hose Specifications	
Seawater inlet hose	32 mm (1-1/4 in.) I.D. (wire reinforced)
Seawater pickup	Low restriction with 32 mm (1-1/4 in.) connections
Seacock (optional)	
Sea strainer (optional)	

SEAWATER INLET

Seawater Inlet Specifications	
See Seawater Inlet Restriction Test; Collect data at the seawater pump inlet (vacuum).	
Maximum water inlet restriction	17 kPa (2.5 psi)

SEAWATER FLOW

Seawater Flow Specifications					
See Seawater Supply Test; Collect data within 152 mm (6 in.) of the seawater pump outlet.					
Inboard Models	**Cooling**	**Seawater Pickup**	**RPM**	**Minimum Flow liter (gallon) per minute**	**Minimum kPa (psi)**
350 Mag MPI	Closed Cooling System	Through-Hull	4000	106 liter (28 GPM)	138 kPa (20 psi)
350 Mag MPI Horizon					
MX 6.2 MPI					
MX 6.2 MPI Horizon					
8.1S Horizon				76 liter (20 GPM)	75 kPa (11 psi)
8.1S HO					

Seawater Flow Specifications					
See Seawater Supply Test; Collect data within 152 mm (6 in.) of the seawater pump outlet.					
Tow Sports Models	**Cooling**	**Seawater Pickup**	**RPM**	**Minimum Flow liter (gallon) per minute**	**Minimum kPa (psi)**
5.7L	Closed Cooling System	Through-Hull	4000	65 liter (17 GPM)	42 kPa (6 psi)
350 Mag MPI					
Black Scorpion					
MX 6.2 Black Scorpion					

COLLECTING SEAWATER PRESSURE DATA

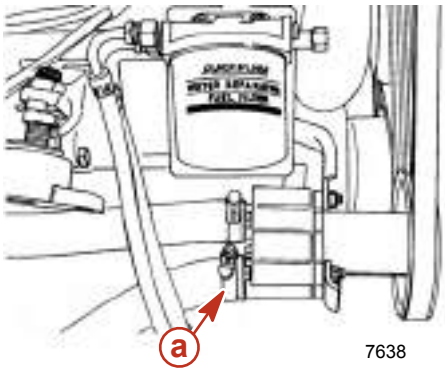
IMPORTANT: For models equipped with a seawater pressure transducer, collect the seawater pressure data using a Computer Diagnostic System (CDS).

Computer Diagnostic System (CDS)	Order through SPX

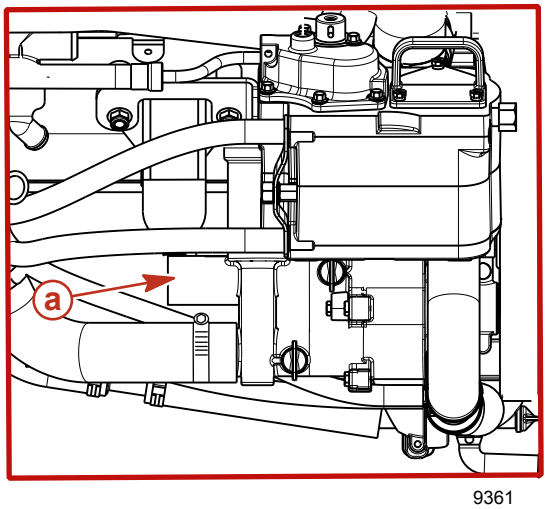
IMPORTANT: On inboard models, the seawater pressure data is to be collected within 152 mm (6 in.) of the seawater pump outlet.

Seawater Inlet Hose

- A reinforced hose capable of supporting 10 in. Hg vacuum must be used to prevent the seawater inlet hose from collapsing from pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible with the least number of bends to minimize restriction.
- All connections must be secured with a hose clamp.
- Fasten hose as appropriate to maintain proper routing and to prevent chafing or contact with other moving parts.



Typical composite seawater pickup pump

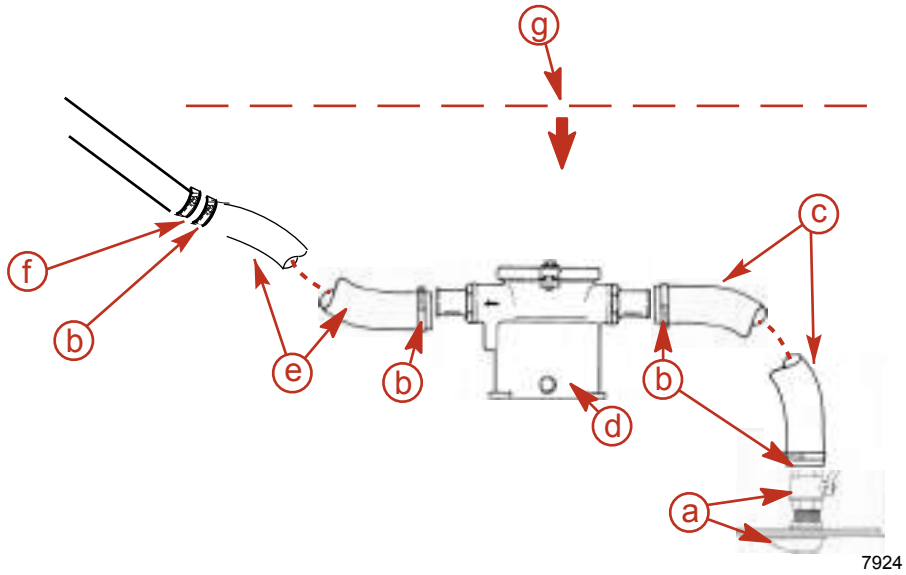


Typical brass seawater pickup pump

a - Seawater inlet hose connection

Through-Hull Seawater Pickup System

IMPORTANT: Seawater hose used must be wire reinforced to avoid collapsing hose when suction is created by seawater pump impeller.



Typical installation shown with a through the hull seawater pickup

- **a -** Quicksilver seawater pickup and seacock
- **b -** Hose clamp
- **c -** Seawater hose to seawater strainer
- **d -** Quicksilver seawater strainer
- **e -** Seawater hose to engine
- **f -** Seawater pump hose connector (if equipped)
- **g -** Below seawater pump level

IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slipstream. This will cause propeller ventilation and will adversely affect boat performance.

IMPORTANT: Make gradual bends in the seawater hoses to avoid kinks. Hoses must not come in contact with steering system components, engine coupler, or drive shaft.

- The seawater pickup must be large enough to permit sufficient seawater flow to engine seawater pickup pump for adequate engine cooling.
- The seawater pickup also must supply a positive head while underway.
- The seawater pickup should be located as close to the seawater pump inlet as possible and in an area where an uninterrupted, solid stream of seawater will flow past when the boat is underway.

Seawater Pickup

Either a through-transom or through-hull seawater pickup can be used. Select pickup location to minimize seawater inlet hose length while providing an optimum location for seawater pickup. The location should be in an area that will provide a solid, air-free flow of seawater under all operating conditions. Avoid areas with a disturbed seawater flow, such as those behind or in close proximity to the propeller. Locations that are too far forward or outboard should also be avoided as these are prone to aeration problems at high boat trim angles and in turns. Check for aeration as outlined under **Seawater Supply Test**.

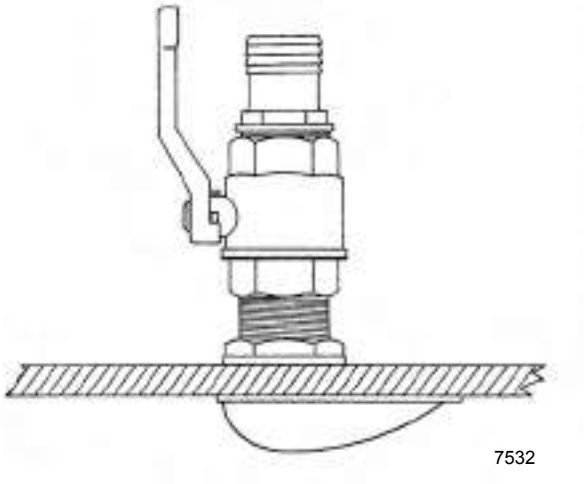
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as pickup may create turbulence and allow air to flow into the propeller slip-stream. This will cause propeller ventilation and will adversely affect boat performance.

Openings in seawater pickup should be approximately 3 mm (1/8 in.) maximum to prevent larger debris from entering and clogging the cooling system.

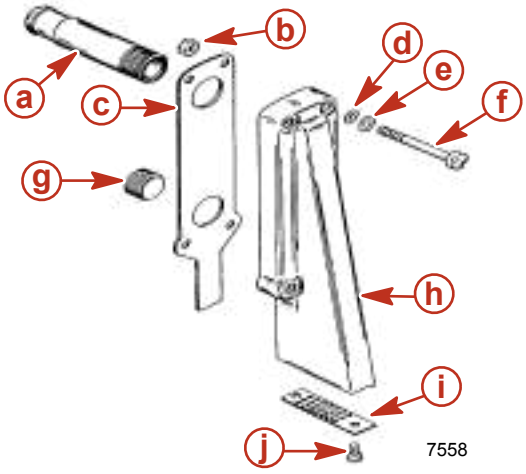
IMPORTANT: Use a seawater strainer if the seawater pickup openings exceed 3 mm (1/8 in.).

Provisions should be made to minimize galvanic corrosion, given the hull material being used and the composition of the surrounding components. Some industry standards and regulations also require that the pickup be connected into the boat's bonding system to minimize stray current corrosion. Refer to applicable standards and regulations for more details.

IMPORTANT: External seawater pickup must have an integral seacock.



Typical seacock



Typical transom pickup

a - Hose fitting
b - Nut (4)
c - Gasket
d - O-ring (4)
e - Washer (4)
f - Screw (4)
g - Plastic plug
h - Pickup
i - Screen
j - Screw (2)

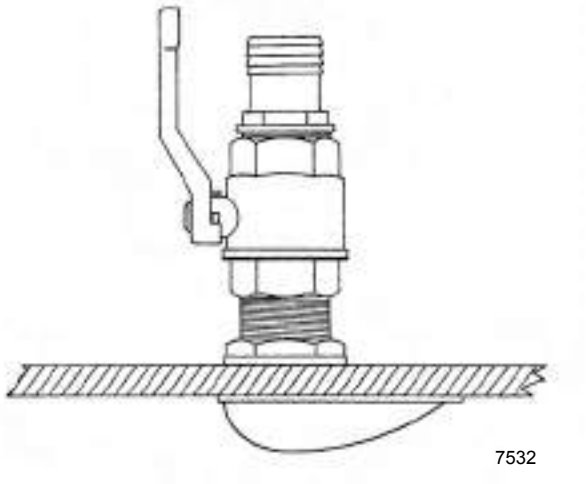
Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822

Tube Ref No.	Description	Where Used	Part No.
116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Seacock

The ABYC and other industry standards and regulations require the use of a seacock on certain types of applications to stop the entry of seawater in the event of a leak in the cooling system. Refer to applicable standards and regulations for specific requirements. The seacock also allows the seawater to be shut off when servicing the engine.

The seacock must provide minimum restriction to seawater flow (see **Specifications**). A ball valve or gate valve is recommended. The ball valve is most common and is typically equipped with a lever type handle that operates in a 90 degree arc. This design gives a clear indication of whether the valve is open or shut. Industry standards and requirements typically require that the seacock be rigidly attached to the hull at the seawater pickup. Seacock location should be readily accessible for quick, easy operation.



Typical seacock

Sea Strainer

A sea strainer is recommended if the boat is to be operated in an area with a high debris content. The strainer must be sized to minimize restriction (See **Specifications**) and to provide a reasonable service interval. Locate the strainer in an area that will be easily accessible for servicing. If the boat is not equipped with a seacock, the strainer should be located above the seawater-line to prevent seawater entry into boat when servicing. The strainer must have provision to allow draining in freezing temperature periods.

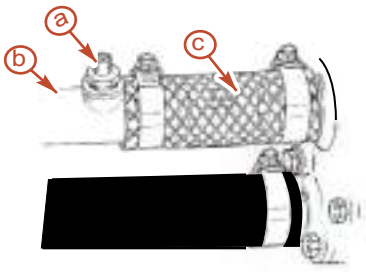
Typical Sea Strainer

Seawater Supply Test

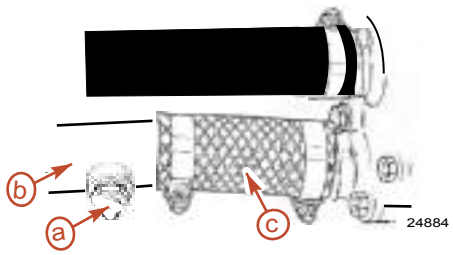
Seawater Inlet Restriction Test

Maximum seawater inlet restriction must not exceed 17 kPa (2.5 psi) when measured at the inlet side of the seawater pump. Pressure can be tested using pressure gauge and hardware. Gauge must be capable of accurately reading a vacuum (below atmospheric pressure).

1. Install an adapter into the seawater inlet hose at the seawater pump to allow the connection of a pressure gauge.



Brass seawater pump



Composite seawater pump

a - Connection for the pressure gauge
b - Adapter
c - Seawater pump inlet connection

2. Zero the pressure gauge.
3. Connect the pressure gauge to the connection on the adapter.
4. With boat in the seawater and while underway, operate engine at 1000, 2000, 3000, 4000, and WOT while observing gauge.
5. Pressure should be steady and not exceed 17 kPa (2.5 psi). Check the following if abnormal readings are obtained.

FLUCTUATING READINGS

- Pickup located too far forward or outboard on the boat, allowing air to enter system.
- Pickup located too close to propeller or some other object and picking up disturbed seawater flow.
- Loose connection in the system allowing air to enter.
- Seawater inlet hose collapsing; wire reinforced hose not used.

EXCESSIVE PRESSURE READING

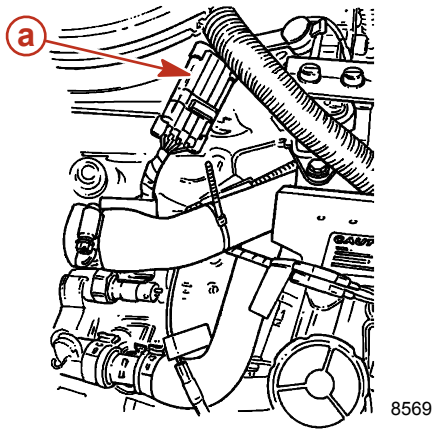
- Seawater supply components improperly sized.
- Seawater pickup not located on hull in an area with a solid, air-free flow of seawater.
- Excessive bends in seawater inlet hose.
- Seawater inlet hose collapsing; wire reinforced hose not used.

Seawater Pressure Test for MPI Models

IMPORTANT: MPI models must use the flow values as listed in Specifications, see Seawater Supply Test Specifications.

IMPORTANT: The boat must be in the seawater for this test.

1. Connect an appropriate scan tool to the diagnostic connector.



a - Diagnostic connector

2. Operate the boat and advance the the throttle to 4000 RPM.
3. Measure the seawater pressure. If seawater pressure does not meet specification, seawater inlet plumbing changes are required.

Seawater Aeration Test

The engine cooling system must receive a solid, air-free stream of seawater in order to operate effectively.

1. Install a piece of clear plastic wire-reinforced tubing in seawater inlet hose of seawater pickup pump.
2. Operate engine from idle to WOT, while putting the boat through normal operating maneuvers. Simultaneously, watch the seawater flow through the clear plastic tubing.

3. Seawater flow should be solid with only tiny bubbles being acceptable (due to pseudo-cavitation). If it is not:
   - Pickup located too far forward or outboard on the boat, allowing air to enter system.
   - Pickup located too close to the propeller or some other object and picking up disturbed seawater flow.
   - Loose connection in the system allowing air to enter.

Closed Cooling

Description

Closed cooling is a standard feature on some models and is available as an accessory or a factory installed option on others. When closed cooling is used, a mixture of antifreeze and water is circulated through the water jackets in the engine block, cylinder heads, and —on some applications—the exhaust manifolds to dissipate the heat. Refer to Water Flow Diagrams. This coolant is then passed though a heat exchanger. Here the coolant rejects heat to seawater (water in which the boat is being operated), which is simultaneously being passed through the exchanger. The heat is then carried away by the seawater and discharged overboard via the exhaust elbows. The design of the heat exchanger allows for the transfer of heat, while ensuring that the two coolants are separated. In this manner, the expensive engine components are never exposed to seawater, which can be corrosive in salty, polluted, or mineral laden water areas.

Mercury MerCruiser's closed cooling systems are developed by the same people who design our engines to ensure compatibility and the same high quality standards. Our systems employ several exclusive features to provide unsurpassed cooling efficiency and durability. An exclusive double-acting thermostat is used on V6 and V8 models, which provides increased coolant velocity through the engine and heat exchanger to prevent hot spots and improve performance. Mercury MerCruiser's heat exchangers also incorporate several state-of-the-art designs to enhance the heat transfer between the coolants for an additional margin of cooling capacity. Features like these allow our systems to continually operate at WOT in water temperatures up to 38 °C (100 °F), where most after-market systems fall short of this mark. This additional cooling capacity translates into longer cooling system life with fewer problems regardless of where the boat is operated. Contact your sales representative to order your closed cooling systems factory installed or refer to the Mercury Precision Parts and Accessories Guide to obtain the part numbers for the accessory kits.

The term full closed cooling, also known as full fresh water cooled or full FWC refers to the use of an ethylene glycol mixture in the engine and the exhaust water jackets. The ethylene glycol coolant mixture is circulated through the exhaust cooling passages as well as the engine cooling passages.

Antifreeze Recommendations

⚠ CAUTION

Alcohol or Methanol based antifreeze or plain water, are not recommended for use in the coolant section of the Closed Cooling System at any time.

Factory installed closed cooling systems come filled with an extended life antifreeze. This coolant allows for a service interval of 5 years or 1000 hours (whichever occurs first), versus 2 years or 400 hours for standard antifreeze. When adding coolant to these systems (i.e. when filling coolant recovery bottle, installing hot water heater), we recommend that only an extended-life antifreeze be used. Mixing this coolant with even a small amount of regular antifreeze will require that the service interval be reduced 2 years. If you are installing closed cooling kits at your facility, we would also encourage you to use the extended Life coolant to allow your customer to take advantage of the reduced maintenance costs.

Pre-mixed extended life coolant is available from Quicksilver or can be purchased at most automotive stores and other locations where antifreeze is sold. Extended-life coolant is available from Texaco under the name Havoline Extended Life Dex Cool. Prestone also offers a version of this antifreeze called Extended Life 5/100. Only coolants that state that they are compatible with Dex Cool should be used. Extended-life coolants can be identified by their orange color (vs. green for standard coolant) and their corresponding orange cap on the container.

All antifreeze should be mixed 50/50 with pure water (Quicksilver coolant is already pre-mixed). If installing closed cooling kits at your facility, be sure to observe the special filling procedure in the installation instructions.

Closed Cooling System Capacity	
8.1S Models	18 liters (19 quarts)
All Other Models	19 liters (20 quarts)

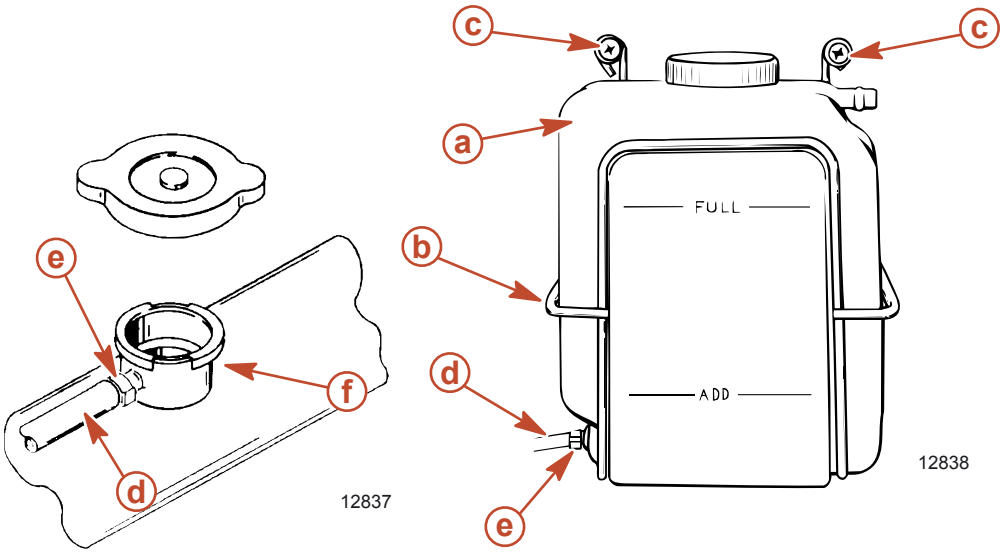
Coolant Recovery System

All Mercury MerCruiser closed cooling systems (except for 8.1S models) are equipped with a coolant recovery system that must be installed by the boat manufacturer. Coolant recovery bottle mounting location must meet these requirements:

- Within approximately 122 cm (4 ft.) of heat exchanger filler neck to allow connection with tubing provided.
- Even with or slightly above heat exchanger filler neck.

NOTE: *This differs from the previous recommendation and has been changed to ensure that air does not enter the cooling system upon cool down.*

- Accessible for observing level and servicing coolant.



a - Recovery bottle
b - Mounting bracket
c - Screw and flat washer (2 each provided)
d - Plastic tubing
e - Tubing clamp
f - Heat exchanger fill neck

Water Heaters

⚠ CAUTION

Avoid overheating damage. Mercury MerCruiser is not responsible for engine damage caused by improper heater installation.

Mercury MerCruiser engines are designed to allow connection of a water heater. Ensure that the water heater complies with the following:

Description	Specification
Engine operating temperature range	71–79° C (160–175° F)
Maximum pressure at the heater connections	172 kPa (25 psi)

IMPORTANT: Engine may not maintain proper temperature if heater supply and return hoses are too large.

- Maximum ID of heater supply and return hose: 16 mm (5/8 in.).
- Make heater connections only at locations specified.
- Do not reposition the temperature senders or switches for the purpose of making the connections. Senders and switches may not operate properly if repositioned.
- Heater should be mounted so that heater element is below connections on engine to avoid air locking. On models with closed cooling systems trapped air will eventually work its way back into the cooling system and could cause overheating.
- The system should be arranged so that the heater hoses slope progressively upward (toward the engine) to minimize the need for air venting. Avoid U-bends in the hoses.
- Hoses should be kept as short as possible with a minimum number of bends.
- Hoses should be properly supported to prevent chafing and interference with moving parts on engine.
- Drain plugs should be fitted at the lowest point in the system for draining.

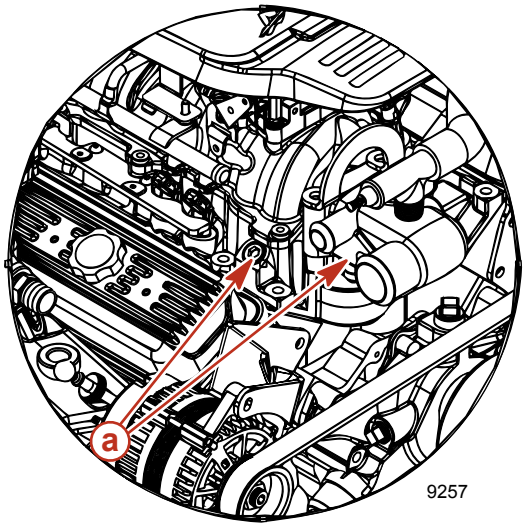
- On models with closed cooling systems, additional coolant must be added to the fresh water system to fill the heater. See **Antifreeze Recommendation**. Operate the engine while filling and recheck the level several times to ensure that all air has been purged from the system.

IMPORTANT: Closed cooling system capacity will be different than shown in Operation, Maintenance, and Warranty manual. Be sure to advise owner of the proper capacity for your application.

- Refer to heater manufacturer's instructions for specific installation details.

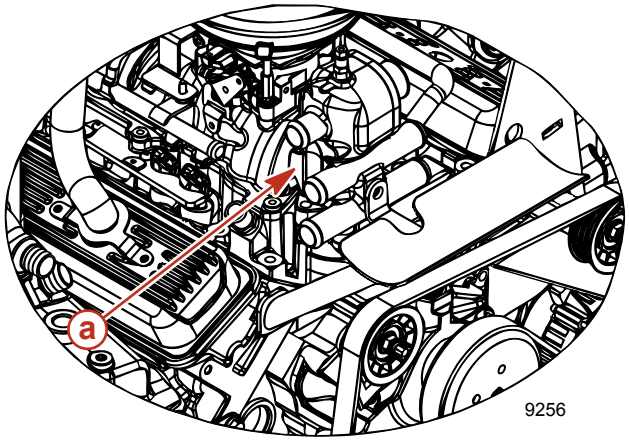
Water Heater Hose Connection Points

WATER HEATER CONNECTIONS: MPI MODELS



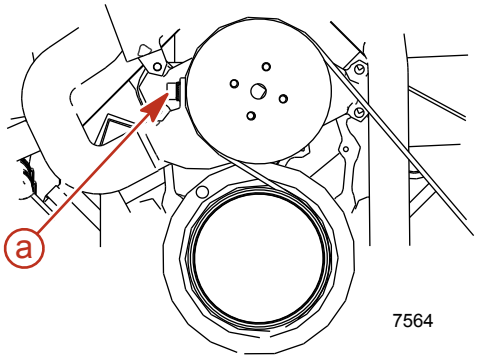
Seawater cooled models

a - Location for hot water supply connection



Models with closed cooling

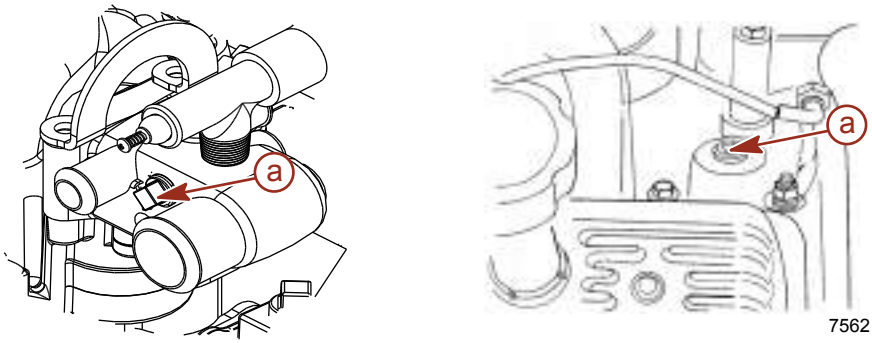
a - Location for hot water supply connection



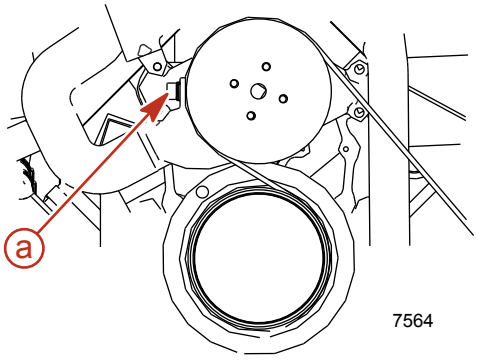
Water circulating pump housing

a - Location for return hose connection

WATER HEATER CONNECTIONS: CARBURETED MODELS



a - Location for hot water supply connection

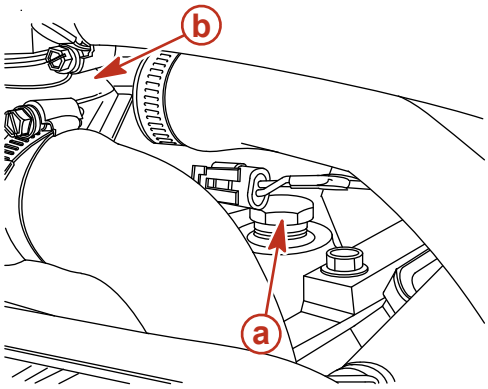


Water circulating pump housing

a - Location for return hose connection

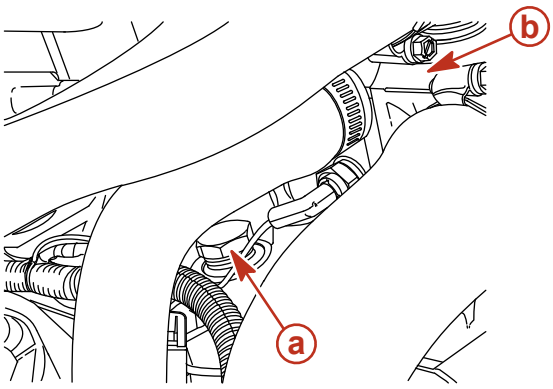
WATER HEATER CONNECTIONS: SCORPION MODELS

NOTE: *Some models may be equiped with additional fittings.*



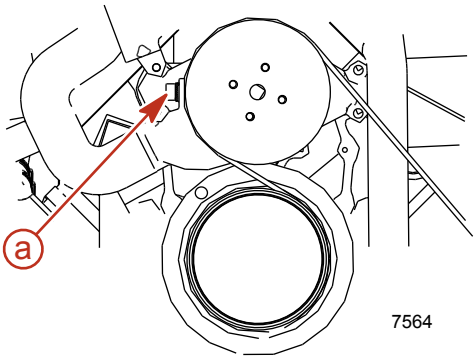
Port side intake manifold plug

a - Location for hot water supply connection



Starboard side intake manifold plug

b - Thermostat housing

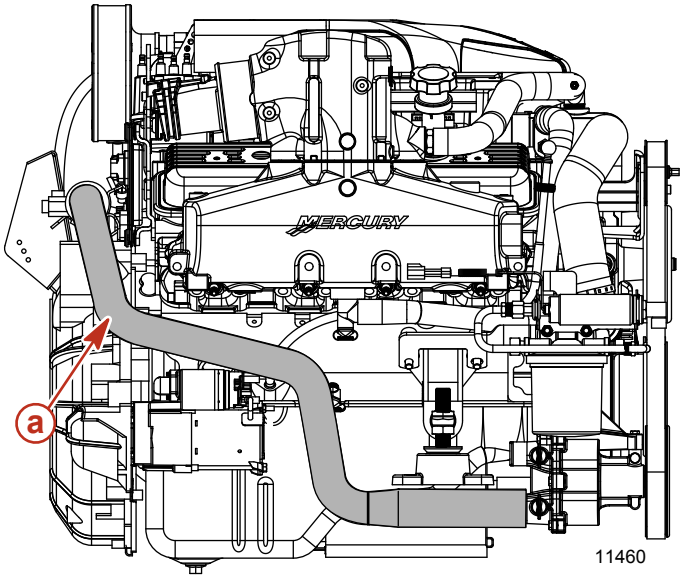


Water circulating pump housing

a - Location for return hose connection

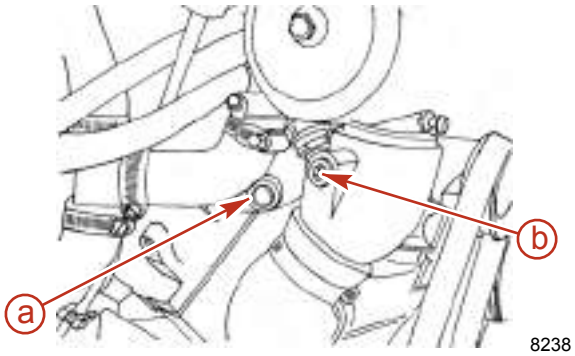
IMPORTANT: When connecting a cabin shower:

- **Supply hose Must Not Exceed 16 mm (5/8 in.) inside diameter (ID).**
- **Do not reposition shaft log seal.**



a - Hose for cold water supply

WATER HEATER CONNECTIONS: 8.1S MODELS



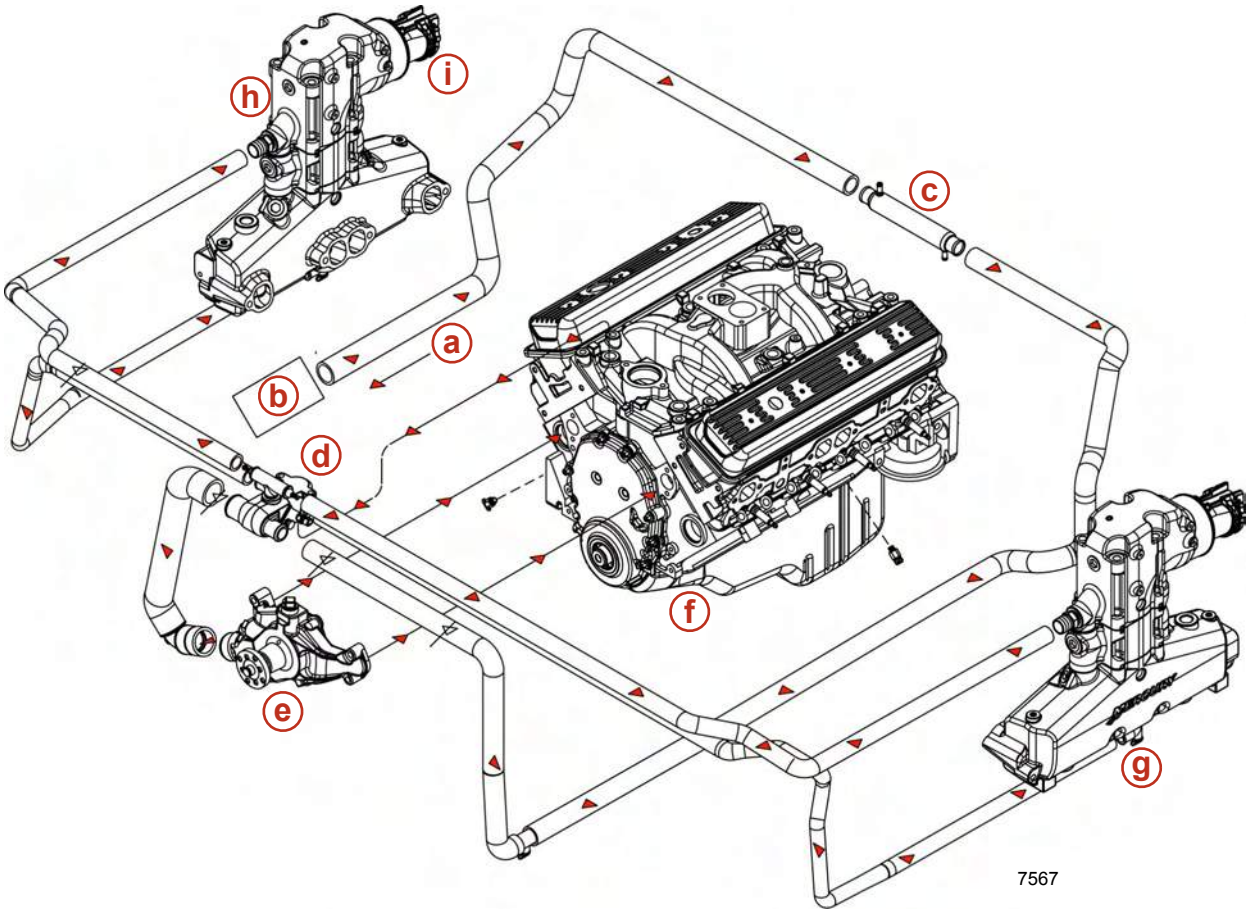
a - Location for hot water supply connection

b - Location for return hose connection

5.7L Tow Sport Water Flow Diagram

Inboard and Tow Sport (Carburetor) Water Flow Diagram

SEAWATER COOLING SYSTEM



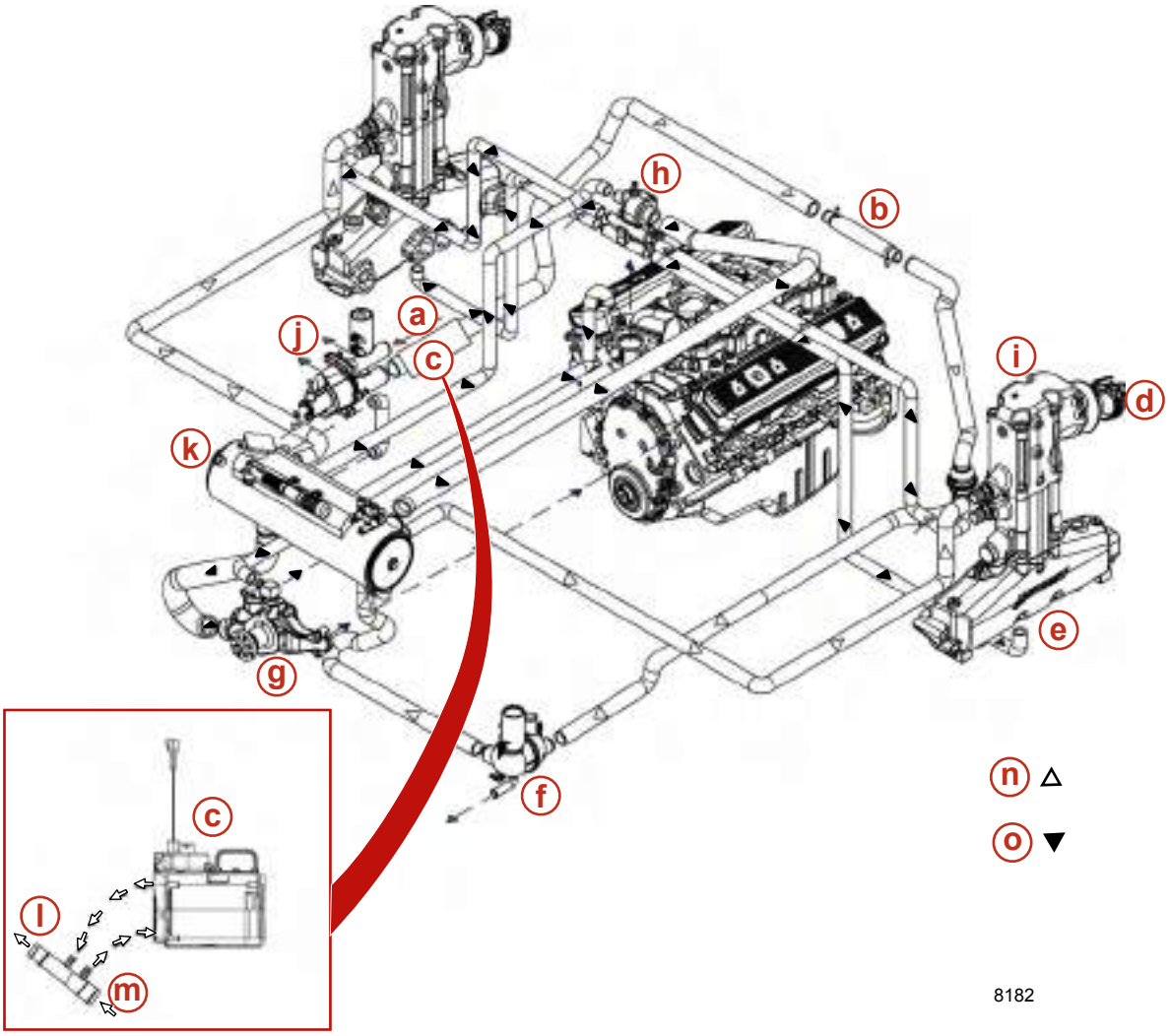
a - Seawater inlet
b - Seawater pump
c - Transmission cooler
d - Thermostat housing and cover assembly
e - Engine water circulating pump
f - Engine block and cylinder head assembly
g - Exhaust manifold, typical
h - Exhaust elbow assembly, typical
i - Exhaust outlet
j - Warm riser

Inboard V8 Water Flow Diagrams

Mie Water Flow Diagrams

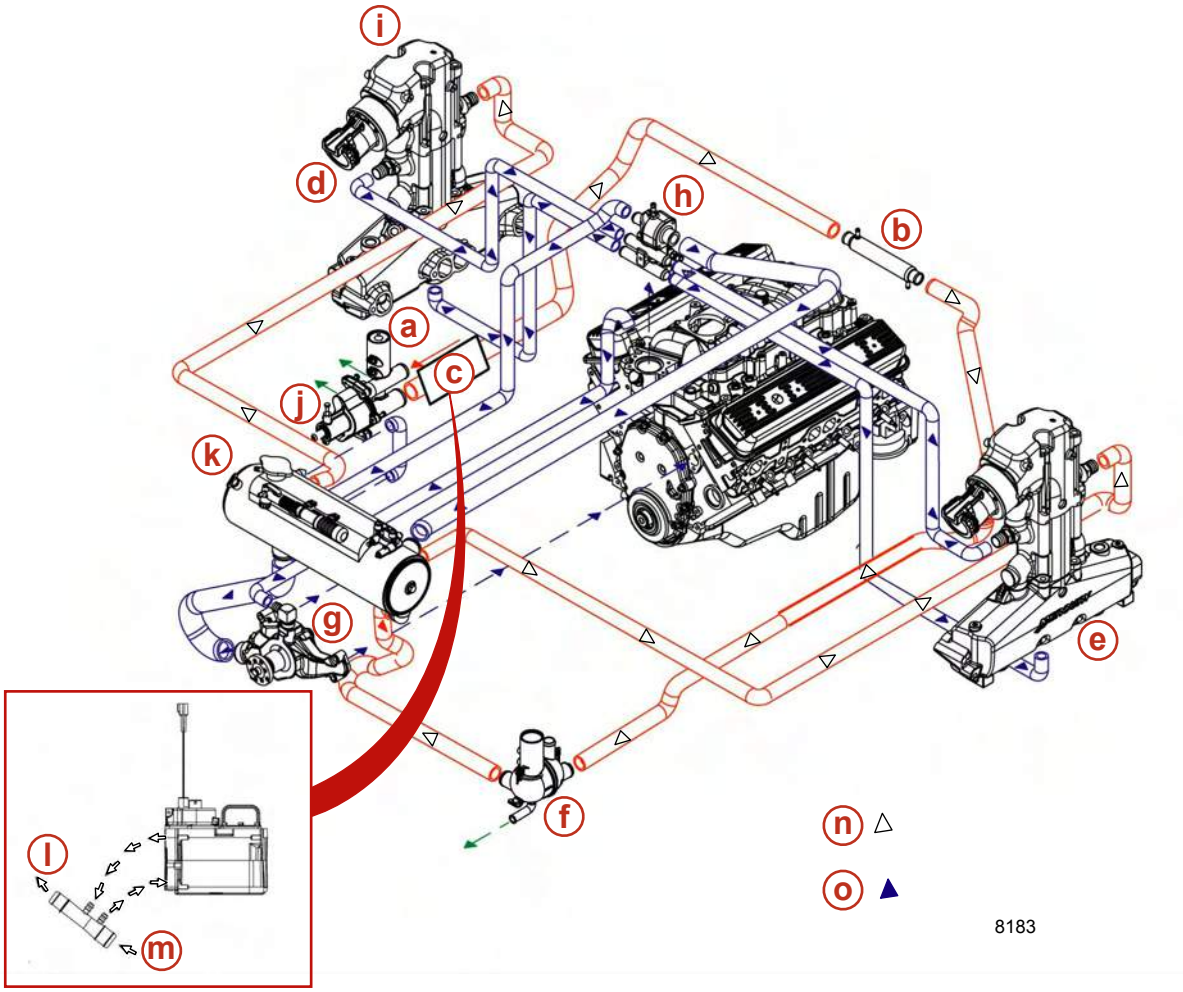
CLOSED COOLED INLINE EXHAUST MODELS

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.*



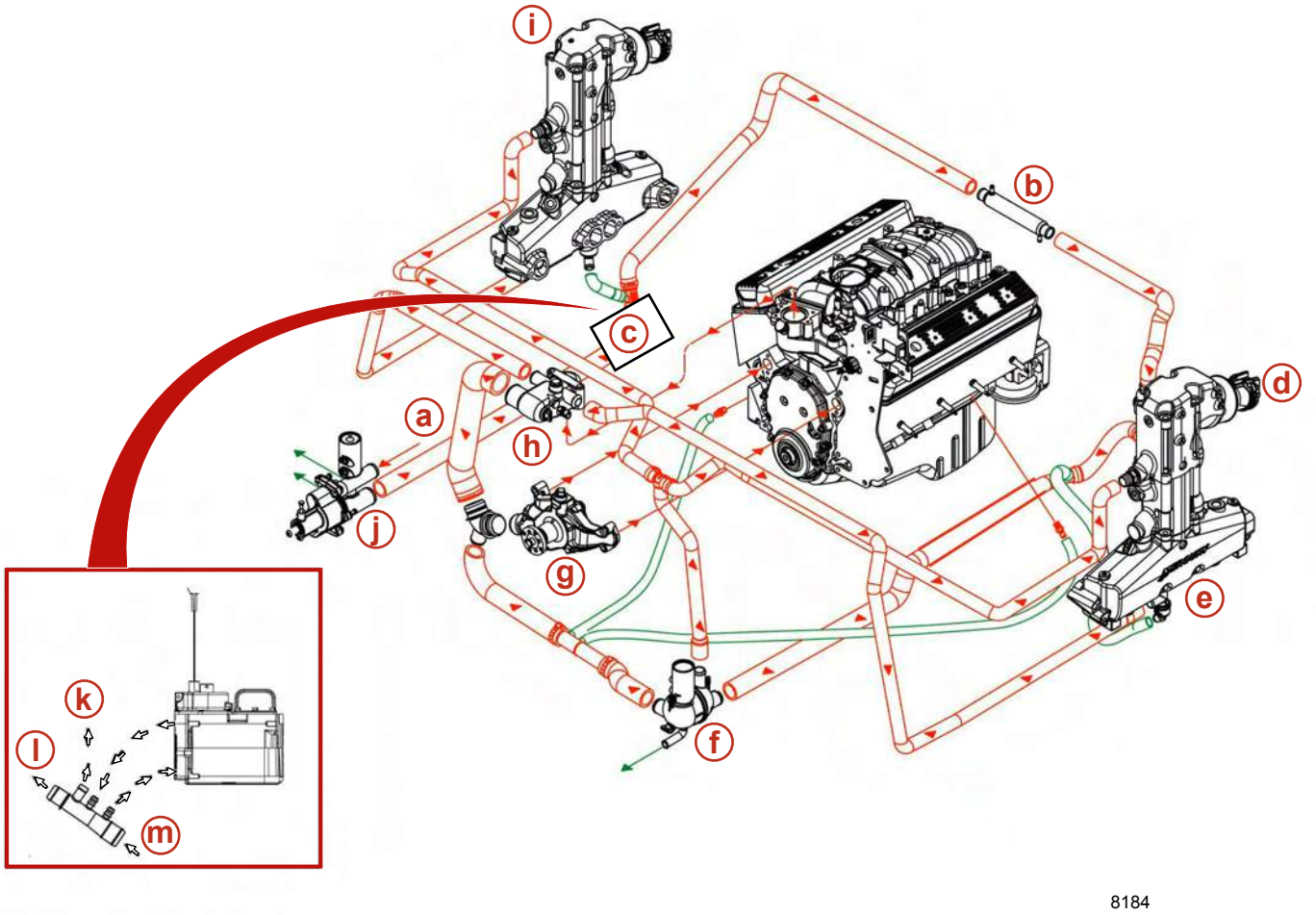
a - Seawater inlet
b - Transmission cooler
c - Gen III Cool Fuel module
d - Exhaust and seawater outlet
e - Exhaust manifold
f - Distribution housing
g - Water circulating pump
h - Thermostat housing
i - 14 degree exhaust elbow
j - Seawater pump
k - Heat exchanger
l - To transmission cooler
m -From seawater pump
n - Seawater
o - Ethylene glycol mix

CLOSED COOLED V-DRIVE EXHAUST MODELS



a - Seawater inlet
b - Transmission cooler
c - Gen III Cool Fuel module
d - Exhaust and seawater outlet
e - Exhaust manifold
f - Distribution housing
g - Water circulating pump
h - Thermostat housing
i - Exhaust elbow
j - Seawater pump
k - Heat exchanger
l - To transmission cooler
m -From seawater pump
n - Seawater
o - Ethylene glycol mix

SEAWATER COOLED MODELS

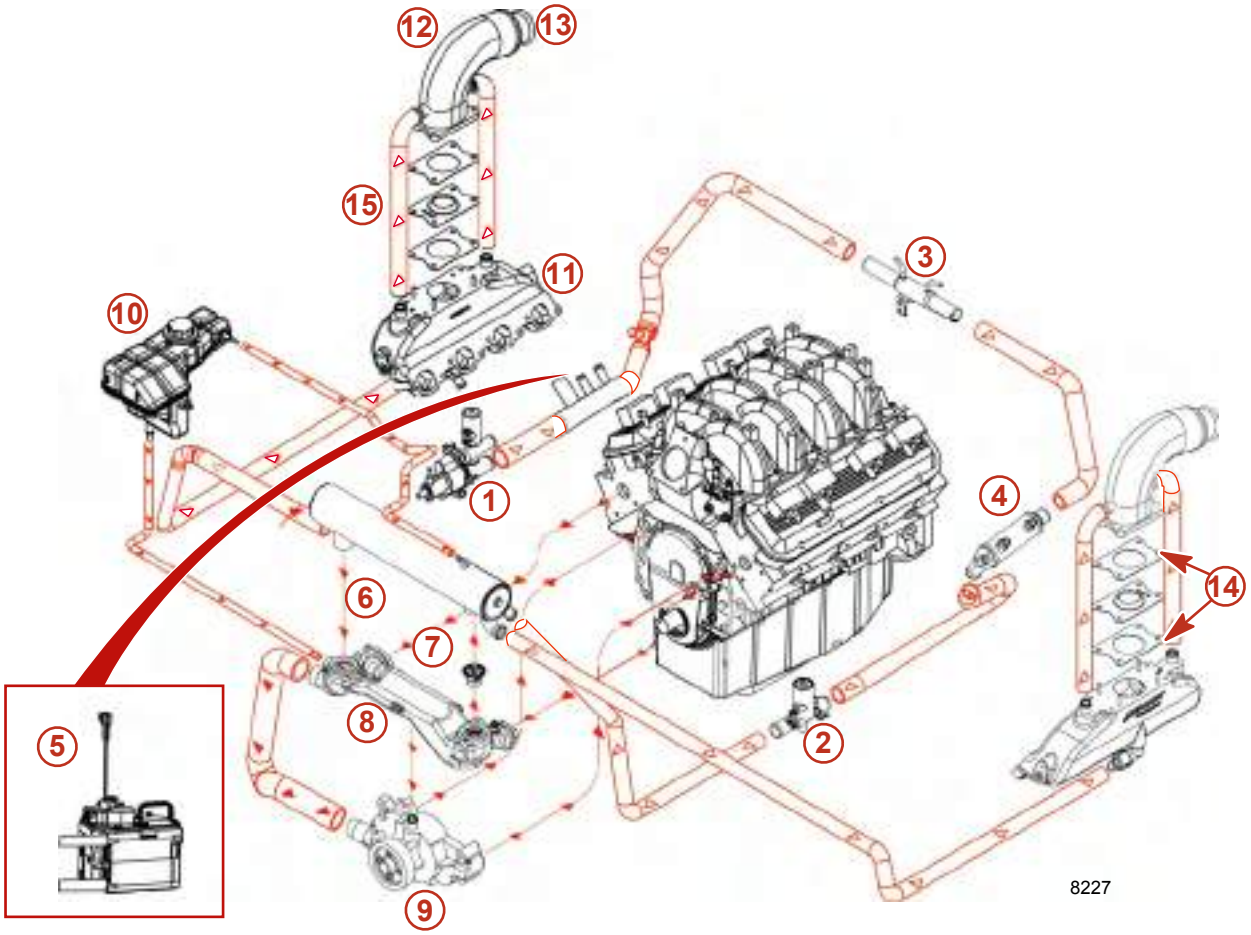


a - Seawater inlet
b - Transmission cooler
c - Gen III Cool Fuel module
d - Exhaust and seawater outlet
e - Exhaust manifold
f - Distribution housing
g - Water circulating pump
h - Thermostat housing
i - Exhaust elbow
j - Seawater pump
k - Drain from starboard exhaust manifold
l - To power steering cooler
m -From seawater pump

8.1S and HO Inboard Water Flow Diagram

Coolant and Water Flow Diagrams

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump/Air actuator
2 - Air actuator
3 - Transmission cooler
4 - Oil cooler
5 - Gen III Cool Fuel Module
6 - Heat exchanger
7 - Thermostat
8 - Crossover
9 - Water circulating pump
10 - Coolant reservoir
11 - Exhaust manifold
12 - Elbow
13 - Water and exhaust outlet
14 - Gasket (2 per side)
15 - Turbulator (1 per side)

Notes:

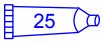
Electrical System

Section 8A - Electrical System

Table of Contents

8A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminals	Obtain Locally
	Liquid Neoprene	Engine cable connections All electrical connections	92-25711-3

Finding Other Diagrams

NOTICE
Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

General Information

This section covers the engine portion of the electrical system. For instrumentation related information, see **Section 9**.

The electrical system is a 12-volt, negative ground system. High output (65/72 amp) alternators are included as standard equipment. Their high output design helps ensure that the battery remains fully charged for trouble-free starting, while providing extra capacity to handle the accessories used on today's boats. All alternators are equipped with an external sensing circuit to maintain the battery at the optimum voltage level, while providing for the use of a battery isolator, if desired. Special high-capacity marine starters are also employed to provide reliable starting and long life in the rigorous marine environment. Mercury MerCruiser starters, alternators, distributors, solenoids, circuit breakers, fuses, and other components that could generate a spark comply with external ignition standards and regulations to prevent the ignition of combustible fumes in the engine compartment should they exist. These components should not be confused with standard automotive components, which typically do not have this provision. The electrical system is equipped with numerous overcurrent protection devices (circuit breakers, fuses) to protect the engine against shorts and overloads. See **Wiring Diagrams** for the location of these devices. The engine compartment should be designed to allow access to these components.

IMPORTANT: No one component is more important in ensuring the reliability of the electrical system than is the battery and related hardware. The installation of the battery and cables is the responsibility of the boat manufacturer. The guidelines outlined in this section must be carefully followed when selecting and installing these items.

Precautions

⚠ WARNING
Electrical, ignition, and fuel system components on Mercury MerCruiser engines and sterndrives are designed and manufactured to comply with U.S. Coast Guard rules and regulations to minimize risks of fire or explosion. **The use of replacement electrical, ignition, or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided.** **When servicing the electrical, ignition, and fuel systems, it is extremely important that all components be properly installed and tightened. Otherwise, any opening in the electrical or ignition system would permit sparks to ignite fuel vapors from leaks in the fuel system, if they existed.**

⚠ CAUTION

Always disconnect the battery cables from the battery before working around electrical system components to prevent injury and damage to the electrical system if a wire should accidentally cause a short circuit.

⚠ CAUTION

Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories:

- **Do not tap accessories into engine harness.**
- **Do not puncture wires for testing (probing).**
- **Do not reverse battery leads.**
- **Do not splice wires into harness.**
- **Do not attempt diagnostics without proper, approved service tools.**

⚠ CAUTION

Avoid fire hazard. The accessory wire on the 14-pin engine wiring harness cannot exceed 15 amp current draw. An optional kit must be used for accessory power or switched power.

IMPORTANT: The accessory wire in the 14-pin harness will not support amperage in excess of 15 amps. Refer to Quicksilver Accessories for an optional relay kit that will accommodate a higher amperage draw.

Industry Standards and Regulations

⚠ WARNING

When designing and installing the electrical system, adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) for the market in which the boat will be sold.

The following excerpts from the ABYC Standards should be observed when designing and installing the electrical system. These are just a few of the more fundamental standards that, if observed, can significantly improve the overall reliability and durability of the boat and engine package. The list is not intended to be all-inclusive, and should not be used as a substitute for reading the standards.

- Current carrying conductors shall be routed as high as practical above bilge water level and other areas where the water may accumulate. The wiring and connections must be water-tight.
- Conductors should be routed as far away as practical from exhaust pipes and other heat sources. Unless an equivalent thermal barrier is provided, a clearance of 51 mm (2 in.) should be provided between conductors and the water cooled Mercury MerCruiser exhaust system components.
- Conductors that may be exposed to physical damage shall be protected by self-draining loom, conduit, tape, raceways, or other equivalent protection.
- Conductors passing through bulkheads or structural members shall be protected to avoid insulation damage such as chafing by using grommets.

- Conductors should be routed to clear sources of chafing such as steering cable and linkages, throttle connections, and other moving engine components.
- Conductors should be supported throughout their length and should be secured at least every 46 cm (18 in.), using industry approved fasteners.
- All connections shall be in locations protected from the weather, in weatherproof enclosures or should be watertight. If connections are exposed to immersion, they must be watertight.
- Metals used for terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug. Aluminum and unplated steel shall not be used for studs, nuts, and washers.
- No more than 4 conductors shall be secured to any one terminal stud.
- Only industry approved terminals shall be used, which typically include ring and captive spade types.
- Solder shall not be used as the sole means of mechanical connection in any circuit. Solder connections shall be properly supported to minimize flexing of the solder connection.
- Twist-on connectors (i.e. wire nuts) shall not be used.
- Wire size and insulation rating shall be selected in accordance with industry standards with the proper overcurrent protection being used.

Battery and Battery Cables Requirements

⚠ CAUTION

Electrical system is negative (-) ground. Do not reverse battery cables or alternator and other electronics may be damaged.

⚠ WARNING

When designing and installing the electrical system, adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) for the market in which the boat will be sold.

⚠ CAUTION

Avoid electrical system damage. When installing the battery, be sure to connect the negative (-) battery cable to the negative (-) battery terminal and the positive (+) battery cable to the positive (+) battery terminal.

Battery

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 positive battery terminal is properly insulated in accordance with regulations.

IMPORTANT: It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.

IMPORTANT: Battery cables should always be tightened with a wrench

Select a battery that meets these specifications:

- The battery is a 12-volt marine type.

IMPORTANT: Do not use a battery with wing nut connectors.

- The battery has tapered post or side terminal connectors.
- The battery capacity rating meets or exceeds the recomended **Cranking Battery Specifications**:

Cranking Battery Specifications	
Model	Minimum required rating
5.7L (350 cid) carbureted models	375 cca / 475 mca / 90 Ah
5.7L (350 cid) / 6.2 L (377 cid) MPI models	750 cca / 950 mca / 180 Ah
8.1S (496 cid) - all	750 cca / 950 mca / 180 Ah
All DTS Models	800 cca / 1000 mca / 190 Ah

- The battery has a reserve capacity rating that meets or exceeds the electrical accessory loads of the particular application. Refer to applicable standards for calculation procedure.
- The battery is located as close to engine as possible and in an accessible location for service.
- The battery compartment is properly vented in accordance with the industry standards and regulations.
- The battery is properly secured in accordance with the industry standards and regulations. Some standards and regulations require that the battery is installed in an enclosed case.
- The battery is not installed above or below a fuel tank, fuel filter, or fitting in a fuel line. (ABYC Standard)
- The battery is installed so that the metallic objects cannot come in contact with the ungrounded (positive) battery terminal. (ABYC Standard)
- The fuel system components within 305 mm (12 in.) and above the horizontal plane of the battery top surface is shielded with dielectric material. (ABYC Standard)
- The battery parts that are continuously energized, such as the positive battery terminal and the cable connections are physically protected with boots or other forms of protection to prevent accidental short circuits (ABYC Standard).
- The battery installation for multiple engine installations require special battery considerations.

Battery Cables

NOTE: *The battery should be located as close to the engine as possible.*

1. Select proper size positive (+) and negative (-) battery cables using the chart.
   a. Add the positive and negative cable lengths together.
   b. Divide by 2 to obtain the average cable length.
2. Battery cables must comply with SAE J1127 or comparable standards.

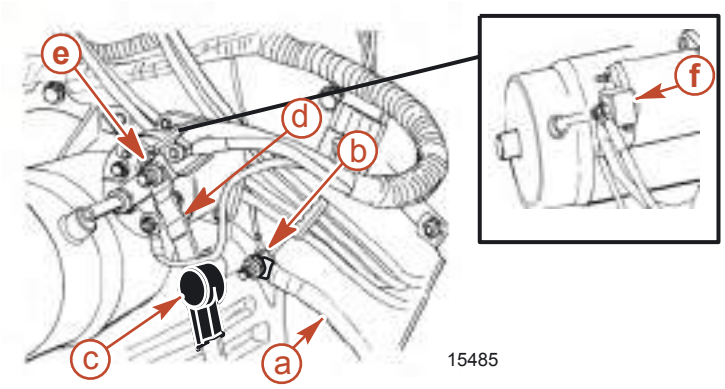
Battery Cable Length Requirements	
Average Cable Length	Cable Gauge
Up to 1.1 m (3-1/2 ft.)	25 mm^2 (4)
1.1–1.8 m (3-1/2–6 ft.)	35 mm^2 (2)
1.8–2.3 m (6–7-1/2 ft.)	50 mm^2 (1)
2.3–2.9 m (7-1/2–9-1/2 ft.)	50 mm^2 (0)
2.9–3.7 m (9-1/2–12 ft.)	70 mm^2 (00)

3.7–4.6 m (12–15 ft.)	95 mm^2 (000)
4.6–5.8 m (15–19 ft.)	120 mm^2 (0000)

- Multiple engine installations (including generator sets) require that a negative cable be run between the engines. The cable must be of sufficient size to carry the highest cranking current that could be encountered. Refer to ABYC Standards.
- On applications with crossover (parallel) cranking motor circuits in multiple engine installations (including generator sets), a separate negative ground cable must be run between the engines (in addition to the cable mentioned above). The cable must be sized to handle the highest load in the cranking circuit. (ABYC Standard)
- Battery cables must be routed above normal bilge water levels throughout their length.
- Battery cables must be routed to avoid contact with metallic fuel system components.
- The positive battery cable must be routed to avoid contact with any portion of the engine or drive train.
- Cables that are exposed to physical damage should be protected by conduit, raceways, tape, etc.
- Cables that pass through bulkheads or other structural members should be protected against chafing with grommets, etc.
- Battery cable terminals must be soldered to cable ends to ensure good electrical contact, using electrical grade (resin flux) solder only. Some form of mechanical connection (i.e. swage, crimp) is also recommended, and is required if length of solder connection is less than 1-1/2 times the diameter of the stranded area of the cable (ABYC standard). See **Multiple EFI Engine Battery Precautions**.

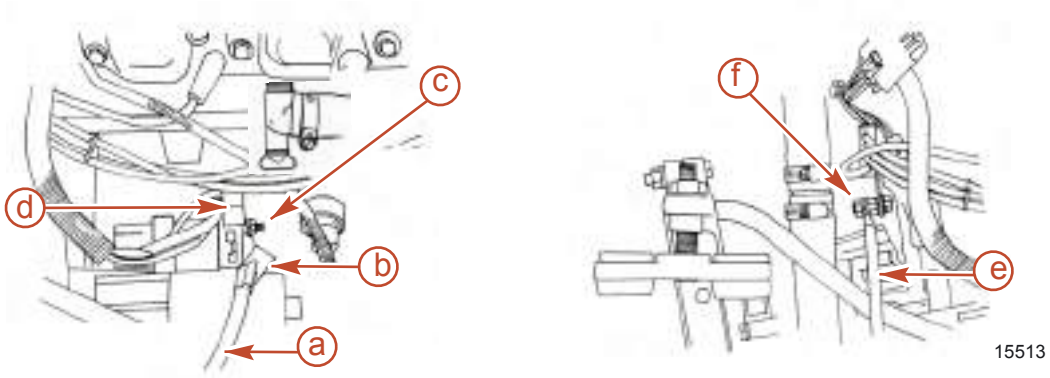
Battery Cable Connections

BATTERY CABLE TO ENGINE CONNECTIONS



Typical inboard battery cable to engine connections

a - Negative (-) battery cable (BLACK)
b - Ground stud (one each side of flywheel housing)
c - Rubber boot (side over positive terminal to prevent accidental shorting)
d - Positive (+) battery cable (RED)
e - B+ starter terminal
f - 90-Amp fuse (DO NOT REMOVE)



Typical tow sports battery cable to engine connections

- **a -** Positive (+) battery cable (RED)
- **b -** Boot (side over positive terminal to prevent accidental shorting)
- **c -** B+ starter terminal
- **d -** 90-amp fuse (DO NOT REMOVE)
- **e -** Negative (-) battery cable (BLACK)
- **f -** Ground stud (one each side of flywheel housing)

- Do not connect negative cable to other than the unpainted locations shown to ensure good electrical contact.

⚠ CAUTION

Failure to properly secure the positive battery cable to the boat could result in damage to the starter solenoid.

- Secure cables to the boat using industry-approved fasteners to prevent stressing the cable and terminals.
- Apply liquid neoprene on the connections at the engine to prevent corrosion.

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

BATTERY CABLE TO BATTERY CONNECTIONS

IMPORTANT: Engine electrical system is negative (–) ground.

1. Connect the engine positive (+) battery cable (usually RED) to the positive (+) battery terminal.
2. Connect the engine negative (–) battery cable (usually BLACK) to the negative (–) battery terminal.
3. Ensure that all battery terminal connections are tight. Then spray the battery terminals with a battery connection sealant to help retard corrosion.

Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminals	Obtain Locally

Electrical Connections

⚠ CAUTION

Avoid damage to the electrical system components caused by improper work or diagnostic practices. Observe the following precautions when working on or around an electrical harness, or when adding electrical accessories:

- **Do not tap electrical accessories into the engine electrical harness.**
- **Do not puncture (probe) wires for testing.**
- **Do not reverse battery leads.**
- **Do not splice wires into the electrical harness.**
- **Do not attempt diagnostics without proper, approved service tools.**

IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on engine and to avoid contact with moving parts.

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

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are engine RPM, coolant temperature, water pressure, battery voltage, fuel consumption, and engine operating hours.

The SmartCraft Instrument package will also aid in Engine Guardian diagnostics. The SmartCraft Instrument package will display critical engine alarm data and potential problems.

Refer to the **Mercury SmartCraft Operator's Supplement** (90-10229023) for the warning functions monitored and basic operation of the SmartCraft Instrument package. Refer to the instructions included with the instruments for installation instructions.

Engine Harness

GENERAL INFORMATION

- Fuel injected MerCruiser engine models are "SmartCraft" ready and may be rigged using the SmartCraft instrumentation, analog instrumentation, or a combination of both.
- The SmartCraft data is carried in the 14-pin system without the use of a special data harness.
- Adapters have been made to adapt a 14-pin connector engine to a 10-pin connector boat and from a 14-pin boat to a 10-pin engine.
- If an adapter is used the accessory current through the boat harness is limited to 15 amps even if the boat has a 10-pin harness that in the past has been capable of handling larger accessory loads.
- SmartCraft data is not supported across the adapters so a separate CAN line will be needed on a boat using SmartCraft instrumentation and an adapter harness.

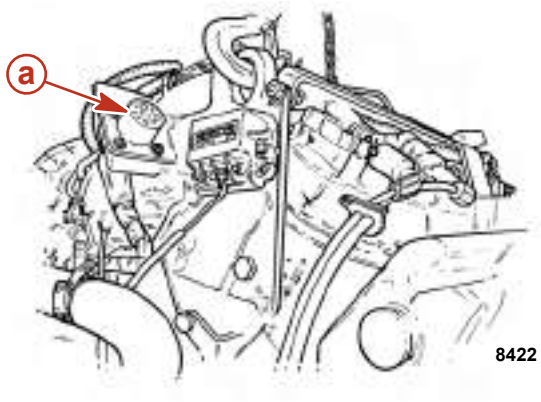
ENGINE HARNESS INSTALLATION

⚠ CAUTION

Avoid fire hazard. The accessory wire on the 14-pin engine wiring harness cannot exceed 15 amp current draw. An optional kit must be used for accessory power or switched power.

IMPORTANT: The accessory wire in the 14-pin harness will not support amperage in excess of 15-amps. For protection, the main power relay fuse may blow if an excess of 15-amps is applied. Refer to the Mercury Precision Parts Accessories Guide for an optional accessory power relay kit that will accommodate higher amperage draw.

1. **Route the instrumentation wiring harness back to the engine, making sure that the harness does not rub or get pinched. If an extension harness is required, be sure to secure the connection properly.**
2. **Fasten the harnesses to the boat at least every 45.7 cm (18 in.) , using appropriate fasteners.**
3. **Models with a 10-pin harness or SmartCraft Harness: Place the hose clamp over the instrumentation wiring harness.**
4. **Connect the instrumentation wiring harness to the engine harness plug. Secure the connection with the hose clamp.**

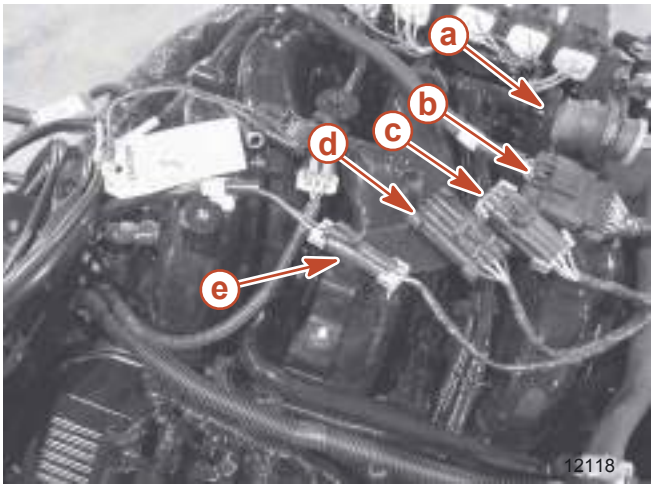


Typical 10-pin harness

a - Engine harness plug

5. **Tighten the hose clamp to secure the wiring harness to the engine harness plug.**
6. **Models with a 14-pin Harness: Connect the instrumentation wiring harness to the engine harness plug.**
   a. **Connect the depth transducer connector to the DLC/Depth transducer connector on the engine harness.**
   b. **Connect the paddle wheel/tank level connector.**

c. Connect the power harness (Clean Power with 5-amp fuse) connector (DTS only).

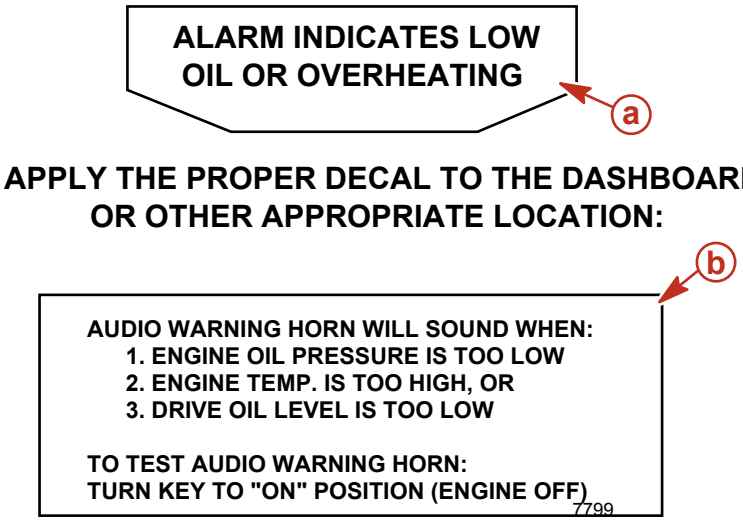


Typical 14-pin DTS harness

a - Engine harness connector
b - Transmission harness connector
c - Paddle wheel/tank level connector
d - DLc/depth transducer connector
e - Power harness connector/clean power with 5-amp fuse (DTS only)

Audio Warning System

1. Place the large decal on the instrument panel or other appropriate location where easily viewed by the operator.



a - Small decal (transparent)
b - Larger decal

2. Test audio warning system during Pre-delivery Preparation section.

Multiple EFI Engine Battery Precautions

Situation

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself. The engine will now run normally. This ECM shut down usually happens so fast that the engine just appears to have an ignition miss.

Recommendations

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's electronic control module (ECM) has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is running off its own battery. DO NOT operate engines with switches in **BOTH** or **ALL** position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

NOTE: *Sure Power Industries Inc., Model 32023A meets this design specification.*

1. The boat may have 2 engines connected to a single Model 32023A battery isolator.
2. The Model 32023A battery isolator is connected to 2 banks of batteries.
3. Each bank contains 2 batteries with the cranking battery for 1 engine in each bank.
4. The second battery in each bank is connected in parallel to the cranking battery.
5. The Model 32023A battery isolator is designed for this type of use; 2 battery banks, 2 charging sources, 120 amps (maximum alternator output).
6. When the engines are running, either engine's alternator could be charging either bank of batteries through the Model 32023A battery isolator.

Any other manufacturer's battery isolator that is the same type as the Sure Power Inc., Model 32023A could also be used.

Generators: The generator's battery should be considered another engine's battery.

Battery Switch

⚠ WARNING

When designing and installing the electrical system, adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) for the market in which the boat will be sold.

A battery switch may be desirable to allow the power to be turned off when the boat is not in use and to allow switching between batteries in multiple battery applications. Certain industry standard and regulations require the use of a battery switch and should be consulted for requirements.

- The intermittent rating of the switch shall not be less than the maximum cranking current of the largest engine cranking motor that it serves.
- The minimum continuous rating of the switch shall be the total of the ampacities of the main overcurrent protection devices connected to the battery switch or the ampacity of the feeder cable to the switch, whichever is less (ABYC Standard).

- Connect the battery switch into the positive (+) battery cable as close to battery as possible.
- The switch should be located in a readily accessible location for use in an emergency.
- The switch should never be turned off while the engine is running to avoid damage to the alternator. Switching between batteries should also be avoided while the engine is running (unless the switch has been specially designed for this purpose).
- The switch should not be used to connect multiple engines to one battery (or battery bank). See **Multiple EFI Engine Battery Precautions**.

Battery Isolator

⚠ WARNING

When designing and installing the electrical system, adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) for the market in which the boat will be sold.

A battery isolator can be installed to allow the charging of an auxiliary battery for use in operating accessories. The battery isolator will allow the alternator to charge both the cranking battery and auxiliary battery at the same time, while preventing accessories connected to the auxiliary battery from discharging the cranking battery. The alternators used on Mercury MerCruiser products are equipped with a special external sensing circuit to ensure optimum charging performance in these types of applications (by compensating for the voltage drop across the isolator).

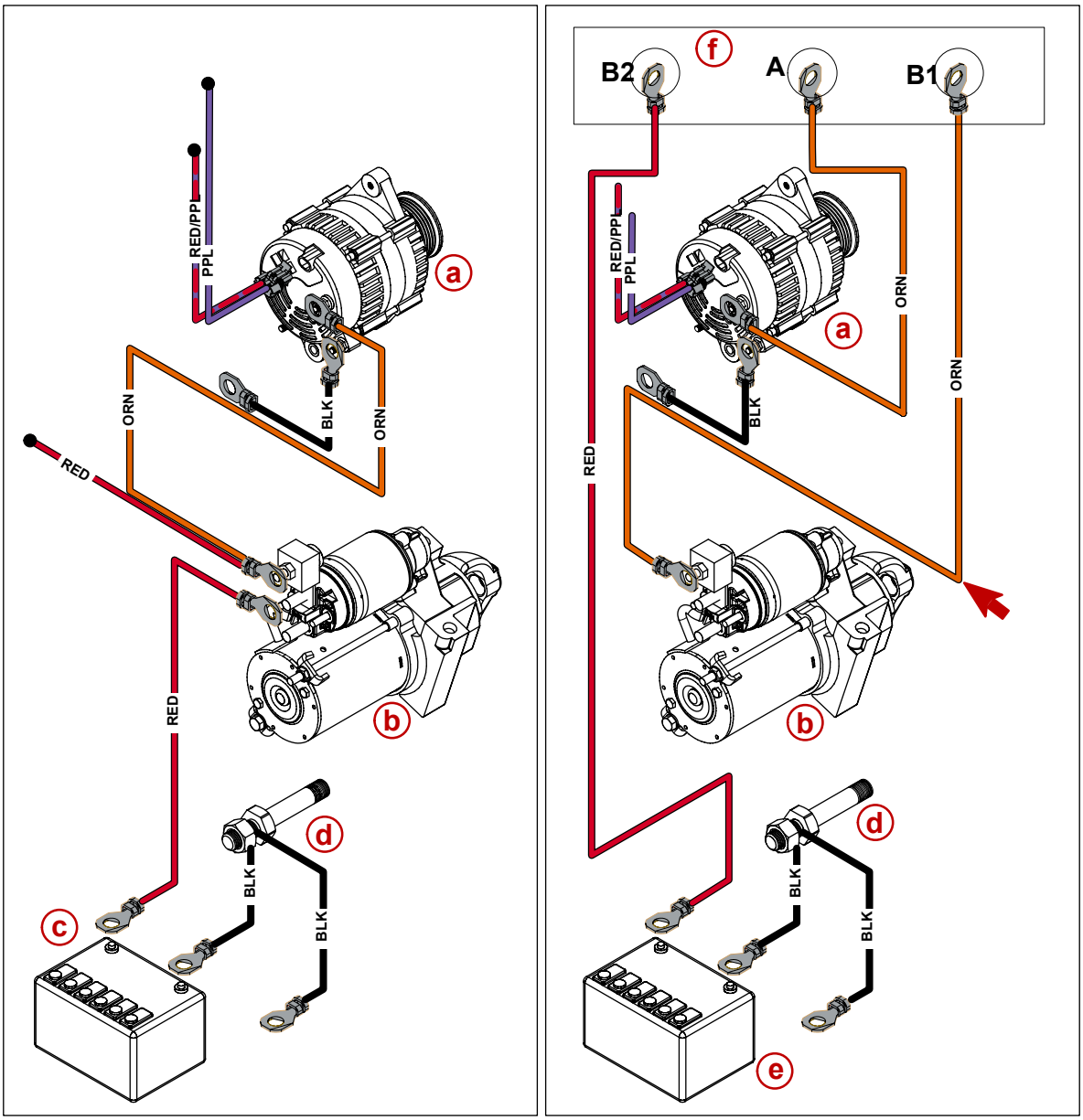
A special isolator is required for multiple engine installations where the cranking batteries are to be charged from a common source. See **Multiple EFI Engine Battery Precautions**.

The manufacturer's instructions should be carefully followed when making the installation.

⚠ CAUTION

Mercury MerCruiser cannot be responsible for problems resulting from installation of the isolator. The installer and the isolator manufacturer must ensure that the installation and any modifications to the Mercury MerCruiser product comply with all applicable standards and regulations, including (but not limited to) wire size, type, routing, terminals, and overcurrent protection.

Battery Isolator Diagram



a - Alternator
b - Starter
c - Cranking battery
d - Ground stud
e - Auxiliary battery
f - Isolator

⚠ CAUTION

Avoid wiring damage. Do not cut the orange wire flush with the wiring loom. Doing so will damage other wires in the loom.

1. Disconnect the orange wire from the alternator battery terminal. Splice sufficient gauge wire to the orange wire and connect as shown.
2. The splice wire must be a minimum of 8 AWG.
3. Insulate and seal the end of the wire with liquid neoprene and heat shrink tubing.

Notes:

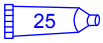
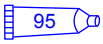
Instrumentation and Controls

Section 9A - Instrumentation and Controls

Table of Contents

9A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical connections	92-25711-3
		Electrical connections	
 95	2-4-C with Teflon	Cable guides and pivot points	92-802859A1

Instrumentation

Requirements and Recommendations

IMPORTANT: This section includes information on Quicksilver's standard (non-digital) instrumentation and mechanical (cable-actuated) remote controls. Refer to the Smart Craft applications manual for information on Mercury's new digital instrumentation and remote controls.

Mercury MerCruiser inboard and tow sports engines, designed to comply with the ABYC Standards, use the four basic gauges shown below:

- Tachometer
- Oil pressure
- Water temperature
- Voltmeter (battery charge indicator)

An extensive array of Quicksilver gauges, instrumentation harnesses, extension harnesses, and related accessories are available through Mercury Precision Parts to satisfy your instrumentation needs. We recommend the use of Quicksilver instrumentation because they are specifically designed for compatibility with our engines, and engineered to the same high quality and performance standards. Refer to the **Mercury Precision Parts Accessories Guide** for a complete list. Wiring diagrams of some of the basic instrumentation configurations are provided at the end of this section.

Important Installation Information

Instrumentation should be installed in accordance with the instructions that accompany them.

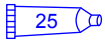
⚠ WARNING

When designing and installing the instrumentation, you must adhere to the applicable boating industry standards and regulations (NMMA, ABYC, SAE, USCG, EUs, RCD, ISO, etc.) for the markets where the boat will be sold.

- Ensure that harnesses are routed to avoid getting pinched or chafed.
- Avoid routing the harness in an area where it could be damaged or short circuited later in the assembly process, such as when a screw is inserted or a hole is drilled.

IMPORTANT: Harness receptacles can be damaged by overtightening clamps.

- The cannon plug connection on the extension harness (at engine and dash) must be secured with a hose clamp to avoid a loose connection or water entry.
- Support harness every 46 cm (18 in.) using industry approved fasteners. (ABYC Standard)
- Coat exposed connections on gauges with liquid neoprene to avoid corrosion.

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

Accessory Connections

⚠ CAUTION

If Quicksilver wiring harness is used and a fused accessory panel is to be installed (40-amp current draw maximum), be sure to connect it as shown in the wiring diagrams. Do not connect accessory panel at any other location as wires in wiring harness may not be of sufficient size to handle current load.

⚠ CAUTION

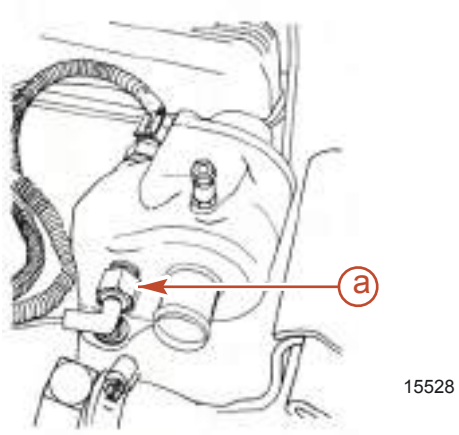
Avoid fire hazard. The accessory wire on the 14-pin engine wiring harness cannot exceed 15 amp current draw. An optional kit must be used for accessory power or switched power.

IMPORTANT: The accessory wire in the 14-pin harness will not support amperage in excess of 15-amps. For protection, the main power relay fuse may blow if an excess of 15-amps is applied. Refer to the Mercury Precision Parts Accessories Guide for an optional accessory power relay kit that will accommodate higher amperage draw.

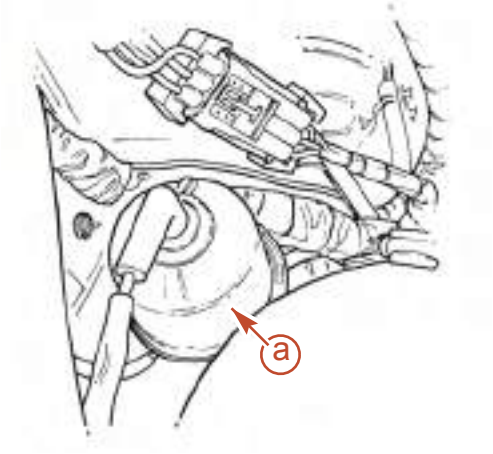
A fused accessory panel with up to a 40-amp current draw can be connected to the helm harness. On dual station applications, the combined current draw for both stations must not exceed 40 amps. If optional accessory power relay kits are installed, the combined current draw for both stations must not exceed 40 amps per kit. Each helm harness may support up to two accessory power relay kits. The boat manufacturer is responsible for ensuring that the accessory connections are made in accordance with the industry standards and regulations. See information under **Industry Standards and Regulations**.

Dual Station Instrumentation

Instrumentation and harnesses are available through Mercury Precision Parts and Accessories to accommodate dual station (helm) applications (see wiring diagram for typical installation). When oil pressure and water temperature gauges are used at both stations, dual station oil pressure and temperature senders must be installed on the engine to obtain the proper gauge readings. Refer to the**Mercury Precision Parts and Accessories Guide** for part numbers.



a - Typical coolant temperature sender



a - Typical oil pressure sender

Audio Warning System

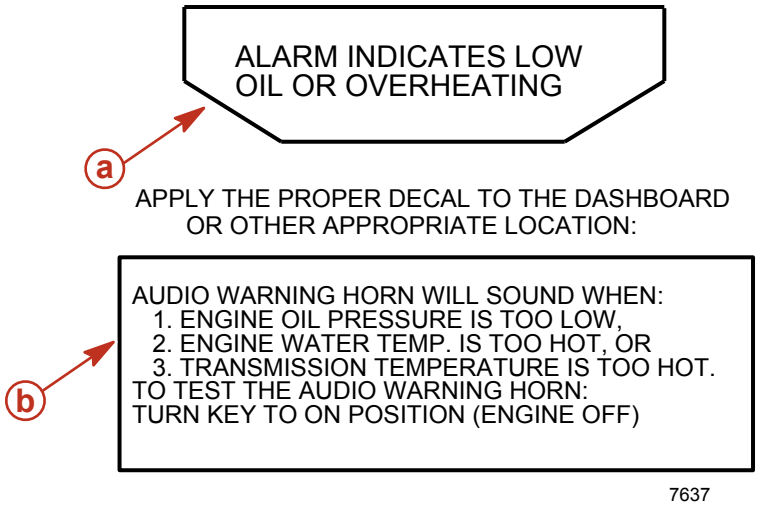
All models are equipped with an audio warning system as standard equipment to alert the operator of insufficient engine oil pressure, excessive engine temperature, or a low drive unit lubricant condition. The following items are particularly noteworthy for proper installation of the system:

⚠ WARNING

Fire or explosion hazard. The horn is not external ignition-proof, therefore, do not mount the horn in the engine or fuel tank compartments.

- Select mounting location where alarm is out of the elements, yet can be readily heard.
- Alarm should be within 46 cm (18 in.) of instrumentation to allow connection to switched side of ignition switch.
- Coat electrical connections with Liquid Neoprene to avoid corrosion.
- Small transparent decals (2) provided should be installed on engine water temperature gauge and oil pressure gauge.
- Place large decal on the dash within easy view of the operator.

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



a - Small decal (transparent) **b -** Large decal

Engine Guardian

IMPORTANT: The operator should be made aware that boat speed could be reduced to idle and may not respond to throttle should Engine Guardian be called on to protect the engine. This is covered in the Operation, Maintenance, and Warranty manual.

Mercury MerCruiser MPI models are equipped with an Engine Guardian to provide additional protection against engine damage. The system is designed to help reduce the potential for engine damage by reducing engine power when a potential problem is sensed. Engine Guardian monitors:

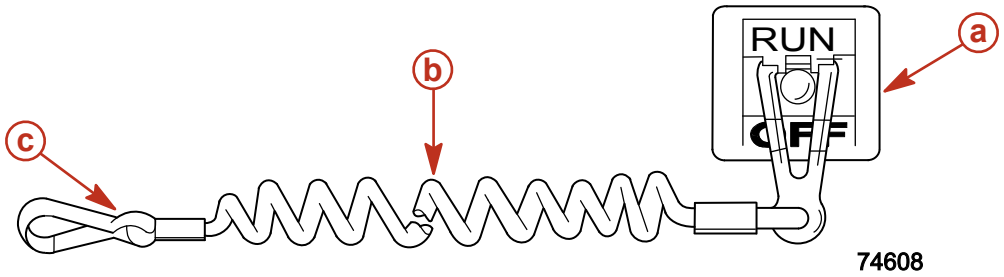
- Oil pressure
- Coolant temperature
- Seawater pressure
- Exhaust manifold temperature (8.1S models)
- Engine overspeed

For example, if the seawater pump inlet becomes partially blocked, Engine Guardian will reduce the available power level of the engine to help prevent damage from decreased water flow to the engine. If the debris passes through and full water flow is restored, engine power levels are restored to normal. In other words, Engine Guardian is a looped feedback or smart system. Likewise, the system will reduce RPM if insufficient oil pressure or excessive coolant temperature is experienced. Digital electronics allow the system to monitor the oil pressure versus engine RPM to more quickly alert the operator of an abnormal condition.

Lanyard Stop Switch Information

⚠ WARNING

Avoid abrupt deceleration of the boat from lanyard stop switch activation. Boat damage and personal injury or death could occur. Never leave the operator's station with the engine operating and in gear.



a - Stop switch
b - Lanyard
c - Clips to operator

The purpose of a lanyard stop switch is to turn off the engine when the operator moves outside the operator's position (as in accidental ejection from the operator's position).

Accidental ejections, such as falling overboard, are more likely to occur in:

- low sided sport boats.
- bass boats.
- high-performance boats.

Accidental ejections can also occur from:

- following poor operating practices.
- sitting on the seat or gunwale at planing speeds.
- standing at planing speeds.
- operating the boat at planing speeds in shallow or obstacle infested waters.
- releasing your grip on the steering wheel while it is pulling in one direction.
- consuming alcohol or drugs.
- maneuvering the boat at high speeds.

Some remote control units are equipped with a lanyard stop switch. If your remote control is not equipped with a lanyard stop switch, one can be installed on the dashboard or side adjacent to the operator's position. The lanyard is a cord usually 1.2–1.5 m (4–5 ft.) long when stretched out with an element on one end made to be inserted into the switch and a snap on the other end for attaching to the operator. The lanyard is coiled to make it as short as possible to minimize the likelihood of entanglement with nearby objects. It stretches to minimize the likelihood of accidental activation should the operator choose to move around in an area close to the normal operator's position. If it is desired to have a shorter lanyard, wrap the lanyard around the operator's wrist or leg or tie a knot in the lanyard.

While activation of the lanyard stop switch will stop the engine immediately, the boat will continue to coast for some distance depending upon the velocity and degree of any turn at shut-down. However, the boat will not complete a full circle. While the boat is coasting, it can cause injury to anyone in the boat's path as seriously as the boat would when under power.

We strongly recommend that other occupants be instructed on proper starting and operating procedures should they be required to operate the engine in an emergency (e.g. if the operator is ejected).

⚠ WARNING

Avoid contact with the boat hull and propeller from accidental ejection. Personal injury or death could occur. Always properly connect both ends of the lanyard stop switch.

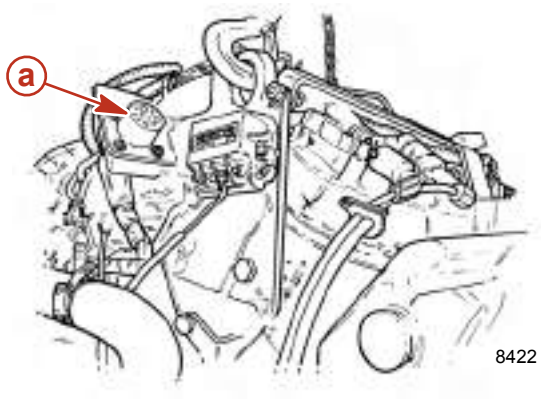
Accidental or unintended activation of the switch during normal operation is also a possibility. This could cause any, or all, of the following potentially hazardous situations:

- Occupants could be thrown forward due to unexpected loss of forward motion, a particular concern for passengers in the front of the boat who could be ejected over the bow and possibly struck by the gear case or propeller.
- Loss of power and directional control in heavy seas, strong current, or high winds.
- Loss of control when docking.

Instrumentation Harness Receptacle

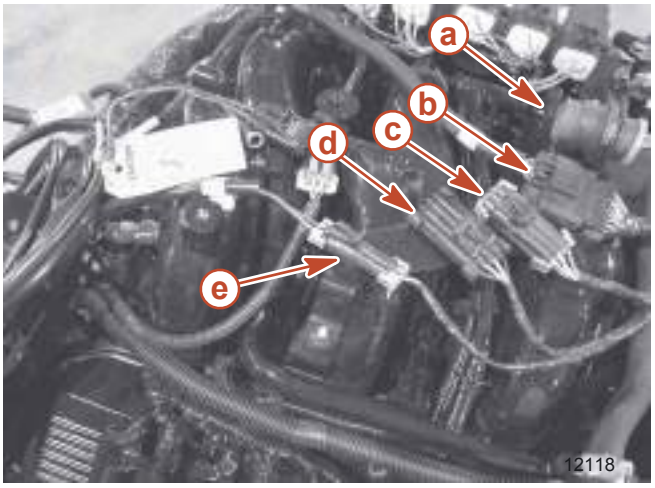
A receptacle is provided on the engine for connecting Quicksilver cannon plug style instrumentation harnesses. The receptacle location varies from model to model and is called out on the power package installation drawings to assist in determining the required instrumentation harness length and routing. Be sure the connector is fully engaged into the receptacle when making a connection. The harness connection must be secured with a hose clamp to prevent loosening and moisture entry. DO NOT overtighten as a short in the harness receptacle may result.

IMPORTANT: Loose or corroded harness connectors are a common source for engine malfunctions.



Typical round 10-pin harness

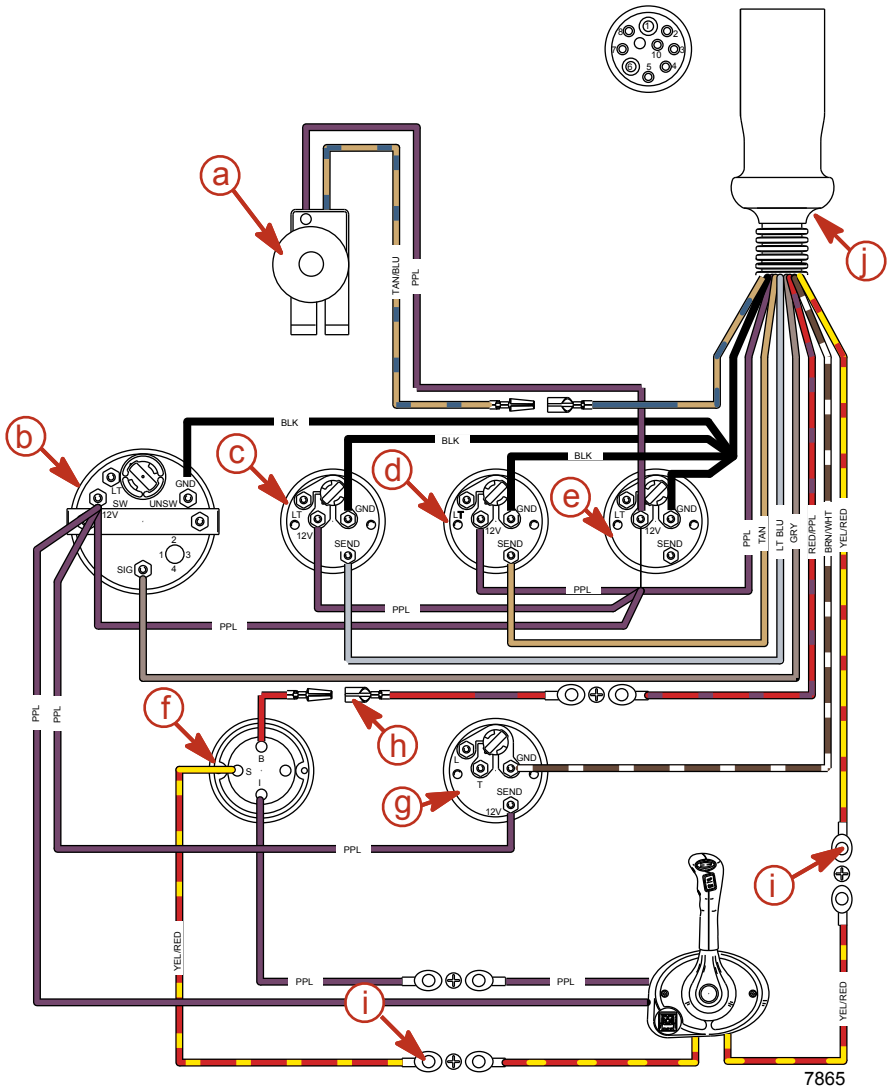
a - Engine harness connector



Typical 14-pin DTS harness

a - Engine harness connector
b - Transmission harness connector
c - Paddle wheel/tank level connector
d - DLC/depth transducer connector
e - Power harness connector/clean power with 5-amp fuse (DTS only)

10-Pin Instrument Harness

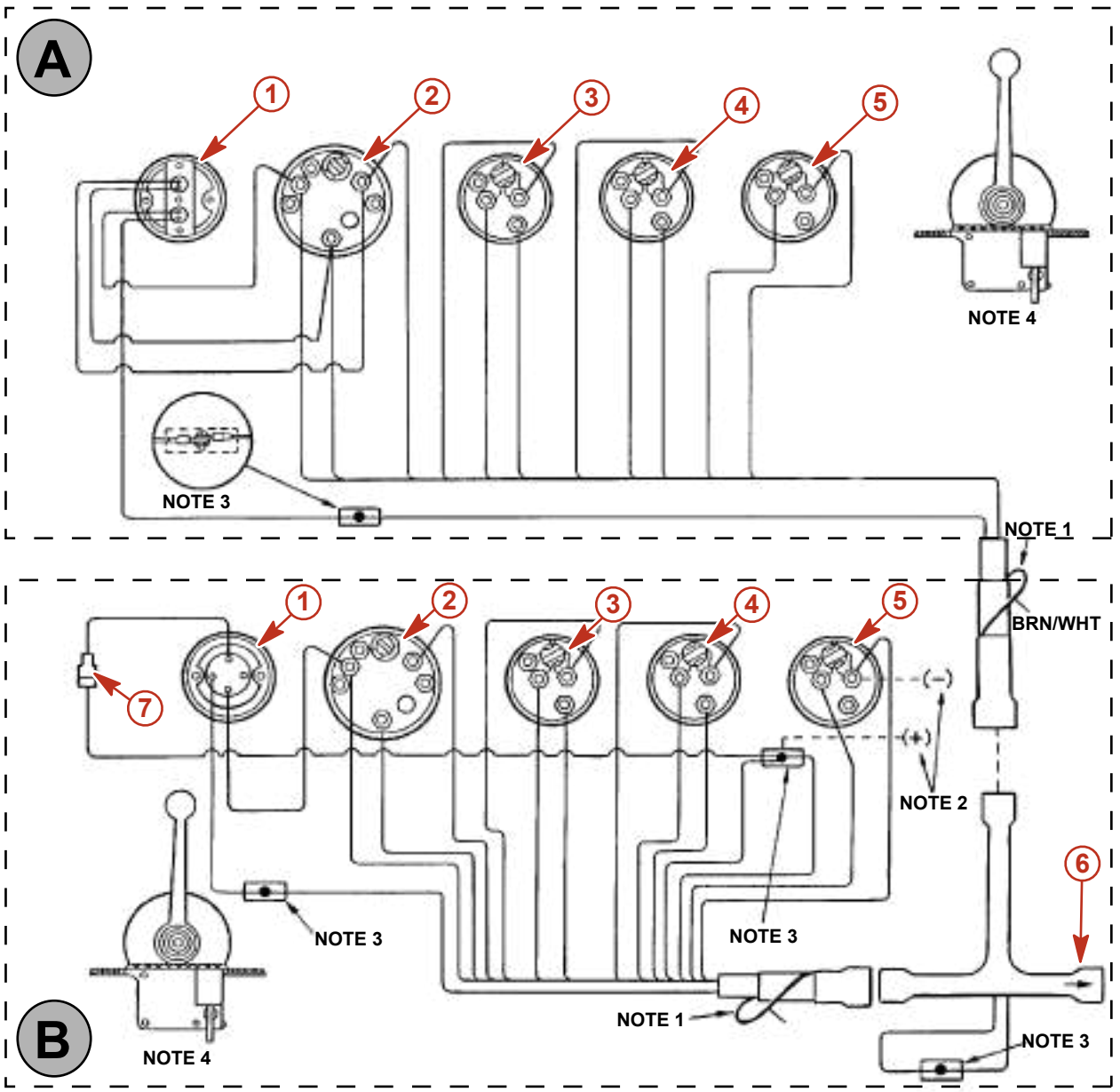


a - Audio warning buzzer
b - Tachometer
c - Oil pressure
d - Water temperature
e - Battery meter
f - Ignition switch
g - Trim indicator (Sterndrive only)
h - See **Note 1** and **Note 2**
i - See **Note 3**
j - To engine wiring harness

Refer to gauge manufacturer's instructions for specific connections.

- **Note 1:** Connect wires together with screw and hex nut; apply liquid neoprene to connection and slide rubber sleeve over connection.
- **Note 2:** Power for a fused accessory panel may be taken from this connection. load must not exceed 40 amps. panel ground wire must be connected to instrument terminal that has an 8-gauge black (ground) harness wire connected to it.
- **Note 3:** Lanyard stop switch lead and neutral safety switch leads must be soldered and covered with shrink tube for a water proof connection. if an alternate method of connection is made, verify connection is secure and sealed for a water proof connection.

10-Pin Instrument Harness Dual Station



A - Primary Station

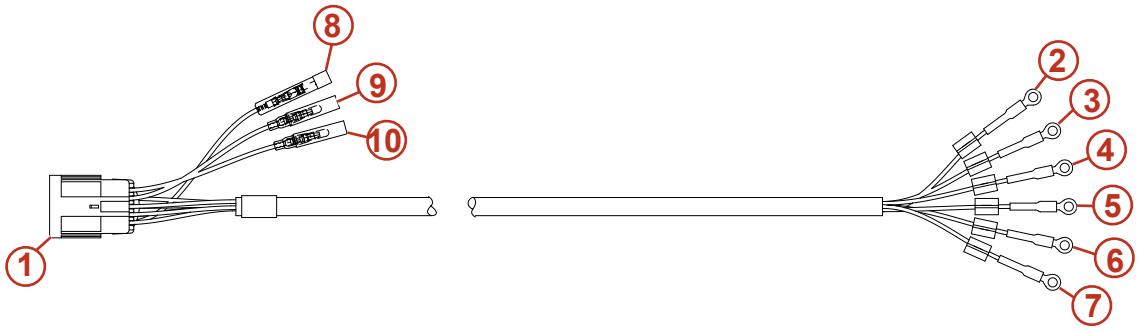
1 - Start/stop panel
2 - Tachometer
3 - Oil pressure
4 - Water temperature
5 - Battery meter

B - Secondary Station

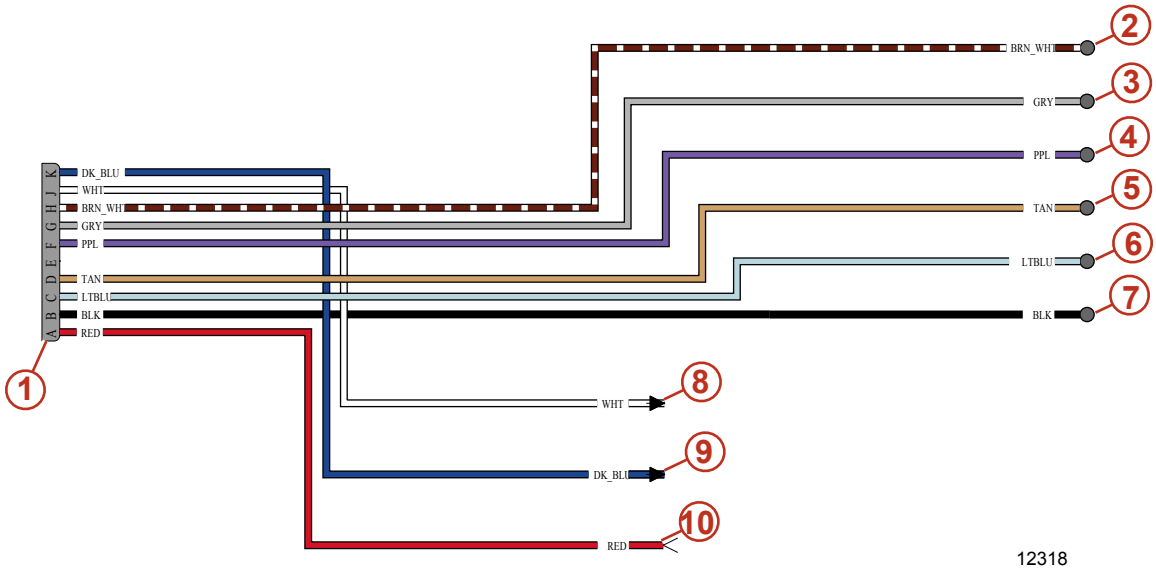
1 - Ignition switch
2 - Tachometer
3 - Oil pressure
4 - Water temperature
5 - Battery meter
6 - To engine
7 - 20-ampere fuse

- **Note 1:** The BROWN/WHITE wire is taped back at the instrument end. If installing on a Mercury MerCruiser inboard, the BROWN/WHITE wire is taped back at the engine end, or it may be used for an accessory limited to 5 amperes. Power must be taken from accessory panel connection. See **Note 2**.
- **Note 2:** An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **must not** exceed 40 amperes.
- **Note 3:** Connect the wires together using a screw, nut and sleeve. Apply liquid neoprene to the connection to prevent corrosion.
- **Note 4:** Neutral start safety switch in the remote control is not used. The switch is located on the transmission on inboard and ski models.

14-Pin Instrument Harness



1 - Connector to boat harness
2 - Trim (Sterndrive only)
3 - Tach
4 - Key on (+)
5 - Temp
6 - Oil
7 - Ground (–)
8 - Can (+) or spare
9 - Can (–) or spare
10 - 12V (+)



1 - Connector to boat harness
2 - Trim (Sterndrive only)
3 - Tach
4 - Key on (+)
5 - Temp
6 - Oil
7 - Ground (–)
8 - Can (+) or spare
9 - Can (–) or spare
10 - 12V (+)

Remote Control and Cables

Requirements and Recommendations

We recommend using Quicksilver remote controls, which have been specifically designed for compatibility with our engines, and to the same high quality and performance standards. An extensive array of Quicksilver remote controls and cables are available through the **Mercury Precision Parts Accessories Guide.**

A single lever control (shift and throttle function in same lever) or a two-lever control (separate shift and throttle levers) can be used on single station applications. Two-lever controls are required on dual station (helm) applications.

- Remote control must provide a cable travel (at engine end).

Remote Control Cable Travel	
Function	**Travel [with 6.8-9 kg (15-20 lb.) load applied]**
Shift	70– 80 mm (2-3/4–3-1/8 in.)
Throttle	70–80 mm (2-3/4–3-1/8 in.)

- The remote control must be set up to retract the shift cable when going into FORWARD gear on Velvet Drive 71C and 72C in-line transmissions. On Velvet Drive 5000 and all Hurth transmissions, shift cable actuation must be set up to achieve the desired propeller rotation. See information in **Section 2 - Transmission and Drive Line.**

⚠ CAUTION

Transmission failure may occur. Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.

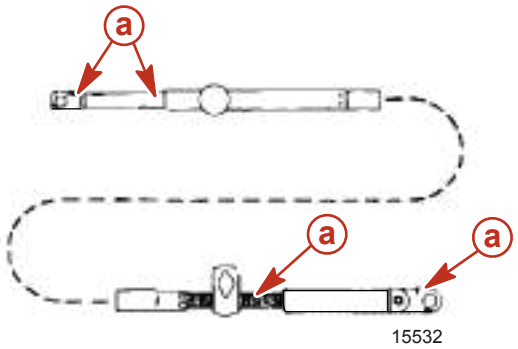
- The remote control must be set up to fully extend the throttle cable for idle.

- A neutral start safety switch is included in the transmission. The switch in the remote control should not be used.

Installation

Install the remote and cables in accordance with the instructions which accompany them and the instructions in the power package installation manual. To ensure minimal shift and throttle effort, be sure to observe the following important information:

- Do not fasten the cables to the boat or any other objects within 92 cm (3 ft.) of the remote control and engine attaching points.
- Keep bends to a minimum.
- Route cables so that they do not have less than an 20 cm (8 in.) radius at all bends.
- Ensure that the cables are not kinked or pinched.
- Lubricate the cable guides and pivot points with 2-4-C Marine Lubricant or motor oil.



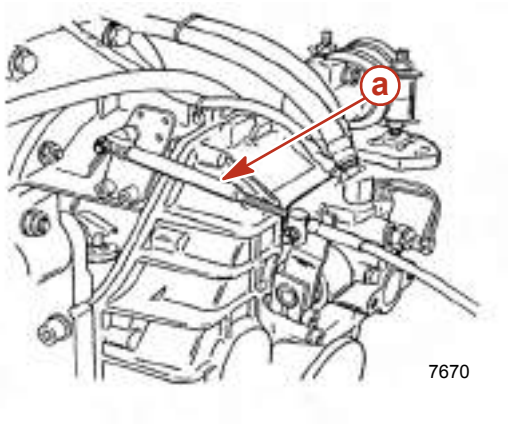
a - Points to lubricate

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Cable guides and pivot points	92-802859A1

- Tighten cable attaching nuts until they contact, then loosen 1/2 turn (until the washer under the nut can be turned with your fingers). The attaching points must be free to pivot.

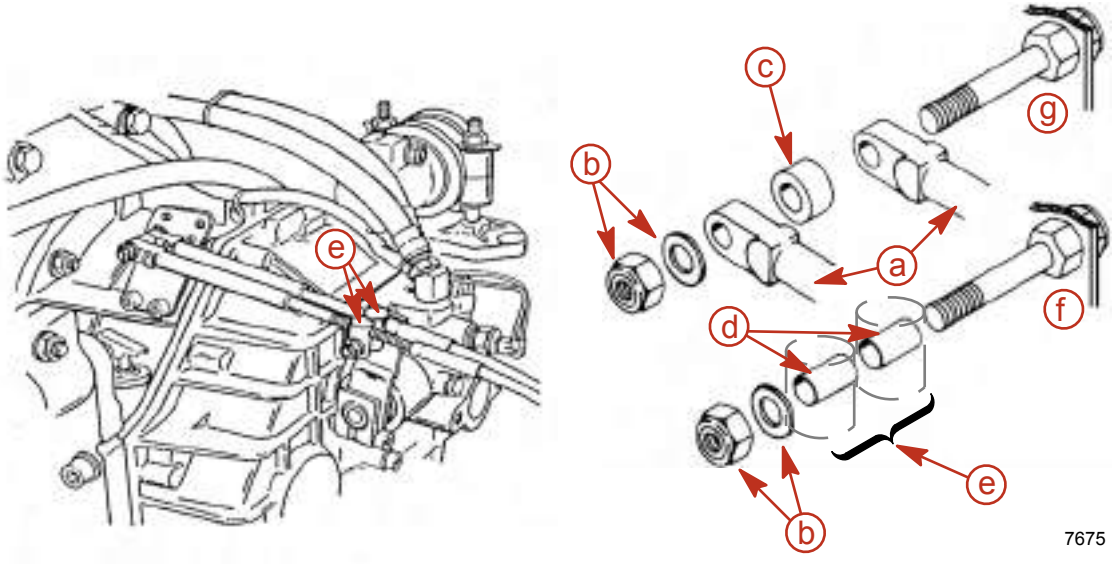
Dual Station (Helm) Cable Setup

The remote control cables can be connected in series or parallel. When connected in series, the remote control cables from the secondary station are connected to the remote control at the primary station. The primary station cables are then connected to the engine, using the single cable attachment procedure. On some applications, it may be preferable to connect both sets of cable directly to the engine, using a parallel connection. Mercury MerCruiser inboard engines come equipped with the necessary hardware for making either type of connection.



Typical series cable installation

a - Shift cable



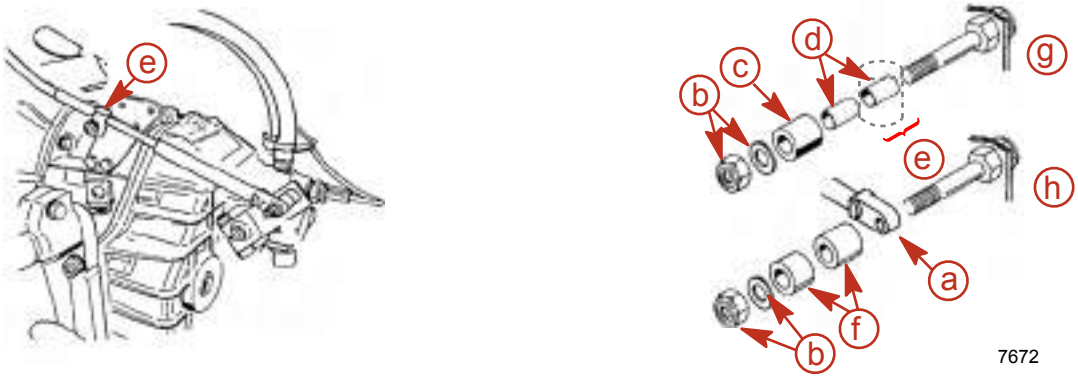
Typical parallel cable installation

a - Cable end guide
b - Locknut and washer
c - Spacer (fits over bushings)
d - Bushing
e - Cable barrel location

Cable Attachment Hardware

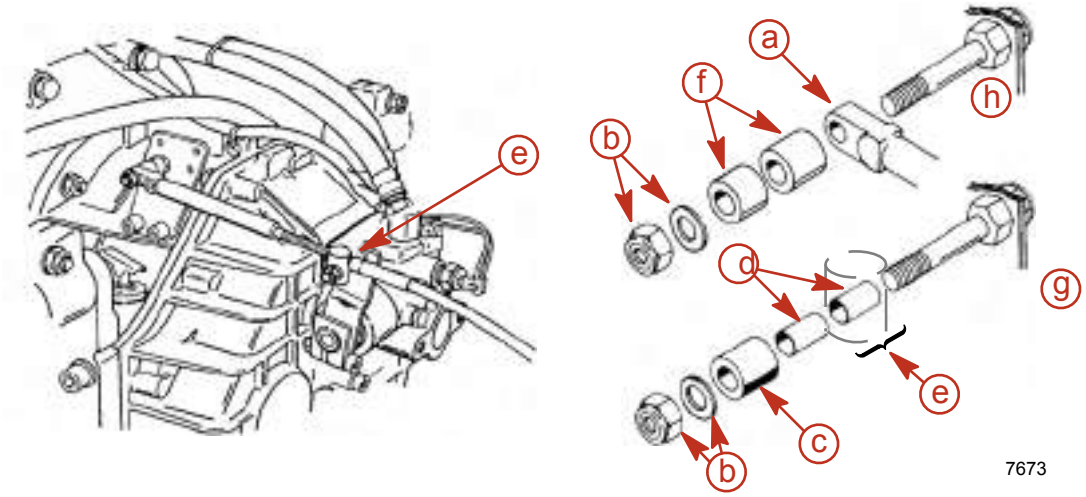
INBOARD MODELS

Inboard models can accommodate forward or aft shift cable entry and single or dual cable attachment. Hardware must be installed as shown.



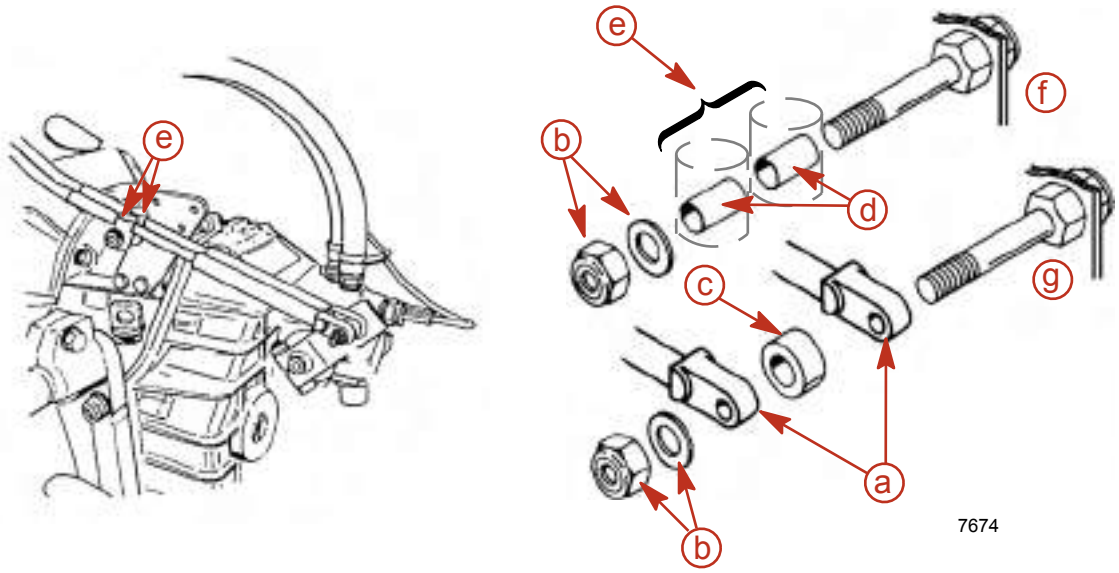
Typical single cable: forward entry

- **a -** Cable end guide
- **b -** Locknut and washer
- **c -** Spacer (fits over bushings)
- **d -** Bushings
- **e -** Cable barrel location
- **f -** Spacer (fits over stud)
- **g -** Cable barrel stud
- **h -** Cable end guide stud



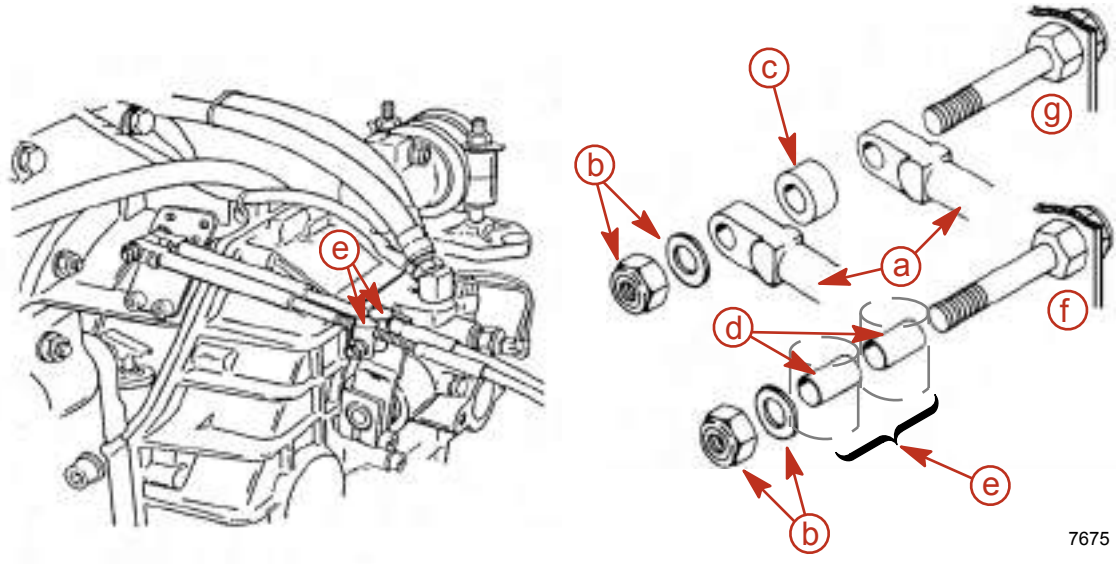
Typical single cable: rear entry

- **a -** Cable end guide
- **b -** Locknut and washer
- **c -** Spacer (fits over bushings)
- **d -** Bushings
- **e -** Cable barrel location
- **f -** Spacers (fits over stud)
- **g -** Cable barrel stud
- **h -** Cable end guide stud



Typical dual cable: forward entry

a - Cable end guides
b - Locknut and washer
c - Spacer (fits over stud)
d - Bushings
e - Cable barrel locations
f - Cable barrel stud
g - Cable end guide stud

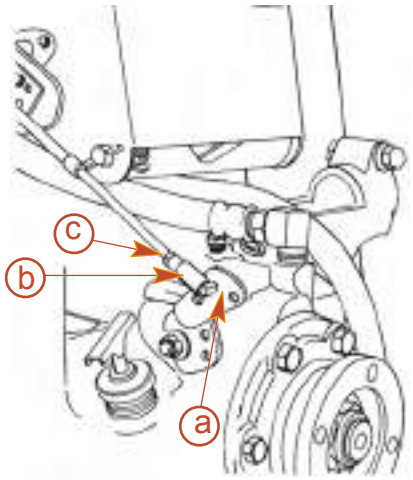


Typical dual cable: rear entry

a - Cable end guides
b - Locknut and washer
c - Spacer (fits over stud)
d - Bushings
e - Cable barrel locations
f - Cable barrel stud
g - Cable end guide stud

TOW SPORTS MODELS

Tow sports models accommodate single cable forward entry only. Attaching hardware is provided for a Morse cable.



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a - Throttle lever stud
b - Cable end
c - Locknut

Cable Adjustment

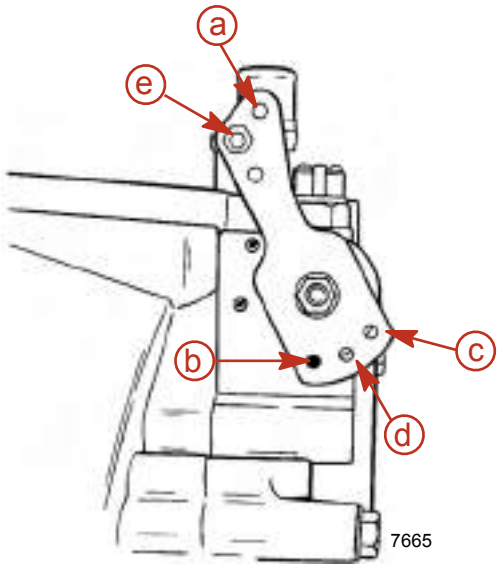
⚠ CAUTION

Transmission failure may occur. Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.

The shift and throttle cable must be installed and adjusted exactly as stated in the installation instructions to achieve proper operation and avoid transmission problems. The following items are of particular importance.

- The throttle cable must be adjusted to fully close the engine throttle plates when the remote control is in the neutral, idle position. Failure to do this will result in a high idle, erratic idle, or both.
- Transmission shift lever must be positioned fully in the FORWARD, NEUTRAL and REVERSE selector positions (see **Section 2 -- Propeller Rotation**).

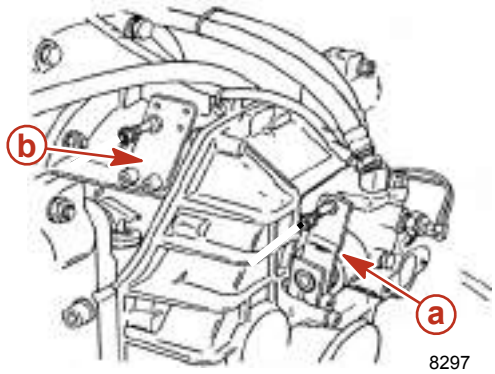
- On Velvet Drive models, the shift lever must be in the designated detent position for each gear.



Velvet Drive 5000 series (8 degree down angle shown, V-drive similar)

a - Transmission shift lever
b - Poppet ball must be centered in this detent hole when left-hand propeller shaft rotation is desired
c - Poppet ball must be centered in this detent hole when right-hand propeller shaft rotation is desired
d - Poppet ball must be centered in this detent hole for neutral position
e - Install shift lever stud in this hole when using quicksilver shift cables

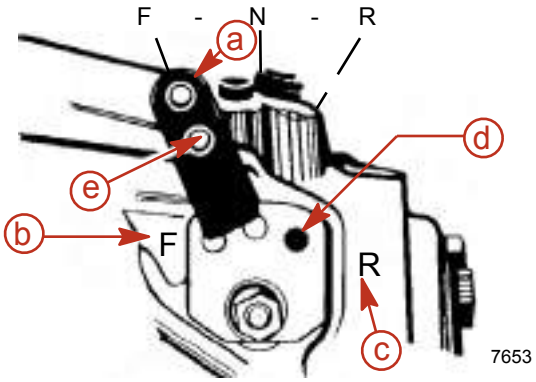
- On ZF Marine (Hurth) transmissions, the shift lever must be against the stops for forward and reverse, and in the centered detent position for neutral.



Typical ZF Marine (Hurth) transmission shown

a - Shift lever
b - Shift cable bracket

- Velvet Drive In-line 71C and 72C transmissions must be operated with the shift lever in the FORWARD gear selector position when propelling the boat forward. Damage to transmission will result if it is operated in REVERSE (with the wrong rotation propeller) under full power.



Velvet Drive 71C and 72C Transmission

a - Transmission shift lever

b - Shift lever must be over this letter when propelling boat FORWARD

c - Shift lever must be over this letter when propelling boat in REVERSE

d - Poppet ball must be centered in detent hole for each F-N-R position (FORWARD gear shown)

e - Install shift lever stud in this hole, to center poppet ball in FORWARD and REVERSE detent holes

Notes:

Predelivery Preparation

Section 10A - Predelivery Preparation

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10 A

Predelivery Inspection

It is the boat manufacturer's responsibility to perform the checks called out on the checklist included in the literature packet with each engine (see the copy at the end of this section) to verify that the power package has been properly installed and is performing correctly. Each check on the list should be checked-off to indicate to the dealer and customer that it has been completed. Some of the checks may require that you consult the installation manual or the Operation, Maintenance, and Warranty manual for specific information or procedures.

⚠ CAUTION

Avoid engine overheating. If engine is to be tested on land, water must be supplied to the seawater pickup pump. Do NOT operate the engine above 1500 rpm.

If for some reason it is not possible to perform some of the checks at your facility (i.e. performance checks), arrangements should be made with the dealer to ensure that these checks are completed before delivering the boat to the customer. Financial compensation to the dealer for performing these checks is left up to the discretion of the boat manufacturer.

Once the checks are completed, the power package must be prepared for shipment.

Operating Engine With the Boat out of the Water

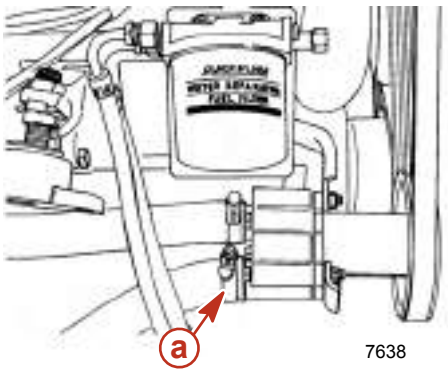
⚠ WARNING

Avoid Injury: If engine is to be tested with the boat out of the water, the propeller must be removed to avoid injury.

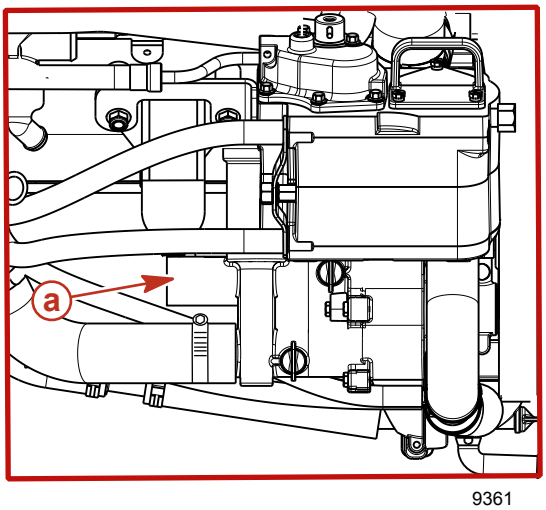
⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

1. Disconnect the water inlet hose for the seawater pickup pump. Connect the water hose using appropriate hardware.



Typical composite seawater pump



Typical brass seawater pump

a - Seawater inlet hose

⚠ CAUTION

Avoid engine damage on boats with water lift mufflers. Engine must be started immediately once water hose is turned on. Exhaust flow is required to purge water from muffler(s). Failure to run engine will cause muffler to be filled with water, which could potentially backup to the engine.

2. Partially open the water tap (approximately 1/2 capacity). DO NOT exceed 276 kPa (40 psi).

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1500 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose causing the engine to overheat.

3. Place the remote control in NEUTRAL, idle speed position and start the engine.
4. Operate the engine in NEUTRAL (out of gear) between 1200–1400 RPM.
5. Closely monitor water temperature gauge to ensure that engine does not overheat.

Propeller Selection

NOTE: *A book called* ***Everything You Need to Know About Propellers*** *(90-86144--92) is available from Mercury Precision Parts and Accessories. This full-color book provides the latest in propellers, how they work, types, design and manufacturing, how to select the proper propeller for a given application, and answers to many commonly asked questions about boating performance.*

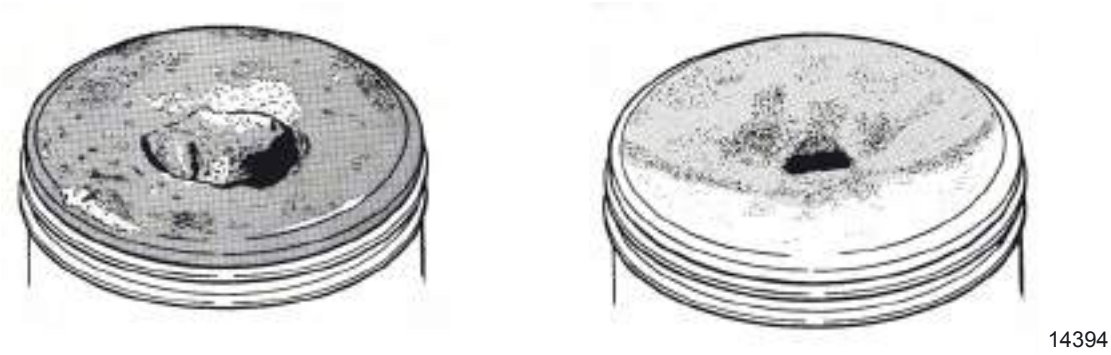
Selection Procedure

⚠ CAUTION

Installed propeller must allow engine to run near the maximum rpm of the engine's specified wide open throttle (WOT) rpm range to avoid engine damage. Using a propeller that the causes engine to operate below the specified WOT rpm range can cause piston and/or valve damage (even if the engine is not operated at WOT). Conversely, using a propeller that allows engine to operate above the specified maximum rpm will cause higher than normal wear and/or damage.

Using a propeller that does not allow the engine to operate within the specified WOT RPM range can cause detonation or pre-ignition damage to the engine (even if the engine is not operated at WOT). Conversely, using a propeller that allows the engine to operate above the specified maximum RPM will cause higher than normal wear or damage. A lower pitch or smaller diameter propeller must be used if RPM is too low, while a higher pitch or larger diameter must be used if RPM is too high. There is a change in RPM between propeller pitches that is generalized as follows:

MIE Models	Diameter or Pitch Change	RPM Change
Gasoline	1 Inch	150



Detonation **Pre-Ignition**

It is the responsibility of the boat manufacturer and/or the selling dealer to equip the power package with the correct propeller. Select a propeller that will allow the engine to operate at the maximum RPM of the engine's specified wide open throttle (WOT) RPM range. (See **Section 1 - Important Information** for specifications). Use an accurate service tachometer to verify RPM.

Example: Prop the engine as close to 4800 RPM as possible on an engine with a specified WOT RPM range of 4400–4800.

When selecting the propeller, the boat should be loaded as outlined below. Weights can be used to simulate the load. Loading the boat in this manner will help to ensure that the RPM do not fall below the specified range when a heavy load is placed aboard by the operator.

1. Half-full fuel tanks
2. Full water tanks (if equipped)
3. Four people in seats at helm and stern (equally distributed)

Equivalent Weights	
1 person + gear	86 kg (190 lbs)
1 US gallon gasoline	0.72 kg (6 lbs)
1 US Gallon Water	1 kg (8.3 lbs)

Select model and initial pitch propeller to begin testing with using information provided in the *Mercury Precision Parts and Accessories Guide.* A vast array of propeller models and pitches are available to suit virtually any boat application. Initial selection is typically done by boat weight.

Operate boat at wide open throttle and adjust power trim to achieve optimum speed without using excessive trim. If RPM is above the specified range, a higher pitch propeller must be used. A lower pitch propeller must be used if RPM is too low. There is typically a 200–300 RPM change for every 2 in. change in propeller pitch.

NOTE: *Engines are equipped with an RPM rev-limiter. The rev-limiter is set slightly above the specified WOT range of the engine and is designed to help prevent damage from a temporary excessive engine RPM condition. The rev-limiter must not be operated against continuously. When rev-limiter is activated, the engine will appear to have a misfire. Once the RPM drops into the specified operating RPM range, normal engine operation resumes. On carbureted engines with Thunderbolt V Ignition, service (or boat) tachometer is not able to give an accurate RPM reading when the rev-limiter is activated.*

For better acceleration, such as is needed for water skiing, the next lower pitch propeller can be used. Care must be exercised when not pulling skiers to prevent over-revving the engine. When cruising, the next highest pitch propeller should be used.

Because of the many variables of boat design, only testing will determine the best propeller for a particular application. Just because a certain size propeller is used on a given model of boat does not mean all boats like that model can use the same pitch propeller. Variances in the boat and accessories can require that a different pitch propeller be used to get the engine to operate a the maximum RPM of the specified RPM range. The following factors may also cause a loss of engine RPM and require the use of a lower pitch or smaller diameter propeller:

1. Warmer weather and greater humidity.
2. Operating in a higher elevation.
3. Operating with a damaged propeller or dirty boat bottom.
4. Operating with increased loads (accessories added).

The owner should be advised to recheck the WOT RPM after the first 50 hours of operation to ensure that it is still within the specified range. By this time the engine has gone through the break-in period.

IMPORTANT: The correct propeller must be used for optimum boat performance and engine life.

Cruising RPM

Modern inboard engines operate at higher engine speeds than those produced just a few years ago. This increased RPM along with better breathing is largely responsible for the significant increase in horsepower of these new engines. Along with the higher WOT RPM comes higher cruising RPM. This higher RPM is critical for optimum performance and efficiency. The materials and design of the new engines allow these higher speeds without a durability penalty. In fact, over-propping the boat to reduce the cruising RPM to previous levels will increase the susceptibility to engine damage from detonation and pre-ignition. The recommended cruising RPM ranges are listed in the following table.

Cruising RPM for Peak Efficiency	
Model	**RPM Range**
5.7L	3200–3600
350 MAG MPI	3400–3800
350 MAG MPI Horizon	3400–3800
Black Scorpion	3600–3800
MX 6.2L MPI	3600–4000
MX 6.2L Black Scorpion	3600–4000
8.1S Horizon	3200–3600
8.1S HO	3400–3800

How Elevation and Climate Affect Performance

Elevation has a noticeable effect on the wide open throttle power of an engine. Since air gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure, and temperature have a noticeable effect on the density of air; heat and humidity thin the air. This condition can become particularly bothersome when the propeller testing is done on a cool, dry day, then later on a hot, sultry day and the boat does not seem to have the same performance.

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. In some cases, a gear ratio change to more reduction is possible and very beneficial.

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 2 or 3 miles per hour in some cases.

In pointing out the practical consequences of weather effects, an engine running on a hot, humid, summer day, may encounter a loss of as much as 14% of the horsepower. With the drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended RPM. This will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however, can be somewhat regained by switching to a lower-pitch propeller that allows the engine to again run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine be propped 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 the engine will also be operating in an RPM range that discourages detonation. This enhances overall reliability and durability of the engine.

Power Package Preparation for Shipment

Extended Storage

If the boat will not be operated for more than a month, the engine should be prepared for extended storage as outlined in the owner's operation, maintenance, and warranty manual. This is particularly important to protect the internal surfaces of the engine against corrosion and to avoid fuel system problems due to fuel decomposition. The products required to perform this procedure are listed following (See **Section 1** for part numbers).

- Quicksilver 2-Cycle Outboard Oil (required for EFI / MPI models only)
- Quicksilver Gasoline Stabilizer for Marine Engines
- Quicksilver Storage Seal (required for carbureted models only)

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

Draining the Cooling System

⚠ CAUTION

Seawater section of cooling system must be completely drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine. Damage caused by freezing is not covered by the Mercury MerCruiser Limited Warranty.

Protect the engine against corrosion and freeze damage. Flush and drain all water from the engine cooling system after performing the **Predelivery Inspection Checklist**. The cooling system should be drained prior to shipment even during warm temperature periods. This will avoid controversies with your dealers as to who is responsible for any freeze damage problems that may occur due to the engine not getting drained prior to shipment at Mercury MerCruiser as well as at your facility.

Specific flushing and draining instructions are provided in the Operation, Maintenance and Warranty manual that accompanies each engine. On closed cooled models, only the seawater section of closed cooling system need be drained provided that the proper mixture of antifreeze and water is used in the closed cooling section to protect engine to lowest temperature to which it will be exposed. Do not forget to drain the sea strainer and mufflers (if applicable), which are not included in our draining instructions.

IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol (a nontoxic and environmentally safe) antifreeze be used in the seawater section of the cooling system as an additional measure against corrosion and freeze damage. Make sure that propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the antifreeze manufacturer's recommendations.

⚠ CAUTION

If the boat is in the water, the seacock must remain closed until the engine is to be restarted to prevent water from flowing back into the cooling system or the boat. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged to prevent water from flowing back into the cooling system or the boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open the seacock or reconnect the water inlet hose before starting the engine.

Engine Corrosion Protection

All engines that will be subjected to a corrosive environment during shipment should be sprayed with Corrosion Guard. Corrosion Guard is specially formulated to provide a protective barrier against the corrosive elements to keep the power package looking like new. Refer to application instructions on the Corrosion Guard container.

Disconnecting the Battery

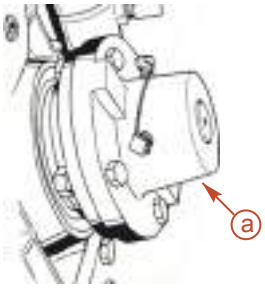
All battery cables should be disconnected from battery for shipment. Some regulations require that the battery be shipped dry (without electrolyte). Check applicable regulations.

Disconnecting the Propeller Shaft Coupling

⚠ CAUTION

Failure to disconnect the coupling for shipment could result in damage to transmission and propeller shaft.

On applications with a rigid propeller shaft coupling, the coupling must be disconnected from the transmission flange before boat is removed from the water for shipment. Coupling should not be reconnected until the boat is in the water at its final destination and the engine alignment has be rechecked. Some misalignment may occur during transit, particularly on large boats.



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a - Typical rigid propeller shaft coupling

Predelivery Inspection Checklist

Not Applicable	Check / Adjust	CHECK BEFORE RUNNING	Not Applicable	Check / Adjust	ON THE WATER TEST
☐	☐	Drain plug in and petcocks closed	☐	☐	Engine alignment (Inboards only)
☐	☐	Seawater inlet valve open	☐	☐	Starter neutral safety switch operation
☐	☐	Engine mounts tight	☐	☐	Water pump operation
☐	☐	Engine alignment	☐	☐	Instrument(s) operation
☐	☐	Sterndrive or transmission fasteners torqued	☐	☐	Fuel leaks
☐	☐	Power trim cylinders fasteners tight	☐	☐	Oil leaks
☐	☐	Battery fully charged and secured	☐	☐	Water leaks
☐	☐	All electrical connections tight	☐	☐	Exhaust leaks
☐	☐	Exhaust system hose clamps tight	☐	☐	Ignition timing
☐	☐	All fuel connections tight	☐	☐	Idle_____ RPM, within specifications
☐	☐	Correct rotation propeller (installed and torqued)	☐	☐	Forward - Neutral - Reverse gear operation
☐	☐	Throttle, shift and steering system fasteners tightened properly	☐	☐	Steering operation throughout range
☐	☐	Throttle plates open and close completely	☐	☐	Acceleration from idle RPM
☐	☐	Crankcase oil level	☐	☐	WOT_____ RPM within specifications (in FORWARD gear)
☐	☐	Power trim oil level	☐	☐	Power trim operation
☐	☐	Sterndrive oil level	☐	☐	Trim tab adjustment
☐	☐	Power steering fluid level	☐	☐	Boat handling
☐	☐	Closed cooling level			**AFTER ON WATER TEST**
☐	☐	Transmission fluid level	☐	☐	Propeller nut torque
☐	☐	Alternator belt tension	☐	☐	Fuel, oil, coolant, water and fluid leaks
☐	☐	Seawater pickup pump belt tension	☐	☐	Oil and fluid levels
☐	☐	Power steering pump belt tension	☐	☐	Apply Quicksilver Corrosion Guard to engine package
☐	☐	Audio warning system operation	☐	☐	C.A.R.B. Hang Tag and Owners Manual in boat (If registered to a CA resident.)
			☐	☐	C.A.R.B. Decal properly affixed to boat hull (If registered to a CA resident.)

Notes: