

Exhaust System

Section 7A - General Information

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General Information - All Models

Exhaust System Notice

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boatbuilder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

Reference Note

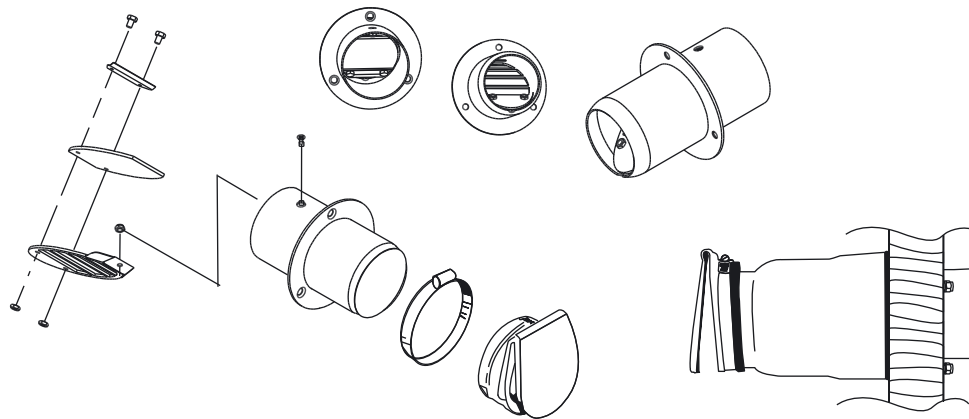
Refer to the appropriate **Mercury MerCruiser Product Applications Manual** for vessel integration, application, and exhaust systems installation requirements.

Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boatbuilder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Through-the-Hull Exhaust 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 are available through the **Mercury Precision Parts and Accessories Guide**.



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General Information - Catalyst Models

Preventing Contamination of the Emissions Control System

Catalyst and oxygen sensors can become contaminated, leading to component failure. Phosphorus, found in some marine-grade oils, and other compounds will damage or destroy a catalyst's ability to clean the exhaust. Catalyst-friendly oil, like Mercury Full Synthetic MerCruiser Engine Oil, prevents this damage. Approved synthetic oils must be used in MerCruiser engines with emissions control.

NOTICE

Acetoxy silicone sealants and other compounds can damage oxygen sensors and catalysts. Use only compounds and sealants approved by Mercury Marine for use on catalyzed engines, such as Loctite 587 High Performance Blue.

Fiberglass is a silica-based material that can contaminate the catalyst and the oxygen sensors. To reduce the possibility that the engine will ingest harmful fiberglass and poison the emission control components, protect the engine from fiberglass dust and debris during construction and cleanup.

Determining Catalyst Health

Catalyst health can be determined by observing onboard diagnostics - marine (OBD-M) catalyst monitor ratios with CDS G3. Remove the catalyst from the exhaust manifold for inspection only if live data indicates that a catalyst may be compromised. Below is an example of a Live Data screen at completion of the catalyst monitor test. Actual values may differ. Note that the catalyst monitor ratios indicate that both catalysts may be damaged.

Name	Value	Units	Description
O2Adpt_ITerm_PortTbl	-0.04,0.00,0.00,0.00,0.00,0.00		PORT Short Term Adaption Test
PO2S_e_DisableReason	Finished		Post O2 Sensor Monitor
O2SR_e_SwitchRatioDisableReason	FinishedKey		Pre O2 Sensor Monitor
O2SR_e_DisableReasonPort	None		PORT Pre O2 Sensor Monitor
O2SR_e_DisableReasonStbd	None		STBD Pre O2 Sensor Monitor
O2SR_PreCatSwitchPort	0.88	Ratio	PORT Pre O2 Sensor (A) Monitor Ratio
O2SR_PreCatSwitchStbd	0.80	Ratio	STBD Pre O2 Sensor (A) Monitor Ratio
CATM_e_DisableReasonCommon	None		OVERALL Catalyst Monitor
CATM_e_StatusPort	FinishedKey		PORT Catalyst Monitor
CATM_e_StatusStbd	FinishedKey		STBD Catalyst Monitor
CATM_O2LeanRespTimePort	0.40	ms	PORT Pre O2 Sensor (A) Learn Response
CATM_O2RichRespTimePort	0.11	ms	PORT Pre O2 Sensor (A) Rich Response
CATM_O2LeanRespTimeStbd	0.25	ms	STBD Pre O2 Sensor (B) Learn Response
CATM_O2RichRespTimeStbd	0.10	ms	STBD Pre O2 Sensor (B) Rich Response
CATM_r_OSCIndexEWMASPort	0.87	Ratio	PORT Catalyst Monitor Ratio
CATM_t_OSCRawPort	210.45	mg	PORT Catalyst Monitor Raw OSC
CATM_r_OSCIndexEWMASStbd	0.73	Ratio	STBD Catalyst Monitor Ratio
CATM_t_OSCRawStbd	175.26	mg	STBD Catalyst Monitor Raw OSC

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CDS G3 Live Data screen

- a - Pre O2 sensor monitor—finished
- b - Port and starboard catalyst monitors—finished
- c - Catalyst response times (all less than 0.92 seconds)
- d - Port catalyst monitor ratio—failed (value is less than 1)
- e - Starboard catalyst monitor ratio—failed (value is less than 1)

The time it takes for the pre O2 sensor to transition from rich to lean compared to the post O2 sensor value is directly related to the catalyst's oxygen storage capacity (OSC). The OSC is measured in milligrams. If the catalyst monitor ratio is below 1.00, and the catalyst response time is below 0.92 seconds, inspect the catalyst for damage.

Use known good O2 sensors and repeat the test if the catalyst monitor ratio is below 1.00 and the catalyst response time is above 0.92 seconds.

Refer to **Service Manual #49 - PCM 09 Diagnostics** for information about catalyst monitor testing with CDS G3.

Measuring Exhaust Elbow Height - All Models

General Information

Install exhaust elbows within the specified height dimensions to prevent water intrusion. Install exhaust elbow risers as needed to obtain the proper exhaust elbow height and exhaust angle. Risers cannot exceed 203.2 mm (8 in.). Take all measurements with the boat in the water and loaded to simulate the maximum loading conditions for normal operation.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not the waterline outside of the boat. Refer to Clear Hose Measurement Method from Muffler Drain for instructions.

IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boatbuilders must communicate any load distribution conditions that affect the exhaust system, such as maximum occupancy of the swim platform, to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Model	Minimum Exhaust Elbow Height (above waterline)
8.2 ECT sterndrive models	33 cm (13 in.)

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Model	Minimum Exhaust Elbow Height (above waterline)
8.2 inboard models and non-ECT sterndrive models	38 cm (15 in.)

Model	Minimum Exhaust Hose Slope within 45.7 cm (18 in.) of Engine	Minimum Exhaust Hose Slope Remainder of System (if applicable)
8.2	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.

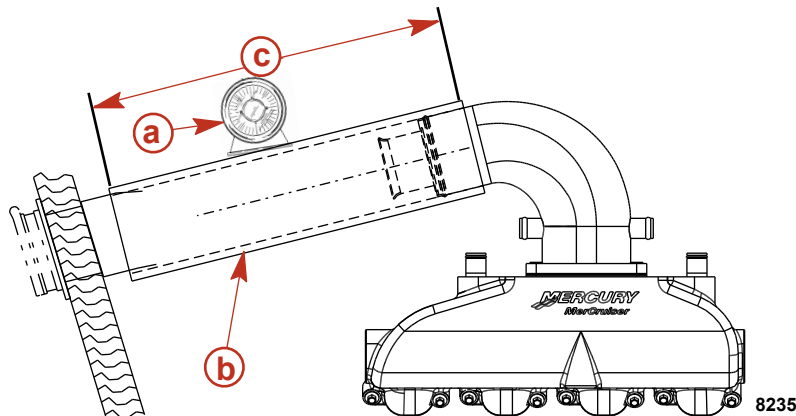
The maximum exhaust riser height is specified in the table below.

Exhaust Riser Options			
Model	Low	Medium	High
8.2 noncatalyzed	51 mm (2 in.)	152 mm (6 in.)	203 mm (8 in.)
8.2 triple catalyst models	51 mm (2 in.)	102 mm (4 in.)	152 mm (6 in.)
8.2 single catalyst models	51 mm (2 in.)	102 mm (4 in.)	152 mm (6 in.)

Model	Minimum Exhaust Hose or Tube length
8.2 sterndrive models	30 cm (12 in.)
8.2 inboard models	46 cm (18 in.)

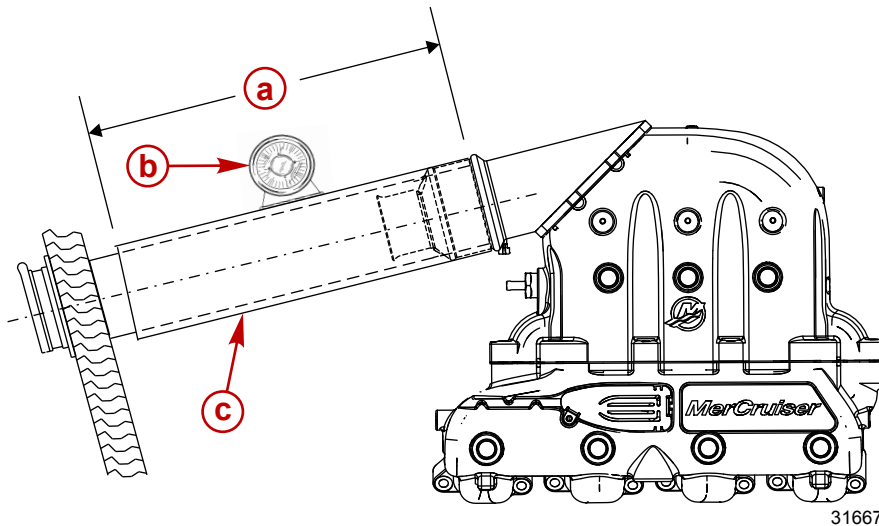
Exhaust Angle Measurement

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. Perform all exhaust angle measurements 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**.

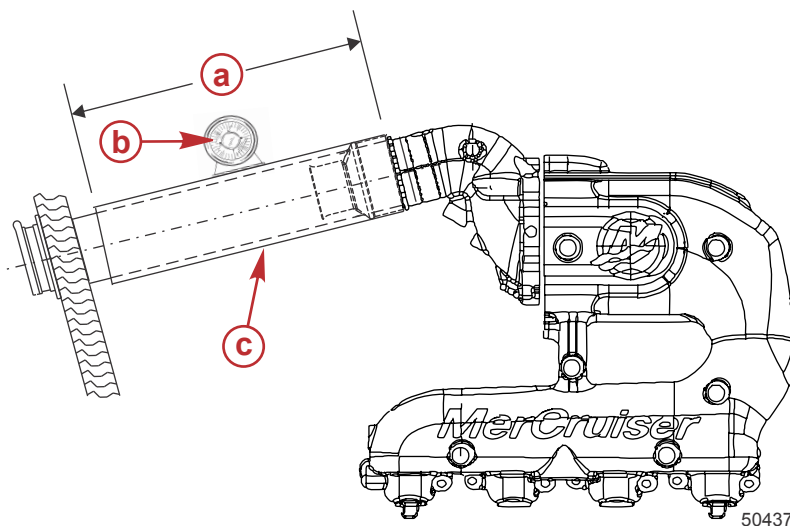


Models without emissions control

- a - Inclinometer
- b - Exhaust hose or tube
- c - Length of exhaust hose or tube

**Triple catalyst design**

- a** - Length of exhaust hose or tube
- b** - Inclinometer
- c** - Exhaust hose or tube

**Single catalyst design**

- a** - Length of exhaust hose or tube
- b** - Inclinometer
- c** - Exhaust hose or tube

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 nonproduction 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 boatbuilder 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 the OEM boatbuilder 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

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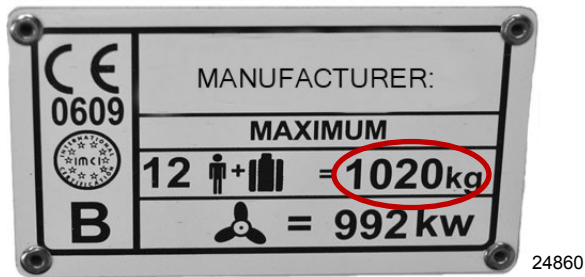
3. For the purpose of MerCruiser waterline height measurements:
 - One person is equivalent to 74.84 kg (165 lb)
 - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, 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 add 181.45 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 (Boats with a Capacity Plate)

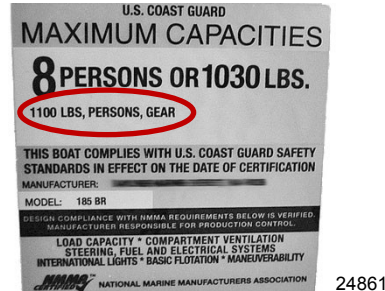
For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 in. for an 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 lbs, 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 the boat loading diagram.



CE capacity plate



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 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.

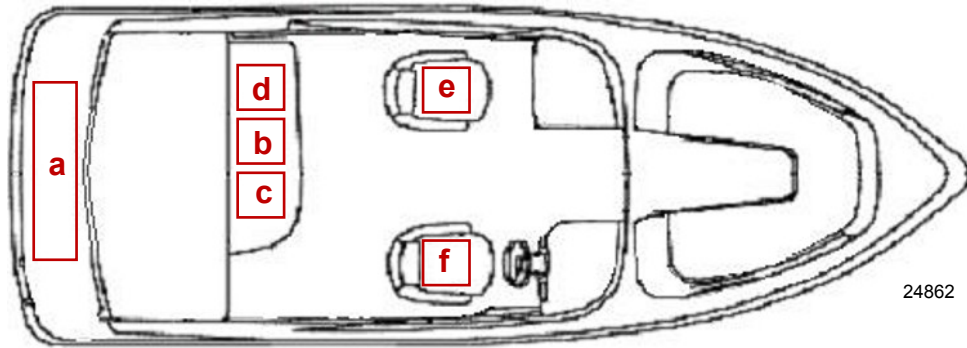
NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

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

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.
 - $400 \text{ lb} + 165 \text{ lb} = 565 \text{ lb}$
 - $565 \text{ lb} + 165 \text{ lb} = 730 \text{ lb}$
 - $730 \text{ lb} + 165 \text{ lb} = 895 \text{ lb}$
 - $895 \text{ lb} + 165 \text{ lb} = 1060 \text{ lb}$

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- 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 (Boats 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 in. for an 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%

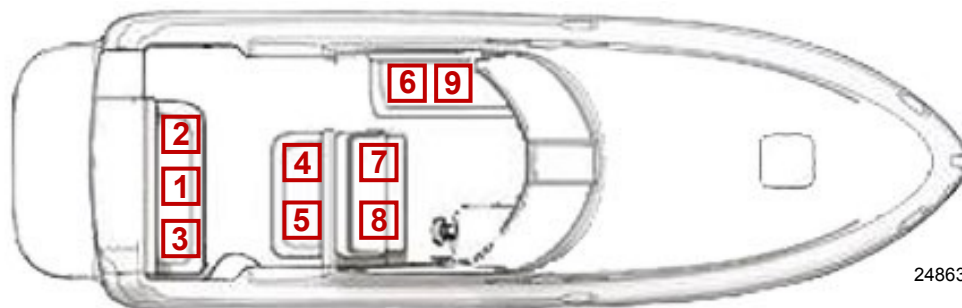
- Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
- Load the swim platform if equipped.
- Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
- Load a person 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 loaded into each seat in that row.
- 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

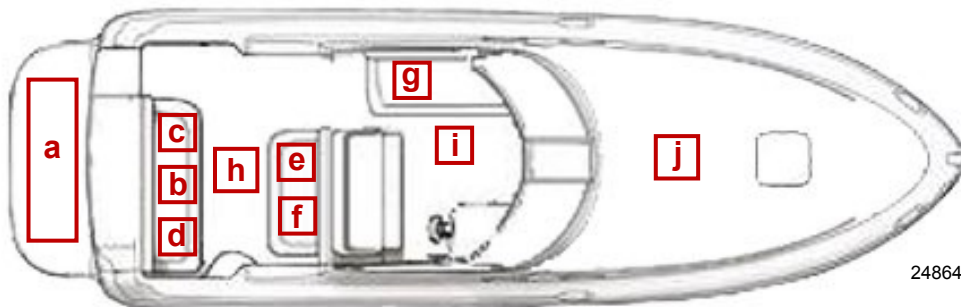
This example uses nine persons as the maximum passenger load.

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

- To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
 - 9 passengers × 25 lb = 225 lb
- To determine the preferred cargo distribution for aft, center, and bow storage:
 - To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%.
 - 225 lb × 25% = 56.25 lb
 - 56.25 lb rounded down = 56 lb
 - To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%.
 - 225 lb × 50% = 112.50 lb
 - 112.50 lb rounded up = 113 lb
 - 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
- 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
- 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

General Information

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.
 - $985 \text{ lb} \div 165 \text{ lb} = 5.9$ 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.
 - $500 \text{ lb} + 225 \text{ lb} = 725 \text{ lb}$
 - $725 \text{ lb} + 165 \text{ lb} = 890 \text{ lb}$
 - $890 \text{ lb} + 165 \text{ lb} = 1055 \text{ lb}$
 - $1055 \text{ lb} + 165 \text{ lb} = 1220 \text{ lb}$
 - $1220 \text{ lb} + 165 \text{ lb} = 1385 \text{ lb}$
 - $1385 \text{ lb} + 165 \text{ lb} = 1550 \text{ lb}$
 - $1550 \text{ lb} + 165 \text{ lb} = 1715 \text{ lb}$

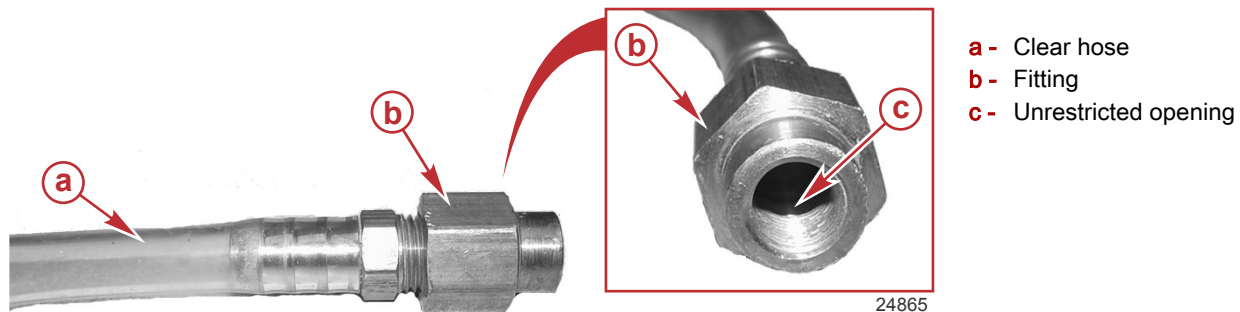


Cargo, swim platform, and passenger weight loading diagram

- 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

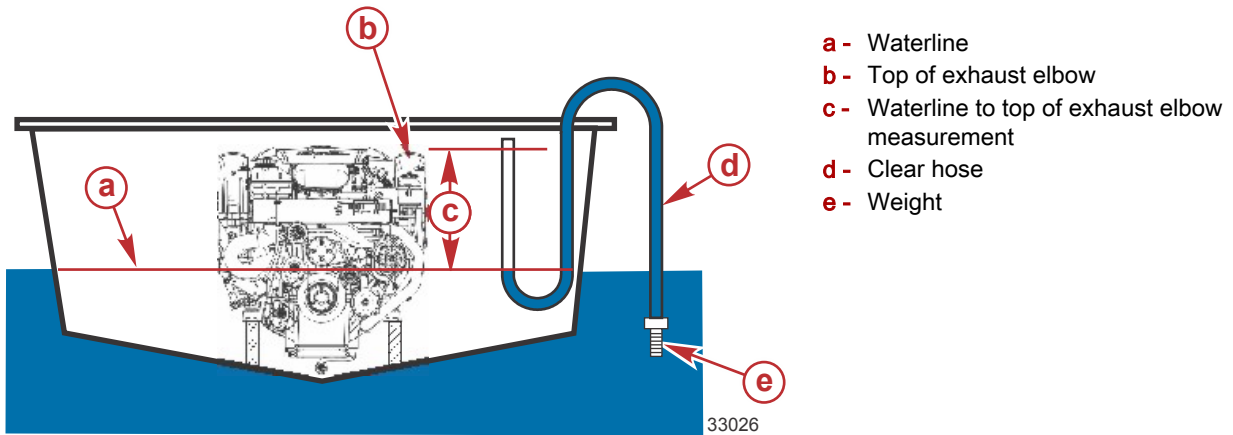
1. Obtain an 8–10 mm (5/16–3/8 in.) inner diameter (ID) clear hose approximately 4.5 m (15 ft) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



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 manifold collector and 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.



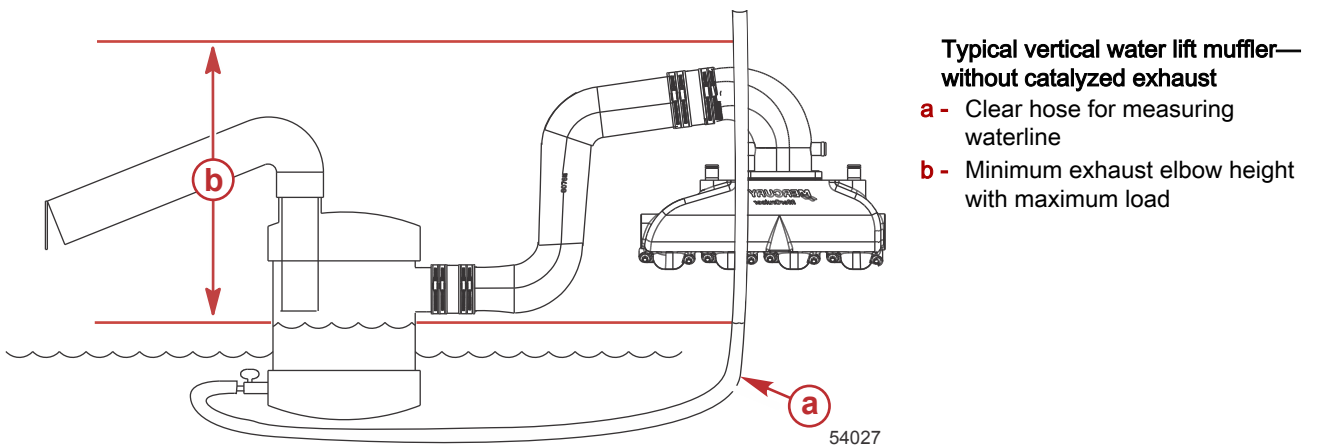
Clear Hose Measurement Method from Muffler Drain

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

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

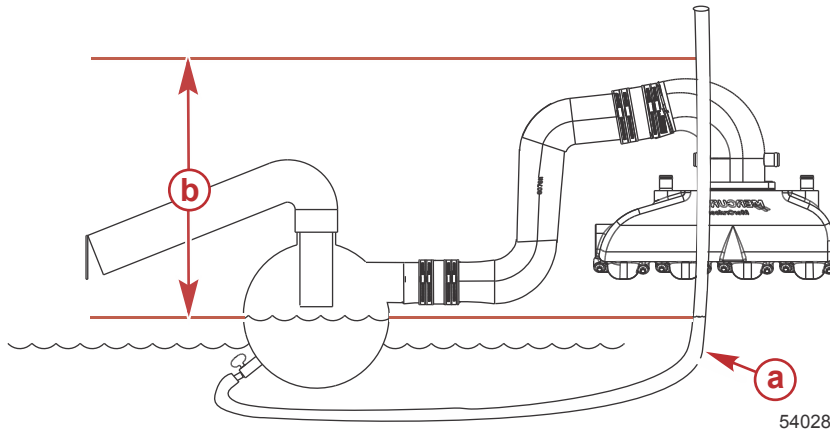
IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

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 waterline.
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 8.2 models.



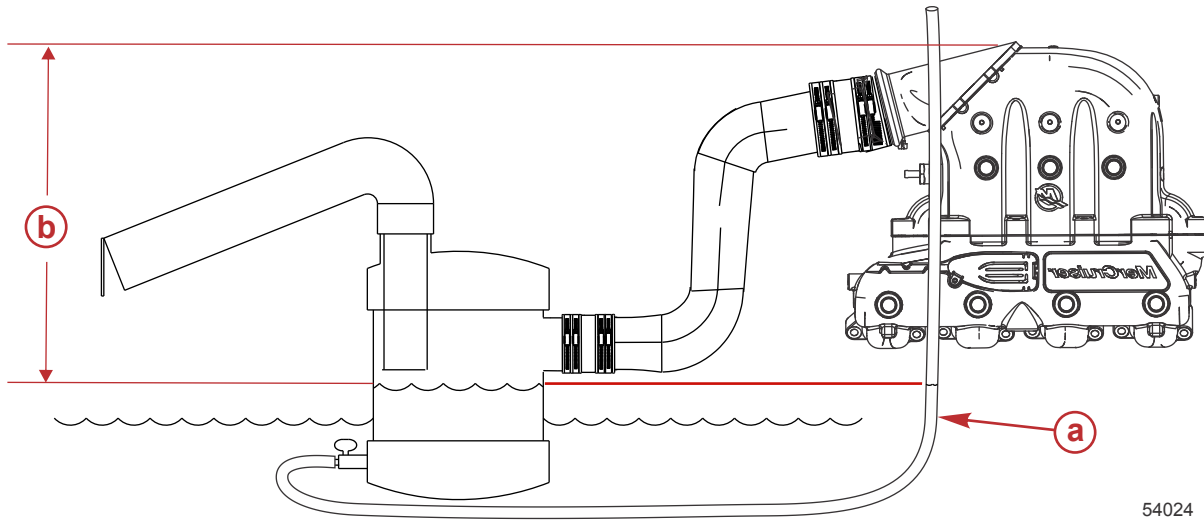
General Information

IMPORTANT: Horizontal water lift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



**Typical horizontal water lift muffler—
without catalyzed exhaust**

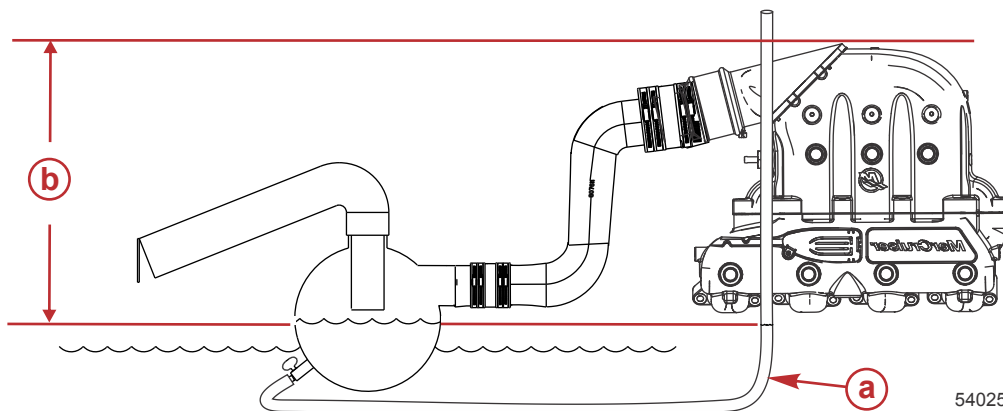
- a** - Clear hose for measuring waterline
- b** - Minimum exhaust elbow height with maximum load



Typical vertical water lift muffler—triple catalyst manifold

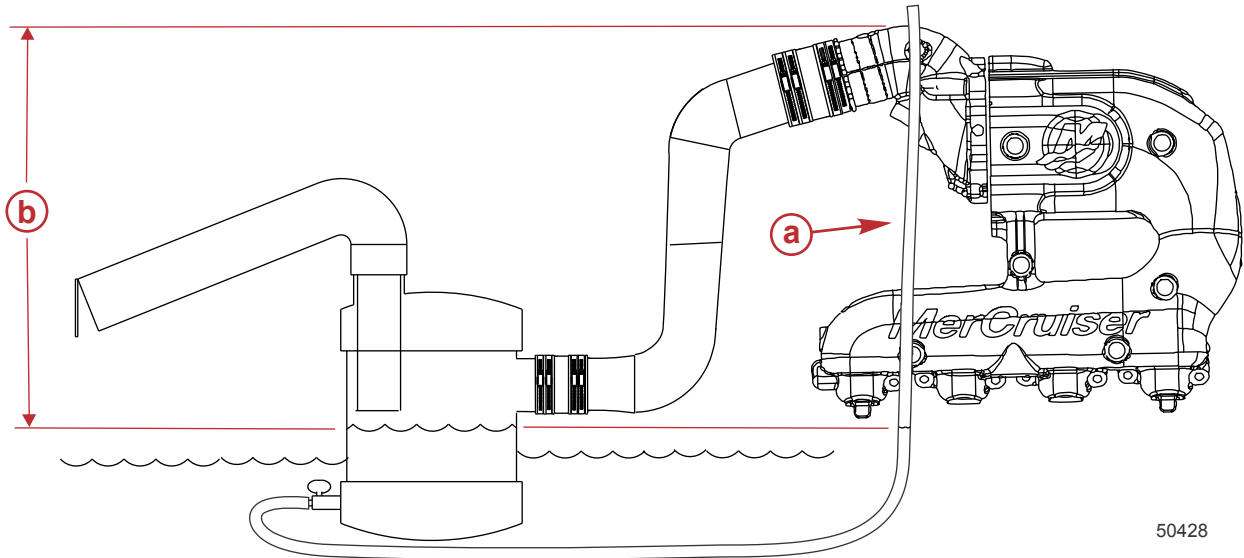
- a** - Clear hose for measuring waterline
- b** - Minimum exhaust elbow height with maximum load

IMPORTANT: Horizontal water lift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



Typical horizontal water lift muffler—triple catalyst manifold

- a** - Clear hose for measuring waterline
- b** - Minimum exhaust elbow height with maximum load

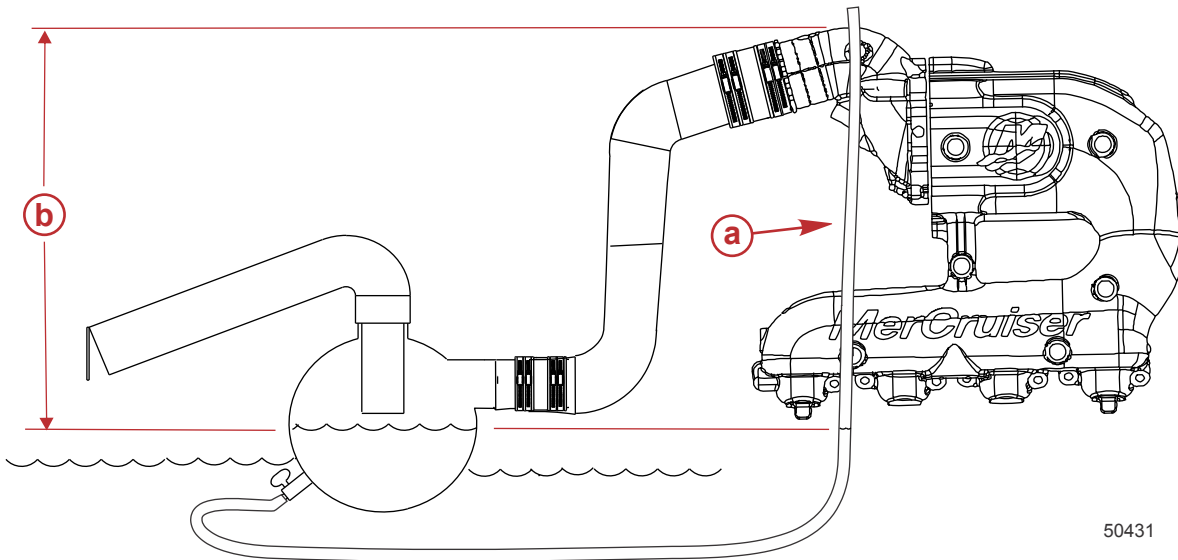


50428

Typical vertical water lift muffler—single catalyst manifold

- a** - Clear hose for measuring waterline
- b** - Minimum exhaust elbow height with maximum load

IMPORTANT: Horizontal water lift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



50431

Typical horizontal water lift muffler—single catalyst manifold

- a** - Clear hose for measuring waterline
- b** - Minimum exhaust elbow height with maximum load

Notes: