Air Intake System

Section 4A - Air Intake System

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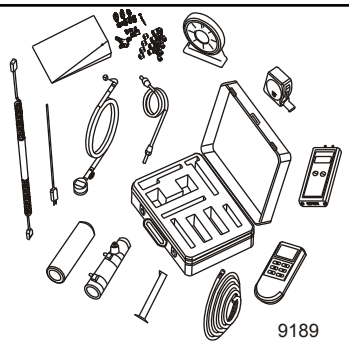
Special Tools

Boat audit kit	91-862791A 1
 9189	Includes an array of high quality meters and gauges for checking that the power package is installed properly.

Engine Compartment Ventilation

⚠ WARNING

Improper boat design and construction may result in serious injury or death. 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.) when designing and constructing the boat and other components, such as the engine compartment, fuel delivery system, or exhaust system.

Adequate ventilation is required to properly evacuate the fumes from the engine compartment and for proper engine operation. Insufficient ventilation results in poor engine performance, especially 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, increasing the possibility of vapor lock.

IMPORTANT: This section does not cover the design of the ventilation system, as it pertains to ventilation of fumes from the engine compartment. Ventilation requirements vary among boat designs and region. 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.)

- The ventilation system must comply with the specifications for maximum pressure differential, fuel inlet temperature, and temperature at the top of the engine compartment as defined in **Engine Compartment and Fuel System Pressure and Temperature Test**.
- Refer to the following table for ventilation system specifications as a starting point for designing the system. The air inlet requirements can vary significantly from one boat design to the next. Perform the following test complies 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)
Tow Sports			
Tow Sports 5.7 TKS	0.226 (486)	316 (49)	150 (5.3)
Tow Sports 5.7 MPI	0.239 (506)	329 (51)	
Scorpion 350			
Scorpion 377	0.268 (567)	367 (57)	
Inboard Models			
5.7 TKS Inboard	0.220 (466)	303 (47)	150 (5.3)
5.7 MPI and Horizon 5.7	0.229 (486)	316 (49)	
6.2 MPI and Horizon 6.2	0.258 (545)	355 (55)	
Horizon 8.1	0.332 (660)	426 (66)	170 (6.0)
8.1 H.O.	0.325 (689)	445 (69)	

- Increase ventilation openings if the boat is to be equipped with a generator set.
- On boats where more than one engine model is to be offered, size the ventilation system for the largest horsepower offering.
- Air vent cross-sectional specifications are for engine combustion air only and do not consider the ventilation of fumes.
- 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).
- Ensure that water does not enter the ducts.
- Install all air inlet ducts in an area where they will not pick up exhaust fumes.

Engine Compartment and Fuel System Pressure and Temperature Test

NOTE: *Because of the 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.*

Use 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.

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This test is very sensitive to the ambient temperature and the Reid Vapor Pressure (RVP) of the fuel used during the test. The 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.

Perform this test needs with the boat in the water and underway. No special loading requirements are necessary, but the boat should be capable of reaching WOT. Use a shop tachometer or digital multimeter to determine RPM.

Description	Specifications
Maximum engine compartment pressure differential @ WOT (inside vs. outside)	51 mm (2 in.) H_2O
Maximum temperature at fuel inlet	44°C (110° F)
Maximum temperature @ top of engine compartment	80 °C (176 °F)
Maximum fuel pressure drop @ fuel inlet	6.9kPa (1 psi)

Connections

⚠ WARNING

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

1. Remove the brass inlet plug in the fuel connection fitting.
2. Test the engine with the longest length of fuel line or the most fuel components.
3. 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. Use the following hardware:
   - ¼ in. NPT female brass cross and appropriate fittings.
   - Fuel inlet connection.
   - Thermocouple.
   - Fuel supply hose.
   - Pressure gauge hose.
4. Install the thermocouple into the brass cross with a ¼ in. NPT thermocouple fitting. Connect the thermocouple to the meter using an extension cord.
5. 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.
6. Route the manometer hose to allow reading the engine compartment differential pressure.
7. Position another thermocouple above the flame arrestor on the engine to read the peak engine compartment temperatures.
8. Keep the hoses, thermocouples, and fitting away from moving parts. Use a tie strap if necessary.
9. Zero the pressure gauge before starting the engine.
10. 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, 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 and 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 the **Heat Soak Test**. 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 temperature begins to lower or has remained steady for 5 minutes. 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 as described in the following chart. Potential causes are listed following.

Condition	Description
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 extreme temperature 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 temperature conditions.
Bog	Much more severe than a stumble. The engine drops more than 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.

TROUBLESHOOTING

IMPORTANT: A blower may be required to get proper ventilation.

Symptom	Cause	Action
1. Excessive engine compartment temperature or pressure differential.	**1.0** Insufficient cross-sectional area of vents and related hardware.	**1.0** Increase cross-sectional area of air vents and related hardware.
	1.1 Inlet and exhaust vents improperly located on boat (too close to each other, both in high pressure or low pressure areas).	**1.1** Determine the correct location and modify hull as needed.
	1.2 Vent hoses too restrictive (excessive bends, too small, lying in water).	**1.2** Install proper diameter vent hoses. Route to avoid bends and water.
	1.3 Vent hoses not positioned to allow good circulation of air.	**1.3** Route hoses to allow proper circulation.
2. Excessive fuel inlet temperature.	**2.0** Excessive engine compartment temperature.	**2.0** Correct engine compartment temperature problems.
	2.1 Too much fuel tank, lines, and related hardware exposed to the engine compartment.	**2.1** Mount tank or lines in less exposed location or increase insulation. Reduce exposure or insulate components.
	2.2 Fuel line located too high in engine compartment (warmest air is in top of compartment).	**2.2** Route fuel line to a lower location.
	2.3 Fuel line too close to hot surface on engine.	**2.3** Route fuel line to a cooler location.
3. Excessive fuel pressure drop.	**3.0** Fuel system has excessive restriction (lines too small, too many fittings).	**3.0** Refer to Fuel System Specifications and correct the fuel system accordingly.
	3.1 Auxiliary fuel filter utilized.	**3.1** Remove additional fuel filter and use only Mercury supplied fuel filters and pumps.
	3.2 Anti-syphon valve too restrictive	**3.2** Install correct anti-syphon valve.
4. Everything is within specification, but the engine still hesitates, stumbles, bogs, or stalls.	**4.0** RVP of fuel too high.	**4.0** Ensure that a winter blend fuel is not being used.