

Figure 7-11  
Standard stern drive engine installation

Figure 7-12  
Higher stern drive installation

### **What is the correct height to mount the engine on the transom?**

For a propeller to best satisfy particular boating needs, the engine must be attached to the transom at the correct height. Over the past 30 years, industry standards for transom height have been developed: 15" for "short shaft" engines, 20" for "long shaft" engines, and 25" for "extra-long shaft" engines.

#### **Standard Mounting**

A correct conventional installation would generally place the ant ventilation plate on many engines about even with the boat bottom when the engine propeller shaft is parallel to the boat bottom (Figures 7-8 and 7-11).

#### **Lower Mounting**

Setting the engine lower (deeper in the water) (Figure 7-7) tends to:

1. cause excessive spray,
2. increase gear case drag,
3. reduce underwater clearance, and
4. adversely affect handling of faster boats.

However, there are exceptions to the above. Many small fishing engines and some larger engines are designed to run with their ant ventilation plate an inch or two below the boat bottom. This can assist in reducing or eliminating propeller ventilation.

#### **Higher Mounting**

In the past, the only negative effect from mounting an outboard or stern drive higher than standard was an increase in propeller ventilation, which could cause difficulty in planing,

particularly with heavier loads. However, as available power has steadily increased, and with improvements in propeller design-particularly in the field of high-performance propellers-owners of faster boats have explored a new, higher range of performance that can be achieved by raising their engines above the old standard height. It is becoming more common to raise outboards three inches or more above the standard on fast-boat installations (Figures 7-9 and 7-10). Outboard manufacturers are now recommending that engines be mounted higher than the old standard, provided boat speed justifies it. In fact, a growing number of boat builders are building their faster outboard-powered boats with transoms 1" to 3" above the standard height (usually 20").

Boat builders of sport boats using stern drive propulsion are only slightly more conservative. Referring to the use of non-racing stern drives, the "X" dimension is raised on fast, conventional single-drive boats by 1" to 2" (Figure 7-12) and on other bottom styles (such as catamarans) by 2" to 3". Twin drive installations will call for even less elevation.

However, by raising an engine or drive to excessive transom heights, the increased risk of engine overheating due to insufficient cooling water is a major concern. Manufacturers cannot be held responsible for, nor accept, any warranty obligations for overheating damage caused from this type of excessive setup and operation. Thus, the driver must accept the responsibility of constantly monitoring the engine cooling water pressure and/or temperature.

Some engines are equipped with overheat horns, but any engine can be rigged with a water pressure gauge. However, a water pressure gauge can give you a false sense of security from a temporary, high pressure reading, resulting from a steam pocket trapped at the top of the block. And the overheat horn doesn't give any feel for how close to overheating the engine is running. A water temperature gauge is the most reliable instrument for monitoring the operating temperature of your engine.

Top-of-the-block water temperature should not be allowed to exceed 140° (60°C) while water pressure at full throttle should not be allowed to fall below 70% of the full throttle reading taken at a more conventional transom height. Remember, as engine installation height is increased, your freedom to trim the engine out without overheating is reduced.

### **Raising the engine can provide several advantages:**

1. Reduced lower unit drag, thus increased speed (approximately one MPH per inch in the 60-80 MPH range).
2. Improved handling on faster boats. Excessive rudder in the water at higher speeds on a light boat can increase handling problems and cause "chine walking" (left to right to left rocking motion).
3. Greater clearance to underwater obstacles.
4. When combined with trimming out (the usual case), reduction of steering torque to nothing, especially at around a 23" transom height for a long-shaft engine.
5. In a few cases, improved planing off, by allowing the propeller to take in surface air, thus considerably increasing engine RPM, which results in more available horsepower when it is needed.

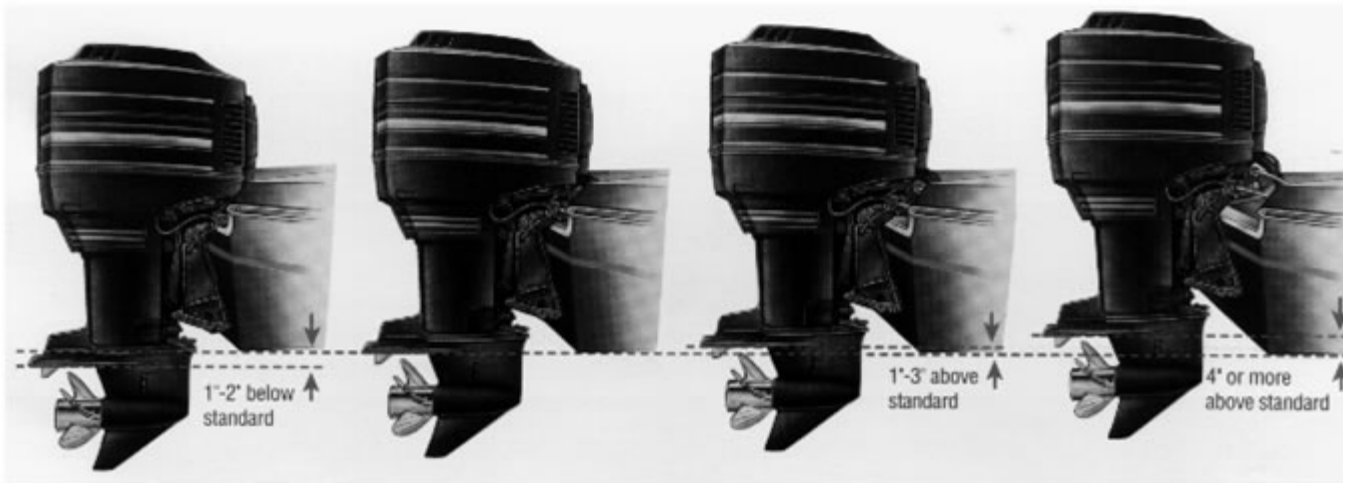


Figure 7-7  
Work application:  
heavily loaded, slow speed

Figure 7-8  
Normal duty:  
average speed installation

Figure 7-9  
Sport application:  
sport and ski

Figure 7-10  
High-performance applicati  
maximum speed is primary  
consideration

Figure 7-13  
Standard installation with  
the antiventilation plate  
approximately flush with  
the boat bottom and the  
propeller blades below the  
water surface.

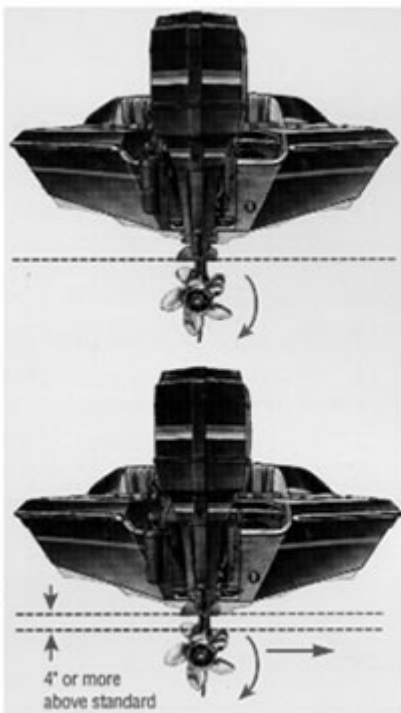


Figure 7-14  
The same boat and engine  
as in Figure 7-13 but with  
the engine raised sufficiently  
on the transom to place the  
antiventilation plate well  
above the boat bottom.  
This locates the arc of the  
propeller above the water's  
surface. The arrow pointing  
to the right indicates the  
direction in which the stern  
of the engine (not the boat)  
will be pulled as the surfaced  
propellers tries to walk  
across the surface, very  
much like the simulated  
paddle wheel in Figure 7-15.

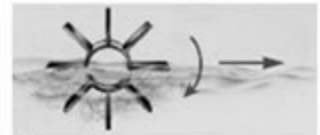


Figure 7-15  
Paddle wheel

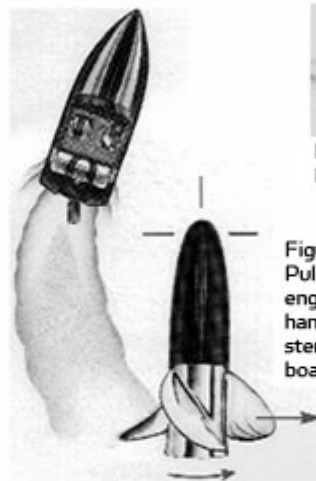
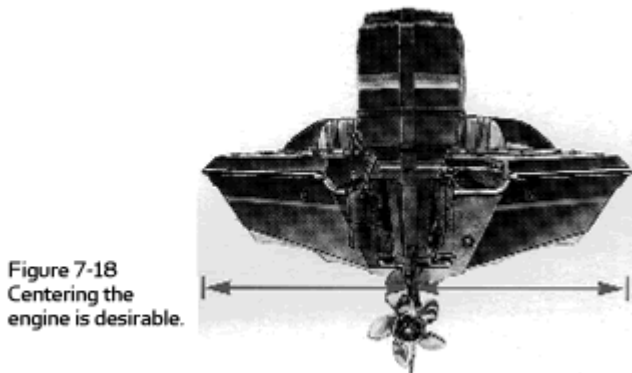


Figure 7-16  
Pull to the right on the stern of the  
engine forces the boat into a right-  
hand turn. This situation requires  
steering wheel effort to the left if  
boat is to be held in a straight line.

There are also some disadvantages to raising the engine above standard installation height (Figure 7-13):

1. As the engine is raised higher on the transom, the risk of overheating from lack of sufficient cooling water increases. Cooling water flow must be monitored more frequently.
2. At higher transom heights the trim tab is no longer effective as a means of altering steering torque. Heavy steering torque may be encountered, and the driver must maintain a continuous firm grip on the wheel at all times when neither power steering nor no-feedback steering is employed (Figure 7-14).
3. Engine raising is not for heavier, slower boats.
4. A higher-rake, cupped, sharp-edged propeller is generally required.
5. In many cases plaining off, particularly with a load, is more difficult.

6. There is a little more vibration, which may reduce riding comfort, and eventually may loosen parts on the engine and boat.
7. Dual-engine installations provide a new problem because, during turns, the outside engine is lifted higher out of the water than a single, centrally located engine. This usually means that with dual engines, they must be mounted an inch lower than a single engine on a boat of similar speed.
8. The transom must be sufficiently strong when mounting more than an inch above the original transom top. Your boat dealer or boat builder should be contacted.
9. As an outboard or stem drive is progressively raised, the propeller will eventually break the surface of the water. As this occurrence increases, a blade sweeping across the top, fanning through air, will not pull as hard in a sideways or propeller torque direction as the fully submerged blade sweeping across the bottom of the propeller arc. This will cause a right-hand rotation propeller to want to move or walk to the right much as a paddle wheel would try to do (Figure 7-15). This action in turn tries to pull the aft end of an outboard or stem drive to the right, thus causing the boat to want to go into a right-hand turn if not resisted at the steering wheel (Figure 7-16). This steering pull will either add to or subtract from the steering pull generated by the propeller shaft running trimmed in or trimmed out. When the propeller is elevated perhaps 5" or more above the standard height, the "paddle wheel" effect will completely dominate any other steering torque cause (Figure 7-17).



### Centering the Engine

Generally, centering the engine within approximately 1/4" (6.4 mm) is desirable (Figure 7-18). As an engine (installed on a normal vee-bottom hull) is moved off center, it is increasingly lifted out of the water when the boat is turned in the opposite direction, thus increasing the likelihood of ventilation. Spray problems also may arise.



Figure 7-19  
Engine or drive trimmed 'in'  
(bow too low).



Figure 7-20  
Engine or drive trimmed 'out'  
(bow too high).  
Porpoising



Figure 7-21  
Engine or drive properly trimmed.

### What is the "trim angle" of the engine?

Trim angle of an outboard or stern drive is the angle between the boat bottom and the propeller shaft formed by moving the engine/stern drive closer to the boat transom, called trimming "in" or "down" or "under," or moving the outboard/stern drive further away from the boat transom called trimming "out" or "up." When a boat is cruising on plane and the trim is adjusted so that the propeller shaft is parallel to the surface of the water, that is said to be running at "neutral" or "zero" trim. On outboards without power trim, this angle is adjusted by changing the hole in which the adjustable tilt pin is inserted. The term "trim" is generally used when referring to adjusting the outboard or stern drive within the first 20° range of travel.

This is the range used while operating your boat on plane. The term "tilt" is generally used when referring to adjusting the outboard or stern drive further up out of the water.

The trim angle of the outboard/stern drive has a distinct effect on the plaining angle of the boat that, in turn, significantly alters top speed and handling. The engine/drive should be trimmed in for best start-up acceleration and shortest time to plane. The engine/drive would then be trimmed out for peak performance. If trimmed "in" (under) too far (Figure 7-19), the bow drops and the boat runs too wet. In this condition, top speed drops, fuel economy decreases, the boat may over-steer in one direction or the other ("bow steering"), and steering torque will increase (to the right with a right-hand rotation propeller). Occasionally, extreme trim under can cause a boat to list to the left (with a right-hand propeller).

If trimmed "out" too far (Figure 7-20), the propeller may lose its hold on the water, fast vee-bottom boats may start to "walk" from right to left to right, etc. ("chine walking"), steering torque will increase in the opposite direction to that when trimmed in (Figure 7-19), and getting on plane may be difficult or labored. Porpoising of the boat may also occur.

Many newer outboards with power trim can only trim within the 20° range while underway above idle speed. All stern drives and older outboards with power trim have the capability of trimming all the way up, even when the boat is on plane. However, it is unwise to operate on

plane when trimmed beyond the maximum trim position (into the tilt range), as the engine no longer receives side support from the clamp brackets. Severe damage could occur in a turn if the gear housing should strike a submerged object. Figure 7-21 shows proper trim position.

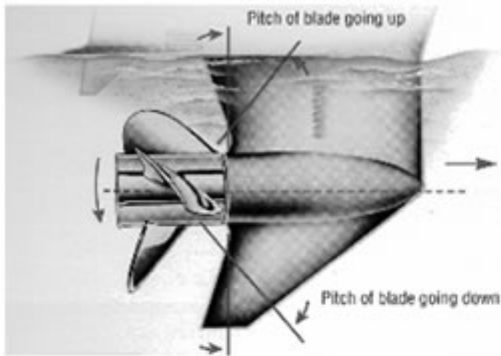


Figure 7-22 Trimmed parallel to water surface. Little or no steering load.

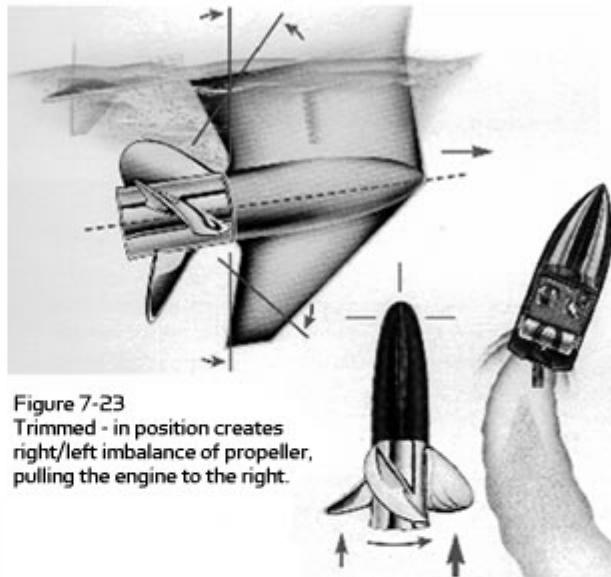


Figure 7-23 Trimmed - in position creates right/left imbalance of propeller, pulling the engine to the right.

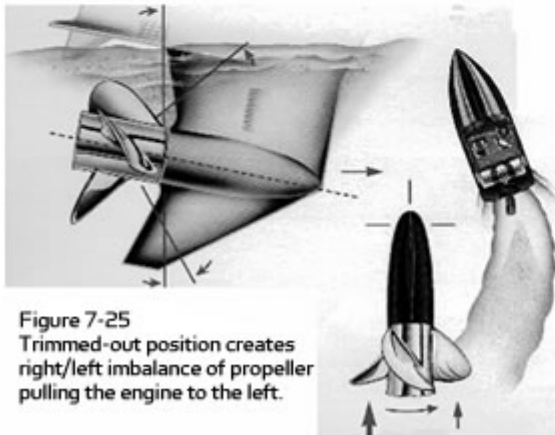


Figure 7-25 Trimmed-out position creates right/left imbalance of propeller pulling the engine to the left.

Figure 7-26

Figure 7-24

### How does trim angle affect steering torque?

When the propeller is run fully submerged and with the propeller shaft approximately horizontal (parallel to the surface of the water) as shown in Figure 7-22, there should be little, if any, steering load. Although this also applies to stern drives, there are other complications due to a stern drive's tilted steering axis, which can independently cause some steering torque.

However, with the engine or drive unit (right-hand rotation propeller) trimmed in (Figure 7-23), because of the propeller shaft tilt, the downward-moving blade on the right side of the propeller shaft has effectively more pitch, while the opposite is true of the upward-swinging blade on the left side (relative to the surface of the water). This right/left imbalance pulls the engine or drive unit to the right, and makes the boat want to go into a right-hand turn. Naturally, the driver must resist this force if the boat is to continue in a straight line.

Figure 7-24 shows the gear housing and propeller of the trimmed-in engine as viewed from the surface of the water. Note that the propeller blade on the right side produces more thrust than the blade on the left, as indicated by different-size arrows, and that the boat is actually being

pulled into a right turn.

The entire situation reverses when the engine or drive unit is trimmed out well past horizontal (Figures 7-25 and 7-26).

To help counteract this steering imbalance, most outboards and all stern drives are equipped with an adjustable trim tab. Since the tab must be in one selected position, the driver must choose the engine trim position that he desires to balance (Figure 7-27).

In many boat and engine installations the engine or drive unit will be operated in a slightly trimmed-out position. This will cause the stem of the engine to move to the left, causing the boat to want to turn to the left. The trim tab, when properly adjusted, can steer the engine back in line, if, in this case, the trailing edge of the trim tab is moved to the left (Figure 7-27). For right-hand steering torque, the opposite is true.

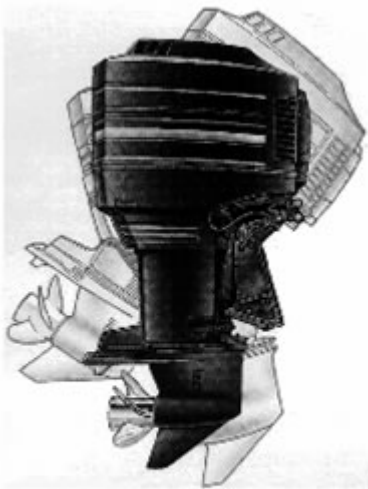


Figure 7-28  
Power trim controls the angle of the drive relative to the transom at the touch of a button.

### **What is power trim?**

Trimming can be controlled far more conveniently by power trim, which is standard on most stern drives, standard on larger outboard motors, and optional on others.

Power trim permits control of the angle of the propeller shaft relative to the boat bottom at the touch of a button (Figure 7-28). While on plane, the angle of the boat bottom to the water has much to do with maximum top speed, fuel economy, handling, and choppy-water ride.

Boat bottoms have the least drag at an angle of from 3° to 5° with the water. If they run flatter than 3°, as most light planing boats tend to do, or steeper than 5°, as stern-heavy boats just barely on plane may do, efficiency suffers. Power trim can pay back dollars in fuel savings or give added thrills and safety with a faster, better-handling boat, or push a stern-heavy boat onto plane that otherwise might not make it.

Here's a useful tip on operating power trim when a boat runs aground. It generally is best to

not try to power out in forward. Rather, with the engine or drive trimmed out sufficiently (Figure 7-20) to not dig into the bottom, but still give the propeller a fair bite, operate carefully in reverse. This works better because, in the trimmed-out position in reverse, there is some downward thrust that helps lift the stern of the boat a little and forces propeller wash under the boat. Operating in forward tends to push the stern down harder against the bottom.



Figure 7-29  
A tachometer measures engine revolutions per minute (RMP).



Figure 7-30  
A speedometer measures boat speed in miles or kilometers per hour or knots

### Why do I need a tachometer and speedometer?

A tachometer ("tach") (Figure 7-29) measures engine RPM while the speedometer (Figure 7-30) measures boat speed in miles or kilometers per hour, or knots. A knot equals one nautical mile per hour, so it is incorrect to use the expression, "knots per hour." Here's the relationship between these three units of measurement:

An engine is designed to run at wide-open throttle (WOT), within certain RPM limits. Without a tachometer, the operator has little opportunity to know if the engine is at a dangerously high or low RPM level. Once the correct propeller is selected, the engine will run at wide-open throttle within the recommended maximum RPM range. Any deviation from this established WOT RPM other than that associated with climatic conditions, elevation, or gross load changes, is an indication of a performance problem.

A speedometer, when used with a tachometer, also will give hints of engine or boat problems, should an unusual speed drop occur. With experience, a boater will be able to detect problems at part throttle using the combination of the tach and speedometer. For a good, solid speed reading, it is important to install the speedometer pickup as low and close to the center of the boat as possible without creating a water disturbance ahead of the propeller or water intakes.



Figure 7-31  
Transom-mounted pitot tube

## Tachometers and Speedometers as Performance Indicators

For engineering tests, extremely accurate and expensive tachometers are used. RPM information from these instruments provides unquestioned input for engineering evaluation. Tachometers commonly installed in boats are not intended to provide this same degree of accuracy. Therefore, a slight variance from the true RPM is common with these instruments.

The common type of boat speedometer consists of a pitot (pronounced PEE-tow) tube, an instrument panel-mounted gauge that is calibrated to indicate miles per hour (MPH), kilometers per hour (KM/H), or knots, and the connecting tube or hose. The pitot tube is usually mounted on the transom so that the lower portion of the tube remains submerged in undisturbed water when the boat is underway (Figure 7-31). The forward portion of the pitot tube incorporates a hole, which points toward the direction of travel. Some newer outboard models have a pitot tube built into the leading edge of the gear-housing strut.

As the boat moves forward, water enters the pitot tube through this hole and compresses the air trapped within the connecting hose and the bellows or Bourdon tube in the gauge. This water-to-air pressure, which varies in relation to the boat speed, actuates the needle movement mechanism, indicating the speed of the boat. The accuracy of the speedometer may suffer from winter freeze damage caused by trapped water in the line or instrument head, from a damaged pitot tube, from weeds, mud, or debris caught on the pitot tube, from a pitot tube that is partially or completely tilted up, or from an improper pitot tube installation location.

For engineering tests, more accurate timing devices are used, such as computers and pressure transducers, whereby water pressure is converted into an electronic signal. This is sent to a computer that then calculates boat speed.

These variables are explained to prepare you for any unusual results that you may obtain in calculating your boat speed, propeller slip, or angle of attack, using the equations in this book.

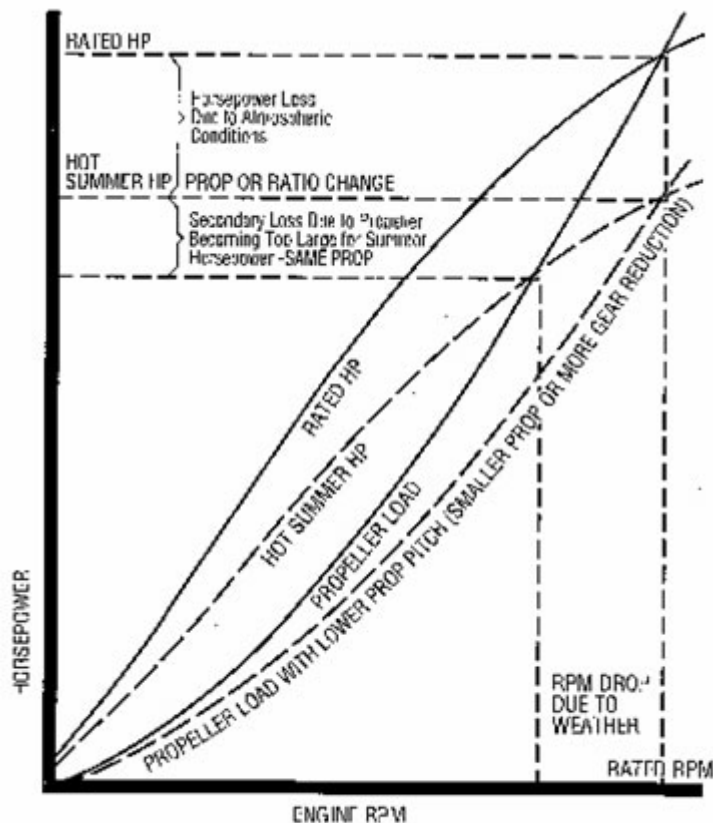


Figure 7-32  
The effect of elevation and climate on engine performance

## How do elevation and climate affect performance?

Elevation has a very noticeable effect on the wide-open-throttle (WOT) power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air, like using a supercharger in reverse. If the boat has been set up at a lower altitude and then moved to a much higher altitude, there will be a noticeable reduction in power, thus RPM.

Although some performance can be regained by dropping to a lower-pitch propeller, thus bringing the WOT RPM back into the recommended range, a basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver propeller repair station can determine how much diameter to

remove from a lower-pitch propeller for specific high-elevation locations.

In some cases, a gear ratio change to more reduction is possible and very beneficial. However, this fix is only safe while the power level is reduced. If the engine is again run at a lower altitude, the gear ratio change must be reversed to prevent excessive torque on drive train parts.

It is a fact that weather conditions exert a substantial effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions now established by the International Standards Organization (ISO).

The marine engine rating code J1228 of the Society of Automotive Engineers (SAE) standardizes the computation of horsepower from data obtained on the dynamometer, correcting all values to the power that the engine will produce at 80.6°F (27°C) temperature, relative humidity of 60%, and a barometric pressure of 29.53 inches (750 mm) of mercury.

Summer conditions of high temperature, low barometric pressure, and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds - as much as two or three miles per hour in some cases (Figure 7-32). Nothing will regain this speed for the boaters, but the coming of cool, dry weather.

An engine, running on a hot, humid summer day, may encounter a loss of as much as 14%

of the horsepower it would produce on a dry, brisk spring or fall day. The horsepower that any internal combustion engine produces depends upon the density of the air, which it consumes and, in turn, this density is dependent upon the temperature of the air, its barometric pressure, and water vapor content (humidity).

Accompanying this weather-induced loss of power is a second, but more subtle, loss. At rigging time in early spring, the engine was equipped with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. With the coming of the summer weather and the consequent drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine may operate at less than its recommended RPM.

Due to the horsepower/RPM characteristics of an engine, this will result in further loss of horsepower at the propeller with an additional 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 the 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 equally important, the engine also will be operating in an RPM range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

### **How does weight distribution affect boat performance?**

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed with a moderate to fast-planing boat, all movable weight-fuel, battery, anchor, passengers-should be as far aft as possible, to allow the bow to come up to a more efficient angle (3°-5°). But on the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable "porposing" (bouncing). Secondly, as weight is moved aft, getting on plane becomes more difficult (Figure 7-34). Finally, the ride in choppy water with some boats become more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit their needs.

Weight and passenger loading placed well forward (Figure 7-35) increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution (Figure 7-36). Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability, and riding comfort. In extreme rough water

conditions, the safety of the boat and passengers may be in jeopardy.



Figure 7-34  
Weight concentration far aft is often preferable for top speed but still has some disadvantages.



Figure 7-35  
Weight concentration far forward impairs performance, handling, and operator visibility



Figure 7-36  
Uneven lateral weight distribution can product severe listing.

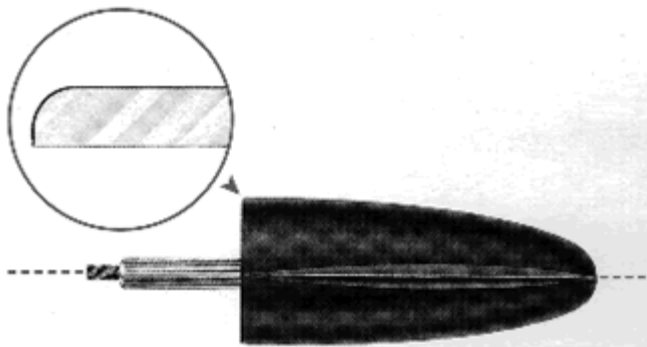


Figure 7-37  
Any torpedo roundint at this corner encourages blowout at a lower speed.

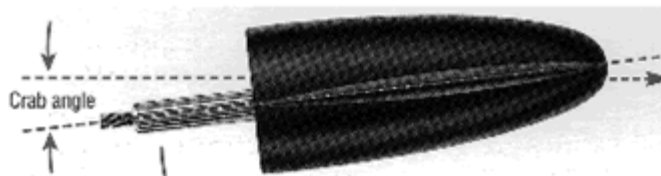


Figure 7-38  
Surfacing right-hand rotation propeller pulls the aft end of the gearcase to the right.

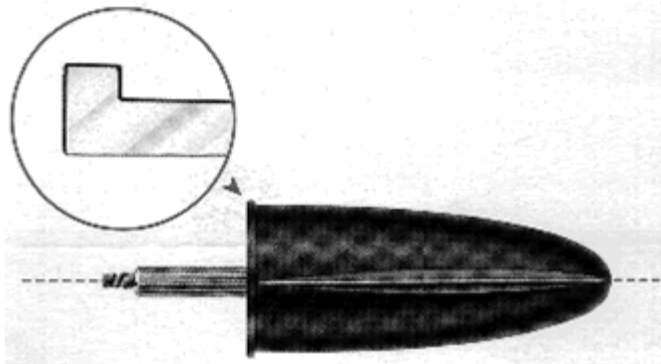


Figure 7-39  
A slightly conical - shaped torpedo with a slight raised sharp edge just ahead of the trailing edge can drive the onset of blowout to a notably higher speed.

## What is "blowout?"

Many high-performance boaters are aware of a phenomenon that limits their top speed below what would otherwise be possible with the available horsepower. This phenomenon is commonly called "gear case blowout," "propeller blowout," or just "blowout." Following is an explanation of why blowout occurs and how to correct it.

## Why Blowout Occurs

To be practical, the torpedo of a non-racing gear case or gear housing must be of a diameter and length just sufficient to house the shafts, gears, bearings, shift mechanism, exhaust passage, and a few other related parts. Hydrodynamics designers can only hope to make the exterior shape of the gear housing the best they can (within their design constraints) to deter cavitation from occurring at the torpedo nose or any surface interruptions, such as a lubricant filler hole or water intake. Inevitably, as speed is increased, cavitation will occur.

Since low pressure is the cause of cavitation, anything that further reduces the pressure on any side of the torpedo will hasten cavitation. Trimming the unit out will cause lower pressure on the underside of the torpedo, around the skeg; but an even more insidious culprit is the effect of a

surfacing propeller pulling the aft end of the torpedo to the right with a right-hand rotation propeller. This causes lower pressure on the left side because of the angle at which the gear case is forced to run through the water. This is commonly called the "crab" angle (Figure 7-38). The typical combination of a surfacing right-hand propeller and trimming out for best speed creates an extra-low pressure pocket on the lower left side of the torpedo.

However, cavitation itself does not cause the "blowout." Blowout occurs when the very low-pressure cavitation bubbles eventually reach back to the aft end of the torpedo in sufficient quantity to suddenly pull in, or connect up with the engine exhaust gases. The cavitation and exhaust gas linkup is more prevalent with a non-through-hub exhaust propeller.

Once the connection is made, the exhaust follows the cavitation bubbles forward and floods out over the low-pressure side of the gear case (the left side with a right-hand

rotation propeller) and feeds back into the propeller blades, causing a sudden and drastic reduction of lift or thrust generated by the low-pressure side of the propeller blades. This partial unloading of the propeller creates four sudden reactions.

1. The bow-lifting effect of the rake diminishes, causing the bow to drop.
2. The hard-steering torque to the right is suddenly reduced, causing the boat to veer slightly to the left.
3. The reduced load on the propeller allows the engine to rev up by 200 to 300 RPM.
4. The wetter boat bottom and reduced propeller efficiency cause the boat to go slower by perhaps a couple of miles per hour.

## How To Correct Blowout

With the latest gear case designs, blowout should not be a problem below 80 MPH. However, if the problem exists, contact your dealer. A special gear case is available for many V-6 outboards and some stern drives that should cure the problem. The gear case known by the name "Crescent" has an extended torpedo nose, more rudder area, improved high-speed cooling water intakes, and a cupped skeg, which greatly reduces "crabbing" and steering pull to the right.

Other than running with excessive trim out, the most significant cause of the blowout is a torpedo that has been buffed in a way that rolls off the trailing edge of the torpedo (Figure 7-37). Some gear cases eliminate this problem by casting the torpedo in a slightly conical shape, leaving a slight raised sharp edge just ahead of the trailing edge of the torpedo (Figure 7-39). This patented feature, which can vary from .005" to .050" in height, retards the connection of exhaust to torpedo cavitation by creating a higher pressure fence much like the diffuser ring or flare on the aft end of a Quicksilver through-hub exhaust propeller, which deters the exhaust from being drawn forward into the low-pressure side of the propeller blades. Within the range given, the higher the bump, the higher the speed protection, but with slight additional drag.

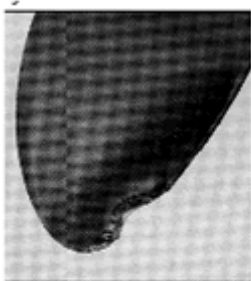


Figure 7-40  
A damaged propeller blade significantly reduces performance.

## How should I maintain and service my propeller?

Essential to good propeller maintenance is periodic inspection to detect even small dings, which can lead to blade failure if not dressed or repaired. A damaged propeller, even one that only appears slightly damaged by running through silt and sand, can significantly reduce performance efficiency and fuel economy, and can more severely damage itself through cavitation erosion emanating from the blades' irregular leading edges (Figure 7-40). In one test with a damaged propeller, top speed fell more than 13%. Acceleration was off over 37%. Optimum cruise miles slowed 21%. Worse yet, damage usually is not done to each blade uniformly and, therefore, the damage can set up imbalance vibrations that can cause fatigue damage to other parts of the engine or drive. If you boat in shallow or rocky waters, you will want to check your propeller more frequently for possible damage.

To aid in the future removal of the propeller, liberally coat the propeller shaft spline with Quicksilver Anti-Corrosion Grease or 2-4-C. To assure that the propeller remains secure on the shaft during the season, periodically check the self-locking prop nut for tightness.

\*Stainless steel propellers only

### **What is marine fouling?**

Fouling is a kind of unwanted buildup (usually animal/vegetable derived) occurring on the boat's bottom and lower unit. Fouling creates additional drag, which reduces boat performance. In fresh water fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals, and other pollutants. In salt water, barnacles, moss, and other marine growth often produce a dramatic build-up of material quickly. So it's important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as anti-fouling paint, will reduce the rate of bottom fouling. However, because lower units (outboard and stern drive) are made primarily of aluminum, be sure to select an anti-fouling paint having a copper-free, organo-tin base. The BIS Tri Butyl Tin Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instruction, it is very effective in controlling marine fouling.

### **What are some common signs that it may be time for a new propeller?**

Your boat takes longer to get on plane than it used to. It uses more fuel. It doesn't seem to run as fast as it did when it was new. If your boat feels sluggish, one of the first things you should check is your propeller. Is it showing signs of wear and tear? Does it have more than its share of nicks, dings and missing paint? These symptoms can accumulate and significantly impair the performance of a perfectly good engine.

### **What is Pitch?**

Pitch is the theoretical distance, in inches, that a propeller moves forward during one revolution. Think of a screw as you turn a screwdriver once around. The distance that the screw travels into the wood is the pitch. Propeller size is specified in inches of pitch.

### **How do I know what pitch is right for me?**

Consult the engine owner's manual to find the recommended wide-open-throttle (WOT) range for your engine. If the current propeller is at WOT RPM within the specified RPM range, select a replacement or upgrade propeller with the same pitch as the current propeller.

If the current propeller isn't at WOT RPM within the recommended RPM range, select a replacement or upgrade propeller with a larger or smaller pitch using the following rules:

Adding 1 inch of propeller pitch will reduce WOT RPM by 150 to 200.

Subtracting 1 inch of propeller pitch will increase WOT by 150 to 200.

If you're upgrading from a three blade to a four-blade propeller, remember that a four-blade propeller generally turns 50 to 100 RPM less than a three-blade prop with the same pitch.

### **Stainless Steel vs. Aluminum?**

It's a question of strength and performance. Aluminum propellers usually cost quite a bit less, however, stainless steel is over five times more durable than aluminum. If you're looking for quicker acceleration, superior top speed, or better overall performance, you should consider a stainless steel propeller.

### **Three- vs. Four-blades?**

Four blade propellers usually:

Plane the boat faster than 3-blade propellers

Keep the boat on plane at a lower speed

Give improved mid-range speed at the same RPM as a 3-blade propeller

Provide quicker acceleration than most 3-blade propellers

Run smoother than 3-blade propellers

Have better holding power in rough conditions

Are less likely to ventilate in sharp turns

Provide better low speed handling

Are not quite as fast on the top end as a comparable 3-blade propeller

### **Hydraulic Outboard Jack Plates?**

In addition to the **power tilt and trim system** that swings the engine around a pivot point on the mounting bracket, flats boat operators find it useful to be able to move the **engine mounting bracket itself up and down** on the transom. A **hydraulic power jack plate** is mounted to the transom of the boat, and then the engine is mounted to the moving part of the plate. The boater can then move the engine up and down as well as tilting it in and out with the power tilt and trim.

The jack plate has several uses, most involving shallow water operation. **If an engine has no jack plate**, it must be mounted low enough so as not to cause cavitation when

running into chop, or when executing turns. In calm water on a straight course, it could be mounted higher, and that's where the jack plate comes in. Jacking the engine up to go across shallow water works better than tilting the engine out in most cases because tilting to high angles puts the cavitation plate in front of the propeller, encouraging cavitation. Lifting the engine vertically keeps the plate above the propeller and aligned with the movement of the boat.

Also, a tilted engine throws a rooster tail of water up into the air. If you throw water up, Newton's Law says it must push you down equally hard. You're in shallow water, and don't wish for the **boat to be pushed down**, especially at the stern. An engine tilted at a high angle to go across shallow water will raise the bow and lower the stern of a boat. A boat equipped with a jack plate can avoid all those negative consequences of tilting the engine; by simply raise the engine up with the jack plate until it is on the verge of cavitation.

### **Better gas mileage, too**

A jack plate also increases **fuel efficiency**, because the engine can be raised as high as any given set of operating conditions will permit for cruising. The less engine you must drag through the water in order to get thrust from your propeller, the better. It may need to be all the way down if it is rough, but calm conditions will allow you to run with the engine higher.

### **Makes planing easier**

Hydraulic jack plates also are useful when it is necessary to get a boat **on or off plane in shallow waters**. To get on plane, the plate is first raised all the way up, then full throttle is applied and the power jack plate is simultaneously started down. As the transom squats in the water initially, the engine is still high enough to miss the bottom, and cavitation is not yet a problem. As the boat starts to come over onto a plane, the engine is starting to arrive down at the proper level for high speed cruising. Slowing down into shallow water is essentially the reverse of the above procedure. As the boat is slowed down, the jack plate is raised, and some also tilt the engine out at the same time, so that when the stern of the boat is at the lowest point coming off plane, the engine is already jacked up high and tilted out a bit to minimize draft.

