The Art Of The SEA TRIAL

Don't Assume Others Know What To Do Or How To Do It

Story And Photography By Steve D'Antonio

"Negative, we don't run vessels at full throttle around here," declared the dealership's captain and lead mechanic, shortly after I handed him my requested sea trial guideline.

Puzzled, I asked, "Why not? The engine has over 200 hours on it and it is rated by the manufacturer to operate at full throttle."

"Do you know anything about the melting temperatures of different metals?" he responded, not without a hint of condescension. As a matter of fact, I did, but that was irrelevant.

In my 24-year career in the marine industry I've witnessed and performed hundreds of sea trials. I'll admit it; I never tire of them and learn something new every time I set out on one. In my opinion, however, the thoroughness with which many are conducted is inadequate at best, and at worst negligent.

There's more to a sea trial than taking the wheel and heading out for a boat ride. As the vessel owner or buyer, you may have to set the standard.

In the vast majority of cases those directing the trials (more often than not industry professionals, mechanics, surveyors, or brokers) either don't understand the goals, are misinformed or improperly trained for the task at hand, are in too much of a hurry, or they are simply too lazy to put the vessel and its systems through its paces to ensure all systems are operating under load and in as close to real-world conditions as possible. Whether you are considering purchasing a vessel, troubleshooting, testing a repair or new installation, or simply making sure all systems are working properly aboard a vessel you own and believe to be sound, the onus falls on you, the vessel owner or buyer, to ensure that a rigorous and complete sea trial is performed. And, while you may not carry out some or all of the tests detailed below, familiarity with and insistence upon them will undoubtedly pay dividends.

Clockwise from top left: All types of engine instrumentation offer valuable information; Tools such as a digital multimeter are an essential part of any sea trial—make sure alternator output is tested with the vessel's battery charger off; Fluid analysis, it's as close as you can get to a mechanic's crystal ball.

WHEN, WHY, AND WHAT'S THE GOAL?

There are a variety of circumstances under which it's advantageous to carry out sea trials. Perhaps the most common, and the one with the most to lose if it's not carried out properly, involves pre-purchase surveys and inspections. In other cases, sea trials should be carried out to diagnose a problem such as an unusual vibration or noise, inability to reach rated maximum rpm (or exceeding it), to search for a leak that occurs while under way, to test a new installation such as a depth finder, sonar, or autopilot, or for engine-related issues such as excessive fuel consumption, smoke, or overheating. In still other cases, sea trials should be carried out after major engine or running gear repairs and after a repower.

Pre-purchase sea trials and those carried out after a major refit or repair work necessarily take on greater importance, beyond most other trials. As the buyer or service customer, it likely represents your final opportunity to determine if the vessel handles properly and the way you would expect her to handle in a seaway, and to uncover any obvious or latent flaws or defects in the systems, engines, or gear as the vessel is under way.

Rest assured, while it's certainly not the intent, your goal is *not* to avoid breaking things. I notice a tendency in many sellers, professional captains, and mechanics to baby a vessel during trials, in essence to avoid running the vessel hard. To an extent, it's understandable. Owners treat their vessels well and hired professionals don't want to be responsible for a failure. However, if something fails or breaks on a sea trial whose parameters are reasonable and within the bounds of the engine manufacturer's operating requirements, chances are good it was going to break anyway. It would simply do so at a later date and when you are less prepared.

The goal of the sea trail is, among other things, to determine if all systems function normally even when run hard and to do so under the conditions and time and place of your choosing. The alternative is less appealing to be sure. Once you own the vessel or after you've left the yard that carried out the repair, refit, or repower work, you're on your own in more ways than one, and your financial and legal recourse may be murky. More importantly perhaps, the failure may come on a dark, windy night while you are transiting a lee shore or while in heavy seas. Both could lead to the loss of the vessel, or worse.

If you contract with an industry professional to assist you during the sea trial, such as a surveyor and/or mechanic, you will be relying heavily on them to do the heavy lifting, the monitoring, the testing, and to ask the right questions. By no means should you assume they will do any of this. I've encountered many surveyors

Clockwise from top left: Sea trials should be rigorous, especially when evaluating recent engine or running gear work; There's no substitute for a trained professional mechanic who's working as your advocate; Mechanically controlled engines should have their rpm verified using a handheld strobe tachometer.

and mechanics who appeared to simply be along for the ride during sea trials, and more interested in chatting than checking. You should make your expectations of them clear and do so in writing.

Among other things, mechanics should, at a minimum, inspect the engine and generator for full compliance with the manufacturer's original installation guidelines (such compliance applies to new vessels as much as used) to assure you that they meet these important standards. Compliance with these guidelines may spell the difference between whether or not you have warranty coverage, as well as a reasonable expectation of reliability.

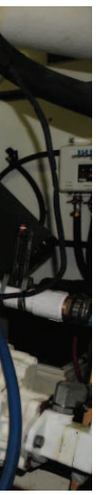
Mechanics should check crankcase and exhaust back pressure and strobe taching mechanical engines, as well as exhaust plumbing and gas temperature. For electronic engines, mechanics should come prepared to use a laptop to retrieve error codes and monitor operating characteristics. I've worked with all manner of mechanics and in short, the value of a savvy, experienced, curious one cannot be overstated. It's one more sharp arrow in your sea-trial quiver.

PREPARATION

Before the vessel ever slips her lines, preparations for a sea trial must be made. Make certain you have a note pad to record any observations you may have. A camera can also be helpful, preferably one that takes still as well as video images.

Begin by ensuring the vessel is ready to go to sea, especially if she's been dockside for some time, or in the case of a pre-purchase trial, if the present owner rarely puts to sea in anything other than benign conditions, or rarely puts to sea, period. Vases and other glassware as well as furniture, TVs, and other gear that might fall or shift should be securely stowed. The appropriate number of PFDs must be present, as well as a Coast Guard-approved safety gear package, and those aboard should be made aware as to their location.

Tanks, fuel, water, and waste should be at least half full. Ideally, fuel and water should be full. Where tanks are concerned, filling them will not only increase engine load (particularly for semi-planing vessels), it will also be more likely to reveal leaks. I've encountered tanks whose tops were so badly rusted that I could pass several fingers through the hole, yet, because they were not full they didn't leak during a sea trial.



Conduct a dockside, visual inspection of the vessel's key systems, particularly running gear, including the engine and transmission fluids, stuffing box, gearshift and throttle components, shaft coupling, exhaust system, and steering gear. Be sure to look under engines and generators and note (and photograph if you can) any accumulation of oil, coolant, or other fluids. You'll return to this area after the trials are complete for a comparison look.

Ensure that engine alarms operate. Typically, this can be done by turning the keys or ignition switches to the "on" position without starting the engines. A low oil pressure alarm should chirp or sound continuously. If you hear nothing, it's possible the engines are operating without low oil pressure or high water temperature alarms. Without them, there will be no warning to an impending overheat or catastrophic loss of oil pressure, either of which could cause rapid, irreparable, and costly damage to the engines.

For pre-purchase sea trials, in advance of the established trial date ensure that a qualified individual, typically the broker or a designated captain, will be present to operate the vessel. You should not operate the vessel except under their watchful eye and only when sea room permits, especially if the waters are unfamiliar to you. If you already own the vessel and she's being tested after refit or repair work, the yard that carried out the work should run the vessel with you aboard.

Among the most valuable arrows in your sea-trial quiver, an infrared pyrometer will enable you or a professional to analyze the operation of a variety of components, from exhaust systems to stuffing boxes.

Each and every system that could or might ever be operated while under way should be operational and should be checked. This includes, obviously, main propulsion engines; however, it also includes the wing engine and the generator. The former should be operated to propel the vessel for a minimum of 10 to 15 minutes, as well as the generator. Engines should be cycled through gear positions several times to ensure proper operation of controls and transmissions. Additionally, a back-down test should be performed. More on that in a moment.

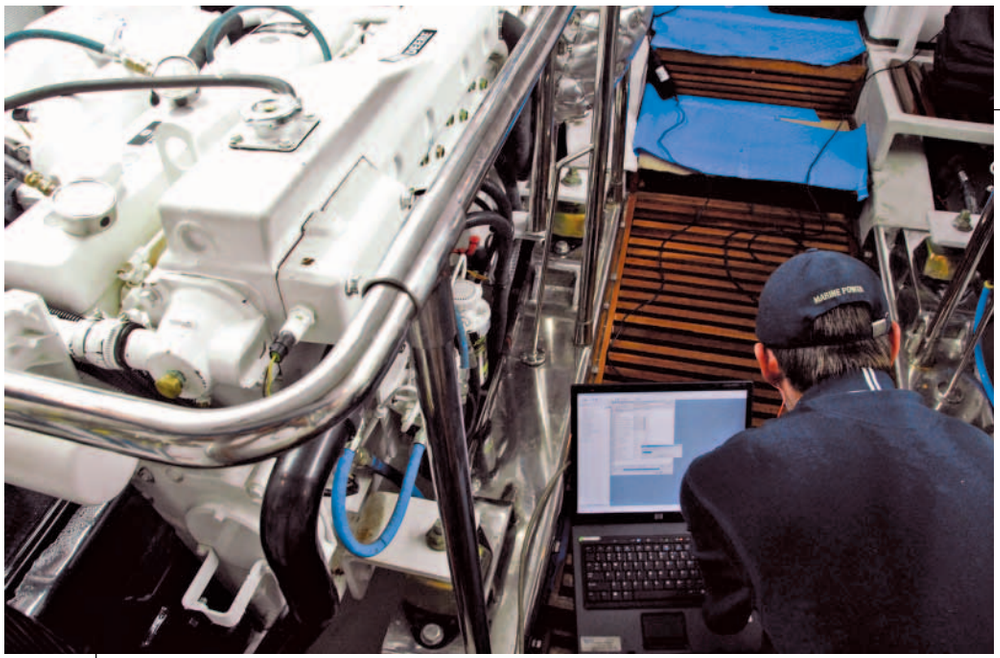
Generators should be run, while under way, to at least 50 percent and preferably at or above 80-percent load. Doing so ensures that they are capable of carrying and sustaining a heavy load that is not hindered in any way by vessel motion and they add heat to the engine room for a more thorough, real-world test. Include in the "run list" watermakers, and of course, all navigation electronics, radar, depth finders, plotters, etc. If the sea trial is being carried out to test a specific installation or repair, a new or repaired turbocharger, heat exchanger, or running gear component, then emphasis should be placed on this equipment specifically and it should be closely monitored during the trials.

One of the more important and often overlooked aspects of a sea trial is temperature monitoring, specifically the temperature of the air being drawn into the engines and generators. Don't confuse this with the temperature of the engine room. While that's important in its own right, it is not as easily quantifiable as the intake air temperature and there is not a clearly defined mandate for its limits. The cooler an engine room operates, the better off all of the gear and equipment that lives there will be, particularly "soft" items like motor mounts, hoses, insulation, and electrical components.

Most engine manufacturers specify a maximum differential temperature between the air their engines consume and the air outside the vessel, often referred to as the delta T, or symbolized as ΔT. Typically, the maximum delta T is 30°F, which means, on a 78°F day, the temperature of the air entering the engine should not exceed 108°F. Ideally, you should obtain the installation and operating specifications for your engine or the one you are sea-trialing. These, in as little as two pages, often include a variety of useful data including the manufacturer's specified maximum delta T and required area for engine combustion air cross section, as well as the maximum rated and idle rpm, and fuel consumption curves.

Such documents are available for most engines, even those no longer manufactured. Don't rely on others to provide this information or recite it from memory, as even professionals make mistakes. Going into a sea trial without this document is tantamount to flying blind.

The conditions under which a vessel is trialed can have a significant impact on how she performs. Most vessels, even those that are poorly found and ill maintained, will perform acceptably in glassy calm conditions. If she's a vessel that's designed for bluewater, offshore passagemaking, then she should be tested



in offshore conditions to the extent possible, i.e., something other than a dead calm. Clients of mine who were interested in such a vessel recently waited until gale conditions were predicted before scheduling a sea trial. After quality of construction, seaworthiness was high on their list, and rightfully so. They made this known to the broker, who confirmed that the vessel was designed to endure such conditions with aplomb. When the appropriately nasty forecast arrived, they all went for a sea trial, and they ran the vessel hard. This was the only way they could know for certain that they would feel comfortable and safe aboard, and it worked; they were duly impressed with the vessel's seakeeping abilities when exposed to seas and wind from all directions.

Top: Interconnecting an electronically controlled engine to a laptop and program that will display and record a plethora of operation and historical information is a sea-trial prerequisite. Above: Check fluids before and after sea trials. Look for significant changes in level, color, and odor.

While displacement vessels can only be run at displacement speed, planing or semi-planing vessels can be operated at a wide range of throttle settings. If you are sea-trialing a planing vessel, she should be operated at planing speeds even if you rarely intend to operate her that way. Often, flaws or insipient problems only reveal themselves when the vessel is operated in this manner, especially if it's something the present owner rarely does.

In advance of conducting your sea trial, prepare a written outline (see sidebar) that clearly describes the manner in which you would like the vessel to be operated. Provide a copy to the designated captain as well as to the broker.

SEA TRIAL

This process cannot be rushed. This is your one and only chance to thoroughly evaluate the vessel and its systems or repairs and you simply should not be pushed through the necessary steps.

When you arrive at the vessel for a sea trial the engines should be cold, not having been run for at least a day. Begin by shutting off and disconnecting shorepower. In order to evaluate them, engine start batteries should have no charge source present when engines are being started. If the vessel is a twin screw, start one engine and let it run for five or 10 minutes; observe and note any unusual noises or abnormalities. Is the engine difficult to start? Did it require more than three seconds of cranking? Was excessive smoke produced? Shut that engine down and start the other engine, carrying out the same observations. Only after the engine start-up procedure has been completed should other equipment such as generators, air conditioning, or ventilation systems be started.

Trials should be conducted with the vessel in its typical cruising trim, which means the engine room hatches and doors should remain shut at all times, other than when folks are passing through them. Any other condition does not represent how the vessel will be used and may provide false readings, particularly for engine room temperature and engine performance. This also means that the generator should not be providing power to the DC electrical system via a battery charger or inverter/charger. Doing so can easily mask an inoperative alternator. During the sea trial, house and start battery voltage should be monitored, and if you are relying on a mechanic to carry out engine tests, the output amperage of the alternator(s) should be checked as well. Because so many inverter/chargers default to charge mode automatically, when a generator is

Top: Among the more commonly overlooked aspects of engine room operation is the delta T, or the difference between outside air temperature and air being consumed by the engines. Above: The loads placed on the average motor mount are tremendous and the role they play in reliable vessel operation is significant. They should be inspected at rest and while under load.

running for instance, the only way to be certain they are not providing power is to turn the genset off while testing alternator output. Aboard approximately 25 percent of the vessels I sea-trial, operators are so accustomed to running with the generator on, all the time, they are unaware that their alternator isn't producing any charge current.

Prior to getting under way, the helmsman should be reminded to carefully monitor all engine instrumentation, especially coolant temperature and oil pressure, and to heed, but not rely on, their related alarms.

Once under way, with the engines at normal operating temperature and proper sea room, run (both engines for twins) at 1500 rpm for 10 minutes. At the end of this timed run you or your expert, surveyor, or mechanic should measure the temperature of all accessible components of the exhaust system using an infrared pyrometer. No portion of the dry exhaust, or the metallic riser for wet exhaust systems, should exceed 200°F. The same holds true for the wet exhaust's rubber and fiberglass components; however, in practice, anything over 150°F in their case is cause for alarm (most exhaust alarms themselves are set to sound at 165°F).

If all systems appear to be operating normally and no serious anomalies are noted, you may move on to the next phase of the sea trial, running at 80-percent load (or 60 percent of maximum rated rpm if the engine instrumentation does not provide load information) for 60 minutes. Advance the throttle in 500-rpm increments, dwelling at each for five minutes (for some engines, those that are rated at a maximum 2500 rpm for instance, that's only one dwell period), during which time temperature readings should be taken for the exhaust and stuffing box. On a sea trial I performed recently, one of the vessel's stuffing boxes overheated seriously enough to cause a column of steam to rise above it; clearly, that's too hot. While there's no hard and fast guideline for stuffing boxes, my rule of thumb is similar to that of engine air intake, a delta T of no more than 30°F above ambient seawater temperature.

If the engine aboard the vessel you are sea-trialing is capable of providing load and fuel consumption information, make a note of this at each rpm increment. Beware, however; at idle speed and very low rpm these readings may be erroneous and thus, at these rpm, they should be taken with the proverbial grain of salt.

During the 60-minute, 80-percent run, periodically visit the engine room to take temperature readings of the aforementioned components as well as the following:

• Alternator casings: These rarely exceed 200°F.

• Coolant expansion tank: This should be roughly the same as the dash gauge, rarely above 195°F.

• Transmission: Most rarely exceed 160°F although some, such as Detroits, will run as hot as 180°F. It's best to get a spec from a dealer or the manufacturer. An overheating transmission can be a sign of worn clutch discs, a fouled cooler, or improperly adjusted controls.

• Oil temperature: This should be measured at the middle of the oil pan. Typically at this load it will ideally be roughly similar to coolant temperature, and as high as 220°F. Higher than this temperature leads to increased oxidation and shorter lubricant life. In short, it does no good, while anything under about 160°F will cause varnish and sludge build-up, which in turn could lead to eventual oil starvation of bearings, rings, and valve trains.

• Thrust bearing: For vessels so equipped, the acceptable temperature is dependent upon the manufacturer. For one of the more popular brands, the range for the thrust bearing itself (don't confuse this with the CV joint) is approximately 120°F to 160°F. Anything above this often indicates an alignment issue.

Entering the engine room of a vessel that is under way, in a seaway, while inspecting and taking readings on rotating machinery, is not for the faint of heart. Unless you are experienced in doing so, leave this to a professional. If you do choose to enter this space to undertake this work, be sure to wear both ear and eye protection and be certain you have no loose clothing, draw strings, tassels, or ponytails that can be ingested by propeller shafts, belts, or pulleys.

At the conclusion of the 60-minute, 80-percent run, check and record the temperature at the engine air intake. Now you are ready to move on to the

100-percent throttle run. Advance the throttle to its maximum position, while monitoring the tachometer. The engine should reach the wide-open throttle rating established by the manufacturer and slightly more. For instance, an engine rated at 2500 rpm should attain 2500–2540. The slight overage allows for weight that almost certainly will be added to the vessel. If an engine fails to reach its full rated rpm, it's failing to meet the manufacturer's installation specifications and it's also an indication that it's overloaded. Overloading an engine never bodes well and in severe cases it can lead to serious damage. Slightly underloading, on the other hand, by slightly over-revving, ensures the engine is in a safe rpm zone. If the engine exceeds the rated rpm by too much, that's undesirable as well. While it won't cause any damage per se, it means the engine is failing to provide the horsepower it was designed to produce, and you are paying for more engine than you are getting until it's corrected. Once again, ideally it should reach rated rpm and just slightly more.

If it's an electronically controlled engine, the instrument rpm reading is likely accurate. If the engine is mechanically governed, then the rpm should be verified with a stroboscopic shop tachometer.

If after three or four minutes the engine fails to achieve its rated rpm, that is, it's either significantly under (more than 100 rpm) or significantly over (more than 50 rpm), then there's little sense in continuing this portion of the trial as it will serve no purpose. If it does reach the proper rpm, stay the course for 10 minutes while carefully monitoring instruments for signs of overheating or dropping oil pressure. At the conclusion of this segment of the trial, return to the engine room to take another round of temperature readings and do so once again while idling back to the dock.

If you are interested in the vessel's performance and speed specifically, be sure to conduct reciprocal runs and then average the results to eliminate the effect of tides, current, and wind.

Next, conduct a steering system test. At approximately 1200–1500 rpm, execute two full turns, rotating the wheel lock to lock. During this test you or your expert should be in the lazarette or "tiller flats" area monitoring rudder stocks, tiller arms, tie rod hardware, hydraulic rams, cables, and pulleys, etc., for any signs of wear or inappropriate movement.

As you are returning to the dock, perform a back-down test. While motoring ahead at approximately 1000 rpm, shift to neutral, wait three seconds, and then shift into reverse, applying no throttle for at least 10 seconds. The engines should not stall. If they do then there may be an issue with propeller size, gear reduction, or simply idle rpm. Either way, such stalling is not normal and it's not safe. Just imagine if it were to occur in a marina fairway on a windy day.

If the engines do not stall in this test, quickly increase throttle to approximately 50 percent and hold it there for three to five seconds. During this test, you or your expert should be in the engine room closely monitoring motor mounts and checking for signs of excessive movement or loose hardware.

The trial doesn't end when you've returned to the dock. While it may be uncomfortably warm, now is the time to conduct another inspection of the engine room. How does it smell? Is there an odor of fuel, coolant, burning oil, exhaust, or the telltale acrid whiff of electrical or battery anomalies? Has any fluid accumulated under the engines or generators? Is there water, oil, or fuel in the bilge that wasn't there before?

The final step in your sea trial tour? Conduct an analysis of all vital fluids, engine and generator crankcase oil and coolant, transmission fluid, and, if applicable, stabilizer hydraulic fluid.

No sea trial will reveal all of a vessel's secrets, but thorough ones can be expected to tell you what you need to know to complete an evaluation of a vessel you are considering buying or one that you've entrusted to others for repair or refit work.

SEA TRIAL *Guidelines*

- Engine instruments should be closely monitored throughout the sea trial.
- Start one engine, let it run for five minutes, shut it down, then start the other engine. Let it run for five minutes, then restart the first engine.
- When it is safe to do so and in compliance with the Rules of the Road and good seamanship practices, operate the main engines while under way at 1500 rpm for 10 minutes.
- Operate the main engines at 80-percent load for 60 minutes.
- Operate the main engine at 100-percent load for 10 minutes.
- At 1200–1500 rpm, perform two full lock-to-lock steering turns while observing steering gear.
- Perform reverse test: While moving ahead at approximately 1000 rpm, shift to neutral, and then with no more than a three-second delay, shift to reverse without providing any throttle. Wait five seconds and then advance the throttle to 50–75 percent for five seconds.
- Operate the get-home system at 80-percent load for a minimum of 15 minutes.
- Engine instruments should be closely monitored throughout the sea trial.