

Understanding Shaft Lines, Bearings and Propellers

An owner's guide to torque transmission,
alignment, sealing and propeller condition

A shaft line carries every propulsion load
from the gearbox into the water.

Reliability depends on alignment, support,
sealing and a correctly matched propeller.

Absolute Marine

Commercial thinking for private cruising.



SHAFT SEAL

COUPLING

STERN TUBE / BEARINGS

TRANSMIT | SUPPORT | SEAL

GUIDE OVERVIEW

What the shaft line is designed to do

The shaft line transmits gearbox torque to the propeller, supports the rotating shaft, carries or transfers thrust and prevents uncontrolled seawater entry where the shaft passes through the hull.

SCOPE	This guide focuses on conventional inboard shaft-driven yacht propulsion. It covers rigid and flexible couplings, shafts, bearings, stern tubes, seals and fixed-pitch propellers. Exact dimensions, clearances and procedures remain manufacturer- and vessel-specific.
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By the end of this guide, you should be able to:

- Trace the propulsion load path from gearbox coupling to propeller and hull structure.
- Identify shafts, couplings, thrust arrangements, bearings, stern tubes, seals and propeller hardware.
- Recognise alignment, bearing, leakage, fouling, impact, corrosion and cavitation warning signs.
- Understand why haul-out inspection and loaded sea-trial evidence complement each other.
- Ask better questions during purchase, survey, refit, grounding response and offshore preparation.

CORE PRINCIPLE	A shaft line is one continuous mechanical system. A bent propeller, worn bearing, poor alignment or failing seal can increase load and damage elsewhere in the driveline.
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Safety

A rotating shaft and coupling can catch clothing, tools or body parts instantly. Keep guards fitted, isolate all starting and control arrangements before inspection, and treat any below-waterline seal or stern-tube work as a flooding risk.

SYSTEM ARCHITECTURE

How torque, thrust and structure connect

The shaft line does more than turn the propeller. It must remain aligned while transmitting cyclic torque, propeller thrust, bending loads and impact loads into bearings, gearbox or a separate thrust structure.



Thrust, vibration and alignment loads travel through the complete driveline and into the hull structure.

The main load paths

- Torque: Engine power passes through gearbox, coupling and shaft to the propeller.
- Thrust: Propeller thrust is carried through the shaft to the gearbox thrust bearing or a separate thrust bearing.
- Radial support: Stern-tube and strut bearings control shaft position while allowing rotation.
- Water containment: The stern tube and shaft seal control seawater or stern-tube oil at the hull penetration.
- Structural support: Engine beds, thrust foundations, stern tube and struts transfer loads into the hull.
- Monitoring: Vibration, temperature, leakage, sound, rpm and vessel performance reveal changing condition.

SHARED CONSEQUENCES	A shaft-line fault can affect propulsion, gearbox load, flooding control and steering response at the same time. The consequence is often greater than the cost of the failed component.
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PROPELLER SHAFTS

Materials, geometry, tapers and securing details

The shaft must withstand torque, bending, fatigue, corrosion and local contact stresses. Surface condition and transitions around keyways, threads, bearings and seals are particularly important.

DIAMETER

Sized for torque, bending and fatigue

MATERIAL

Strength, corrosion and repair compatibility

TAPER / KEY

Transfers propeller load without local damage

RUNOUT

Straightness supports alignment and sealing

Surface finish and transitions around tapers, keyways, threads and bearings are important fatigue details.

Area	What can go wrong	Owner focus
Shaft material and diameter	Undersizing, unsuitable alloy, corrosion or undocumented replacement reduces margin.	Material certificate where available, diameter, model calculations/records and repair history.
Straightness and runout	Impact, poor handling or fatigue bends the shaft or flange.	Measured runout at defined points, not visual judgement alone.
Taper and propeller fit	Poor contact, fretting or incorrect lapping concentrates load.	Contact pattern, key fit, draw-up/fit procedure and no rocking on the taper.
Key and keyway	Loose fit, bottoming, sharp corners or corrosion create movement and fatigue stress.	Correct dimensions, end shape, fit and evidence of fretting or cracking.
Threads, nuts and locking	Damaged threads, wrong nut order or poor locking allows propeller movement.	Manufacturer arrangement, cotter/tab/locking method and adequate thread condition.
Seal and bearing journals	Wear grooves, pitting or poor finish damage seals and bearing film.	Surface measurement, sleeve history, corrosion and compatibility with replacement seals.

DO NOT HIDE SHAFT DAMAGE

Sleeves and coatings can restore a running surface when correctly engineered, but they should not conceal cracking, excessive diameter loss or unsuitable repair of a highly loaded shaft.

COUPLINGS AND THRUST

Connecting gearbox, shaft and hull structure

The coupling transfers torque and helps define alignment. Propeller thrust must then be carried through the gearbox or a dedicated thrust bearing into a structure designed for the load.



Component	Purpose	Owner focus
Rigid flange coupling	Provides a precise bolted connection between gearbox and shaft.	Face condition, bolt fit/torque, fretting, runout and measured alignment.
Flexible coupling	Controls torsional vibration or small movement depending on design.	Correct rating, element condition, age, bolts and no misuse to mask misalignment.
Split or clamp coupling	Clamps to shaft without an integral flange.	Correct fit, fasteners, key/anti-slip arrangement and no evidence of movement.
Gearbox thrust bearing	Carries propeller thrust internally and transfers it through engine mounts/beds.	Gearbox rating, mount condition, end float, oil and evidence of axial movement.
Separate thrust bearing	Carries thrust directly into a dedicated foundation.	Bearing condition, temperature, lubrication, foundation and flexible links either side.
Thrust foundation	Spreads axial load into hull structure.	Cracking, corrosion, loose fasteners, movement and repair history.

FLEXIBLE IS NOT ALIGNMENT-FREE	Most flexible couplings tolerate only limited offset or angular error. Static alignment and mount condition remain important even when a flexible element is fitted.
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SHAFT BEARINGS

Supporting rotation in water, oil and structure

Bearings support the shaft while maintaining a fluid film or rolling contact. Wear, contamination, lost lubrication or misalignment increases movement, heat and vibration.

WATER-LUBRICATED

Rubber/composite bearing
uses seawater film

OIL-LUBRICATED

Stern tube uses controlled
oil supply and seals

ROLLING ELEMENT

Inboard bearing carries
radial or thrust load

STRUT BEARING

External support controls
shaft movement

Bearing clearance, alignment, lubrication and water quality determine how well the shaft remains supported.

Bearing type or area	Common weakness	Owner focus
Water-lubricated cutless bearing	Abrasive water, poor flow, misalignment or excessive clearance wears grooves and lands.	Clearance measurement, even wear, water supply, debris and shaft surface.
Oil-lubricated stern-tube bearing	Low oil, contamination, seal failure or wrong viscosity damages the bearing.	Tank level, pressure/head, oil condition, leakage and temperature.
Strut bearing	Strut movement, grounding or corrosion changes support position.	Strut-to-hull condition, bearing fit, alignment and impact history.
Intermediate bearing	Foundation movement, poor lubrication or misalignment creates heat and noise.	Temperature trend, lubrication, fasteners and shaft contact pattern.
Rolling-element thrust/radial bearing	Lubrication loss, brinelling, fatigue or incorrect preload/end float.	Noise, vibration, temperature, oil/grease condition and specialist measurement.
Bearing carrier / housing	Loose fit, corrosion or cracking allows the bearing to move.	Fit, fasteners, foundation, witness marks and repair history.

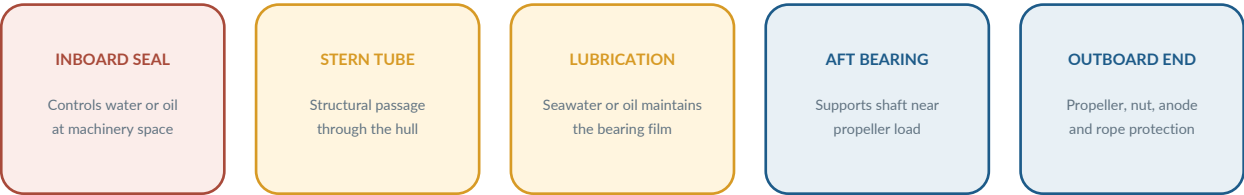
CLEARANCE NEEDS
CONTEXT

A single clearance number is only useful when compared with the bearing material, shaft diameter, manufacturer's limit, support spacing and wear pattern.

STERN TUBES AND LUBRICATION

The structural passage through the hull

The stern tube supports bearings and contains seawater or lubricating oil around the shaft. Its condition affects alignment, flooding risk, bearing life and pollution control.



Area	What can fail	Owner focus
Stern-tube structure	Corrosion, cracking, bond failure or movement relative to hull.	Internal/external inspection, supports, welds/laminates and grounding history.
Water-lubrication supply	Blocked scoop, hose or injection line starves bearing or seal.	Source, valves, flow, venting, hose condition and behaviour at low speed/reverse.
Oil header or gravity tank	Low level, wrong head, air, contamination or unnoticed loss.	Normal level, alarms, top-up trend, sampling and isolation arrangement.
Oil circulation pump / cooler	Loss of power, blocked filter or cooler failure raises temperature.	Backup, pressure/flow alarms, filter and loaded temperature.
Vent and drain arrangements	Air pockets or trapped water prevent correct lubrication and diagnosis.	Known fill/vent procedure and no undocumented blanking or cross-connection.
Environmental leakage	Oil loss to sea or seawater entry contaminates the system.	Consumption trend, sheen, oil condition and applicable environmental requirements.

TOP-UP IS NOT DIAGNOSIS

Repeated addition of stern-tube oil or water-lubrication flow changes deserves explanation. A stable system should have a known consumption or leakage baseline.

SHAFT SEALS AND STUFFING BOXES

Containing water where the shaft enters the yacht

Shaft seals must contain seawater while allowing a rotating shaft to move slightly with mounts, thrust and hull flex. Each type has different cooling, leakage and emergency requirements.



Every seal depends on shaft surface, alignment, cooling or lubrication and a clear emergency response to leakage.

Seal type or area	Common weakness	Owner focus
Packed stuffing box	Packing too tight overheats shaft; too loose leaks excessively.	Correct drip/temperature behaviour for the design, packing age, hose and adjustment access.
Mechanical face seal	Damaged faces, lost compression, bellows/hose failure, air or debris causes leakage.	Bellows age, set distance, clamps, vent/burp or water-feed procedure and spare retention collar where applicable.
Lip seal	Worn lip, shaft groove, fishing line or lost lubrication damages sealing edge.	Shaft/liner surface, spare seal position, water/oil supply and replacement method.
Oil stern-tube seal	Lip/face failure allows oil loss or seawater entry.	Header level, sampling, leakage monitoring, liner condition and emergency arrangement.
Stern-tube hose / bellows	Age, cracking, chafe, wrong clamp placement or movement causes sudden leakage.	Manufacturer interval, material, full inspection, clamp condition and no unsupported load.
Emergency sealing provision	No practical method exists to reduce leakage after seal or hose failure.	Soft patches, plugs, compression method or shaft-locking plan only where designed and practised.

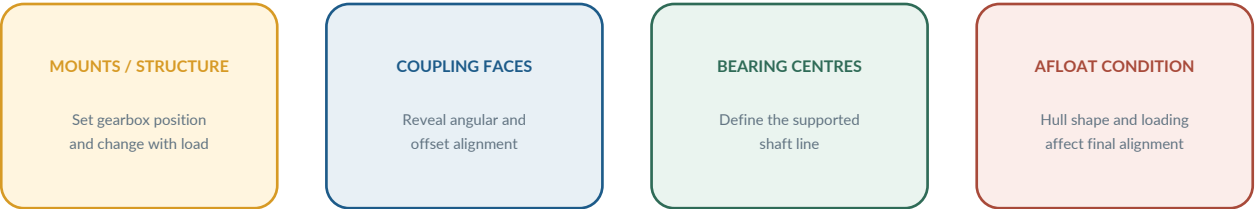
SEAL LEAKAGE CAN ESCALATE QUICKLY

A small change in leakage may indicate lost cooling, shaft movement, fishing line or hose failure. Treat it as a flooding-control issue as well as a maintenance fault.

ALIGNMENT AND SHAFT STRAIGHTNESS

Why the yacht must be considered as a complete structure

Alignment places gearbox, couplings, shaft bearings and stern tube on a compatible centreline. Hull flex, launch condition, loading, mount settlement and bearing wear can all change that relationship.



Condition or measurement	What it can reveal	Owner focus
Coupling face and offset alignment	Angular and parallel relationship between gearbox output and shaft.	Measured afloat after settling, at suitable temperature and with mounts in good condition.
Shaft runout	Bent shaft, flange error or local surface distortion.	Measurement location, support condition and comparison with applicable limits.
Bearing wear pattern	Uneven support or misalignment across the shaft line.	Clearance at several directions, contact pattern and relationship to strut/stern tube.
Mount movement	Settled or failed mount changes gearbox height and torque reaction.	Compression, oil damage, fasteners, loaded movement and replacement history.
Hull loading and tank state	Large changes in trim or structure alter the shaft line.	Align in the specified afloat condition and revisit after major weight or structural change.
Vibration analysis	Frequency may distinguish shaft speed, propeller blade pass, engine order or bearing fault.	Use repeatable rpm/load data and competent interpretation rather than subjective feel alone.

ALIGNMENT IS NOT ONE BOLT ADJUSTMENT	Changing engine mounts to improve coupling readings can move load elsewhere. The complete bearing line, shaft straightness, hull condition and thrust path should be considered.
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PROPELLER FUNDAMENTALS

Diameter, pitch, blade area and rotation

The propeller converts shaft torque into thrust by accelerating water. Its geometry must match the engine, gearbox ratio, shaft speed, hull resistance and available aperture.

DIAMETER
Sets swept area and absorbed power

PITCH
Nominal forward travel per revolution

BLADE AREA
Controls loading, thrust and cavitation margin

RAKE / SKEW
Shapes clearance, noise and load distribution

The propeller must match engine power, gearbox ratio, shaft strength, hull speed and available aperture.

Feature	What it influences	Owner focus
Diameter	Swept area, efficiency, absorbed power and required hull/tip clearance.	Correct size for aperture, ratio and power; no undocumented reduction to hide overload.
Pitch	Nominal advance per revolution and engine loading.	Actual measured pitch, previous repitching and ability to reach specified loaded rpm.
Blade count and area	Thrust capacity, smoothness, cavitation margin and drag.	Match to power, wake, noise target and aperture rather than more blades automatically being better.
Rake and skew	Blade position, clearance, pressure pulses and load distribution.	Repair should preserve designed geometry and balance.
Rotation and handedness	Direction of thrust and twin-screw manoeuvring behaviour.	Match gearbox output direction, taper and securing hardware.
Material	Strength, stiffness, corrosion behaviour and repairability.	Alloy identification, dezincification/corrosion, previous weld repair and compatibility with shaft/anodes.

PROPELLER CHOICE IS AN ENGINEERING DECISION	Changes to diameter, pitch, blade area or gearbox ratio affect engine load, shaft torque, cavitation, clearance and vessel performance. Review the complete propulsion system.
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PROPELLER FLOW AND LOADING

Cavitation, ventilation, wake and hull clearance

A propeller operates in the disturbed water behind the hull. Excessive local blade loading or poor inflow can reduce thrust, create erosion and transmit noise and vibration into the yacht.

CAVITATION

Local pressure forms and collapses vapour

VENTILATION

Air is drawn from surface or hull flow

WAKE / NON-UNIFORM FLOW

Each blade sees changing water velocity

TIP / HULL CLEARANCE

Insufficient spacing raises noise and pressure pulses

Phenomenon	Possible cause or effect	Evidence to consider
Cavitation	Local pressure falls enough to form vapour; collapse can erode blades and create noise.	Pitting pattern, load/speed, blade geometry, wake and specialist propeller assessment.
Ventilation	Air reaches blades from the surface, hull or exhaust and causes loss of thrust.	Occurs with heel, waves, turns or trim; note rpm rise and intermittent thrust.
Non-uniform wake	Each blade sees changing inflow, producing cyclic pressure and vibration.	Hull appendages, shaft angle, blade count/skew and vibration at blade-pass frequency.
Insufficient tip clearance	Pressure pulses interact strongly with hull, increasing noise and vibration.	Measured clearance, hull structure, diameter change and designer guidance.
Overloading	Too much pitch/diameter, fouling or vessel weight prevents rated engine speed.	Loaded rpm, smoke, gearbox temperature, fuel burn and hull/propeller condition.
Singing or tonal noise	Blade-edge vibration or wake interaction creates a narrow frequency tone.	Speed range, blade-edge condition and specialist modification rather than random grinding.

DAMAGE PATTERNS ARE CLUES

Cavitation erosion, edge damage, polishing and unequal blade marks can reveal loading and inflow problems. Repair the cause as well as the visible blade.

DAMAGE, FOULING AND CORROSION

Rope strikes, grounding, blade damage and material loss

Underwater damage can create immediate vibration or a small change that develops into fatigue. The whole driveline should be considered after a significant impact or entanglement.

FOULING

Growth raises drag and changes blade loading

ROPE / NET

Wrapped material loads shaft, seal and bearings

IMPACT

Bent blade or shaft causes vibration and fatigue

CORROSION / EROSION

Material loss weakens blades, shaft or hardware

Condition	Possible consequence	Owner response
Marine growth	Higher drag, imbalance, cavitation and engine overload.	Clean before performance judgement and inspect shaft, rope cutter and intakes at the same time.
Rope, net or line	Loads propeller, shaft, gearbox, strut and seal; line may enter lip seals.	Reduce load/stop, assess leakage and vibration, then inspect underwater and at seal.
Blade impact or grounding	Bent/cracked blade, shaft runout, coupling movement or bearing/strut damage.	Do not assume a dressed blade is the only repair; measure the complete driveline.
Propeller imbalance	Cyclic force accelerates bearing, seal and structural fatigue.	Professional measurement and balance after repair, not visual matching alone.
Galvanic corrosion	Shaft, propeller, nut or strut loses material due to electrical potential differences.	Bonding/anodes, shore-power conditions, alloy compatibility and corrosion pattern.
Cavitation erosion or dezincification	Surface pitting or weakened alloy can progress despite cosmetic repair.	Identify mechanism, material and remaining section before repair or reuse.

**NEW VIBRATION AFTER
IMPACT IS SIGNIFICANT**

Continuing to run through vibration can convert a repairable propeller fault into bearing, seal, coupling or shaft damage. Use the minimum operation needed to preserve safety.

MONITORING AND WARNING SIGNS

Learning what normal rotation, temperature and leakage look like

Shaft-line defects often show through a change in vibration, temperature, leakage, sound or propulsion performance. Record the operating condition rather than describing a symptom only as present or absent.



Observation	Possible interpretation	Owner response
New vibration at shaft speed	Bent shaft, coupling, propeller imbalance, bearing wear or fouling.	Note rpm, load, direction, sea state and whether it changes in neutral or gear.
Blade-pass vibration or hull drumming	Propeller wake, blade damage, cavitation or insufficient clearance.	Compare after cleaning and inspect propeller geometry and hull interaction.
Bearing or stuffing-box heat	Lost lubrication, excessive packing compression, misalignment or wear.	Reduce load, compare temperatures and inspect lubrication/leakage before damage escalates.
Shaft-seal leakage increases	Seal wear, hose/bellows issue, fishing line, shaft movement or lost cooling.	Treat as flooding risk; inspect bilge rate and prepare containment/isolation.
Oil level changes in stern tube	Seal leakage, seawater entry, temperature change or incorrect reading.	Record quantity and sample condition; investigate repeated top-up or rising level.
Reduced speed at same rpm / higher fuel use	Fouling, blade damage, cavitation, propeller mismatch or hull condition.	Compare clean-condition baseline and loaded engine/gearbox data.
Metallic knock or coupling dust	Loose bolts, failed flexible element, key movement or excessive driveline lash.	Stop or reduce load and inspect before continued torque application.

DO NOT NORMALISE IT

A seal that has always leaked more on one tack, a bearing that runs hotter than the other or a narrow-rpm vibration deserves explanation. Familiarity does not remove fatigue or flooding risk.

MAINTENANCE STRATEGY

Haul-out inspection, measurements, records and spares

A shaft line needs both afloat evidence and out-of-water inspection. Good records explain what was measured, what limits were used and why components were repaired or replaced.

Area	Good maintenance evidence	Why it matters
Afloat baseline	Vibration, bearing/seal temperature, leakage, rpm, speed and load recorded.	Provides comparison before and after haul-out or repair.
Shaft and coupling	Runout, taper/key condition, flange/coupling inspection and bolt records.	Confirms torque transfer and straightness rather than appearance alone.
Bearings and supports	Clearances, wear pattern, strut/stern-tube condition and replacement fit.	Shows whether alignment and lubrication remain credible.
Seal and stern tube	Seal age, shaft surface, hose/bellows, water/oil supply and leak history.	Controls flooding, lubrication and pollution risk.
Propeller	Pitch, diameter, blade tracking, balance, cracks/corrosion and repair report.	Confirms engine loading and smooth thrust production.
Alignment	Afloat alignment after settling and after mount, shaft, strut or structural work.	Reduces bearing, seal, coupling and gearbox load.
Post-work sea trial	Loaded rpm, vibration, temperature, leakage and vessel speed documented.	Confirms the complete system under representative demand.

Offshore spares and recovery equipment

- Seal-specific emergency parts, hose/bellows clamps, approved packing and tools where owner intervention is realistic.
- Flexible-coupling element or critical fasteners only where replacement and alignment can be completed safely.
- Stern-tube oil or approved lubricant, sampling containers and clean transfer equipment for the installed system.
- Leak-control materials, bilge-pump capacity and lighting suitable for safe inspection near the shaft line.
- Drawings, clearances, seal procedures, propeller data, alignment records and specialist/haul-out contacts.

WORK TO REFER	Shaft removal, crack testing, propeller repair, bearing fitting, alignment, seal commissioning, stern-tube repair and structural/strut work require competent specialists and suitable lifting or haul-out facilities.
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FAILURE RESPONSE

Protecting propulsion, flooding control and the driveline

A shaft-line failure can involve rotating damage and seawater entry simultaneously. The immediate response should reduce load, protect people and preserve enough time to control leakage or manoeuvre safely.



Evidence	Possible failure	Immediate thinking
Sudden severe vibration	Propeller/shaft impact, rope, coupling, bearing, mount or strut failure.	Reduce load or stop; avoid re-engagement until leakage and external/internal damage are assessed.
Rapid shaft-seal leakage	Seal face/lip, bellows/hose, clamp or shaft movement failure.	Protect crew, increase bilge control, reduce/stop shaft rotation and apply designed containment if safe.
Bearing temperature rises	Lost water/oil lubrication, excessive packing, misalignment or bearing failure.	Reduce load and restore verified lubrication only within the approved procedure.
Shaft or propeller entanglement	Rope/net loads seal, bearing, gearbox and shaft.	Stop rotation, assess flooding and do not send a person into the water unless conditions and controls are appropriate.
No thrust despite shaft rotation	Propeller lost/damaged, hub/key failure or severe ventilation.	Stabilise vessel and compare rpm, shaft movement and underwater evidence.
Oil loss or seawater in stern-tube oil	Seal or line failure compromises lubrication and pollution control.	Reduce load, monitor bearing/seal condition and seek repair before prolonged operation.

DO NOT APPROACH A MOVING SHAFT

A visual inspection is not worth entanglement injury. Stop and isolate all sources of shaft movement before removing guards or reaching near couplings, seals or bearings.

Twin-engine degraded operation

After one shaft line is disabled, consider stopped-propeller drag, whether the shaft must be locked, remaining-engine load, steering response and the possibility that a freewheeling damaged shaft could worsen leakage or bearing damage.

OFFSHORE READINESS

Buyer questions and readiness checklist

An offshore-ready shaft line has known geometry, measured bearing and alignment condition, controlled sealing, a correctly matched propeller and a crew able to respond to vibration or leakage before options disappear.

Area	Questions for purchase or survey
Architecture	Can the complete shaft, bearing, thrust, stern-tube, seal and propeller arrangement be traced and documented?
Shaft and coupling	Are material, dimensions, runout, taper/key condition, coupling and bolt arrangements supported by records?
Bearings and supports	Are clearances, wear pattern, struts, stern tube and thrust foundations credible and recently measured?
Sealing and lubrication	Is seal type, age, shaft surface, water/oil supply, leakage baseline and emergency response known?
Propeller and loading	Are diameter, pitch, blade condition, balance and loaded engine rpm appropriate for the yacht?
Damage history	Are grounding, rope strike, water ingress, shaft replacement and propeller repair events fully explained?
Degraded operation	Are shaft-locking, one-engine operation, leakage control, spares and haul-out options realistic for the cruising plan?

Quick readiness check

	Readiness statement
☐	I can trace torque and thrust from gearbox coupling through shaft, bearings and propeller.
☐	Shaft material, dimensions, runout, coupling and propeller-fit information are available.
☐	Bearing clearances, stern-tube condition and alignment are supported by recent evidence.
☐	Seal type, normal leakage, lubrication/cooling and emergency response are understood.
☐	The propeller is clean, undamaged, balanced and matched to the engine and gearbox ratio.
☐	There are no unresolved vibrations, hot bearings, oil changes, leaks or impact concerns.
☐	Spares, leak-control materials and access support realistic owner-level response.
☐	More than one person knows how to stop shaft rotation and respond to rapid seal leakage.

KEY TAKEAWAY

A dependable shaft line combines sound shaft and propeller geometry with controlled alignment, suitable bearings, reliable lubrication and sealing, credible thrust support and early recognition of vibration, heat, leakage or impact damage.

Guidance to consult

Use the installed gearbox, coupling, shaft-seal, bearing and propeller manufacturers' current instructions, together with applicable flag-state, coding, class, insurance, yard and propeller-specialist requirements.

Understanding Yacht Systems

Practical guides for owners, buyers
and offshore cruising crews.

AMTG-017

Understanding Shaft Lines, Bearings and Propellers

RELATED GUIDES

AMTG-013 Understanding Marine Diesel Engines
AMTG-016 Understanding Gearboxes and Marine Transmissions
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