



Navy 44 Systems

Skipper/XO Training

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Outline of Topics



- Propulsion System
 - Westerbeke Auxiliary Diesel Engine
 - Fuel System
 - Cooling System
 - Exhaust System
 - Propulsion Shafting and Propeller
- Navy 44 Through Hulls
- Skipper Marine Head
- Water systems
- Refrigeration System
- LP Gas Galley Stove
- Bilge Pumping System
- Steering System
- Corrosion Protection
- Miscellaneous Topics
 - Fluid Identification and Storage



Westerbeke Diesel Engine



- Why a diesel engine?
 - Simple, reliable, higher efficiency, and safer
- Differences from gasoline engines
 - Max Compression Ratios: Gas = 12:1; Diesel = 25:1
 - Ignition
 - Gas = Sparkplug;
 - Diesel = Spontaneous Combustion with *direct* fuel injection
 - Higher efficiency fuel
 - Diesel has more stored energy per gallon (147,000 BTU vs. 125,000 BTU)

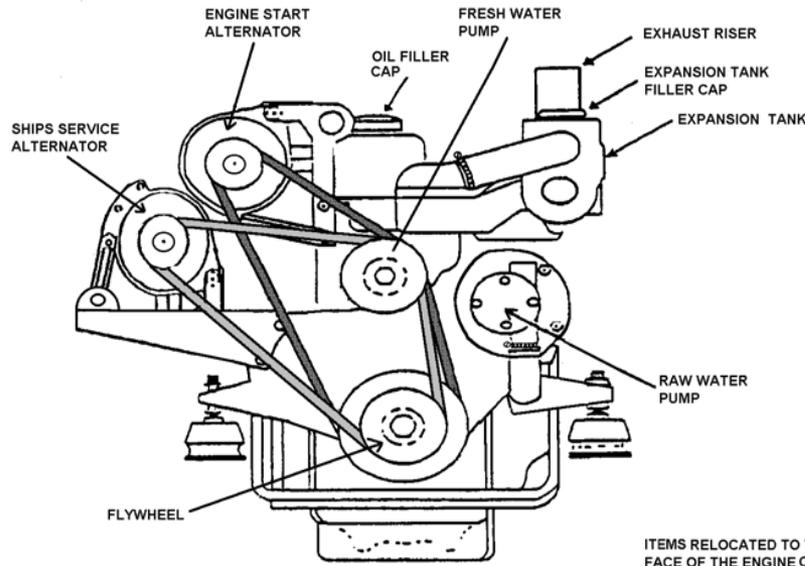
Diesel fuel is less flammable!



Westerbeke Diesel Engine

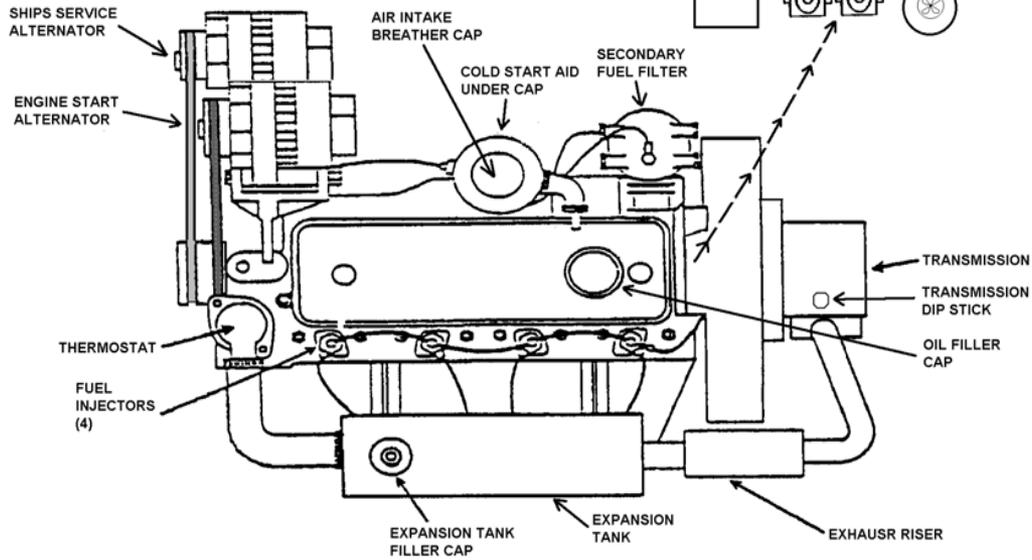
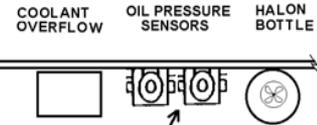


- Description
 - Westerbeke Model W-40-NA
 - 4 Cylinder; Water Cooled
 - Compression ratio 22:1
 - 37 H.P. at 3000 RPM
 - Dual Loop Cooling System
 - Fuel Consumption 0.8 gph @ 1800 RPM (Optimum Cruise)
 - Secured with rubber cushioned mounts to reduce vibration
 - 5 non-compressible fluids
 - Sea/Raw Water, Coolant, Oil, Transmission Fluid, Diesel Fuel



FRONT VIEW

ITEMS RELOCATED TO THE INSIDE FACE OF THE ENGINE COMPARTMENT



TOP VIEW



Starting a Westerbeke Diesel Engine



- Precautions

Within 30 Seconds After Start You Must Have:

- Oil Pressure Indication
- Water Discharge From Exhaust

OR

SHUT THE ENGINE DOWN

Engine Alarm Must Be ARMED whenever the Engine is Operating

**10 - 12 seconds of cranking max per start attempt
If it does not start, wait 30 sec then try again**



Westerbeke Diesel Engine



- Normal Engine Start Procedures (BIB 3-4.5)
 - Ensure Engine Pre-Start Checks are complete (BIB 3-4.4)
 - Energize the electrical system
 - Engine-Start Battery to ON
 - Ship Service (SS) Battery Selector to “Both” (UP)
 - Ensure the following switches are in the ON position
 - DC Main Circuit Breaker
 - Start Battery Alternator
 - SS Battery Alternator
 - Engine Alarms
 - Note-Racor filter alarm will sound for 4 sec when electrical power comes on, if the red light then comes on, there is water in the bowl



Westerbeke Diesel Engine



- Normal Engine Start Procedures (BIB 3-4.5)
 - Procedures Cont
 - Ensure that the clutch is not engaged (knob below throttle lever is out)
 - Advance the throttle to $\frac{3}{4}$ throttle or greater
 - Depress the Pre-heat button on the Engine Instrument Panel for approx. 15 sec
 - Simultaneously depress the Pre-heat and start buttons until the engine starts.
 - If oil pressure is not indicated within 30 seconds, **SHUT THE ENGINE DOWN**
 - Check the transom exhaust for water. If no water is evident within 30 seconds, **SHUT THE ENGINE DOWN**
 - Advance the throttle to a fast idle (1200-1500 RPM) and check

	Idle	Fast Idle
Oil Pressure	20-30 #	30-60 #
Coolant Temp	170-190 F	170-190 F
Ammeter	0-15 Amps	30-50 Amps



Westerbeke Diesel Engine



Operating Limits

Belt Tension $\frac{1}{4}$ - $\frac{1}{2}$ inch at midpoint

RPM **Idle** 750-1000
 Cruise 1800-2200
 Max 2500

Max Heel **17°** continuous
 25° for 30 minutes

Oil Pressure **30 – 60 psi** normal
 10-15 psi Alarm

Temperatures **170° – 190° F** normal
 205° F Alarm



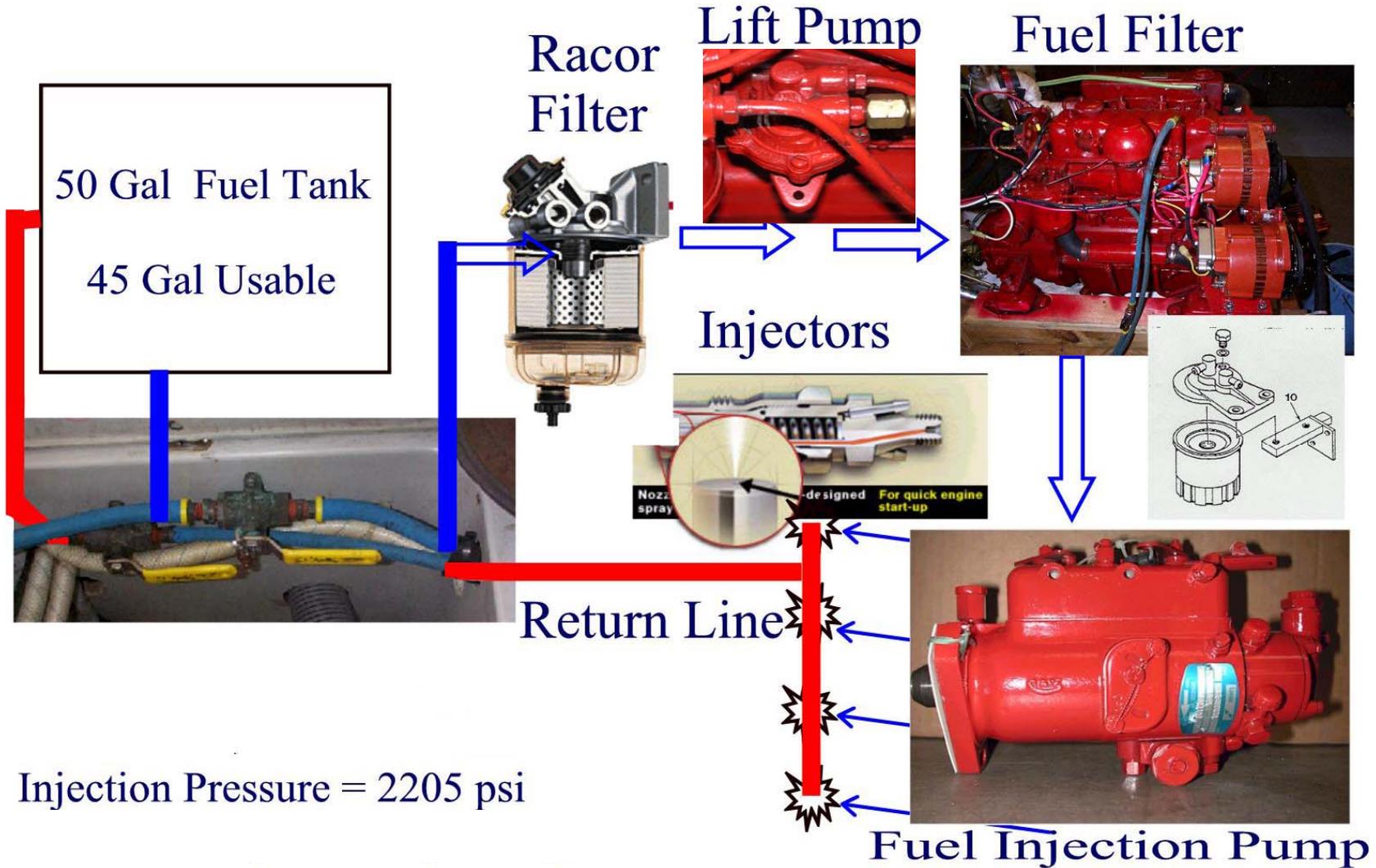
Westerbeke Diesel Engine



- Fuel System
 - Closed Loop Return System
 - 50 gal aluminum tank (45 gal useable)
 - 2 Bronze shutoff valves in midships bilge
 - Primary Racor filter (10-micron) mounted port aft outside engine compartment
 - 4-second “Water Alarm” and “Light” on switch panel
 - Transparent sediment bowl on bottom with drain
 - Engine mounted secondary filter
 - High pressure injector pump



Fuel System Flow



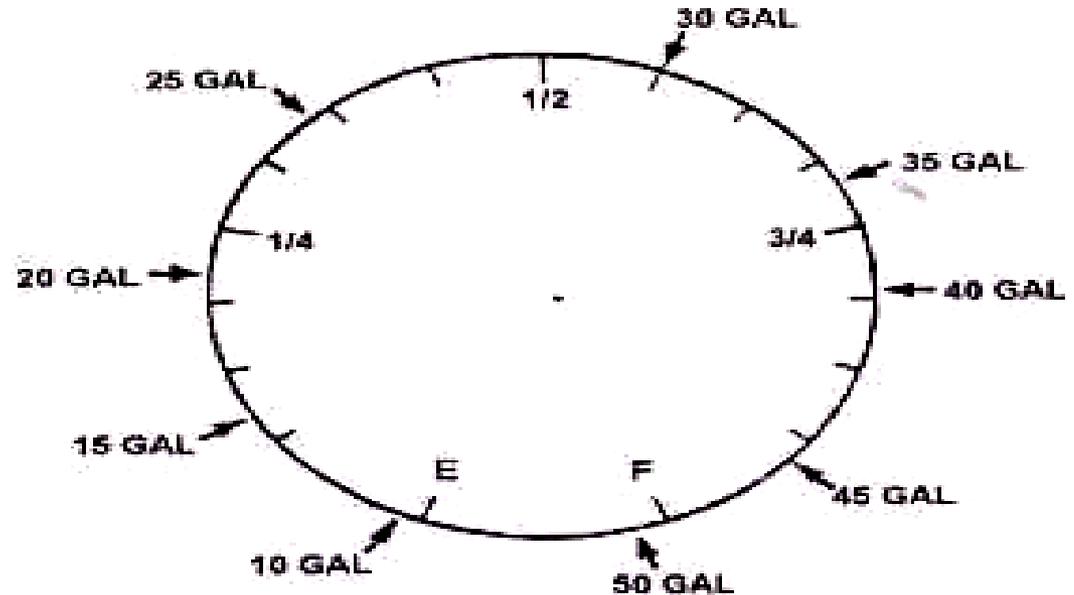


Fuel Quantity Indications



- Fuel Quantity Gage is non-linear due to conformal shape of fuel tank

FUEL QUANTITY GAUGE



DIP STICK READINGS

GALLONS

45
40
35
30
25
20
15
10
5

INCHES UP FROM BOTTOM

13 1/2
12 1/4
10 3/4
9 3/4
8 1/2
7
5 3/4
4 1/4
3



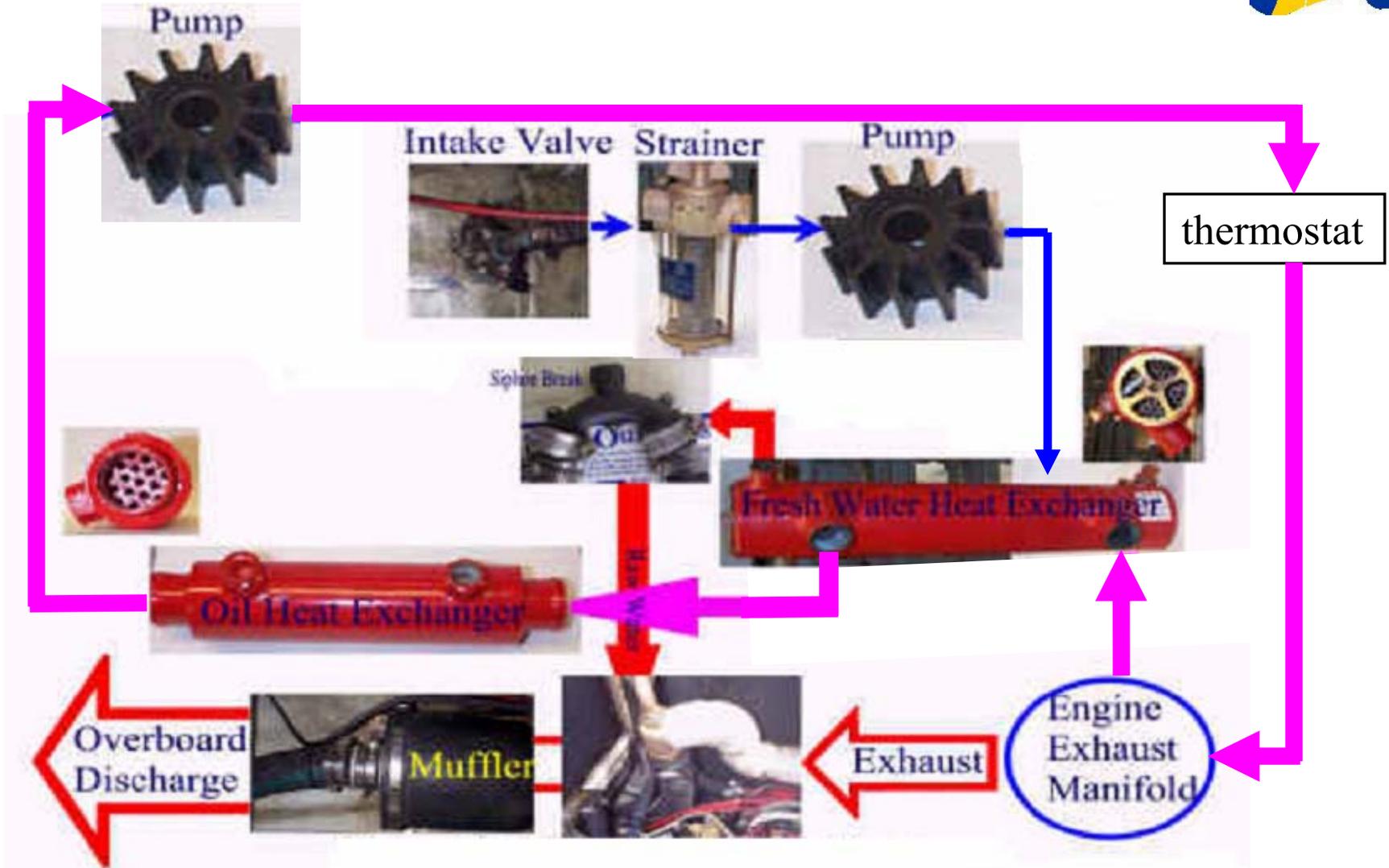
Westerbeke Diesel Engine



- Cooling System
 - **Two Independent Loops**
 - Primary Loop: Captive fresh water and antifreeze coolant circulates inside the engine and “around” heat exchanger tubing
 - Secondary Loop: Raw/salt water circulates outside of engine “through” heat exchanger tubing and exhaust
 - **Siphon break and high loop:** Located in secondary loop and exhaust pipe to prevent sea water from back-flowing into engine



Westerbeke Cooling System

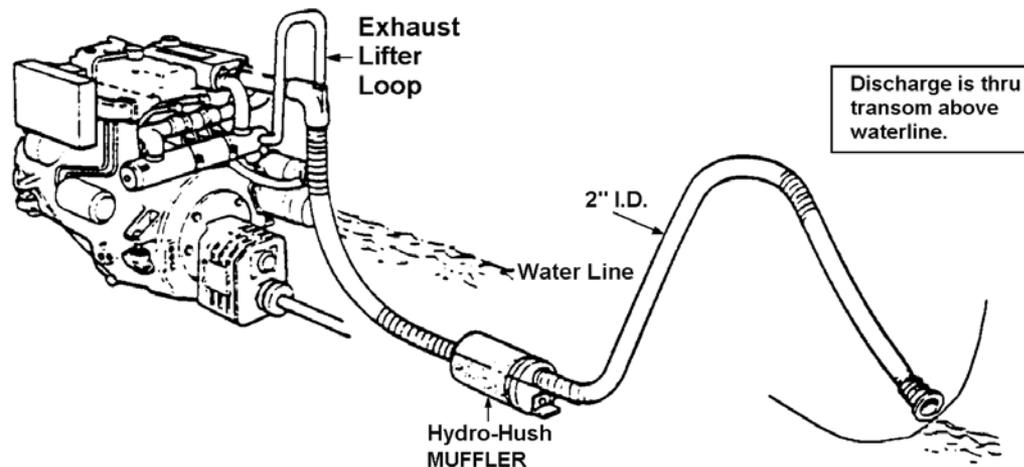




Westerbeke Diesel Engine



- Exhaust System
 - Water cooled exhaust riser
 - Anti-siphon valve (located on port bulkhead above engine)
 - Hydro Hush exhaust muffler with drain plug
 - High Loop before exiting at transom



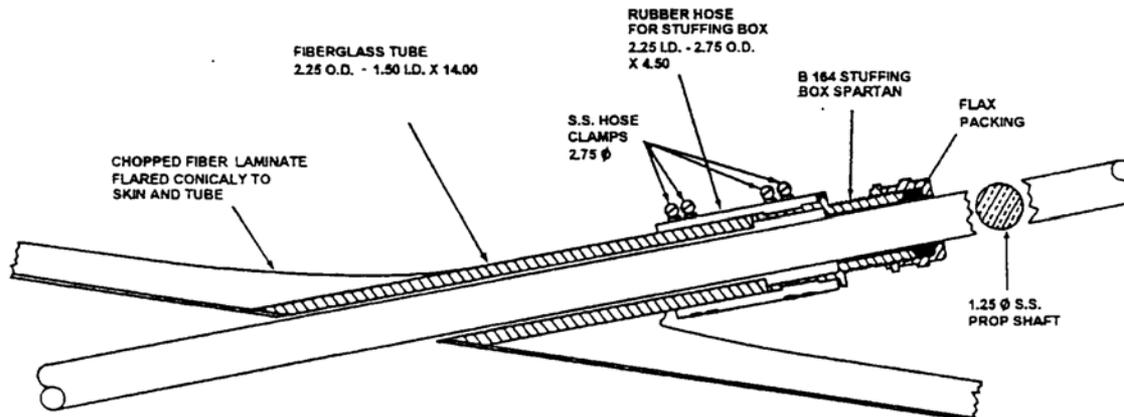


Propeller Shaft and Prop



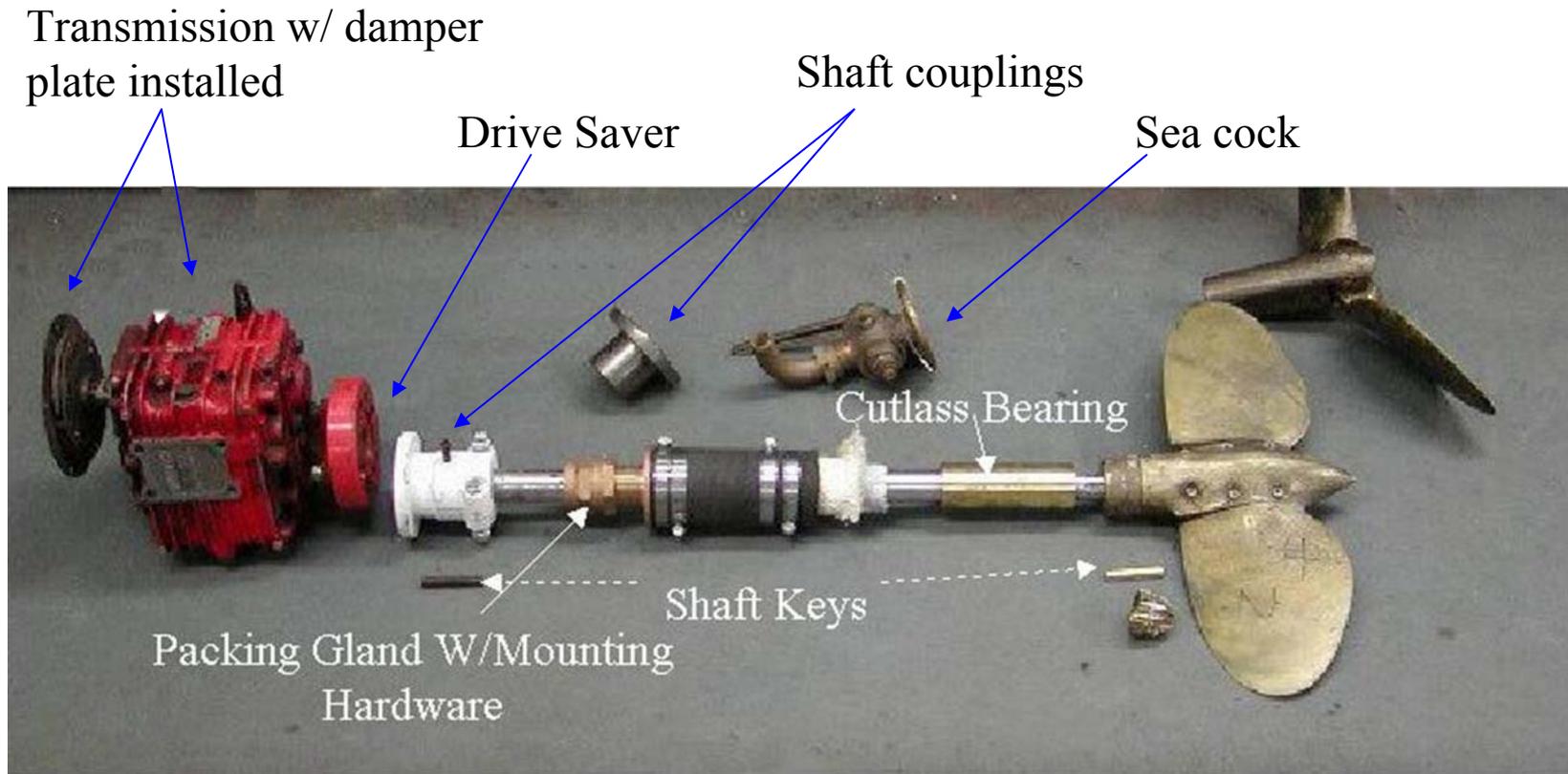
- Components

- Spartan Stuffing Box - Provides the seal inside the boat
 - **Lubricated and cooled by sea water (2 - 3 drops per min)**
- Shaft Log - Isolates packing gland movement from boat
- Flex Coupling between transmission and prop shaft
- Cast manganese bronze strut with Cutlass bearing supports outboard end of shaft
- Max Prop, 19-inch diameter feathering propeller





Drive Train





Engine Problems

Problem	Cause	Action
Excessive vibration	<ol style="list-style-type: none">1) Prop not unfeathered2) Bent or misaligned shaft3) Loose mounts	Secure engine and investigate
Engine fails to secure (runaway engine)	Broken/disconnected throttle linkage	<ol style="list-style-type: none">1) Pull T-handle2) Block air intake3) Secure fuel valve

Always try simple or easiest first!



Engine Problems



Problem	Cause	Action
No Cooling Water Discharge	<ol style="list-style-type: none">1) Sea cock closed2) Sea strainer clogged3) Raw water pump failed	<ol style="list-style-type: none">1) Secure engine2) Check sea cock3) Check strainer4) Check belts and hoses5) Remove cover and check impeller
Engine stops suddenly – unintentional engine shutdown	<ol style="list-style-type: none">1) Fouled prop2) Air/water contamination in fuel line	<ol style="list-style-type: none">1) Throttle idle and neutral2) Check prop3) Check fuel level and valves4) Check fuel at injectors



Engine Problems



Problem	Cause	Action
Engine will not crank (underway with following sea)	<ol style="list-style-type: none">1) Electrical2) Exhaust muffler flooded3) Raw water siphoned into cylinders	<ol style="list-style-type: none">1) Check battery voltages and wiring2) Check all fluid levels3) Check and drain muffler4) Check if engine can be turned manually



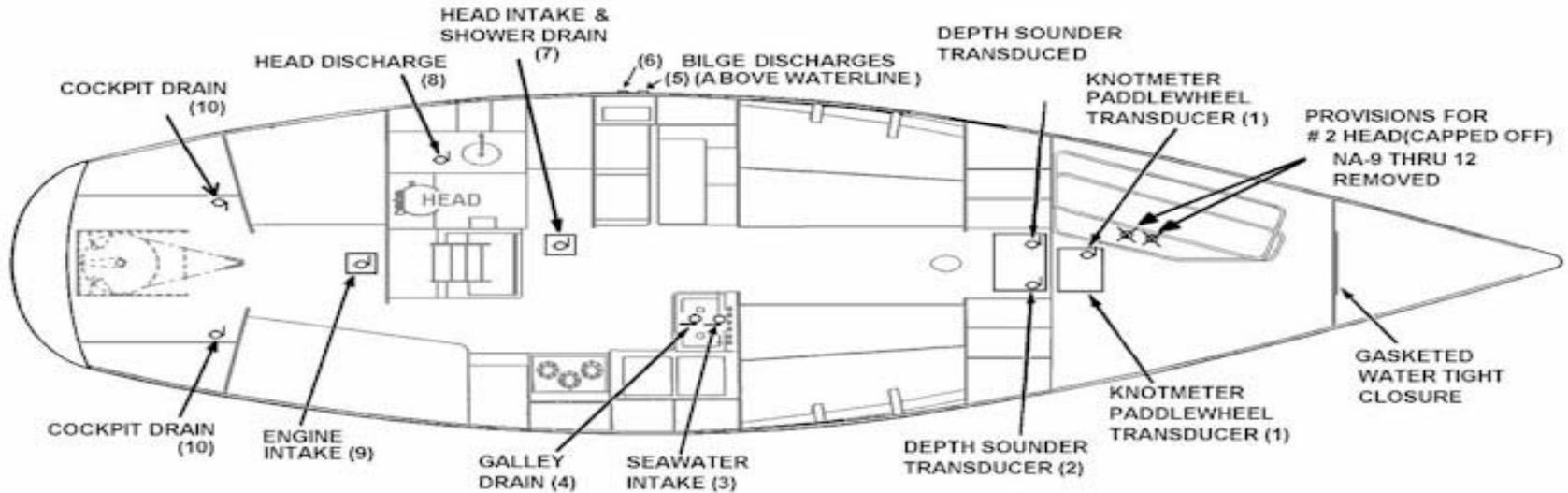
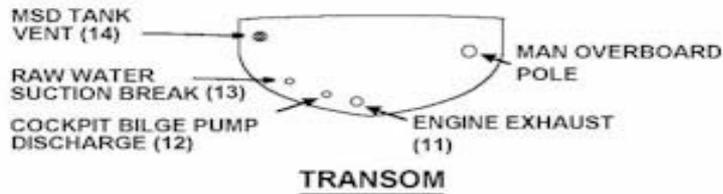
Engine Problems

Problem	Cause	Action
Engine overheats (with or without alarm)	<ol style="list-style-type: none">1) Cooling system malfunction2) Low oil3) Fouled prop4) Faulty thermostat	<ol style="list-style-type: none">1) SECURE THE ENGINE and let cool2) Check raw water loop for blockage & integrity3) Check oil level4) Check fresh water coolant level and loop5) Check for air lock in FWC6) Check prop7) Check thermostat

Note:
Oil with opaque, cloudy, gray, or foamy appearance indicates water contamination



NA-44 Through Hulls





Skipper Marine Head



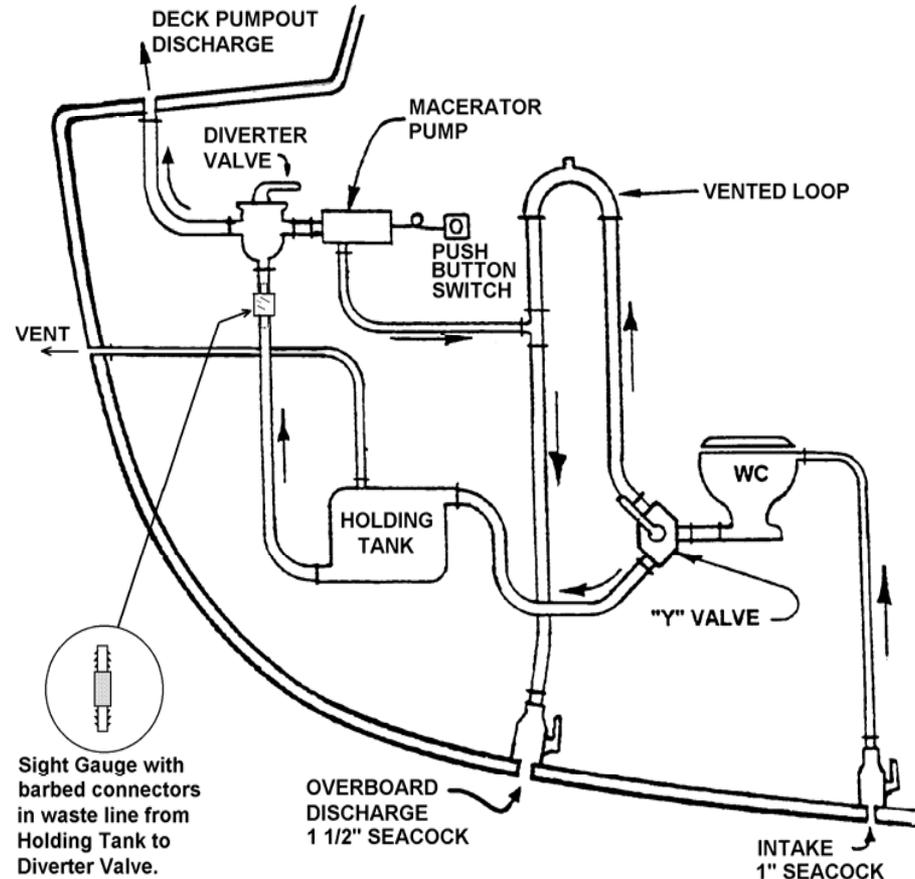
- Description
 - Wilcox-Crittenden Skipper Marine Head
 - Raw/Seawater for flushing
 - 10 Gallon holding tank under cockpit Fwd Port locker
 - Macerator pump and diverter valve to empty holding tank
 - Vented anti-siphon loop and Joker valve to prevent back-flow of sea water into bowl and prevent flooding



Skipper Marine Head



- Normal Operation
 - Ensure “Y” valve is proper position and Sea Cock is open
 - Depress DOWN foot valve and pump in water to wet bowl
 - After use, Press DOWN foot lever and pump water into bowl to flush
 - RELEASE foot lever and pump bowl dry
 - Leave lid down and ensure foot lever is UP

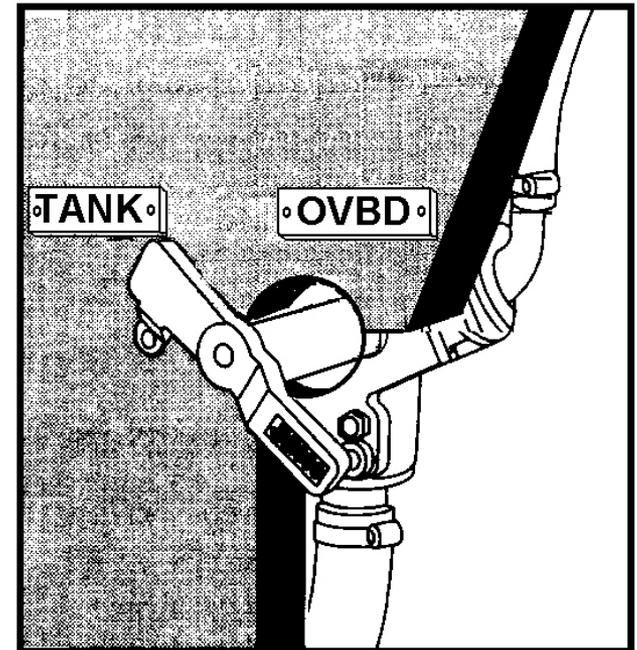




Skipper Marine Head



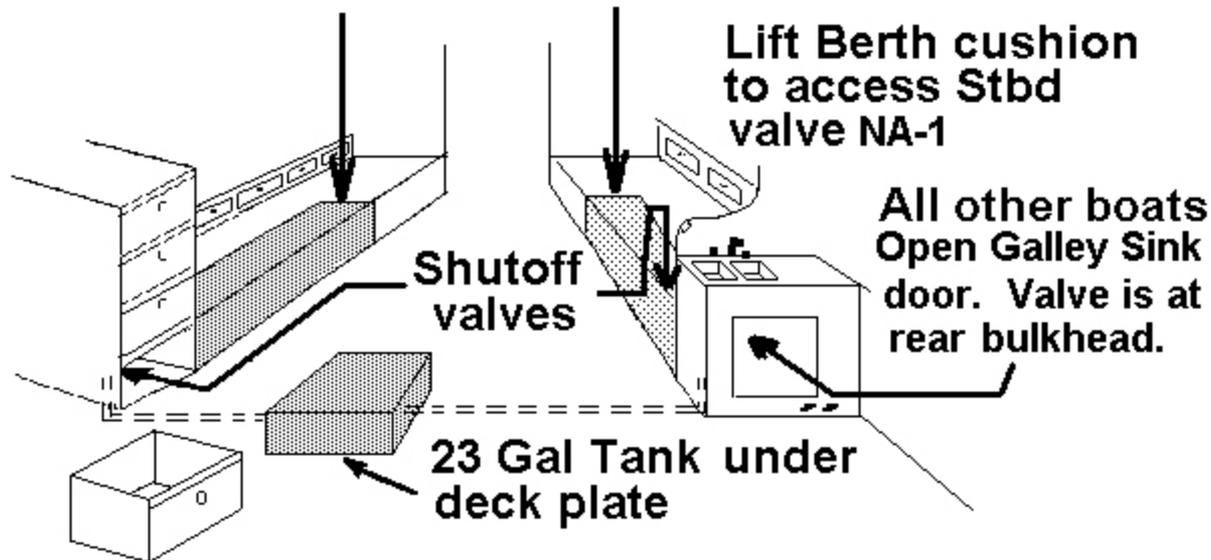
- “Y” valve
 - Select TANK for territorial waters
 - Select OVBD for open ocean
- Sea cocks (2)
 - Intake and Discharge
 - 90 Degree Marine Valves
 - Most appropriate type
 - OPEN - handle is aligned with flow
 - CLOSED - handle perpendicular





Fresh Water System

70 Gal Tank under each Settee Berth



Remove lower Nav Station drawer to access Port valve

- Use foot pumps to pump water (saves power)
- Use electric pump when your running the engine or on shore power



Fresh Water System



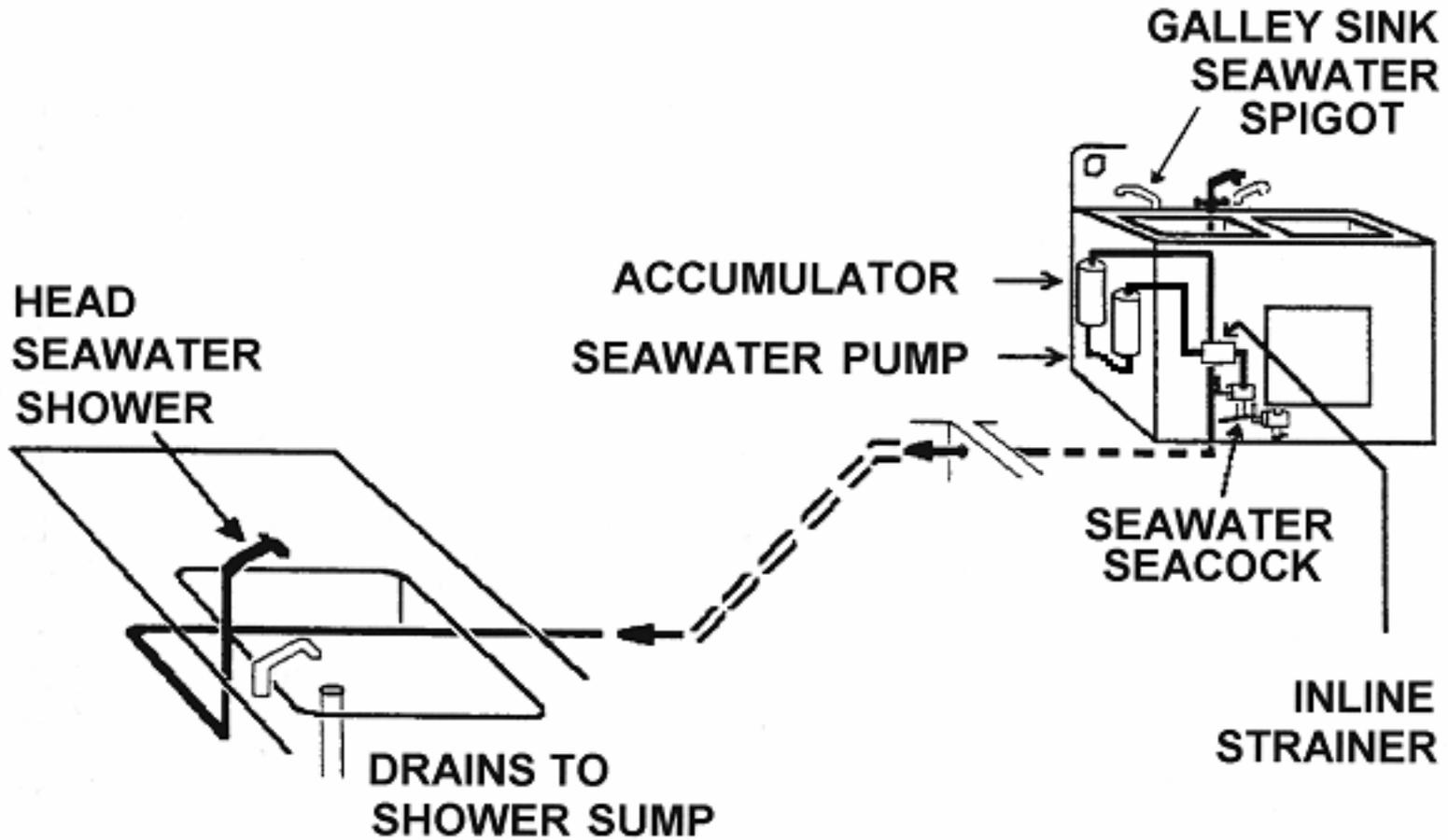
Tank access



Water pumps



Sea Water System

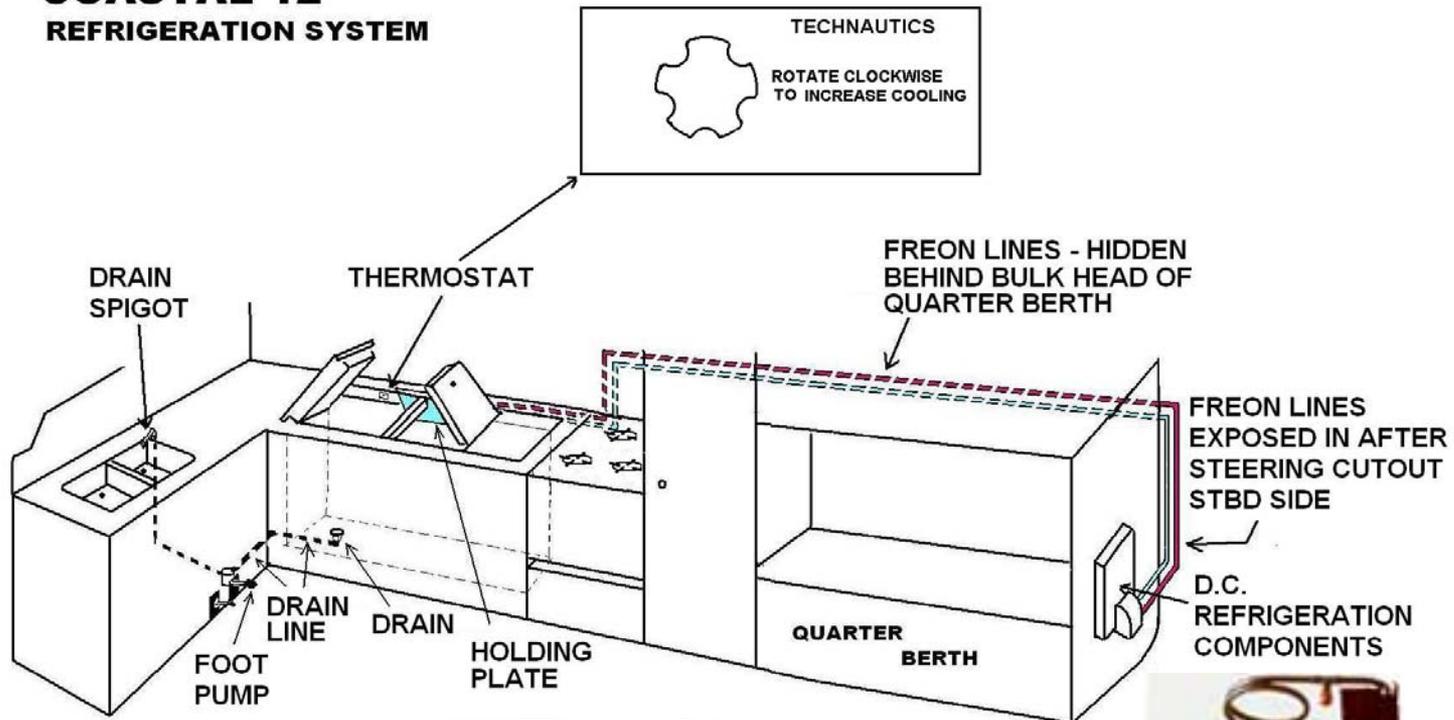




Reefer



TECHNAUTICS COASTAL 12 REFRIGERATION SYSTEM





Reefer Operation



- Thermostat
 - Set to 7 (all the way clockwise) when you first load it but then once the temperature has come down to where you need it, turn the dial back to about 1-3 to allow the system to regulate the temp without running the compressor non-stop which drains your batteries quickly
 - Be careful not to hit it so you don't damage it



LP Gas Galley Stove



- Description
 - Three burners with an oven
 - Gimbaled
 - Uses LP gas from two 10-pound LPG tanks stored in the starboard aft cockpit compartment
 - Both manual and electrical solenoid cutoff valves
 - Pressure gauge for leak checks (Not a “fuel gage”)

NOTE

The “righty-tighty” rule is reversed for the connection fitting between the tank and supply line



LP Gas Galley Stove



- LPG is extremely explosive
 - Leaks are very *DANGEROUS*
- LPG is heavier than air and sinks to low points
- LPG is naturally odorless - “smell” added for sale
- Testing for leaks
 - Pressurize system and observe constant pressure for 15 min
 - *Best Method* - Use 50/50 soap and water solution. Apply to all connections and look for bubbles



LP Gas Galley Stove



- Normal Operation
 - Lighting the Stove

*This Procedure Minimizes
Chance of Fire/Explosion*

- Open manual shutoff valve on LPG tank to be used
- Turn **ON** “GAS VALVE” switch on switchboard
- Turn **ON** “LPG GAS” switch on galley bulkhead
- Open burner valve and light with match





LP Gas Galley Stove



NOTE

This procedure ensures all the gas is burned from the lines

- Normal Operation
 - Shutting off the Stove
 - Leave burner on stove lighted
 - CLOSE manual valve at tank
 - When flame goes out - Turn OFF “LPG GAS” solenoid switch on galley bulkhead
 - Turn OFF “Gas Valve” switch on switchboard
 - Turn OFF burner



LP Gas Galley Stove



- Normal Operation
 - **Operating the Oven**
 - Light a burner to remove any air
 - Turn oven control knob 1/4 turn counter clockwise and move pilot light cover plate in bottom of oven
 - Hold flame to pilot light while pressing and holding the button on front of stove below door
 - Hold button for 15-20 sec to ensure thermocouple energized
 - **Safety feature to prevent gas leaks from unlighted oven**
 - Control oven temp with control knob
 - **Securing Oven**
 - Follow same procedures as for stove
 - Rotate selector knob to OFF and check to ensure pilot flame out



Bilge Pumping System

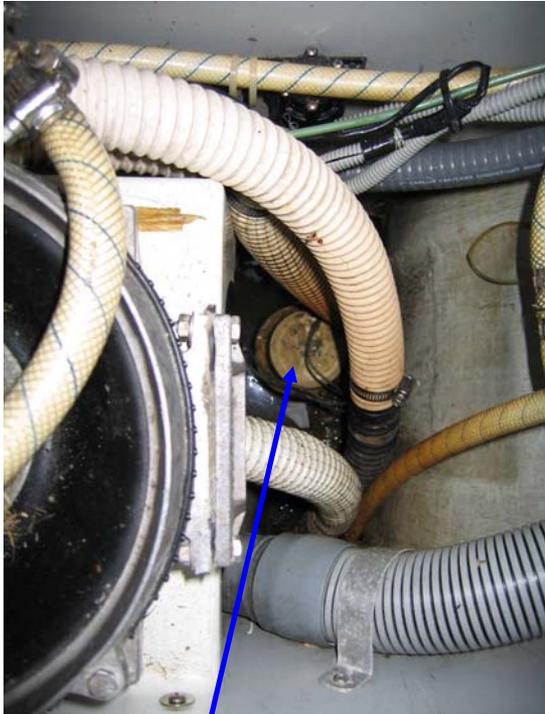


- One Electric and Two Manual Bilge Pumps
 - **Rule 3500 Electrical Pump in main bilge**
 - 58 GPM activated by switch on Switchboard
 - Outlet on portside amidships
 - **Edson Model 638A in main bilge**
 - 30 GPM, handle stowed on front of wet locker
 - Outlet on port side amidships
 - **Edson Model 554 under portside cockpit seat**
 - 30 GPM, handle stowed in sheet locker
 - Outlet on transom
- Flooding
 - All 3 pumps combined can not keep up with a 1.5” diameter hole 2 feet below the waterline.

All Pumps are Self-Priming. Failure to prime is a probable indication of a ruptured diaphragm.



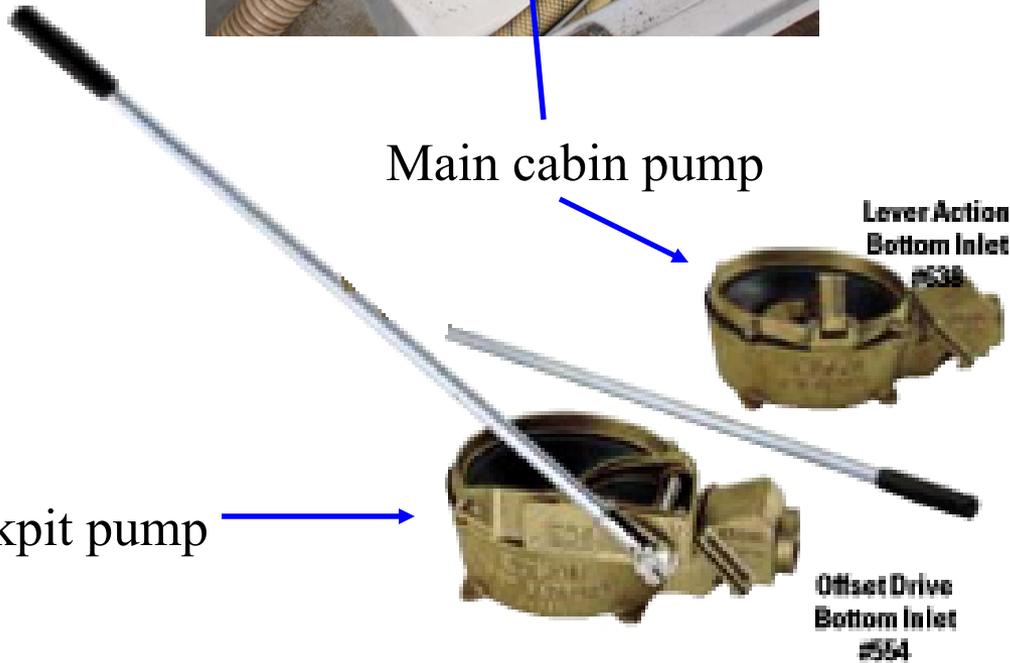
Bilge Pumping System



Electric pump



Main cabin pump



Cockpit pump

Lever Action
Bottom Inlet
#538

Offset Drive
Bottom Inlet
#554



Shower Sump pump



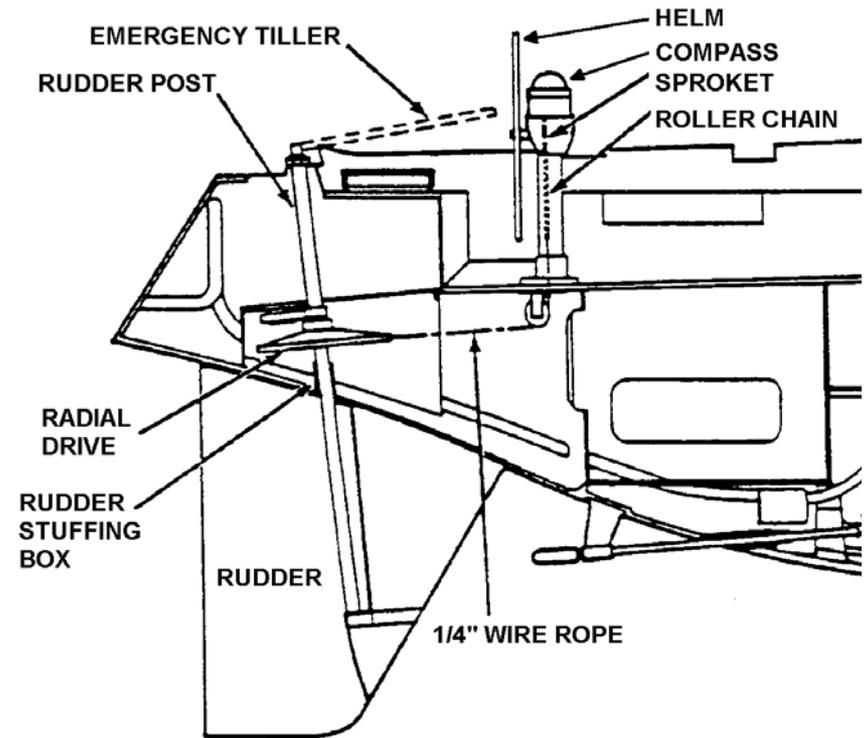
- Manual Head Shower-Sink Sump Pump
 - Pumps gray water from shower sump overboard
 - Outlet is through the head intake line fitting
 - The head sink drains into the shower sump
 - Pumps into toilet bowl if head intake sea cock secured



Steering System

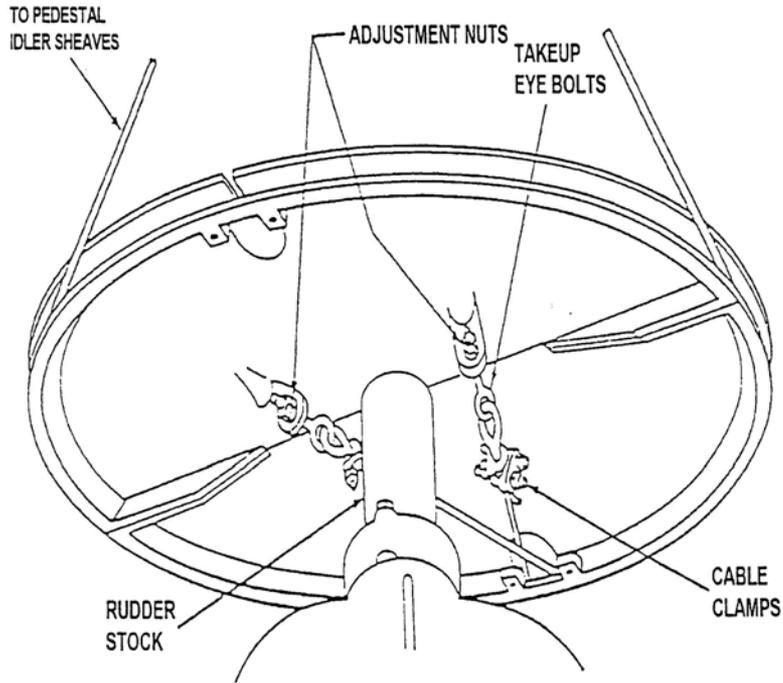


- Cable system
 - Must ensure cable is not slack enough to jump out of groove on radial drive
- Chain & sprocket
 - It is possible for the chain to jump off the sprocket; take the compass pedestal apart to repair





Steering System



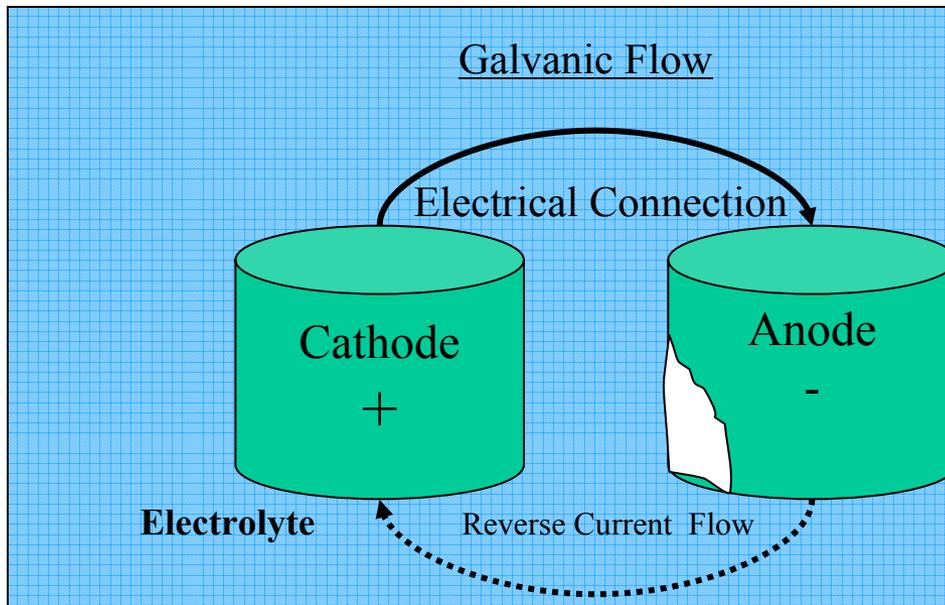
VIEW LOOKING UP FROM UNDER
RADIAL DRIVE STEERING





Corrosion Protection

- Galvanic Corrosion
 - Dissimilar metals (Separate or within one)
 - Both in contact with an electrolyte (seawater)
 - Some electrical connection



Sample Metals & Alloys

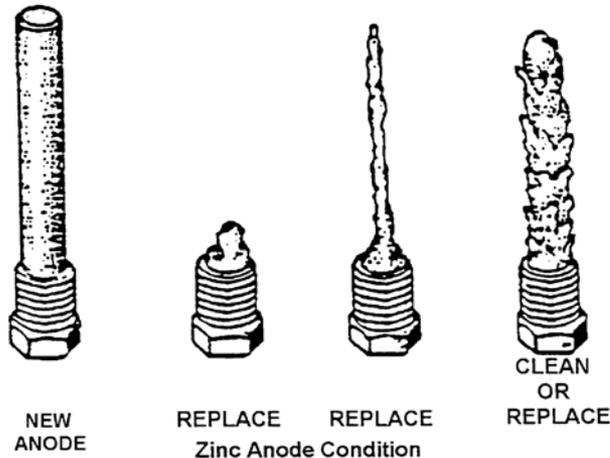
- Magnesium
- Zinc
- Galvanized Steel
- Iron
- Brass
- Bronze

Anodic ↑
↓ Cathodic



Corrosion Protection

- Sacrificial Zinc Anodes (Cathodic Protection)
 - All Underwater Fittings are bonded together
 - Zinc plates or disks are connected to individual pieces to be protected or to bonding system
 - Security is a major concern when connected to moving parts such as prop shafts
 - **Need to be replaced when 50% consumed**



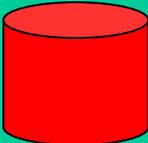
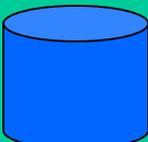


Fluid Identification and Storage

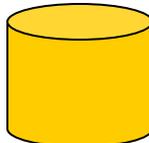
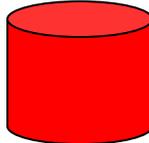
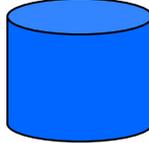
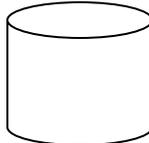


- **Fluids are Stored in Color Coded Containers**

Standard Coding

	Diesel Fuel
	Gasoline
	Kerosene

Navy-44 Storage

	Diesel Fuel
	Engine Oil
	Antifreeze/Coolant
	Transmission fluid



Questions?



Backups and Additional Slides