



# Navy 44 Systems

**Skipper/XO Training**



# Outline of Topics



- Propulsion System
  - Westerbeke Auxiliary Diesel Engine
  - Fuel System
  - Cooling System
  - Exhaust System
  - Propulsion Shafting and Propeller
- 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, 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 BTU per gallon (147,000 vs. 125,00)

**Diesel Fuel Less Flammable!**

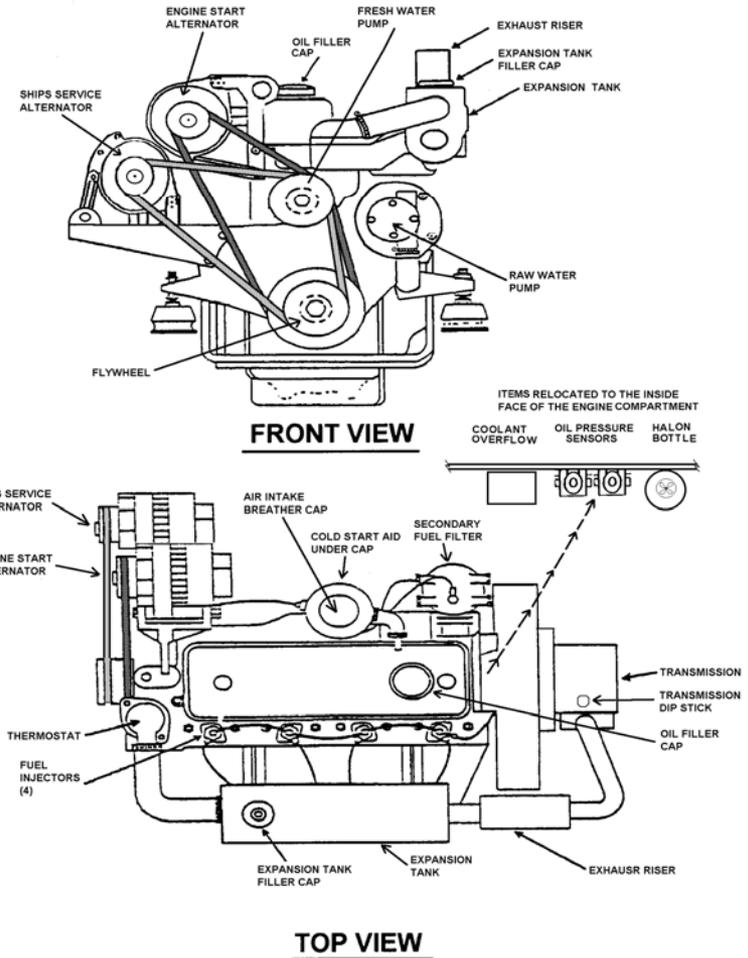


# Westerbeke Diesel Engine



- 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 motor mounts to reduce vibration
- 5 incompressible fluids
  - Sea/Raw Water, Coolant, Oil, Transmission Fluid, Diesel Fuel





# Westerbeke Diesel Engine



- Normal Procedures
  - Starting the Engine
    - 10 - 12 seconds of cranking max per start attempt
    - If no start, wait 30 sec then try again

**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**



# 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**



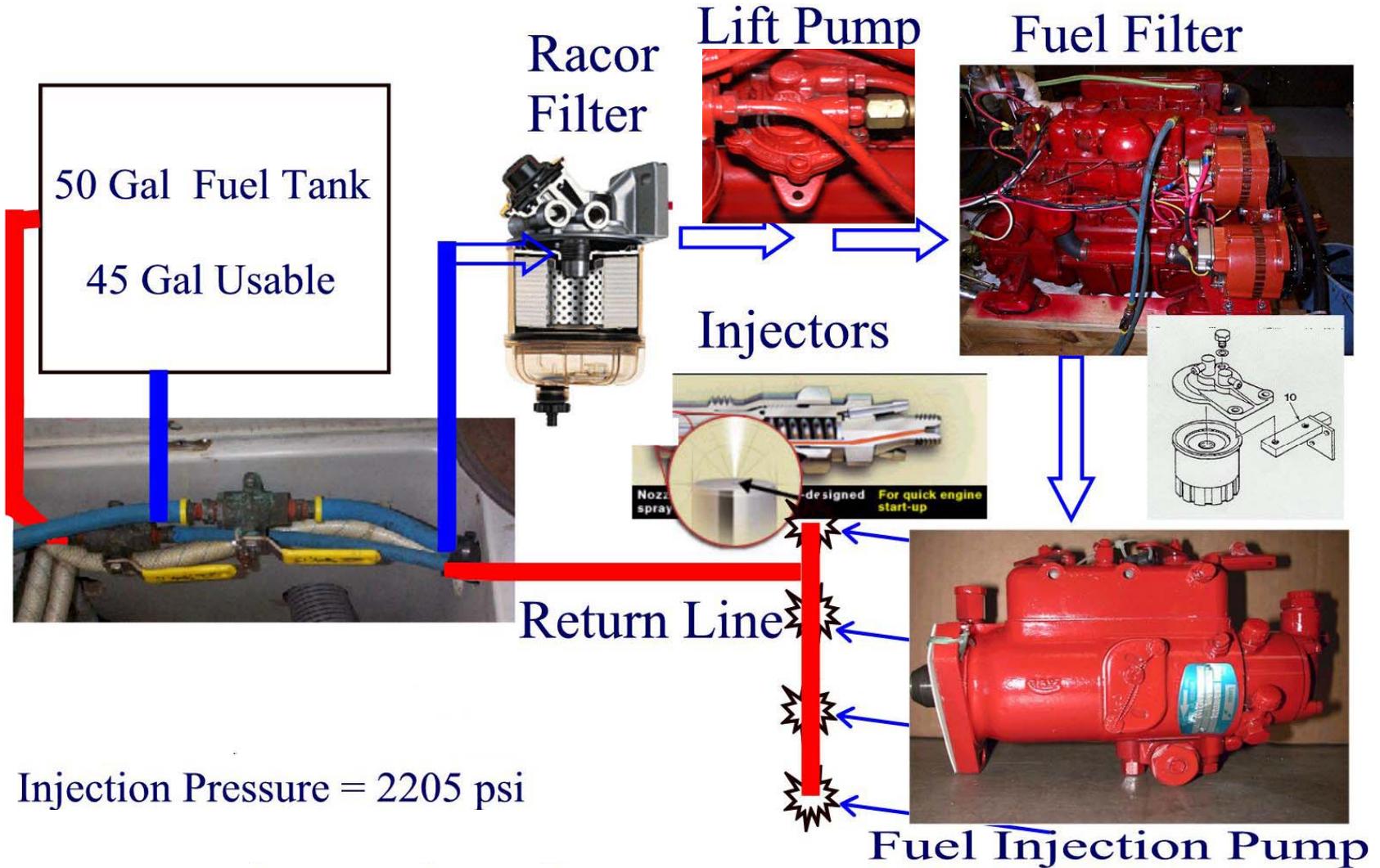
# Westerbeke Diesel Engine



- 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

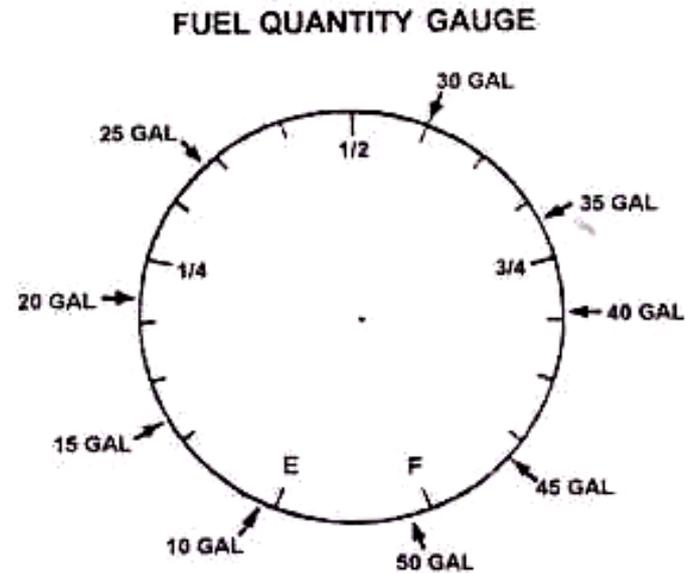




# Fuel Quantity Indications



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



## DIP STICK READINGS

<u>GALLONS</u>	<u>INCHES UP FROM BOTTOM</u>
45	13 1/2
40	12 1/4
35	10 3/4
30	9 3/4
25	8 1/2
20	7
15	5 3/4
10	4 1/4
5	3



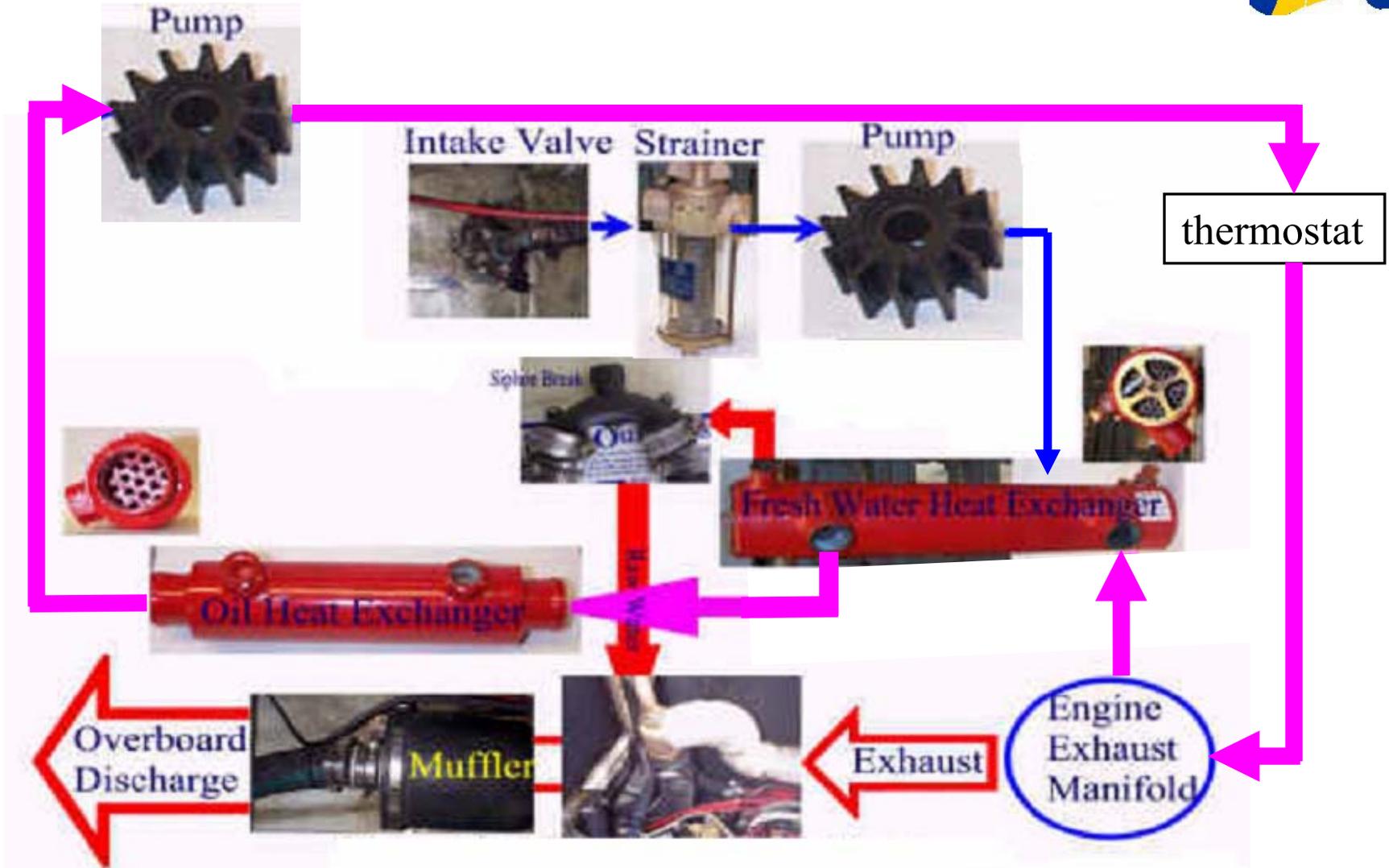
# Westerbeke Diesel Engine



- 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

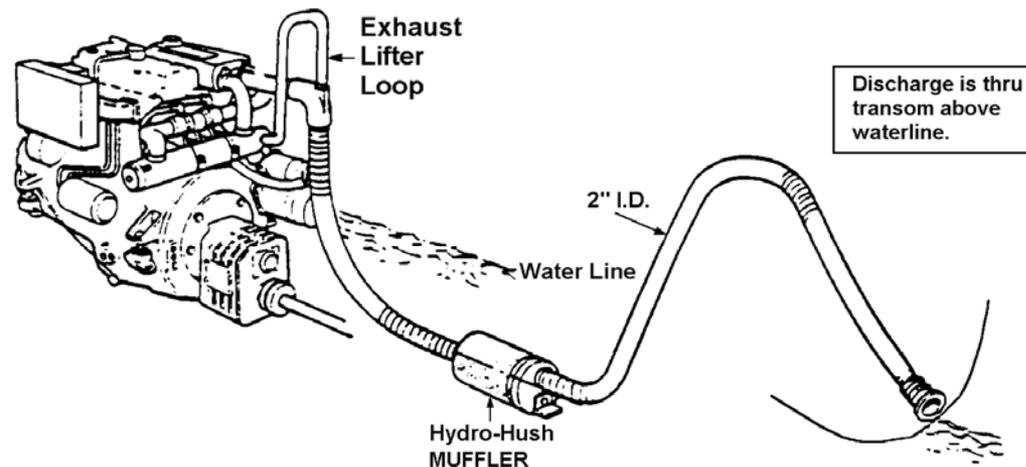




# Westerbeke Diesel Engine



- 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

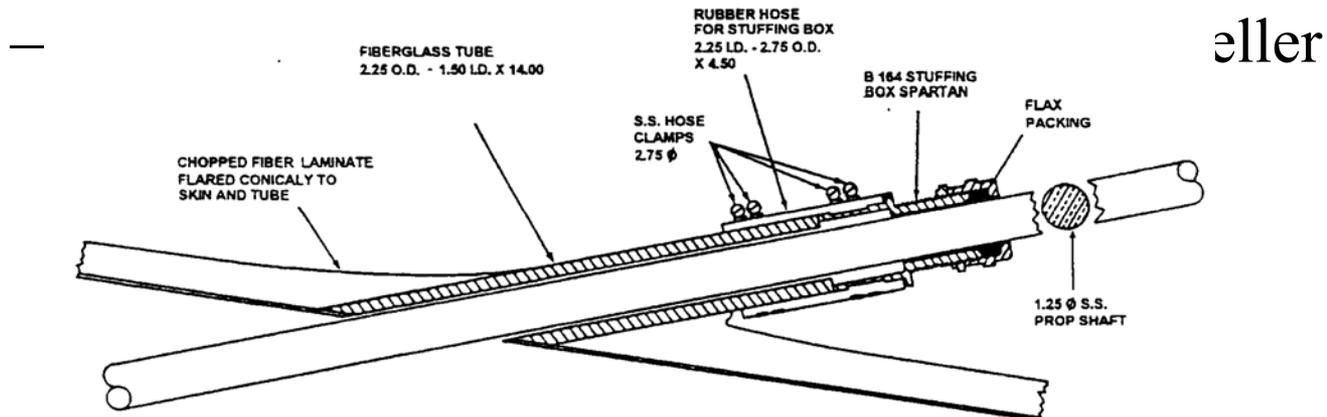




# Propeller Shaft and Prop

- 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





# Drive Train

Transmission w/ damper plate installed

Drive Saver

Shaft couplings

Sea cock



Packing Gland W/Mounting Hardware

Cutlass Bearing

Shaft Keys



# Engine Problems



<b>Problem</b>	<b>Cause</b>	<b>Action</b>
Excessive vibration	<ol style="list-style-type: none"><li>1) Prop not unfeathered</li><li>2) Bent or misaligned shaft</li><li>3) Loose mounts</li></ol>	Secure engine and investigate
Engine fails to secure (runaway engine)	Broken/disconnected throttle linkage	<ol style="list-style-type: none"><li>1) Pull T-handle</li><li>2) Block air intake</li><li>3) Secure fuel valve</li></ol>

*Always try simple or easiest first!*



# Engine Problems



<b>Problem</b>	<b>Cause</b>	<b>Action</b>
No Cooling Water Discharge	<ol style="list-style-type: none"><li>1) Sea cock closed</li><li>2) Sea strainer clogged</li><li>3) Raw water pump failed</li></ol>	<ol style="list-style-type: none"><li>1) Secure engine</li><li>2) Check sea cock</li><li>3) Check strainer</li><li>4) Check belts and hoses</li><li>5) Remove cover and check impeller</li></ol>
Engine stops suddenly – unintentional engine shutdown	<ol style="list-style-type: none"><li>1) Fouled prop</li><li>2) Air/water contamination in fuel line</li></ol>	<ol style="list-style-type: none"><li>1) Throttle idle and neutral</li><li>2) Check prop</li><li>3) Check fuel level and valves</li><li>4) Check fuel at injectors</li></ol>



# Engine Problems



<b>Problem</b>	<b>Cause</b>	<b>Action</b>
Engine will not crank (underway with following sea)	<ol style="list-style-type: none"><li>1) Electrical</li><li>2) Exhaust muffler flooded</li><li>3) Raw water siphoned into cylinders</li></ol>	<ol style="list-style-type: none"><li>1) Check battery voltages and wiring</li><li>2) Check all fluid levels</li><li>3) Check and drain muffler</li><li>4) Check if engine can be turned manually</li></ol>



# Engine Problems

<b>Problem</b>	<b>Cause</b>	<b>Action</b>
Engine overheats (with or without alarm)	<ol style="list-style-type: none"><li>1) Cooling system malfunction</li><li>2) Low oil</li><li>3) Fouled prop</li><li>4) Faulty thermostat</li></ol>	<ol style="list-style-type: none"><li>1) SECURE THE ENGINE and let cool</li><li>2) Check raw water loop for blockage &amp; integrity</li><li>3) Check oil level</li><li>4) Check fresh water coolant level and loop</li><li>5) Check for air lock in FWC</li><li>6) Check prop</li><li>7) Check thermostat</li></ol>

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



# 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

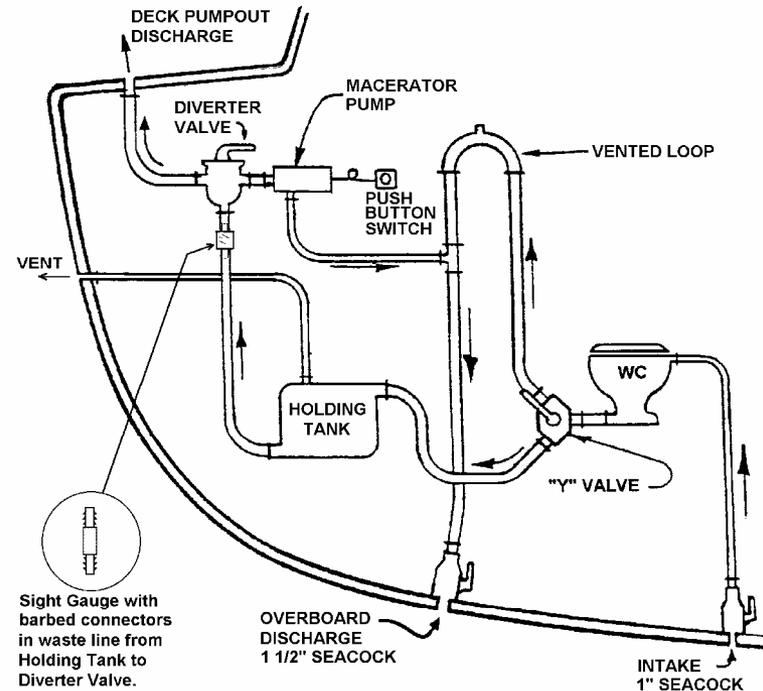


# Skipper Marine Head



- 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

*If you didn't eat it...!*

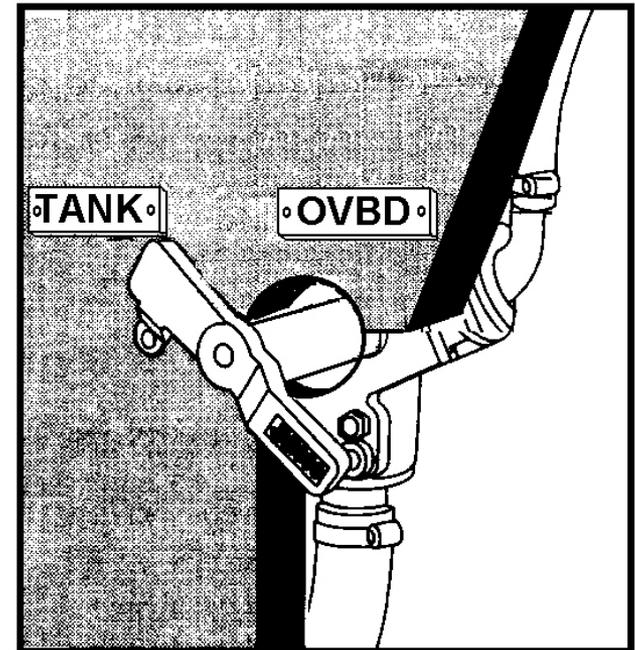




# Skipper Marine Head



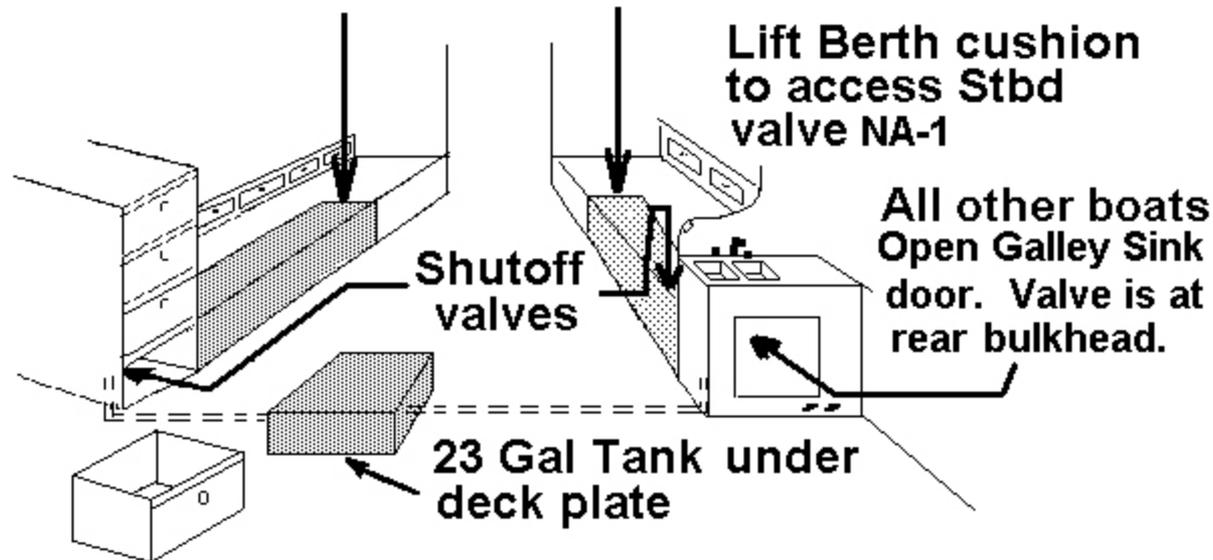
- “Y” valve
  - Select TANK for Territorial Waters
  - Select OVBD for open ocean
- Sea Cocks (2)
  - Intake and Discharge
  - 90 Degree Marine Valves
    - Most appropriate type
  - OPEN - handle is aligned with flow
  - CLOSED - handle perpendicular





# 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



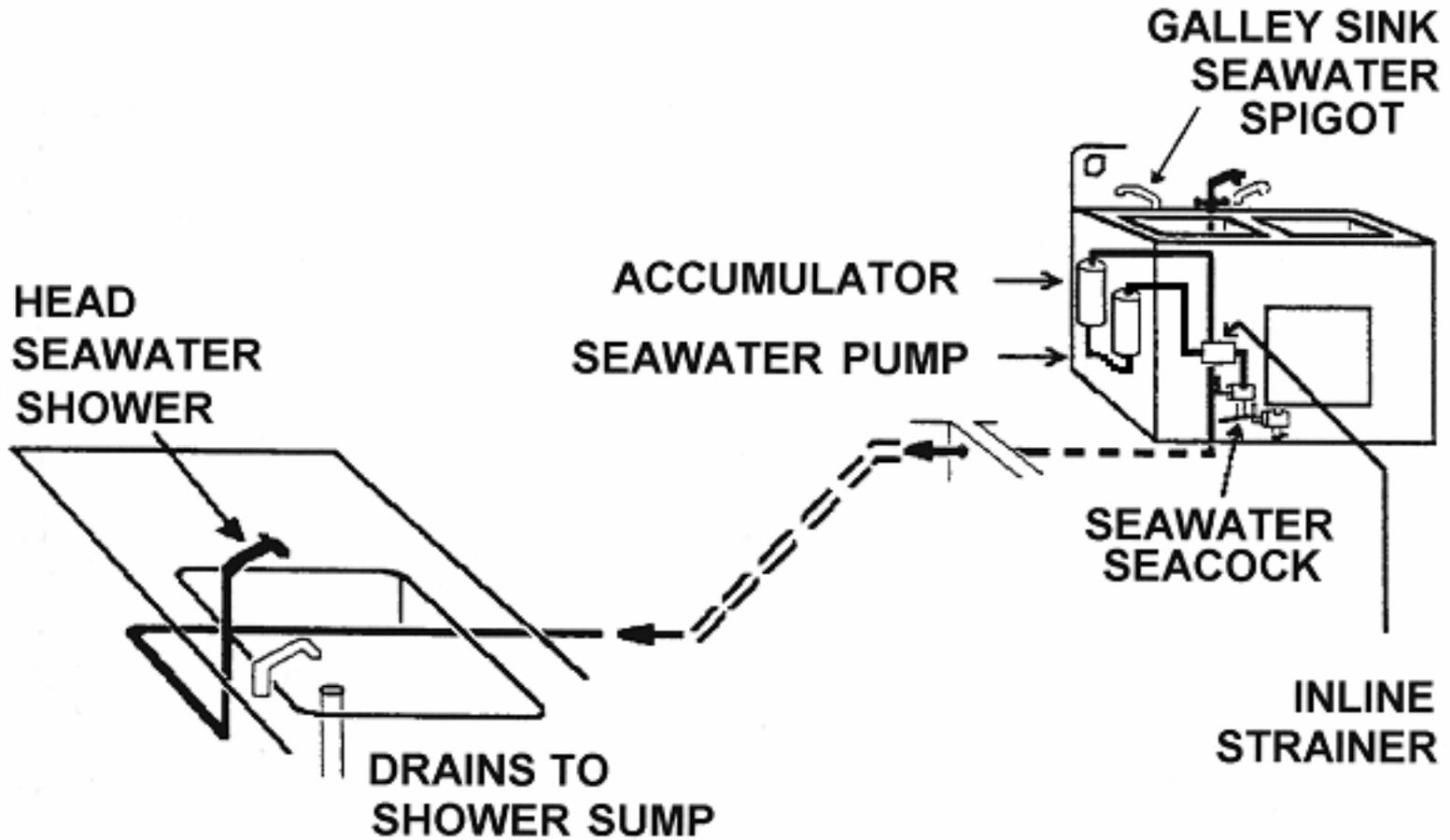
Tank access



Water pumps



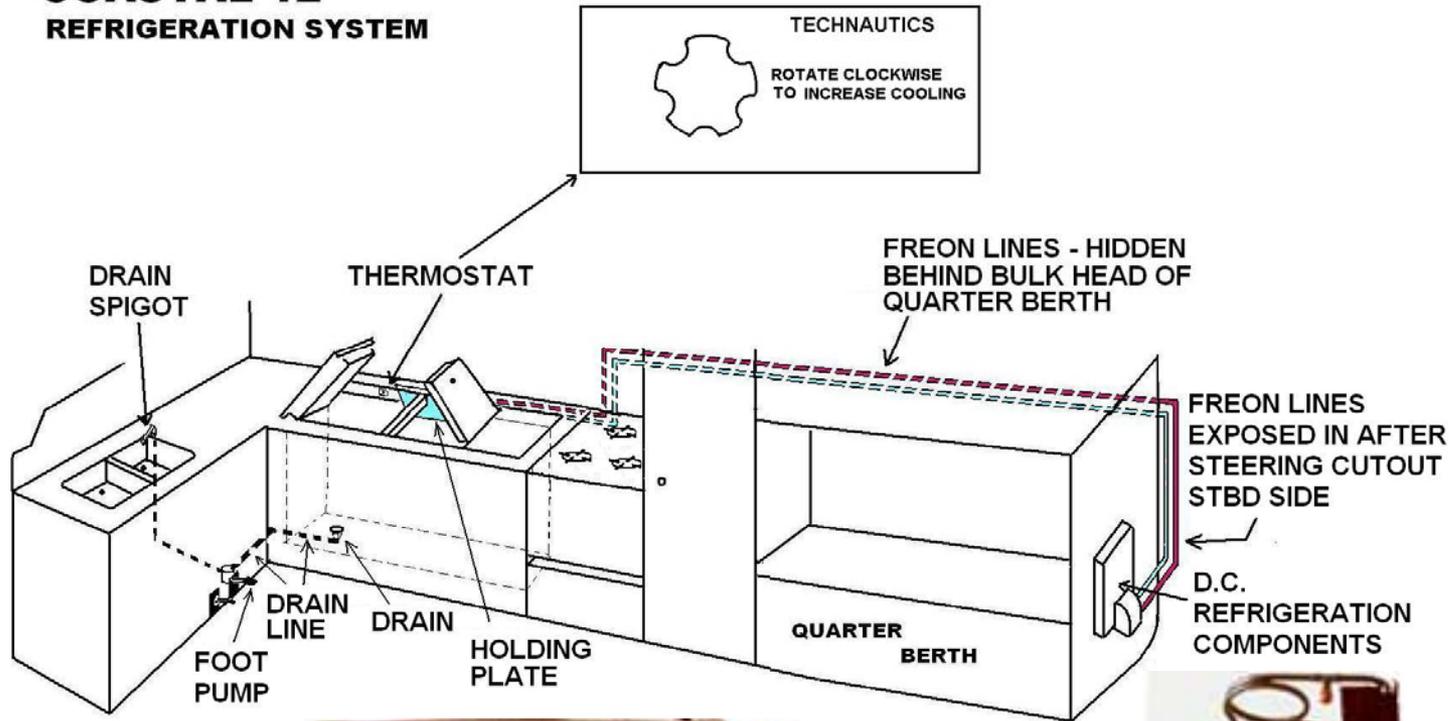
# Sea Water System





# 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

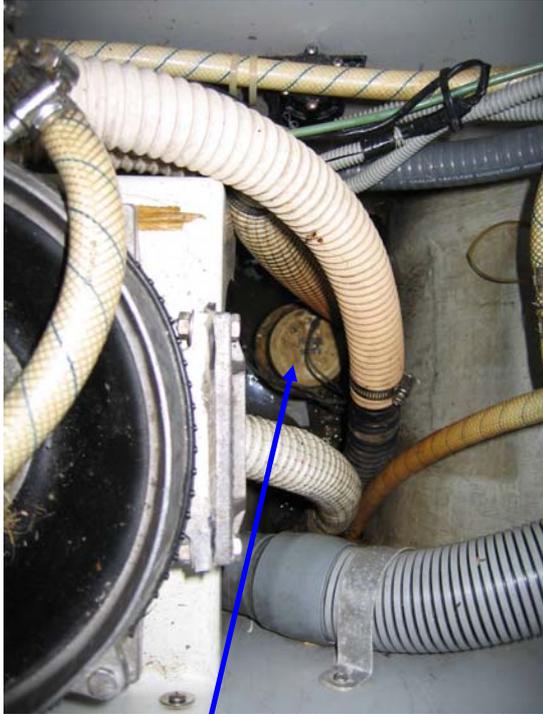


- One Electric and Two Manual Bilge Pumps
  - **Rule 3500 Electrical Pump in main bilge**
    - 58 GPM activated by switch on Switchboard
    - Outlet on portside amidships
  - **Edson Model 638A in main bilge**
    - 30 GPM, handle stowed on front of wet locker
    - Outlet on port side amidships
  - **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.*



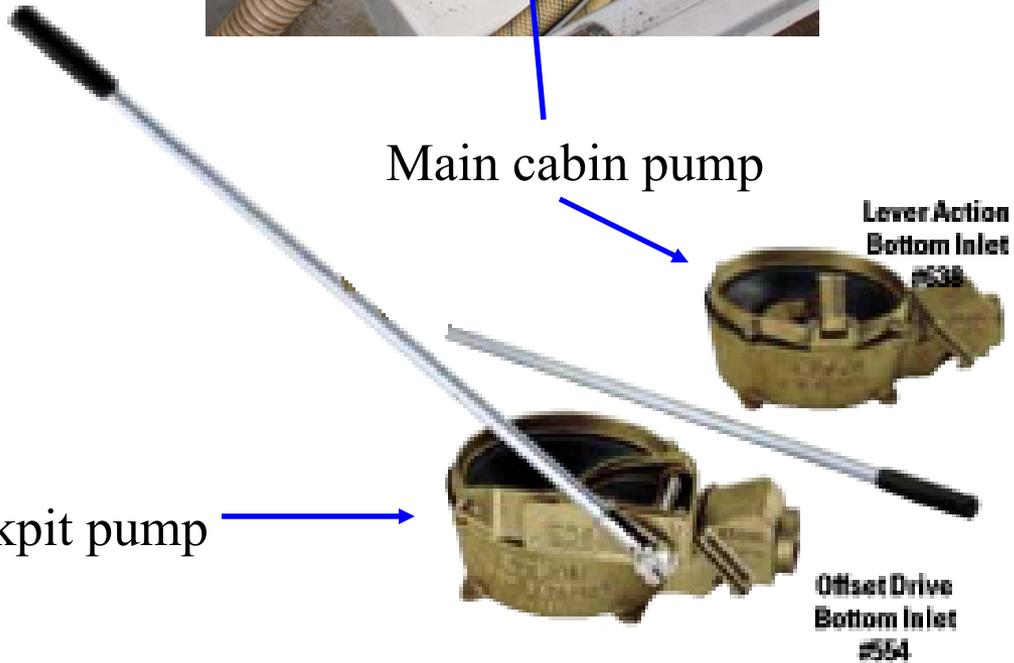
# Bilge Pumping System



Electric pump



Main cabin pump



Cockpit pump



# Shower Sump pump



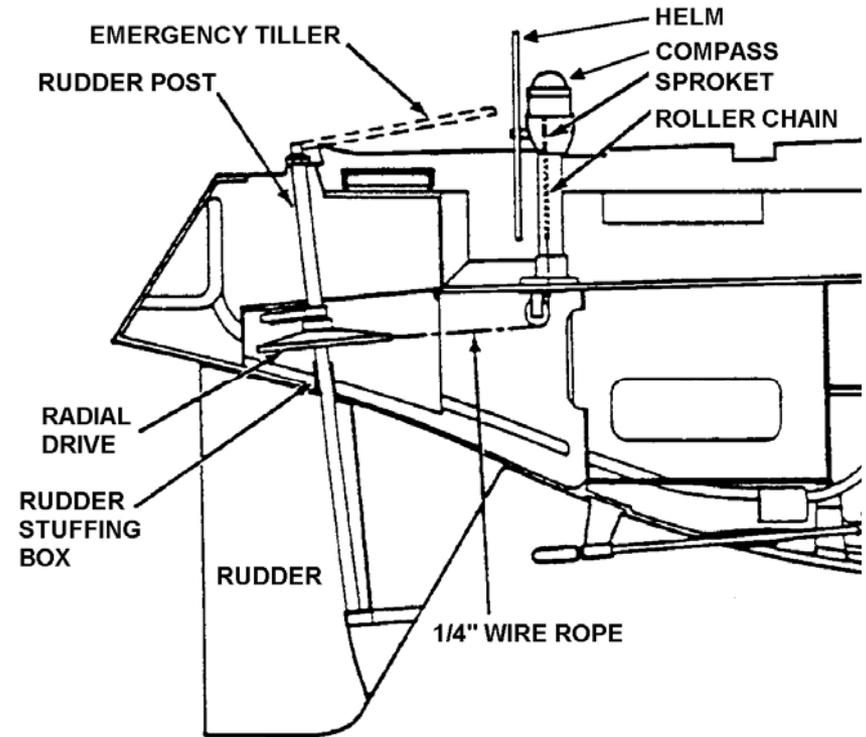
- Manual Head Shower-Sink Sump Pump
  - Pumps gray water from shower sump overboard
  - Outlet is through the Head intake line fitting
  - The head sink drains into the shower sump
  - Pumps into toilet bowl if head intake sea cock secured



# Steering System

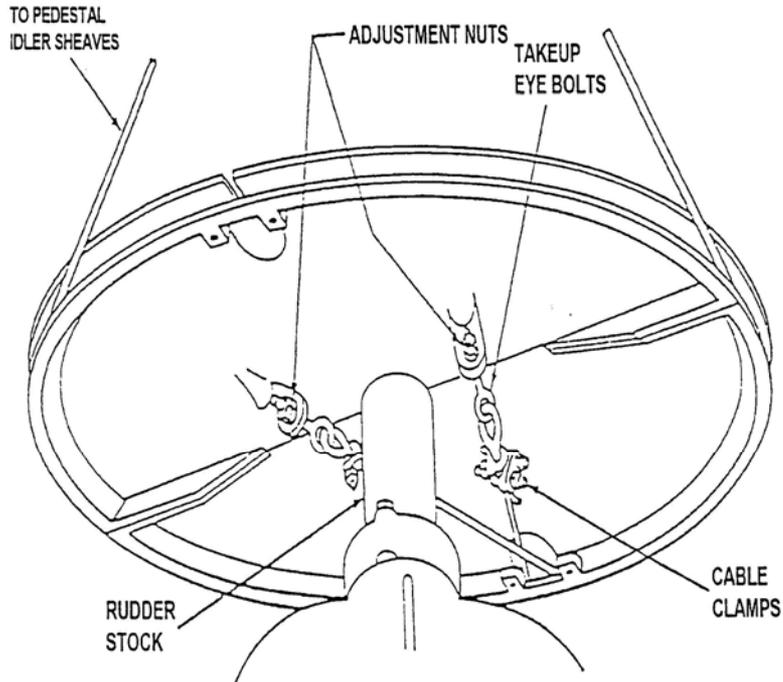


- Cable system
  - Must ensure cable is not slack enough to jump out of groove on radial drive
- Chain & sprocket
  - It is possible for the chain to jump off the sprocket; take the compass pedestal apart to repair





# Steering System



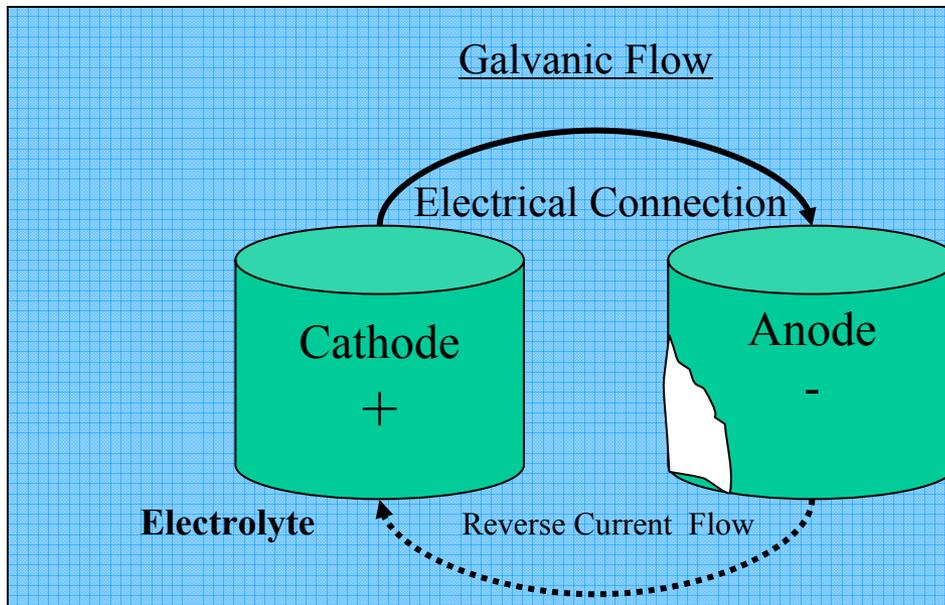
VIEW LOOKING UP FROM UNDER  
RADIAL DRIVE STEERING





# Corrosion Protection

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



## Sample Metals & Alloys

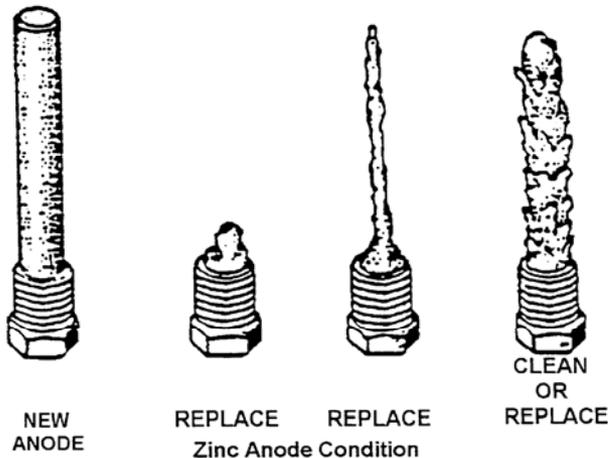
- Magnesium
- Zinc
- Galvanized Steel
- Iron
- Brass
- Bronze

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**



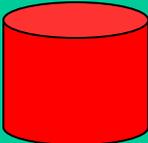
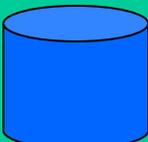


# Fluid Identification and Storage

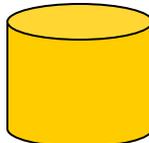
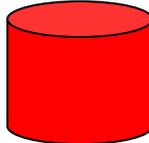
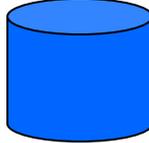
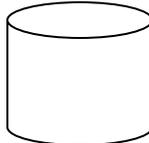


- **Fluids are Stored in Color Coded Containers**

**Standard Coding**

	Diesel Fuel
	Gasoline
	Kerosene

**Navy-44 Storage**

	Diesel Fuel
	Engine Oil
	Antifreeze/Coolant
	Transmission fluid



*Questions?*



# Backups and Additional Slides



# NA-44 Through Hulls

