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 \textit{direct} fuel injection
  – Higher efficiency fuel
  – Diesel has more BTU per gallon (147,000 vs. 125,00)

\textbf{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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Belt Tension</strong></td>
<td>¼ - ½ inch at midpoint</td>
</tr>
<tr>
<td><strong>RPM</strong></td>
<td><strong>Idle</strong> 750-1000</td>
</tr>
<tr>
<td></td>
<td><strong>Cruise</strong> 1800-2200</td>
</tr>
<tr>
<td></td>
<td><strong>Max</strong> 2500</td>
</tr>
<tr>
<td><strong>Max Heel</strong></td>
<td>17° continuous</td>
</tr>
<tr>
<td></td>
<td>25° for 30 minutes</td>
</tr>
<tr>
<td><strong>Oil Pressure</strong></td>
<td>30 – 60 psi normal</td>
</tr>
<tr>
<td></td>
<td>10-15 psi Alarm</td>
</tr>
<tr>
<td><strong>Temperatures</strong></td>
<td>170° – 190° F normal</td>
</tr>
<tr>
<td></td>
<td>205° F Alarm</td>
</tr>
</tbody>
</table>
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

50 Gal Fuel Tank
45 Gal Usable

Racor Filter
Lift Pump
Fuel Filter
Injectors

Injection Pressure = 2205 psi

Return Line

Fuel Injection Pump
Fuel Quantity Indications

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

thermostat
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

Transmission w/ damper plate installed

Drive Saver

Shaft couplings

Sea cock

Cutlass Bearing

Shaft Keys

Packing Gland W/Mounting Hardware
## Engine Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Action</th>
</tr>
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</table>
| Excessive vibration                          | 1) Prop not unfeathered  
2) Bent or misaligned shaft  
3) Loose mounts | Secure engine and investigate               |
| Engine fails to secure (runaway engine)      | Broken/disconnected throttle linkage            | 1) Pull T-handle  
2) Block air intake  
3) Secure fuel valve |
## Engine Problems

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<th>Action</th>
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<tr>
<td>No Cooling Water Discharge</td>
<td>1) Sea cock closed</td>
<td>1) Secure engine</td>
</tr>
<tr>
<td></td>
<td>2) Sea strainer clogged</td>
<td>2) Check sea cock</td>
</tr>
<tr>
<td></td>
<td>3) Raw water pump failed</td>
<td>3) Check strainer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Check belts and hoses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5) Remove cover and check impeller</td>
</tr>
<tr>
<td>Engine stops suddenly – unintentional engine shutdown</td>
<td>1) Fouled prop</td>
<td>1) Throttle idle and neutral</td>
</tr>
<tr>
<td></td>
<td>2) Air/water contamination in fuel line</td>
<td>2) Check prop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Check fuel level and valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Check fuel at injectors</td>
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| Engine will not crank (underway with following sea) | 1) Electrical  
2) Exhaust muffler flooded  
3) Raw water siphoned into cylinders | 1) Check battery voltages and wiring  
2) Check all fluid levels  
3) Check and drain muffler  
4) Check if engine can be turned manually |
## Engine Problems

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| Engine overheats (with or without alarm) | 1) Cooling system malfunction  
2) Low oil  
3) Fouled prop  
4) Faulty thermostat | 1) SECURE THE ENGINE and let cool  
2) Check raw water loop for blockage & integrity  
3) Check oil level  
4) Check fresh water coolant level and loop  
5) Check for air lock in FWC  
6) Check prop  
7) Check thermostat |

**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

- 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
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
    • 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

*This Procedure Minimizes Chance of Fire/Explosion*
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.
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 & sproket**
  - It is possible for the chain to jump off the sproket; take the compass pedestal apart to repair
Steering System
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
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