VIC·MAUI
INTERNATIONAL YACHT RACE

# EMERGENCY STEERING

# Emergency Steering

- Priority is to make sure you are not rudderless
- As important as hull integrity, standing rigging and mast!
- Rudder failure is a serious emergency
- Can cause flooding leading to sinking
- Know how to steer without a rudder
- Incidence of mid-ocean rudder failure is about 1%
- Lying helplessly abeam to a large swell is perilous
- Self-reliance is mandatory

# Vic-Maui Rudder Loss Incidents

1992

- Ajax (Santa Cruz 40) Rocket J Squirrel (Swan 39)
- Foxfire (Kaufmann 44)

2006

- Renegade (Andrews 70)

2008

- Something Wicked (Beneteau First 40.7)

2014

- Anduril (Farr 395)

2016

- Mountain (J109)

Multiple years

- Steering cable failures

2019

- Oex (2019 Transpac Santa Cruz 70)

# Why Steering Systems Fail

Groundings
Collisions with floating objects
Construction and design errors
Fatigue - load cycle and material property dependent
Not following manufacturer recommended maintenance schedule

## Rudder Stock Failure

- Material fatigue with repeated and reversing torsion stress
- More rapidly if loads near ultimate strength

- Stainless steel suffers when deprived of oxygen (inside rudder tube with stagnant seawater)
- Corrosion if oxide film on shaft removed by contact with solid bearing surface
- Composite may be overstressed if given a severe hit but may not show damage
- Breaks rather than bends

## Bearing failure

- Grit trapped inside rudder tube abrades stainless steel stock, resulting in corrosion

## Framework failure

- Corrosion of welded internal web from water trapped inside rudder

## Delamination

- Water inside foam-cored rudder in fiberglass rudders can delaminate the skin from the foam

# What's Hiding Inside Your Rudder

**Potential Problems**:

- Corrosion
- Bad workmanship
- Faulty design
- Inferior materials

Spade rudders are more vulnerable than skeg-hung rudders — large loads at lower bearing.

Most common failure is the rudder stock breaking where it emerges from the hull.

**"To summarize; You need a workable emergency steering system."**

# KNOW YOUR STEERING SYSTEM

1. A rigorous inspection of the steering system by a qualified technician is required. This shall include inspection of all steering system components including control cables and swages, pulley attachments, pulleys and sheaves, steering quadrant and bearings, rudder tube.
2. Designate specific crew to have extensive knowledge of steering system.

# PREVENTATIVE MAINTENANCE

3. Service and inspect all components prior to the race:
    - No worn, misaligned, or fatigued parts
    - Lubricate
    - Inspect & service rudder stock bearings
    - Examine stuffing box, lip seals or rubber gaiter while moving at hull speed (If rudder tube is not well above waterline)
    - Vertical alignment (spade rudder must rotate in place)
    - Ease of rotation stop to stop
    - Strong stops prevent rudder movement beyond about $35^0$
    - Drill 1/8” holes in rudder blade & check for rust coloured water

- Examine edges of blade, especially at top where stock enters it
- Remove rudder to inspect bearings. Self aligning bearings for example are best removed once a year or at least every other year, cleaned and lubed
- Perhaps use non-destructive sonic testing

Note 1: See Notice of Race - Appendix A Revise 3.02.2
Watertight and Structural Integrity of a Boat

4. Take spares (cable/kevlar line, linkages)
    - Use manufacturer's recommended spares
    - Ensure you have the required tools
    - Include location on Safety Equipment Chart
    - Include the steering system as part of your daily inspection while racing

*If rudder condition in doubt, it may be cheaper to replace than risk losing it on the high seas*

Subjecting a material to repeated load cycles will weaken it with time, and will do so even more rapidly if those loads approach its ultimate strength

In practical terms this means that marginally spec'd stock will fail before a stronger one and that all of them will weaken with time

# Training Before Race

1. At crew meetings discuss scenarios if rudder is lost
2. Practice using the emergency tiller
3. Practice using the emergency steering, proof of deployment is a required element
4. Practice inspections in uncomfortable seas
5. Practice changing steering cables
6. Ensure more than one crew member is knowledgeable about the steering system
7. Reinforce role of Person in Charge and rest of crew in case of incident

# Good Seamanship

1. Sail balanced
2. Gear down in heavy weather
3. Avoid putting a rudder hard over to prevent a broach to avoid “dynamic stall”
4. It’s a long way—don’t overstress the steering system

# OSR 4.15.1 a)

"An emergency tiller capable of being fitted to the rudder stock except when the principal method of steering is by means of an unbreakable metal tiller"

# OSR 4.15.1 b)

"there are two methods (e.g. tillers, wheels) of controlling a rudder, neither of which shares components with the other except for the rudder stock."

# 2022 VIC-MAUI APPENDIX A

# OSR 4.15.2

Revise 4.15.2 Emergency Steering

Add sentence "Video or photo proof of deployment and use of emergency steering must be provided."

# Interpretation No 1/2004- Emergency Rudders

OSR 4.15a) does not necessarily require an emergency rudder

Key is for an effective alternative method of steering to be devised and tested so that a method is developed which is most suitable for each yacht and crew.

# Design Considerations For Emergency Rudders

1. Type of failure of primary rudder (clean break or bent rudder stock)
2. Ease of steering — it must work
3. Anticipate going a long distance & high sea state
4. Must work with storm jib and trysail
5. Attachment method to the hull--how will you install the rudder while at sea

6. Stowage – safe storage of emergency rudder when you're (hopefully) not using it
7. Know the forces: (1’ x 4’ blade at 7 kn = 1666 lbs). <u>These forces are “HUGE” and any emergency steering or tiller will be very difficult to use requiring big blocks, strong line, and 2 winches.</u>
8. Blade size (underwater surface area)

# Examples Of Emergency Rudders

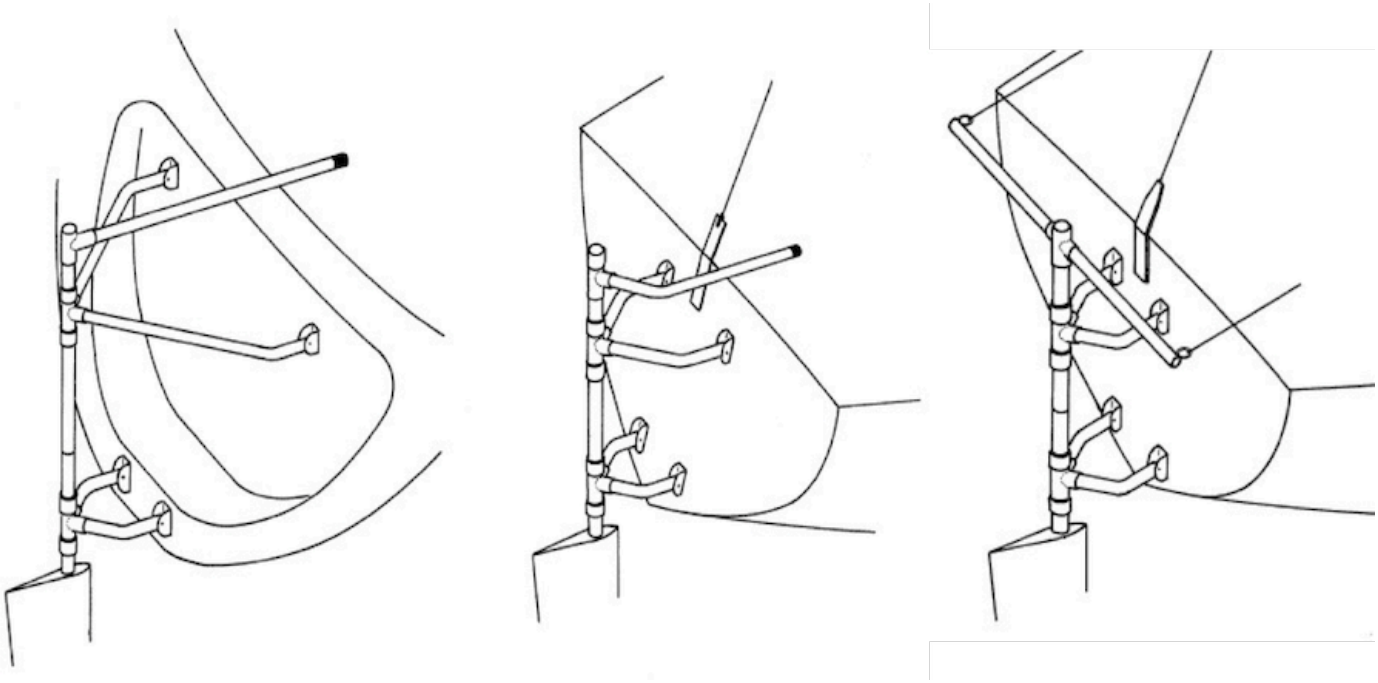
# SOS Rudder from Scanmar

“The SOS Rudder is an emergency steering system designed to get you to the nearest port in case of rudder failure. DO NOT ATTEMPT TO CONTINUE TO RACE, OR TO CARRY A HEAVY PRESS OF SAIL”

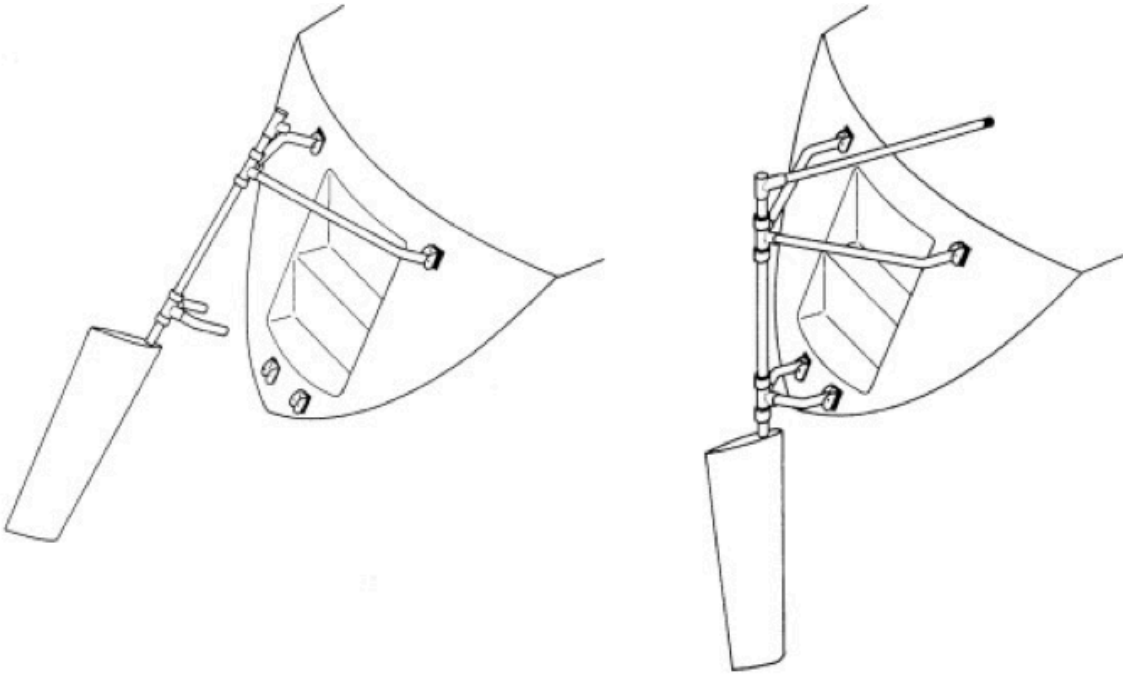
# SOS Rudder


Great

# Three Configurations



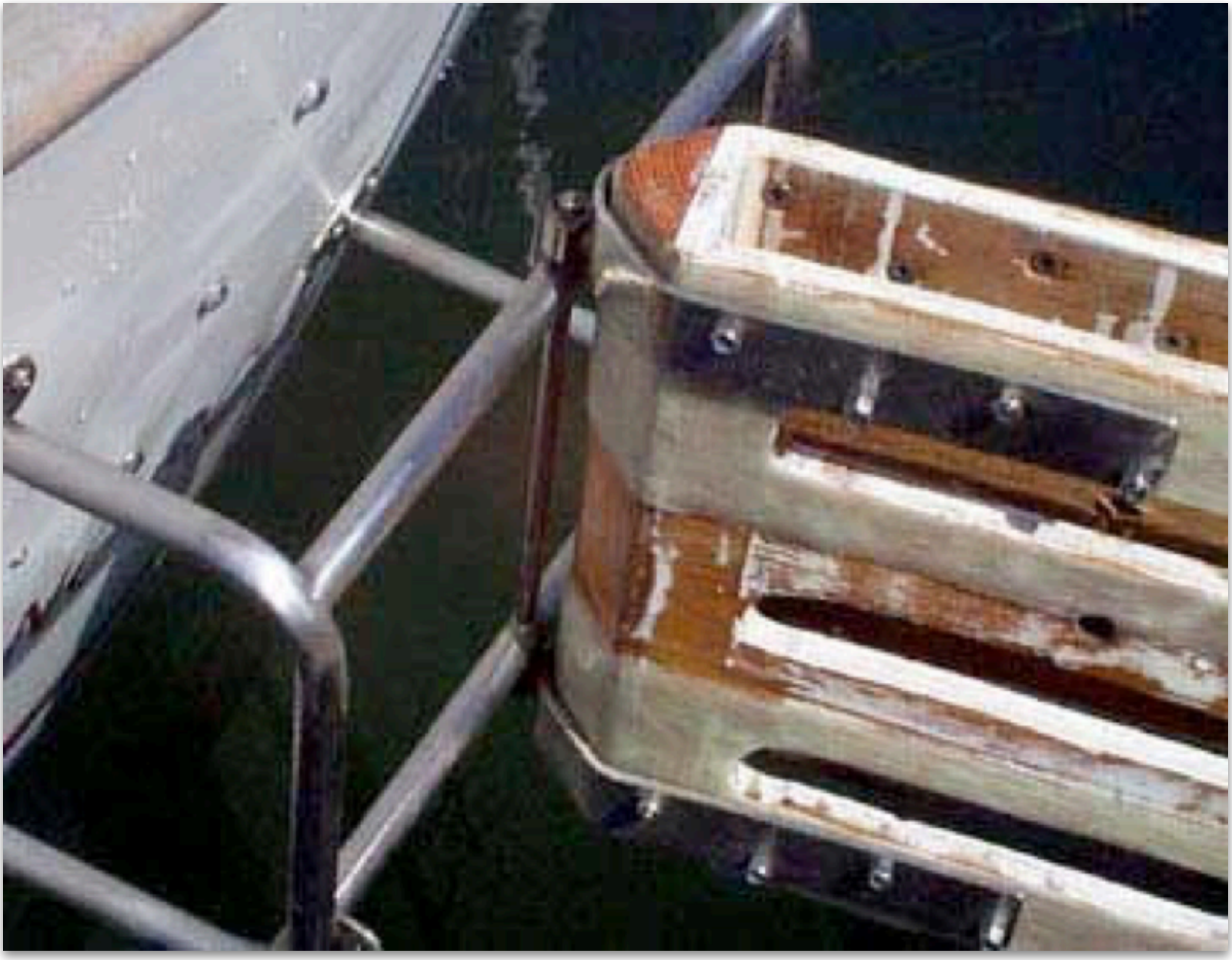
# Installation



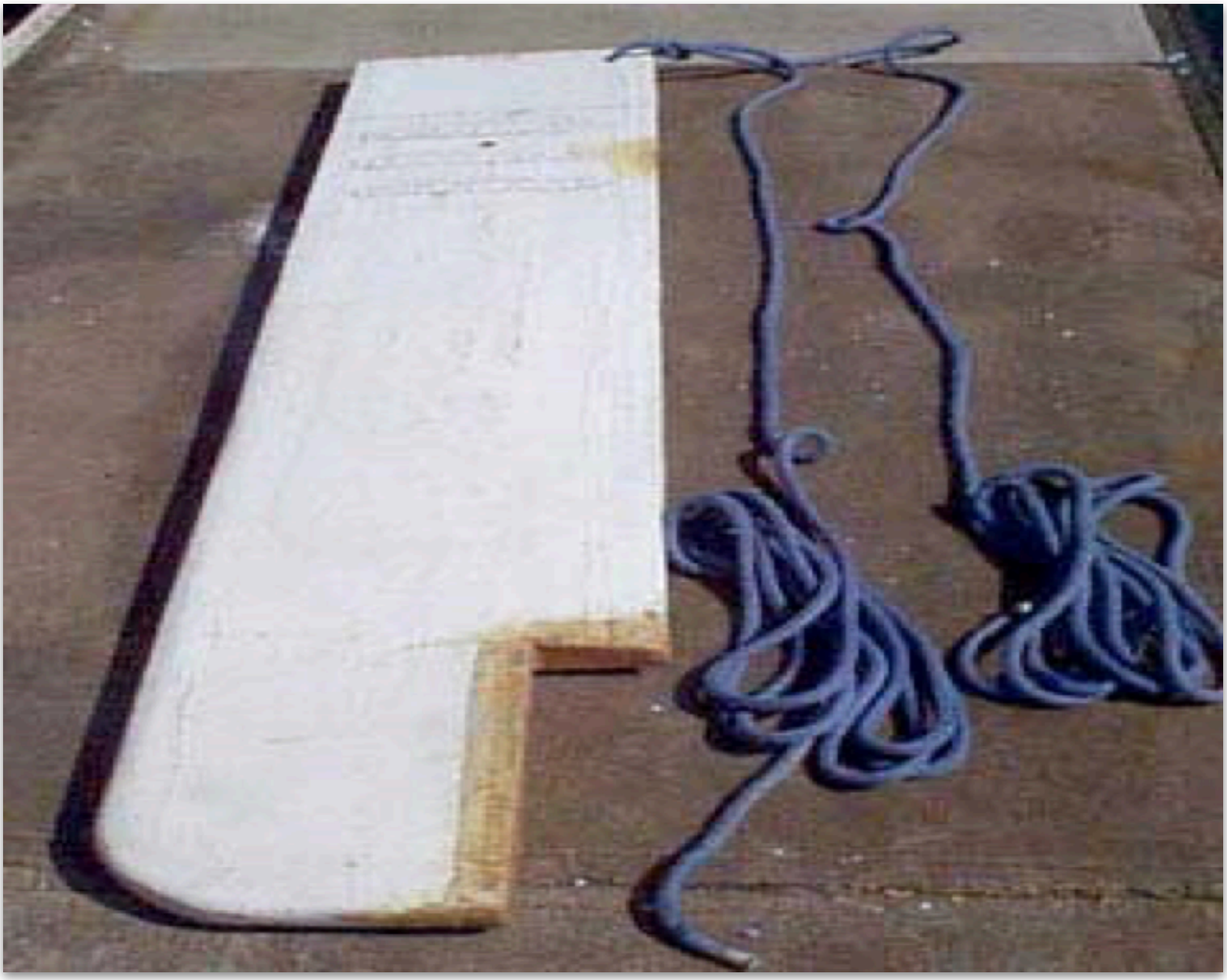
# THREE POINT FRAMEWORK TO HOLD PINTLES AND GUDGEONS

Hanging off the back of the boat to install this rudder in any sort of sea state would be difficult and dangerous.

# RUDDER IN CASSETTE SYSTEM

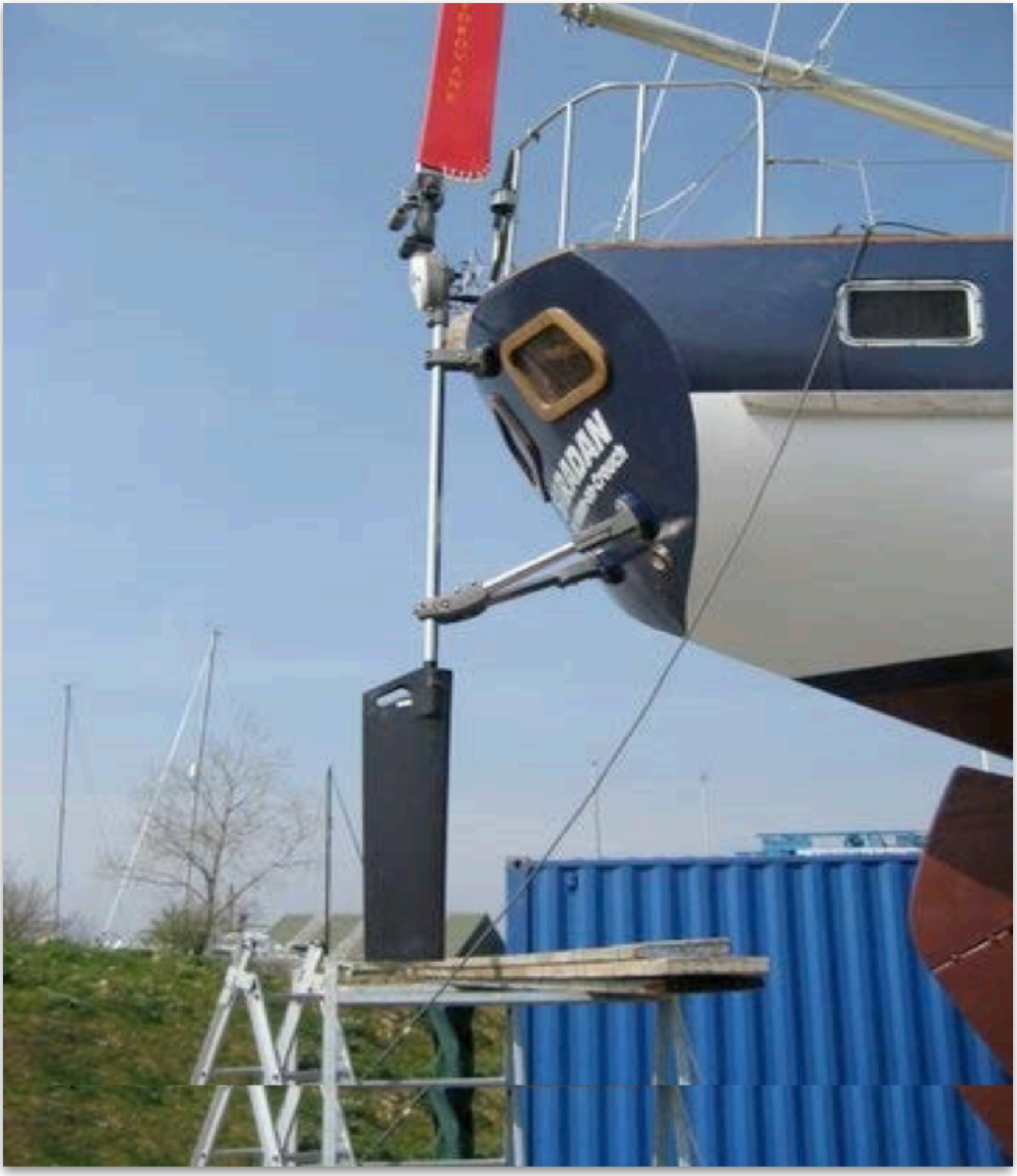


# RUDDER FOR CASSETTE



# RUDDER IN CASSETTE

# HYDROVANE



www.hydrovane.com

# RANDOM THOUGHTS

1. If rudder is intact use the auto-helm or autopilot during repairs (e.g., steering cable break)

2. Wind vane may work but may be too small if main rudder is lost

3. Plywood clamped to Spinnaker pole with U bolts won't work

4. Need over 100 pounds force on tiller leading to wear and damage at fulcrum

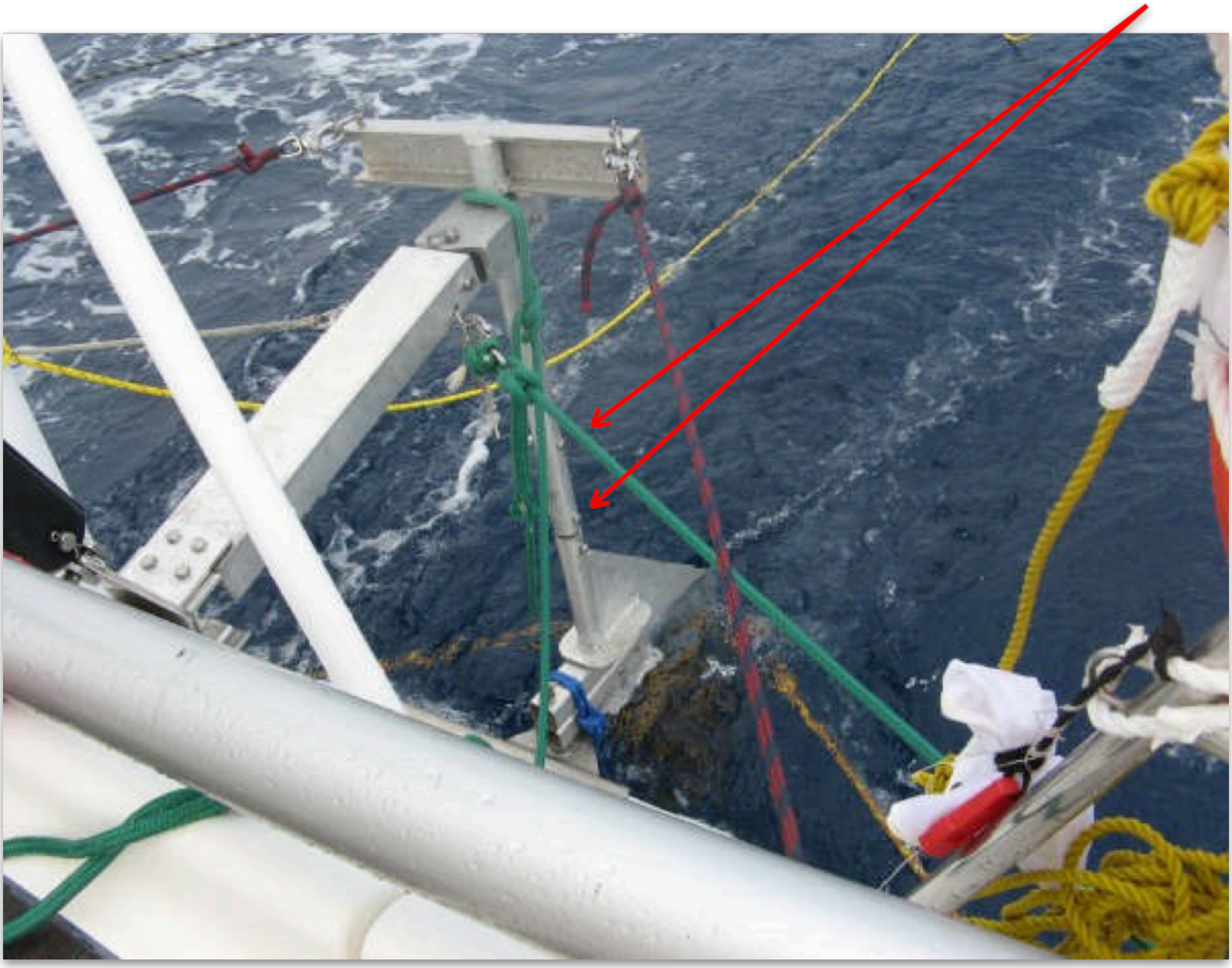
5. Be wary of one-off designed and built emergency rudders

# It Can Happen!


2008 VIC-MAUI

Something Wicked, Beneteau 40.7

CLEAN BREAK



DESIGN FLAW
Hana Mari
(Light winds, no seas)

UNDERESTIMATING LOADS

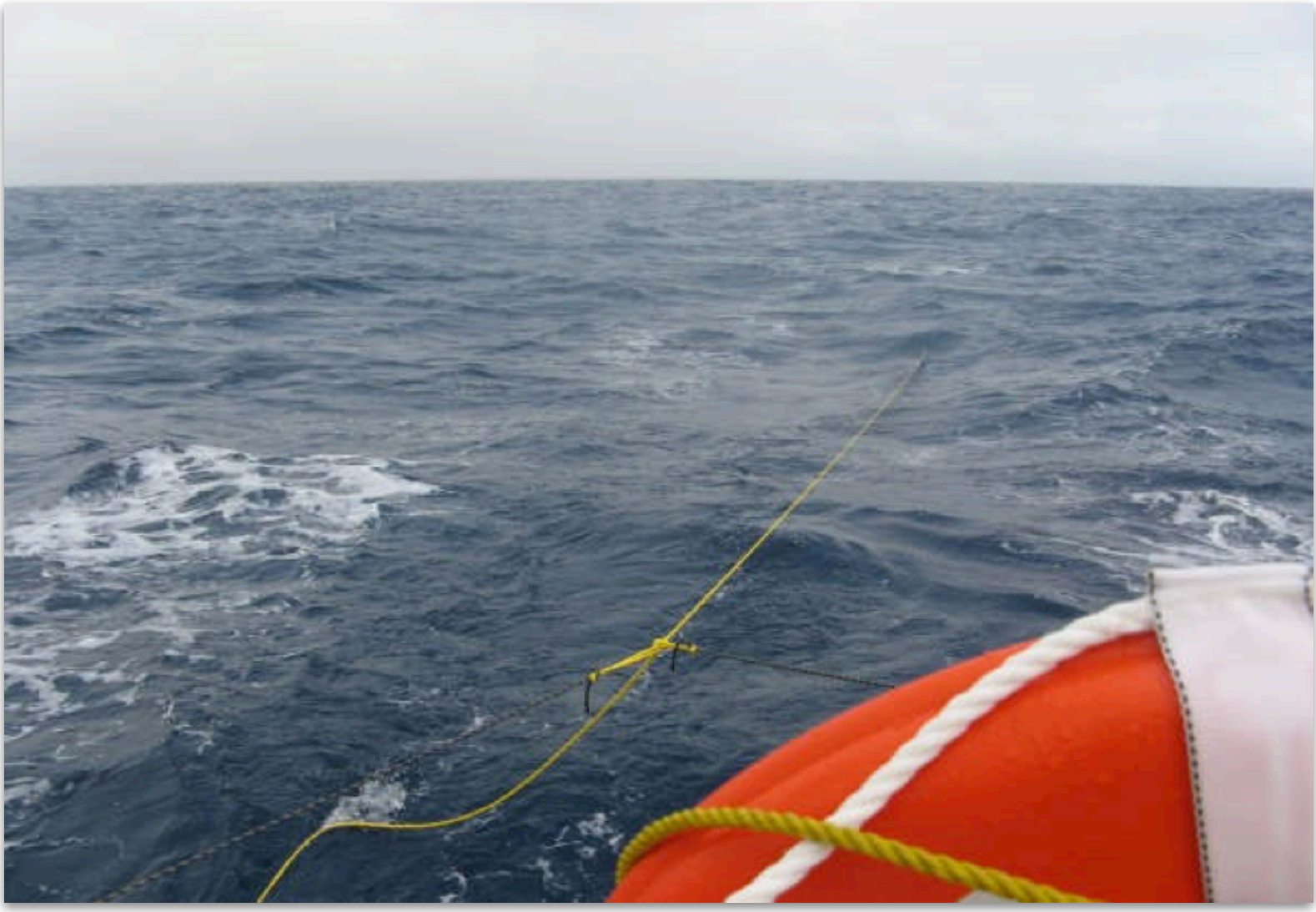
“Torsion loads on the frame were immense and caused the welds to fail. This was under power at less than 3 knots”.

# Steering With A Drogue

# SPINNAKER POLE LASHED TO PUSHPIT

# STEER TO STARBOARD

# STEER TO PORT



# Drogues For Emergency Steering


Manufacturer: **Jim Buoy**

Model: 926 (18” diameter)

https://www.jimbuoy.com/pages/marine/anchors.htm

Manufacturer: **Burke Marine**

Model: BOAT LENGTH - 10.9 m — 16.8 m

https://www.burkemarine.com.au/pages/seabrake

Online Presentations:

https://bermudarace.com/emergency-steering-drogue-new-approach/

# Seven Things

8. Don't underestimate the forces on the rudder;

(3,750 lbs on 9 sq Ft rudder at 16 knots)

9. Inspect and service all components of steering system
10. Money is well spent dropping and inspecting rudder stock
11. Emergency rudder must work in strong winds and high seas
12. Must steer boat with or without wind, whether or not yacht's rudder is still in place
13. Be wary of one-off designs!
14. Plan how you will install emergency rudder at sea
15. Take a drogue that is appropriately sized
16. Use a spinnaker net—most steering failures occur downwind

# Appendix 1:
# Checklist for Inspection Of A Wheel Steering System

## Inspection of Wheel Steering System

**When the boat is hauled for its annual service, a good external inspection is in order:**

**1. Of the rudder assembly**

- Check for external damage to rudder blade particularly at the bottom
- Ensure rudder has not taken on any water
- Sound with a small hammer to check integrity
- Check for corrosion bleeding out, indicating signs of water intrusion and possible crevice corrosion internally
- Condition of rudder post visible between blade and hull
- Make sure rudder is not bent

*NOTE: To take things one step further, the rudder may be removed for a more thorough inspection of the rudder post and non-destructive sonic testing can be done to check the integrity of the post*

**2. At the steering pedestal**

- Check condition of wheel and make sure there is no excess play between pedestal shaft and wheel, and that retaining nut is tight
- Check wheel brake operation
- Check wheel pilot assembly if equipped. Make sure it is securely fastened to wheel and drive belt is in good condition
- Move wheel from lock to lock and check for smooth operation with no unusual sounds

**3. Inspect rudder post packing gland assembly**

- Adjust if necessary

**4. At the steering quadrant**

- Inspect steering cables for broken wires within cable, especially at wear points
- Inspect condition of steering chain
- Make sure cables are adjusted to correct tension
- Inspect cable clamps and make sure they are installed correctly and are tight
- Inspect quadrant assembly and fasteners
- Inspect condition of sheaves and make sure there is no excessive wear on pivot shafts and sheave bores — make sure cotter pins are all in place

**5. Inspect fittings and attachments to hull or under deck**

- Inspect for signs of cracking or delamination of any attachments to the hull or other supports for steering components under the deck (e.g.; for bases of sheaves)

**6. Inspect autopilot assembly if equipped.**

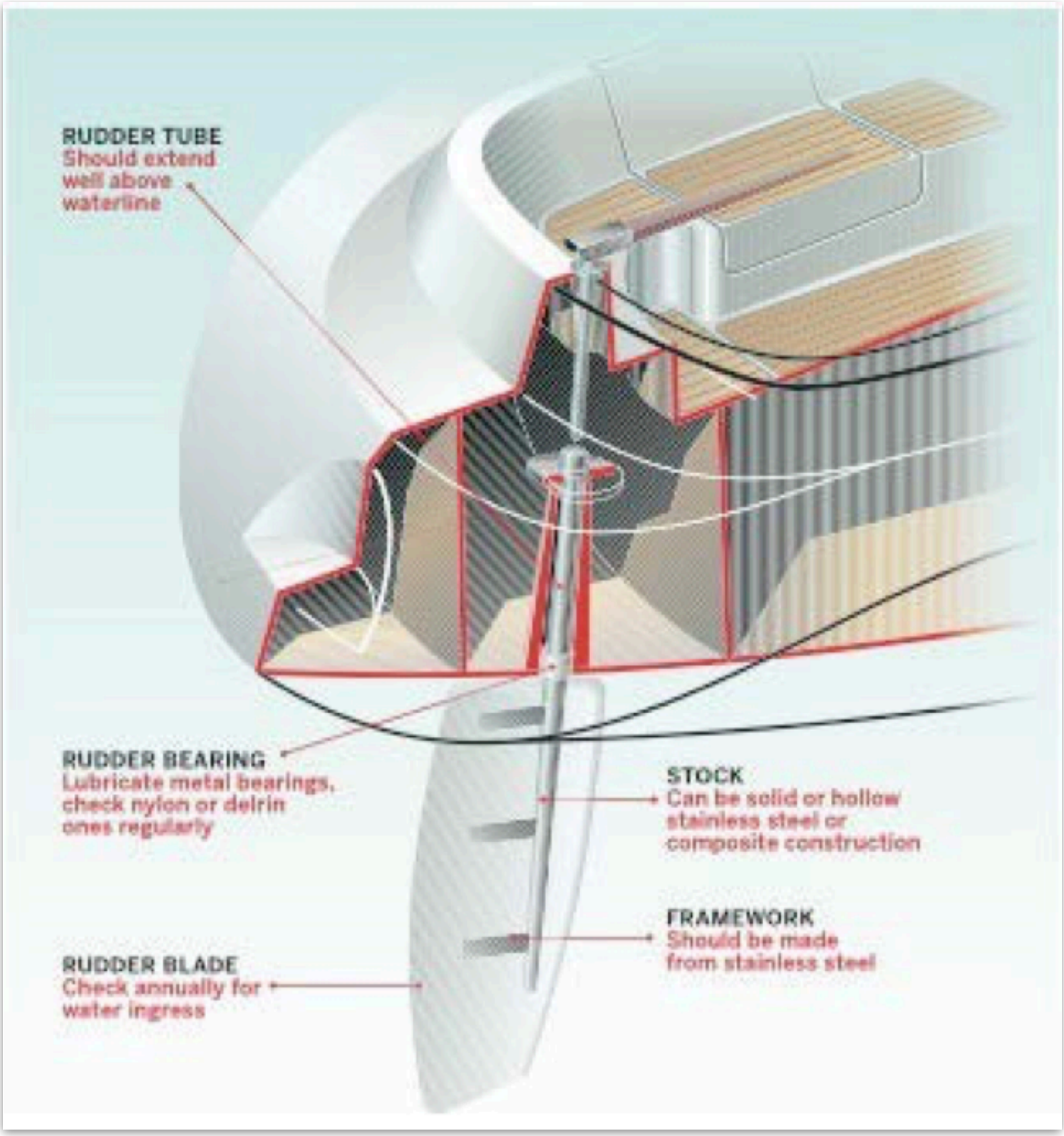
- Make sure actuator is securely fastened and connection at rudder post or quadrant is secure

Generally a pair of eyes is your most valuable tool for inspection!

*Credit: Based on advice from Stan Coppen, Technician at Canoe Cove Marina in Sidney BC*

# Appendix 2:

# Cross section of Spade Rudder and the Force on a Steering System



# RUDDER FORCES

$F = A * Cl * 1/2 * RHO * V^2$

F = force (lb)

A = area below transom (ft^2)

Cl = Coeff. of lift (use 3.0 to allow for pumping transients)

RHO = density of water (1.9905 slugs/ft^3)

V = design speed (ft/sec) (1 knot
= 1.6878 ft/sec)

$F = 8.5 * A * V^2$

F = force (lb)

A = area below transom (ft^2)

V = design speed (knots)

Example: 1 ft. x 4 ft. blade @
7knots: F=1666 lbs