VIC-MAUI OFFSHORE SAILING:

21 hrs TOTAL

Seven 3 hour sessions at R.V.Y.C., Patio Lounge, in preparation for the 1992 Vic-Maui. Tuesday nights, 1900-2200, starting January 14th.

Instructor: Dr. Jack Balmer, with guest speakers.

1/ Introduction. Other preparatory courses recommended (Piloting, Celestial Navigation, First Aid & CPR). Hull Shape & Stability. Modifications necessary for bluewater sailing: rig, tankage, ports, hatches & windows, securing storage, emergency steering, through-hull fittings. IYRU/ORC standards. Coast Guard requirements.

2/ Sail handling for maximum speed and safety, reefing methods, heavy weather sailing. Crew safety. Shipboard emergencies, muster stations, abandon ship drill, life rafts, raft dangers, flooding, fire-fighting. Dismasting, lightning strikes, medical problems. First Aid kit, tools and repair items.

3/ Meteorology, clouds, visibility. Ocean winds and waves, fronts, depressions, storm avoidance, wave action. Weather information, weather chart interpretation, weatherfax stations.

4/ Provisioning & cooking aboard, methods of food storage, food substitution. Watch-keeping schedules, duties of on and off watches. Chafe prevention. Distress signals. Nautical sayings & proverbs.

5/ Navigation, celestial vs electronic, Loran, Satnav, GPS. Route planning. Celestial navigation definitions. Navigation charts & books. Collision avoidance & ColRegs. Time zones, navigational miscellany, trig. functions for navigation, use of a calculator for sight reduction.

6/ Radio waves. Offshore communication, daily race communication. Amateur radio nets. EPIRBS. Radio installations, antennas, ground planes. Battery capacity and charging methods suitable for racing yachts.

7/ Clearing into and out of Hawaii, the legalities & paperwork, flag etiquette. Cruising the islands. Sighting reefs, anchoring techniques in coral. Availability of parts & services in the Hawaiian islands.

Video & slides will also be presented during the course.

INTRODUCTION:

Compared to local races, or even the Swiftsure, the Vic-Maui is a marathon event. Success comes from continually driving the boat during the ten to twenty days of the races, but only within the confines of safety and good seamanship.

Once at sea, yachts must be completely self-reliant. It is the intent of these seminars to provide information which will improve safety and comfort during the passage there, and the return trip.

There are some subjects that cannot be covered in the twenty-one hours of this course. It is assumed that the skipper and some of the crew on each yacht are adept at coastal piloting, and that the navigator is experienced in celestial navigation. Although sat-nav and GPS units are becoming relatively inexpensive, complete reliance on them is not advised. Celestial navigation should always be considered the prime method of position fixing.

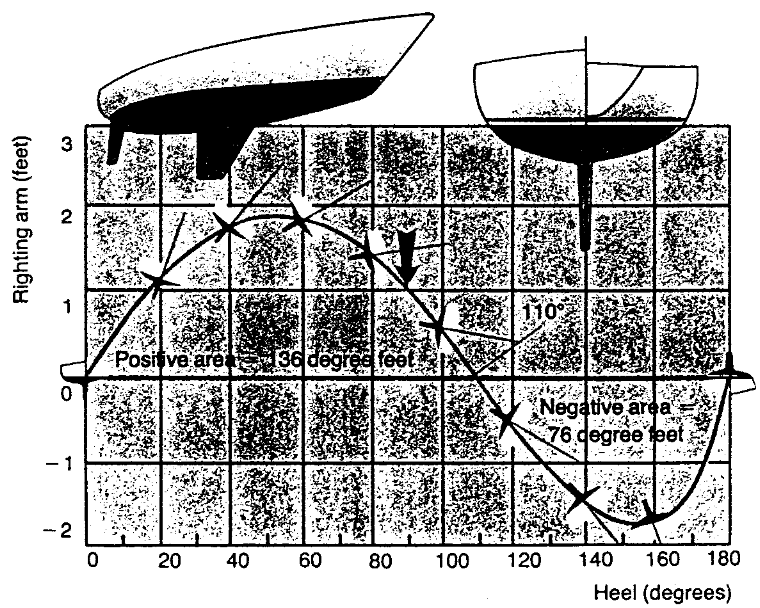
One or two in each crew should have taken a Standard First Aid course recently, and a C.P.R. course within the last year. A hands-on safety course (including fire-fighting and life raft operation) is planned soon by the Vic-Maui committee for competitors. This will be given through the Pacific Maritime Training Institute, so the information given during these seminars will not duplicate that of the P.M.T.I. marine emergencies duties course.

HULL SHAPE AND STABILITY:

Any modern ocean racing yacht is by necessity a compromise between speed, stability, seakindliness, and ease of steering. Most monohulls will fall into one of the three following types, and by examining each we can get an idea of what characteristics to expect.

A hard-bilged beamy boat, like a modern IOR design has more initial stability (form stability), but loses much of its stability at increasing angles of heel. It rolls less easily but has a harsher movement from wave action. If rolled, it could stay inverted for up to four minutes.

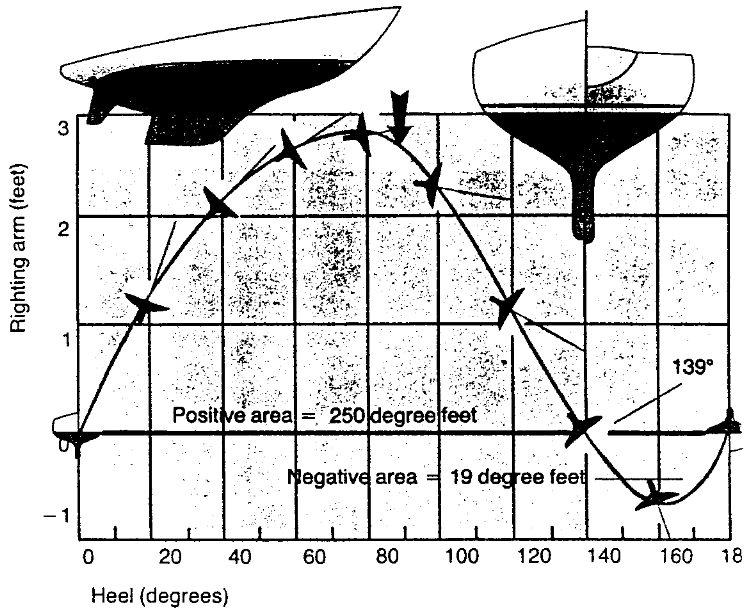
The deep fin keel and balanced rudder produces fast turning, but with the disadvantage of poor tracking. Low wetted surface should produce faster speed, but it also requires greater attention to prevent broaching when flying the spinnaker in good winds and larger seas.

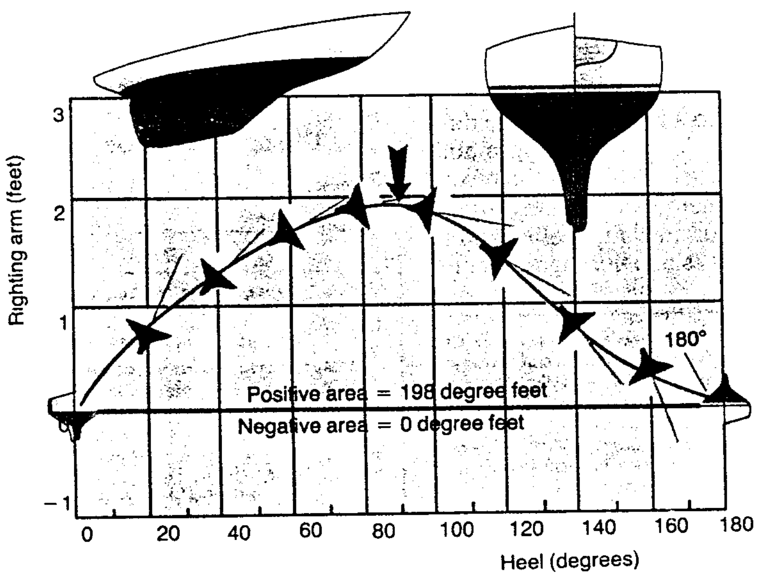


(Stability drawings courtesy of "Cruising World".)

Boats designed in the 1970's to the old CCA rule usually have a moderate beam and fairly slack bilge, enough fullness at bow and stern for good buoyancy, and a sharp enough entry to cut into waves rather than pound. This type may remain inverted for 20 seconds only when rolled.

These are good compromise hulls for ocean sailing, particularly if the rudder is hung from a skeg, as they then have good tracking ability, and the rudder is less vulnerable than a balanced type.





Many offshore cruising yachts have a full keel configuration. These often are slack-bilged and a little narrower. They roll more easily but produce more and more positive righting moment the more heel is applied. The roll will be slower on waves, producing a more sea-kindly movement. It retains positive stability at all angles of heel.

They track very well and the rudder is protected but the steering is less responsive. As there is greater wetted underwater surface there is a penalty in speed.

Any gear aboard which can shift greatly reduces stability, as does the Free Surface Effect of partly filled tanks. All tanks preferably should be baffled fore and aft. Since empty tanks or completely full ones no not exhibit Free Surface Effect, this is another reason for utilizing two or three separate water tanks.

On an ocean passage, extra weight (from fuel, water, extra sails, or repair materials) is unavoidable. All heavy items and gear should be placed as low and as close to the centre of the boat as possible, and secured to prevent movement. Excess weight in the ends (such as might come from sails in the bow or an anchor chain) produces more pitching, giving a wetter, more uncomfortable ride and a great reduction in speed.

PREPARING A BOAT FOR OFFSHORE:

The Rig:

The chainplates must not only be husky, but designed so that the stress is transferred down vertically to the hull, transom, or bow. There are a number of ways this can be done, but loading horizontal areas of the deck is not acceptable.

Whatever diameter stays are considered adequate for local waters, go one size up all around, including turnbuckles and toggles. I would also suggest that a sloop going offshore should be re-rigged so that it could be made into a cutter (See page 7). A detachable inner forestay and running backstays are all that is required. A storm staysail hanked onto this forestay will allow the jib to be dropped or rolled, and will bring the centre of effort back and lower. With a heavily reefed main, it will be as much sail as you want in force nine winds.

Sails, too, should be heavier, and specially beefed up at the clews and cringles. A husky main that can be deeply reefed might work just as well as a trysail in winds up to storm force. Note the ORC requirement for trysails and storm jibs (sections 10.21.1 and 10.21.2) If the main is on a track, I would suggest metal, rather than plastic, slides. Although some sailors decry roller furling jibs, they sometimes eliminate having crew go up on a slippery, heaving foredeck to drop and lash down a jib.

If possible, there should be duplicates of all halyards, and spares of all sheets and other running rigging. Not all blocks need be duplicated, but enough so that there is a replacement aboard in case one shatters.

Chafe on running rigging is a perpetual problem, but to a large extent can be solved by good anti-chafing pads on spreader ends, and leading lines so that they do not rub on other rigging.

For winches, follow the old adage that it is impossible to get ones that are too large.

Pulpits and stanchions should optimally be an inch and a quarter in diameter, and a good thirty inches high, and must be through-bolted or welded. (My feeling is that the ORC regulations are too lenient in this regard, as 24" lifelines will catch just at the knees.) Do not use screws for any deck fitting. Along with a high bulwark (usually part of the hull design), two lifelines make a fairly safe enclosure, and netting on each side from mast to bow will keep sails and crew on board. Never rely completely on the lifelines.

Jackstays (see ORC reg. 6.65), also known as safety lines, should be used as one harness anchorage point for crew going up on deck. The other harness line, usually shorter, is also snapped on to secure points of the mast or near the bow.

Examining the Rig:

You may want to have a professional rigger check out the standing and running rigging before leaving. If you are not certain of your own capabilities in this area, this well worth the expense.

If you wish to do it yourself, here are some of the things to look for:

1/ Is the standing rigging of adequate size for offshore? 1x19 cable is not as strong as rod rigging of the same diameter. Some experienced offshore sailors suggest replacing the standing rigging every five years.

2/ Look for broken strands, particularly near swage fittings.

3/ Examine the swage fittings carefully for tiny longitudinal rust marks, as these could the first indication of incipient failure. There are also kits (such as Magnaflux) which can be used to point out fracture lines, but these may be difficult to use with the rig standing. Chainplates and tangs should also get the same examination.

4/ Take a hard look at the turnbuckles and toggles. My own preference is for open-barrel turnbuckles, where the threads can be checked. Loosen them and coat the threads with a graphite grease (like Nev'r Seize) before re-tuning the rig. Check the cotter pins, then tape so that lines will not snag.

5/ Check all mast sheaves. Do they turn easily (re-grease anyway!). Has the groove been over-cut by halyard wire? Is there so much space on the side of the sheave that a halyard could jump and jam? In the last case shims should be placed.

6/ Look at the spinnaker block crane for signs of structural failure. Also at the U-bolts holding the blocks, and at the blocks themselves. Plan to spend a little time at the masthead in a comfortable bosun's chair to check everything, including the contacts for the lights. A trilight that fails due to a spot of corrosion can be a pain to repair at sea.

Since many rigging failures can be traced to failure to replace a worn or strained component, a critical examination of every bit of the rigging before starting is vital.

Running Rigging:

Again, look for frayed sheets or halyards. My own suggestion would be to have two main halyards, two jib halyards, and two spinnaker halyards for a sloop rig. Are the lead blocks heavy enough? Very critically look at the turning blocks for jib and spinnaker guys. They should spin easily and be of a size to handle twice the line load. Turning blocks must be through-bolted to heavy under-deck backing plates.

All blocks used with kevlar lines must be of a larger diameter than for dacron. When running with spinnaker offshore, remember to adjust the halyard in or out a few inches at every watch change, to prevent chafe at the block.

Tankage:

Fuel capacity should be enough to power at least half the distance of the passage. With a diesel engine, it is possible to attain this, but unlikely for gasoline engines. It is also necessary to have some method of preventing a heavy following sea from flooding the engine. A high exhaust loop is good in most conditions, but a big brass gate valve is more certain.

Fresh water is probably the most important item aboard on ocean passages. Since a person loses 4-6 pints (4.5-7 litres) of water daily in the tropics, and survival is unlikely with more than 20% of body water loss, I would suggest carrying a minimum of one and a half imperial gallons (6.8 litres) per person, for each day anticipated for the voyage. That should provide enough for drinking, cooking, washing, and even an occasional fresh water shower, and a fair bit for reserve.

My personal feeling is that the ORC suggestion of 2 gallons (9 litres) per person per 1000 miles, or even the Vic-Maui minimum of 15 gallons per person for the race, is inadequate. It is very difficult to catch rain water during a passage, and relying of supplies of beer or soft drinks is of doubtful value, as both also cause some dehydration.

Reverse osmosis watermakers work quite well, and can eliminate some tankage, but they are fairly expensive, as are their replacement membranes. If you have enough extra electric power to run one, you might consider the Recovery Engineering 12 volt units (4 amps for the one imp. gal/hr unit, 8 amps to run the 2.8 imp. gal/hr one). Water should be divided into three tanks. Then if one becomes fouled with salt, two-thirds still remains. Where the water is suspect, it is prudent to dose each tank with chlorine bleach when filling - about one tablespoon for ten gallons. The chlorine taste disappears after a day or so.

Ports & Windows:

Hull ports must not only be absolutely watertight, but both glaze and frames must be able to withstand heavy pounding. My personal preference is metal frames with at least quarter inch (6.4 mm) of lexan (polycarbonate) glaze. Large glass cabin windows should be covered outside with even thicker sheets of the same material. Solidly attach the plastic, and leave space between it and the glass for the lexan to bend in under pressure.

Adequate ventilation when underway is a necessity, but difficult to get without leaks in heavy weather. "Dorade" type vents work most of the time, but even they must be closed off when green water starts rolling over the foredeck.

Securing Storage:

Batteries should not only be in their own acid-resistant boxes with provision to let charging gases escape, but should be solidly strapped down with polypropylene webbing. Stoves, spare anchors, and any other heavy gear should also be secured so that they will not move in case of a knock-down.

Emergency Steering Gear:

- Tiller which attaches to rudder post head.
- Board clamped to spinnaker pole, making an emergency rudder.
- Steering with the sails.

Through-hull Fittings:

- Seacocks (preferred) vs. gate valves. Bronze vs. plastic.

Softwood plugs should be carried for all hull openings, including the shaft log and exhaust. They should be of the correct sizes, and tied to their seacocks by a length of cord, ready for immediate use.

Cockpit Drainage:

The drains must be large enough to empty a flooded cockpit within 30 seconds at any degree of heel. It is also recommended that wash boards of door covers be ready at hand to seal cockpit openings off up to deck level. The same applies to any deck opening leading to a below-deck box which cannot be sealed watertight. (Again, see the ORC regulations)

Corrosion & Electrolysis:

Expect much more when offshore in warmer temperatures and saltier water. Aluminum, unless anodized, is particularly susceptible, especially when fastened with stainless or brass. Avoid dissimilar metals where possible, and use a bedding material (such as Nev'r Seize) on bolt threads. Stainless fittings and winches on the mast and boom should be underlain with a thin vinyl insulating sheet.

Tools, even stored below deck in dry places, should have a light coating of oil or grease to retard rusting. Note: NEVER use steel wool on stainless steel aboard - bronze or stainless steel wool is available. Otherwise you are certain to get surface rusting.

IYRU/ORC Standards and Coast Guard Requirements:

The safety regulations required by the ORC and the Coast Guard should be taken as the minimum necessary. In many cases, such as in fire-fighting equipment, it is prudent to even double the number of portable extinguishers required.

In the following pages, suggestions will be given as to various safety and emergency equipment that might be aboard during ocean races or passages. In many cases these would have to be modified to the requirements of individual yachts. A first aid kit, for example (page 12), would also contain the emergency prescription medications which might be needed for individual crew members.

SAIL HANDLING:

Sail Trim offshore should be the same as sail set for racing or coastal cruising. The apparent wind we see will a combination of the vectors of the true wind and the boat's forward movement; and always seems to be coming from ahead of the true wind direction. When the true wind is on the beam or ahead, the apparent wind will be stronger, while aft of that it is lighter.

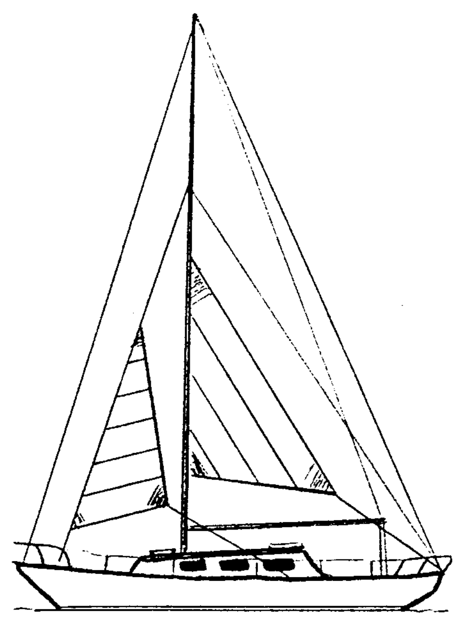
Offshore winds are usually stronger than in Georgia Straits, so much less sail need be carried. The formula for the force of the wind is: $P = .0034\,AV^2C$, where P is the force in pounds, A is the cross-sectional area in square feet, V is the wind velocity in knots, and C is the coefficient of drag. C for hull surfaces will be less than one, for a flat plate is 1.2, and for a spinnaker is about 1.5. Since the force is a function of the square of the wind speed, doubling the wind speed means four times the force, and tripling it produces nine times the force. The force exerted on a 2000 sq.ft. spinnaker in 30 knots is (.0034 x 2000 x 900 (30 x 30) x 1.5) in excess of 9000 pounds.

If a boat is sailing well at full hull speed in 20 knots of wind, then only a quarter of that sail area is needed in 40 knots to retain the same driving force and heel angle. Shortening sail must be done as the wind increases, so should be accomplished quickly and efficiently, and before the boat begins to wallow with excess heel.

Reefing Methods are basically slab reefing and roller reefing. Slab reefing (tying off a portion of the sail with reef points and earings, or reef lines) is usually easier on the main, while roller reefing commonly is used for jibs. Both have disadvantages: slab reefing can produce chafe on the sail, while roller reefing does not adequately flatten the sail for heavier winds.

Changing to smaller, heavier, and flatter sails like a spitfire jib and a storm trysail, as shown in the diagram, is preferable in gale force winds.

As the centre of effort in a sail is an intersection of the lines drawn from the clew to halfway wp the hoist, and the head to halfway along the boom; it means it is necessary to set sails lower and closer to the mast if we want to reduce heeling and keep the boat easily steered.



An intermediate forestay added to a sloop rig has a number of advantages. It allows an inner staysail to be hanked on, ready for use to make the boat a cutter. In heavier winds, the jib can be partially or fully furled, while off-wind it and the jib can both be winged out if there is too much wind for even a small spinnaker. When used with detachable running backstays, this system prevents the mast from pumping or bowing. This inner forestay can also be detachable, using a pelican hook and turnbuckle.

Heavy Weather Sailing:

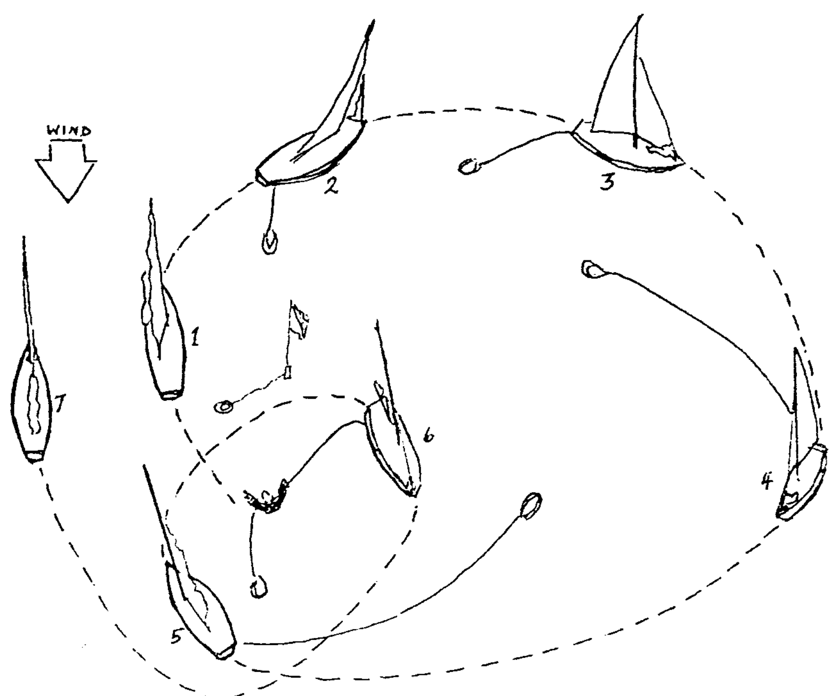
After the wind increases, within an hour or two the waves will as well. Wind waves will be added in height to the swells, and make beating to weather both tiring and slow. Bearing off slightly so that the apparent wind is 40° to 45° will give a much easier ride and increase boat speed so that it more than makes up for the lack of pointing angle. Off the wind, it is inadvisable to run directly down-wind, particularly in heavier winds, as the wave action makes it difficult to prevent an accidental gybe. A heading of less than 150° from the wind will be much easier. In either case, head on the tack that takes you away from the low pressure centre. Buys Ballot's (or the hip pocket) law says that in the northern hemisphere, when you face the wind, the low will to your right and slightly behind you (or away from your hip pocket). In the southern hemisphere the reverse holds true.

Sail should be reduced more than you think necessary, the inner forestay and running backstay set, and the storm jib hanked on, ready to be raised as needed. My preference is for the main halyard, mainsail reefing lines, and topping lift to be run back to the cockpit. The main can then be slab reefed further without anyone going on deck. If the jib is on a roller-furler, half of it should be rolled early. This type of furler becomes progressively more difficult as the wind increases. A quarter of the jib out, combined with the storm staysail, makes a useful combination and keeps the centre of effort (of the sails) ahead of the centre of lateral resistance (of the keel); thus keeping the boat balanced.

Crew Safety:

Apart from the safety jack lines, there should also be tether pads in the cockpit where safety harnesses can be fastened. In heavy weather these harnesses must be worn by all crew going on deck, and should have two nylon rope leaders ending in caribiner shackles. A water light (strobe is best), PFD, and whistle complement the foul weather gear and deck boots or shoes. Even in calm days offshore, non-slip deck shoes should be worn. It is far easier to prevent someone falling over than it is to retrieve them !

There are a number of techniques for rescuing a crew in the water, but the one most commonly advised is to turn immediately to windward, dropping the sails as the boat turns through the wind, and deploying a "lifesling". The collar of the sling should also have a self-activated water light, so as the boat (now under power) circles the person, the line will drift down to him and he can see the collar. Once in the floating collar, he is gently pulled to the boat, climbing up a ladder (if capable), or lifted with a halyard.



SHIPBOARD EMERGENCIES:

1) Fire, Explosion	2) Grounding	3) Foundering	4) Man Overboard
5) Medical	6) Collision	7) Stability Loss	8) Weather
9) Mech. Breakdown	10) Struct. Failure	11) Personnel Problems	12) Dismasting

Muster List:

1/ Emergency Signal
2/ Location of Muster Station (usually the cockpit in a yacht)
3/ Location of emergency equipment (Life jackets, PFDs, Fire, Flares, etc.)
4/ Use of Overboard & Fire equipment (Initial action)
5/ Designation of Duties (Fire, Raft preparation, Communication, etc.)
6/ Location of Emergency Repair Equipment & Gear
7/ Recommended Attire for abandon ship & firefighting
8/ Abandon Ship Signal - To be given ONLY by Master

Abandon Ship/ Raft:

1/ Done only as a last resort
2/ Gear for raft grab bag (see below)
3/ Launching raft, righting if necessary, entry
4/ Psychological & physiological survival problems
5/ Priorities - protection, communication, water, food
6/ Dangers (see item below)

Abandon Ship Standby Kit:

- This waterproof bag should contain: waterproof & warm clothing, space blankets, an EPIRB (with 406 MHz) with spare batteries, first aid kit*, anti-nausea pills*, water*, ample tinned food, multi-vitamin tablets, portable VHF radio, flares*, hand reverse osmosis desalinator (or both solar watermakers & rain catchment devices), diving speargun, radar-reflective kite, flashlight*, knife* & pliers, cutting board, spare plastic (Tupperware) containers with lids, paper & pencils, plastic sextant & HO 211 tables, almanac, waterproof quartz watch, fishing gear, soap, towels, twine, thread & needles, scissors, sleeping bags, compass, sun block ointment, metal mirror.

* These items may duplicate some in the regular offshore raft package. Note: If you can launch an inflatable dinghy (particularly one with a solid floor) at the same time as the raft, it will enhance survival.

Dangers In A Raft At Sea:

(a) Exposure/hypothermia.
(b) Capsizing in a heavy sea.
(c) Crowding/claustrophobia
(d) Dampness (salt water boils)
(e) Thirst/hunger.
(f) Depression - loss of morale.
(g) Shark attacks, tearing raft bottom.
(h) Infection/ food poisoning
(i) Slow leakage of air from raft tubes.
(j) Sun/heat stroke.

LIFE RAFT NUTRITION:

Water: To reduce dehydration: avoid exertion, smoking, eating too much, alcohol, talking, breathing through mouth, overheating.

Salt: 1/2 oz. (5-10 gm.) is required daily. Seawater contains 15 gm./ pint.

Food: 70 cal/hr is needed for metabolism, and another 45 cal/hr for the simplest activities. This converts to 2040 calories/day necessary to prevent body fat, then muscle, being converted to energy.

FLOODING:

1/ Stopping inflow: Seacocks, plugs, collision mats inside & externally
2/ Pumping: Submersible electric, belt driven from engine, using salt water line, manual pumps, buckets, intake strainers, free limber holes.

FLOODING RATE FOR VARIOUS HOLE SIZES & DEPTHS- in Imp. Gal/Min

Hole Diam.	1'	2'	3'	4' (Depth)
1/2"	2.5	3.4	4.3	4.9
1"	10	14	17	20
1 1/2"	22	31	38	44
2"	39	55	68	78
2 1/2"	61	86	106	122
3"	88	124	153	176

FIREFIGHTING:

1/ Fire Prevention is first step, and includes: ship cleaning (removing dust, grease, oily rags, etc.), proper storage of flammable items & fuels, engine fire prevention (flame arrestors, drip pan, refuelling), smoking, electric wiring, galley stoves, heaters.
2/ Actual fire fighting preferably should be done by people trained in techniques.
3/ C.C.G. required fire equipment is totally inadequate for offshore. Double the number of portable extinguishers (with large halon ones), install a salt water fire hose and automatic 7# halon unit in engine room.
4/ Fire spreads by conduction, radiation, and convection. The first two only pertain to small yachts.
5/ Fire requires heat, oxygen, fuel, and a chemical chain reaction. Eliminating any of these stops the fire momentarily, although it may reignite when the missing requirement returns.

CLASSES OF FIRES:

"A", symbolized by a triangle, are fuelled by combustible solids (wood, fabrics, rubber, and fibreglass resin).

"B", symbolized by a square, are fuelled by flammable liquids or gases (diesel, gasoline, propane, alcohol, and paint).
"C", symbolized by a circle, are electrically caused, and usually spread by igniting A or B materials.
"D", symbolized by a star, involve combustible metals (sodium, potassium, magnesium, or aluminum). In a yacht they are secondary to other fires, and since they can only be put out by special dry powders, will not be covered in the table below.

EXTINGUISHER USE:

	Water	Foam	CO_2	Dry Chemical	Halon
A (solids)	YES	YES	YES	YES	YES
B (liquids)	No	YES	YES	YES	YES
C (electric)	No	No	YES	YES	YES

Water - Best used in a fine misting spray as coolant for prime firefighter, and to eliminate heat after initial flame has been put out. Useful for preventing fire spread by radiation and conduction.
Foam - Water based, with protein, AFFF, or FFFP additives. Last is best as it is not dirty, sticks to surfaces, and smothers by oxygen deprivation.
CO_2 - Smothers and cools fires, but is fairly slow working and requires the operator to get quite close to the fire. Large bottles are necessary.
Dry Chemical - Works by breaking chain chemical reaction. Efficient and fast, portable extinguishers work from 10 feet away. May produce an initial flash; not dangerous, but unnerving. Must be shaken occasionally.
Halon - Breaks chain reaction almost instantaneously, also has some cooling. Can be used from 15 feet away. 1211 Halon CAN produce phosgene gas in fires over 900° F. (500° C.). Most effective, but ozone destructive.

FIREFIGHTING PROCEDURES

1/ Firemen's protective clothing is made of Nomex, rated to 1100° F. In lieu of this wear wet wool, or even wet cotton, but no synthetics.
2/ In case of electric (C) fires, cut the electric power immediately.
3/ For engine room fires, use remote controlled extinguisher, or determine if automatic one has fired. Do not open door or hatch, as it could allow new oxygen and fresh fuel (you) to enter. Feel the door or handle for heat.
4/ Select correct extinguisher, pull pin and give a short blast to make certain it works.
5/ Approach fire from upwind, crouching low, and walking slowly toward fire. Backup firefighter comes behind, with a mist water spray for first person, and with second extinguisher.
6/ Fire at nearest base of fire, moving nozzle side to side. Then sweep side to side back until initial fire is out. If first portable extinguisher runs out (about 30 seconds for small ones), backup person passes another, after first testing it.
7/ Once initial fire is out, flashback is prevented by cooling with water spray, or smothering with foam.

8/ Watch for re-ignition, cool nearby areas if necessary with spray to prevent it starting in other combustibles. NEVER TURN YOUR BACK ON A FIRE, AND NEVER RUN TOWARDS ONE.

9/ Keep crew not actually involved in firefighting in safe place (muster station) until all danger is over.

10/ Clean up mess. CO_2 and Halon are gases and leave no residue, even on food. Dry chemical and foam do. Remove all partly burned material from site, and if started by a "C" fire, search for cause of the fire before restoring power.

FIREFIGHTING HAZARDS:

1) Smoke makes vision difficult - the only light may be from fire itself.

2) Smoke or gas (CO_2 & CO) inhalation. Keep low, and to windward (or in-draft) side. If feeling faint, give over operation to back-up person.

3) Noxious chemicals: burning fibreglass and other ship-board materials can produce deadly gases. Hydrogen sulphide and sulphur dioxide comes from organic materials; ammonia comes from freon & nitrogen rich materials; nitrogen dioxide arises from cellular nitrates; acrolein from petroleum products. All are lethal after several minutes. More dangerous is hydrogen cyanide, produced by burning urethane materials.

4) Panic - think out a logical plan of attack before rushing in.

(Note: All this is covered by the M.E.D. course at P.M.T.I.)

DISMASTING AND JURY RIGGING:

(a) Quietly analyze the situation.
(b) Save as much of old mast & rig as can safely be done.
(c) Rig a new mast (using old part or boom) & refitting stays.
(d) Use spinnaker pole as boom; new running rigging.
(e) Remake sails to fit new rig.
(f) Head off-wind to the nearest harbour.

LIGHTNING STRIKES:

(a) Check for hull integrity, crew injury.
(b) Rig mast to ground (to prevent further strikes).
(d) Check batteries, disconnect if large current flowing.
(c) Check circuit breakers, do not switch on popped breakers.
(e) Check each circuit with VOM for shorts.
(f) Reconnect electrics as each circuit proved OK or repaired.
(g) Check electronic circuits, leaving wind instruments & marine VHF to the last - they will probably be blown out if the senders and antenna are at the masthead.

POTENTIAL MEDICAL PROBLEMS:

As medical treatment can be two weeks or more away, the prime consideration is to avoid/prevent medical problems from arising. Some problems can be treated satisfactorily aboard, in more serious cases the best that can be done is to keep the patient's condition from worsening before reaching port or within helecopter range. Medical advice can come via marine SSB or amateur radio. Most problems on passages come from cuts, burns, fractures, dehydration, hypothermia or toothache. Infections, stings, and parasitic problems generally arise after reaching a destination.

SUGGESTED FIRST AID KIT ITEMS:

- The minimum items in a waterproof kit (with moisture absorbent):

"Brook" airway	Triangular bandages (3)
Flex splint (aluminum)	Safety pins
3" darning needle (splinters)	Tube ophthalmic ointment
Optic loop	Roll absorbent cotton wool
Antiseptic solution	Soluol-grease solvent
Pressure bandages	Sterile pads(2"x2", 4"x4", 2"x3")
Waterproof tape	Scissors (sterile)
Antibiotic ointment	Sterile suture needle & thread
Aerosol tin ABT burn spray	Sting-kill swabs
Vial of ammonia inhalant	Vial of amyl nitrate inhalant
Analgesic pills (222s)	Anti-nauseant pills /suppositories
Antacid pills (Gelusil)	Zinc oxide & eugenol dental temp. filling
Broad spectrum antibiotics	Assorted "band-aids"
Eye cup	Sterile tweezers
Thermometer	Diarrhea medicine
Moist bandage pads	Laxative
First aid manual	

REPAIR ITEMS FOR BOAT & RIG:

Add the following tools to a usual set: hacksaw with tungsten blades, impact wrench, special wrenches for rudder post and keel bolts, tap & die set (coarse), 12v drill & drill index, files, 12v (or butane) soldering iron, full wrench & screwdriver sets, chisels, prop puller, VOM, large hammer, vice, grinder, manual (or foot) operated sewing machine, fids, palm, bolt cutters, nicopress & sleeves, feeler guage, measuring tape, circlip pliers, vice-grip pliers, pipe wrenches, plumbing tools, grappling hook, wire brush, whetstone, razor knife, wood saw, punch, hand pump.

- Also include the following materials: water activated fibreglass repair material,epoxy and styrene resin, gelcoat, glass cloth, epoxy filler, sealing compound, WD40, anchor winch oil, spare screws, clevis rigging pins, nuts and bolts, plumbing items (including teflon tape, hoses, and assorted clamps), sail material, sail thread, whipping cord, sail slides & hanks, rigging tape, seizing wire, PVC tape, electric wiring & connectors, distilled water, spare flashlight cells & bulbs for all lights, turnbuckles & toggles, grease.

METEOROLOGY

Air contains 78.08% Nitrogen, 20.95% Oxygen, .93% Argon, .03% CO_2 (99.99% Tot.)

Troposphere - all weather is in this lowest layer
- is bordered on top by Tropopause layer, temperature here is - 40 to -80° C, so no water vapour is present.
- Above is the Stratosphere, then the Ionosphere.
- is 5 miles (8 Km) high at poles, 10 miles (16 Km) at equator
- air temperature drop in the troposphere is about 1° F per 300 feet (.6° C. per 100m). This is the average lapse rate. Diurnal lapse rate varies this, especially over land.
- Lapse rate drop in Stratosphere is small (the ozone layer here)
- air pressure drops with height - average is 1mb/30 feet, but the actual varies with temperature; more with cold air than hot
- is not heated by sun, but by the surfaces below

Radiation - hotter body = shorter wave length & more intense emission
- much is absorbed by earth, which re-radiates long heat waves back
- thick cloud reflects 80° back, absorbs about 7°
- water vapour & cloud absorb most of outgoing long wave radiation (greenhouse effect; cloudy night = less drop in surface temp.)
- Max. comes at about 1400, and ceases at nightfall
- land is strong absorber, water is weak

Factors affecting radiation heating from sun:
1/ Inclination of solar beam: latitude; declination; & sun's altitude
2/ Nature of surface: Snow & Ice reflect 80°, dry rock & soil absorb well, but temperature of sea is changed little, due to (a) a high specific heat, (b) rays penetrate to some depth, (c) stirring effect, (d) much heat lost through evaporation,(e) water reflects at an angle

Air temperature tends to follow surface below, but the annual range, like the diurnal, is greater over land than sea. Factors changing air temp at sea are: Latitude, season, proximity to land, winds, currents, upwelling of cool water, and presence of ice or snow.

Humidity & Condensation

Water vapour is invisible, comes from evaporation mostly at sea.
Cloud & Fog are visible water droplets in liquid state.
Saturated air - maximum water vapour is limited by temperature, and increases greatly as temperature rises.
Dew-point is temp. to which unsaturated air must drop to become saturated.
Absolute humidity - water vapour of air at any given time in mass/unit vol.
Relative humidity = Absolute Humidity/Saturation value at same temperature. A fall in temp. of saturated air results in condensation. The higher the initial dew point, the more water condensed.
Hygroscopic nuclei are minute particles (sea spray, soot, smoke) that attract & absorb moisture, on which water vapour condenses at dew-point.

<u>NOTES:</u> 1/ Cold air is denser (heavier) than warm, so gives higher barometric pressure at surface for same height.
2/ Absolute humidity of air at 0° F. is nearly zero.

<u>Adiabatic</u>: = without gain or loss of heat (thermally insulated)

Heating & Cooling - arises from compression or expansion.

If unsaturated air rises it cools adiabatically by expansion, eventually reaching its dew-point (saturation), above which it condenses to water (or ice), forming clouds. Moist air gives low cloud base, dry air a high cloud.

<u>Dry Adiabatic Lapse Rate (DALR)</u> - When unsaturated air rises, it cools at a constant rate of 5.4° F. per 1000 feet. (1° C/ 100 m.)

<u>Saturated Adiabatic Lapse Rate (SALR)</u> -As saturated air rises, excess water vapour condenses, releasing the latent heat of vaporization, thus reducing the expansional cooling. SALR is always less than DARL (near the surface, about half). SALR increases with height, as water vapor is reduced, but never exceeds DALR.

<u>Evironmental Lapse Rate (ELR)</u> - Is not due to air rising, but because within the Troposphere the temperature on average drops 1° F./ 300 feet. The diurnal variation of the ELR at low altitudes over land is marked, will be small at sunrise, steep by 1400. The ELR shape can vary because of a surface inversion, a temperature inversion at height, or an isothermal layer.

Surface inversion (negative lapse rate) - caused by radiation cooling of land at night, or warm air mass moving over cold surface.

Inversion at height - caused by dry air subsiding & warming by compression during descent (associated with anticyclones).

Isothermal layer - caused for same reason as inversion at height.

<u>Stability</u> -

Stable air offers resistance to vertical movement; in unstable air this movement is stimulated. Lapse rate is the governing factor. Air will rise if it is warmer than surrounding temperature: ie. if the DALR or SALR is higher (warmer) than the ELR.

Unsaturated air is stable when the ELR is less than DALR, unstable when it exceeds DALR.

Saturated air is stable when the ELR is less than SALR, unstable when it exceeds SALR.

When DALR meets ELR at a certain height, there will be no clouds.

When SALR is higher than ELR, clouds form vertically up to the point where they meet (are the same temperature).

Air is conditionally stable when the ELR lies between DALR and SALR.
If air is unsaturated when DARL meets ELR, it is stable.
If air is saturated before DARL meets ELR, then SALR comes in, and it is unstable (SALR usually is less than ELR at low altitudes).

Initial Uplift of Air - the main causes are:

1/ Thermal uplift (will change diurnally)
2/ Turbulent uplift - air flowing horizontally can set up eddies
3/ Orographic uplift - airstream meeting hills
4/ Frontal uplift - happens mainly in depressions
5/ Resulting from converging winds - at fronts & centres of depressions

CLOUDS:

Cirrus (thread) - high, feathery, ice crystals
Cumulus (heap) - cauliflower shaped, flat base
Stratus (layer) - shapeless or sheetlike
Nimbus (dark) - uniform dark grey, often have precipitation or virga trailing underneath

CLOUD TYPES

Low Clouds (Near surface to 2,000 m):

Stratus (St) - layer or sheet, like fog but base between 500′ and 2000′. It indicates a stable air mass, may produce drizzle. When blown into patches by wind it is Fractostratus (Fs).
Nimbostratus (Ns) - low, dark, shapeless, ragged, often with scud below (Fractostratus). Base usually 500′-2000′ (150 - 600m). Rain cloud, prospects of bad weather. Sometimes rain does not reach ground.
Stratocumulus (Sc) - extensive layer of patches or rolls, light grey. Base 1500′ to 4500′ (460 - 1350 m). No special significance.

Low Clouds which can rise to 14,000 m:

Cumulus (Cu) - Cauliflower shaped, base between 1500′ and 5000′. Often in trade wind area. If small, a fair weather cloud; if large indicate unstable air, possibly showers, squally wind.
Cumulonimbus (Cb) - Thundercloud, cumulus type but large vertical extent. Top looks more mountainous, or fibrous. Base height 1500′ to 5000′.

Medium Clouds (2,000 to 5,500 m):

Altocumulus (Ac) - lens or almond shaped patches, often near hills. Base above 6500′ (2000 m). No special significance.
Altostratus (As) - Thin, formless veil or sheet, usually grey. Base above 6500′. No special significance.

High Clouds (5,500 to 14,000 m):

Cirrus (Ci) - Mares′ tails. Fibrous, above 18,000′. If it grows, with a falling barometer, gives warning of coming storm.

Cirrostratus (Cs) - diffuse, thin veil, whitish. Often produces halo around sun, or gives sky milky effect. Above 18,000'. Indicates coming rain. If following cirrus, means depression or storm coming.
Cirrocumulus (Cc) - Mackerel sky. Base height above 18,000' (5500m). "Not long wet, not long dry". Fair weather, little wind indicated.

Precipitation

All types of condensation from water vapour is called hydrometeors.
Cloud, fog, and mist are hydrometeors, but not precipitation.
Rain, drizzle, snow, sleet, & hail is precipitation, as are in a strict sense, dew, hoar frost, rime, and glazed frost.
Precip. from cloud, but not reaching ground, is virga (fallstreaks).
Drizzle - drops are smaller (.2 to .5 mm in diameter), and lighter than rain drops, so fall slower.

When there is active convection in a cloud, water droplets are carried up, cool, and condense more. They increase in size due to:
1/ collision & coalescence of small ones with larger ones.
2/ adherence of supercooled water droplets onto ice crystals.

When droplets get large (& heavy) enough to overcome upward motion of air, they fall, collecting smaller droplets as they go.
Evaporation takes place in warmer unsaturated air below, so rain only reaches ground if drops are large & numerous enough.

Rain:
Convection rain - unstable atmosphere, high rel. humidity, large lapse rate in lower levels due to strong solar heating of land surface. Cool moist air moving over warm sea also causes it. Showers, or heavy rain & thunder, often in tropics.
Orographic rain - moist air meeting hills or mountains (monsoons).
Frontal rain - depressions in the temperate latitudes (23° to 66°)

Snow:
The lower the temperature, the smaller the snowflake (only unite lower).
Air temperatures over 37° F (3° C) near surface cause sleet (rain/snow).

Hail:
Comes from cumulonimbus clouds when convection currents carry water, supercooled, drops up to where ice crystals are present, and coalesce. Dropping through cloud, they meet water drops which slowly freeze on hailstones, surrounding them with a coat of hard clear ice. Clouds with large vertical extent (cumulonimbus) can produce large hailstones, as hail may circulate up & down a few times within cloud.

Glazed Frost:
Rain falling on frozen surfaces coats them with smooth clear ice. (also called Black Ice. Not to be confused with black frost, in which ground is frozen, but above dew (or frost) point of the air, so no deposits of hoar frost occur. Hoar frost comes when ice crystals or frozen dew deposit on surfaces below both dew point & 0° C.

Glazed Frost from Sea Spray:

Sea water freezes at -2° C, so spray can freeze on surfaces. If the sea temp. is -2° C, air temp. below this, and gale blowing, ice builds rapidly. Head into warmer conditions; also hack away ice or use hot water hoses.

THUNDERSTORMS

Can produce: a) torrential rain (reducing visibility), or hail.
b) sudden wind squalls.
c) interference with radio communications.
d) damage to magnetic compasses with lightening strike.

Conditions necessary for formation:

1/ Cumulonimbus cloud with precipitation & the base below the 0° C isotherm.
2/ ELR must exceed SALR to a height of 10,000' (3,000 m) above cloud base, thus facilitating convection.
3/ Adequate supply of moisture from below releases latent heat by convection. In temperate latitudes, often found in <u>cols</u> or <u>shallow depressions</u>. Tropical thunderstorms are more frequent and violent.

Other favourable conditions:

1/ High surface temperature.
2/ Little surface wind.
3/ Trigger action, like horizontal convergence of surface air, orographic or frontal uplift, isolation over land, or advective heating (by the horizontal movement of air).

Lightning & Thunder:

Electric charges build in a Cb cloud because of intense activity. Upper part is positive, lower down negative. Lightning is electric spark, turning air white hot. Can be inside a cloud, between clouds, or cloud to ground. Lightning between clouds or cloud to ground (through clear space) is forked. When channel is obscured by cloud, we get sheet lightning.

Thunder is sound resulting from expansion & contraction of air, it rumbles because sound travels from different parts of lightning path. Sound travels at 335 m/sec, or one nautical mile in 5.5 seconds.

Types of thunderstorms:

1/ Heat thunderstorms - over land, mostly in summer, late afternoon or evenings of hot sultry days with light winds. Often on mountainous tropic islands. Require warm moist conditions, strong surface heating & convection.

2/ Coastal thunderstorms - any season, day or night. Most often in winter, with large lapse rate of Polar maritime air. Triggered orographically, they dissipate soon.

3/ Frontal thunderstorms - most common in winter (more depressions), mostly day but sometimes at night. These are the only type found over the ocean (except in doldrums). Mostly come from active cold fronts where there's a big difference between warm & cold air masses, as in a V shaped trough (line Squall). Occlusions (cold) sometimes produce thunderstorms.

VISIBILITY:

Good Visibility - favoured by strong winds & air temp. less than surface.

Poor Visibility - caused by: visible moisture (water droplets) in air.
solid particles (dust, smoke, sea salt)

Mist: visibility 1100 to 2200 yards due to visible moisture.
Haze: " " " " " solid particles.
Fog: visibility less than 1100 yards due to any cause.

Fog forms when air drops below its dew-point.
1/ temperature of surface must be below the dew-point of the air.
2/ there must be a little wind - enough to mix up the air at the surface.

Radiation Fog:

(Radiation Inversion = inversion coming from nocturnal radiation cooling)

Radiation fog (ground or swamp fog) forms over land at night, often in autumn & winter over low flat ground, particularly when sky is clear, letting long-wave radiation from ground escape. Can drift onto sea (10 miles max.)

Occurs mainly in anticyclones and wedges (clear skies), and is most intense one hour after sunrise, often dispersing by noon but in winter can stay for days (particularly in large industrial areas - smog).

Conditions favourable for formation of radiation fog:
1/ Relative high humidity.
2/ Cloudless sky at night, letting radiation from ground escape.
3/ A little wind (less than 8 mph), 3 to 6 mph is ideal.
4/ Land surface initially cold and wet.
5/ High degree of smoke in the air, which are hygroscopic particles.

Advection Fog:

(Advection = horizontal movement of air/ or transferring heat by this)

Advection fog can form any time day or night over land or sea (sea fog). It is possible when air moves from warm land or sea over a cold sea surface or current; and is probable when this air is carried over a surface lower than its dew-point; and nearly certain when the wind speed is less than 16 knots.

1/ Air moving from warm land onto cold sea surface:
- happens mainly in spring & early summer.

- even if air is dry, it gets moisture from sea while dew-point falls.
- examples are warm air from Europe onto the North Sea, or Barkley Sound

2/ Air moving from warm sea onto cold sea surface:

- examples are Grand Banks off Newfoundland, (warm moist southerly air stream over cold Labrador current, and where cold Kamchatka current meets warm Kuro Shio current flowing northeast. Winds are south in summer so there often is fog here.

3/ Warm air advancing surface that gets progressively colder:

- can form any time of day or night, any season, and cover large area of ocean. Common where tropical maritime air moves to higher latitude. ie: winds from Azores into British Isles brings fog to English Channel.

Other Fogs:

Dust fog (haze), like dust haze from Sahara.

Sea smoke or steaming fog, when very cold dry air flows over a warm water surface. Rapid evaporation, then convection takes moist air up into colder air. It looks like steam or smoke rising from water. Mainly in high latitudes, winter. Air temp. must be 16° below that of sea surface.

Frontal fog comes at or near a front or occlusion, caused by warm rain falling through cold lower air. May also be found at boundary of two air saturated masses, cold & warm (mixing fog).

SEA FOG:

- usually advection, most common in spring and early summer, along coasts.

Is possible when wind blows from warm region onto a cold sea surface.
Is probable if sea temperature is below the dew-point of air.
Is almost certain if, with both above, the wind is less than 16 knots.

ATMOSPHERIC PRESSURE / WINDS

Atmospheric pressure at any level is caused by weight of air above (cold denser than warm). At 18,000', air pressure is half of that at ground.

Average pressure at sea level is 14.7#/sq.in. = 1013.25 mb = 29.92'.

Atmospheric pressure is exerted equally in all directions, so a differential causes wind.

Isobar passes through all points of equal barometric pressure.

Surface winds are 10° to 15° off the isobars over the sea, and 20° to 30° from the isobars over land. At a height over 2000 feet above ground, free from surface friction, the air flows parallel to the isobars.

BUYS BALLOT'S LAW: If an observer in the northern hemisphere faces the wind, the centre of low pressure is toward his right and somewhat behind him; and the centre of high pressure is toward his left and somewhat in front of him. If an observer in the southern hemisphere faces the wind, the centre of low pressure is on his left, somewhat behind him, and the centre of high pressure is on his right, somewhat in front of him.

Pressure gradient is the change of pressure per unit distance (at right angles to isobars) and is steep when isobars are close, slack when widely spaced.
The pressure force is exerted at right angles to the isobars, but because of Coriolis effect, the air at the surface flows nearly parallel to the isobars.

In the middle latitudes, a gradient of 1 millibar in 30 nautical miles gives a surface wind speed of about 24 knots.

$$\text{Wind Speed (kn)} = \frac{\text{Change in Pressure (mb.)}}{\text{Distance (N miles)},90^\circ \text{ to isobars}} \times 30 \times 24 \quad (720)$$

In latitudes within 5° of the equator, Buys Ballot's Law does not apply, since the earth's rotation is not effective. The wind flows straight across the isobars.

The Geostrophic wind is a hypothetical wind in the free atmosphere (above the layer of surface friction (600 m or 2000') which would flow parallel to straight equidistant stationary isobars.

The Gradient wind is a hypothetical wind in free atmos. which would flow parallel to curved equidistant stationary isobars; this wind speed is less than geostrophic when circulating around low, and greater when moving around high pressure.

Diurnal Variation of Wind

In the day, convection currents are strongest, so retarding effect of surface friction is diffused through a greater depth of turbulence, so reduction of wind force is less. At night, depth of turbulence is shallow, so retarding effect is greater, and wind force is less.

Diurnal variation of wind speed over the sea is negligible.

Temperature & Surface Pressure

Sea remains cool, land warms in summer. From land, air rises to upper levels, creating a high pressure there. Denser air over cool sea creates high surface pressure at sea level, and since the air subsides, a low pressure over sea at upper levels. Thus, a rotational air flow is established.

AIR MASSES

An air mass is a huge body of homogenous air covering thousands of square miles, with the temperature and humidity uniform in any one horizontal plane.

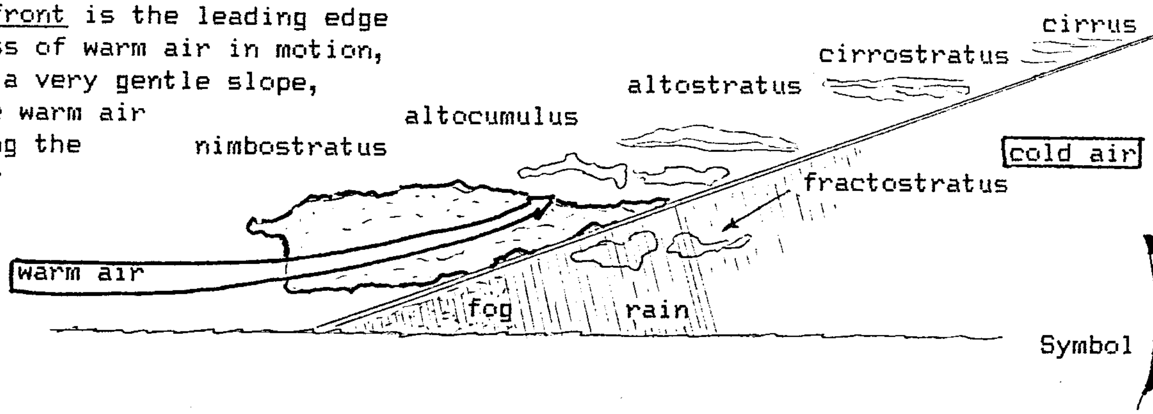
At the junction between air masses, fronts are produced. (See the next page for examples of a warm front and a cold front.

OCEAN WINDS AND WAVES:

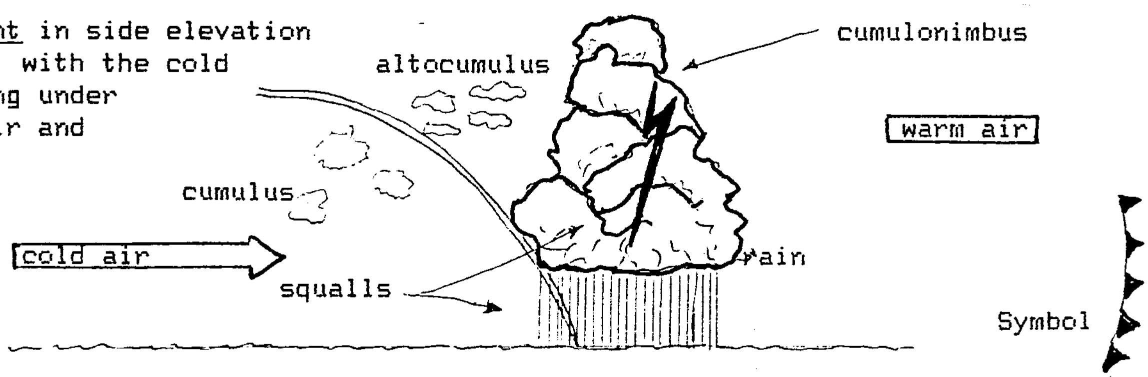
As the earth rotates eastward (at 1000 m.p.h. at the equator), the effect on the two fluids above it, the sea and the atmosphere, is that the earth spins out from under them. This gives them a westerly flow, which is combined with the Coriolis effect to produce both currents and winds which move to the southwest in the northern hemisphere and to the northwest in the southern hemisphere. As winds are named for the direction in which the come, these Trade Winds are northeast and southeast respectively, and generally are 15 to 25 knots in strength. Closer to the poles the prevailing winds usually are westerly. When possible, we try to go with the wind and current, so this is the basis for the "Sailing routes of the World".

Also because of the earth's rotation, winds spin out of a high pressure zone (a ridge) clockwise, known as an anticyclone; and into a low pressure zone (or trough) counterclockwise, called a cyclone. This is in the northern hemisphere - exactly the opposite happens in the southern hemisphere. On a weather map, the isobars join points of equal pressure, and show how much above or below the are from the standard of 1013.25 millibars (29.92 inches). The closer these isobars are, the more wind we can expect. Actual barometric readings are not as important as the TENDENCY - how quickly the barometer is rising or falling.

A warm front is the leading edge of a mass of warm air in motion, and has a very gentle slope, with the warm air overlying the cold for as much as 1000 miles.



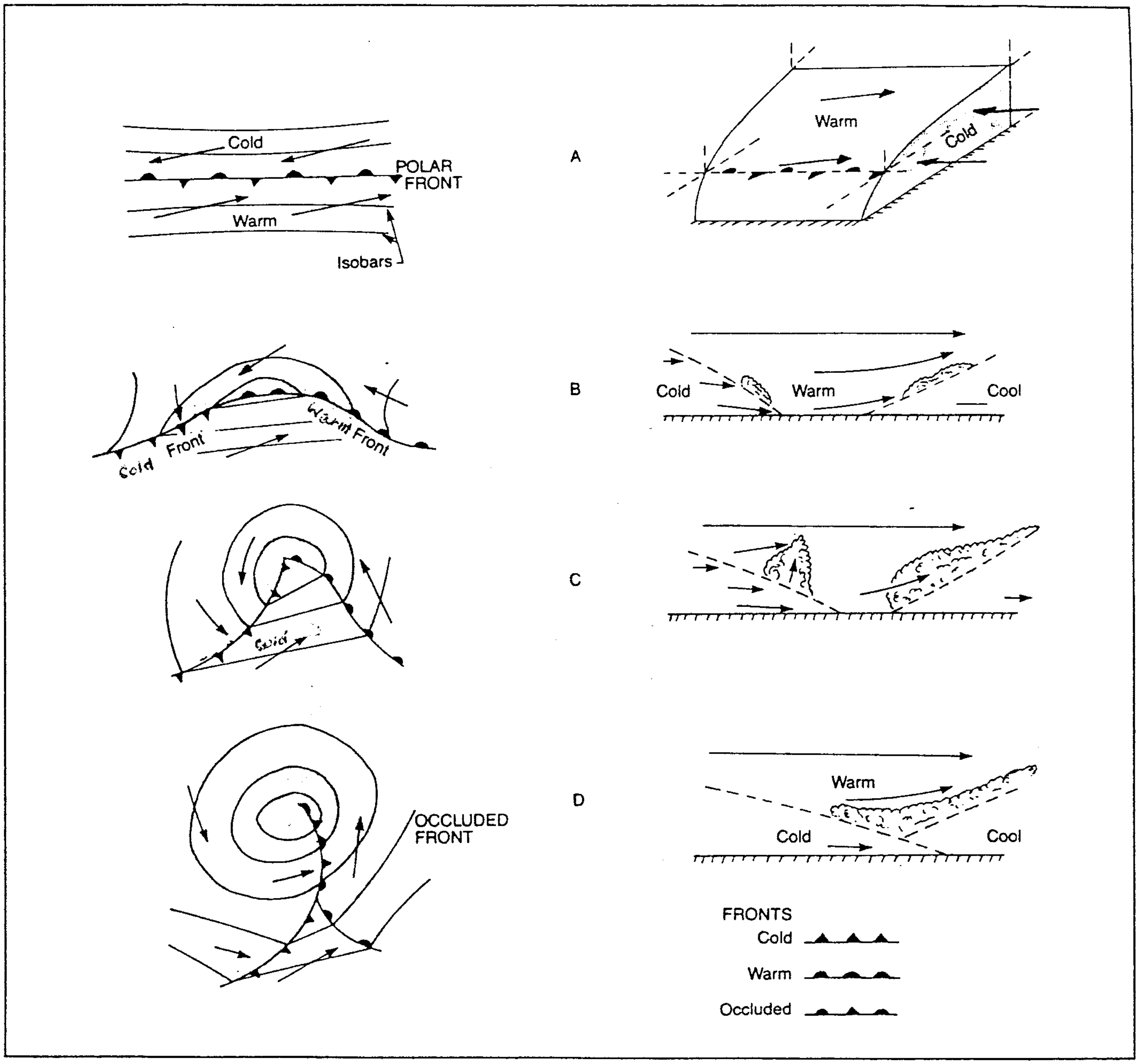
A cold front in side elevation is steeper, with the cold air creeping under the warm air and forcing it upwards.



DEPRESSIONS:

These begin, as pictured below, at the intersection between a warm and a cold front. Since the winds are moving in opposite directions, a bulge soon develops. This amplifies into a wave form, with a depression, with cyclonic winds at its crest. As the cold front moves under the warm, an occluded front is produced. As in "D", at the end of the occluded front is now the centre of a low pressure area. Further deepening of the depression can lead to a storm or even hurricane, as described before.

Off the B.C. coast, depressions of this nature can form very quickly, and are known locally as "bombs". When looking at this type of formation on a weather chart, you can be certain that it will bring heavy or storm force winds.



Birth of a depression and cold front occlusion. *Left side*, plan view; *right side*, sectional view. A polar (stationary) front (A) develops a kink (B) that amplifies into a wavelike bulge (C) delineated by warm and cold fronts. Bulge grows and an occluded front (D) is formed as advancing cold front overtakes warm front and lifts it upward. Shaded area denotes precipitation; arrows give direction of air flow.

Depressions:

Are roughly oval or circular in shape, with worst weather (strong to gale force winds) in centre. When the pressure gradient becomes steeper, it deepens. When it weakens, it fills up. Depressions tend to move toward areas of low or falling pressure, and steer around high pressure regions.

Anticyclones:

Also are roughly circular or oval, but the pressure gradient is slight. Weather is quiet, dry, settled, with little wind near the centre. Land & sea breezes are marked, especially in summer.

Summer Highs: Dry, sunny, warm, may have cloud & rain in outer portions.
Winter Highs: 1/ Cloudless sky, sharp frosts or radiation fog at night.
2/ Covered with stratus cloud, dull cold, foggy or misty.

Highs may remain stationary for long periods. Anticyclone intensifies as pressure rises, declines as the system weakens.

Secondary Depressions:

Form within the isobaric pattern of a primary depression, often when it old and filling up. The secondary may deepen until it absorbs the primary. Secondaries often develop into much more vigourous system than their primaries.

Troughs:

A system of isobars which sharply curve along the trough line. A trough is deep or shallow depending on the curve of the isobars. Weather in a trough is cloudy with precipitation (line squalls). Fronts are all troughs - a trough is not always a front.

Ridge (or Wedge):

This is a wedge shaped extension of an anticyclone between two areas of low pressure, with the isobars having their greatest curvature along the axis of the ridge. Has the fair weather, light winds, of the high. A ridge with sharply curved isobars moves faster than a flat one.

Col

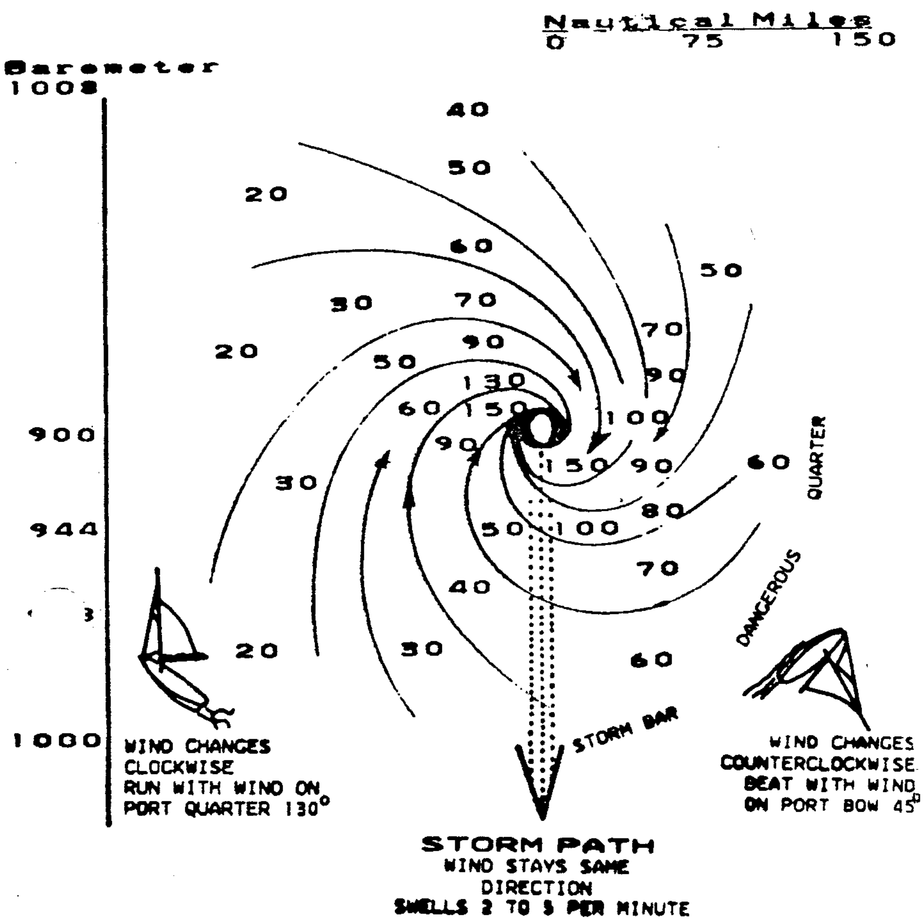
An area of indeterminate pressure between two highs and two lows, Generally has light variable winds, thundery in summer and dull, foggy, or misty in winter.

Straight Isobars:

Isobars run more or less parallel across a large area. It is usually the outlying portion of a large and distant depression or anticyclone. There is no particular type of weather associated with straight isobars.

Typhoons or hurricanes are areas of very low pressure and generally occur in late summer (northern or southern) in the tropics. Winds can reach 150 knots near the center, and most yachts avoid sailing in the tropics at this time of year. These destructive storms originate in hot, humid areas, and generally move west in the North, and east in the Southern hemisphere, but can have an erratic course. If they remain stationary for a period of time, they gain strength, but if moving quickly, they seem to lose force. There is a dangerous and a safe side to the direction the path the storm is moving. In the diagram to the left, the boat to the far left is in the safe side, and runs with the wind on her port quarter, while the boat on the right, who is in the dangerous quarter, close reaches on port tack to get as far away from the storm centre as possible. This is all in the southern hemisphere - in the northern hemisphere the wind would be blowing counter-clockwise, so the boats would be on starboard tack, and the on the left would be close reaching in the dangerous quarter. Hurricanes are sometimes found south of Hawaii in the late summer months, but seldom get as far north as the Hawaiian islands.

SOUTHERN HEMISPHERE HURRICANE
WIND DIRECTION AND SPEED (KNOTS)



Waves:

Are generated by the wind. It takes time for the waves to build, and after the wind abates, it is some time before the waves settle down. Ocean swells are caused by winds some distance away, and although they can be twenty feet or more in height, have little effect on yachts, even though the speed of the average Pacific ocean swell is 35 m.p.h.(slightly less in the Atlantic). Wave height is never more than one-seventh the wave length; and a rule of thumb is that wave height in feet will be about half the wind speed in knots. These figures pertain to areas where the fetch is long enough for the waves to build.

As waves approach shallower water, their speed slows and the height builds. A wave with crests 400' apart will "feel bottom" in 200 feet of water. The height will increase as the length shortens, and eventually it will become a breaker. Waves begin to break when wave height to wave length reaches 1/7, or when the wave height is more than 3/4 of the water depth. Wave heights in the open ocean seldom get as high as 1/10 their lengths, and ratios of 1/15 to 1/50 are most common, even in rough weather. Ocean swell is practicaly always more than 100′ in length.

Wind Direction & Speed in relation to isobars (in middle latitudes):

Wind direction is 12° off the isobars over the sea, 24° over land.

Wind speed can be calculated by measuring the distance (at 90°)between adjacent isobars and the millibar difference between them.

$$\text{Wind Speed (knots)} = \frac{\text{Millibar difference}}{\text{Distance (N. Miles)}} \times 720$$

Wave Action:

Period (sec.)	Wavelength (ft.)	Wave Speed (kn)
5	128	15
10	512	30
15	1161	46
20	2048	61
25	3200	76

Water speed/wave speed = 3x (wave height/wave length).

Minimum fetch & duration to produce a fully developed wave:

Wind (kn)	Fetch (M)	Duration	Avg.Height(ft.)	Sign.Height(ft.)	Avg.Highest 10%
10	10	2.4 hrs.	.9	1.4	1.8
15	34	6 "	2.5	3.5	5
20	75	10	5	8	10
25	160	16	9	14	18
30	280	23	14	22	28
40	710	42	28	44	57
50	1420	69	48	78	99

Waves in Georgia Strait are limited by wind strength & fetch; maximum wave heights are less than 9′, with the average wave less than 2′.

- Waves against current may increase in height up to 25%, but waves can be trapped in an opposing current, creating a lens, which amplifies the energy, by as much as 4.
- Sternwaves of a ship is always 39° to each side of the course.
- Tsunamis on the ocean have a wave length of 54 - 325 nautical miles, a height less than 3′, and take 10 minutes to one hour to pass. They can travel at 400 mph or more, but would probably not be felt by a yacht.

Cross seas, caused by a changing wind direction, are more cause for concern. Not only will the wave come from the seemingly wrong direction, but waves can meet and build, producing the odd rogue wave, much higher than the others, which could cause a knockdown or flood the cockpit. These type of seas are fairly common down the Oregon coast, but are seldom seen in the trade wind areas.

FREAK (ROGUE) WAVES:

1 in 23 is twice the height of the average.
1 in 1175 is over 3 times the average height.
1 in over 300,000 exceeds 4 times the average height.

In general, the wave action in deep water in the tropics is the most comfortable, while the seas further north or south, or in shallower water (like the continental shelf) will be more troublesome.

Barometric Readings:

Using the tendency:

If the pressure is falling at 1 millibar/hr. = gale force winds are coming.
" " " 2 " " = storm " " "
" " " 3 or more millibars/hr = hurricane force winds.

WEATHER INFORMATION SOURCES:

(a) Local continuous WX broadcasts on WX1 - 162.55 MHx, WX2 - 162.40 MHz, WX3 - 162.475 MHz, and 21B - 161.65 MHz.

(b) Scheduled voice broadcasts on:

2054 KHz, (VAI, VAG, VAH),

- From Tofino & Prince Rupert 4125 KHz.
- From N.Bend, Ore.(NOF) & Port Angeles (NOW) -2670 KHz.
- From Ft.Collins (WWV) & Hawaii (WWVH) on 2500, 5000, 10000, 15000 KHz.

(c) Radiotelegraph (morse) from Vancouver (CKN) on 4268, 6946, 15982, 4235, 6351.5, 8453, 12876, and 17175.2 KHz.

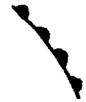
BEAUFORT SCALE

WITH CORRESPONDING SEA STATES

Beaufort number	Wind speed knots	Seaman's term	Estimating wind speed — Effects observed at sea	Term and height of Wave - ft.	Sea state code
0	under 1	Calm	Sea like mirror.	Calm, glassy, 0	0
1	1-3	Light air	Ripples with appearance of scales; no foam crests.		
2	4-6	Light breeze	Small wavelets; crests of glassy appearance, not breaking.	Rippled, 0-1	1
3	7-10	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps.	Wavelets, 1-2	2
4	11-16	Moderate breeze	Small waves, becoming longer; numerous whitecaps.	Slight, 2-4	3
5	17-21	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray.	Moderate, 4-8	4
6	22-27	Strong breeze	Larger waves forming; whitecaps everywhere; more spray.	Rough, 8-13	5
7	28-33	Moderate gale	Sea heaps up; white foam from breaking waves begins to be blown in streaks.	Very rough, 13-20	6
8	34-40	Fresh gale	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks.		
9	41-47	Strong gale	High waves; sea begins to roll; dense streaks of foam; spray may reduce visibility.		
10	48-55	Whole gale	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced.	High, 20-30	7
11	56-63	Storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	Very high, 30-45	8
12	64-71	Hurricane	Air filled with foam; sea completely white with driving spray; visibility greatly reduced.	Phenomenal, over 45	9

WEATHER CHART SYMBOLS

 = Cold Front

 = Warm Front

 = Stationary Front

 = Occluded Front

 = Weak Cold Front

 = Weak Warm Front

 = High Pressure Ridge

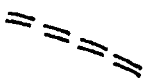
 = Low Pressure Trough

 = Tropical Disturbance

 = Tropical Depression

 = Tropical Storm

 = Hurricane (N.Hemis.)

 = Convergence Zone (ITCZ)

 = Clouds (Major)

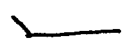
// or ∇ = Rain

 = Thunderstorm

H = High Pressure centre

L = Low Pressure Centre

 = NW wind 5 kts.

 = W wind 10 kts.

 = SW wind 15 kts.

 = S wind 35 kts. (gale)

 = E wind 50 kts. (storm)

 = N wind 65 kts. (hurr)

 = Strong Ocean Thermal Front

WEATHERFAX:

North Pacific

NPN GUAM (US NAVY): 7643.4, 10253.4, 13805.9, 186 8.4 KHz
WWD LA JOLLA: 8644.4, 17408.9
NMC SAN FRANCISCO: 4344.4, 8680.4, 12728.4, 17149.6
CKN ESQUIMALT: 4266.4, 6944.4, 12123.4
NPM PEARL HARBOUR: 2120.4, 4853.4, 8492.4, 9394.4, & 14824.4
(Schedule for NE Pacific at 1242 GMT)
(These WXFax frequencies have been corrected for upper side band.)

South Pacific (1988)

TIME (GMT)	CHART	STATION	FREQ.KHz
2000	MSL ANALYSIS SPC	AUS	AUS
2015	MSL ANAL SWP (90E - 180)	AUS	5098.4
2145	MSL ANAL TNZ	NZ	11028.4
2215	MSL ANAL S.HEM	AUS	13918.4
2330	MSL PROG (WIND & SWELL)	NZ	
2335	SCHEDULE	NOOA(HAWAII)	
2345	MSL PROG H+42	NZ	NZ
0045	MSL PROG H+24	AUS	5803.4
0115	SCHEDULE	AUS	9457.4
0200	MSL NEPHANALYSIS(SAT.CLOUD)	AUS	13548.4
0215	MSL ANAL SWP	AUS	16218.4
0300	MSL ANAL TNZ	NZ	
0330	MSL ANAL SWP	NZ	NOOA
0430	MSL PROG (WIND & SWELL)	NZ	5036.1
0445	SCHEDULE	NZ	7768.4
0745	MSL ANAL SPC	AUS	9980.9
0800	MSL ANAL SWP	AUS	11088.4
0945	MSL ANAL TNZ	NZ	16133.4
1030	MSL ANAL S.HEM	AUS	
1130	MSL PROG SWP (WIND & SWELL)	NZ	US NAVY
1200	MSL PROG S.HEM H+24	AUS	4800.9
1415	MSL ANAL SWP	AUS	9438.4
1500	MSL ANAL TNZ	NZ	9453.4
1530	MSL ANAL SWP	NZ	13860.9
1600	MSL PROG SWP H+24	NZ	16396.4
1630	MSL PROG H+12 (WIND & SWELL)	NZ	16398.4

MSL = Mean Sea Level
TNZ = 25°S - 55°S, 140°E - 170°E
SWP = 10°S - 60°S, 120°E - 140°W
SPC = 10°S - 90°S, 140°E - 80°W
AUS = Maps cover to 180° Longitude, except for Nephanalysis and Conical (SPC) which cover most of the South Pacific
S.HEM = All of the Southern Oceans

NOAA NATIONAL WEATHER SERVICE
RADIOFACSIMILE SCHEDULE TRANSMITTED VIA USCG
POINT REYES, CALIFORNIA (NMC)

TIME (UTC) TRANSMITTED	AREA	CHART
0145	-	TEST PATTERN
0149	5	SURFACE FORECAST VALID 00Z
0200	5	SEA FORECAST VALID 00Z
0300	-	TEST PATTERN
0304	3	SEA SURFACE TEMP ANALYSIS
0315	4	SEA SURFACE TEMP ANALYSIS
0326	1	SATELLITE ANALYSIS
0339	4	SATELLITE ANALYSIS
0500	-	TEST PATTERN
0504	5	00Z SURFACE ANALYSIS
0515	5	EXTENDED SURFACE FORECAST
0526	-	E PACIFIC SEA SURFACE TEMP ANALYSIS
1500	-	TEST PATTERN
1503	1	SATELLITE PICTURE
1515	2	SATELLITE PICTURE
1715	-	TEST PATTERN
1719	6	12Z TROPICAL ANALYSIS
1730	5	12Z SURFACE ANALYSIS
1741	2	SATELLITE PICTURE
2015	-	TEST PATTERN
2019	-	RADIOFACSIMILE SCHEDULE
2030	5	500MB MAX WIND
2041	2	SATELLITE PICTURE
2330	-	TEST PATTERN
2334	6	18Z TROPICAL ANALYSIS
2345	5	18Z SURFACE ANALYSIS

AREAS:
1 30N-50N EAST OF 132W
2 05N-55N EAST OF 140W
3 40N-50N EAST OF 135W
4 28N-40N EAST OF 136W
5 30N-60N EAST OF 160E
6 20S-30N EAST OF 160W

FREQUENCIES: DAY 8682, 12,730, AND 17,151 KHZ
NIGHT 4346, 8682, AND 12,730 KHZ

NOTE: THESE FREQUENCIES ARE ASSIGNED. TO CONVERT TO CARRIER FREQUENCY SUBTRACT 1.9 KHZ FROM ASSIGNED FREQUENCY.

COMMENTS ON THE SCHEDULE OF CHARTS ARE INVITED. WRITE TO: NATIONAL WEATHER SERVICE, 660 PRICE AVE, REDWOOD CITY, CA 94063. VISIT US WHEN IN PORT.

NOAA HAWAII

KVM 70 FACSIMILE BROADCAST SCHEDULE

TIME (UTC)	AREA	CHART
2335-2345	--	TEST - ID & FACSIMILE SCHEDULE
2347-2359	PA-25	TROPICAL SURFACE ANALYSIS VALID 18Z
0001-0013	PA-21	36HR FORECAST WEATHER MAP VALID 00Z
0015-0027	GOES-W	FULL DISK INFRA-RED SATELLITE IMAGE
0030-0044	PA-21	PACIFIC WEATHER MAP VALID 18Z
0046-0058	PA-21	SATELLITE NEPHANALYSIS
&		SIGNIFICANT CLOUD FEATURES VALID 23Z
0100-0112	PA-20	36HR SIG WV HT CHART VALID 00Z
0533-0545	--	TEST - ID & FACSIMILE SCHEDULE
0547-0559	PA-25	TROPICAL SURFACE ANALYSIS VALID 00Z
0601-0613	PA-21	72HR FORECAST WEATHER MAP VALID 12Z
0615-0627	GOES-W	FULL DISK INFRA-RED SATELLITE IMAGE
0630-0644	PA-21	PACIFIC WEATHER MAP VALID 00Z
0646-0658	PA-21	SATELLITE NEPHANALYSIS
AND		SIGNIFICANT CLOUD FEATURES VALID 05Z
1103-1115	--	TEST - ID & FACSIMILE SCHEDULE
1117-1129	PA-25	TROPICAL SURFACE ANALYSIS VALID 06Z
1131-1143	PA-21	PACIFIC WEATHER MAP VALID 06Z
1145-1157	GOES-W	FULL DISK INFRA-RED SATELLITE IMAGE
1200-1214	PA-21	36HR FORECAST WEATHER MAP VALID 12Z
1216-1228	PA-21	SATELLITE NEPHANALYSIS
AND		SIGNIFICANT CLOUD FEATURES VALID 11Z
1230-1242	PA-20	36HR SIG WV HT CHART VALID 12Z
1748-1800	--	TEST - ID & FACSIMILE SCHEDULE
1802-1814	PA-25	TROPICAL SURFACE ANALYSIS VALID 12Z
1816-1828	GOES-W	FULL DISK INFRA-RED SATTELITE IMAGE
1830-1844	PA-21	PACIFIC WEATHER MAP VALID 12Z
1846-1901	PA-23	SURFACE ANALYSIS VALID 12Z
1903-1915	PA-21	SATELLITE NEPHANALYSIS AND
		SIGNIFICANT CLOUD FEATURES VALID 17Z
1917-1929	PA-26	SEA SURFACE TEMPERATURE ANALYSIS

AREAS:			
PA-20	60N-05N, 110W-140E	PA-25	30N-50S, 105W-180
PA-21	40N-25S, 110W-160E	PA-26	60N-40S, 60W-100E
PA-23	60N-10S, 115W-155E	GOES-W	PACIFIC AREA

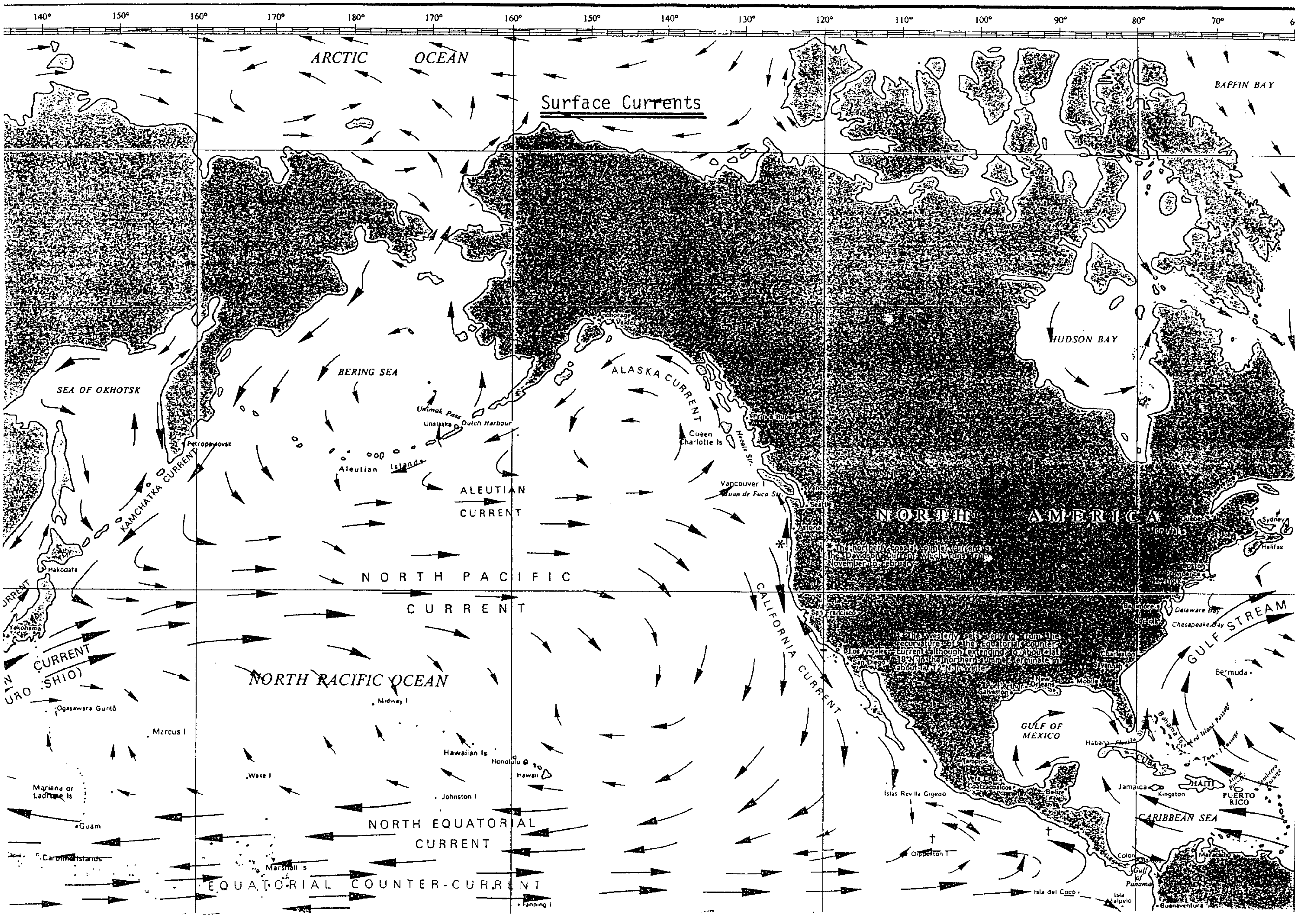
KVM 70 HONOLULU INVITES TOU TO VISIT WHEN IN PORT AND TO ADDRESS COMMENTS ON THIS BROADCAST TO: NOAA, NATIONAL WEATHER SERVICE, P.O. BOX 29879, HONOLULU, HI 96820 OR PHONE: (808) 836-1831.

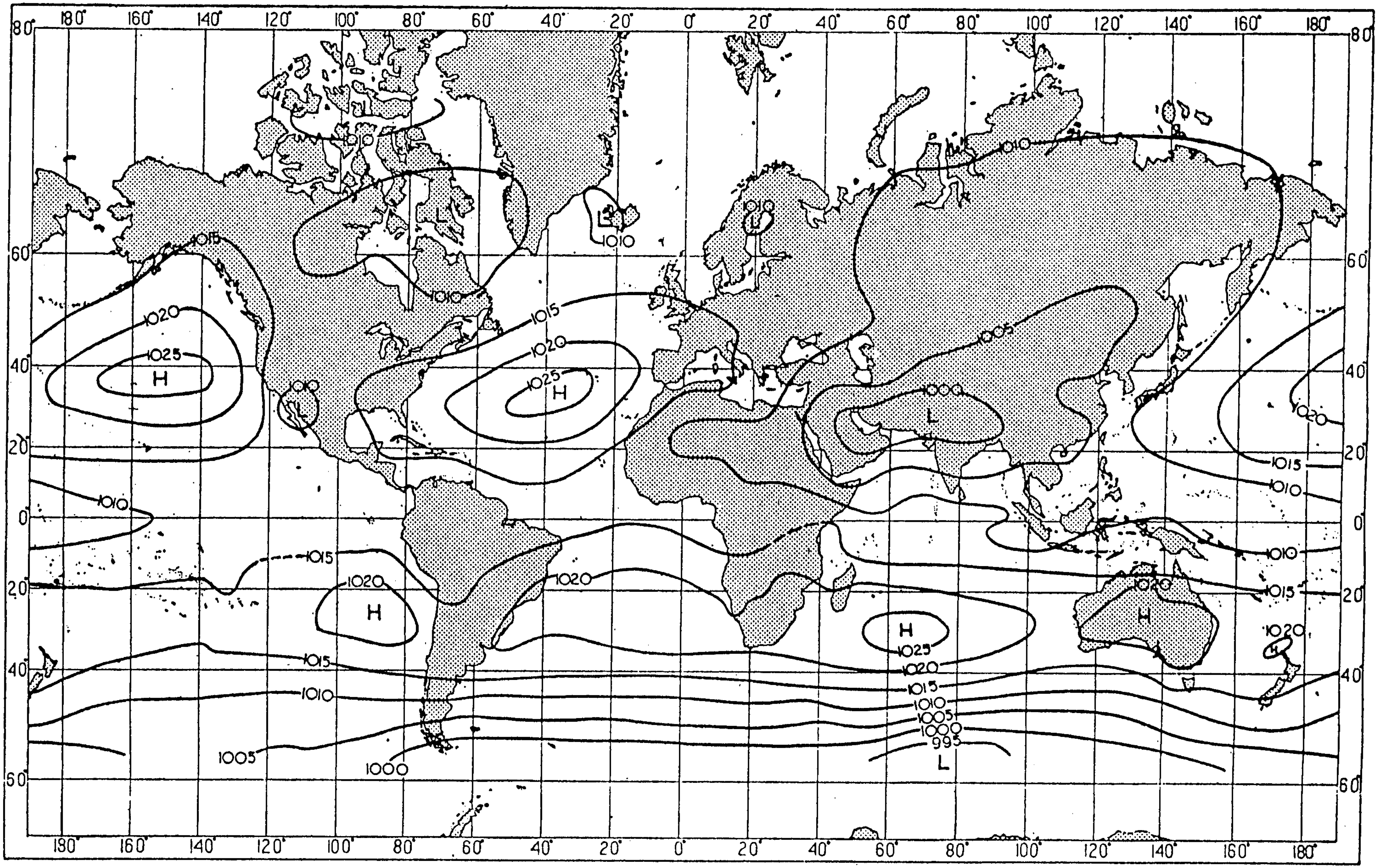
SKY	WEATHER	PRESSURE	PRESENT WIND	WIND FORECAST
Clear		Steady	Light	No Change except for land and sea breezes
Clear		Rising	Moderate Northwesterly	Becoming strong or possibly gale force Northwesterly
Clear		Falling	Strong Northwesterly	Northwesterlies may diminish
Invading Cirrus Cloud Thin overcast with ring around sun.		Falling	Light	Rising Southeasterly
Thickening Alto Stratus Overcast, Sun appears as if viewed through ground glass or not visible.		Falling	Moderate Southeasterly	Becoming Strong Southeasterly
Overcast Altostratus Lower layers forming	Rain	Falling	Strong Southeasterly	Rising Southeasterly Possibly reaching Gales
Overcast	Heavier Rain	Falling Rapidly	Strong Southeasterly	Becoming Gale Force Southeasterly
Overcast	Rain	Rising	Light	May not change but watch barometer
Clearing	Rain just ended	Beginning to rise	Strong Southeasterly just abated	Expect a wind shift to Southwest or Northwest.
Clearing	Rain just ended	Beginning to rise rapidly	Abrupt shift into Northwest	Becoming strong to gale force Northwesterly
Small Cumulus clouds		Unsteady	Light	Some gusts
Towering Cumulus cloud	Showers	Unsteady	Moderate winds	Strong and gusty winds
Cumulonimbus clouds may have anvil	Heavy Showers or Hail Thunder	Unsteady	Moderate to strong winds often from Southwest	Watch for gale force gusts or squalls

NOTE The above are rules of thumb only. SO LISTEN TO THE FORECAST

Pressure rising rapidly > 1 millibar / hour or .03 inches of mercury / hour
Pressure falling rapidly> 1 millibar / hour or .03 inches of mercury / hour

light winds............	less than 12 knots
moderate winds..........	12 knots to 19 knots
strong winds...........	20 knots to 33 knots
gale force winds........	34 knots to 47 knots
storm force winds.......	48 knots to 63 knots
hurricane force winds...	greater than 63 knots


Surface Currents
ARCTIC OCEAN
BAFFIN BAY
HUDSON BAY
NORTH AMERICA
SEA OF OKHOTSK
BERING SEA
Unimak Pass
Unalaska
Dutch Harbour
Aleutian Islands
Petropavlovsk
KAMCHATKA CURRENT
Hakodate
Yokohama
ALASKA CURRENT
Queen Charlotte Is
Hecate Str.
Vancouver I
Juan de Fuca Str.
ALEUTIAN CURRENT
NORTH PACIFIC CURRENT
CALIFORNIA CURRENT
San Francisco
Los Angeles
San Diego
* The northerly coastal counter current is the Davidson Current which runs from November to February.
NORTH PACIFIC OCEAN
Midway I
Ogasawara Guntō
Marcus I
Hawaiian Is
Honolulu
Hawaii
Wake I
Johnston I
Mariana or Ladrone Is
Guam
Caroline Islands
Marshall Is
Fanning I
NORTH EQUATORIAL CURRENT
EQUATORIAL COUNTER-CURRENT
Islas Revilla Gigedo
Clipperton I
Isla del Coco
Isla Malpelo
GULF OF MEXICO
Galveston
New Orleans
Mobile
Tampico
Vera Cruz
Coatzacoalcos
Belize
Habana
CUBA
Jamaica
Kingston
HAITI
PUERTO RICO
CARIBBEAN SEA
Colon
Gulf of Panama
Buenaventura
Bahama Is
Crooked Island Passage
Turks I Passage
Bermuda
GULF STREAM
Delaware Bay
Chesapeake Bay
Sydney
Halifax
Boston
140° 150° 160° 170° 180° 170° 160° 150° 140° 130° 120° 110° 100° 90° 80° 70° 60°
70 60 50° 40° 30° 20° 10°



Average pressure at mean sea level in July

PROVISIONING & COOKING ABOARD:

Since the cook will be the one most subject to sea-sickness, a Transderm patch worn for three days will be helpful. Some people prefer to use Sea Bands. Depending on the layout of the galley, it may be necessary to rig attachment eye-bolts for the cook's safety belt.

To prevent food burning on a propane stove, use a Simmer Ring (Weil Co., Ont.), available at Ming Wo, or the U.S. made Flame-Tamer (by Tricolator).

A pressure cooker is very good in heavy weather, saves washing up, and also can be used to can or even bake bread. Unless you have a large crew, a smaller aluminum one will be lighter and easier to use. Leftovers can be kept without refrigeration for a day or two in a pressure cooker after being brought to pressure.

Boats without refrigerators will rely on dried or canned foods. Realize that the crew may get tired of canned food as a regular diet. Ice will not last long in an ice box in the tropics.

A freezer is a nuisance to keep in good operation, but very rewarding when working well. Items should be labelled and dated, and used in rotation. Sauces, stews, casseroles, curries, or partially-prepared meals can be made at home, then brought to the boat frozen. It may take several days for the boat freezer to freeze a lot of meat. Bread and cheese freeze well, but milk spoils quickly after thawing. A thermal blanket laid over the frozen food improves efficiency.

In the tropics, a jug of drinking water kept in the refrigerator is a treat, as the water in the tanks will be at sea temperature (80 degrees F.).

Aluminum or teflon-coated pans are less subject to surface corrosion than stainless ones, when washed in salt water. To save storage space, choose pans that are versatile. An egg-poaching tray used with the skillet serves double duty. A small square cake pan can be used for a small roast; a flat strainer which snaps onto various saucepans eliminates the need for a colander, and the base of a salad drier can double as a mixing or salad bowl. A folding toaster also saves space. Aluminum foil used in a roast pan, and muffin cups in a muffin pan save on washing. During passages instant coffee is easier to use than a filter system.

PROVISIONING & STORAGE:

Baking bread may be necessary on passages, because it spoils quickly in the heat and humidity of the tropics. Store all flour, rice, and cereals in large screw-top lidded glass jars padded to prevent breakage.Put 2 bay leaves in each jar to avoid weevils. Honey is easier to use than molasses when making whole grain bread, because heat causes the molasses to expand so it is difficult to store. To eliminate a lot of cleaning up (again for water conservation), use 2 layers of wax paper when rolling out pastry dough, and also line bread and cake pans with wax paper.

Buy unwashed, unrefrigerated eggs from a farm for long-term storage. Store them in foam cartons (not cardboard which attracts cockroaches), and turn the cartons over every 2 days. Another system that may work for keeping eggs, as well as many other food items, is a home vacuum sealing device, such as "Food Saver" (available from Costco). Margarine may be easier to keep than butter in the heat of the tropics.

Powdered milk and U.H.T. milk mixed together provide the best way to carry milk in your fridge or ice box. Your crew who drink milk should get used to drinking this prior to departure, or your milk will go to waste. Use this for any recipe calling for heavy cream but double the amount of powdered milk. Use dried powdered cream for coffee.

In Hawaii do not bring groceries on board in cardboard cartons because cockroaches lay their eggs in the glue. Once they invade your boat you will have difficulty getting rid of them.

Where the ocean water is cold, fruits and vegetables can be kept in the bilge, but in the tropics this is less successful. Cabbage should be soaked in water to which bleach has been added (for 20 min.), then after drying, wrapped in foil before storage. Citrus fruits also should be wrapped individually in foil and kept in the bilge. They may last for a month this way.

Onions, which should be kept separate from potatoes so they don't absorb moisture, are best stored in well-ventilated string bags or baskets; likewise carrots and potatoes. Zucchini, cucumbers, tomatoes, and avocados will last for a week in the bilge, but most salad vegetables, cauliflower and broccoli need refrigeration. Usually on a passage you will use all the salad greens during the first week; then you will try to be creative with beans, coleslaw, sauerkraut, tomatoes, or citrus fruit. Dried fruits keep well and are useful for salads and quick breads.

Since dehydration is a big problem in the tropics, take iced tea mix, powdered lemonade, lemon and lime juices, as well as soft drinks.

Joy detergent works well as a salt water soap for washing dishes.

Paper products (toilet paper, tissues, and towels) seem to be used very quickly, so fill every nook and cranny in the boat with paper items before leaving. Wrap them in plastic bags first, in case you get water in the bilge.

The person provisioning should take the time to plan, prepare and cook as well as pack the food, buying all necessary provisions, and labelling everything. It is also important to have a master key as to where everything is packed just in case the cook gets sick.

Garbage Disposal:

At sea, food items as well as biodegradable paper and cans can be thrown over. But no plastic or styrofoam should be discarded at sea, but instead be compressed into a garbage bag for disposal or burning when you reach port.

WATCHKEEPING SYSTEMS:

- Baltic Watch: "A"; 0400-0800, 1600-1800, 2000-2200
  "B"; 2400-0400, 1200-1600
  "C"; 0800-1200, 1800-2000, 2200-2400
  Same routine each day, each has 8 hour sleep, 2 or 4 hr.watches.
  -Three watches of one or two people.

- 3 On,6 Off Watch: "A"; 2400-0300, 0900-1200, 1500-1800
  "B"; 0300-0600, 1200-1500, 2100-2400
  "C"; 0600-0900, 1500-1800, 2400-0300 (becoming "A")
  Watches change each day, each has 6 hour sleep, 3 hour watches.
  - Three watches of one or two people.

- 4 Hr. Watches (3 watches) "A"; 2400-0400, 1200-0400
  "B"; 0400-0800, 1600-2000
  "C"; 0800-1200, 2000-2400
  Same routine daily, 4 on, 8 off, allows two 8 hour free spells.

- 4 Hr. Watches (2 watches): "A"; 2400-0400, 0800-1200, 1600-1700, 1800-2200
  "B"; 0400-0800, 1200-1600, 1700-1800, 2200-0200
  In this case, watches change every day. One or two on each watch.

- Swedish Watch: "A"; 2400-0400, 0800-1300, 1900- 2400
  "B"; 0400-0800, 1300-1900, 2400- 0400 (becoming "A")

One of these watch systems would word for a crew of two, three, four, or six watchkeeping crew. On some yachts either skipper or cook does not stand a regular watch. How watches are organized depends on the experience of crew members and their ability to rest between watches, as well as weather conditions. The skipper should make certain that crew members do not become fatigued.

Alternate watchkeeping (in case of injury):

(a) Skipper or cook could be on a watch, if they had not previously.
(b) Change to an alternate watch system, using one less person.

Duties of those on, and off, watch:

On watch: Steering, scanning for vessels every few minutes, adjusting or shortening sail, checking the bilge, nav lights, and all equipment, checking standing and running rigging for wear, keeping course, entering log, waking the new watch 20 min. ahead of time & staying with them until they adjust, briefing the new watch, waking skipper for any unusual occurrence, checking for changes in weather, and meal preparation.

Off watch: getting adequate rest, keeping dry & warm, eating properly, being prepared to answer "all hands on deck" call, conserving electric power at night, routine ship cleaning.

In addition, schedules should be set up to inspect & maintain bilges, sea cocks, heads, hatches, galley & supplies, rigging, helm, electronics, safety gear, fuel & water, and machinery.

MISCELLANEOUS:

Preventing chafe:

- Spreader end protection (leather or PVC boots).
- Canvas, sheepskin or leather to sew on vulnerable areas.
- Snap shackle swivel blocks to lead lines away from chafe areas.
- Use of a reaching strut for the spinnaker guy.
- Detachable boom topping lift.
- Use of spinnaker (whisker) pole topping lift & downhaul.
- A well-designed deck layout of winches and turning blocks.

The International Distress Signals:

1) A gun or explosive signal fired every minute.
2) Continuous sounding of a fog signal apparatus.
3) Flares, multi-stars, hand-held flares, orange smoke flares.
4) SOS made by radiotelegraphy or other signal apparatus.
5) "Mayday" sent by radiotelephone.
6) Code signal flags "N" over "C".
7) Any square flag or shape with a ball above or below it.
8) Flames on a vessel (burning tar barrel, etc.).
9) Slowly & repeatedly raising & lowering arms at side.
10) Signal from an EPIRB.

Proverbs & Nautical Sayings:

Red sky at night - sailor's delight. (Fair weather probable)
Red Sky in morning - sailors take warning. (Unsettled weather probable later)
Mare's tails & mackerel scales make tall ships carry low sails. (Cirrus & cirrocumulus clouds presage lows and warm fronts)
First rise after very low - indicates a stronger blow. (Refers to barometer)
Bright yellow sunset precedes strong winds.
Green sky indicates a deep low to west or north.
Low dawn - fair weather; high dawn - maybe wind.

Red (or Green) over White - Fishing at Night. (Fishing lights)
Red over Green - Sailing Machine. (One option for masthead light on sailing vessels)
Empty head over bloody nose - over there a Pilot goes. (White over red light = Pilot boat)

NAVIGATION:

The basic method of navigation offshore is celestial. Electronic (Satnav and GPS) should be only supplemental. Some sailors have made passages using only satnav and a knowledge of coastal navigation; and a few of these have found themselves locked in a port waiting for replacement electronic parts.

Sextants: A metal sextant may be easier to use, because of its weight, but may be damaged by spray, or could be lost overboard. Inexpensive plastic sextants (Davis or Ebbco) are nearly as accurate (good to within 4 miles), and much less expensive. Get one with a good array of shades.

Time: An inexpensive quartz wristwatch with a "time freeze" button will be as accurate and easier to use than an expensive chronometer. It can be kept on GMT, while the ship's clock is on local time. Correct the time from WWV or WWVH (exactly on 2.5, 5, 10, 15, and 25 MHz); which also give storm warnings on the 16th minute from WWV (Ft.Collins, Co.) and on the 49th minute from WWVH (Kekaha, Kauai).

Sight Reduction: Can be done with the Nautical Almanac and reduction tables (H.O. 249, or the Lifeboat H.O. 211); with the almanac and a scientific calculator; or by a nautical computer, which contains an almanac. The advantage of the last two methods is using your DR position as an assumed position.

Most offshore sailors use only sun sights, taking a morning and afternoon, or a morning and noon sight. More accuracy comes from taking a number of star sights either in morning or evening. Venus and the moon can also be used, but require a little more work. When calculating dip, include not only your eye height off the water, but half the height of the waves – you take sights when on the crest of the wave.

Electronic Navigation:

Loran ground waves only reach out 400 or so miles, and its sky waves are relatively inaccurate. Loran is only available in the northern hemisphere (Decca, in Europe, is similar but uses different equipment).

Satnav can give fixes to within a quarter mile, provided an accurate course and speed are entered. It also provides distance and a great circle course to the destination. As in celestial sights, do not rely on satellites below 10° or over 80° elevation. Also make certain the rig is not confusing the signals from two concurrent satellites. At the equator, there could be waits of up to four hours to get satnav fixes. As satellites fail, they are not now replaced.

GPS eliminates practically all these problems as it works anywhere, has the speed/all course features of loran, and is extremely accurate (unless detuned by S.A.). At the present time, GPS is operating continuously.

Weather fax decoders (like the Seafax from Datamarine) are small and inexpensive now. Taking a signal from a receiver, it is processed and sent to a small printer (the Kodak Diconix runs on 12v.). For the price, a weatherfax unit is well worth while for storm avoidance.

RADIO NAVIGATION

<u>LORAN</u>: LOng RAnge Navigation

Coverage - Northern hemisphere only, within 500 miles of land (1000 for the less accurate sky waves). Loran C is a pulsed,low frequency (100 KHz), long range (700 to 1000 Miles over seawater average), hyperbolic system. Loran stations have PEPs from 300 to 2000 Kilowatts.

Master (M), & secondary stations (W,X,Y,Z) are located on land, and the time differences in microseconds between master & one slave produces a hyperbolic LOP. TDX means time difference from master to X secondary. The speed of light is roughly 300,000 Km/sec, or 300 metres/microsecond (exactly; 299,782 Km/sec in a vacuum, and 299,702 in air).

GRI (Group Repetition Interval) is between 40,000 & 99,990 microseconds. First four numbers used for identification (Local is 5990). Secondaries have 8 pulses (each lasting 200 μs), & spacing between pulses of 1000 μs. The master transmits a 9th pulse, used for receiver automatic acquisition and blink alarm. This 9th master pulse has a 2000 μs spacing. Each cycle of the pulse takes 10 μs.

For accuracy, the third RF cycle of both master & secondary pulses are used. This also reduces possibility of using skywaves mistakenly.

Envelope to Cycle Difference = pulse envelope distortion caused by skywaves, phase shift, which shifts 3rd cycle crossing point & causes inaccuracy.

Phase coding: for identification, carrier phase is changed every second GRI, on even pulses (& master 9th). This prevents the delayed skywaves from affecting TDs, as the phase of the secondary is compared to the master. Skywave signals arrive about 30 μs (60 at night) after ground wave signals. When using the skywave, subtract 30 to 40μs from display TDs for a more accurate position.

Alarms: SNR (signal/noise ratio), Cycle, & Blink. SAM (system area monitor) measures TDs, and if any error exists, sends blink alarm. Function alarms include arrival, XTE (cross track error), and anchor watch.

Accuracy depends on transmitter, medium, antenna, receiver, interference, charts & user. Interference comes from TV receivers, alternators, florescent lights, and gasoline engines. Absolute accuracy is between .1 and .25 Miles. (At baseline, 700′ or 1/10 μs). Repeatable accuracy, or ability to return to a pre-set TD position) is about 50 feet.

Operation:

1/ Turn on receiver.
2/ Select GRI chain & secondary stations (by crossing angles & gradients).
3/ Tune notch filters (if provided) to minimize interference.
4/ After signals are acquired, and Cycle and SNR alarms are off, turn on "track" control (if provided).

NEVER USE A MASTER-SECONDARY PAIR WITHIN 20 μSECONDS OF BASELINE EXTENSION.

Cycle-Step Switch: used manually set the correct reading in fringe areas, or to move the receiving cycle up (for skywave use).

A.S.F. (Additional Secondary Phase Factor), or "land effect". This happens because loran radio waves partly follow the contour of land, and thus travel slower than over sea. ASF correction is made on many new loran charts, but only partially corrected for in receiver lat.-long. computation.

Most Significant Digit, MSD, - TD must change by 1 μs, or it can cause the display to blank.

Cycle Selection Error - if distant station is master, TD will be 10 μs low, but if distant station is a secondary, the TD will be 10 μs high.

Loran Interpolator on loran charts is used to measure off portions of TDs when charting. A homemade plotter can also be used.

SATNAV: SATellite NAVigation, using the U.S. Military Transit system, was developed in the early sixties, and will be discontinued in 1996. Coverage - worldwide. Satnav receivers obtain 300 MHz signals from satellites in a fairly low polar orbit. Each satellite is regularly programmed from ground stations to know its precise position at any time, and this information is sent to a receiver in coded form. By using the doppler effect, a series of LOPs over a space of a few minutes produces fixes to within a quarter mile. To achieve this, the accurate course and speed of the boat must be entered, either manually, by an interfaced compass and log, or from loran data.

Satnav also provides distance and a great circle course to the destination. As in celestial sights, do not rely on satellites below 10° or over 80° elevation. Also make certain the rig is not confusing the signals from two concurrent satellites. At the equator, there could be waits of up to four hours to get satnav fixes. There originally were more than a dozen satellites, but as the system is being phased out, when satellites fail, they are not now replaced. Near the equator, there could be intervals of up to four hours or more between fixes.

GPS: Global Positioning System is the replacement for Satnav, and uses the American NAVSTAR system. It works on a time-difference principle (like loran), in that the satellites know exactly their position and the precise time. The coverage is worldwide. The satellites are in a high orbit, at 10,900 miles, and are located in fixed positions north & south of the equator. Each satellite orbits the earth twice daily. The signal frequency also is very high, 1.575 GHz (1575 MHz), so shipboard interference is not a problem. Also, because of the high frequency, a full wave length is about 7 1/2 inches, so only a tiny antenna is required. The Standard Positioning Service (SPS) is available to everyone without charge on the L1 (1575.42 MHz) frequency, while the Precise Position Service (PPS) is only available to the US military on the L2 (1227.6 MHz) frequency. The latter system produces accuracy to within an inch.

As each satellite transmits pseudo-random noise (PRN) time codes, the receiver uses three of these to calculate which precise time correction (and position) that would be necessary to cross all three time differences, eliminating the cocked hat. Thus it has the exact time and consequently can keep updating its position by the time differences from each satellite (in nanoseconds).

Other data transmitted from each satellite is the Ephemeris data which defines the satellite position as a function of time; and the Almanac which is a health message defining the orbits and health of all the satellites in the system. From the latter comes the Horizontal Dilution of Precision (HDOP) which can be read in many sets over the past 24 hours in a graph showing the uncertainty figure in nautical miles, with and without SA in place. A HDOP of 2.2 would give an uncertainty of .02 Nm (121'), but with SA (described below) in place it might be .06 Nm (364').

The accuracy of this system is much better than originally predicted, giving guaranteed positions (two dimensionally) of better than 500' at any time, and within 164' 95% of the time. Tracking six satellites, often it will be within 15 m (50'), which is naturally the number that the ad writers use to promote their units. Generally, accuracy without SA is between 50' and 100', about 95% of the time. Exact positions and time (accurate to one second in 30,000 years) are updated to satellites from a master station in Colorado, which at any time can effect "S.A." or selective availability. This is a means of diddling with the time signals given by each satellite, de-tuning the accuracy. Since the U.S. military used ordinary commercial units for their soldiers during the Persian Gulf war, S.A. was not used at that time, but has been in place since the beginning of July, 1991.

The original 7 Block I satellites are being added to by Block II. By 1993 there will be 24 Block II ones (21 plus 3 operating spares). When all these working satellites and spares are up, at any time there will be more than 3 satellites in radio view. In December 1991, 16 satellites were working, not including the original prototype 7, which will soon be cancelled. With only these 16, there may be odd times during the day (usually short in duration) when only two satellites are in view, so no updated positions are possible.

Since the super-high frequency signal can be blocked by solid structures or materials, the antenna must be located in a clear area. The mast, rigging, or sails will not bother the incoming signals, but the transmission from a low satellite could be blocked by a nearby hill or mountain. Proximity to a high cliff or mountain is the only time that GPS may not operate. On sailing yachts, locating the antenna on the masthead is not recommended, since the lateral movement will produce inaccuracies in speed and course readings (updated every second).

The more expensive receivers can process the signals from all satellites concurrently, while the less costly ones do it consecutively. The single channel sequencing receivers listen to each satellite for 30 seconds to acquire data, thus may need 90 seconds for the first fix. Single channel multiplexing units use shorter times for each satellite, and may miss some data. For sailing yachts, single channel sequencing might be preferred due to the lower cost. Multichannel receivers are somewhat more expensive, and are also used for aviation where speeds will exceed 200 knots, since positions are more quickly updated.

But since prices on GPS units have dropped considerably in the last year, there now is little cost difference between single channel and multichannel sets. The more expensive units often include extra features such as plotters (graphic displays), extensive waypoints and routes, a selection of chart datums, man overboard alarm, or Differential GPS capability. The last would utilize a GPS receiver in a known location, which would broadcast correction factors to other units, producing an accuracy within 3'. The Soviet Union has the GLONASS system, which uses the same basic concepts as the American. Future joint use may greatly improve accuracy, and some sets can have the software upgraded to take advantage of this.

GPS eliminates practically all the problems encountered by loran or satnav, as it works continuously anywhere in the world, and has all the speed, course, way-point distance, and WP course features of loran.

ALL THIS EQUIPMENT MUST BE CONSIDERED ONLY AS NAVIGATIONAL AIDS, AND DOES NOT REPLACE COASTAL OR CELESTIAL NAVIGATION.

ROUTE PLANNING:

The fastest and most comfortable passages are made with the prevailing winds and current. But the shortest route across an ocean will follow a great circle track. Usually a compromise must be made, depending on weather conditions.

The areas to be avoided are:

- The very light wind areas in the centre of highs.
- Shallow water (such as off continental shelves).
- Sailing into a deep depression ridge.
- Hurricane or cyclone areas in late summer.

Suggested routes for each time of the year can be found in the "Sailing Route" chart in the book "Ocean Passages of the World". In the tropical trade wind areas the wind will be roughly from the east, while the current also flows west. When sailing north or south, it is sometimes necessary to make extra easting when possible, to prevent having to beat to weather to a destination.

CHARTS & BOOKS:

You will need: Pilot Charts, Great Circle (gnomonic) charts, and small scale charts covering 3000 or more miles. Daily work charts for your location can be easily made from plain paper. The sailing and current charts in Ocean Passages of the World are very useful, although the book costs about $80.

You also need large scale charts of islands, harbours, and coastline. These should be bought before leaving, can be traded with other yachts, and some are available from Bluewater Cruising. These coastal charts are expensive, but necessary. Avoid charts which are outdated, and also avoid copied charts. The poor resolution usually found on most make them useless for accurate pilotage.

Admiralty, Canadian, American, New Zealand, and Australian charts are good, but ones in a foreign language may be difficult, although symbols are the same.

NECESSARY BOOKS:

1/ Collision Regulations (1983 edition is latest).
2/ Canadian chart # 1 (Symbols). Jan. 1988 is latest.
3/ Admiralty Tide Tables (Vol.3 = Pacific)
4/ Radio Aids (incl. weather stations) for the Pacific.
5/ Light List for the Pacific ocean.
6/ Sailing Directions for the area of the ocean.
7/ Nautical almanac (annual).
8/ A navigational text, like Bowditch, Chapman, or Dutton.
9/ A book on medical emergencies and first aid.
10/ Books on meteorology, signal flags, and national flags.

COLLISION AVOIDANCE:

Ships travel well-defined routes; and once out of shipping lanes, you are unlikely to see one. Also, after the first day out on the Vic-Maui race, you are unlikely to see another yacht, even one eight or ten miles away. I would recommend running at night with a bright masthead trilight, and have someone scan around the horizon every five minutes or so, even when out of shipping lanes. 10 or 12 miles is maximum range to see a ship.

If anything is sighted, use VHF 16. It will carry about 25 miles to a freighter, and they usually are happy to have someone to talk to. At sea, unless there is other traffic around, you don't even have to switch channels.

Both submarines and whales will pick up the signal from a sounder, so in a pod of whales, or submarine lanes (around the Hawaiian Islands), leave it running. A free-wheeling prop will also suffice. There have been odd cases where yachts have hit a partially submerged container, or been rammed by whales, but this is extremely rare. Usually on a passage it is uncommon to even see anything floating by. (No logs to worry about!)

TIME ZONES:

Since the earth rotates in exactly 24 hours, each hour or time zone is 15° of longitude. The Greenwich meridian marks the centre of GMT, so the first time zone changes start at 7 1/2° east and west, the second at 22 1/2°, etc.

Maui (and all Hawaii) is two hours behind PST.

NAVIGATIONAL MISCELLANY:

The earth is an oblate spheroid, with a rotation of 24 hours, and a revolution of slightly less than 365 1/4 days. It's axis is tilted 23 1/2°, but this wobbles in a tight circle every 26,000 years (Precession), and also nods in and out every 18.6 years (Nutaton).

The moon orbits every 27 1/3 days, and its swaying and nodding is called Librations.

The sun moves through the galaxy at 150 miles/second (540,000 mph), while the earth revolves around the sun at 1100 miles/minute (66,000 mph).

The speed of light is 186,234 miles/sec, 300,000 Km/sec (300,000,000 m/sec).

Wave height = 1/7 of wave length * half (in feet) the wind speed (kn)

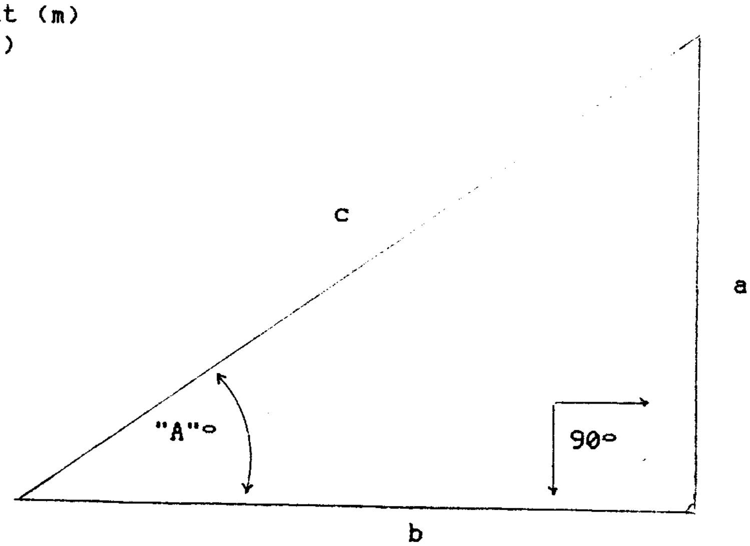
Radio/radar horizon = 2.21 x $\sqrt{\text{antenna height (m)}}$
plus 2.21 x $\sqrt{\text{target height (m)}}$
(for vision, use the number 2.1)
Standing 10' up from the water,
the horizon is 3.6 Miles.

In a right angle triangle:

Sine angle "A" = $\frac{a}{c}$

Cosine angle "A" = $\frac{b}{c}$

Tangent angle "A" = $\frac{a}{b}$



In three minutes, a ship moves in hundreds of yards equal to her speed (in knots)

WEIGHTS & MEASURES:

1 nautical mile = 1852 metres * 6076 feet = 10 cables = 1 min. of latitude
1 Imperial gallon = 4.546 Litres = 1.2 US gallons (5 Imp.gal. = 6 US gal.)
1 Imp. gallon: of gasoline weighs 7.2 pounds (45 pounds per cubic foot)
of diesel weighs 8 pounds (50 pounds per cubic foot)
of fresh water weighs 10 pounds (62.4 pounds per cubic foot)
of seawater weighs 10.3 pounds (64 pounds per cubic foot)

CELESTIAL NAVIGATION - DEFINITIONS

Alt. = Altitude: the angle made at the observer between a heavenly body and the horizon directly below it. (See Ho)

AP = Assumed Position.

dec. = Declination: the angular latitude of the GP of a body north or south of the equator.

Departure = The distance in N.miles between two meridians at any parallel of latitude.

D'Lat.= Difference in latitude.

D'Long.= Difference of longitude.

CoLat. = Angular distance from the observer to the elivated pole.

Elivated Pole = The pole nearest to the observer (P).

GHA = Greenwich Hour Angle: the westerly longitude of the GP of the observed body.

GP = Geographic Position: the position on the earth's surface directly beneath a heavenly body (X).

HH' = Horizon H to H' :the tangent of the earth's surface at Z, observer's position.

Ha = Apparent altitude: Hs corrected for dip and index error.

Ho = Observed altitude: Ha corrected to give the true altitude.

Hs = Sextant altitude, before any corrections are made.

Lat. = Latitude: the angular distance from the equator.

LHA = Local Hour Angle: the same as GHA but measured westward from the observer's meridian.

Long. = Longitude: the angle between the prime meridian and the meridian of any point, east or west.

MidLat. = The mean of two positions of latitude, the cosine of which is used to determine departure from D'Long.

♈ = GHA Aries.

t = Meridian Angle: the easterly angle between GP and observer. 360° - LHA = t .

SHA = Siderial Hour Angle: the westerly arc between ♈ and the meridian of a body's GP.

Z = Azimuth Angle: E or W measurement between GP and the Elivated Pole.

Z' = Zenith: the point directly above the observer Z.

Zn = Azimuth: the true bearing of a heavenly body.

Zdist. = Zenith Distance: the compliment of altitude. Zdist. + alt. = 90°.

RADIO WAVES:

Aboard a yacht, the range of radio frequencies used are:

1/ Low Frequency, measured in kilohertz (KHz): as in RDF beacons.
2/ Medium to High Frequency, measured in hundreds of kilohertz, which includes loran, commercial AM, weatherfax, and HF (SSB).
3/ Very High Frequency, measured in Megahertz (thousands of kilohertz), which covers marine and amateur VHF, commercial FM, TV, satnav, and EPIRBs.
4/ Super High Frequency, measured in Gigahertz (thousands of megahertz), used in radar and GPS.

The higher the frequency, the shorter the wave length (Wave length, in metres = 300/frequency, in MHz), and therefore the smaller the antenna required.

VHF and SHF signals, although reflected off hard objects, pass through the ionosphere, and therefore travel only a little more than line of sight. This is also the limit of low frequency, which travels only by ground wave.

Medium frequency signals (like 2182 or 4125 KHz) bounce back once from the lowest layer of the ionosphere, and have a ground wave extending to a few hundred miles as well as a sky wave going a thousand or two thousand miles. The higher the frequency in HF, the higher the ionospheric layer that will be reflective. 14 or 16 MHz signals will have multiple skips, each extending about 2500 miles. The degree of reflection of these bounces depends on the amount of ionization in the upper atmosphere, caused by changes in the 12 year sunspot cycle, and also varying summer to winter, and during the day. 1988 was the lowest cycle time; it should improve until 1994.

OFFSHORE COMMUNICATION:

The carrier waves are modulated to carry voice (except for CW, or morse code, where the carrier is simply interrupted). Frequency modulation (FM) is free from static, but requires too much band width to be used in MF or HF. Since offshore communication is well beyond the range of VHF, for voice we must use amplitude modulation (AM) in the HF bands. In AM, there is the carrier, and two modulated side bands on either side, each with a fraction of the strength of the carrier. By suppressing the carrier and one sideband, the full strength of the signal is carried by the remaining single side band (SSB). By convention, the upper sideband is used in all marine HF, and the higher amateur HF frequencies.

Marine SSB radios, required for the race, require installation by an expert; but they have long distance capability, and can be used for business communication offshore. Recently these have become much more sophisticated, and have dropped in price. Another useful means of communication is amateur radio. Amateur SSB has a number of advantages, including much lower price. But it also has two inconveniences: the first is that it is absolutely necessary to hold an amateur licence to use it. Although a number of yachts offshore have ham radio aboard, by law it is illegal to even possess a unit without an amateur licence (any of the thousands of listening amateurs, however, will respond to a non-licenced operator in the case of a true emergency). The other disadvantage is that no business may be conducted on amateur radio.

AMATEUR RADIO NETS

There are many regularly scheduled radio nets operating daily throughout the Pacific and Atlantic oceans. Our local DDD net comes on at 2000 PST at 14.115 MHz. They open with a call for any emergencies, then have any marine amateurs check in. They will also put through a local phone patch.

E.P.I.R.B.s

The older ones operated only on 121.5 and 243 Mhz frequencies. The newer units also use 406 MHz, include identification codes. and signal not only aircraft but to the COSPAS-SARSAT satellite system. When this type of EPIRB is activated, the signal will be detected and position relayed within four hours.

Radio Installations:

For any HF (High Frequency) SSB radio, a tuner is necessary. Most today are automatic; they work well, but are fairly expensive. An alternative is a large manual one which shows power out and power reflected. With a little effort, a perfect match on either amateur or marine transceivers can be obtained. Multi-band HF antennas are sold, or insulators can be used on a backstay to make a very functional HF antenna. A single antenna and tuner can be used for both marine and amateur HF by installing a rotary antenna switch.

Radio Antennas, along with coaxial cables and a good ground plane, are more important in transmitting than the power output of the rig. Use a plated steel masthead antenna on a loading coil for the VHF radio, as it can be trimmed in length to give a precise match in the centre of the band (channel 16 in marine VHF). Many fibreglass antennas are notoriously out of tune. If you have one professionally installed, get it checked with a SWR meter by the technician. As there is more coaxial cable power loss in VHF than HF, it is important to use RG-8/U (or equivalent) cable. Previously this only came in 1/2 inch diameter size, but is now available in 1/4 inch.

The connector between the cable and antenna must be made watertight. This applies to loran and satnav as well. Wrap each outside connection, bottom to top, tightly with PVC tape, and then pack on a coax connector sealer. This is available at most amateur or marine radio stores. Even then, it probably is a good idea to change older coaxial cables every few years, as any water seeping into a foam dielectric (the inside insulator) can short out the cable. Many failures in satnav and radio units can be traced to this fault.

The cabinets of all electronics should be grounded, but HF radios also require a ground plane. This can be an external honeycomb plate, or external metal ballast can be used; but the best solution is to have a copper mesh laid inside the hull (underwater) as the hull is being built. The disadvantage to the first two ground planes is that a wired contact is made between the water and the negative side of the boat's electrical system. This possibly could create electrolysis in bronze through-hull fittings. A mesh ground plane inside the hull need not contact the sea - it can be a inch or two away from the water and still have very little impedance at radio wave frequencies.

BATTERY CHARGING:

No matter how much total battery capacity there is aboard, batteries must be recharged daily as the current is used. This has been a problem with some yachts in past Vic-Maui races. Each day as current was used for electronics, running lights, the daily radio roll call, and a dozen other uses, the batteries were not brought up to a full charge again. In some cases the radio signals became so weak as to be unreadable. This happens because the more discharged batteries are, the faster the voltage will drop, since more amperes must be used to produce the same power at the lower voltage. (Power, in watts = volts x amps).

Each cell in a charged battery has a number of negative plates of sponge lead connected together, and positive plates of lead dioxide, also joined. All the plates are immersed in a sulphuric acid solution. This charged cell will have a fairly low internal resistance. As a battery discharges, both negative and positive plates turn to lead sulphate, and the acid of the electrolyte becomes weaker, producing a higher internal resistance. When it is recharged, the chemical changes revert the plates and electrolyte back to the original state.

A fully charged 12 volt lead acid battery will read 13.6 volts (2.27v per cell) right after a charge and have a specific gravity of 1.275. After a period of time when it settles down it should read 12.7 volts, both open and using current. At half charge, it will show 12.35v open, 12.2v in use, and a 1.200 specific gravity; while a nearly discharged battery reads 11.8v open, and only 9 volts using current. The specific gravity readings are done with a hydrometer, and must be corrected for temperature. Add 4 gravity points (.004) for every 10° F. above 80°, and subtract the same for every 10° below 80° F.

To calculate the daily amp-hours that will be required at sea, multiply the amperage drain of each piece of equipment by the time it will be used. Add these all together, and you have the amp-hours needed each day.

Batteries cannot deliver their total rated capacity, because as they are discharged, they become less and less productive, and if they're taken down until flat, their life is severely shortened. So write off the lowest one half amp/hour capacity of the battery. Also assume that the generating ability in a sailboat will not be enough to fully recharge them. This is because most alternator regulators were designed for vehicles, a completely different situation from our use. Thus, an 85% charge is about all we can normally expect, unless they are brought up by a good regulated charger running off shore power, or an alternator controller. Therefore we can only count on 35% of a battery's rated capacity as being really useful.

<u>Methods of charging on a racing yacht:</u>

1/ Engine Alternator: Most boats rely on an engine driven alternator. In many cases, this will not adequately charge the batteries. Generally the problem is not with the alternator, but that the regulator that came with it was designed for use in vehicles, where the small amount of power used for starting is quickly replenished. For marine use these regulators leave something to be desired. You might by chance have one with a high voltage setting, but in most cases it will give a high current for only a few minutes before tapering off. This won't be adequate, particularly if the engine is only run for short periods of time to recharge batteries. The old spring-loaded relay regulators could be adjusted, but the only modern electronic regulators which have this feature are ones made for marine use. In Vancouver, Ib Hansen of Davidson Marine makes them, as well as marine alternators. This regulator, which can be used on any alternator drawing less than four amps of field current, sells for about $65. More sophisticated marine regulators, which are really alternator controllers, are made by Ample Power, 4300 11th Ave. N.W., Seattle, and by Cruising Equipment, 6315 Seaview Ave. N.W., Seattle. Both of these units will allow the alternator to charge in stages, like a good shore power charger, but are quite expensive.

2/ Bypassing The Regulator: This can be done with a 20 ohm, 50 amp adjustable pot. Some boats have installed systems where the regulator can be bypassed, and the alternator output adjusted by a manual controller. This works, but has one problem - it requires constant vigilance to prevent overcharging. This is another point: batteries do not like to be overcharged. If brought up to over 14.4 volts they begin to gas freely (with explosive hydrogen and oxygen), and they become hot. This can result in a brittle lead peroxide to form on the positive plates, causing the grids to swell and crumble, and the plates to warp. We want to fully charge the batteries but at the same time avoid overcharging. A half charged cold battery, with its high internal resistance, needs a high amperage to take a charge; whereas a hot fully charged one will accept a high charge to it's detriment. Battery charging is a delicate business.

3/ Solar Panels: Also known as photovoltaic panels, these convert sunlight directly into DC current. They are expensive, but are light in weight and long-lasting. The new ones produce more current, and some are flexible and can be walked on. Solar panels have the advantage of being trickle chargers, so often can be used without a regulator. There should be a germanium diode in the circuit to prevent current flowing the wrong way at night, and the battery voltage must be monitored every so often.

4/ Wind Generators: These are windmill driven alternators, and produce a small but steady current whenever turning. They would create drag if the boat were moving to windward, but might actually help when sailing off-wind, although the turbulence created could be harmful to air flow over the sails. Other disadvantages are that they are noisy and may be difficult to stop if the wind picks up to gale force.

5/ A Separate Genset (gasoline or diesel): Small, light-weight units are available, some of which can produce a large DC current. In this case, it may be wise to use an alternator controller to prevent overcharging. The disadvantages of small gensets are that they are noisy and often smelly.

FOREIGN PORT CLEARANCE:

The most important document apart from the ship registration (and passports, or visas if needed for some crew) is the official clearance paper from the last country visited. Without it you cannot enter another country.

Entering Maui from Victoria is usually simplified by the Race Committee. Passing the finish line, racing yachts are normally automatically checked in. But payment of an entry fee and cruising permit for the Islands is required. When visiting other Islands, it is necessary to check in by phone on arrival. Also, a departure permit (and payment of another fee) is mandatory before leaving.

Be aware of your legal responsibilities regarding hospitalization and medical expenses of crew, and that you may have to pay for their flight home. You can also be in deep trouble if any of your crew are carrying an illegal drug. Hawaiian authorities are now very serious about drug control.

To simplify matters, it is useful to carry a number of copies of the following:

1/ A list of all items aboard, with date/place of purchase, and serial numbers. (Canadian yachts should have this list checked and stamped in Victoria)
2/ A list of all members of the crew: with full names, citizenship, addresses, birth dates, birth places, passport # and place/date of passport issue.

Flag Etiquette:

On entering foreign waters, your own ensign is flown from the normal position, and the national flag of the country in the position of first importance (usually from the upper starboard spreader). Below it, the yellow "Q" (quarantine) flag is flown until the vessel is cleared by the health authorities (this probably will not be necessary in Maui). The courtesy flag for foreign yachts remains up at all times while in the country.

Cruising the Hawaiian Islands:

Apart from a handful of bays which offer safe anchorage in the leeward side of the islands, most moorage is in marinas where a trench has been cut through the fringing reef into the lagoon area. Use the buoys or range markers for entry. Lateral buoys in the Hawaiian Islands are the same as on the North American mainland. Elsewhere in the world they are the opposite colour.

One hazard in the Islands are submarines, which may be travelling submerged or with only the sail showing. Sometimes they mistakenly think that the ColRegs do not apply to them, and will not give the right of way to a sailing yacht. Submarine lanes are marked on charts of the Hawaiiam Islands, and if crossing one at night it may be prudent to have the engine running or the sounder turned on.

REEFS, CORAL, & ANCHORING

Coral reefs can rise from deep water very sharply, but can be sighted by breaking waves, a sharp lightening of water colour, or by the sound of surf. Try to enter a reef area with the sun behind you, and have someone go up to the lower spreaders to sight the shallow areas. Coral is nearly as hard as rock, and as sharp as glass. Use updated large scale charts in coral reef areas, and remember that in places the reef can extend out many miles from land.

Behind the reef there is often a lagoon area deep enough for anchoring. Coral reefs have the one redeeming quality of making good breakwaters. The scope used in anchoring is similar to local use, and depends on the wind. In any coral area a chain rode must be used as coral will cut rope very quickly. A good kedge anchor, like a Bruce or CQR, works well in coral, because of their strength. In sand sand or mud bottoms a Danforth or Fortress type of anchor might hold better. It often is useful to have a floating trip line and buoy going to the anchor in areas where there are coral heads.

Force on an Anchor Rode: Horizontal Load in Pounds vs. Boat Beam (Approximate)

Wind	9' Beam	11' Beam	13' Beam	15' Beam	17' Beam
15 Knots	180	300	400	500	680
20 "	330	560	750	940	1,270
25 "	480	830	1,100	1,380	1,860
30 "	700	1,200	1,600	2,000	2,700
40 "	1,300	2,250	3,000	3,750	5,060
50 "	1,930	3,300	4,400	5,500	7,430
60 "	2,800	4,800	6,400	8,000	10,800
70 "	3,760	6,450	8,600	10,750	14,500
80 "	5,200	8,630	11,500	14,380	19,400

STRENGTH:	Breaking Load (pounds)	Safe Working Load* (pounds)
1/4" BBB Chain	2,600	520
5/16" " "	3,900	780
3/8" " "	5,500	1,100
1/2" " "	9,500	1,900
1/4" Shackles(Drop forged)	5,000	1,000
3/8" " "	10,000	2,000
1/2" " "	20,000	4,000
3/8" Nylon 3-strand Rope**	4,000	418
1/2" " "	7,100	712
5/8" " "	10,500	1,100
3/4" " "	14,200	1,484
3/16" 7x19 SS Cable	3,900	975
1/4" " "	6,600	1,650
5/16" " "	9,000	2,250
3/8" " "	12,000	3,000

* The safe working load of chain and shackles are usually taken at 20% of their breaking strength, while cable is calculated at 25%, and nylon line at only 11%.

** This assumes the line has a long splice, which reduces it's strength by only another 5%. A knotted line is reduced in strength by 45%. Polypropylene line has about 60% the strength of nylon, and manila only a third.

Recommended Sheave Diameters: 3 times a rope diameter; 15 to 30 times a wire or kevlar diameter.

AVAILABILITY OF SERVICES IN THE HAWAIIAN ISLANDS

Repair services and parts are available in the larger cities, but even Honolulu will not have the selection of parts or services that are found in Seattle or Vancouver. Often parts will have to be brought from the mainland.

Minor repairs, fuel and water, can be found in towns, especially marinas, but in some areas (such as Hanalei Bay in Kauai) there is neither fuel nor water hoses. Some knowledge of engine, refrigeration, and electric repairs and maintenance is very useful in outlying areas. Workshop manuals for the engine and transmission should be carried, along with some spare parts. Engine belts, pumps, pump parts, zinc anodes, fuel and oil filters, and spare oil must be aboard. A gasket kit may be a necessary adjunct, and for gasoline engines spare plugs, distributor cap, rotor, points, and capacitor should also be added. Ask a mechanic's advice as to what spares might be required for your own engine.

Obtain, if you can, the names, addresses, and telephone numbers of the distributors or repair centres in the Islands for all machinery and electronic equipment aboard. The schematics of electronic devices can be very useful, but usually are not freely given out (except for radar sets).

NAUTICAL TERMS THAT LANDLUBBERS* USE

LANDLUBBER - Lubber is an old English term for a big, clumsy person, thus a Landlubber was the shipboard term for someone who had not yet acquired his sea legs.)

ABOVE BOARD - Any transactions done on deck, or above board, could be seen by everyone, and therefore was assumed to be fair and honest.

ALOOF - A Dutch "jacht", from which comes the English word yacht, which during a race wanted to move away from the rest of the fleet, might luff (te loef) and pinch to windward.

A NEW SLANT - Described a change of course in relation to wind direction.

BY AND LARGE - This term rises from sailing with, or by, the prevailing wind, when the largest sails aboard could be set.

CASH ON THE NAIL - On the shore-side in Bristol there are four brass mooring bollards, called nails, where the merchants settled their deals.

CHEW THE FAT - When preserved in brine aboard ship, fat required a great deal of chewing, so it appeared that the sailors were talking at length.

COLD ENOUGH TO FREEZE THE BALLS OFF A BRASS MONKEY - The brass rack holding the shot was known as a monkey, and in very cold weather it would contract more than the iron shot balls, thus squeezing them off.

CUT AND RUN - When a vessel wanted to make a very fast departure, the mooring lines or even the anchor rode would be slashed, and the ship would run with the wind.

EMBRACE - A fathom of line could be measured by stretching it from hand to hand across the chest, or to grasp it in the (outstretched) arms.

FAGGED OUT - Referred to a frayed line, which was worn out.

FOOTLOOSE - Described a unfastened sail or one where the sheet was loosened, or LET FLY.

FOUL UP - A line which was not laid out to run freely was said to be fouled.

/E A WIDE BERTH - Came from steering well clear of possible unknown hazards, which was also known as GIVING SOME LATITUDE.

GROGGY - A condition which arose when too much diluted rum, or grog, was consumed. Grogham was the coarse cloth of sailor's clothes, so when Admiral Vernon instituted the daily tot of rum in the English navy, it came to be known as grog.

GO TO THE HEAD - The sanitary facilities in older sailing ships were located near the figurehead (which came to be known as the ship's head) because this was the most leeward area in these vessels, which could only sail on a broad reach or with the wind aft.

GOVERNMENT - A word derived from the Latin "gubernator", who was the helmsman aboard Roman ships.

HAND OVER FIST - (as in making money hand over fist) comes from the manner in which sailors quickly made their way down the rope rigging to get back on deck.

IN THE DOGHOUSE - Aboard slave ships, one crew member had to remain on deck at all times to watch for possible escapes, so slept in an open and uncomfortable "doghouse", so named because of its small size.

IN THE OFFING - The offing, another old English Term, is the portion of sea visible from land, so a ship arriving would be in the offing.

KNOCK OFF WORK - On the slave galleys, the rhythm beater would sound a special knock on the block to signal a rest or change in shifts.

KNOW THE ROPES - An experienced deckhand aboard a sailing ship would know the function of each of the many halyards and sheets.

LANDMARK - Was any prominent aid to navigation situated on the land.

LAY OF THE LAND - The first visual inspection done from the ship on a new and unknown coast gave rise to this term.

LEADING LIGHTS - These are naturally the beacons placed to give the line into a harbour entrance.

LIMEYS - The English Admiralty were the first to give lime juice to sailors on navy vessels to prevent scurvy.

LOOSE ENDS - Referred to the frayed ends of lines which required whipping.

.AINSTAY - The most important shroud aboard a sailing ship was the headstay or mainstay.

MAKE ENDS MEET - To save money, owners would instruct their captains to have old broken lines spliced together (make the ends meet) rather than replace them.

MAKE HEADWAY - A ship which was sailing fast enough to overcome a contrary current was making headway. If not, it was SET BACK.

MESSY - The mess, where the common sailors ate, was usually in dirty disarray.

SHIP'S COME IN - During the sailing spice trade in Clipper Ships, an owner who's ship came back to port first stood to make a fortune.

NOW YOU'RE TALKING - The sound of the water rushing past the hull when a ship was making good knots was referred to as the ship talking.

OPPORTUNE - Portus is the Latin word for harbour, so when a Roman sailing ship finished a voyage, it was ob (before) portus - back at the harbour entrance.

OVER A BARREL - Miscreants were sometimes tied over a barrel for flogging.

OVERHAUL - When lines running through blocks were slackened by pulling in the opposite direction, they could be examined closely for wear.

OVERREACH - A ship which sailed too far on one tack than was necessary to clear a headland was overreaching.

PIPE DOWN - The bosun's mate last whistle call for the day was Pipe Down, which meant that the off duty crew should be silent and climb into their hammocks.

REAL McCOY - During prohibition, the Canadian rumrunner Bill McCoy became well known for never diluting the whisky he smuggled.

REEL OFF - A line reeling off a drum could move very quickly.

ROUND ROBIN - This was a circular ship-board petition, where there were no initial signatures (hence no leaders), which was then presented to the captain.

RUBBING SALT INTO THE WOUND - This technique was the only ship-board antiseptic available in early days.

SCRAPING THE BARREL - Aboard early sailing ships, everything had to be used down to the last drop.

SCUTTLEBUTT - A water butt (keg) on deck for the seaman's use was scuttled with a hole drilled part way up to prevent it from being completely filled. Sailors would congregate around this scuttlebutt to swap gossip and rumors.

SLOPPY - An expression that well described a "sloppe", or loose shipboard garment that was usually stored haphazardly.

SLUSH FUND - The grease rendered from the salt pork aboard was used for lubrication of gear, but the excess rancid slush was sold on reaching port, and the funds used to buy a few luxuries for the crew.

SNUB - A vessel or a sail was quickly halted by snubbing the lines.

SON OF A GUN - When in port, Admiralty Ships of the Line, to prevent desertion, seldom allowed sailors shore leave. Ladies of the Evening were allowed aboard, however, and a child conceived in the hammock slung over the guns was known as a son of a gun.

SOUND OUT - A cautious captain would sound bottom with a lead line before proceeding into shoal waters.

STAND BY - A ship would stand by another in distress to give assistance if necessary.

STAND-OFFISH - When a vessel did not moor in port, but anchored in the roadstead, it was standing off.

STRANDED - The expression used when a vessel was grounded on the shore.

THE BITTER END - Riding bitts were used for the anchor cable, and the bitter end was reached when the very last part of the cable was paid out.

THE COAST IS CLEAR - A term used when the coast had been surveyed and known free of underwater dangers.

THE DEVIL TO PAY - The devil seam, which margins the waterways, was the most onerous seam to pay (or caulk), and sailors who were given this difficult task were BETWEEN THE DEVIL AND THE DEEP BLUE SEA.

TOUCH AND GO - A hazardous method of tacking up a channel, by feeling bottom before going about onto the other tack.

UNDERWAY - A ship which is not moored, or when the anchor has been weighed (lifted off the bottom), is legally underway.

WALLOP - In one of the many wars with France, an English captain, Sir John Wallop, razed over twenty French towns in reprisal for a French raid on an English city.

WASHED OUT - Flag signals were recorded on a slate, and after read, were cancelled by being washed out.

YOU CAN'T BEAT A DEAD HORSE - Crew were sometimes pressed into service when the mate paid their shore-side debts; thus for the first month or more the sailors would be working without pay. These unwilling men were known as DEAD HORSES as they often would not even respond to punishment.

Complied by Jack Balmer, 1991