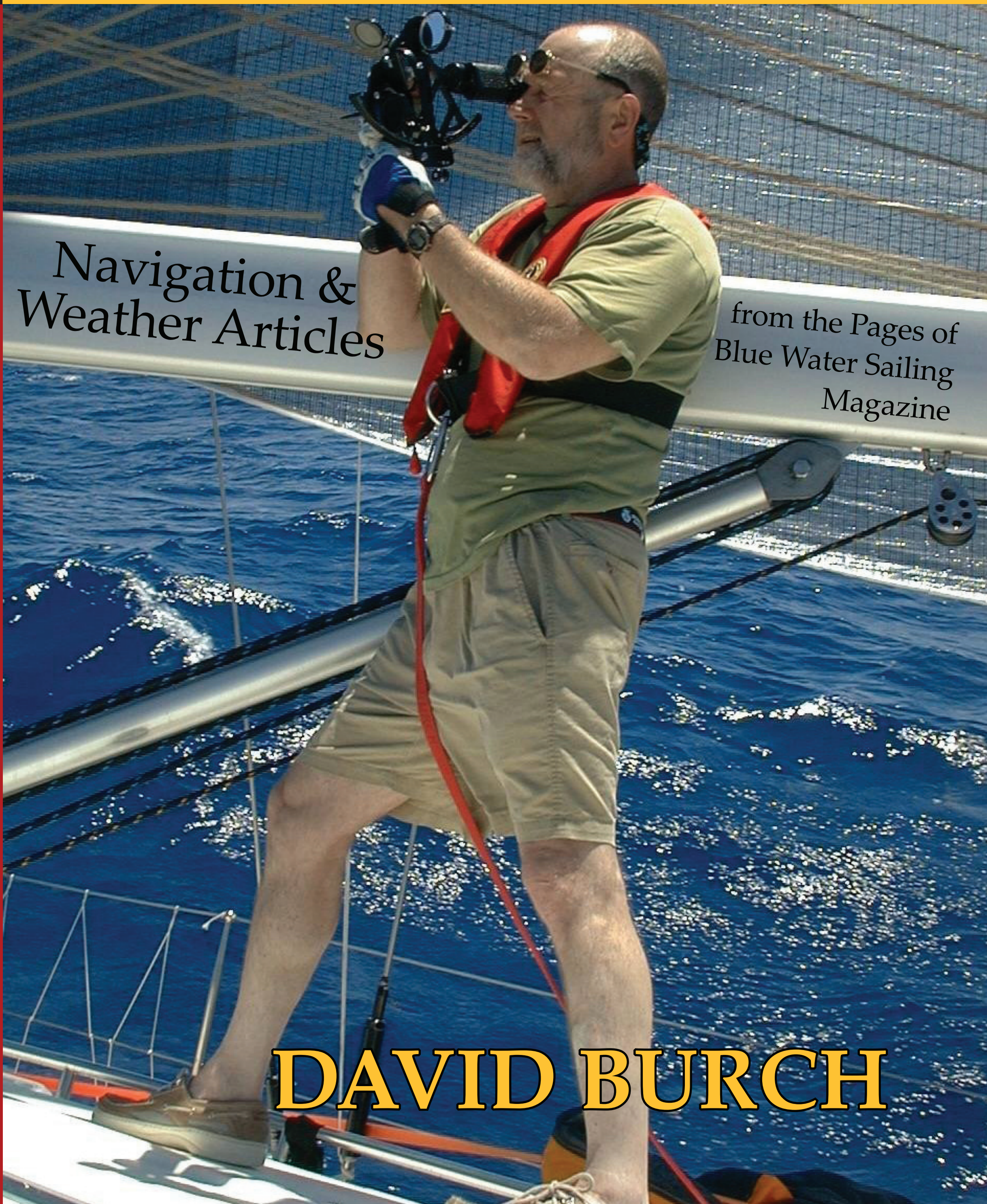
BURCH AT THE HELM



Navigation & Weather Articles

from the Pages of Blue Water Sailing Magazine

DAVID BURCH

BURCH AT THE HELM

STARPATH®

www.starpathpublications.com

ISBN 978-0-914025-39-9

Published by
Starpath Publications
3050 NW 63rd Street, Seattle, WA 98107
Manufactured in the United States of America
www.starpathpublications.com

Contents

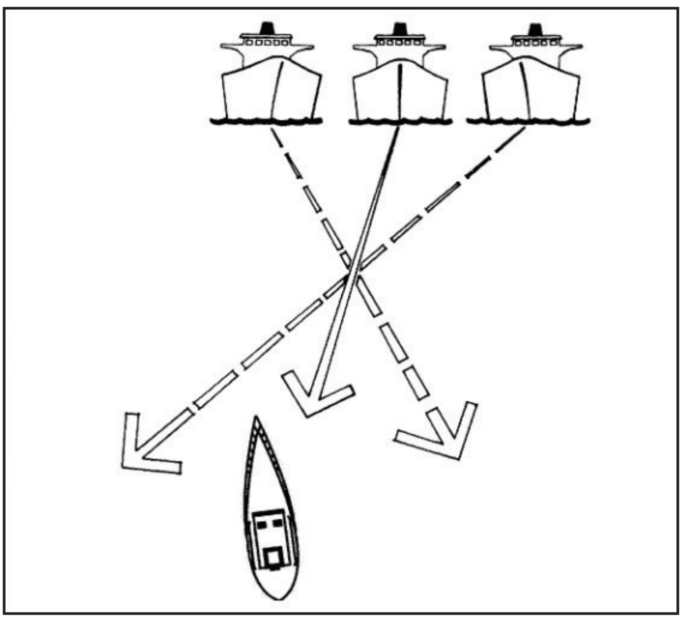
Preface

The articles included here were originally published in Blue Water Sailing magazine over a period of several years. They cover diverse topics, but each is intended to enhance the safety and efficiency of navigation. Though published in a magazine devoted to sailing, these subjects and the information contained applies to all vessels, power, sail, and paddle.

They have been regrouped by topic, so the order presented here does not reflect the order of original publication. For the most part they deal with special issues, not often covered in detail in standard references. Some were motivated by issues of the day when published, but we have updated all as needed with new resources on the topics.

Questions, comments, or contact with the author can be made by email to helpdesk@starpath.com. Other books and products from Starpath can be seen at www.starpath.com

GENERAL NAVIGATION



Unofficial, Official Definitions & Conventions in Navigation

Like everywhere else on the boat, proper communication in navigation is always crucial to efficiency, and could be crucial to safety. Some conventions are widely used and long standing—to the point of being as much seamanship as navigation. Others, strangely enough, are evolving with time. They are different now than they were 10 years ago.

First the easy ones that comes up most often. All courses, headings, and bearings that are less than 100° should be preceded with leading zeros. Thus our course is 035 (oh, three, five), not 35 (three, five or thirty-five), and 005 (oh, oh, five) not 5. This is the way we should say them and write them. It should be considered not optional.

We deal with many angles in the nav station, especially when you get a sextant in your hand, so the goal here is to uniquely distinguish directions (headings, bearings, and courses) from everything else that might be an angle less than 100°.

Generally we should always specify the units of the directions, namely True, Magnetic, or Compass, but that rule can be demoted to an as-needed level, because we have so many rules that tell us what to use for specific subjects. For example, although the navigator cannot avoid using all three units (true, magnetic, and compass, no one else on the boat should have to deal with that. All courses and headings and bearings discussed on the boat and kept in the logbook should be Compass.

If someone wants to discuss true bearings or magnetic bearings that is fine, so long as they do not confuse the helmsman, which brings up a valuable tool that has wandered off of many modern ocean going yachts, namely, a *course box* or some equivalent. It is simply a way to post the correct course to steer in prominent view of the helm. Vessels from the Golden Age of Sailing all had one, and any ocean passage will point out their value—even if it is just piece of duct tape in clear view of the helm, with the latest course printed boldly. Then cross it out and add a new one as it changes. It makes an easy way to keep track as watches change, or for a quick reference to check when the steering gets dicey.

The navigator can't avoid the other units because winds, currents, and swell directions are always given in True. Also, light sectors and range lines on nautical charts are always in True. A NE wind is one coming from 045 T. Swells are labeled like winds, the true direction they come from. A westerly swell is flowing from west to east. A current set of 135, on the other hand, means the water is flowing toward 135 T.

Angles *on the bow*, for navigation purposes or for wind directions, do not use leading zeros. We can say, for example, the apparent wind angle is 30° on the port bow. Bow angle winds are commonly used on sailboats: what is your wind angle? Answer: 30° apparent. The answer here assumes we know what tack we are on, but if you are recording this in the logbook, you must say 30° port or something like that. Another common use of bow angles is the piloting trick to find distance off. Measure the angle on the bow of a landmark, run a known distance, and then measure the bow angle again. From these data you can figure your distance off the landmark. These angles are likewise spoken and written without leading zeros.

On the other hand, larger vessels do not use port and starboard bow angles for recording apparent wind angles, but instead use proper relative bearings. Instead of 30° port, they would call this 330 R. On the starboard side, 30° starboard would now be 030 R. So even though both are relative to the bow, bow angles are considered angle increments, whereas relative bearings are considered directions. Relative bearings using this convention are common in radar work on vessels of any size. The EBL (electronic bearing line) would be read as 022 R, not 22 R.

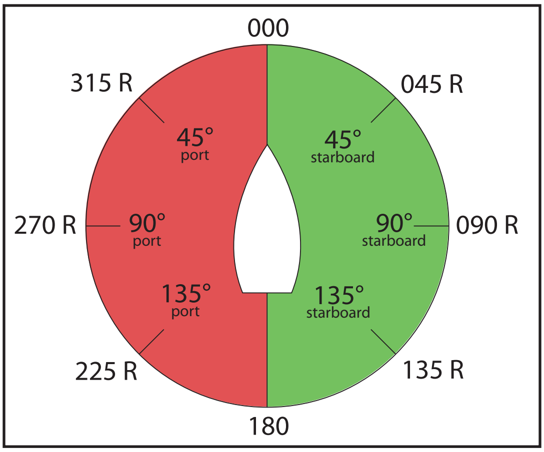


Figure 1. *Bow angles vs. relative bearings. Relative bearings are a direction relative to the bow and thus use leading zeros. Bow angles are thought of as a location on the bow, and thus do not use leading zeros.*

Another easy one. Times always include leading zeros. Thus the time is 0820, never 820. Likewise when recording or speaking times using seconds, we always use leading zeros: 03h 22m 06s.

When reporting a position, it is conventional to give the Latitude first and then the Longitude, but even more important, give the labels N,S or E,W at the end of the angles. Thus I am located at 47° 23.4′N, 122° 20.5′ W. Latitudes and longitudes are best written without leading zeros.

In celestial navigation we deal with the declination of a star. The declination of a star is the latitude over which it circles the earth once a day. All declinations are written with the label N,S in front of the angle. Thus the star Arcturus with declination N 19° 11′ passes just north of the southern tip of the big island of Hawaii at latitude 18° 55′ N. All of the various coordinates and angles used in cel nav do not use leading zeros, ie they are not directions, so they do not use leading zeros.

We can optimize our communications in the electronics world by distinguishing between course and speed over ground (COG, SOG) and course and speed made good (CMG, SMG). COG and SOG are electronic navigation terms made popular by Loran manufacturers when we first had convenient access to this valuable data, though the phrases were used long before then. There were competing terms to COG and SOG originally, but these two won out—or so it seemed for some time. Now the competition begins all again. The contestants include: electronics makers, NMEA, the IMO, navigation teaching facilities, and all the rest of us as end users.

It is more important than might appear, and with more interesting history and intrigue than we would ever guess. For now let me just seed the ground by proposing that COG be restricted to the instantaneous course I am now achieving relative to the fixed ground that I read and have knowledge of from my GPS. Likewise for the SOG; it is an output from the GPS that tells how

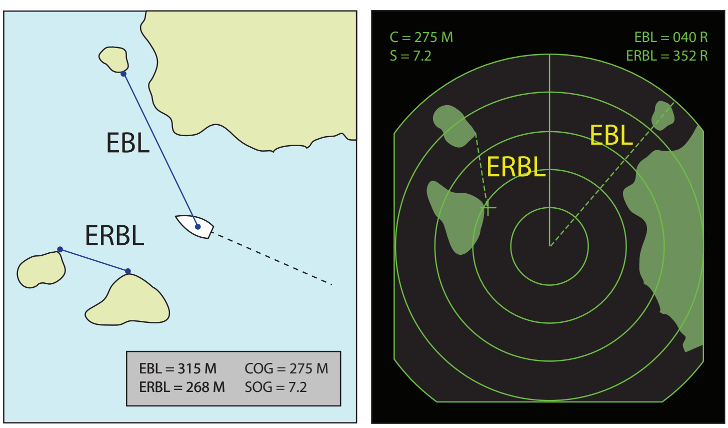


Figure 2. *A fine distinction in terminology that promotes good communications. An electronic bearing line (EBL) measures bearings from the boat; an electronic range and bearing line (ERBL) measures from an arbitrary point on the display. These are used on both echart displays and on radar screens. On electronic charts, the EBLs and ERBLs always include range as well. In radar the range from the vessel is measured with a VRM (variable range marker).*

fast I am moving at this moment relative to the ground.

CMG and SMG, on the other hand, are more flexible terms that are used to describe what we compute or anticipate our course and speed would be based on some correction to the knotmeter and compass. The terms are also used in a rather different context to describe the net progress achieved between two times, regardless of compass or knotmeter.

Thus if I steer 200 M at 6 kts with a current of 2 kts on my port beam, then I can solve a vector plot (or compute some other way) to conclude that my course made good will be 218 M and my speed made good will be 6.3 kts. Or in their other context, if I am now 1.0 miles NW of where I started 15 minutes ago, then my CMG was 315 T and my SMG was 4.0 kts, regardless of what route I took or how my speed might have varied along the way.

Keeping these concepts separate will help us distinguish what we are doing (COG and SOG) with what we might have planned. Or when going back over a logbook we can compare what we were actually doing at specific times (COG and SOG) with what we achieved in the end (CMG and SMG).

To further illustrate that we are still struggling with electronic terminology, we only have to look at the VMG (velocity made good) output from our electronic charting systems (ECS). At one point in time VMG was purely wind data—how fast I am progressing upwind or downwind. Now we must be careful. Depending on what brand ECS we have and what options, it could be that, or it could be VMG to the next waypoint, totally unrelated to the wind. Some units only offer one or the other, some offer both. Raytheon Marine calls them VMG-wind and VMG waypoint. Furuno uses VMG (for wind, in tune with tradition) and they use VMC (velocity made course) for the progress to the next waypoint. This VMC is what NMEA calls WCV, waypoint closing velocity, though I have not seen this term at the user interface side. It is what you want to optimize if you are racing, or trying to evaluate one heading vs. another for any navigation reason. VMG (wind) is for sailing performance, not for navigation. In Loran C days, WCV was often called SOA on the output side, for Speed of Advance, but that was simply wrong. It is no longer used.

Before leaving the electronic world, I should point out the difference between an electronic bearing line (EBL) and an electronic range and bearing line (ERBL, pronounced "urbel"). These terms apply to measurement tools on both radar and ECS displays, though the ECS producers are slow to pick up the ball on the terminology. There is no controversy as there is with COG. The IMO specifies the distinction: EBL is measured relative to the boat; ERBL is arbitrary point to point, anywhere on the screen. Some radars refer to ERBL as a "floating EBL," which makes sense, but distracts from the value of a consistent terminology. Hopefully we will see more urbel speak in the future. As it turns out, some ECS and some radar have just one type, while others have both. The latter could easily promote their enhanced options by adopting the preferred names.

The power of the Internet lets us research maritime terms in great detail, in multiple languages, though conventions and preferences are harder to discern. The terms and conventions we use in our online courses can be seen at www.starpath.com/glossary. §

Figure 3. *Course boxes were a traditional way to keep the present course posted for all to see in the cockpit or wheelhouse. Some equivalent remains an asset to navigation on all vessels. Periodically these become available online from decommissioned vessels or antique sellers.*

Hazards of Misinformation

Maritime lore is permeated with high esteem for what is called "local knowledge." It means a kind of information not found in standard references, only known to locals, or to folks who have sailed a particular route many times. It is often considered prize information, and indeed it can be—if there were not value to the concept on some level, it would have fallen from such popular use.

On the other hand, part of sound marine education is learning to make careful evaluation of all input that affects our decision making. We cannot take things for granted without some background, no matter how often they are repeated. Part of the reason to study navigation is to learn what the dependable sources are. *Chart No. 1* to explain the charts and the Coast Pilots to explain navigational concerns not shown on the charts are two basics. The US Coast Pilots and their counterparts for international waters include a wealth of information, often in fine detail, about most waterways around the world.

Beyond the references, we can also prepare ourselves with fundamental knowledge of oceanography and meteorology. Then if we are given some special suggestions or information on navigation we can vet it against on our own knowledge and resources. If the new information is consistent with what is known in standard references, then we have confidence in its use. If it is contrary to what we know, then we must be very careful. In many cases, what is considered local or special knowledge is actually well documented in the standard references, and it is only considered special knowledge by those who are not familiar with the standard references.

Local knowledge can often go astray when someone with experience in one type of vessel projects it onto the needs of another type of vessel. You can go aground on routes that are sworn to be good by those who simply do not know how much water you draw. Another example is the often recommended summertime passage of the West Coast of sailing out 100 miles, then transit the coast, then come back in, which more often than not just adds two days to your voyage as you much enhance your chances of much worse conditions—compared to running right along the coast, just outside the sea buoys.

A famous example related to equipment is the shark that ate the taffrail log, which was repeated so often it became gospel in the minds of many mariners. If you have ever used one, you will know they fray off if not maintained properly, which will look like it was bit off by a fish. This piece of misinformation about the shark has likely contributed to decline in use of these devices, which is a great pity. They are one of the most accurate means of ocean navigation, totally independent of all electrical power, and tremendously dependable—provided they are maintained.

The motivation of this note, however, is a much more tragic story about misinformation. When the Somali pirates murdered four sailors in February of 2011, a New York Times article on the event from Feb 22, 2011 included several quotes about the skipper and crew of the vessel. One of them stated

"…friends said he often turned off his G.P.S. instrument because pirates had learned to use them as homing devices."

We might analyze the nuances of this sentence—something the editors and authors of the article apparently did not do—but that is not the point. It is a clear statement, and it is totally wrong. To what extent this misinformation contributed to the tragedy cannot be known, but we must guard against this sort of thing at all times. It is another shark, eating another taffrail log, just far more serious.

GPS instruments are receivers; they are not transmitters. They do not broadcast anything. They do not communicate with the satellites, they just listen to them. No one can home in on an operating GPS unit on your boat. Turning off the GPS has no affect whatsoever on your being detected by any one, with any kind of equipment; it just makes your own navigation more difficult.

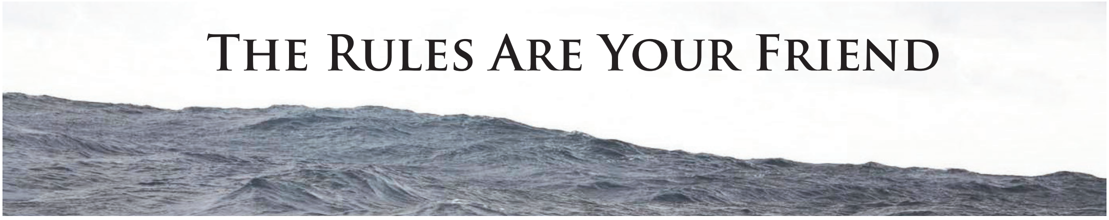
If we were to look for nuances, we might speculate that "G.P.S. instrument" was intended to mean an AIS (automatic identification system), which does indeed broadcast your position, because that is what it is designed to do. But if that were the intended meaning, it would be stretching the sensibility of the rest of the sentence. Nevertheless, the actual published sentence is inexcusably wrong, and its implications were not appreciated.

It is the job of the navigator to question things. If you see a light on the horizon that is not supposed to be there, your job is to not rest until you know what is going on with it. Recall that a third mate (sailing as AB) on the Exxon Valdez told the third mate in charge twice that a light was on the wrong side of the bow, but all records indicate he did not take her seriously. §

Figure 1. *MV* Costa Concordia *run aground off the west coast of Italy January, 2012, relying on the skippers local knowledge of the area.*

Figure 2. *The damaged MV* Cosco Busan *after striking the bridge tower fender. There was a professional pilot on board who is tested on local knowledge to get the license. He also tested positive for a lot of other things after the allision with the bridge.*

The Rules Are Your Friend



The Nav Rules are indeed our friends—they were created with the mission of protecting us from harm. The official name is International Regulations for the Preventing Collisions at Sea, abbreviated COLREGS. In the US, we see these most often in the USCG publication called The Navigation Rules, International – Inland, which we do not exaggerate when calling it the most important book in navigation.

We tend to think of collisions in dramatic images of ships colliding with extensive destruction, not to mention the image we all have of some tragic encounter between sailboat and ship, but the Rules are intended to prevent all collisions, regardless of the damage or injury done. In short, the Rules also serve as a guideline for good behavior at sea that can save us unnecessary anxiety and maybe even save us some money on a bright sunny day when no one is hurt at all.

The point at hand was brought to our attention recently by a local sailor who called to describe an encounter, wondering what their rights were in the circumstance. It is a simple tale with several messages.

There were two sailors aboard a 30-foot sailboat under power approaching a narrow channel known locally as Hole in the Wall on the Swinomish Slough. As they approached the entrance they came up on a 42-foot powerboat pulling a 14-foot runabout on a 60-foot line that was headed toward the entrance, but at a very slow speed.

The sailors decided to overtake the powerboat which they could easily do without slowing down. After they passed the powerboat they found they had to come back in front of the power boat to align for the narrow channel ahead, which they did, and then they slowed down for the approach.

At this point, the power boat decided to increase its speed and in turn over take the sailboat, which it did, but at this point they were all getting closer to the entrance so the power boat had to do precisely what the sail boat did and turn in front of it.

The sailors watched this taking place and both realized that the trailing runabout might not make it past their bow. As they watched this take place, sure enough, the prop of the raised outboard on the runabout carved a nice deep, foot-long gouge in the gelcoat of the bow.

The sailors presumed this was a clear cut case of their rights violated, because a vessel is supposed to stay clear when it passes; but it is not really quite that simple. Essentially every maritime collision involves the violation of at least one Rule by both vessels involved. This fact alone, by the way, is adequate cause for learning and obeying the Rules. If you do so, you are statistically very unlikely to be ever involved in a collision.

In the encounter described we have a series of lessons. First, of course, a sailboat under power is a power boat, so none of the Rules that refer to sailing vessels apply. The initial decision of the sailboat to overtake may not have been prudent. If it were known that it would have to immediately come back in front of the overtaken vessel after passing, then it definitely was an error. Rule 13 requires that you stay clear of a vessel being overtaken, and coming back in front of it and slowing down is not staying clear.

The same applies to the power boat over taking the sailboat. Both were wrong on some level, but the sailboat might argue that it was far enough ahead that its maneuver was reasonable. The powerboat maneuver, on the other hand, was by definition wrong because of the outcome.

But we are still not up to the gouge. Both sailors on the sailboat watched that event develop. They even discussed its possibility. But they did nothing about it. In short, they were observing the risk of collision develop and not responding. The proper response would be 5 or more short blasts on an air horn. This could well have saved them the trouble of this encounter. The power-

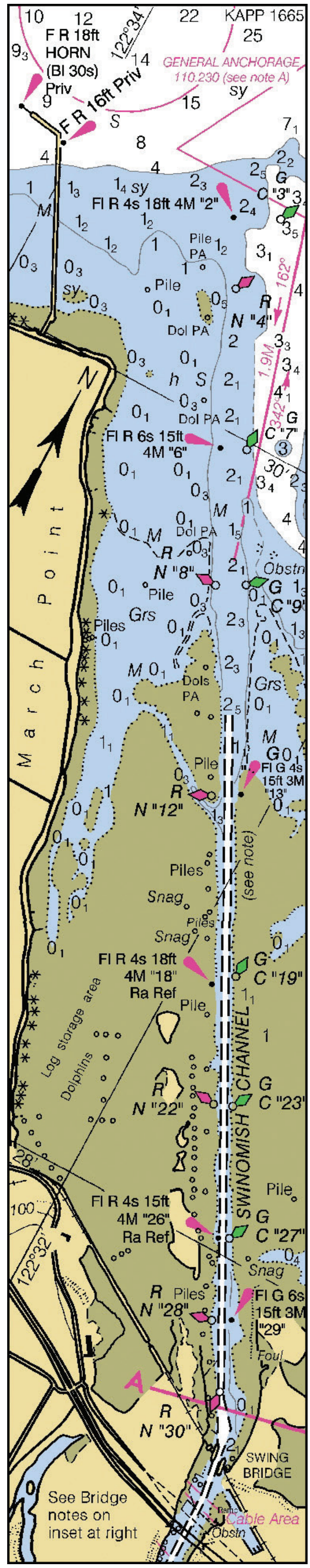


Figure 1. *A popular long narrow channel in the Pacific Northwest that provides frequent opportunity to rely upon the Navigation Rules*

boat was not aware of what was taking place, nor that it even happened.

An air horn at hand for such events would be valuable. We should not sail into any questionable traffic situation without sounding the danger signal (Rule 34d). This rule applies to all vessels; sailboats can use it, just as ships and car ferrys use it.

Rule 34d. When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.

Whenever we do use Rule 34d (called the danger or warning signal) we should also be considering stopping or slowing down. I do not know how fast things evolved in this incident, but that is always a factor in how we respond, which means we need to have our gear (air horns, flares, handheld VHF, handheld lights) in ready reach. It is easy to overlook these basics, whose need could come upon us with very short notice and in the most benign circumstances. The warning signal can also be given with flashes of a spot light, which could be more effective in some circumstances.

In any event, once you sound the danger signal—or certainly when you sound it the second time—you should be slowing down. Think of yourself explaining to the judge that you sounded the danger signal because you thought the situation was dangerous and did not know what was going to happen…. but you kept driving on in to it at the same course and speed.

Study of the Rules is a rewarding pastime, practical and captivating. They constitute a remarkable document with an immense assigned task—the prevention of collisions between a vast array of vessels in a vast array of circumstances: vessels barely visible at 100 yards to vessels the size of horizontal skyscrapers; drifting without power or traveling at 30 knots or more; following unmarked lanes or crisscrossing open waters offering nothing more than an educated guess as to their intended course; in all conditions of weather, clear or fog, calm or storm; and often with no common language between their drivers.

The USCG Navigation Rules book is 224 pages, but the part that covers steering and sailing rules (right of way) is just the 16 rules of Part B—a total of 12 pages. The rest covers important issues of lights, sounds, and general issues. All parts are important and in some ways interrelated, but mastering these 12 pages adds a lot of confidence to your navigation. At www.starpath.com/navpubs we made a pdf of these 12 pages that you can download and mail to your smartphone. Then if you are sitting around with a few minutes to spare you can ponder a few of the nuances, such as the difference between *staying clear* and *do not impede*.

One of the International Rules (Rule 1c) states that "an appropriate authority" can make rules for specific waterways that take precedence over the COLREGS. The US government has done so with what are called the US Inland Rules. These are very similar to the COLREGS in most cases, with a few important exceptions. A new ebook available online called *Annotated Navigation Rules*, highlights all the differences in an easy to interpret manner using color codes. The Canadian government has done so as well for Canadian Waters. A convenient set of the COLREGS with the Canadian modifications clearly marked in red is available as a free download at www.starpath.com/navpubs. An iPhone app for mastering the rules is described at www.navrulesmobile.com. It includes a special terms section that discusses nuances, such as noted above, close quarters, proper look out, and so on. §

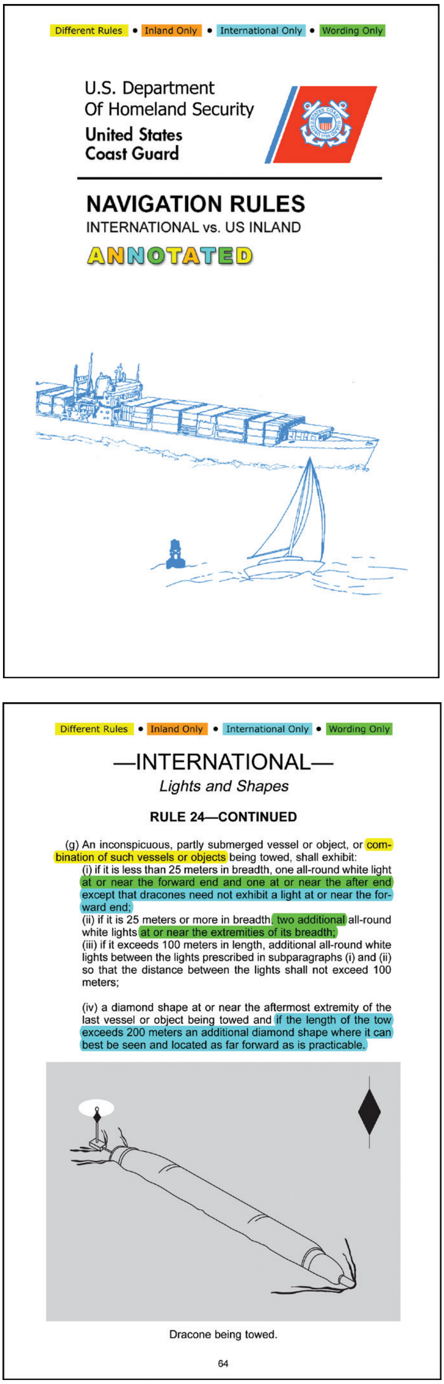


Figure 2. *This ebook publication is an exact copy of the USCG Nav Rules book, highlighted to show all differences between Inland and International Rules. Yellow is used when Inland and International have different rules; orange means it is a rule unique to Inland waters; blue means unique to International waters; and green means the wording is different but the meaning is the same.*

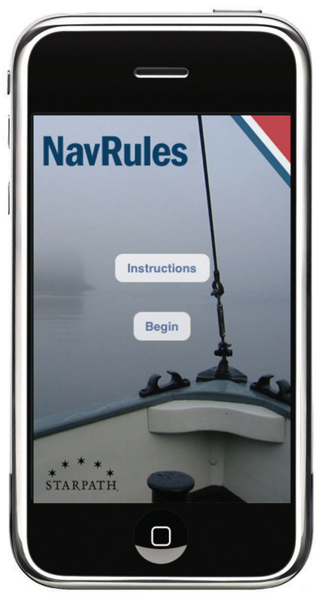


Figure 3. *This iPhone app includes a full set of the rules with related discussion, along with a quiz module that presents the full set of USCG exam questions, with answers linked to the related Rules. It includes several ways to monitor progress and to study questions related to specific rules or specific topics. Details at www.navrulesmobile.com*

Timekeeping in Navigation & Weather

There are a dozen or so timekeeping systems used in navigation and weather, and we cannot avoid using several of them from the nav station. In the end, the main time we care about is GMT, more properly called UTC, or Universal Coordinated Time. All weather data is coordinated and reported according to UTC. In principle, we should all be calling this UTC, not GMT, but GMT is still common.

It is rather like the fact that we should all be using the metric system for these two subjects—it is in fact U.S. law that we should—but no one does, and no one complains.

Universal Coordinated Time (UTC)

UTC is the world standard time system used by all nations to coordinate weather and navigation information. It corresponds to the time used in Greenwich England for half of the year, formerly called Greenwich Mean Time. The town of Greenwich actually switches to daylight saving time in the summer, but all scientists and navigators continue with UTC. The official UTC system (like GMT) does not employ any form of daylight saving time.

Since all weather maps and GPS information use UTC, it would seem we would want to keep our watches and ship's clocks on UTC for convenience. It turns out this is not very convenient in practice. For daily activity—at home or underway—it is much better to have our clocks reading close to what we are used to, which is often referred to as local time.

Local time, however, is a nebulous term—when used, it should always be followed up with the definition of what we mean. There are two basic times it could mean. Local time could be the local standard time or it could be the local zone time. To confuse matters a bit, local time is also sometimes used in phrases such as Pacific Time, which is intended to be Pacific Standard Time in the winter and Pacific Daylight Time in the summer—the one phrase covering both, depending on the season.

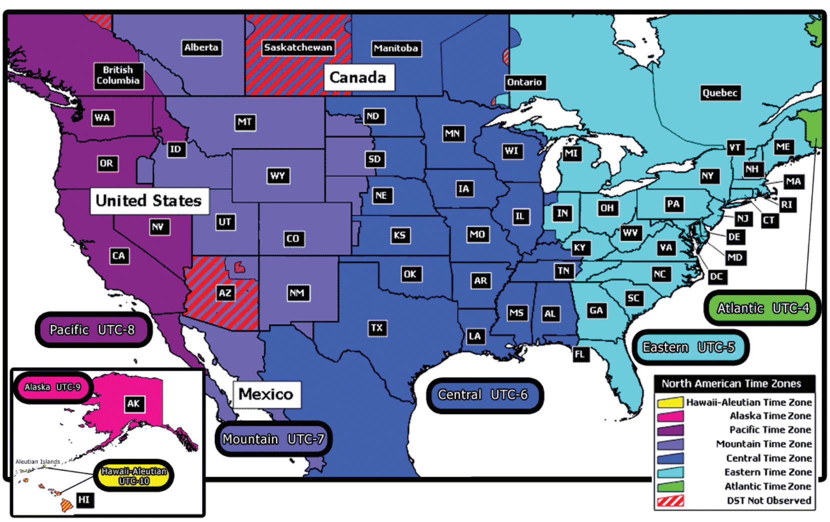


Figure 1. *North American time zones from nist.gov. That site, along with time.gov, is a good source for various aspects and history of timekeeping.*

Zone Time (ZT)

Zone time is by far the most precise of the several local times. It is the one that commercial ships and navies use when crossing an ocean—and that we all use when sitting at the USCG office taking a license exam! Zone time is determined

entirely by the longitude of your vessel at the time you record it. It will differ from UTC by a whole number of hours called the zone description (ZD).

In this time system, the world is divided into 24 time zones, each 15° wide, centered at the standard meridians, which are the longitudes that are multiples of 15 (e.g. 0, 15, 30, 45....165, 180). The borders between time zones thus take place at 7° 30′ on either side of the standard meridians.

The only exceptions are the two zones (ZD = ±12) on either side of the International Date Line, which are only 30 minutes wide (7° 30′ of longitude).

If you are keeping zone time (ZT), then you can find UTC from:

UTC = ZT + ZD, where, again, the ZD is determined by your longitude. This formula is the one that determines (or helps you remember) the sign (±) of the ZD. If your location is slow on UTC (e.g. any west longitude), then the ZD of that location is +. Eastern longitudes have negative ZDs.

To find the zone description of any particular longitude, round the longitude off to the nearest whole degree, divide by 15, and then round the result off to the nearest whole hour.

Zone time never uses daylight saving time. It is used worldwide. Zone time is never used in civilian matters; it is only for ocean navigation. One could argue that official NOAA Tide and Current Tables are given in what is essentially ZT, but we are more likely to use a reproduction of these, which converts the times to standard times.

Standard Time (EST, PST, ETC.)

Standard time is the time system used for civilian matters and for near coastal and inland navigation. Some coastal weather forecasts specify the local standard time in addition to the UTC of the report. Standard time is essentially the local zone time modified by politics and geography, and then susceptible to changes for daylight saving time.

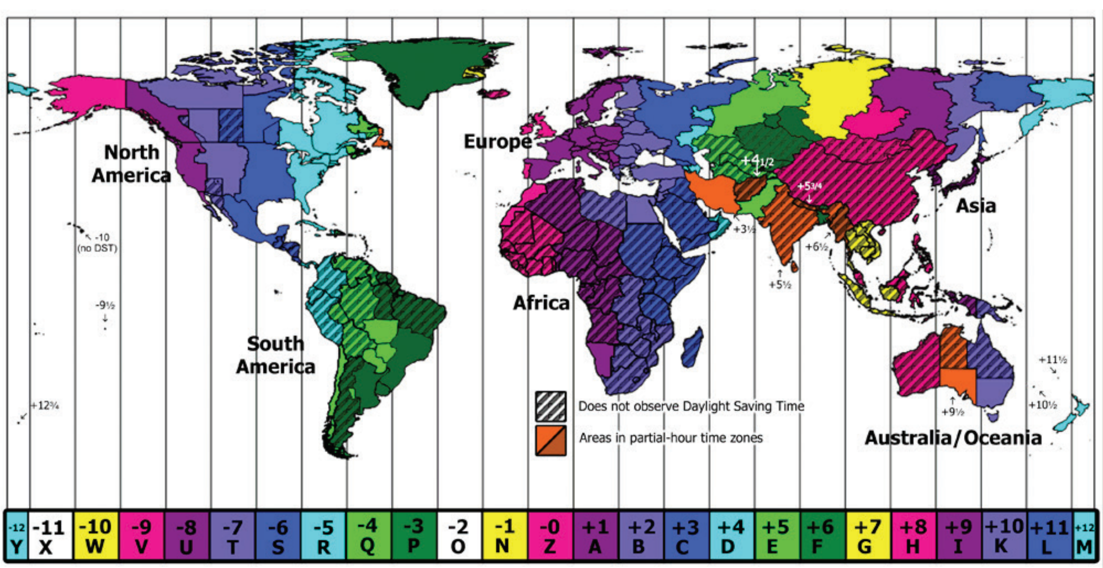


Figure 2. *Gray lines and bottom labels define zone time zones; the boundaries shown define standard time zones. Unfortunately, this nice graphic from nist.gov has the time zones labeled in the landsman's convention. The navigator's ZD of the U.S. West Coast is +8, not -8. Since Zone 0 (UTC) is labeled Z, UTC is often called zulu time, and noted (e.g. 1200z). We'll leave it to those interested in history to discover why there is no J zone (there was a reason). And if you want to ask trick questions on your navigation tests, note that ZD +12 and ZD -12 are just 30m wide, not the normal 1h.*

Standard time zones do not follow longitude lines rigorously as do the zone-time zones, but they will often be approximately along those lines, diverting to follow state and country boundaries, or maybe a river flow. We still speak of the zone descriptions of standard zones in the same way as zone times—namely, Eastern Standard Time (EST) has ZD = +5. Eastern Daylight Time would be ZD = +4, and so on. In other words, we would have UTC = EDT + 4h.

A complexity arises because standard times are often described outside of marine navigation circles as, for example, EDT being 4h behind UTC or slow on UTC. This leads to writing EDT = UTC – 4h. This is the same equation (with sides swapped), but in this line of thinking the time zone is described or labeled as -4h. Thus we often see computer and smart phone apps using reversed signs for the time zones, so we have to keep an eye out on this detail.

Watch Time (WT)

Watch time is the practical solution to timekeeping in navigation and weather. It is simply the time on your watch. To navigate by WT, I simply need to know the zone description of my watch. If I happen to have my watch set on Pacific Day light Time, that would correspond to ZD = +7. Thus, the ZD of my watch is +7 and that is all I need to know, no matter what longitude I am at as I cross the Pacific.

No matter where I am in the world, I find UTC by:

$$\text{UTC} = \text{WT} + \text{ZD}.$$

This is by far the best way to navigate, and we should always do so unless we are compelled to use ZT by labor laws, unions or some government regulation. It is easy to see that if you work day and night on ocean crossing vessels, you would want some semblance of order to your daylight and meal times, which would justify changing the ship's clocks each time you cross a time zone.

On a private vessel, however, this time changing just adds tremendous confusion to your weather and navigation. It is much better to just live with the fact that mid-day might be 2pm on your watch by the time you arrive—or you can choose to set it ahead before you leave. In other words, you go an hour or two off local time as you proceed, but that is not distracting. To minimize timekeeping errors, do not change your watch time when underway. Wait until you arrive.

Chronometer Time (CT)

For completeness, we include here also the very worst type of timekeeping—the one called Chronometer Time. This is UTC kept on a 12-hour watch face, without specifying AM or PM! Absolutely no one in the world would consider using such a time system—that is, almost no one. This is the time system used on USCG celestial navigation exams. It is the way they help support navigation schools, and we are grateful to them.

I should add that there are several forms of Universal Time and the conventions on terminology and abbreviations have not settled in yet, which is why so many folks hang onto GMT. The time that is equivalent to GMT is officially called Coordinated Universal Time, Type 1, and abbreviated UTC1, though this formal terminology is not often seen in navigation or weather resources. This is usually abbreviated as UT (*Nautical Almanac*) and UTC (NOAA weather maps). Some weather maps and forecasts also use the abbreviation Z (zulu) to mark a UTC, as we used to do for GMT. Thus, when we see a map valid at 1200Z it means 1200 UTC.

There are other time systems that have implications on navigation and weather, but only indirectly. These include the Julian Time system used by astronomers to keep track of an absolute time stamp for events in the past and future and the Solar Time system used to keep track of time relative to the time the sun crosses your meridian. The latter was used commonly in the old days of navigation, but no longer, though it still comes into play when predicting the passage times of weather satellites in sun-synchronous orbits. §

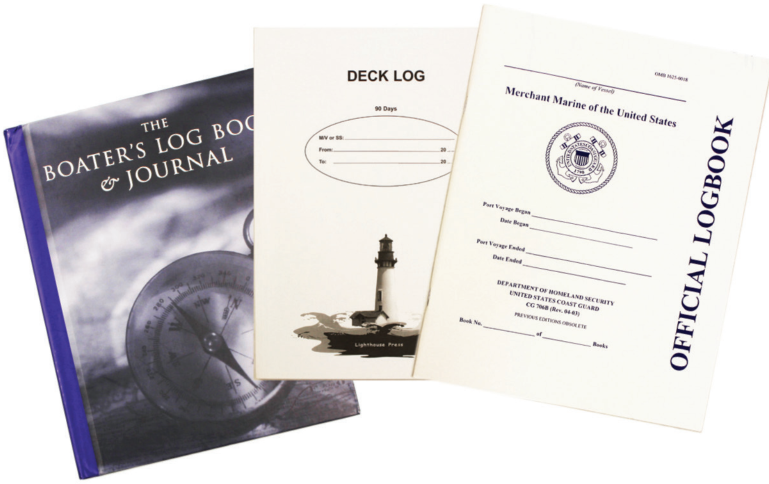
Logbook Procedures

Navigators and vessel owners usually have set ideas about logbooks and record-keeping underway. They vary from the most formal (pondering the notion of the ship's log as a legal document) on down to none at all (pondering… or rather, not pondering anything). A visit to Captains Nautical Supply store today found some two dozen logbook options for sale, varying from 2 x 3 inches in size to almost 2 x 3 feet in size. The preprinted forms included varied from blank lined pages to amazingly complex patterns of forms and tables to be filled in.

The choice inevitably has to be personal, but I offer here some guidelines to what has worked for me and then come back to the legal matters alluded to above. For an ocean voyage I typically have three logbooks. One is the ship's log, or deck log, which is the normal logbook referred to above. Every vessel should have one of these for all voyages and day sails. This is best done with some structured layout in a bound book. We will come back to what goes in it, and when, and why. To this basic logbook, I like to add a weather logbook and a third bound book, which could be called a notebook or a logbook.

The weather log is for transcriptions of voice broadcasts or a place to paste printed forecasts or maps, and generally a place for notes about the weather. This can be just a blank notebook. Numbered pages are nice for cross reference. Make entries sequentially from the front, and record the date at the top corner of the page. Try to avoid setting up some coded system of starting a new section in the back. Dated pages in sequence are always best. It will grow to be one of your most important books. Even on a day sail or race, you will have a set of VHF weather reporting stations you care about. You can record these in the broadcast sequence and record the reports in columns to watch how things change throughout the day. Remember the Marine Weather Service Charts explain all weather resources in your area along with their schedules (see www.starpath.com/navpubs). You can also make notes on your own observations related to weather that are too specific or personal for the ship's log. It can also be the place you make a time schedule of when various reports and forecasts are available for quick reference so you don't miss any. This is a deceptively challenging task, discussed in depth in the book *Modern Marine Weather.*

The third book is a navigation journal of sorts. A place to do all general reckoning related to the navigation of the vessel. In other words, do



not use scrap paper. All computations go in this book, no matter how simple—if something ends up not making sense, the paper trail can be helpful. Also record your observations and insights along the way that improve your navigation. Navigation knowledge proceeds much faster with a written record. You may learn some trick about radar tuning, or how far you can hear a buoy gong in certain sea state, etc. When you do a piloting fix there are always pertinent notes that can be added to describe it. At the end of the voyage you can then go back over what you learned. Sometimes I find these books that are 20 years old and discover when I first learned something that I now take for granted—or relearn something I had forgotten about. Though I discovered the value of this extra logbook by experience, I have since learned that the US Navy uses the Navigation Workbook (OPNAV 3530) for exactly the same purposes, so this has proven value in prudent navigation.

This book need not be for navigation alone, it could be for other matters of seamanship you picked up on the voyage. I recorded once, for example, a fantastic knot that I learned from an experienced sailor, and to this day I have never seen that knot in any other book. Again, sequential entries from the front with dated pages are best.

If you sail on a race boat with a lot of crew, boldly mark your notebooks "DO NOT USE FOR SCRAP PAPER," otherwise you will find pages torn from them at random.

The ship's log, however, is the main point at hand. The bare minimum it should include is time, date, position, course, and speed, entered every 4 hours or so. A more appropriate and useful log would include more columns and be entered more often.

The design we use (www.starpathpublications.com) is two-up letter size pages with 30 numbered rows. Columns on the left hand page include Date, Time, Log reading, Tack, Course (compass), Speed (knotmeter), Lat / Lon, and then 3 columns without headings for your choice of data. The usual ones I use here are COG, SOG, and WCV (waypoint closing velocity), which may have different names depending on your GPS model. In some cases you might want to change this to VMG, which is progress relative to true wind direction. The thin column for tack (P or S or M for motor) would seem redundant with the wind and course data we have, but it is still often referred to. It is best to record actual compass course and knotmeter speed (instead of just COG and SOG) because these are the data you will need to check your previous DR if you end up without GPS.

On the right-hand side we number the rows again 1 to 30 and the columns are Apparent wind speed, Apparent wind angle, Barometer, and Comments. We also ask that the person filling in the log put their initials in the Comments column or beside it. If you have true wind instruments and are confident they are working properly, you could record true wind instead of apparent.

The comments could be weather or sea state notes—these are ones related to the navigation at hand, as opposed to general matters of weather and forecasts in the weather log—sails set, when you charged the batteries, if you sight or speak another vessel, fridge or freezer temperatures, etc. Sailing anywhere near the Gulf Stream or similar currents around the world, the sea water temperature would be another key factor to log. I have never recorded or found much use for air temperature outside of the Arctic, but the full picture would include the outside air temperature. Certainly if you are sailing in very high latitudes, the air temperature becomes crucial.

When to enter the log is easy. Make an entry anytime something changes. An average steered course change of 5° is a lot, and calls for an entry, as does a change of speed by a knot or so. Racing sailors tend to make an entry every hour, which is helped by the numbered rows. If not entering on the whole hour, record the time in the row with the nearest hour. This way the several watches can carry out distance made good contests per hour or per watch. When cruising it would be unlikely to enter every hour, but on any voyage the rule is at least every four hours, even if nothing changes, and if something does change make an entry. Keep in mind that if all your electronics fail, your latest logbook entry determines your navigation knowledge. In an emergency or near landfall you will be happy to have this be recent data.

You will also find that in doing weather analysis underway it is crucial to have a log entry at the synoptic times of 00, 06, 12, and 18 GMT, which are the times the weather maps are valid. Then you can compare your barometer and wind with the weather maps. You might set your watch alarm to remind you in local time when these entries should be made. Remember, too, the free service Starpath offers to provide you with live weather data at sea from ship reports. Send an otherwise blank email to shipreports@starpath.com with the word "help" in the subject line to learn about the service. With this you can get all the ship reports within 300 miles of your (or any) position over the past 6 hours. Do this an hour or so after synoptic times to check your barometer and weather maps. You can also read about this at www.starpath.com/barometers.

If you are on a route to a foreign port in a vessel of any size, or your vessel is over 100 T in local waters, then 46 USC §11301 (ecfr.gpoaccess.gov) explains the legal requirements for logbooks, which are indeed rather elaborate, though the regulations are addressed mostly to safety issues, along with the makeup and behavior of the crew. Specific types of vessels have specific logbook entry requirements, although navigation entries are not addressed. Logbook procedures for Sailing School Vessels, for example, are covered in CFR 46 §169.841. We learn from all these required procedures that we might want to include in our non-required logbooks a couple of pages to list:

• Departure and destination

• Documentation or registration number of the vessel

• Draft of the vessel

• Names and nationalities of all crew members. (If you are sailing into foreign waters you should also know if any has been convicted of a crime.)

• List of the safety drills and inspections you have carried out, station bills established, and a statement that all crew members have been in-