

Tackling Shipping Traffic with AIS

The latest navigator's electronic tool gets a serious workout near the Dardanelles.

By JOE MINICK

It's been several years since the Automatic Identification System (AIS) became a mandated way of life for the commercial side of the marine industry. We added an AIS receiver to the nav station aboard our Mason 43, *Southern Cross*, when one came on the market, and after using it for the last three or four years in some of the most heavily traveled waters of the world, it has become one of the more valuable electronics onboard.

Where once we relied on radar and a good set of field glasses—and still do—AIS has added a whole new dimension to collision avoidance. Yet, it's not uncommon to hear statements like AIS “is only useful in the open ocean” and other questionable arguments for ignoring its potential as a safety tool. So, in this report, we take an inside look at the value of operational AIS for the rest of us.



AIS targets clutter Southern Cross' plotter as it starts its passage across the southern approaches to the Dardanelles. The planned route is shown in red, and none of these vessels are in sight yet, but there is already a conflict, shown in red, approaching from the south. Still time to get some planning done.

AIS OVERVIEW

In a nutshell, AIS is a seemingly simple system that transmits dynamic information about a vessel's speed, course, and position plus static information including the vessel's name, call sign, and Mobile Maritime Service Identity (MMSI) number over marine VHF frequencies (see table page 14). AIS receivers listen for that information as it's sent by any AIS transceiver-equipped vessels that are in range, and AIS transceivers transmit and receive the data.

In actual practice, it's far from simple. A fair bit of effort went into developing a protocol for a shipboard system, without any central control, that can manage data transmissions by an unknown number of vessels that appear and disappear at random. The result was a self-managing network that alternately transmits on two VHF channels, known as AIS 1 and AIS 2, using

a system of automatically assigned time slots to prevent one vessel's transmission from blocking another.

Initially, there was only a Class A AIS system intended for larger commercial vessels, but the recent introduction of a Class B system for small craft that do not need to meet the International Maritime Organization's (IMO) AIS requirements has changed the landscape significantly. The two systems are operationally similar but include important differences that affect the operational aspects of AIS interpretation. Most notable are the differences in transmit power, the type of data transmitted, and the requirement for Class B AIS to avoid interference with Class A systems.

OPERATIONAL FACTORS

AIS is a tool to reduce the hazard of collision with another vessel, and from

All photos by Joe Minick, unless noted

MMSI	Name	Course	Speed	CPA	TTP
211000000	NAVIGATOR	270	10.0	0.20	1.0
211000001	NAVIGATOR	270	10.0	0.20	1.0
211000002	NAVIGATOR	270	10.0	0.20	1.0
211000003	NAVIGATOR	270	10.0	0.20	1.0
211000004	NAVIGATOR	270	10.0	0.20	1.0
211000005	NAVIGATOR	270	10.0	0.20	1.0
211000006	NAVIGATOR	270	10.0	0.20	1.0
211000007	NAVIGATOR	270	10.0	0.20	1.0
211000008	NAVIGATOR	270	10.0	0.20	1.0
211000009	NAVIGATOR	270	10.0	0.20	1.0
211000010	NAVIGATOR	270	10.0	0.20	1.0
211000011	NAVIGATOR	270	10.0	0.20	1.0
211000012	NAVIGATOR	270	10.0	0.20	1.0
211000013	NAVIGATOR	270	10.0	0.20	1.0
211000014	NAVIGATOR	270	10.0	0.20	1.0
211000015	NAVIGATOR	270	10.0	0.20	1.0
211000016	NAVIGATOR	270	10.0	0.20	1.0
211000017	NAVIGATOR	270	10.0	0.20	1.0
211000018	NAVIGATOR	270	10.0	0.20	1.0
211000019	NAVIGATOR	270	10.0	0.20	1.0
211000020	NAVIGATOR	270	10.0	0.20	1.0
211000021	NAVIGATOR	270	10.0	0.20	1.0
211000022	NAVIGATOR	270	10.0	0.20	1.0
211000023	NAVIGATOR	270	10.0	0.20	1.0
211000024	NAVIGATOR	270	10.0	0.20	1.0
211000025	NAVIGATOR	270	10.0	0.20	1.0
211000026	NAVIGATOR	270	10.0	0.20	1.0
211000027	NAVIGATOR	270	10.0	0.20	1.0
211000028	NAVIGATOR	270	10.0	0.20	1.0
211000029	NAVIGATOR	270	10.0	0.20	1.0
211000030	NAVIGATOR	270	10.0	0.20	1.0
211000031	NAVIGATOR	270	10.0	0.20	1.0
211000032	NAVIGATOR	270	10.0	0.20	1.0
211000033	NAVIGATOR	270	10.0	0.20	1.0
211000034	NAVIGATOR	270	10.0	0.20	1.0
211000035	NAVIGATOR	270	10.0	0.20	1.0
211000036	NAVIGATOR	270	10.0	0.20	1.0
211000037	NAVIGATOR	270	10.0	0.20	1.0
211000038	NAVIGATOR	270	10.0	0.20	1.0
211000039	NAVIGATOR	270	10.0	0.20	1.0
211000040	NAVIGATOR	270	10.0	0.20	1.0
211000041	NAVIGATOR	270	10.0	0.20	1.0
211000042	NAVIGATOR	270	10.0	0.20	1.0
211000043	NAVIGATOR	270	10.0	0.20	1.0
211000044	NAVIGATOR	270	10.0	0.20	1.0
211000045	NAVIGATOR	270	10.0	0.20	1.0
211000046	NAVIGATOR	270	10.0	0.20	1.0
211000047	NAVIGATOR	270	10.0	0.20	1.0
211000048	NAVIGATOR	270	10.0	0.20	1.0
211000049	NAVIGATOR	270	10.0	0.20	1.0
211000050	NAVIGATOR	270	10.0	0.20	1.0

The target page is intimidating, with 51 targets displayed in the left panel. Columns show the age of the last update, CPA predictions, and more for each target. More information for the highlighted target is shown in the center panel, including collision potential, detailed CPA predictions, MMSI, call sign, and dynamic information. The right panel displays set parameters, including alarms, track lengths, and other display options. In these crowded waters, the Minicks use a CPA separation of 1 nautical mile as the primary alerting parameter, with separation time deliberately set to an equivalent lower value.

AS	VALUE GUIDE	AIS TYPES COMPARED	
MAKER	AIS-A	AIS-B	
TRANSMIT POWER	12.5 watts	2 watts	
DYNAMIC POSITION REPORTS	Transmitted every 2-10 seconds, determined by vessel's speed	Transmitted every 30-180 seconds, determined by vessel's speed	
MMSI NUMBER	Yes	Yes	
NAVIGATIONAL STATUS	Underway using engine, not under command, at anchor	No	
RATE OF TURN	Yes	No	
SPEED OVER GROUND (KNOTS)	Yes	Yes	
TRUE COURSE OVER GROUND	Yes	Yes	
TRUE HEADING	Yes	Yes	
POSITION ACCURACY	Yes	Yes	
LONGITUDE AND LATITUDE	Yes	Yes	
UNIVERSAL TIME (UTC) WHEN MESSAGE WAS SENT	Yes	Yes	
COURSE OVER GROUND	Yes	Yes	
Transmitted every 6 minutes			
STATIC DATA	MMSI number, IMO number, radio call sign, vessel name, vessel type (cargo, etc), vessel dimensions (meters), vessel draft, destination, ETA at destination, type of position device, location of reference point for the reported position (GPS antenna)	MMSI number, radio call sign, type of vessel, vessel's dimensions, location of the reference point on the vessel for reported position (GPS antenna)	

OCEAN TESTED

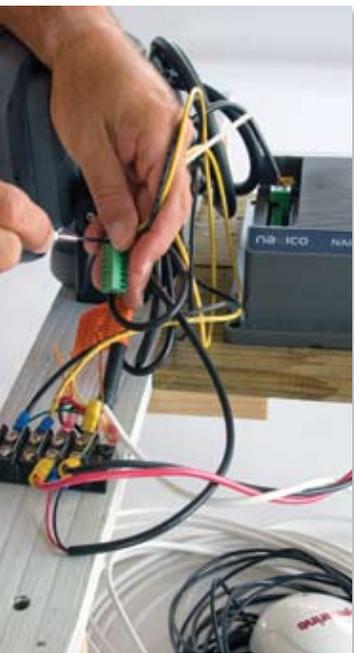
a small-boat standpoint, this basically means not placing your vessel in the path of another. Both the International Regulations for Avoiding Collision at Sea (commonly called COLREGS) and the U.S. Inland Navigation Rules spell out the maneuvers required of all vessels when avoiding collision. Correctly interpreting AIS information to accomplish this requires a working knowledge of AIS characteristics.

From an operational standpoint, it's useful to have an understanding of the timing and content of messages that AIS transceiver-equipped vessels transmit. However, the format and presentation of the information you actually see is determined by the type of display you are using on your own boat. This can be a simple textual display of the transmitted data, a radar-like display with the range and bearing of AIS targets, or a more detailed view of traffic displayed directly on a digital chart, complete with past tracks and course predictors.

AIS transmissions can be received using standalone AIS receivers. The characteristics of an AIS receiver may not be the same as those used with certified AIS systems, and it's important to know what, if any, differences you might encounter with a specific receiver. Some AIS receivers can receive only on one AIS channel at a time, even though you may be able to select either channel for use. AIS transmissions are sent by alternating between the two AIS channels, so a single-channel receiver will only receive every other message sent. The result is slower updating of any target's position as it moves. Also, depending on make and vintage, some AIS receivers cannot decode and display information received from the newer AIS-B systems, so these vessels won't show up on the display at all.

In day-to-day operation, there are significant differences between radar and AIS traffic displays, and it's a mistake to think that AIS is an acceptable substitute for radar. Obviously, rocks and obstructions never transmit AIS information, but neither do military vessels and a high percentage of the world's small craft.

AIS-A transmits more frequent dynamic reports, navigational status, and substantially more static data than AIS-B (above). We tested the AIS-B transceivers from Navico (left) and West Marine (below) for the September 2009 issue.



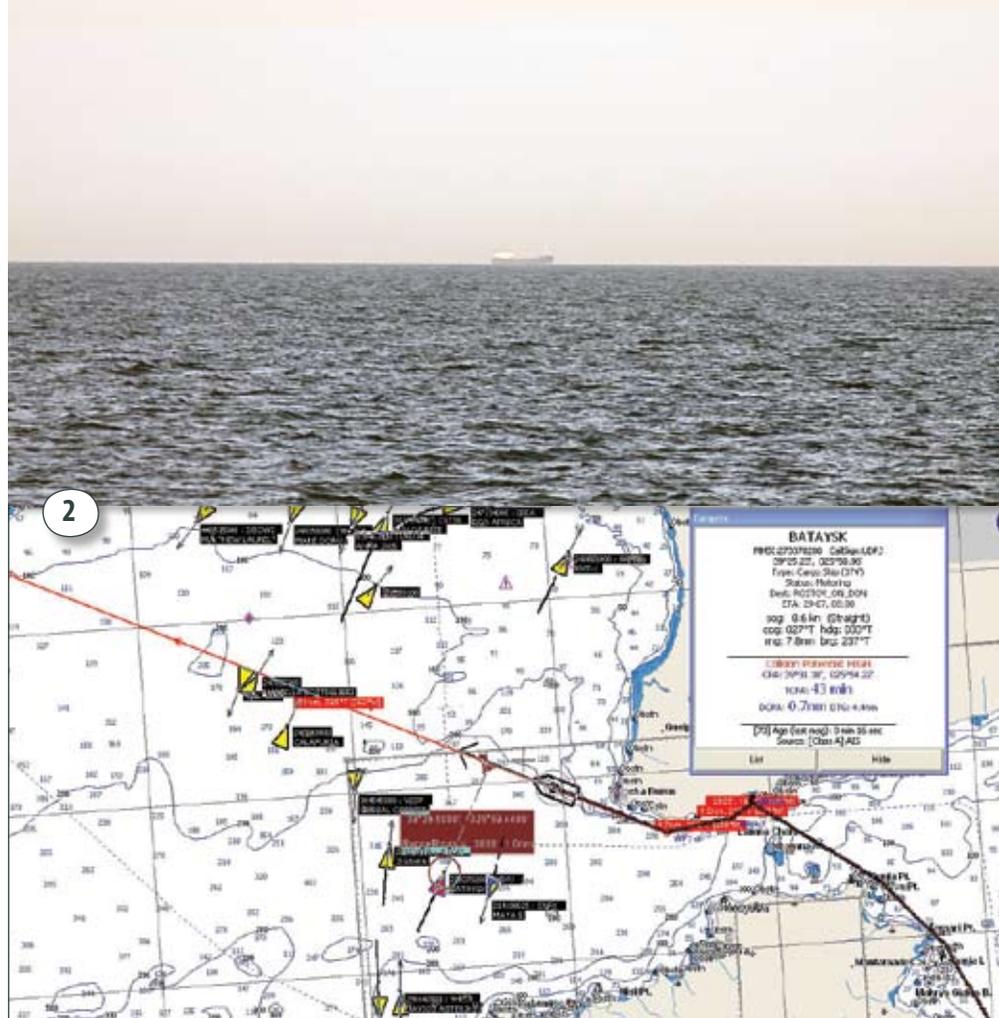
Photos by Al Herum

System integrity is another consideration. If your onboard radar system is functioning normally, it will provide you with information about any target that can reflect radar frequencies. On the other hand, even though you have a fully functional AIS device, you are still dependent on the messages transmitted by other AIS devices, and they do fail. We have seen several instances of intermittent or just plain missing AIS transmissions from larger commercial vessels that were presumably required to have operational AIS installed.

AIS does have several advantages that truly enhance collision avoidance. It can track multiple targets in an active seaway without suffering loss of lock or confusion between targets, a common problem with the Mini Automatic Radar Plotting Aid (MARPA) feature found on many small boat radar systems. Course changes made by other vessels are seen almost as soon as they occur, and track lines created from earlier position reports are useful when estimating possible future course changes. Information about the ship's size, radio call sign, and MMSI can be used if contact with another vessel is needed to ensure safe passage, and rapid updating of the closest point of approach (CPA) is very helpful in rapidly changing conditions.

Unlike radar, when a vessel being tracked by AIS moves out of range, the last message received is still in use, and unless provision is made to remove it, the target vessel continues to be displayed in the last known position even though it may be miles away at the time. The last known speed and course are still available, so the relative motion of your own vessel produces very realistic-looking figures for the CPA calculation and may even trigger a warning of a potential collision with this ghost vessel as you approach. The clue to detecting this phenomenon is the time stamp included with each update that indicates how old the last message really is.

Operating on VHF frequencies limits the AIS system to line-of-sight communication, but the actual range has proven to be more than was initially



The first conflict is now identified as the merchant vessel Bataysk. The boat's icon is shown in red on the display to alert the crew to a potential collision. A tracking window has been opened to display continuously updated information about the target where the CPA is shown as a 0.7 nautical miles crossing situation. The crossing geometry displayed by brown arrows and co-located points on both tracks indicates that the Minicks will cross in front of this vessel before reaching the CPA.

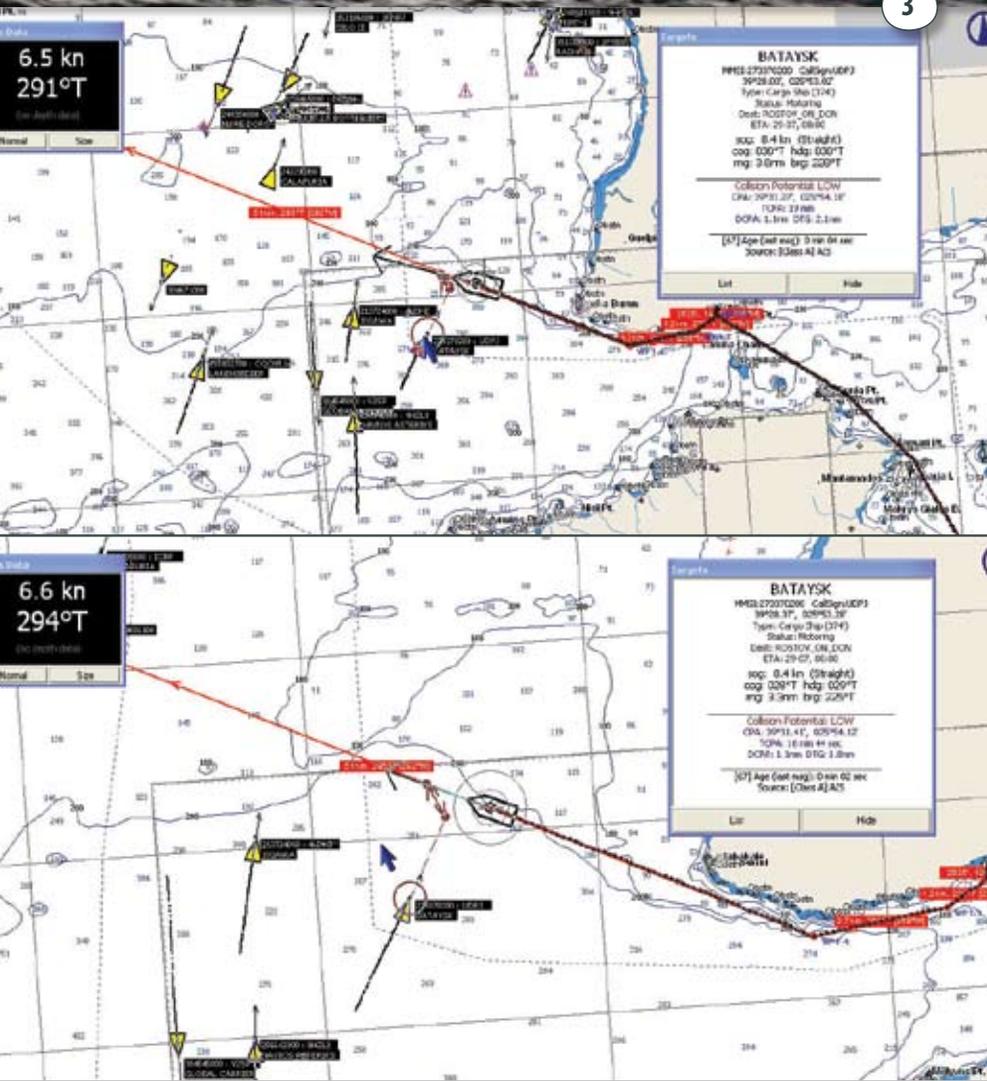
expected by many users. Traffic can easily be seen at 20 to 25 miles with a stern-rail mounted antenna, and a useful range of 60-plus miles isn't uncommon with a higher masthead antenna. Obstructions are also less of a factor than might be expected. Transmissions from AIS-equipped vessels can often be received even when the signal path appears blocked by higher terrain and other obstructions.

PUTTING AIS TO WORK

The messages broadcast by AIS-equipped vessels contain the raw data, but there's still a fair bit of processing required to convert this into information that can be easily used to assess the potential conflicts with other ships. The most critical work is constantly calculating the closest point of approach

between your vessel and others in your area. The CPA is often expressed in several formats including your predicted position at the CPA (lat/long), the distance, bearing, ETA to this position, and the all-important estimate of the distance or clearance between your vessel and the conflicting vessel.

Once the CPA has been computed, the display system can use this information to help you better assess the situation. Visual and audible alarms can alert you to potential conflicts that are still miles away, allowing early adjustments in course and speed to resolve the conflict. The rapidly updated CPA shows the results of any adjustments in course and speed made by either vessel, but it's equally important to recognize that the CPA is only a prediction and requires careful monitoring.



With an increase in speed, the Minicks increased the crossing distance, and the distance at the CPA is shown as 1.1 nautical miles, which now occurs a bit further along their path, after they have crossed the other vessel's predicted track. The crossing geometry has been more clearly defined by zooming in on the display (bottom).

The display software determines how the CPA is displayed, and it's important to understand exactly what format is being used and what it's telling you. Confusing the distance to the CPA with the separation predicted at the CPA could be disastrous. A potential problem exists with CPA information in the more standard formats. The location of the CPA and the separation distance don't convey enough information to accurately determine the relative geometry of the two vessels at the CPA.

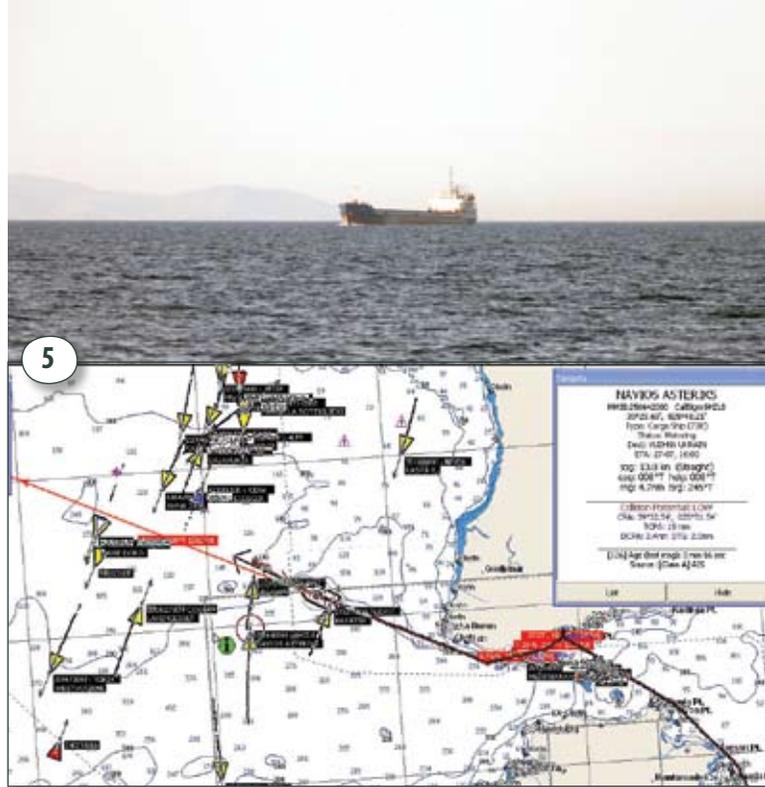
With a typical chartplotter display, it may be possible to see the relative positions of the two vessels when passing abeam, but a crossing situation can still be difficult to assess accurately. For the prudent skipper, crossing a mile or so behind a fast-moving merchantman might be acceptable but crossing ahead of one would certainly get your attention under the same circumstances. Some display systems include special functions to show the crossing situation at the CPA, and if you are planning a new installation, consider choosing one with this capability.

Whether you display AIS information on a dedicated display, a chartplotter, or PC, there are still several setup options that determine how and what you actually see. Inevitably, these are set to default values by the manufacturer, so the system will be functional when first installed, but accepting these default values without being aware of their implications can lead to a serious misunderstanding of what the system is or isn't telling you. Setup parameters and options can vary somewhat, but all need to be considered carefully.

Automatic purging or removing of targets that are no longer updating is a feature that solves the problem of lingering images of vessels that are no longer communicating with the AIS network. The user can often decide whether to enable this function and input how long to wait after the last update before purging takes place. However, you should understand the potential consequences when making these choices. If this feature is dis-



After a few brief moments in the ship's crosshairs, but still keeping a safe distance, they're across. The actual range when they crossed the other vessel's bow was greater than 1.5 nautical miles. They've reduced speed to keep a little in the reserve, which has shortened the predicted CPA to 1 nautical mile, but they are now going safely away from the Bataysk.



With the first conflict resolved, the next vessel approaching from the south is now displayed in the tracking window, showing a predicted CPA of 2.4 nautical miles. They will cross well ahead, according to the plot. Time to start planning the next move as two more potential conflicts, shown in red, are approaching from both sides of the intended track.

abled, the update times must be manually checked to determine the age of the target's transmission, a time-consuming task in heavy-traffic areas. If it's enabled and updating is lost for any reason, including a system failure, the target will no longer be displayed, even though it could potentially remain a serious threat.

It's also possible to request that the system not display stationary vessels or vessels whose speed is less than a selected value. This has some value in removing clutter from an overloaded display but requires an understanding of the potential for unexpected surprises when this feature is enabled. These vessels will still be there even if you aren't seeing them on the display. When closing the shore to clear a busy channel on a dark night, the lights of moored vessels along a busy shoreline can be easily overlooked. In busy areas, tugs, fishing boats, ferries, and others get underway at random. Many will be broadcasting AIS messages that can provide valuable insight to the local situation.

ALARM SETTINGS

Alarms can usually be configured to alert you to potential conflicts with other vessels. Inevitably, the parameters required to trigger an alert are based on CPA calculations that are compared to values input during system setup. These parameters should be chosen with care and with the understanding that you will probably need to adjust them occasionally to fit the area you are navigating through. Understanding exactly how these alerts are generated on your system is essential.

The most common approach requires the user to input a minimum separation distance and/or time at the CPA. Once this is done, any time the predicted CPA is less than the selected value, the alert is given. This method has the advantage of warning the crew of a potential conflict while the vessels are still miles apart rather than waiting until the minimum CPA is reached. Not all alarm functions are alike, and a working knowledge of the alarms included with your specific system is a must.

Consider the alarm parameters with

care. If you don't have the ability to determine the exact geometry of a crossing situation select a distance that you would be comfortable with when crossing ahead of another vessel, double it, and then still worry about it. It's easy to get closer, but it's surprisingly hard to increase your separation in the last mile or so. Keep in mind that the CPA is only a prediction and has a way of changing, usually for the worse, as you close with other vessels.

AIS UNDERWAY

To examine the full potential of AIS, we put it to use crossing traffic in an area near Turkey's Dardanelles Strait that is known for unusually heavy traffic, but devoid of any traffic separation scheme to regulate its flow.

Although there were some predictable routes, i.e. a northerly or southerly flow, vessels can be found traveling in almost any direction through this area. The crossing was made with good visibility, with a constant lookout on deck, and a radar watch supplementing the AIS device. SOBvMAX charting soft-



Even under clear skies and calm conditions and with the aid of both AIS and radar, the unpredictable flow of heavy traffic headed in and out of Turkey's Sea of Marmara (top) provided a nerve-straining exercise for PS contributors Joe and Lee Minick. The couple cruise a Mason 43 (lower right), and are currently based in Turkey.

ware with AIS capability (reviewed in October 2007 issue) running on an onboard computer was used to display AIS targets received from a single-channel AIS receiver. The software's ability to display crossing geometry at the CPA proved to be invaluable. A 4-foot long AIS antenna was rail-mounted 8-feet above the waterline.

PUTTING IT ALL TOGETHER

The sequence of photos on these pages shows the view from deck and near simultaneous images from our onboard computer running SOBvMax software. These photographs were taken with a telescopic lens, so the approaching vessel was actually further away than how it appears here. Tracking the displayed information and how we used it offers a good illustration of the usefulness—and possible pitfalls—of AIS.

In comparing our observations from the deck and the radar watch with the information supplied by AIS system, several differences were readily apparent. Most of the actions taken to resolve conflicts actually took place before the

deck watch had enough visual information to act based on their own observations, often before the other vessel was even in sight from the deck. Although the target was readily in sight on the radar display, which was not equipped with Mini ARPA, it was difficult to manually plot a close crossing scenario from several miles away with any degree of accuracy.

We needed to establish the other target's track relative to our own and to estimate the CPA. In addition, tracking the multiple targets created high levels of workload for the navigator. This generally resulted in the need to make larger corrections to ensure adequate separation; these corrections were generally started later than those made using AIS data. However, larger corrections create their own problems in high-density traffic areas by generating more conflicts with other traffic. These secondary conflicts might have been avoided if a more judicial adjustment were possible.

Mini ARPA would have been a plus, but this feature is still limited by the number of targets it can track simul-

taneously. AIS information was a noticeable improvement over the other methods employed, and the best of all worlds might well be one of the newer chartplotter/radar display that can overlay a radar image on the AIS target as well as find those other things that go bump in the night.

THE CAVEATS

This evaluation was done in high-density traffic where one must accept less than ideal separation to accommodate the increased traffic flow. Doing this also reduces the margin of safety and significantly increases the need for accurate and careful navigation. In our view, this passage would have been ill-advised in bad weather or conditions of poor visibility.

Nothing is predictable. Halfway through the passage, we observed a large northbound merchantman begin a wide sweeping 180-degree turn and return to the south. This would be extremely difficult for a shorthanded crew to cope with on a dark night if they were relying only on observations from the deck as numerous other vessels altered course around them.

Every skipper must decide what constitutes a safe separation between his vessel and others. All maneuvers to avoid a collision must be conducted in accordance with the COLREGs, even though it might look like a turn the other way would actually be better.

The other vessel will take any required action based on the assumption that you will follow standard collision avoidance rules. It's understandable that some will take exception to crossing the bow of an oncoming commercial vessel with 1.5 nautical miles of clearance. High-density traffic creates these situations where the margin is barely acceptable.

For another opinion, we interviewed two merchant captains who were familiar with this area, and neither was uncomfortable with a crossing at this distance provided that it was done in settled weather with good visibility. Prudence dictates the need for wider separation whenever circumstances would permit it. ▲