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The Japan Ship Owners' Mutual Protection & Indemnity Association
Loss Prevention and Ship Inspection Department

Bridge Watchkeeping and Collision Avoidance

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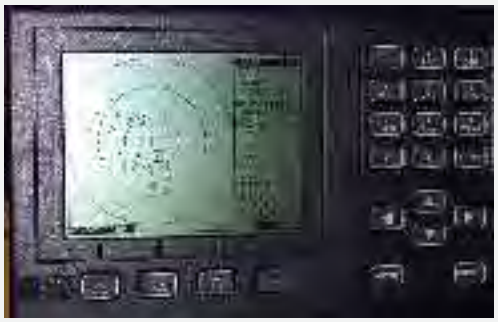
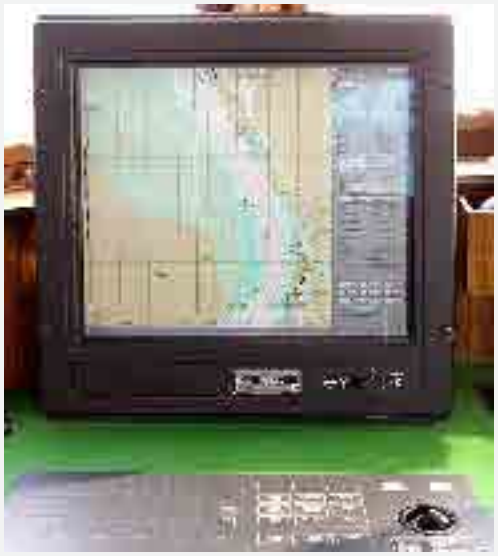
Introduction

Fifty years ago it was generally acknowledged that the introduction of radar on board commercial ships did not have the dramatic effect of reducing the numbers of collisions which was expected. When automatic radar plotting aids (ARPAs) were launched on the shipping community, there was concern that the industry would have difficulty in providing the advanced training necessary to enable operators to use the equipment properly and safely. Now we can say that, despite considerable investment in training and, even though the equipment has been available to almost all navigators of seagoing commercial ships for many years, the advanced computer technology of the ARPA has not rendered the ship collision a thing of the past.



AIS

In recent years, as a further aid to collision avoidance watchkeeping, the navigator has been given the Automatic Identification System (AIS). This technological advance provides the navigator with the ability to identify another ship by name. Also, in many cases, information transmitted by other ships in the area is displayed on the radar screen and on electronic charts (ECDIS) so that the navigator can view that "live" data.



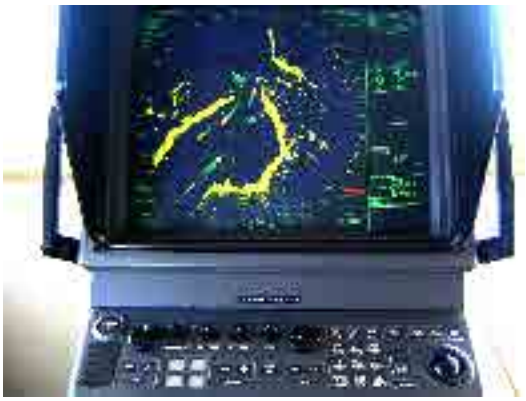
ECDIS

Throughout this period of technical advancement, government authorities worldwide have warned that over-reliance upon a single electronic aid is a primary cause of collisions. It is a fact that some navigators on ships fitted with the most sophisticated collision avoidance systems are so captivated by their electronic displays, and the movement of targets across their screens, that they routinely fail to look out of the bridge windows to make a proper visual appraisal of what is going on around their ship!

We will discuss in this article the use of ARPA and AIS, the information they give the navigator and what it means, with some reminders of the International Regulations for Preventing Collisions at Sea 1972 (COLREGs) and then give some thoughts to be considered and some guidelines which should be followed.

ARPA – Risk of Collision

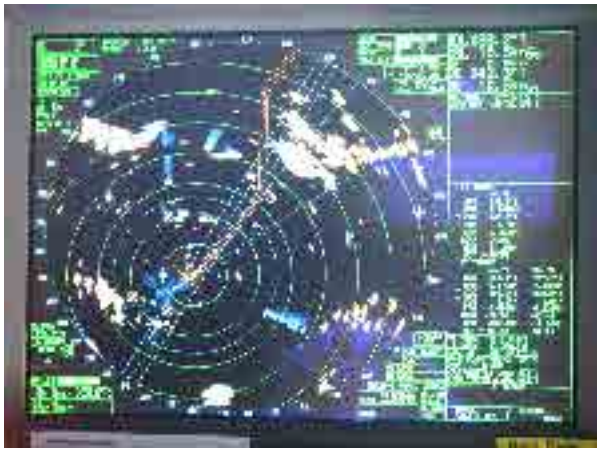
The introduction of ARPA provided a significant advance in collision avoidance because any risk of collision with any of the other ships in the area is constantly assessed by computer technology and the results are displayed for the navigator to use. That is, of course, provided they are plotted or automatically detected. This technology has brought into focus the fact that it is necessary to determine the distance off at the closest point of approach (CPA) of another ship in order to establish whether or not there is a risk of collision with that other ship.



ARPA

However, although the results of the computer calculation are provided so that the navigator can evaluate the situation, those results are in absolute terms, to two decimal places, such that the CPA shown on the display is a simple numerical value; for example 0.16 miles.

Do you plot all the targets on the radar screen, those which are within a certain range or only those which might affect your passage, or do you just rely on AIS targets?



Radar

The display of CPA distance provided by an ARPA has seductive qualities. It usually provides a convincingly precise result which might appear entirely unremarkable. That is, unless the navigator has activated a closest point of approach alarm, in which case a distinctive marker is displayed on the screen and, if the CPA distance is less than the alarm set distance, an alarm will not sound. Invariably, if the CPA distance is less than the passing distance required by navigational practice on board (for example as given in the master's standing orders or in night orders) but is nevertheless positive, the navigator will be tempted to accept that CPA distance as being safe and will then be tempted to reduce the margin of safety for the particular situation. He justifies this action by convincing himself that the computer has advised him that, although the CPA distance is less than the minimum passing distance given in standing orders, the passing distance of the ship being plotted remains positive and therefore no risk of collision exists.

The belief that an ARPA can tell the navigator that no risk of collision exists is entirely false.

What is the minimum passing distance given in standing orders on board your ship? When using an ARPA do you activate the closest point of approach alarm and, if you do, what range do you use?

An ARPA does not have the intelligence to consider all of the circumstances which are involved with a close quarters situation, and cannot evaluate all of the contributing factors in order to carry out a full risk assessment. It does not have the ability to consider possible future events, weather conditions, steering accuracy, safety contingency, traffic situations, navigational situations or, as important as any of these, peace of mind! It can only make a calculation based on past information.

In the days before ARPA, in almost all clear weather encounters with shipping traffic, navigators relied upon visual bearings of an approaching ship to determine whether or not there was a collision risk. In the appraisals made in those days, the value for CPA was assumed to be either "zero" or "sufficient" depending upon the rate of change of observed relative bearings. One of the advantages of such a visual assessment is that the visual check requires the navigator to become physically involved with the dynamics of the situation. That is, by following a procedure as follows:-

Using his eyes and an azimuth mirror, shadow pin and other equipment on a compass repeater on a number of occasions to obtain a series of relative bearings of the other ship and noting those bearings down.

By sighting the navigation lights, or the masts/cranes, to estimate the aspect and approximate heading of the other ship.

By observing the display presented on the radar screen to obtain the range of the other ship and the closing speed.

This process makes use of the watchkeeper's senses in a broad appreciation of the situation. The process is still relevant and should be used when appropriate today.

Do you routinely take visual bearings of an approaching ship to establish whether or not risk of collision exists?

The CPA in pre-ARPA days on board most ships was generally never less than 0.5 mile in open waters. The watchkeeper determined the CPA distance by applying his knowledge and experience, and by using a combination of visual bearings and observations, and the simple technology provided by radar range rings or the variable range marker and a bearing cursor. By use of these methods, the navigator was sure that either (a) the other ship would pass with a distance off his own ship greater than the minimum passing distance given in the standing orders, or whatever he considered safe in the prevailing circumstances, without any action being taken, or (b) the distance off would not be a safe distance and therefore action was required.

The advantage of the pre-ARPA appraisal techniques was that, in a sense, it was consistent with the requirements of Rule 7 (a). "If there is any doubt such risk shall be deemed to exist".

Checking for a risk of collision by visual bearings as described above produces two benefits:-

1. First, there is a requirement to start the process of assessing whether or not a risk of collision existed early because there is a need for a series of bearings to be taken in order to obtain a reliable answer.

2. Second, the assessment in most cases does not take account of fine detail or small margins. That is, if a small change in bearing occurs, this must be treated as if there is no change of the bearing at all.

There can be no doubt that an ARPA provides the watchkeeper with a powerful tool for studying and analysing the movements of ships in the immediate sea area around his own ship. However, being a computer, an ARPA, on the one hand, is only capable of making calculations, whilst on the other hand the results of those calculations will have a measure of precision far and beyond that which is strictly necessary or justifiable for ordinary navigational purposes. It is that computer ability to cheerfully predict CPA distances to an accuracy of 0.01 mile, and to therefore predict actual CPA distances as small as 0.01 mile, that provides one of the pitfalls which, unfortunately, occasionally brings about disaster. Remember that 0.01 mile is 1/10th of a cable or 18 metres and also that the antenna is above the bridge with the bow possibly 300m, 1.6 cables or 0.16 miles, ahead of the bridge, so that a CPA distance of 0.25 miles could lead to a collision.

Furthermore, the convincingly precise display presented by an ARPA can instil confidence to the extent that the navigator feels he can relax and delay a collision risk appraisal, he feels he can maintain full speed in congested waters and/or he can delay a collision avoidance manoeuvre until the range of the other ship has closed to some extent. However, this often results in the development of a close-quarters situation where only a large alteration of course will be enough to avoid collision. The navigator may know precisely what tracks other ships have been following at an earlier stage, but that knowledge must be used in such a way that action is taken in ample time in accordance with the requirements of Rule 8: Action to Avoid Collision.

Do you use the ARPA properly to take early action to avoid potential close-quarters actions in multiple vessel situations, or does it give you confidence to navigate at passing distances and speeds closer and faster than you would if you did not have it?

The computer may provide accurate information on the situation around a ship but this does not provide the navigator with the freedom to navigate close to or within the margins of safety. In fact, the exact opposite is the case; the large amount of information should permit the navigator to take early action when appropriate and to improve his collision avoidance strategy for overall navigational benefit, always bearing in mind good seamanship practice.

The following are guidelines to be followed for successful watchkeeping with ARPA:-

1. Appreciate that the ARPA display cannot tell you that there is no risk of collision.

2. Understand that the information provided by the ARPA does not allow you to reduce the minimum allowed CPA distance to less than is considered safe by the master, and as instructed in his night orders and standing orders.

3. Recognise that the information provided by the ARPA does not permit you to delay taking collision avoidance action.

4. Do not rely only upon the information given by the ARPA display and, when appropriate, use a series of individual bearings to assess whether or not there is a risk of collision with another ship.

ARPA – Action to avoid collision

The navigator of the pre-ARPA days was aware of one important factor; that is, unless he was in restricted visibility, he was navigating his ship on a visual basis and so too were all the navigators of other ships he could see. For that reason, good navigators had an appreciation that any alteration of course had to be large enough to be readily apparent to the navigator of the other ship. By day, this was done by reference to the alignment of ship's masts/cranes, whilst at night this was done by applying knowledge of the aspect of the navigation lights. For example when altering course to starboard for a ship crossing ahead (under Rule 15: Crossing Situation), a navigator would make sure that he changed his ship's heading sufficiently to bring the other ship from his starboard bow onto his port bow so that he changed the view of the masts/cranes by day or at night changed the navigation light displayed by his own ship towards the other from green to red.

The proper use of visual references made actions unambiguous.

A navigator using an ARPA is tempted to make an alteration of course which will simply bring about a prediction of the safe passing of the other ship by achieving the required mathematical result on the computer. That is to say, he will make an alteration of course which results in the predicted CPA distance, as calculated by the ARPA, being equal to the minimum required CPA distance. This may, or equally may not, result in a change in the aspect of the masts/cranes or navigation lights, or as a change in target trail on a radar screen which can be seen by the navigator of the other ship. If the COLREGs are adhered to, then the alteration should be large enough to be observed visually or by radar. It is important to remember that an alteration of course of less than 10o is unlikely to satisfy the requirement.

What change in the ship's heading is the minimum acceptable alteration of course under normal circumstances so as to be readily apparent to others?

The need to comply with the meaning of Rule 8: Action to Avoid Collision - that, is making action taken "large enough to be readily apparent" to the navigators of other ships - becomes critical when circumstances require that manoeuvres must take place at close range, for example, when the distance between ships is less than 3 miles.

This might, for instance, arise in a multi-ship encounter in a strait where a ship is avoiding crossing traffic. Here, the ARPA may be of assistance in judging where there will be a gap in a traffic flow sufficient to permit a safe manoeuvre. When such a situation has been identified, the navigator must focus all of his attention on the manoeuvres to be undertaken. In this type of situation it is imperative that all action taken is unambiguous to a navigator on another ship and this means the heading must be altered so that the aspect of the ship in daylight or the navigation lights at night change significantly.

Collision Avoidance with AIS

When they were first introduced, Automatic Identification Systems delivered a whole new layer of information onto the navigation bridge. The technology provides the navigator with the identification (name, call sign and MMSI number) of other ships in his immediate sea area. The data received also includes the heading, speed and position of, and some additional information about, the other ships.

When AIS was launched on the shipping industry in the 1990s, some representatives of the electronics industry were predicting that the system had the potential to replace radar as the principal collision avoidance aid. In 2000, IMO adopted a new requirement for all ships to carry Automatic Identification Systems capable of providing information about the ship to other ships and coastal authorities automatically. Since 2004 the equipment has been a compulsory provision on board all ships of 300 gross tonnage and upwards engaged on international voyages, on board cargo ships of 500 gross tonnage and upwards not engaged on international voyages and on board all passenger ships irrespective of size.

The greatest beneficiaries of AIS information are the shore stations, and coastal and port authorities, because the system allows identification of traffic approaching ports or transiting straits. The system compliments traffic surveillance systems and is of considerable assistance when issuing traffic guidance messages and warnings, and for search

and rescue purposes.

VHF

As far as the navigator on board ship is concerned, the eye catching benefit of the AIS is that the names of ships which are in his vicinity can be presented on the ARPA screen. It was considered that, in theory, this would be of considerable assistance when deciding upon an appropriate collision avoidance strategy. The fundamental question here is, however, in reality: Does the enhanced knowledge of target identity make the task of avoiding a collision any easier?

Discussing intentions with a clearly identified ship at an early stage can, without doubt, and in certain circumstances, be an advantage. Examples of this type of encounter might include overtaking in a narrow channel and meeting a ship in a river with bends. However, these events are only a relatively small proportion of the total of all ship encounters around the world.

As far as the relationship between individual ships in any encounter is concerned, it is the International Regulations for Preventing Collisions at Sea 1972 that must be complied with in every case. Navigators should not need to be reminded that there is no provision in the COLREGs either for use of AIS information or for contact to be made between ships to allow actions to be discussed. There are very good reasons for this.

If a navigator has any doubt as to whether or not VHF contact to discuss collision avoidance strategy is a valid option, he should, for a moment, imagine himself in a busy seaway off an archipelago which is crossed by both local and international traffic. He should consider, for example, how many different nationalities of watchkeeping personnel there might be on the bridges of ships which are within the range of his radar. He should then think about the possible standard of English spoken by those many watchkeepers and bear in mind that some of those watchkeepers might have only poor, broken English and that others, particularly the watchkeepers on board coastal ships, might have no English at all.

Before you call another ship on VHF ask yourself: what do you hope to learn that cannot be obtained by plotting its target and following the COLREGs? If you are in doubt about another ship's intention, use the appropriate sound and light signals.

He might also like to consider how the name of his ship might be pronounced, and how the names of other ships in the area might be pronounced by the navigators on the bridges of other ships. He might then reflect on his experiences of trying to identify calls - which were not instantly comprehensible - from port control operators spoken in broken English.

The navigator should also then consider what evidence he has that the voice he can hear on the radio when contact is established is the voice of the navigator on the bridge of the ship he has identified from the AIS. There are many parts of the world where abuse of the radio frequencies remains a very serious problem and where coastal authorities are powerless to take any action against those abusers. Finally, the navigator should contemplate the effects of all the

foregoing if, through neglect, he is making a desperate attempt to contact the navigator of another ship because of his own failure to take early action to avoid a close quarters encounter.

The following are guidelines for successful watchkeeping with AIS:-

1. AIS should not be considered as a device to encourage communication between ships' navigators.

2. AIS information has the same status as ARPA information, and it should be treated as an information display system.

Finally, some simple good seamanship practice:-

good seamanship

A. You know the COLREGs, they provide guidance for the prevention of collisions in all circumstances, so use them.

B. Understand what the ARPA display and the AIS can provide and what they cannot provide - they cannot tell you that there is no risk of collision.

E. Keep a good lookout. Watch the other ships in the area - there is no substitute for the Mark I eyeball.

C. Do not rely upon one aid to navigation; use the ARPA in conjunction with visual bearings, and any other means, to establish if a risk of collision exists. If there is any doubt, such risk shall be deemed to exist and appropriate action must be taken which is in accordance with the COLREGs.

D. Always make alterations of course large enough to be observed visually or by radar.

F. Do not ever forget that the main engine is there to be used - slow down or stop if the circumstances require.

Safe Watchkeeping

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