AIS: SAFETY OR DANGER?

As you may recall I wrote a feature on AIS in the July 2000 issue of The Pilot and since then events have moved apace and the carriage of AIS became compulsory on July 1st for all new tonnage over 300 GRT. The equipment is to be phased in for all existing vessels over 300 GRT between now and 2008 although there is pressure from the USA to bring forward the implementation date to 2004 and it looks very much as if an accelerated introduction will be ratified. So, since we are likely to see A/5 equipped vessels very soon what impact is it likely to have on pilotage? I must admit at this stage it is very difficult to judge but if the equipment performs to expectations then it will probably result in a reduction of compulsory pilotage in the future. However, having read through a wealth of reports from the IMO/ /ALA seminar on AIS in January 2002 (painstakingly collated by Les Gate) and other articles, my own opinion is that these expectations of the Industry from the system far outweighs its technical limits and although it will be a very valuable VTS tool I personally don't believe that it will deliver the "holy grail" of VTS control of shipping that some are anticipating. Indeed, I personally con sider that unless it is very carefully developed AIS may actually jeopardise ship safety! In order to clarify these opinions it is interesting to look closely at the development of the system. >»

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History

Ever since aircraft started carrying transponders during the 2nd world War, there have been various plans to introduce transponders into shipping. It does seem amazing that the shipping industry has never adopted a system before now but upon reflection the reasons are fairly logical. Basically there was no identified need for ships to be fitted with such equipment. A ship was an autonomous unit and when it left port it had sufficient personnel and equipment to navigate safely to its destination where it could communicate its arrival by WT, RT, Morse lamp or even semaphore! The collision regulations were perfectly adequate for avoiding other traffic and nobody was interested in how the ship got from A-B so long as it arrived safely with its cargo intact. The Master was King!

It was ports, who were installing first generation VTS stations that identified a need to positively identify ships to assist in their statutory "Duty of Care" to the safety of shipping. Initially ship transponder plans revolved around radar but the limitations of information that could be "loaded" on a radar transponder restricted its usefulness and thus the search began for an alternative system of tracking. It was following the introduction of GMDSS/ DSC equipment on VHF CH70 into SOLAS in 1988 that the idea of using VHF as a transponder platform gathered momentum. Two bodies, the International Association of Lighthouse Authorities (IALA) and the International Association of Institutes of Navigation (IAIN) started serious research. In 1990 IALA reported to IMO NAV 36 that they were working on developing a VHF transponder system which would identify and track vessels within a VTS area. By NAV 39 in 1991 IALA had gained considerable support from several countries and presented the operational and technical requirements along with a request to the International Telecommunication Unit (ITU) to adopt a recommendation on the technical characteristics of a VHF/VTS transponder. By NAV 38 in July 1992 the ITU was ready to adopt the transponder system on the DSC frequency of CH 70 but the IMO was not prepared to implement AIS for the following reasons:

* It was seen to be a VTS (VTS was not incorporated into SOLAS until 1999) tool and therefore there was no avenue for implementation through SOLAS or the COLREGS.
* Transponders required an accurate position fixing system (GPS) but no such equipment was required on board SOLAS vessels.
* There was concern that using CH 70 would compromise distress alerts.
* The shipping industry valued anonymity.

It was the introduction of mandatory reporting of shipping in coastal waters into IMO discussions which revived the concept and at NAV 43 IALA was given the go ahead to prepare the draft performance standards. The work was completed and the equipment, now designed around two dedicated VHF channels, was incorporated into the new SOLAS Chapter V in December 2000. The phased introduction from 2002-2008 was agreed at NAV 47 in July 2001. As a result of anti-terrorism concerns from the USA it is anticipated that an accelerated introduction will be incorporated in amendments to SOLAS Chapter V in December 2002.

How it works

A full description of the concept is given in my last article which is now on my website (www.pilotmag.co.uk). However, as a brief explanation, the transponder works by transmitting "packets" of data by digital VHF pulses. This can be received by other ships or shore stations. The basic packet consists of ship's MMSI number, name and position obtained from a dedicated GPS unit which also provides course and speed made good. A wealth of other information depending on the ship's activity may be transmitted including rate of turn, gyro heading and other data such as destination and cargo details. Such packets are updated at varying rates dependent upon the status of the vessel. For example a ship at anchor will transmit every six minutes but a vessel underway and altering course will transmit every two seconds. The basic information will be generated automatically but all other data will have to be input by the officer of the watch. For example if a ship anchors then the OOW will have to remember to manually input that status into the unit once the vessel is brought up! Cargo details, ETA and other voyage data may be requested by a shore station and this is achieved by the shore station "interrogating" the ship's AIS and again the OOW will need to manually input the information if he has not already done this prior to arrival. Other uses are considered to be Search and Rescue and there is the facility to send short safety messages or general text messages either to all ships or an individual vessel. For capacity each packet transmission uses a time slot and there are approximately 4500 time slots per minute available over the two frequencies. Transmissions are organised by a system called STDMA (Self organised Time Division Multiple Access) whereby once a vessel has transmitted it automatically reserves the next due time slot as does the next ship etc. This system is designed to avoid transmission conflicts.

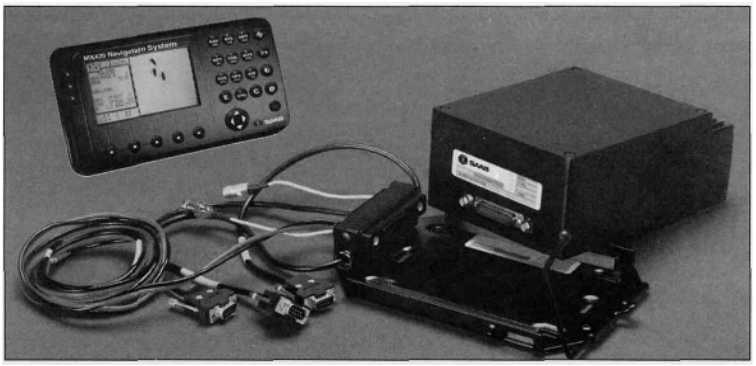

Fig.l Basic AIS Unit

The Equipment

Many of you will probably seen articles on AIS in the maritime press and all show an ECDIS overlaid with AIS vectors but this is very misleading since there is currently no requirement for a vessel to be fitted with an ECDIS. Figure 1 shows a complete AIS unit and you will note that the display unit looks like a GPS display. At the moment, due to the incompatibility of AIS with any existing equipment the display is limited to an "Alpha Numeric" display with a requirement for at least three lines of text. This will enable the OOW to read off the name, course and speed made good and latitude and longitude of another vessel and he will then be able to manually compare this information to his ARPA radar targets to identify other shipping! Data input and status updates use a similar method to that of mobile phone text messaging! However, all the equipment is provided with universally standard connectors to enable future integration of the information into an ECDIS display. For integration into ECDIS there are an agreed set of display criteria. AIS targets will automatically display as a small triangle

pointing in the direction of movement and a vector identical to that currently used by ARPA radar will provide similar anti-collision data. Figure 2 shows three basic display modes of targets:

Activated Target: Shows an ARPA style vector with name and MMSI number.

Selected Target: Shows the same data as an ARPA selected target in a separate window.

Sleeping Target: To reduce information overload all the information on a target can be suppressed and the basic triangle will be similar to an unacquired ARPA radar target.

Any vessel, whether sleeping or not, will automatically alarm if it breaches pre-set anti collision parameters. For inter-ship information the display can incorporate many additional functions which are currently optional. For example if a vessel has the gyro and rate of turn facility connected then this will be provided as a second vector and for a vessel altering course a predictive vector will indicate future track. It is this function that is considered to provide enhanced anti-collision safety in that the alteration of course information will be immediately registered by other shipping but what if a vessel is yawing in a seaway?!! Another idea is that if passage waypoints have been programmed these can also be transmitted and displayed so that the intended track of the vessel will be displayed.

Shore Usage

Having set the standards for AIS, IALA has created a useful VTS tool which should dramatically reduce the verbal VHF transmissions for identification, cargo details, voyage details and waypoint information. The shore station will have the facility to interrogate individual ships for additional information if required. Like all new equipment there are an increasing number of potential uses being considered and developed. However, such additional functions could rapidly exceed the capacity of the system. For example, there is the possibility of a VTS retransmitting non AIS radar targets as AIS targets so that all relevant traffic is included on a ships AIS display. This is designed to prevent the necessity of the OOW or pilot having to monitor two separate displays. Another research area is equipping navigation aids such as buoys with AIS. These buoys will be capable of interrogation by shipping to provide wind and tidal data etc. Interestingly such information need not be produced by equipment actually on the navigation marks but by superimposing it over the mark from the shore station. Trials have already been undertaken exploring the concept of "pseudo" navigational aids where a virtual buoy or mark can be generated by VTS for display on the ship's ECDIS. It is envisaged that such marks could be used to immediately mark a new danger or advise about new survey depths on a shoal. Of course these would be invisible to any non AIS equipped vessels.

AIS and the Pilot

The potential for additional information, readily available on screen without the need for verbally contacting a VTS centre will be welcomed by pilots and it is in Australia that pilots on the Barrier Reef passage are already using a portable AIS unit. I understand that their equipment is being specifically manufactured by an Australian company but the only details that I have been able to locate on such equipment are through the SAAB website. The SAAB equipment, Figure 3, is incorporated into a shock resistant case containing a laptop ECDIS, VHF unit and DGPS. Upon boarding, the pilot removes the laptop from the case which, having the VHF and GPS integrated into its body, is then strapped to a rail on the bridge wing or monkey island. This pack then provides wireless transfer of the AIS data to the laptop which has a seven hour design battery life. Adaptors are included for connection to the ship's electricity supply should the battery fail. Reports that I have read of this experiment indicate that although the number of ships using the system is small the equipment is performing well and that the pilots are adapting to its use although lack of training has resulted in operational difficulties. The problems identified so far are that without gyro heading information vectors will give misleading data for a ship turning and the range is only about 60% of that obtained from a ships own aerial. However the ship board equipment is to be fitted with a pilot connection socket so as more ships are fitted with AIS pilots will be able to plug in their own unit to the ship's AIS. IMPA's view on AIS is that it is important that displays and functions should be to a common standard and emphasises the importance of establishing a comprehensive training course for pilots.

National Security

The introduction of AIS has coincided with the war on terrorism and the USA is the driving force behind an accelerated phasing in of the system. Already the US has effectively suspended shore leave for visiting ships' crews and there is now pressure on shippers to send full details of ships and their cargo bound for the USA upon departure from the loading port. The following is an edited extract from the US

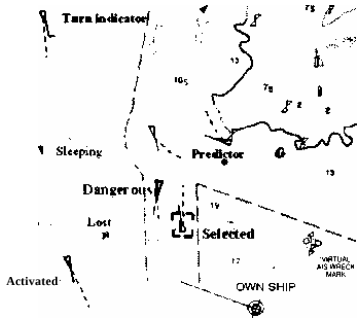

Fig.2 Basic Target Display

Coastguards submission to the IMO/ IALA session: *"In order to achieve a maritime security environment that effectively differentiates between benign and threatening activities, a port or coastal state must have an awareness of all vessels - with their cargo and crew - that operate to and from their ports, or transit their coastal waters. The essence of this maritime domain awareness is the ability to conduct surveillance and reconnaissance of all vessels, cargo, and people that operate in the maritime domain well before the potential threat enters the maritime boundaries. Even though it does not capture all vessels that could be considered a threat to national security, it provides a clear picture of the routine traffic so that movements out of the ordinary can be more readily detected. AIS would contribute to this mission by enabling the shore authority to track certain suspect vessels."*

For these reasons the USA is also pressing for the AIS to be extended into a long range capability through Inmarsat C and some manufacturers are already incorporating this facility into their units. The ultimate aim of the USA is to create a surveillance of shipping to provide what they term as Maritime Domain Awareness (MDA) and another extract from the USCG document states:

"In order to achieve a maritime security environment that effectively differentiates between lawful and unlawful activities, port and coastal states must have an awareness of all vessels operating to and from their ports, as well as those transiting their coastal waters. At the heart of this MDA *are information, intelligence, surveillance, and reconnaissance of all vessels, cargo, and people well outside the traditional maritime boundaries."*

Limitations of AIS

THE CONCEPT

As can be seen from the above AIS has ceased to be primarily considered as an aid to safety of shipping and the concept has effectively been hijacked by various shore

establishments for alternative agendas. In so doing great expectations are being expected of AIS and the acknowledged weaknesses of the system are being ignored in the rush to get a bite of the cherry! It is significant that although virtually no input has been sought from serving ship masters the greatest note of caution has been sounded by the ship owners through the International Chamber of Shipping (ICS). Their concerns are at least reflected in the IMO Guidelines for AIS which state the following caution:

NOT ALL SHIPS CARRY AIS

The officer of the watch (OOW) should always be aware that other ships, in particular leisure craft, fishing boats and warships, and some coastal shore stations including Vessel Traffic Service (VTS) centres, might not be fitted with AIS.

The OOW should always be aware that AIS fitted on other ships as a mandatory carriage requirement might, under certain circumstances, be switched off on the master's professional judgment.

The ICS view goes further: " *The imminent arrival of AIS is not viewed with unreserved joy by the mariner simply because it brings with it problems, for which answers must urgently be found"*

It goes on to list very fundamental limitations such as:

* Automatic acknowledgement of ships reports by shore establishments which have not been addressed by the IMO.
* The primitive data input of existing equipment will generate additional workload for the OOW inevitably at a time when he is probably already overloaded! Even with integrated displays there is a danger of information overload.
* The (mis)use of AIS in collision avoidance. There is no use for VHF in the COLREGS.
* The IMO requirement is for a basic stand-alone unit. Once such equipment has been installed by a ship owner there will be no incentive to undertake an expensive upgrade. The equipment will just remain another bolt on box probably consigned to the back of the bridge. An extended "lead in" time would permit the equipment to evolve to users' requirements.
* Security? ICS points out that what works for State security also works for terrorists and pirates. Basic receiver units could be used to devastating effect in targeting high risk tonnage!

Reading all the reports and the report on the attack on the French tanker *Limburg* has brought a chilling possibility to mind. In its current form AIS could be used by a terrorist / pirate to send fake shore authority transmissions and divert shipping from its intended track and create AIS assisted ambush /ship wreck. No wonder the master insists on the right to switch AIS off. But, will a master's decision to switch off the AIS immediately make his vessel a terrorist suspect? Under the USA's maritime surveillance concept the probability of this is exposed in a proposed amendment to the December SOLAS session requiring that it be compulsory for vessels to keep AIS active at all times underway!!

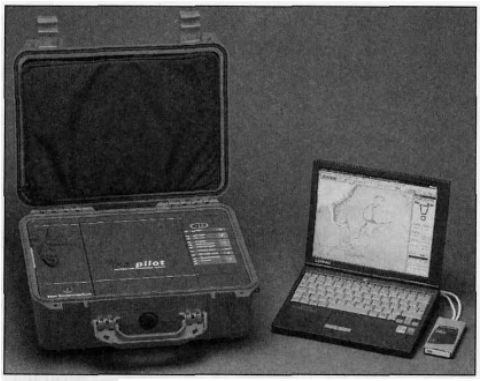

*Fig.*3 *Pilot's portable AIS equipment*

The ICS report includes in its conclusion the following: *"Once AIS equipment is at sea in significant numbers then seafarers can begin to assess the benefits and limitations of the system There will be a delay whilst bridge personnel learn how to use the system to advantage and the training requirement has yet to be established. ICS will urge seafarers to use AIS equipment as an aid, not as an excuse for failing to look out of the bridge windows".*

Wise words indeed!

Equipment Limitations

AIS is unique in that it is being introduced before the technical testing specifications have been authorised by the controlling authority of the International Electrical Commission (IEC). Whilst the shipboard standards have been established and are sure to be approved there is currently no standard for any shore equipment. There is serious concern that the differing agendas of various authorities will result in a non-uniform shore platform which may require vessels to fit additional equipment when trading to different countries! There has also been an amazing naivety from some so called experts who should know better. One claim is that, "/« *practice the capacity of the system is unlimited".* Others accept the possibility of overload but confidently claim that unwanted signals from ships can be eliminated by excluding them from the display by means of a maximum range zone setting. One "expert" clarifies this principle by comparing the situation to a party in a crowded room where a person limits communication with those nearby of interest to him! Wishful thinking I fear. Anyone knows that a heckler at the back of a conference hall can disrupt the whole proceedings and VHF is notorious for its susceptibility to atmospheric effects which frequently result in traffic from distant stations impinging on local traffic. Whilst I am not sure if the digital signal displays similar characteristics to analogue VHF the fact that tests are detecting shipping at extreme distances of up to 70 miles suggests that there will be capacity problems in congested areas. Even if scheduled, a unit will not transmit if another station is transmitting and there is the potential for a weak signal to be "overspoken" by a stronger one.

Another known problem is with the digital VHF signal. Whilst this provides a "clean" data pulse it also requires an unobstructed horizon, short cable runs and is very susceptible to degradation from external interference or adjacent structures. This would logically explain why "impossible" target swap has occurred during some trials. Currently this is being attributed to software incompatibility but if a small craft is close to a large craft the reflected signal may be superior to the true signal resulting in a double AIS vector on the larger vessel. Software is designed to reject such double vectoring so one vessel will disappear! This is purely my very simple explanation and I stand to be proven wrong. If not, remember, you read it here first!!

One final factor is that the whole system relies totally on GPS. Any problems with the GPS signal will render AIS totally useless!

My original article was entitled "AIS, more discussion required?" I was considering entitling this one "chasing rainbows" but it seemed too flippant in view of the potential risks that hasty and unfocussed AIS development poses to ship safety. I sincerely hope that my fears are unfounded.

JCE

AIS links

www.iala-aism.org/mainsite/pages /english/p4/p4m.htm

www.uais.org

www.uscg.mil/vtm/pages/aislinks.htm