Research on
Personal Locator Beacons

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- Safety, Environment & Legislation

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1 Introduction

In the marine industry personal locator beacons (PLB) are commonly used during the transfer of personnel at sea. Different models and shapes are available, working on different principles. Client requirements have evolved over time, following the latest developments. This report describes the currently available technologies (as at April 2015), the different working principles and models available and the pros and cons of different types.

Industry developments now require PLB working on automatic identification systems (AIS). This PLB research has been performed to investigate the different methods of PLB and to identify suitable types.

To achieve industry and client compliance, the main preference is to have PLB installed in the life jackets and have the sets serviced on a yearly basis by the life jacket service station.

During normal working conditions, exposure to the risk of man overboard will arise during crew transfers, both during transit (if on deck) and during the actual transfer between crew transfer vessel (CTV) and vessel/offshore structure. Some IMCA members in the industry work with fully equipped CTV and support vessels. This is considered to be fully self-supporting. This means that, in a man overboard (MOB) situation, the vessels should perform the recovery of the MOB. Therefore, automatic alert of external rescue services is considered not applicable for their scope of work.

2 Abbreviations and Definitions

2.1 Abbreviations

AIS	Automatic identification system
CTV	Crew transfer vessel
DSC	Digital selective calling
ECDIS	Electronic chart display and information system
EIRP	Effective isotropic radiated power
EPIRB	Emergency position indicating radio beacon
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
ITU	International Telecommunication Union
MMSI	Maritime Mobile Service Identity
MOB	Man overboard
MSLD	Marine survivor locator device
PFD	Personal floatation device
PLB	Personal locator beacon
SAR	Search and rescue
SLS	Survivor locator system
SOLAS	International Convention for the Safety of Life at Sea

2.2 Definitions

Distress alert	An alert indicating imminent danger to a person or vessel and requesting immediate assistance
MOB alert	An alert indicating an MOB situation and requesting immediate assistance

3 Personal Locator Beacons

A personal locator beacon is carried on the body by each person and transmits a signal after the person has entered the water. This signal is used to provide an alert and facilitate location of the person.

3.1 Different Working Techniques

Personal locator beacons may work on different techniques/frequencies, which suit different purposes:

406 MHz — This is a long-range frequency which is used to connect directly to rescue services through Cospas-Sarsat satellites. The alert transmission is received by rescue services which will initiate a search and rescue (SAR) operation.

121.5 MHz — This is the aircraft emergency frequency which is also used by civilian distress radio beacons. It is used for alerting vessels nearby and homing, which is a radio directional finding technique to locate the PLB. This technique only provides the direction of the target. The range is presented by the signal strength, meaning no precise range information is available.

This frequency is also used in combination with 406 MHz units for local homing. Satellite support for 121.5 MHz was discontinued in 2009.

Vessels will need to have a special receiver to work on this frequency.

AIS — This system can be used for locating, as the PLB transmits precise position information.

Whether or not an alert is raised and whether or not the symbol for MOB differentiates from normal AIS targets (being other vessels) depends on the model of AIS receiver used. All IMO-mandated vessels are required to have AIS.

This is considered to be the most efficient tool for locating, as in practice all vessels have AIS.

DSC — This system works on VHF 70 and can be used for alerting. It provides information on the location (latitude and longitude), but does not provide information for locating the MOB (in direction and distance). The PLB will continue transmitting until acknowledgement of the distress signal has been received from a vessel. Transmissions are in 'closed loop' and/or 'open loop'.

- Closed loop: PLB will transmit to a pre-programmed MMSI number only, therefore the PLB needs to have the MMSI number of the 'mother vessel' programmed. When no MMSI number is programmed, the PLB will transmit to its default MMSI number, which will not be received by any vessel.
- Open loop: After a preset time (0-10 min), the PLB will start transmitting in an open loop to all stations. It may be possible to set the PLB to transmit in open loop only.

Programming a mother vessel's MMSI is not practicable usually due to the many vessels operating in the area. A DSC operated PLB initially transmitting in closed loop is not considered to be beneficial.

A disadvantage of DSC is the vast amount of false distress alerts and other shipping information that is considered non-relevant to the operator. As such, there is a high chance of MOB distress alerts being disregarded.

When an MOB cannot be rescued by own means, a distress alert will be raised by the vessels and SAR services will be alerted. Both Dutch and UK SAR helicopters operate on all four of the above techniques. Therefore, any of the above techniques would enable SAR services to locate an MOB.

3.2 Radio Equipment MMSI Number

The MMSI number is the maritime mobile service identity, which is a unique identification number assigned to a vessel and is programmed in all radio equipment on board.

An MMSI number with prefix 97 indicates a distress situation. Prefix 972 specifically indicates an MOB situation. All PLB types working on AIS or DSC have a default MMSI number programmed with a prefix 972 to enable correct display of the MOB situation.

3.3 Experience and Lessons Learnt

In the product research, there were the following non-conformities and safety observations on the use of the Sea Marshall AU9:

- No approval by Mullion, PFD supplier, on the integration of the AU9 according to the Sea Marshall manual into the life jackets;
- As the Sea Marshall AU9 manual allowed anyone to install the PLB, numerous cases of incorrectly installed/integrated PLB in the life jackets were identified;
- The PLB were not part of a periodic inspection or service scheme.

To rectify the above or prevent the reoccurrence of the above the following should be put in place:

- Approval from life jacket supplier to have PLB installed;
- Professional installation/integration of the PLB in life jackets;
- Yearly inspection of PLB, this inspection to be carried out simultaneous with the yearly inspection of the life jacket and handled by the currently used life jacket inspection centre.

4 Legislation and Standards

A man overboard locating system can be broken down into two basic features:

1. Alerting, notifying the vessel(s) that a man overboard situation has arisen;
2. Locating, providing the rescue vessel information to locate the man overboard.

Both features can be established by different techniques. When checking legislation and (industry) standards, this research focused on specific requirements for the method of operation of the different techniques of PLB.

4.1 Legislation

4.1.1 International Maritime Organization (IMO)

Marine legislation is organised under IMO. SOLAS is the leading legislation with respect to safety of lives at sea. Requirements are included for distress alerting devices such as EPIRBs and search and rescue transponders (SART). These systems are intended to alert shore based rescue stations (for EPIRB) and enable locating of the vessel in distress (for SART). IMO/ SOLAS does not specify specific requirements for personal locator beacons.

IMO studied the use of man overboard devices using AIS technology in 2012. Relevant conclusions can be summarised as follows:

These locating devices (e.g. man overboard devices) which use AIS technology:

1. should not be used for distress alerting; and
2. should not be used for routine location (being not in an emergency situation).

(Source: ITU-R M.2285-0).

Distress alerting means the alerting of shore based rescue stations (SAR). As some IMCA members are fully self-supporting on their projects and are capable of rescuing an MOB with their own vessels, alerting of SAR stations may not required. In case of escalation of the MOB situation, alerting of SAR stations can be done by the supporting vessel(s). Therefore, conclusion 1 is considered not applicable to those members; conclusion 2 should be complied with.

4.2 Standards

4.2.1 DSC System for use in the Maritime Mobile Service – ITU-R M.493-13

This is a draft revision of an International Telecommunication Union (ITU) recommendation, which is currently being discussed/reviewed by IMO.

The ITU has added a DSC Class M definition, which covers man overboard devices utilising DSC. This device is to be fitted with an internal electronic position fixing device and a receiver operating on VHF DSC channel 70. The DSC receiver transmits to send an alert message and allows acknowledgements to be received by the device. Capability for position request after activation is also required, which allows the device to be polled for its position at any time. Reference is made to ITU-R M.2285-0.

4.2.2 MSLDs – An Overview of Systems and their Mode of Operation – ITU-M.2285-0

This ITU report provides an overview and description of the different systems and modes for MSLDs, dated December 2013. It differentiates between MOB systems working on 'Designated stations' and on 'All stations'.

- **Man overboard – Designated stations (MOB-DS) – General criteria**

  This system is part of a personal notification system comprising a base station and one or more MOB-DS. The system should provide a means to register each individual MOB. When a registered MOB-DS causes an alert at the base station the station should generate an audible alarm at the station which should be manually acknowledged by a responsible person.

  Where the crew vessels carry a Sea Marshall receiver and each person carries a Sea Marshall PLB, alerts are raised 'locally' on the vessels and no external alert is generated.

- **Man overboard – All stations (MOB-AS) – General criteria**

  A device capable of being worn and manually or automatically being activated that causes an alert or notification be sent to all stations. The alert should be either on a GMDSS alerting frequency (i.e. distress alert, e.g. DSC) or frequencies assigned to AIS 1 and/or AIS 2 (i.e. locating/notification signal).

  A device using AIS technology in its current form cannot, of itself, be used to alert all stations to a person in distress, but studies have shown that it has significant value for locating the man overboard. Devices combining both DSC and AIS technology can perform both functions.

  There are two commonly available technologies which can be used to immediately notify all shipping in close vicinity of a survivor in the water needing rescue: DSC and AIS. AIS has the advantage of instantly identifying the location of a survivor or survivors in the water, but AIS may not be used to alert shipping that there is a person in distress. DSC can provide an immediate alert to shipping that there is a person in distress, but cannot readily display the person's position on a ship's navigation display.

- **Usage of 121.5 MHz for man overboard devices**

  In the view of the International Civil Aviation Organization (ICAO) there are the following disadvantages of using 121.5 MHz for a MOB device:

  – No satellite detection of the 121.5 MHz signal to assist with position information and drift
  – If multiple MOB beacons are activated from a single vessel/platform then the ability to direction-find the beacons by SAR assets is seriously compromised due to the known limitations with direction finding equipment where multiple signals are radiating in a small area
  – 121.5 MHz is not a frequency routinely carried by maritime vessels; this limits support assistance that may be provided by nearby vessels to the MOB event.

  Applying this reasoning, the use of 121.5 MHz for MOB devices would appear to have limited applications.

  A disadvantage is that range information is not available when using 121.5 MHz. The receiver provides approximate direction and signal strength only.

4.3 Specifications of Different Models

Specification	sMRT AU10	sMRT V100	Kannad Safelink R10	Weatherdock Easy One	Weatherdock Easy Rescue Pro	Ocean Signal Mob1
						
Standard Compliance	Radio AIS: RTCM 11901.1:2012 ETSI EN 303 098-1 V0.0.4 Radio(121.5MHz): EN 300 152-2 V1.1.1 EN 302 961-2 V1.2.2 Marine: EN 60945:2002 Electrical: EN 60950-1:2006 EMC: EN 301 489-22 V1.3.1 EN 301 489-1 V1.8.1	Radio AIS: RTCM 11901.1:2012 Draft ETSI EN 303 098-1	ITU-R M 1371 Marine: IEC 60945: 2002-08 IEC 61097-14:2010(E) IEC 61108-1:2003-7	GPS: IEC 61108-1	DSC: RTCM 11901.1 AIS: BSH 4615/4361565/10 GPS: IEC 61108-1	DSC: RTCM 11901.1 AIS: EN 303 098-1
DSC	-	TX / RX, 500 mW	-	-	Class D (TX/RX)	TX
AIS Tx Power Output	Nominal 1 W EIRP	Nominal 1 W EIRP	Nominal 2 W EIRP	Nominal 1 W	Nominal 2 W (AIS) Nominal 0.5 W (DSC)	Nominal 0.5 W (DSC)

Specification	sMRT AU10	sMRT V100	Kannad Safelink R10	Weatherdock Easy One	Weatherdock Easy Rescue Pro	Ocean Signal Mob1
Alerting Radius Surface		15 nM	4 nM			
Transmission	GPS fix <1 min		After 10 sec (no GPS) GPS fix after 30-40 sec			
Battery life	3 years	10 years Replace after 5 years	7 years	7 years	5 years	7 year
Continuous operation	12 hours	12 hours	24 hours	36 hours	45 hours (AIS + DSC)	24 hours
Environmental Resistance	IP68	IP68	Immersion to 5m		IP68	
Weight	250g	168g	120g	120g	300g	92g
Introduction	<2013	<2013	2012	April 2015	Summer 2015	
Additional	Buoyant (index=9%) Antenna length 535 mm Distress modulation AM compliant to ITU-R M.690-2 (2012)	Strobe light	Ultra-bright LED beacon + buzzer	Floating	Floating	
Integration into life jacket	– Stick-in attachment to bladder – Mounted inside life jacket	– Stick-in attachment to bladder – Mounted inside life jacket.	– Mounted on oral tube of bladder	– Installed loose into life jacket cover, string attached to life jacket	– Pouch on bladder (requires new bladder)	– Mounted on oral tube of bladder

Specification	sMRT AU10	sMRT V100	Kannad Safelink R10	Weatherdock Easy One	Weatherdock Easy Rescue Pro	Ocean Signal Mob1
Activation	– Manual – Water sensor	– Manual – Water sensor	– Manual – Semi-automatic when professionally installed (upon inflation of life jacket)	– Water sensor	– Manual – Water sensor – Rip cord	
Notes	– Service is required by manufacturer and is performed by manufacturer (sMRT UK) – Long antenna always exposed – Unit requires to be armed prior to operation					

5 Comparison and Conclusion

5.1 Summary of Requirements

- Compliance to legislation/industry standards;
- Easy installation in life jackets;
- Easy service of life jacket and PLB by the same service station.

All compared units operate on AIS, with some units additionally operating on 121.5 MHz or DSC. Since there is currently no stipulated requirement for these additional frequencies, and no requirement for the use of PLB other than contract requirements, any type of device may be chosen.

5.2 Comparison of Technologies

Currently, the only technology which will enable the locating of an activated MOB from all IMO-mandated ships is AIS. Raising an audible alarm and displaying the correct symbol, which would ensure alerting and locating of the MOB, depends on the model of AIS used. It is expected that most vessels have AIS units that provide this, but available information on tests provides contradicting information.

However, as old AIS systems may not show the proper symbol, the MOB may go unrecognised if it is not being looked for. Members should investigate whether their vessels carry AIS systems with updated software to raise an audible alert and show the correct symbol.

Alerting on a secondary system can be performed in two ways: on 121.5 MHz or on DSC (VHF 70).

The 121.5 MHz requires a special receiver to be installed on the vessel. Other vessels usually do not have such receivers. This frequency is reliable for alerting, but provides limited functionality for locating. It can be concluded that this frequency is not an added value since it relies on special equipment to be available on the vessel.

A DSC receiver is mandatory equipment on all IMO-mandated ships and therefore has an added value over the 121.5 MHz technology. The PLB with DSC functionality should be able to be set to transmit on open loop immediately, to avoid delay when first transmitting on the default MMSI. A disadvantage of DSC can be false distress alerts being received on board, which may lead to some ship operators discounting the receipt of a DSC distress alert. It can be concluded that DSC has limited added value.

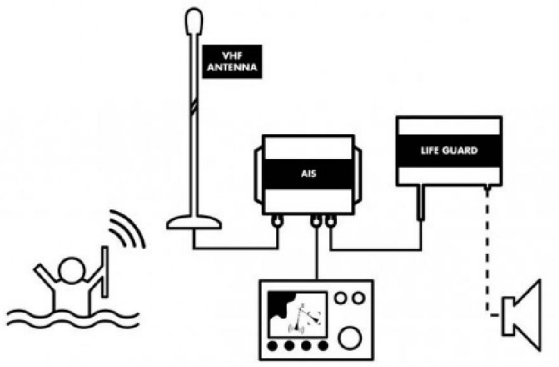
5.3 Conclusion

Based on the restrictions to the 121.5 MHz frequency and DSC, some members opt for an AIS only system. With this decision, however, comes the requirement that all vessels used should have an AIS receiver that correctly displays the MOB symbol and provides an audible alarm (either directly, or through another device). This requirement should be included in charter parties.

Looking at the current available models the Kannad R10 is a popular model, based on the proven technology and experiences from other members.

5.4 Contingency for Old AIS Systems

In case the AIS system on board a vessel does not provide the correct MOB symbol as per IMO requirements and provide an audible alarm, an 'AIS Life Guard' can be connected to the AIS receiver. This unit will detect the MOB signal and provides a 95 dB audible alarm and red warning light. Since all MOB signals start with a 972 prefix, the MOB can then be manually selected from the target list on the AIS receiver to display the direction and range of the MOB.



6 Reference Standards

EU Council Directive 96/98/EC	Directive 2013/52/EU MED (9th Amendment)
ETSI EN 300 152-2 V1.1.1	EPIRB on 121.5 MHz
ETSI EN 301 489-1 V1.8.1	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETSI EN 301 489-22 V1.3.1	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 22: Specific conditions for ground based VHF aeronautical mobile and fixed radio equipment
ETSI EN 301 843-1 (V1.3.1)	Electromagnetic Compatibility (EMC) for marine radio equipment and services
ETSI EN 302 961-2 V1.2.2	Maritime personal homing beacon on 121.5 MHz
ETSI EN 303 098-1 (V1.2.1)	Maritime low power PLB on AIS (Part 1)
ETSI EN 303 098-2 (V1.2.1)	Maritime low power PLB on AIS (Par 2)
ETSI EN 303 132-1 (V0.0.3 54) (Draft)	Maritime low power PLB on DSC (Part 1)
RTCM 11901.1:2012 (compliant)	Standard for Maritime Survivor Locating Devices (MSLD)
EN 60945:2002 incl. IEC 60945 Corr. 1:2008	Maritime navigation and radiocommunication equipment and systems – general requirements – methods of testing and required test results
EN 60950-1:2006	Information technology equipment – Safety – Part 1: general requirements
EN 61097-14:2010	AIS search and rescue transmitter (AIS-SART). Operational and performance requirements, methods of testing and required test results
EN 61108-1:2003	Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results
IMO Res.MSC.246(83)	Survival craft AIS-SART for use in SAR operations
IMO Res.MSC.247(83)	Survival craft radar transponders for use in SAR operations
IMO Res.MSC.256(84)	Adoption of amendments to the international convention for SOLAS
ITU-R M.1371-4 (2010)	Technical characteristics for an automatic identification system using time-division multiple access in the VHF maritime mobile band

ITU-R M.2285-0	Maritime survivor locating systems and devices – An overview of systems and their mode of operation
NCSR 2-12-1 / ITU-R M.493-13	Liaison statement from ITU working party to IMO
R&TTE – 1999/5/EC	European guideline for radio and telecommunications terminal equipment