EPIRB UPDATE - June 2005

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What's Happening with Emergency Position-Indicating Radio Beacons (EPIRB)

EPIRBs and search & rescue systems are undergoing a quiet change in technology. It is important for existing owners and potential purchasers to understand how these changes could affect them. The main changes are as follows:

1. There is a global migration to newer digital 406 MHz beacon systems with GPS options
2. Satellite monitoring of 121Mhz / 243 MHz analogue beacons will be phased out by February 2009
3. Enhancements are only planned in the global satellite coverage network for 406 MHz beacons
4. After 2009 there will be unknown limited support by aircraft monitoring the 121.5MHz frequency.

Why this is important ?

Most owners would say they expect an EPIRB alert to trigger a rapid search & rescue (SAR) operation should they require emergency assistance. Although this may be true in some situations, it is unlikely with older 121 / 243 beacons. This is due to a number of factors including extended beacon warm-up time, poor frequency stability, increased time to calculate a fix, large potential search areas, no idea who activated the alarm, and very high false alarm rates of up to 98% globally. Some countries may not deploy search & rescue teams due to the cost and uncertainties involved.

How 121 / 406 beacons compare

Performance Attribute	***121 / 243 MHZ***	***406 MHZ***	***406 MHZ (GPS)***
Warm-up Time	~ 15 minutes	near instant	
Alert Received by RCCNZ	Variable ~ 1 hour +	~ < 5 min (refer note 1)	~ < 5 min
Time to calculate fix ~	> 2 hours + (refer note 4)	~ 2 hours + (refer note 4)	< 5 min
Position Accuracy	~ 600 kms [2]	~ 20km [2]	~ 100 metres
Transmission power	~ 0.1 watt continuous	5 watts burst	
Price	$NZ 280 +	$NZ 680 +	$NZ 1,900 + as at Mar 05.

Weight	~ 500 grams	~ 550 grams	Varies widely
Technology	Analogue	Digital	
Global coverage for beacon identification	No	Yes (refer note 2)	
Coverage	Intermittent: Low Earth Satellite (or) Aircraft	Global Satellite	
False Alarm Rate	98% = 50 to 1	95% = 20 to 1	
Monitoring by Satellites	Low Earth Orbiting satellites until Feb 2009	Geo-stationary and Low Earth Orbiting plus Medium Earth Orbiting such as GPS and smaller 'Sterkh' Search & Rescue Satellites to be deployed from 2006	
Frequency	121.5 & 243 MHz (refer note 3)	406.xx MHz plus low power homing signal on 121.5 MHz	

Notes:

1. Geosynchronous (stationary) satellites positioned over the Equator receive 406 beacon alerts and GPS positions when available. Without GPS, two passes of polar orbiting satellites (or local over flying aircraft) are required to establish a fix. Expect up to 2 hours delay for 406 and potentially longer delays for 121.5 beacons.

2. Beacon details will only be transmitted if the 406 beacon is registered by the owner.

3. The 121.5 MHz frequency is the current internationally recognised Aviation Distress Frequency.

4. Time is based on satellite and excludes aircraft reports that may reduce time in some circumstances.

Beacon Population

There were approximately 341,000 406 MHz beacons operational globally in 2004. This is forecast to grow to one million by 2012. Growth of 406 MHz Personal Locator Beacons (PLBs) and 406 Emergency Locator Transmitters (ELTs - used in aircraft) will be strong, while growth in EPIRBs is forecast to flatten from 2007.

Search & Rescue Centres

Wellington provides one of 25 Mission Control Centres globally that receive beacon alert information from satellites and provide search and rescue co-ordination services.

Aircraft Monitoring in New Zealand

Aircraft hearing reports can only be achieved on 121.5 MHz as aircraft in NZ do not have a capability to monitor 243 or 406MHz. A 406 should however have a 121.5MHz homing signal of lower power output than a normal 121.5 beacon.

Transient aircraft listening on their guard frequency (121.5MHZ) report to Air Traffic Services the time and place they first hear and loose the signal. ATS in turn pass this onto RCCNZ. Staff will then correlate this information with any that they have from a satellite or of a person overdue etc. In most cases an aircraft hearing report is received before a satellite pass, particularly if the beacon is activated in an area of high aircraft activities. This is due to infrequent and irregular satellite passes.

In the second case where an aircraft is tasked to find a beacon, or is not on a scheduled service, and is receiving a beacon signal, there are several ways in which to localise it. If the aircraft / helicopter has a DF then it will 'home' onto the beacon, otherwise it has to fly a series of patterns to localise it. The type of aircraft and terrain will govern the pattern to be used.

If lucky, aircraft can locate beacons before the RCCNZ have two satellite passes, however, in the majority of cases it is a combination of both. Of course in the extremes of the New Zealand Search and Rescue Region (SRR) there may be very infrequent or no aircraft traffic and location is totally reliant on the COSPAS-SARSAT system.

Satellite Monitoring in New Zealand

The timing of satellite passes varies from a few minutes to several hours in these latitudes and is not as logical as the text below conveys. The RCCNZ have developed a chart that shows the average time ranging from one hour for high elevation passes to six hours for alerts from the extreme of our coverage areas.

Also the ideal accuracy as reflected in the COSPAS-SARSAT test is seldom reflected in real life. At sea (EPIRBs) are often near the given radius values but on land (PLB) km is nearer nm and at times may be as far out as 40 to 60 nautical miles from the beacon position. If the beacon is in a valley satellite tracking is critical to next pass resolution. If the satellite pass is on the opposite side if the valley a "missed alert" normally follows. The orientation of the valley also has an effect on the receipt of 406MHz beacon transmissions. It has been observed that mountain ranges frequently block the beacon GEOSAT reception. In these cases a LEOSAT pass is still the only means to receive the coded message.

Unless the 406MHz beacon has an imbedded GPS, resolution of the position still requires two LEOSAT transits for an unregistered beacon or an aircraft hearing report before a search unit can be dispatched.

On the timings and performance the LEOLUT requires at least four minutes of Doppler signal to be able to process a worthwhile beacon position. Processing and message handling of the received signal can take up to a further average of 43 minutes. On top of this the decision time of the RCCNZ staff before a SAR unit can be dispatched must also add ten minutes.

In the case of a 406MHz, that is in view of one of the two GEOSATs, RCCNZ should have a processed message within four minutes. If it is registered in the NZ data base a phone call should be made to a named contact within five to ten minutes of the received message from the Australian Control Centre.

Purchasing Considerations

406 Beacons

406MHz beacons are the new standard for EPIRBs, Personal Locator Beacons (PLBs) and Emergency Locator Transmitters (ELTs). They are significantly more accurate and reliable because of their ability to transmit beacon identification data, they have improved frequency stability, high power output and may include a GPS co-ordinate transmission capability. The difference between 406 beacon types is that EPIRBs float, PLBs 'may' be waterproof and ELT's are fitted to aircraft.

Most importantly the identity of the beacon will be transmitted on activation and background co-ordination efforts can begin immediately. Another important advantage is that 406 beacons are likely to be in view of a geo-stationary satellite and an emergency distress alert will be relayed to monitoring stations immediately, even though a fix may not be available for up to 1-2 hours. A satellite will normally pass overhead within 35 minutes in New Zealand due our more southerly position near the south pole where 'Low Earth Orbiting' satellites orbits converge. In future the existing Cospas-Sarsat system will expand to include more satellites of different types in the network.

The 406 transmits a number code. That number identifies the country where the beacon was bought and registered. Upon receipt of a report that a transmission with that number code has occurred, the relevant authority in the country where the 406 is registered (RCCNZ in NZ) checks the database and phones the registered owner. This will eliminate many false alerts. It relies on the database being kept up to date by the 406 owner.

The 406 beacon code is transmitted immediately upon beacon activation. Satellites will store information received from a 406 beacon and continue to forward this information to receiving stations. The high power transmission (5 watts) of a 406 beacon offers a significant advantage over older 121.5 beacons. The five watt signal will enable high altitude satellites to receive and relay the emergency signal.

Registration of 406

You can only register a 406 beacon that is coded for your own country. Buying one from overseas or buying second hand from someone who purchased the beacon overseas owner is not advisable.

Accurate positioning information can also be transmitted from 406 beacons to receiving stations, provided the beacon is connected to an external GPS (or) fitted with an integral GPS.

Because rescue co-ordination background work can commence immediately on receipt of 406 beacon activation, it is not vitally important to have GPS transmission on the water. A satellite is generally passing overhead within one hour around New Zealand coastal areas. A 406 satellite fix is likely to be accurate to around 20 kms^2, without a GPS, versus a much larger search area of approximately 600 kms^2 for a 121.5 / 243 beacon. It is important to remember two passes of a satellite or one and an aircraft hearing report are required to develop a reasonably accurate position fix for any non-GPS equipped beacon be it 121.5 or 406.

With the 406 GPS enabled EPIRB or PLB both the position and identity of the beacon is provided within a few minutes. Otherwise only the identity of the beacon is provided within minutes and it may be necessary to wait typically two hours (possibly longer) before determining a firm position location from the polar orbiting satellites.

121.5 Beacons

Monitoring of 121.5 MHz emergency distress frequency is undertaken by aircraft and Low Earth Orbiting satellites.

The 121.5 Cospas - Sarsat system established in 1982 uses Low Earth Orbit satellites that can receive the low power 121.5 signals and relay these to ground receiving stations called LEOLUTs. One of these is located in Wellington together with a Mission Control Centre (MCC) and a Search and Rescue Co-ordination Centre (RCC).

The satellites will not store analogue information sent from a 121.5 beacon therefore both the emergency beacon and the LUT must be visible to the satellite simultaneously before a fix can be calculated by the LUT. This limitation translates into reduced global coverage and potential for longer wait times. The LUTs function is to calculate a position of the beacon and to provide this to global Mission Control Centres who can then engage appropriate Search and Rescue Co-ordination Centre(s). Two satellite passes are necessary to establish a position. A 121.5 Cospas - Sarsat LEOSAR satellite should pass overhead at least every 105 minutes. Because coverage is not continuous globally, users in distress must wait until a satellite is visible to the beacon and a LUT. A fix that is calculated by a LUT receiving a 121.5 signal yields an approximate search area of around 600 kms^2. Only low altitude satellites will pick up the weaker analogue signals transmitted from 121.5 MHz beacons.

Rescue Co-ordination Centres must deal with a number of issues related to 121.5 MHz beacons.

- a high rate of false alarms, typically 98% or more for all beacons globally

- no positive beacon owner identification

- potential for delays in establishing a positive position fix

- blind spots when the LUT and beacon are not visible to the satellite simultaneously

- large search areas of typically 600 kms^2 when signals are relayed from a satellite.

The above issues challenge Rescue Co-ordination Centres to carefully consider deployment of expensive resources. This is has potential to delay search and rescue operations for 121.5 beacon users.

121.5 MHz Summary

Both aircraft and low earth orbiting satellites can receive and relay 121.5 MHz beacon signals.

Satellite position fixes are not as accurate as with 406 MHz beacons and may take extended time to establish due to many situational factors.

The 121.5 MHz transmitted signal can only be received by a LUT when both the receiving LUT and the beacon are in view of the satellite simultaneously thus limiting the area of useful coverage.

Satellite monitoring of 121.5 MHz beacons will cease on 1 February 2009.

Continued aircraft monitoring of 121.5 MHz beacons past 2009 will be limited to local over flying aircraft. Note that 406 beacons also transmit a very weak 121.5 signal to assist homing aircraft.

Conclusion

If positive identification and rapid rescue is your primary objective the purchase of a 121.5 MHz beacon is unlikely to give you the level of comfort offered by a 406 beacon. The primary disadvantage of 406 beacons over 125.5 beacons was price. Since November 2004 this is no longer a significant limitation as at least one manufacturer has designed an affordable unit available to the Australian & NZ markets. New low cost models with integrated GPS are expected in the future.

There is no one perfect solution for all distress situations, but a combination of radio, flares, cell phones and EPIRB seems best with due consideration given to ensuring waterproofing of radios and cell phones.

Acknowledgements:

Jim Lott - Maritime Safety Authority

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Revised June 2005

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