



Search and recovery methods for aircraft and Vessels. Have research vessels a role??

- ICAO rules require state of registration to locate lost aircraft/ flight recorders and investigate aviation accidents
- Many states hold large (€100million+) insurance policies to allow engagement of commercial specialists e.g. Phoenix International , DOS
- RV's can frequently be tasked as state assets
- RV's often in the right place at the right time allowing a rapid response
- Modern RV's often equipped with the right equipment

- *Ireland's position in world aviation leasing market (50% world market share) makes this an important topic for the state….*

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Recent High profile aircraft losses

- The Air France flight from Rio de Janeiro to Paris crashed on June 1st, 2009, plummeting 38,000 ft in just three minutes and 30 seconds because pilots lost vital speed data; according to the French Bureau of Investigation and Analysis (BEA).
- All 228 people onboard the Airbus A330 Flight 447 were killed. The pilots lost contact with air traffic controllers while flying across an area of the Atlantic Ocean known for constant bands of severe turbulence.
- Search and rescue efforts lasted two years! On 3rd April, 2011, almost two years after the loss, the underwater wreckage was located on the ocean bottom, some 14,000 feet below the surface.

- After the surface search, there were four phases to the underwater search:

Phase I: ***Passive acoustic search for the underwater locator beacons***

- The aircraft was equipped with two "black boxes," the flight data recorder (FDR) and the cockpit voice recorder (CVR). These ruggedized devices are designed to withstand the high impacts expected in a crash and are fitted with an underwater locator beacon (ULB) that activates when contact is made with water.

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Air France Flight 447

- The passive acoustic search for the FDR and CVR, which lasted 31 days and ended on July 10, 2009. Four platforms were involved: the French IFREMER research vessel *Pourquoi Pas?,* the French nuclear submarine *Emeraude*, and two tugs hired to assist in the search, *Fairmount Glacier* and *Fairmount Expedition*.

Phase 2: *Side-looking sonar search by the Pourquoi Pas?*

- In order to continue the search after the pingers' extinction, the BEA decided to use the IFREMER towed sonar (called Sonar Acoustique Remorqué - SAR). The *Pourquoi Pas?* was equipped with this side scan sonar for the second phase during its port call in Dakar. The *Pourquoi Pas?* also had the capability to complete the bathymetry survey of the area thanks to its hull-mounted multi-beam sonar.
- Efforts were unsuccessful.

Phase 3 search

- Phase 3 included two search efforts – the U.S. Navy/Phoenix International and the Woods Hole Oceanographic Institute (WHOI). Both efforts used side-scan sonar.

Phase 4 search

- Performed by WHOI, using REMUS 600 AUVs. On the sixth day of this effort, the first debris and bodies were found 38 NM north of the **Last Known Position (LKP).**

Total Cost: 37 million US dollars

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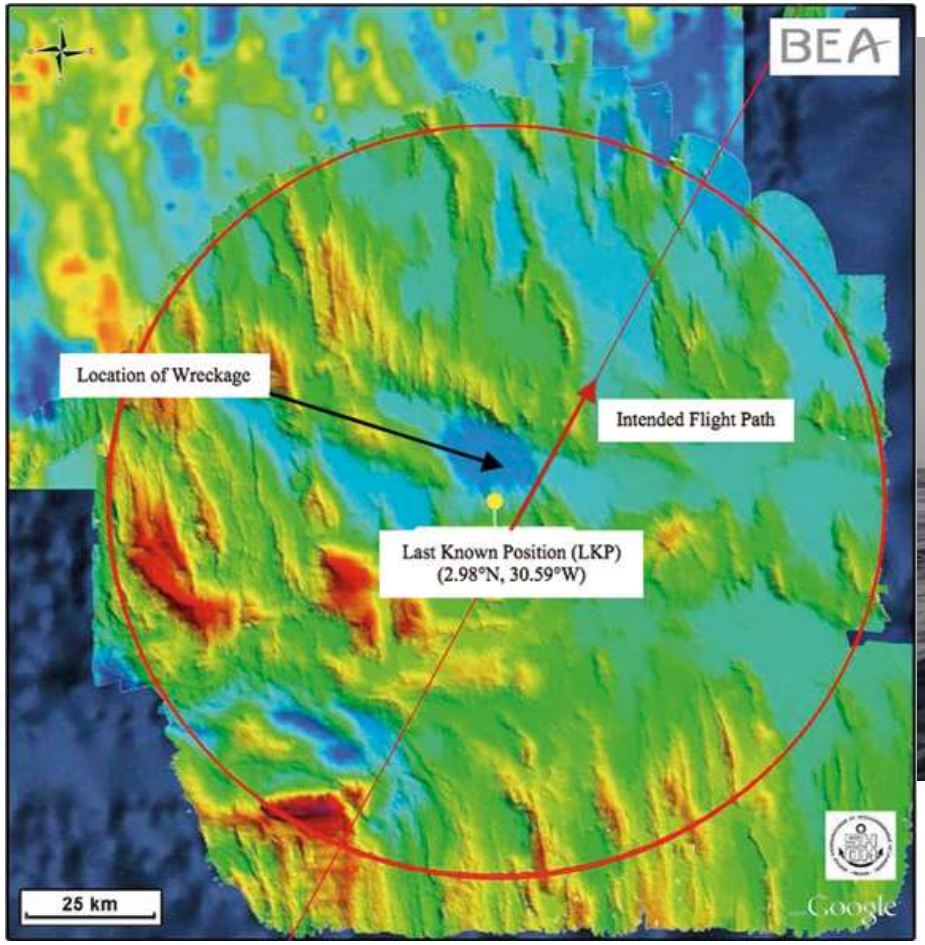
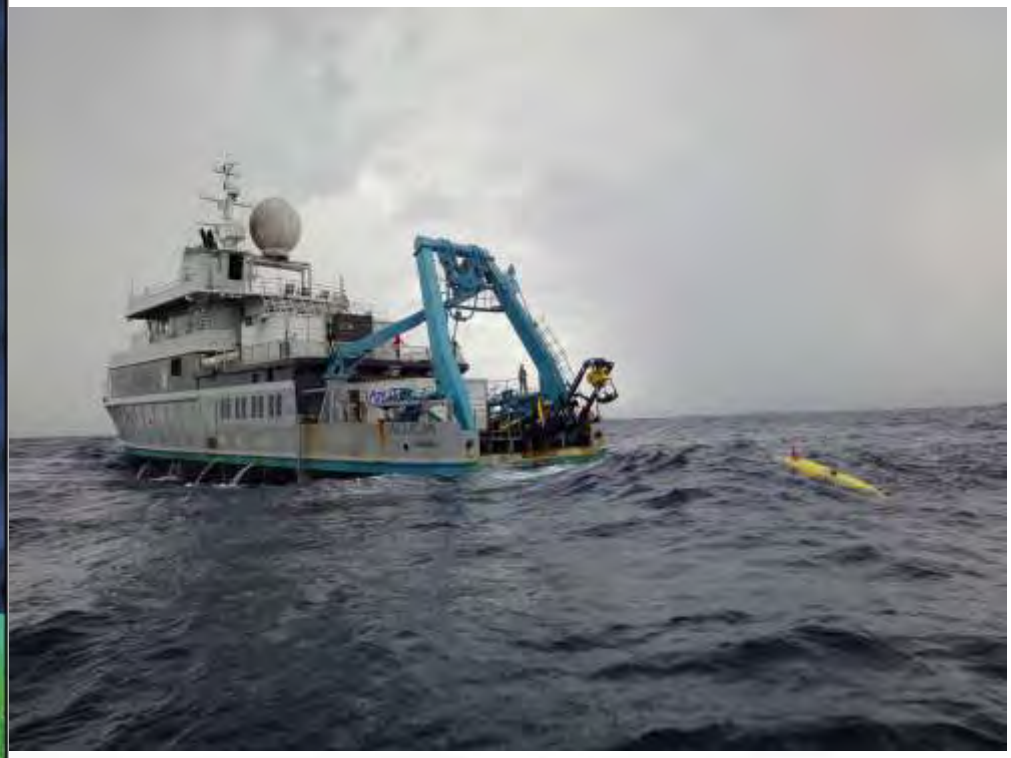
Air France Flight 447





The Alucia and a Remus 6000, an unmanned reconnaissance submarine, at the last-known position of Flight 447.

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EgyptAir flight MS804

- EgyptAir flight MS804 crashed in the Mediterranean on the 19th May, 2016, with 66 people on board: 56 passengers, seven aircrew and three security personnel.
- The Airbus A320 was en route from Paris to Cairo.

- The Egyptian government contracted two ships to hunt for the wreckage - the privately owned vessel, SV *John Lethbridge* and the French navy vessel, *LaPlace*.
- Deep Ocean Search (DOS) owns and operates the 75m long, dynamically positioned survey vessel, SV *John Lethbridge*. It is equipped with a full ocean deep side scan sonar and a light work class ROV, both rated to 6000 meters.

Search effort results:

- In June, it was reported that the SV *John Lethbridge* had found "several main locations" on the sea floor between Crete and the Egyptian coast. The committee stated that it had obtained images of the wreckage. The images will allow search teams and investigators on board the vessel to draw an exact map of the location.

- *LaPlace* detected signals from the MS804's black box on the 1st June, using acoustic detection systems to listen for the "pings" emitted by the flight recorders.

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Malaysian Airline Flight MH370

Flight MH370 disappeared with 239 people on board while flying to Beijing from Kuala Lumpur March 8th 2014.

A search and rescue effort was launched in Southeast Asia soon after the aircraft's disappearance. After initial analysis of communications between the aircraft and a satellite, the surface search was moved the following week to the southern Indian Ocean.

Between 18 March and 28 April, 19 vessels and 345 sorties by military aircraft searched over 4,600,000 square kilometres (1,800,000 sq mi).

Since 30th March 2014 the search has been coordinated by the **Joint Agency Coordination Centre (JACC)**, an Australian government agency established specifically to co-ordinate the search effort to locate and recover Flight 370, which primarily involves the Malaysian, Chinese and Australian governments.

The search for Flight 370 is the most expensive search operation in aviation history. The budget for the search effort is 138 million pounds (sterling).

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Fugro and MH370

Three Fugro specialist survey vessels (with a crew of around two hundred) have been surveying and searching the Southern Indian Ocean search area for the missing Boeing 777.

Fugro Discovery

A Frame - 16 t (SWL)
Length - 70.0m
Maximum Speed - 13 knots
Multibeam Echo Sounder - Kongsberg EM710

Fugro Equator

Beam - 14.0m
Draft - 4.20m
Length - 65.65m
Supports AUV and ROV operations

Havila Harmony

Deck space - 800m²
Length - 92.95m
Moonpool - 6m x 5.28m
High specification FCV 3000 Work Class ROV's

All three vessels are equipped with deepwater search technology.

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Fugro Equator

Fugro Discovery

Havila Harmony





Towed pinger locator

- A **towed pinger locator (TPL)** is a water-borne device used to locate the sonar **"ping"** from the underwater locator beacon which is fitted to the **Cockpit Voice Recorders** and **Flight Data Recorders** installed in commercial airliners.
- A TPL can locate pingers at depths of up to 20,000 feet (6,100 m) underwater.

The Pinger Procedure:

- The locator is mounted in a hydrodynamic shell, or **tow fish**, connected by winch behind a surface vessel across the search area.

- Once located, the beacon and its attached recorders can be retrieved by divers, submersibles or remotely operated vehicles (ROVs), depending on depth.

- Most beacons transmit a pulse once a second at 37.5 kHz.

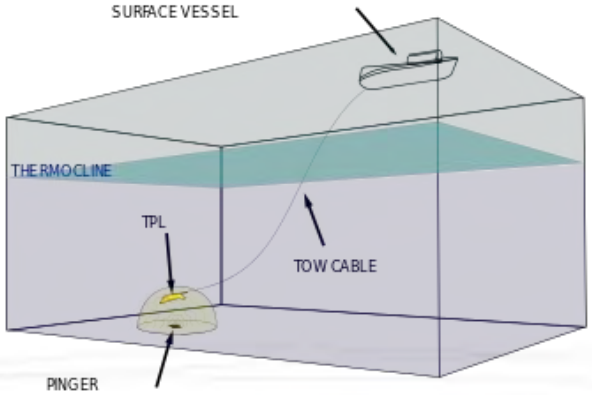

Fig. 1 How a towed pinger locator is deployed

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Hydrophone & TPL

- The hydrophone must be positioned below the thermocline layer which reflects sounds, either back to the surface or back to the ocean floor.
- Since the pinger signal is relatively weak, the hydrophone must be within about one nautical mile (6,076 feet) to detect it.

Fig. 2 United States Navy Towed Pinger Locator




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ECAC Group of Experts
on Aviation Accident
Investigation (ACC)

Second ECAC Workshop on
Underwater Recovery Operations
Larnaca, 18-20 October 2010

Report

ACSA
Group ALCEN

DETECTOR-1000

1. Dip Detector below thermocline and surface noise,
2. Acquire signal for 5 minutes,
3. Recover it back on board,
4. While transitting to next station, Process data: ULB is around or not,
5. Dip again and get homing direction.

Software output: ULB Measured frequency & Repetition rate

Operations not dependant on weather conditions

© ACSA 2010

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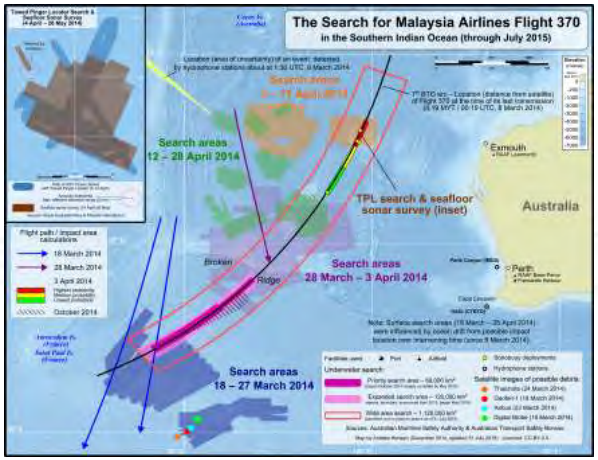
How can RV operators prepare ?

- Useful to have a source of technical information regarding pingers and search techniques
- Partake in multiagency search exercises to location and recover pingers/FDR's
- Engage with national aviation investigation agencies
- Review fleets existing equipment for suitability for search operations
- Establish sources of specialist equipment available for hire worldwide



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Search and recovery methods for aircraft and Vessels. Have research vessels a role??

Video Ray operated for search on board Fishing Vessel Tit Bonhomme Glandore bay 18th – 21st Jan 2012

The request was to carry out a video search / inspection of the F.V. Tit Bonhomme accommodation area for the bodies of the six missing crew men using a portable Video Ray Pro 3 unit (3 Photos below).



The vessel ran a ground and sunk on Adams rock (Island) at the entrance to Glandore Bay, West Cork. Weather conditions were very poor and the vessel was completely wrecked. The video ray equipment consisted of 1 tether management unit consisting of 100m of tether. One ROV Video Ray Pro 3 and portable control console with 15"

23 June 1985 of Air India Boeing B747 VT-EFO. The aircraft was en route from Montreal to London as flight AI-182, but fell into the sea some 100 miles off the south west coast of Ireland, in international waters, with the loss of all 329 lives on boardtwo flight recorders recovered on 9 July (CVR) and 10 July (DFDR) respectively, using three vessels and the submersible tethered robots SCARAB I and II, able to operate at up to 1800 metres

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Black Box Detection

Flaws in Pinger technology

N.C. Kelland, "Deep-water black box retrieval," *Hydro International* **13** (2009).

- Current pinger frequencies are strongly affected by absorption.
- Current pinger source levels (SL) are too low to allow a detection over long ranges.
- Battery runs out because pinger work continually.
- All this could be circumvented by replacing the pinger with a transponder that is activated upon request, and transmits at a higher source level.

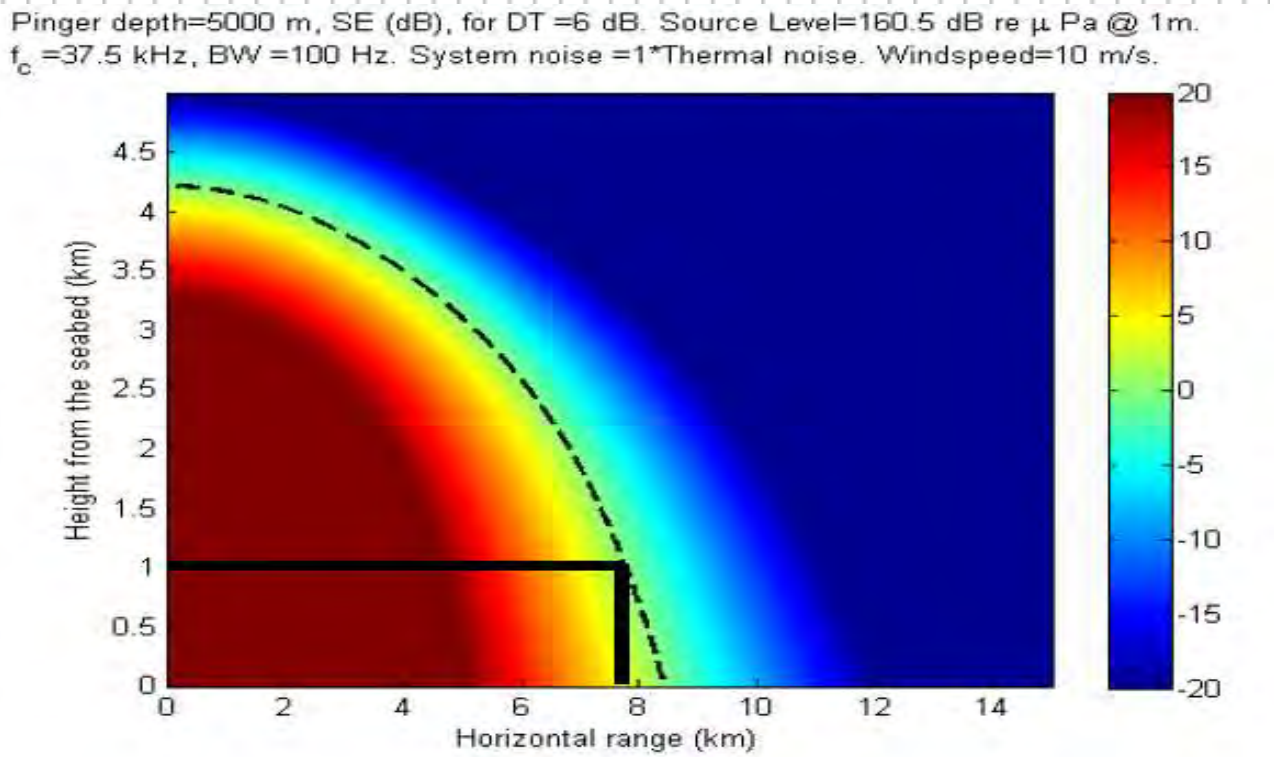
SPECIFICATIONS

Operating Frequency:	37.5 kHz (± 1 kHz).
Acoustic Output:	> or = 160.5db ref 1 µ Pa @ 1m.
Pulse Repetition Rate:	> or = 0.9 pulses per second.
Pulse Length:	> or = 9 ms.
Activation Immersion:	In salt or fresh water.
Power Source:	Lithium battery.
Battery Operating Life	
Stand-by (Shelf life):	6 years.
Operating Life:	30 days with standard lithium battery, 90 days with optional lithium battery.
Operating Depth:	20,000 feet (6,096 m).
Housing Material:	7075 T6 aluminum.
Dimensions	
Length:	3.92 in. (9.95 cm).
Diameter:	1.3 in. (3.3 cm).
Weight:	6.7 oz. (190 g) maximum.

Black Box Detection

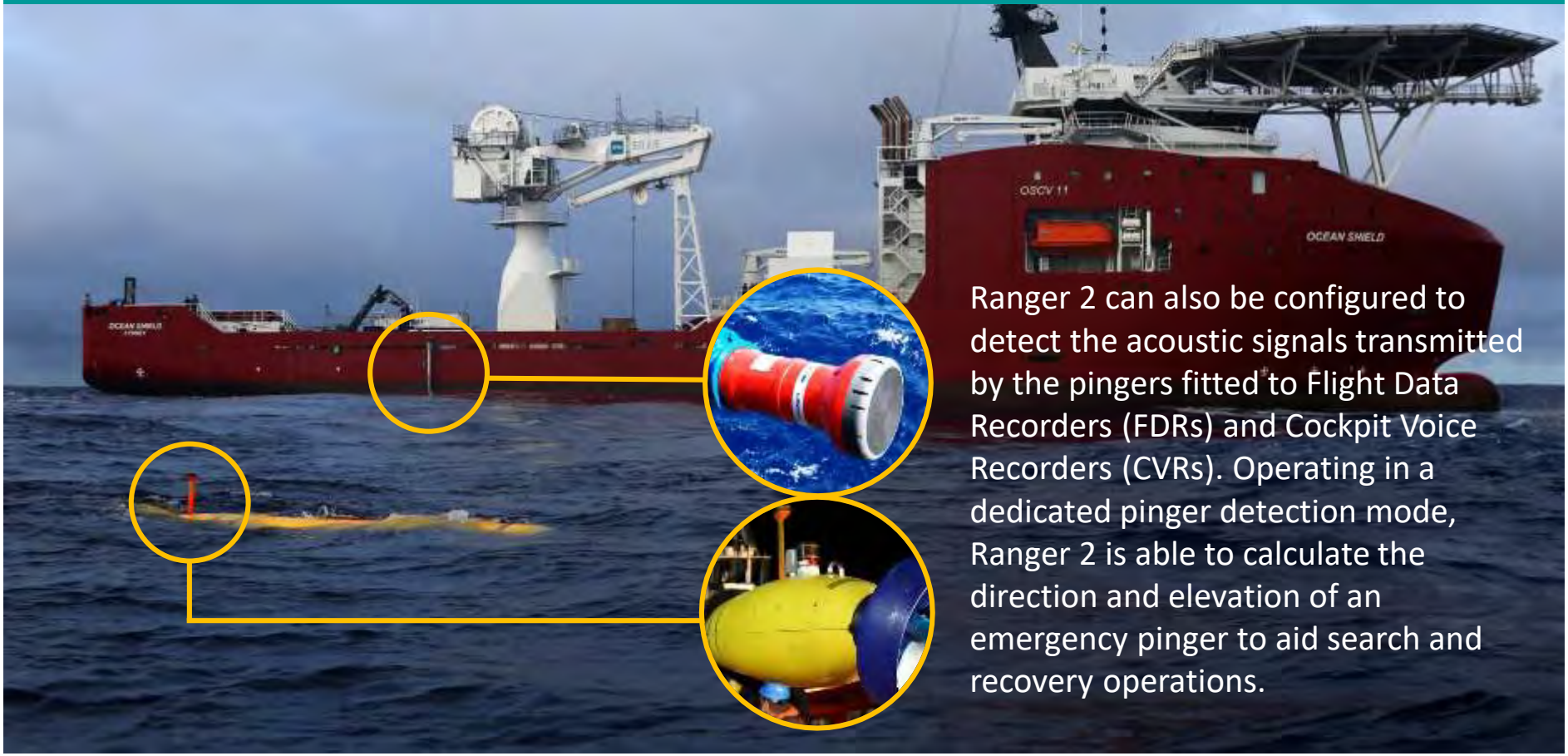
Some simple facts…

- Surface is noisy - quieter at depth
- Absorption decreases with depth



Black Box Detection

Supporting the search for MH370



Ranger 2 can also be configured to detect the acoustic signals transmitted by the pingers fitted to Flight Data Recorders (FDRs) and Cockpit Voice Recorders (CVRs). Operating in a dedicated pinger detection mode, Ranger 2 is able to calculate the direction and elevation of an emergency pinger to aid search and recovery operations.

Black Box Detection

ROV Homer

- ROV mounted range and direction unit
- Pilot selects the target he wishes to ‘home’ into and the unit determines range and direction.
- Data communicated to surface via the ROV umbilical and displayed on the user’s system.
- Indicates range and direction to turn in order to fly the ROV towards the pinger.
- HF (35–55 kHz)
- 0.1m range resolution
- 750m max range
- 4000m and 12000m depth rated versions

Courtesy Depp Ocean Search

Sonardyne

Your data where you need it; when you need it

Sonardyne
SOUND IN DEPTH