ECAC Group of Experts
on Aviation Accident
Investigation (ACC)

Second ECAC Workshop on Underwater Recovery Operations

Larnaca, 18-20 October 2010

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The ECAC Secretariat wishes to thank all participants who kindly put at its disposal their photos, many of which are used to illustrate this report.

INTRODUCTION

On 10-12 June 2009 there took place in Dubrovnik, Croatia, a workshop organised under the aegis of ECAC on the special challenges in locating and recovering aircraft and flight recorders lost beneath water, whether at sea or in rivers or lakes. The report of that workshop acknowledged that it had met its objectives, but also that not all of the issues around underwater operations had yet been addressed. In particular, the value was identified of a further workshop to consider the particular difficulties associated with location and recovery in deeper waters.

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A second workshop, this time orientated towards operations in such waters, was therefore organised by ECAC on 18-20 October 2010 in Larnaca, Cyprus. Hosted with great generosity by the Cypriot aviation authorities, the workshop's starting point was once again the reality that any State with a coastline or with aircraft on its national register may find itself responsible for conducting an investigation into an accident either in its territorial waters or on the high seas.

When an aircraft comes down in the sea, the already testing issues around access to the site and recovery of the wreckage and any flight recorders become doubly challenging, and potentially very expensive. This challenge can be greater still, and likewise the potential expense, if the water in question is of considerable depth. Its effective handling will call for a response which is rapid but at the same time very carefully planned, and which is coordinated across many parties.

The Larnaca workshop was designed to provide participants with an understanding of the elements of an effective response to an accident in circumstances where an aircraft has been lost in deep waters, in terms both of search procedures and of the types of equipment which may be required. It aimed at a sharing of learning, expertise and personal experience, and as in Dubrovnik in 2009 it included practical demonstrations, including at sea.

Led by M. PAUL-LOUIS ARSLANIAN as chairman of ECAC's expert group on aircraft accident and incident investigation (ACC), the workshop enjoyed support from the Air Accident and Incident Investigation Board of Cyprus, and full technical assistance from the French *Bureau d'Enquêtes et d'Analyses*. It was organised in detail by a Steering Group established within ACC. The seagoing element was greatly facilitated by EDT Offshore, which made available its ROV Support Vessel EDT ARES, and by Phoenix International, whose Remotely Operated Vehicle (ROV) REMORA was deployed from EDT ARES as part of a live exercise to demonstrate techniques suitable for deep water operations.

The workshop was opened by Dr ERATO KOZAKOU-MARCOULI, Minister of Communications and Works for Cyprus, and participants were welcomed by Mr COSTAS ORPHANOS, Chairman of the Cyprus Air Accident and Incident Investigation Board (AAIIB). Invitations to take part had been extended to ECAC's sister organisations and bilateral partners, and ACC was very pleased to welcome to Larnaca representatives from Morocco, Lebanon, Egypt, Singapore and China. A list of all of the workshop's participants is at Annex 2 to this report.

Organisation of the Workshop

The first day of the workshop opened with feedback on the 2009 workshop in Dubrovnik, as an *aide-mémoire* on location and recovery procedures already examined by ACC. There then followed a series of presentations by ACC members and observers on past cases of underwater recovery, and on the planning and organisation of such operations, together with briefings on products and techniques available to investigators.

The second day of the workshop was devoted to practical demonstrations and exercises at sea, which took two forms. One group of participants spent the day aboard EDT ARES, exploring a scenario involving the supposed loss of a light aircraft in deep waters south of Cyprus. This included the live deployment of the ROV REMORA to try to locate and recover the aircraft wreckage, flight recorders and any human remains. A second group of workshop participants was given a demonstration at sea by Advanced Concepts and Systems Architecture (ACSA), of the company's GPS Intelligent Buoys (GIB) system.

On the final day of the workshop, following detailed debriefings on the two demonstrations, there were further presentations on past deep-water recovery operations, including a progress report on the continuing work of the French BEA to locate Air France AF447 and its recorders. The recommendations already advanced in relation to such operations were discussed, and there were further briefings on products and services available commercially to investigators for operations in deep waters. Finally, the opportunity was taken to consider the updating of draft guidance on underwater recovery operations derived from the Dubrovnik workshop, in light of the additional learning in Larnaca.

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FIRST DAY OF THE WORKSHOP: MONDAY, 18 OCTOBER

Chairman's Opening Remarks

In responding to the welcome addresses by the Minister and Mr Orphanos, ACC and workshop chairman Mr ARSLANIAN expressed the group's gratitude to the Cypriot authorities for the kind invitation to hold the meeting in their beautiful country, and for the opportunity this gave participants to improve their knowledge of its people, history and culture. He also thanked all those, in Cyprus and elsewhere, who had worked so hard to prepare the workshop, including the members of the Steering Committee, the French BEA and its Director Mr JEAN-PAUL TROADEC, the ECAC Secretariat, and in particular Captain IOANNIS LOIZOU of the Cyprus AAIIB, for his invaluable contribution. Finally, Mr Arslanian thanked the workshop's speakers and participating companies, as well as sponsors Cyprus Airways and the Electricity Authority of Cyprus.

In opening the programme of work, Mr Arslanian observed that this was the sixth such workshop to have been organised by ACC, under the auspices of ECAC, in order to address specific and important aspects of aviation safety investigations. In 2000, a symposium in Tallinn had addressed the provision of assistance to the victims of aviation accidents and their families, and in 2002 ACC had reviewed in Nicosia the national implementation of aircraft accident and incident investigation requirements. In 2005, in Bucharest, the communication aspects of accident and incident investigation had been considered, and in 2006, in Athens, the drafting and issuing of safety recommendations. Most recently, the June 2009 workshop in Dubrovnik had addressed underwater recovery operations with an emphasis on relatively shallow waters, leading to the present examination of issues specific to operations in deeper waters.

The objectives of the workshop were to develop increased expertise and awareness within safety investigation authorities in Europe and beyond, on the proper handling of an aircraft accident in deep seas, and to foster cooperation between them. In any investigation, access to the crash site and to the wreckage was of primary importance. In cases where the aircraft crashed in the sea, or in difficult desert or mountainous territory, these aspects were a challenge in themselves and demanded an organised and rapid collective response. Preparation and real time action were difficult and expensive, and their improper management might degenerate into a crisis, not to mention the probable loss of evidence.

Without trying to elaborate a comprehensive list of all the challenges encountered in such cases, Mr Arslanian offered a few examples.

The tools, the necessary resources and even the organisation needed in order to perform the task would be different according to a number of parameters, the depth of the water being only one of them. The first step would be to reach as precise as possible an understanding of the environment and its specifics. A good knowledge of the available tools, and of other potential resources, was also needed for correct decisions to be taken.

Information contacts, feedback loops, coordination with all potential partners (for example, relevant military

and foreign affairs contacts, or colleagues from abroad) needed to be established as soon as possible — something which in the emergency circumstances generally prevailing would not always be straightforward.

Costs might vary dramatically, but as a rule of the thumb they would exceed the normal budget of any investigation authority. Countries typically had the resources to deal with the first days of a crash on land: it was different when the aircraft was underwater. Finding the budget and the resources would be a challenge, especially if the role of each actor on scene was not determined in advance.

Mr Arslanian explained that over its three days, through contacts, examples and personal experience, the workshop would seek to address the challenges and review the existing tools, in order to provide every participant with a comprehensive overview of what could be needed to handle effectively any accident situation with a deep water dimension. The first and third days would focus on the different equipment and strategies available, through a number of presentations, and — picking up where the Dubrovnik workshop had left off — the group would review recent experience at sea. Time permitting, it would also discuss how to further elaborate, in light of the learning in Larnaca, the draft guidelines on underwater recovery operations which had been part-prepared during and following the Dubrovnik workshop.

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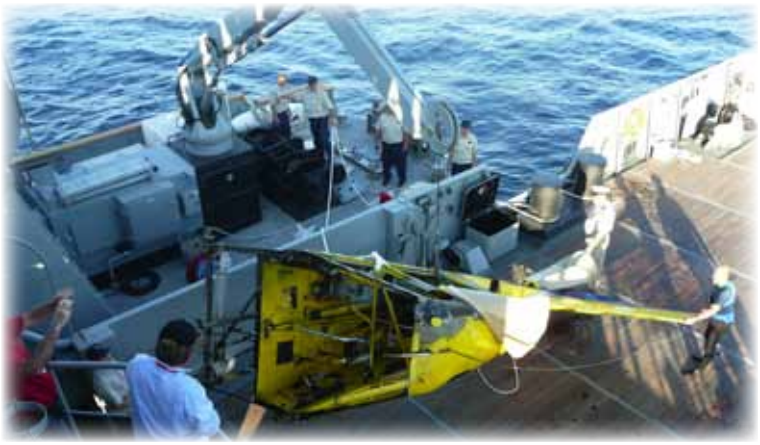
"FEEDBACK FROM THE JUNE 2009 DUBROVNIK WORKSHOP"

A PRESENTATION BY MR DINKO VODANOVIC, CROATIAN ACCIDENT INVESTIGATION BOARD, MINISTRY OF THE SEA, TRANSPORT AND INFRASTRUCTURE

The Dubrovnik workshop had opened with a briefing on aircraft accident investigation in Croatia, followed by a series of presentations by ACC members and observers on past examples of underwater recovery, including from lakes and rivers as well as from the sea, and discussion of the insurance option for the funding of expensive investigations. The workshop's practical exercises at sea were organised around a scenario involving a mid-air collision between a passenger airliner and a small general aviation aircraft, and involved the location and recovery of flight recorders and a substantial piece of aircraft wreckage.

Points registered in discussion in Dubrovnik included the constant challenge represented by the working environment at sea for any delicate operations, owing to the noise and movement of the vessel itself, the confined and sometimes less than laboratory-clean spaces available for working, the threat to electronics posed by water, and the length of time taken at sea simply to travel from point to point and turn, and to safely deploy and recover divers and inflatable craft. Merit was identified in establishing as much commonality as possible in the specification of equipment and software used by different European States, so that such resources could be loaned and used with ease, and shared ownership synergies realised.

The strong consensus view amongst participants was that the Dubrovnik workshop had been very successful, with good presentations and valuable practical exercises. All involved had been were conscious that the workshop had nonetheless addressed only some of the issues and challenges around underwater operations, and that the opportunity should be found to discuss what other elements the group should address, including consideration of the factors around recovery operations in deeper water.



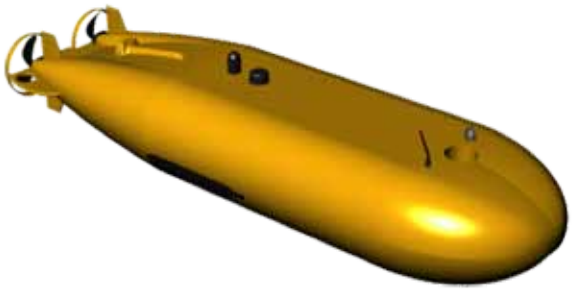
"PRODUCTS AND ASSISTANCE PROPOSED BY ATLAS MARIDAN"

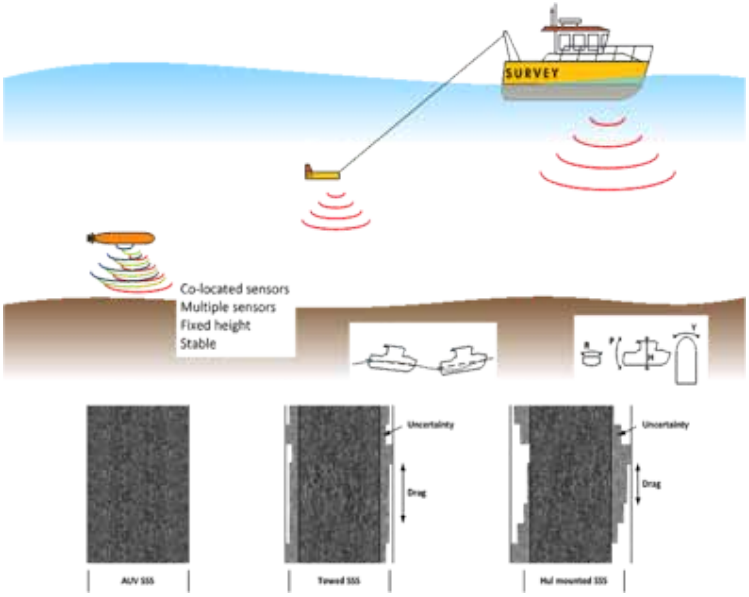
A PRESENTATION BY JESPER BAUNSGAARD, ATLAS MARIDAN, DENMARK

Atlas Maridan is wholly owned by Atlas Elektronik of Bremen, Germany and has its headquarters in Hoersholm, Denmark. Mr Baunsgaard followed up the Dubrovnik presentation on the company's Autonomous Underwater Vehicle (AUV) 'Martin' with one on its more sophisticated, free-swimming search robot 'SeaOtter' Mk II.

'SeaOtter' Mk II offered multiple sensors on a single stable vehicle, with a data output which was time-stamped and geo-located. It was containerised, mobile and had a survey crew of three, and as a battery-powered AUV it offered advantages over any ROV in being untethered, operable using its own navigation suite. It was capable of parallel operations with its support vessel, for rapid searching, and had sled-mounted payload capability for easy integration. It could be leased with or without its crew, and could be made available via a call-off contract.

SeaOtter Mk II's payload could include a Synthetic Aperture Sonar (Vision 600) with a 200m Swath at a constant 25mm/1 inch resolution specification. It could carry, simultaneously, a Reson 7125 multibeam echosounder, a L3 Klein 3000 side-scan sonar, a GeoAcoustics GeoChirp sub bottom profiler, and a camera. It had an obstacle avoidance capability, and could be configured with a sensor selection tailored for the particular mission purpose, including a pinger locator. For core vehicle and navigation specifications, see the slides reproduced at Annex 1 to this report.





"DEEP WATER SALVAGE OF DITCHED AIRCRAFT: UK MINISTRY OF DEFENCE SALVAGE AND MARINE OPERATIONS PROJECT TEAM"

A PRESENTATION BY JAMES WARD, ROYAL NAVY, UNITED KINGDOM

The UK Ministry of Defence's Salvage and Marine Operations unit had over a century's experience in recovering man-made objects from the sea, having been formed in 1906 following the grounding of the British battleship HMS Montagu and the subsequent recommendation that a professional salvage organisation be established. Notable past operations had included the 1954 Comet G-ALYY accident, the recovery five years later of an RAF Victor MkII, and two Nimrod recoveries in 1995. Since then the unit had been involved in recovery operations involving forty aircraft of all kinds, including helicopters.

The civilian-manned unit was headquartered at Bath in south west England, and had Marine Salvage out-stations at Greenock (Scotland) and Plymouth. It held a small amount of high-value air-portable equipment, otherwise hiring in platforms and other tools, and an annual operating budget of some £5m. Aircraft recovery tasks had been undertaken by the unit at depths of up to 4,000 metres, in a variety of seabed conditions. Increasingly, the team was called upon to recover such objects as weapons systems and autonomous air and under water vehicles, often small in size and not generally fitted with locator beacons.

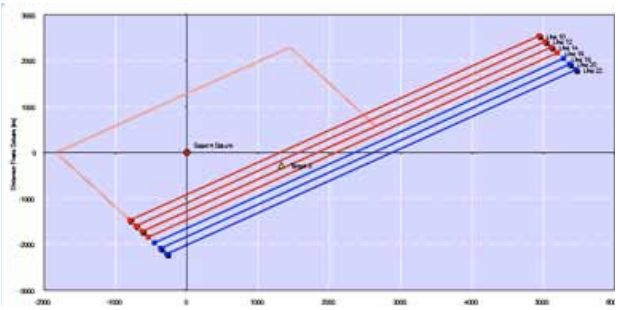
Mr Ward presented as case studies two particular recovery operations undertaken by the Salvage and Marine Operations team.

In December 1994, a Royal Navy Sea Harrier was lost in the Adriatic Sea during a carrier deck landing, sinking in 720 metres

of water. The aircraft was located on the seabed using the GPS fix made at the time of the accident, combined with its sonar locator signal picked up

by three hydrophones. Photographic evidence and eyewitness accounts having indicated that the aircraft was virtually intact, the Dynamic Positioning Vessel AQUAMARINE was contracted, together with a "Super Scorpio" work class ROV. Once on site, the ROV undertook a series of north/south runs using side-scan sonar at 50m range, in poor seabed visibility. After delays occasioned by malfunctions of both the ROV and aboard the AQUAMARINE, a section of wing was located 348 metres north east of the datum position, and the main body of the aircraft, inverted, some 360 metres from that position on the same heading. The aircraft was recovered in deteriorating weather, using strops attached by the ROV to the main and nose undercarriage, in an operation during which the ROV's (single) manipulator was damaged. In subsequent ROV dives the separated wing section and ejector seat were recovered, the grappling hook being manoeuvred using the AQUAMARINE's Dynamic Positioning capability.

The second case study concerned the loss in June 2002, following a catastrophic engine failure, of a Royal Navy Lynx Mk 8 helicopter operating from HMS Richmond 200 miles off Cape Hatteras in the Atlantic. The locator beacon was understood to have ceased operating after eight hours, and the recovery operation was rendered additionally complex by the need to deal with armaments carried by the Lynx. A contract was signed with Oceaneering International for the hire of the Dynamic Positioning Vessel THE PERFORMER, equipped with a Deep Ocean Side-scan Sonar vehicle (DOSS) and a Magellan 750 ROV.



On arrival on site, a search pattern grid was established for a box measuring 4000 metres by 2000 metres, with a lane width of 150 metres, using estimates of the aircraft's drift on sinking and with the direction of search aligned with the expected sea surface current. Deployed on this grid, the DOSS identified a number of potential targets to the north east of the initial search area, although no locator beacon signal had been detected. The search pattern was extended 3000 metres in this direction and in time a firm contact was made. The subsequent ROV operations were much prolonged by technical faults on the vehicle, but the contact was at length confirmed as the Lynx, inverted at a depth of 3837 metres, some 800m from the initially estimated position.

The aircraft's missile, still attached to its weapon carrier, was the first concern of the recovery team. It was able to be separated from the wreck using a special tool fabricated to a Royal Navy pattern, wielded by the ROV manipulators. A main lift line was attached to the helicopter's 'Semi Automatic Cargo Release Unit' hook, that being the strong point on the Lynx for carrying underslung loads. Strops, not intended to be load-bearing, were attached to the three undercarriage points, in case the aircraft broke up during the lift. The initial lift failed when chafing led to the parting of the line, and a stronger cable had to be substituted. Once the ROV had been deployed to clear the wreckage of fallen line, and following further delays caused by a tropical storm, the Lynx was lifted at a rate of some 10 metres per minute and brought aboard THE PERFORMER with minimal collateral damage.

Amongst the lessons learned from this recovery operation was the value of having contingency arrangements and equipment in place, as demonstrated in the need to use an alternate main lift line, and the call which was made on THE PERFORMER's stock of transponders (these having proved surprisingly unreliable). There were also on board THE PERFORMER an additional ROV and a spare umbilical for use with the ROV/DOSS, although neither proved to be needed.

"DATA RECOVERY — A SALVOR'S PERSPECTIVE: UK MINISTRY OF DEFENCE SALVAGE AND MARINE OPERATIONS PROJECT TEAM"

A PRESENTATION BY MARK LOUGHLIN, ROYAL NAVY, UNITED KINGDOM

Mr Loughlin presented an overview of a typical vessel selection and charter exercise for the salvage of an aircraft lost at sea, identifying the main options and highlighting key risks and pitfalls.

The supposed location of the aircraft/recorders was the key factor in vessel selection: the depth and visibility of the water, the currents and tides, and the prevailing weather. Also important were the proximity of the nearest useful port and the availability of suitable vessels in the region. The depth of the aircraft/recorders was the primary constraint on the recovery options, with air diving feasible at depths up to 35 metres, saturation diving at up to 500 metres, work class ROVs at up to 2000 metres[1], specialist ROVs at up to 6000 metres, and very specialist (and scarce) ROVs at below that depth. The strengths and weaknesses of each of these options are detailed in the slides reproduced at Annex 1 to this report.

In approaching the vessel chartering market it was important to issue, through ship brokers, a "Statement of Requirements", indicating the deadline for responses. This Statement should specify the size of the lost aircraft (which would dictate eg the craneage and deck space needed), the depth of the crash site, any human remains issues, the expected duration of the operation, any ancillary issues (eg need for a heli-deck), and any auditing and certification requirements. In then selecting from the proffered vessels, the questions to be addressed would include the capability of the vessel to perform the required task in the time available, its present location and availability, and the *entire* charter cost, including transit times and mobilisation/de-mobilisation. The last of these factors needed particular attention: either a fixed price or a daily rate might apply, and there may be "hidden" costs, for example that of the time taken for divers to decompress, which may be up to a week.

Most of the vessels suitable for aircraft salvage were employed in support of the offshore oil and gas sector, notably in the North Sea, the Arabian Gulf, the Gulf of Mexico and in the seas off West Africa. The chartering of a saturation diving vessel in the North Sea might cost £150,000 (173,000 euro) per day, and larger vessels may carry a crew of 70-80 persons.

Very few vessels were designed and fitted to support operations at depths of more than 2000 metres, and so it may be necessary to charter the vessel and hire the additional equipment separately. This can however give rise to complications in relation to compatibility (power supplies, deck loadings etc). The suppliers of an ROV would specify the dynamic positioning capability (ie DP0, DP1, DP2 or DP3) needed of the vessel from which it could be operated. The total cost of a vessel charter might be simply stated as "Mobilisation + (daily rate x duration) + demobilisation".

It was very important for the charterer, as "principal contractor", to be aware of any shared responsibilities it may have assumed, for example in relation to a sub-sea pipeline being damaged by the vessel during the recovery operation. It was also important to establish that the vessel had the required certification, and to see evidence of appropriate safety equipment, training, maintenance, pollution insurance etc; of its certification by the Flag State and Classification Society; its Common Marine Inspection Document audit; its Diving Equipment Systems Inspection Guidance Notes audit; and evidence of its Safety Management System.

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1 It was noted in discussion that modern work class ROVs could today operate at up to 3000 metres.

An important player in all of this was the International Maritime Contractors Association, which represented offshore, marine and underwater engineering companies. Separate categories existed for contractors, suppliers of equipment, consultancies and training providers, and guidance was offered on all areas of offshore operations.

In sum: vessel chartering is complex and can be costly - but can be even more expensive if mistakes are made. It is important to obtain as much advance information as possible about the nature of the crash site, and about the capabilities of the vessel intended to be hired, *before* chartering, and similarly to understand the nature of the task before selecting the other tools. The contract ("charter party") with the vessel provider should be checked carefully for its fairness and balance. And finally - employing an expert is expensive, but not as expensive as employing a non-expert.

"REVIEW OF ATR 72 TS-LBB SEARCH AND RECOVERY OPERATION"

A PRESENTATION BY MARIO COLAVITA, AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO, ITALY

Mr Colavita presented as a case study the location and recovery of ATR 72-202 TS-LBB, which in August 2005 ditched off Palermo following a dual engine failure, with 39 persons on board. On impact, the aircraft broke into three parts, with 16 of those aboard suffering fatal injuries, and all of the remainder incurring serious or minor injuries.

The Palermo airport tower launched the search and rescue operation, advising the nearest Coast Guard Maritime Rescue Sub Centre of the point of impact. In the course of the ensuing operation thirteen patrol boats, two zodiacs, a water ambulance and three helicopters were deployed, under the coordination of the Coast Guard. The crash site was reached first by a helicopter some 31 minutes after the accident.

The forward and rear sections of the ATR (the latter containing the flight recorder fittings) sank some 45/50 minutes after the ditching, in around 1500 metres of water. The central (ie wing and engines) section stayed afloat until recovered later the same day, and was climbed onto by survivors.

The location and recovery operation was coordinated by the Italian Navy, with the missing parts of the aircraft being found after a three and a half day search of a 10x10 nautical mile square, centred on the location of the wing section, by the ocean research vessel AMMIRAGLIO MAGNAGHI and the oceanography ship UNIVERSITATIS. The search was conducted using a multibeam acoustic sounder (ELAC BOTTOMCHART Mk II, 50 KHz), with a 50% overlap between search lines spaced at 1000 metres and orientated east/west. The vessel speed was 3 to 6 knots.

In narrowing the search to an area of 2.5 sq kms a single beam acoustic sounder was also deployed (SIMRAD EA 6000, 38 KHz), with the track spacing for this phase reduced to 100 metres and the orientation both east/west and north/south. There then followed a side-scan sonar search, the sonar being towed by a REMORA 6000 ROV supplied by Phoenix International and operated from the EDT ARES, onto which the tail section of the ATR was subsequently recovered. The cockpit voice recorder was found in place in the wreckage, but the flight data recorder was missing. It was subsequently located and recovered following detection of its 37.5 KHz pinger signal.

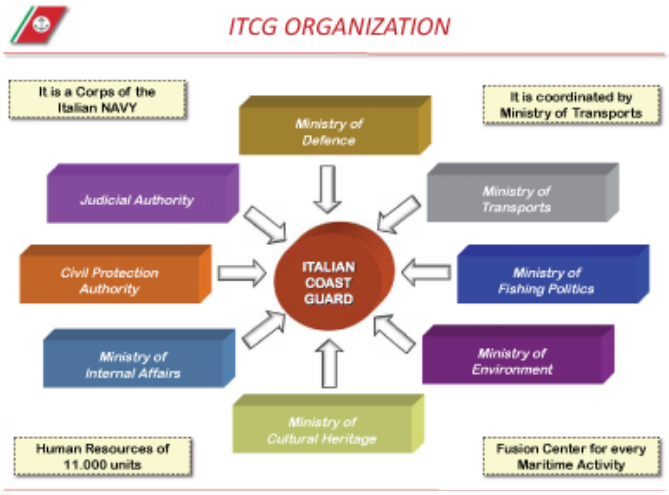
The lessons taken away from this operation by the Italian authorities included the considerable challenge posed by identifying and deploying the necessary resources, under tight time constraints, and the need for careful coordination across many different actors. The international dimension was critical, as too were the relationship with the judicial authority, and the communications aspect, with the media, the relatives of the victims, and public opinion generally.

"PLANNING AND COORDINATION OF SEARCH AND RESCUE OPERATIONS IN THE EVENT OF AN AIRCRAFT ACCIDENT AT SEA"

A PRESENTATION BY LT. VALERIO MAZZARINO, ITALIAN COAST GUARD HEADQUARTERS

The Italian Coastguard is a unit of the Italian Navy employing some 11,000 persons, its activities coordinated by the Ministry of Transport. It is a focus for all maritime activity, including in relation not only to SAR but also to environmental protection, fishing, maritime heritage, defence and judicial affairs.

The Coastguard's search and rescue function is headquartered in Rome but has 16 Maritime Rescue Coordination Centres and 227 smaller Coast Guard Units. It operates 20 aircraft (including 12 helicopters) from 3 aerodromes, in Northern and Central Italy and in Sicily; and some four hundred vessels operated from 113 naval bases. 40 of these vessels are long endurance patrol boats, 95 are all weather search and rescue boats, and 265 are coastal patrol boats. In 2011, the Coastguard will take delivery of a new, multi-role vessel (pictured below) equipped with an ROV and side scan sonar able to operate to a depth of 2500 meters. This would be available for inter-governmental loan. The Coastguard presently has five groups of divers, with 80 divers in all, and an ROV able to operate to a depth of 300 metres.



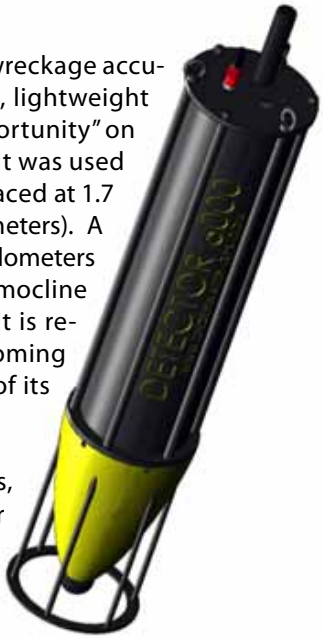
The Coastguard's Contingency Plan for SAR operations is based on prompt receipt of any alarm, clear and simple procedures, and good high-level coordination. Its local risk assessment procedure takes account of the location of coastal airports, take-off, flight and landing routes, seabed morphology, prevailing winds and currents, areas for anchorage, and any danger areas. A holistic approach is taken in the event of an alarm, bringing together the ATS provider, civil aviation entities, the SAR organisation, and civil protection agencies. There is reliance upon a pre-planned sea/port interface, with eg disembarkation, helipad, mobile communications, first aid, and SAR boats waiting areas all defined in advance. Further detail of the Coastguard's incident planning and coordination arrangements is in the slides reproduced at Annex 1 to this report.

The Coastguard also has an important training element, with a course for SAR operators provided by the ANSV's safety investigators. There is also joint training by the ANSV and Coastguard, an operational information exchange, and joint exercises. Exercises are also conducted with other States, with invited international observers.

"ADVANCED TECHNOLOGIES FOR HAYSTACK FINDING, NEEDLES POSITIONING AND BLACK BOXES RECOVERY"

A PRESENTATION BY HUBERT THOMAS, ADVANCED CONCEPTS AND SYSTEMS ARCHITECTURE (ACSA)

Mr Thomas suggested that efficiency in location and recovery was best secured through a careful sequencing of the operational phases, step by step. This began with gaining an understanding of the accident environment, and progressed through location of the general area of the loss (the "hay stack"); location of the underwater location beacons (ULBs) attached to the recorders (the "needles"); determination of the depth of the wreckage; selection of an appropriate means of recovery; and then a recovery which homed directly and speedily onto the targets (VDR and FDR).



The solution offered by ACSA to the need to locate wreckage accurately and quickly involved a team of 2 or 3 experts, lightweight equipment able to be carried on commercial airlines, and use of a "vessel of opportunity" on site. ACSA's new product DETECTOR-1000 offered a very long detection range. It was used to locate the "haystack" over a very wide search area, by conducting stations spaced at 1.7 times the detection range. (In deep water, the grid size could be as large as 10 kilometers). A ship with a transit speed of 20 knots would achieve a coverage rate of 176 square kilometers per hour. DETECTOR-1000 is a Dip Detector which is deployed below the thermocline and sea surface noise. Once it has acquired the pinger signal for five minutes it is recovered aboard and dipped again at a second location, in order to generate a homing direction. Its operation is not dependent on weather conditions. More details of its capabilities are in the slides reproduced at Annex 1 to this report.

The next step was locating the "needles". At a water depth of up to 300 meters, this could be accomplished by ACSA's GIB-Lite product, and by GIB-Plus for depths up to 2000 meters. Guiding the recovery team to the wreckage at up to 300 metres was possible using GIB-Lite, with the vessel's USBL used for wreckage lost at greater depths.

ACSA's GIB buoys comprise a GPS receiver, an acoustic receiver, and a UHF radio. With these, a positioning accuracy of up to within 1 metre for the pinger being sought was possible: during a recent ACSA operation in more than 1000 metres of water it had taken only 15 minutes for the ROV to find the lost aircraft using coordinates calculated using GIB buoys data. GIB equipment had been used in the recovery operation for the 2004 Flash Airlines crash at Sharm El Sheikh, the 2006 Airbus Black Sea Sochi crash, and for the recovery of a military helicopter in the Red Sea in 2007.

In 26% of accidents, the ULB becomes separated from the flight recorder. Further, in some cases, recorders are buried. ACSA's "Red Stripe Lemon Float" addressed this by enabling the recorder's position to be evident when below mud during imaging dives, allowing for homing by the recovery robot and automatic recovery. Its vertical float line facilitates gripping in automatic mode.

This float (pictured here and on page 19) was of particular interest for a new family of underwater robots arriving on the market, called 'Hybrid ROVs'. These are unmanned vehicles able to be operated either in an autonomous mode or by re-

mote control from the surface with only an expendable fibre connecting the vehicle to a surface drift buoy. The key feature of the HROV is that it does not require the involvement of a ship with Dynamic Positioning, and thus offers a very significant advantage in search and recovery operations. The same vehicle can undertake seabed mapping and recorder recovery.

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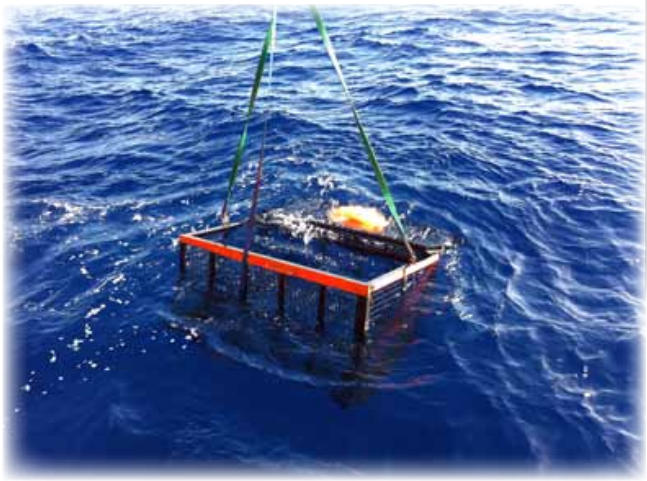
SECOND DAY OF THE WORKSHOP: TUESDAY, 19 OCTOBER

Aircraft Location and Recovery Demonstration by EDT Offshore and Phoenix International

The scenario for the day's principal demonstration was the loss at sea of a Cessna C152 en route from Larnaca to Beirut. The aircraft had taken off at 8.30am, and was reported at 8.55pm to be ditching following engine failure. ATC contact was lost at 8.59am, immediately following which the Larnaca Tower initiated a Crash Alarm. Soon afterwards, debris was spotted in the sea by a passing merchant vessel, and by 9.30am the Cyprus AAIIB had contacted EDT Offshore to give it the go-ahead to begin a search and recovery operation.

EDT Offshore deployed the EDT ARES, a Dynamic Position (DP2) vessel equipped with a 30 tonne Hydramarine Knuckle Boom Crane, a 15 tonne Hydralift Stiff Boom, and a 25 tonne A-Frame. The vessels carried Phoenix International's REMORA ROV, capable of operating at up to 6,000 metres and equipped with twin manipulators and a 37.5 KHz homing device. The EDT ARES carried a basket compatible with REMORA operations, for collecting debris and (separately) any human remains.

The EDT ARES transited to the crash location (as notified by the merchant vessel), and at 11.45am the ROV was lowered into the sea. It reached bottom at 11.52am, where it was joined at 12.03pm by the collection basket



lowered from EDT ARES. The ROV search began with a 360° sweep using the REMORA's directional hydrophone, visual cameras, and forward-looking sonar. Two pings were heard, and the REMORA was steered on a bearing towards the stronger of the two. At 12.13pm visual contact was made with the aircraft wreckage, which was identified as the source of the 37.5 KHz ping.

The options at this stage were to survey the site; to survey the wreckage taking images of the instrument panel and locating the ULB; or to locate the second ULB. As it was proving difficult to get a good fix on the second ULB it was decided to recover the wreckage, and so in the process remove one beacon from the water. By 13.08pm the aircraft had been rigged for recovery by the REMORA, and by 13.24pm it had been lifted onto the deck of the EDT ARES and secured there.

The search for the second ULB was then resumed but homing in on the pinger continued to be problematic. The options were to establish a search grid, or to triangulate on the signal from three or more locations. But at this point the time available for the exercise expired, and the operation was concluded by the recovery of the REMORA and basket, and the EDT ARES' return to Limassol port.

Those workshop participants not involved in the ACSA demonstrations (see page 19) spent the day aboard the EDT ARES, witnessing the launch and recovery of the REMORA and able to follow live and in detail its search and location of the Cessna C152 wreckage via the REMORA's underwater TV camera feed. Participants were later able to witness the recovery aboard the EDT ARES of the wreckage of the aircraft. Live commentary was provided during critical parts of the search and recovery operations, and participants were also fully briefed on the operation of the vessel, including through visits to the Dynamic Positioning station on the ship's bridge, the survey room, and to the control room from which the REMORA was steered.

Advanced Concepts and Systems Architecture (ACSA)
Demonstration of GIB-Lite System

The ACSA GIB-Lite demonstration set out to show that positioning accuracy is a key to success in search and recovery operations.

The exercise was conducted in the waters off Limassol old port, and involved the transporting of workshop participants aboard the work boat CYDIVE II to the exercise area; the dropping at random of an Underwater Locator Beacon (ULB); the depositing in the surrounding waters of four GIB-Lite buoys and use of their GPS telemetry to estimate the ULB's longitude and latitude, and the depth of the water in which it lay; the dropping and mooring of a weighted line, fitted with a transponder, over the ULB's calculated location; the descent of a diver down the line and his guidance to the ULB; and recovery of the ULB and associated flight recorder using a inflatable red float.

The exercise was conducted twice during the day to allow as many workshop participants as possible to witness the operation. The time taken for the different elements of the exercise was shorter, in some cases considerably so, during the second exercise, demonstrating the value of experience and training. The operation was wholly successful in each case, but whereas the first exercise took 2.3 hours, the second took only 1.5 hours.

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THIRD DAY OF THE WORKSHOP: WEDNESDAY 20 OCTOBER

The final day of the workshop opened with a de-briefing on the previous day's demonstrations. This fed into the discussions which followed, on the updating of guidelines for use by those involved in underwater location and recovery operations.

Completion of the Preliminary Guidelines part-prepared following the Dubrovnik Workshop

Following the Dubrovnik workshop in 2009 some preliminary guidelines on underwater recovery operations were part-prepared by participants, to capture the learning from the workshop. The Chairman explained that the opportunity would now be taken to revisit and complete these guidelines in light of the additional learning from the present workshop, for example to include material bearing on vessel chartering, on the benefits of sequencing carefully the elements of a location and recovery operation, on the management of human remains and personal belongings, and on arrangements for handling victims' relatives. The guidance would also be updated in its coverage of the equipment available for operations at sea.

Consideration was given by participants to how much and which parts of the wreckage of an aircraft, apart from the flight recorders, should be recovered, following an accident in water. After a thorough mapping of the wreckage and documentation of the various parts present on the seabed, there was an argument for recovering only those which were judged to be relevant to identifying the cause of the loss, especially if the aircraft in question was very large and the platform's deck space limited. In the case of the Airbus A320 lost off Perpignan in November 2008, the investigators present on board the recovery vessel had, following an analysis of the wreckage and of the existing data, established a "shopping list" of those parts of the aircraft they believed it would be desirable for the divers to recover. No attempt had been made to raise the whole of the wreck. It was recalled that the search phase of the investigation into the loss of TWA 800, in July 1996, had been prolonged by two years in order to look for certain specific parts of the aircraft, which were never in the event located.

The counter-argument was made, that once the recovery platform was on site, and those costs incurred, it was both a false economy and more straightforward to recover as much as possible of the wreckage and only then undertake the examination of key parts, in an easier environment. While on the seabed the wreckage would moreover be subject to movement by currents, confusing the evidential record. It was pointed out that such a strategy was more appropriate where the accident involved a small aircraft, especially when its components were not too widely scattered, and that the availability of the necessary facilities on land to store correctly the recovered parts and to work on them was also an important element to take into consideration. Reducing the number of days at sea was not necessarily a global economy for the investigation, nor a guarantee of efficiency. In short, both arguments had their strengths, and it was a matter of balancing the various considerations.

It was agreed that the workshop's Steering Group should revise the draft guidelines, including in light of comments offered in writing by the workshop's participants, with a view to them being considered at the December 2010 meeting of the ACC. In due course the ICAO Secretariat would be informed of this work.

Further Presentations

There were then the following additional presentations on issues associated with underwater recovery.

"FUGRO: AN INTRODUCTION TO A COMMERCIAL GEOSCIENCE CONTRACTOR WITH A TRULY GLOBAL REACH

A PRESENTATION BY ERIC ROBERTSON, FUGRO SURVEY LIMITED, UNITED KINGDOM

Mr Robertson first provided participants with an overview of Fugro, as a leading service provider in the collection and interpretation of data relating to the earth's surface and sub-surface, and in the support of infrastructure developments on land, at the coast and on the seabed. Amongst its resources Fugro counted 50 vessels, 50 aircraft, 126 ROVs and 8 Autonomous Underwater Vehicles (AUVs). More detail of these and other Fugro services and resources is in the slides at Annex 1 to this report.

Mr Robertson then gave a presentation focused on Fugro's AUV capabilities. These included deployment of the Echo Surveyor, Echo Mapper, Remus and Gavia Surveyor Hafmynd ranges of AUV. These carried essentially standard sensors, but their untethered operation allowed for efficient working in remote and challenging waters. Seabed surveys and pipeline inspections and route reconnaissance had been carried out at depths of 3000 metres and beyond.

DW search & identification tools – AUV & ROV

Echo Surveyor – I & II
Kongsberg Hugin 3000

Echo Surveyor – III & IV
Kongsberg Hugin 1000 / 3000

Echo Mapper – I & II
Bluefin 21

Skandi Carla DP2 ROV support

Recovered plane

FCV3000 Workclass ROV

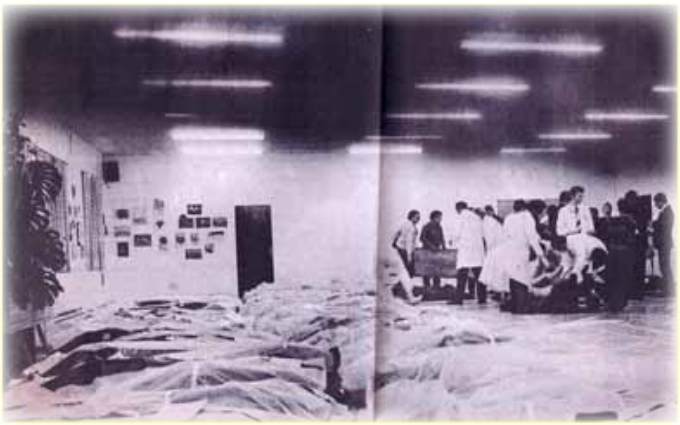
"THE AIR INDIA ACCIDENT: A TRULY INTERNATIONAL EFFORT"

A PRESENTATION BY JURGEN WHYTE, AIR ACCIDENT INVESTIGATION UNIT, IRELAND

Mr Whyte described the search, rescue and wreckage recovery operation which followed the loss on 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 board.

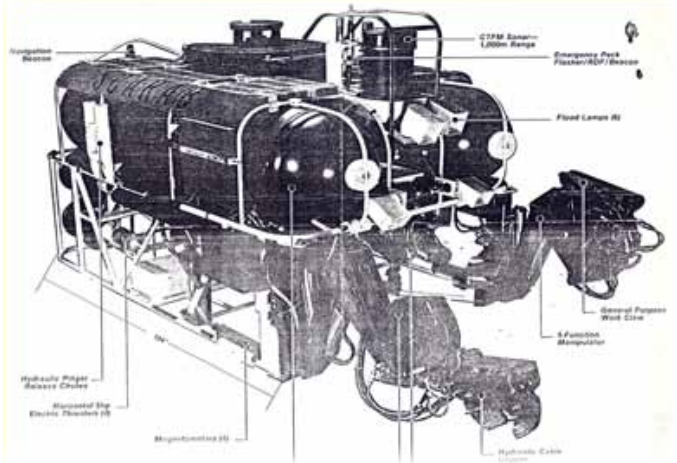
Under ICAO Annex 13, responsibility for investigating the accident lay with India as State of Operator and Registration. India fully accepted this responsibility and accordingly ran the investigation, with international assistance, and compiled and published the Final Report. An Indian Justice was appointed to oversee the entire investigation, and a Court was set up for that purpose. The Court then appointed an Investigator-in-Charge (IIC) to carry out the investigation. A team of Indian officials at once flew to Cork, Ireland, arriving on 24 June.

The early stages of the emergency response saw all local shipping directed to proceed to radar position 51N 12°50W. Cork Regional Hospital, the nearest A&E hospital, was alerted to a possible influx of casualties, and all ATC, radar and telephone recordings were impounded. Within an hour of the loss of radar contact, UK Royal Air Force Nimrod and Sea King aircraft were en route to the location, and very soon afterwards an ELT signal was detected by Shanwick Oceanic Control. Life rafts, wreckage and bodies were sighted floating in the water, and a prohibited flying area was established with a 40 mile radius up to 5,000 feet.

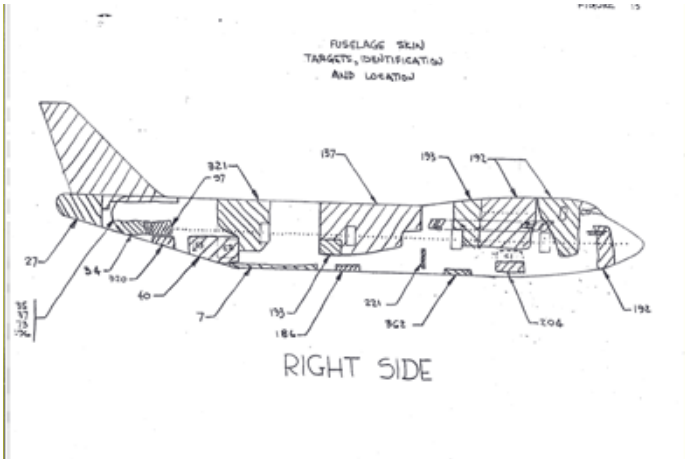


A Control Centre was set up at Cork Airport for the coordination of the ships involved in the body and wreckage recovery operation at the accident site. This was manned by Canadian, Indian, Irish and US representatives, with Indian naval officers in overall control. The Irish naval vessel LE AISLING assumed the role of on-scene-commander at sea. The first day of the operation saw the recovery of 130 bodies, and another was recovered the following day. In all, only 39% of all those on board were recovered.

The bodies of the victims were brought under military and police escort to Cork Regional Hospital, labelled numerically and formally certified as dead. A Senior Registrar with detailed knowledge of Indian Customs and Traditions was appointed. Five refrigerated containers were used to hold the bodies. Post-mortems were conducted by three pathologists, and by 28 June all victims had been photographed and fingerprinted, subjected to autopsy, forensic and dental examination, embalmed, x-rayed and coffined. Through the Interpol pink/yellow form process, identification of the victims followed, and photographs were taken and shown to the relatives prior to viewing.



Relatives arrived in Cork in very large numbers, showing a strong wish to be physically and psychologically close to their loved ones. All but 49 of the dead were Canadians of Indian origin, with various religious beliefs, cultures and customs. Each family of relatives had assigned to it a police officer and counsellor, and accommodation was provided in local hotels and family homes within a 20 mile radius. The visual identifications took place between 27 June and 6 August. The formal inquest into the deaths by an Irish Coroner was held between 17 and 23 September, with verdicts returned in accordance with the medical and pathological evidence.



The investigation of the accident was undertaken through the formation of a number of working groups of technical experts from Canada, India, the UK and the USA. The remits of each group are detailed in the slides reproduced in the Annex to this report. The recovery operation, which was coordinated by the Indian Court, saw the two 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. The robots operated to the maximum of their capability in recovering the recorders. These were found to be in generally good condition, and after being specially packed they were taken to Bombay under Indian escort for download.

The wreckage salvaged from the sea was first examined visually at Cork by a committee of international experts. For further wreckage recovery, an Indian assessor and aircraft maintenance personnel were located on the wreckage recovery ship. They were supplied with recorded video and still photography from the seabed, and used manufacturers' drawings, parts catalogues, wiring diagrams and manuals to identify the individual items. All recovered components/parts were washed and treated with corrosion-inhibiting compounds. Each item was inspected, observations recorded and labelled. Any significant items were segregated for further examination. This operation was completed by 1 October. The next phase was to recover significant wreckage and parts from the seabed. This operation began in the first week of November, and lasted for approximately one month. All significant wreckage was then transported to the Bhaba Atomic Research Centre at Bombay for further examination.

Of particular interest was Target 362 "Forward Cargo Skin" and Target 399 "Fuselage around 2R door". The Final Report of the investigation stated:-

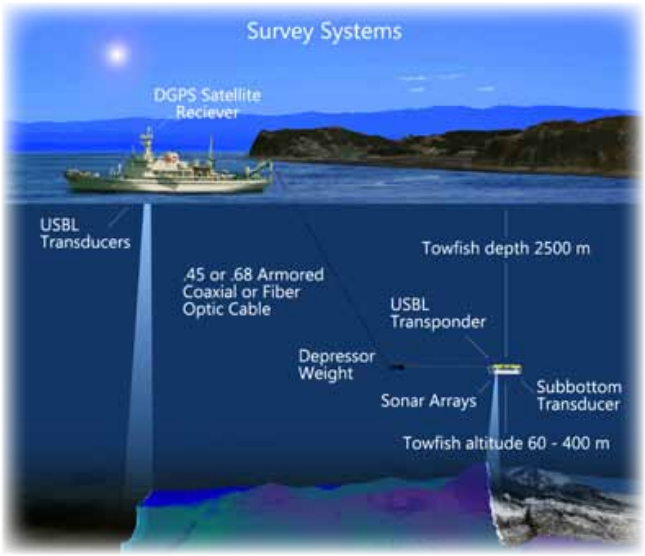
"A metallurgical examination, especially of Target 362 and Target 399, clearly confirms that there was an explosion in the forward cargo compartment. Microscopy around some of the holes discloses that they have such characteristics like twinning which can be present only if the holes had been punctured due to the detonation of an explosive device".

"STATUS OF THE PROSAS SURVEYOR PS60-6000 DEEP TOW SYNTHETIC APERTURE SONAR (SAS) SYSTEM"

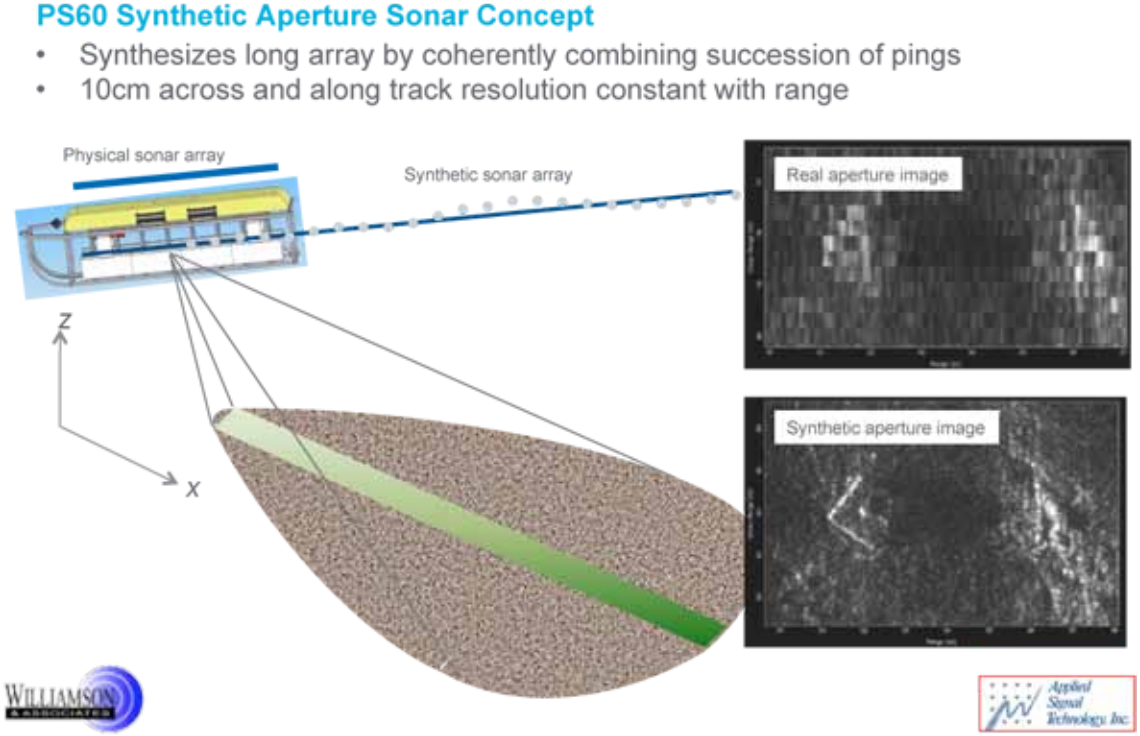
A PRESENTATION BY COLIN STEWART, WILLIAMSON AND ASSOCIATES, INC

Mr Stewart first described Williamson and Associates, as a Seattle based marine geophysical consulting firm providing object search and identification services, engaged in cable and pipeline route surveying and the undertaking of hydrographic and geophysical surveys.

Mr Stewart then gave a presentation on the ProSAS-60 6000 metre rated Synthetic Aperture Sonar System, developed in concert with Applied Signal Technology Inc. This deep-tow concept synthesized a long sonar array by combining a succession of pings. The equipment comprised a towed 2000 lb depressor weight followed by a 50 metre buoyant tether to a neutrally buoyant tow body/ sensor platform. This platform housed the SAS sonar electronics, a Kearfott T-18 INS, a Teledyne RDI 150 KHz DVL, an IXSEA Posidonia SSBL, a Paroscientific Digiquartz Depth Sensor, an AML Oceanographic Sound Velocity Profiler, and a Xenon strobe / RDF beacon. Detail of the sonar navigation design, the Projector Arrays and the Receive Array Modules are in the slides reproduced at Annex 1 to this report.



The ProSAS Surveyor PS60-6000 was presently in the build and procurement phase, with integration and testing due to take place between October and December 2010 and sea trials from December to mid-January 2011. It was expected to be available from that date. Future upgrades would include dual transmitters (Projectors) to double the area coverage rate, a gap-filling sonar with a similar resolution providing imagery and bathymetry, and AUV implementation.



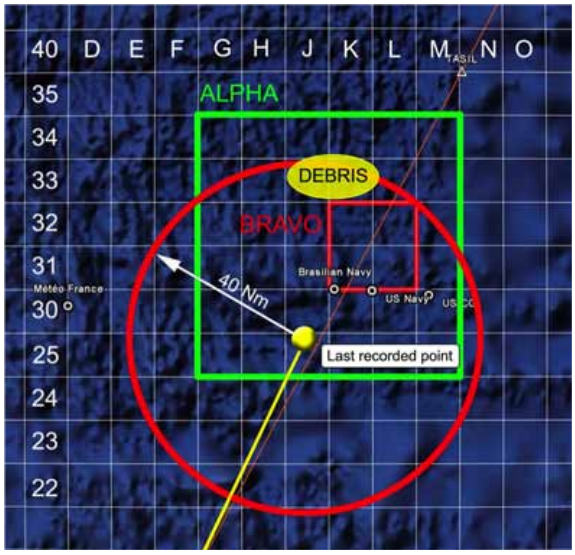
"UPDATE ON THE AF447 SEA SEARCH OPERATIONS"

A PRESENTATION BY OLIVIER FERRANTE, BUREAU D'ENQUÊTES ET D'ANALYSES POUR LA SÉCURITÉ DE L'AVIATION CIVILE, FRANCE

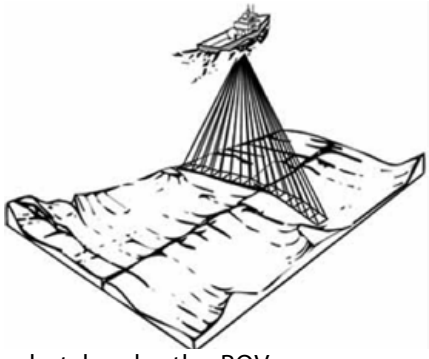
Mr Ferrante reminded the workshop's participants of the circumstances in which Air France AF447 had been lost in the mid-Atlantic on 1 June 2009, and of the air and sea assets which had been involved in the search for the wreckage and flight recorders, thus far without success.

The original search plan had addressed a circle with a radius of 40 nautical miles around the aircraft's last known position. The search was rendered difficult by the mountainous seabed (beneath waters which varied in depth from about 800 to 4,600 metres), and the lack of knowledge of currents in these waters from 1 to 6 June 2009. The latter problem rendered imprecise the retro-drift calculations.

The first phase of the operation (10 June to 10 July 2009) had been an acoustic search, undertaken under extreme time pressure, for signals from the aircraft's ULBs, using Towed Pinger Locators (TPLs) deployed from the ocean-going tugs FAIRMOUNT EXPEDITION and FAIRMOUNT GLACIER. The oceanographic vessel POURQUOI PAS? (operated by IFREMER) and the French Navy



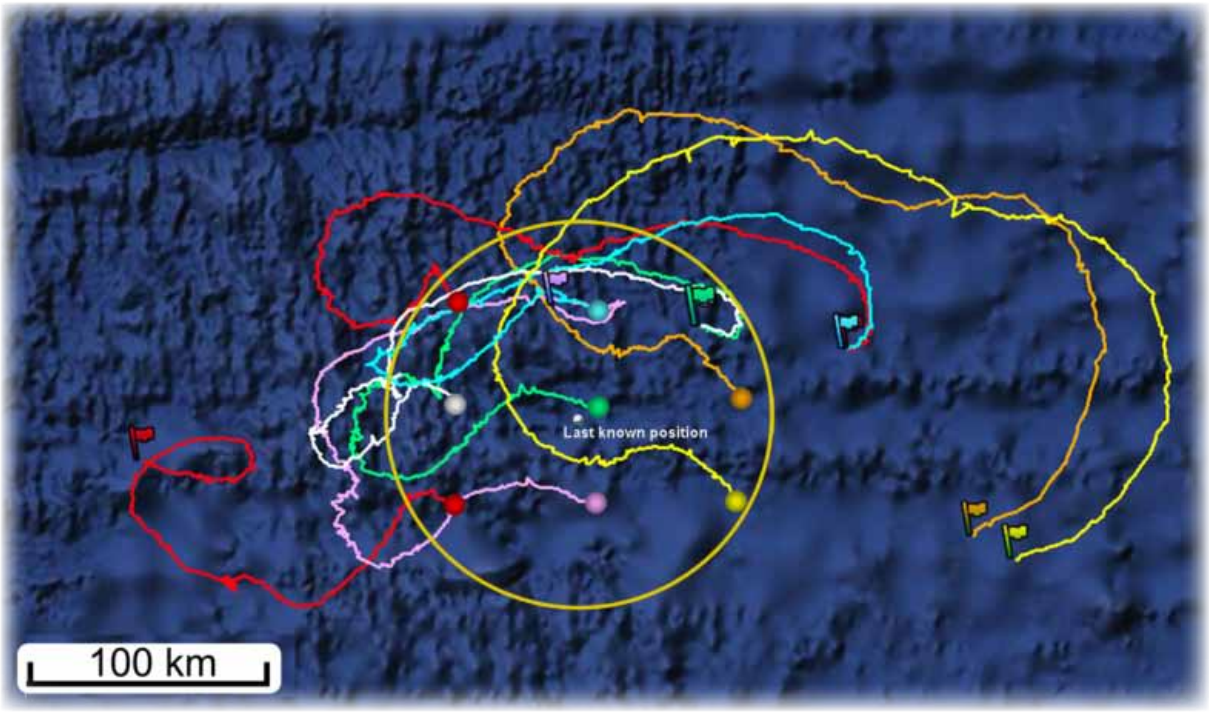
were also involved in this first campaign. During this phase an acoustic device (a hybrid-hydrophone that translates acoustic frequencies) relayed to the surface faint sounds, initially difficult to classify, emitted by whales.



Phase Two (27 July to 17 August 2009) had involved a wreckage search by the vessel POURQUOI PAS? using a hull-mounted multibeam sonar, and a side-scan sonar towed at some 2 knots about 70-100 metres above the seabed. With a swath of 1500 metres, some 100 square kilometres of seabed had been examined each day. Visual verification of targets could only be undertaken by the ROV Victor, which proved a very useful asset in rugged seabed terrain. The only drawback to its use lay in its daily coverage, which was much smaller than that possible with assets such as deep towed sonars or autonomous underwater vehicles (AUV).

Phase Three (2 to 25 April 2010, and 3 to 24 May 2010) saw searches using REMUS and ORION side-scan sonars. The search preparations involved the determination of a new search area, based on wider data collection, work on the models, new reverse-drift simulations, and cross-checking with other sources. The searches were undertaken using the vessels SEABED WORKER and ANN CANDIES, and involved support from the Woods Hole Oceanographic Institute and the US Navy/Phoenix International. The equipment deployed comprised three REMUS 6000 AUVs, TRITON and CURV21 ROVs, and an ORION Side Scan Sonar. Despite the coverage of 6300 km2, no successful results were obtained during this third campaign.

In June 2010 specialised drift measurement buoys were dropped at the assumed crash site, in order to investigate the currents prevailing at this point in the year at this location. The very varied tracks they followed underlined the difficulties of modelling currents in these latitudes and at this season. (See photograph below.)



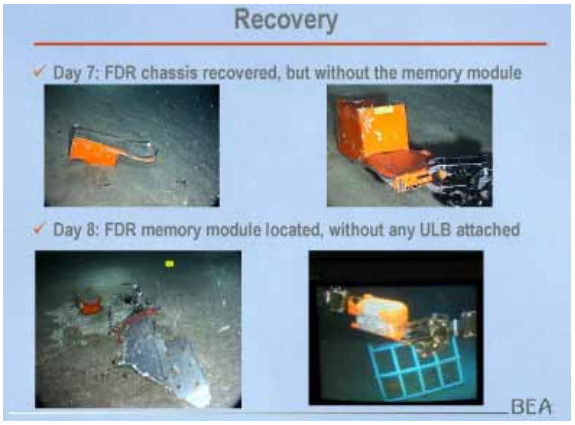
The approximate cost of the original AF447 search and rescue operation was 80 million euros, spent mostly by the Brazilian and French armed forces. Other countries, such as the United States, were also involved in the search and rescue effort. Phases One to Three of the underwater search had cost an additional 23 million euros. This had been a complex, long-lasting and demanding operation for the French BEA and its partners, but it had received excellent support from international partners. Establishing the feasibility of searching such a very large and difficult area of the seabed represented in itself a considerable achievement, and the investigation had also already made possible the development of a number of recommendations by the relevant ICAO working groups. The ICAO High Level Safety Conference of Spring 2010 had reached the important conclusion that "It is not acceptable that an accident cannot be completely investigated due to the lack of recorded data".

"LESSONS LEARNED FROM THE RECENT UNDERWATER RECOVERY OPERATION OFF THE COMOROS ISLANDS"

A PRESENTATION BY OLIVIER FERRANTE, BUREAU D'ENQUÊTES ET D'ANALYSES POUR LA SÉCURITÉ DE L'AVIATION CIVILE, FRANCE

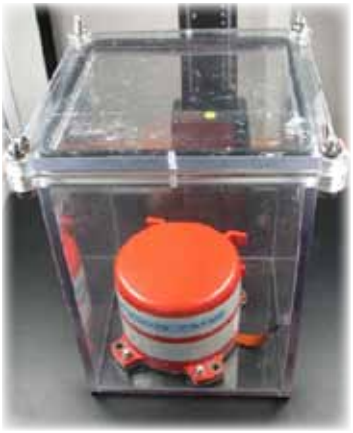
On 30 June 2009, a Yemenia Airbus A310 was lost off the coast of the Comoros Islands, on approach to Moroni Airport. Of the 153 people on board, only one survived. Very strong currents to the north resulted in debris and bodies being found in Tanzania and Kenya. The investigation was conducted by the Comoros aviation authorities, and operations at sea were delegated to the BEA.

The earlier Flash Airlines recovery operation near Sharm el Sheikh (Egypt) helped with the identification of resources for the underwater search, and led to the use of the French Navy BEAUTEMPS BEAUPRÉ oceanographic vessel harboured in Djibouti at the time of the accident. The BEAUTEMPS BEAUPRÉ produced an accurate bathymetry of the seabed with its hull-mounted multibeam sonar. The acoustic search, performed by BEA specialised investigators, took place between 4 and 20 July and involved the use of portable acoustic detectors carried aboard small dinghies to triangulate on the positions of the aircraft's recorders. Their positions were then defined more closely using a Sonardyne Scout USBL borrowed from IFREMER.

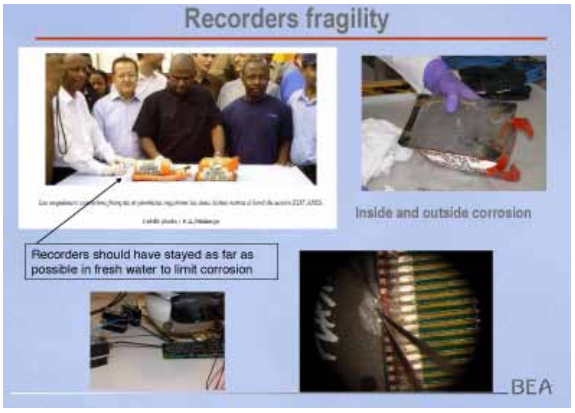


The recovery operation ran from 20 August to 14 September, and was contracted by the BEA to EDT Offshore and Phoenix International. The EDT ARES carried investigators from the Comoros, Yemen and France (BEA and Airbus advisors), as well as Comorian police officers, a coroner and three Red Crescent personnel. Owing to the troubled waters through which it had to pass in travelling from Cyprus to the Comoros, the ship also carried seven armed French commandos. Both the BEAUTEMPS BEAUPRÉ and the EDT ARES encountered very strong head winds and currents, delaying their arrival on site. The latter was equipped with Dynamic Positioning, carried an ROV rated to 6000 metres, and had aboard a 20 foot refrigerated shipping container for storing human remains and the necessary body bags.

The pinger from the Cockpit Voice Recorder was located and recovered by the ROV, and the Recorder chassis - without its memory module - was found several metres away. The memory module was subsequently found in another location. The Flight Deck Recorder pinger could not be detected by the ROV's hydrophone, and was never found, but the Recorder's chassis and memory module were each located, separated from each other, and recovered successfully. The total area covered during the search operation was 140,000 square metres, equivalent to 20 football pitches. Fifty-nine bodies were recovered. The charter costs for France were 2.5 million euros.



Amongst the points highlighted during the operation were the need for a stronger pinger latch onto the memory module; the continued operation after 55 days under water of the Dukane ULB on the Cockpit Voice Recorder; the long time taken (51 days) to move an appropriate vessel and crew to the accident site; and the fragility of the recorders, especially if not kept at all times in fresh water following recovery. One lesson learned by the BEA was the value of developing watertight transparent containers (as pictured left), to enable the recorders to remain visible for display purposes while still resting in fresh water and thus protected from corrosion.



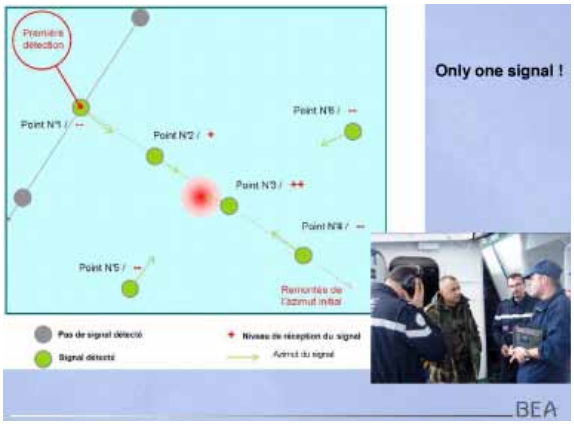
Despite the severe internal and external corrosion that had developed the recorders were able to be read out by the BEA, using techniques at the cutting edge of knowledge in this area. This operation highlighted that pingers can easily last longer than the 30 certified days of emission, and fuelled the BEA safety recommendations relating to ULBs released in the Interim Report n°2 on the accident to AF447.

"LESSONS LEARNED FROM THE RECENT UNDERWATER RECOVERY OPERATION OFF THE LEBANESE COAST"

A PRESENTATION BY OLIVIER FERRANTE, BUREAU D'ENQUÊTES ET D'ANALYSES POUR LA SÉCURITÉ DE L'AVIATION CIVILE, FRANCE

On 25 January 2010 Ethiopian Airlines flight ET409 to Addis Ababa, operated with a Boeing B737-800, crashed into the sea soon after take-off from Beirut International Airport.

The search for survivors was carried out by the Lebanese Army, using Sikorsky S-61 helicopters, the Lebanese Navy and UNIFIL troops. The US military, in response to a request from the Lebanese government, sent the guided missile destroyer USS RAMAGE, a US Navy P-3 aircraft, and the salvage ship USNS GRAPPLE. There were no survivors from the 90 persons on board the aircraft.



The Lebanese Civil Aviation Authority investigated the accident, with support from the US NTSB, the French BEA and Boeing. One peculiarity of this sea search operation was the presence on site of treasure hunters looking for the wreckage of a Curtiss C-46 Commando that crashed off Beirut on 3 October 1957 en route to Kuwait, reportedly carrying a cargo of gold.

After the unsuccessful exploration, by side scan sonar towed by the vessel OCEAN ALERT, of a location identified by the USS RAMAGE further off shore, in deep waters, a pinger from flight ET 409 was located near the shore by the BEA using hand-held hydrophones on 2 February 2010. Its emission was recorded and proved to be very helpful in demonstrating that the wreckage had been positively located. Divers from the Lebanese Navy recovered the Flight Deck Recorder from the debris field on 6 February, and the Cockpit Voice Recorder was found there a week later. Both recorders were read out at the BEA. At the beginning of the search, the "Helle" system had also been used on the location provided by the USS RAMAGE, and proved to be useful in rougher waters to "clear" an area by confirming the absence of any pinger emission.

During the acoustic search, only one pinger was heard. The other one apparently malfunctioned or was destroyed on impact. The investigation was still ongoing at the time of the Larnaca workshop.

"ICAO FOLLOW-UP OF THE AF447 SAFETY RECOMMENDATIONS"

A PRESENTATION BY JEAN-PAUL TROADEC, DIRECTOR OF THE BUREAU D'ENQUÊTES ET D'ANALYSES POUR LA SÉCURITÉ DE L'AVIATION CIVILE, FRANCE

The BEA's second interim report of the investigation into the loss of Air France AF447, published in December 2009 included recommendations that EASA and ICAO:
"extend as rapidly as possible to 90 days the regulatory transmission time for ULBs installed on flight recorders on airplanes performing public transport flights over maritime areas";
"study the possibility of making it mandatory for airplanes performing public transport flights to regularly transmit basic flight parameters (for example position, altitude, speed, heading)";
and that ICAO:
"ask the FLIRECP(19) group to establish proposals on the conditions for implementing deployable recorders of the EUROCAE ED-112 type for airplanes performing public transport flights."

The BEA recommendations were addressed by ICAO's Flight Data Recovery Working Group and Flight Recorder Panel. The ICAO High Level Safety Conference in Spring 2010 recommended that ICAO should:

i. pursue as a matter of high priority a review of SARPs and guidance material with the aim of ensuring that necessary data to support investigations of accidents and incidents are available to investigators, including provisions for the recovery of flight recorder data;
ii. review with priority SARPs and guidance material to improve surveillance, flight monitoring and communications of aircraft operating in oceanic/remote areas and the provision of timely and adequate search and rescue services in areas of need;
iii. urge States to take urgent action to address safety issues arising from accidents in particular those actions which can have an immediate safety benefit at a reasonable implementation cost. One example of such action may be the increase of the ULB battery life from 30 to 90 days;
iv. urge States, as a priority, to take all the necessary measures to utilise aircraft and ground stations available technology to enable permanent communication and surveillance over oceanic and remote areas, including modification of procedures for alerting key personnel.

At the 37th Session of the ICAO Assembly in September/October 2010, the ICAO Secretary General presented a report on the action taken on the recommendations from the High Level Safety Conference, inviting the Assembly to endorse the planned activities and to urge States and other stakeholders to take the measures called for in the relevant State letter (AN 12/53.1-10/56) and in forthcoming ICAO Recommendations. The Secretary General's report to the Assembly included the following:

On underwater locator beacons...
The ICAO Flight Recorder Panel has developed SARPs requiring (a) a 90-day operating life for 37.5 kHz ULBs; and (b) the carriage of a 8.8 kHz ULB. The proposal will be reviewed by the Air Navigation Commission during the fall 2010 session and should then be circulated to States for comments. The adoption of the new SARPs by the ICAO Council is planned for 2012, with a proposed applicability of 1 January 2018. ICAO has sent a State letter urging States to encourage air operators under their oversight to use ULBs with a 90-day transmission

time. It is suggested that 90-day ULBs be recommended as soon as possible and be mandated when new ULBs are purchased or when there is a need to change batteries in ULBs at the end of their certified life (6 years).

On deployable and free floating recorders...
The various options continue to be assessed through the Flight Data Recovery Group established under the auspices of the French BEA, and to which ICAO is associated. The ICAO Flight Recorder Panel will review the conclusions of the FDRG during its next meeting in the second quarter of 2011 and should decide then whether to propose SARPs.

On continuous and triggered transmission of flight data....
The Flight Recorder Panel has developed SARPs requiring that aircraft operating in long-range over-water flights and with a maximum certificated take-off mass of over 27 000 kg be equipped with a means of automatically transmitting sufficient information to determine the position of an accident over water within 4 NM. The proposal will be reviewed by the ANC during the fall 2010 session and should thereafter be circulated to States for comments. Guidance material on means to meet this requirement will be developed using the results of the work conducted on continuous and triggered transmission of flight data. The adoption of the new SARPs by Council is planned for 2012, and the proposed applicability dates are 1 January 2018 for new types of aircraft, and 1 January 2020 for new aircraft of a type first certificated before 1 January 2018.

On improvement of surveillance, flight monitoring and communications of aircraft operating in oceanic/remote areas...
The Operational Data Link Panel (OPLINKP) has completed the SARPs, procedures and guidance material to support implementation of ADS-C and CPDLC. Its work programme is now, in part, designed to encourage the use of these applications and includes a further assessment of changes which might be necessary to improve surveillance, flight monitoring and communications in oceanic/remote areas, in light of more recent concerns. This assessment will include (a) a review of existing SARPs and guidance material; (b) technological alternatives to ADS-C and CPDLC; and (c) a review of ongoing research programmes, such as the SESAR Joint Undertaking-sponsored Oceanic Position Tracking Improvement and Monitoring Initiative which is expected to provide recommendations sometime in winter 2010/11. OPLINKP proposals for improved surveillance, flight monitoring and communications will be presented to the ANC in mid-2011. The ICAO Secretariat will propose during the fall 2010 session to the ANC that a mechanism be established to review ICAO radio communication failure procedures in the light of recent accidents and regional disparities. A State letter is being prepared urging States to take measures to utilize available technology to improve communication and SAR over oceanic and remote areas. This letter relies on the work under way by OPLINKP and the ICAO/IMO Working Group on Harmonization of Aeronautical and Maritime SAR and should be ready in early 2011.

After considering this report from the ICAO Secretary General, the Technical Commission of the 37th Assembly endorsed the planned ICAO activities and urged States and other stakeholders to take the measures called for in the recommendations. It also asked the ICAO Council to take into consideration the possibility of speeding up the work, and the need to follow a risk-based approach. Publication of the new version of ICAO Annex 6 is anticipated in 2012.

Mr Troadec noted that BEA was considering advancing a recommendation that intelligent GPS buoys be dropped at the crash site very soon after the event, in order to yield information about the direction of the prevailing currents, and thus about the possible movement of debris etc.

Concluding his presentation, Mr Troadec recalled the report of the investigation which had been made into the loss off Tahiti in July 1973 of a Pan Am Boeing B707, and pointed out that this report had recommended that the possibilities be examined of automatically ejected flight recorders, and of beacons which would emit a signal for a longer period of time.

CONCLUSIONS OF THE WORKSHOP

The workshop and ACC chairman Mr Arslanian concluded that the workshop had been successful in improving participants' understanding of the challenges posed by underwater location and recovery, and some of the means of addressing them. It was now a matter of capturing the learning which had been gained, and using it to improve the relevant training and techniques, and to raise awareness of the resources available and the important centres of expertise.

The main messages underlined by the workshop, as in Dubrovnik, had been around the critical importance of good preparation; high quality organisation; and international cooperation.

In closing the workshop, Mr Arslanian thanked all concerned for helping make it a success, including the companies which had attended to detail the products they had available, the Cypriot hosts and sponsors, the workshop's Steering Committee, and all participants.

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