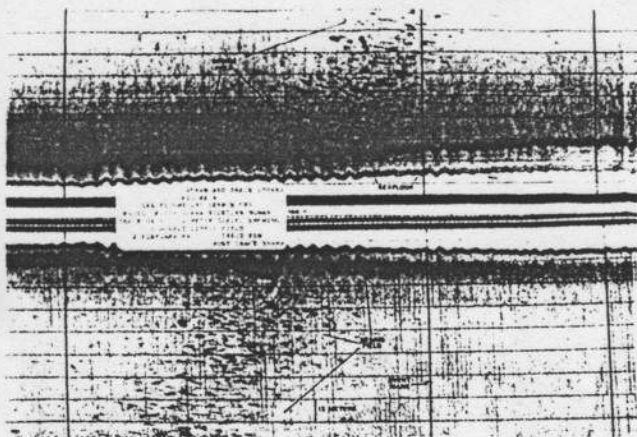


# Anatomy of an Underwater Search

***Search for the Wreckage of South African Airways' Flight 295 was an International Effort in 4500-Meter Waters—Before Considered Unreachable***



A sidescan sonar trace (left) from the Klein "Smartfish" revealed a typical aircraft debris pattern at the 4450-meter water depths. At right, a Sea Beam-generated bathymetric plot provided by the German R/V *Sonne* showed the featureless area of the wreckage site (noted by the aircraft symbol), which was flanked east and west by 700- and 1500-meter seamounts.

By Michael K. Kutzleb  
President  
Steadfast Oceanengineering Inc.

South African Airways Flight 295, enroute from Taiwan to Mauritius, disappeared into the Indian Ocean on November 28, 1987, shortly before its scheduled arrival. The Boeing 747 Combi aircraft, which was carrying passengers as well as cargo, had reported smoke in the aircraft and had just completed an emergency descent to 14,000 feet when communications were lost.

Floating debris was located the following day approximately 135 miles northeast of Mauritius.

Based upon the U.S. Navy's success in locating the pingers from the Air India 747 crash in 1985, the South African government requested assistance from the U.S. Navy's supervisor of salvage (SupSalv). An agreement was signed on December 3 after favorable determination under Section 607 (a) of the Foreign Assistance Act of 1961—and further legal determination that use of U.S. Navy assets for humanitarian purposes would not violate the terms of the comprehensive Anti-Apartheid Act of 1986.

The SupSalv office administers several civilian contracts for the provision of specialized search and salvage services for various projects. For this task, the services of Steadfast Oceanengineering Inc., the Navy's prime contractor for underwater search and recovery operations, were required.

Steadfast, with offices in Falls Church, Virginia, and Fort Lauderdale, Florida, is a leader in the field of underwater search and recovery and specializes in deep water operations.

Steadfast was prime contractor for the search for Korean Air Lines' Flight 007, the Air India 747, and the space shuttle *Challenger*.

The first order of business was to identify what assets were required and where to commence the search. Both the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR) on SAA Flight 295 were equipped with Dukane 37 kHz underwater beacons. These beacons are activated upon immersion in water and are designed to survive an aircraft crash and help pinpoint the location of the flight recorders using underwater acoustic locator equipment. With theoretical detection ranges for these beacons of up to 2 miles, large areas can be covered fairly quickly using suitable pinger locator systems.

## Listening for Beacons

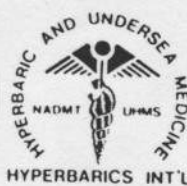
Based on this, it was decided that phase I of the search would concentrate on listening for the beacons; phase II would involve the use of sidescan sonar either to map the debris if phase I was successful or to continue the search if the pingers were not located during phase I.

The Navy's supervisor of salvage, Captain C.A. Bartholomew, keeps two pinger locator systems in his inventory for use in locating downed military aircraft; his office provided them for use on this task in response to an official request from the South African government.

Each system consists of a towed hydrophone, a cable, and a topside processing/display console. The hydrophone and underwater electronics housing are pressure rated to 10,000 psi and could therefore be towed at a sufficient depth to ensure detection of the beacons in the water depths in the search area, which ranged from 2500 to 4500 meters. Previous tests using these locator systems had shown a maximum detection range of approximately 3700 meters under ideal conditions.

A team of U.S. Navy SupSalv and Steadfast personnel, headed by Bartholomew, departed for Mauritius on December 4 to meet with DCA

(Continued on page 38)



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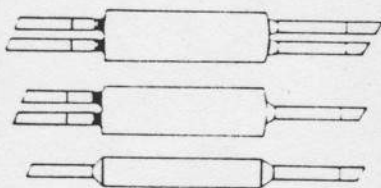
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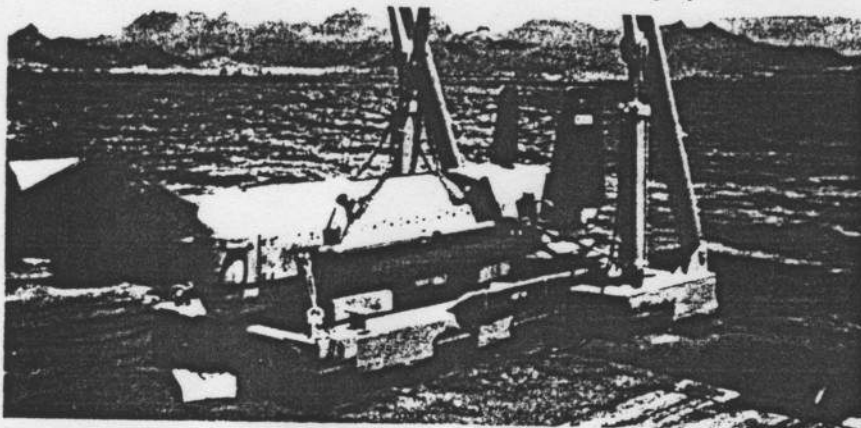
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and SAA personnel. Bartholomew,  
along with Tom Salmon and Bill  
Walker of the SupSalv office, assisted  
the DCA executive committee in the  
planning phase of the search.

The writer was in overall charge of  
the Steadfast project team, together  
with Dr. Johan Strumpfer of the  
South African Institute for Maritime

throughout both phases of the search  
effort.

The *Sonne* also had a video sled  
aboard capable of obtaining photos  
of the seafloor in water depths of up  
to 6000 meters. The *R/V Africana*, a  
South African fisheries research ves-  
sel outfitted with a hull-mounted  
acoustic listening system, was also



Steadfast's search sonar used Klein Associates' dual-frequency "Smartfish" at one end of a 9000-meter coaxial tow cable. Multiplexed signals were processed and recorded topside.

Technology. All available loss data  
was collected for analysis. Using me-  
teorological data and positions of  
floating wreckage obtained by var-  
ious search aircraft over a two-day  
period following the accident, debris  
set and drift were calculated to derive  
a projected impact position. This  
position was then compared to other  
data, such as the projected flight  
path, to define a preliminary search  
area for the phase I search.

## An International Effort

The search was truly an interna-  
tional effort. Equipment came in  
from around the world and had to be  
cleared through customs, transported  
across the island to Port Louis, un-  
packed, set up, and tested. Pinger  
locator systems, navigation systems,  
winches, and A-frames were needed  
for each of the two vessels and had to  
be ferried to the ships at anchor since  
all berths in the port were full. Re-  
trieval of floating debris by commer-  
cial and South African naval vessels  
was still an ongoing effort.

Two ocean-going salvage tugs from  
Pentow Marine in South Africa, the  
*Wolraad Woltemade* and the *John  
Ross*, were provided as platforms for  
the first phase of the search. A Ger-  
man research vessel that was operat-  
ing in the area, the *Sonne*, was tasked  
to conduct a bathymetric survey of  
the search area using a General Instru-  
ments Sea Beam survey system. This  
information proved to be invaluable

used during the phase I pinger search.

An Argo navigation chain, using  
shore sites on Mauritius, Rodriguez,  
and Cocos Island, was set up and  
operated by Geoteam, a Norwegian  
survey company. The system could  
only be used during the day because  
ranges to two of the sites exceeded  
the maximum nighttime range of the  
system. This resulted in the use of  
GPS satellite positioning during the  
night after the Argo signals were lost.  
With the two systems, accurate posi-  
tioning was possible approximately  
18 hours per day.

The *Wolraad Woltemade* got under-  
way on December 11, with the *John  
Ross* joining the search the following  
day. A test pinger was dropped near  
the area in 3600 meters of water, both  
to test the locator systems used and  
to serve as a standard to compare  
with the sounds actually detected  
during the operation. The *Africana*  
arrived on scene to assist on December  
17.

Trial runs conducted on the test  
pinger confirmed that the towed loca-  
tor systems were indeed capable of  
detecting the pingers in the prevailing  
water depths. A consistent detection  
envelope of 1 mile was observed,  
which resulted in the selection of 1-  
mile spacing for the search tracks.  
This gave an overlap of 100% to  
ensure that all areas were covered.

Phase I continued until January 2,  
1988, when we felt that the batteries  
in the pingers would have been ex-



square miles with the three ships during this phase.

Once phase I was completed, the team decided to demobilize all assets and plan for phase II—the sidescan sonar search. All of the data used in the preliminary analysis was reviewed and refined, and new bits of information were added.

During one of the *Sonne's* video runs, newspapers and several pieces of mail were observed on the bottom in one area. This area was along the calculated debris drift axis, coincided with the flight path, and also fit in well with the best estimates of the projected impact position of the aircraft. Based on this information, an area of high probability, measuring 4 x 10 miles, was selected as the primary area of interest for the phase II sonar search.

The search vessels used during the pinger locator phase were not suitable as platforms for a deep sonar search due to their inability to maintain the slow search speeds needed

The *Omega 801*, a 65-meter supply vessel with variable pitch propellers and a large open deck, was chartered to serve as the platform for the sonar search.

#### Around-the-Clock Reliability

During the break between phases I and II, we decided to replace the Argo navigation system with a system that would provide reliable navigation around the clock. A Geoloc system—owned and operated by CGG, a French geophysical survey company—was contracted to provide the high accuracy positioning required during the phase II sonar search. Geoloc, which is manufactured by Serceel, operates in the 2-MHz band using a spread spectrum technique and has a maximum range of approximately 1000 kilometers. Radiated signal strengths are kept below the ambient noise level to eliminate interference, and the system is immune to the tropospheric and sky wave interferences so common to other medium- and

"Smartfish," a dual-frequency (50 or 100 kHz), full-ocean-depth towfish. The signals were multiplexed at the towfish and passed through a 9000-meter coaxial towable to the Klein topside processing, recording, and display equipment. The winch consisted of a traction unit/power pack and a take-up reel capable of storing up to 14,000 meters of towable. A hydraulically operated A-frame was used for launch and recovery of the towfish, with an oceanographic sheave for fairleading the towable over the side.

The search team got underway on January 22 and arrived in the primary area the following morning. High winds and rough seas from a nearby tropical depression prevented the sonar fish from being launched for the next 36 hours, so this time was used to lock in and calibrate the Geoloc navigation system. By Sunday evening, January 24, the weather had abated sufficiently to permit launch of the sonar fish, and the first line was

(Continued on page 40)



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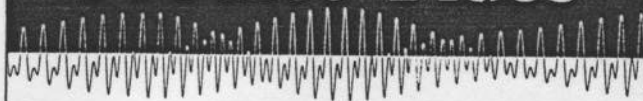
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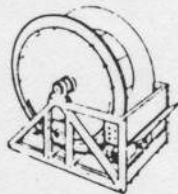
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started just after midnight.

Towing a sonar fish 45 meters off the bottom in 4500 meters of water at the end of a 9000-meter wire is no small feat; thus the first search line was run in an area of relatively flat

site itself, the bottom was flat and featureless, which greatly assisted the search team in mapping the area and flying the towfish at the low altitudes required for the high resolution sonar imaging.

*"As a gauge to measure the complexity of this task, consider that the deepest location of a lost object to date was the R.M.S. Titanic discovery in 1985. [She] was located in less than 4000 meters of water—or over 500 meters shallower than the South African 747."*

topography. This allowed the operators to become familiar with system control and response before tackling the more difficult, central portion of the area where the aircraft wreckage was believed to be located. The Sea Beam charts of this high probability, central area showed several peaks rising 600 to 1500 meters off the seafloor amidst generally rough terrain.

The 50 kHz sonar operating on a scale of 300 meters per side was used for the search. Lane spacing of 300 meters was chosen to give a theoretical overlap of 100%, subject to steering errors, navigation system error, and an anticipated offset in the towfish track relative to the search vessel. This track offset was actually observed to vary from 0 to 200 meters during the course of the search.

#### Successful Search Line

The second search line was run through the center of the area, and a promising contact was noted on the sonar records. Subsequent runs over the next two days showed a typical aircraft debris pattern, with pieces spread out over a 100 square meter section of the bottom.

News of the discovery was passed to the DCA executive search committee on January 27.

Sonar mapping continued for another week using shorter range scales and the 100 kHz system for higher resolution and greater detail of the various pieces of debris. The largest piece in the debris field measured 40 meters long by approximately 5 meters wide, with most pieces measuring less than 5 meters in overall size.

The water depth at the site where the wreckage was located was 4450 meters. Rocky terrain existed within 2 miles east and west of the crash site, with mountains rising 700 to 1500 meters from the ocean floor. At the

Although the sonar portion of the search was almost immediately successful, it was by no means an easy task. Steadfast personnel had conducted numerous search tasks in water depths ranging from 2000 to 3000 meters but had never searched in depths of 4500 meters.

As a gauge to measure the complexity of this task, consider that the deepest location of a lost object to date was the R.M.S. Titanic discovery in 1985. The Titanic, close to 300 meters in length, was located in less than 4000 meters of water—or over 500 meters shallower than the South African 747. The entire fuselage of a 747 aircraft measures only 69 meters in overall length, and from previous experience it was predicted that the aircraft would be broken up into numerous small pieces and spread out over the bottom, thus making detection difficult at best.

The wreckage was indeed broken up and spread out as predicted, but the experience of the sonar operators in interpreting the records, as well as the excellent quality of the records themselves, resulted in the successful completion of the task in spite of difficult operating conditions in water depths previously considered unreachable. /ST/

Michael K. Kutzleb has been working in the field of underwater search and recovery operations for more than 14 years. He has participated in more

than 70 such projects in both deep and shallow waters. Kutzleb previously worked for Seaward Inc. in positions ranging from navigation technician to project manager. He received a bachelor's degree in economics from the University of Virginia.

