ISASI FORUM

"Air Safety Through Investigation"

JANUARY–MARCH 2009

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This photo illustrating ice formation on an engine spinner at very low RPM (probably idle in freezing rain) helped author Al Weaver make his points in his paper *Gas Turbines and Ice—The Mysterious Culprit* presented at ISASI 2008 in Nova Scotia, Canada. Photo source: Internet service

ISASI FORUM
"Air Safety Through Investigation"

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

ISASI Celebrates 45 Years

By Frank Del Gandio, ISASI President

With the onset of 2009, our Society begins the celebration of its 45th year of existence. Also, with the onset of the New Year, ISASI closes it 30th year as an international organization. We filed for incorporation as the Society of Air Safety Investigators (SASI) on March 25, 1964, in the District of Columbia and were approved August 31 the same year. Our international status became effective on Oct. 11, 1978.

We have grown from an initial domestic organization of 10 investigators to an international one of more than 1,570 investigators and other professional air safety advocates. Fifty-nine nations are represented in our membership. On the domestic side, one of the original founders, Truman (Lucky) Finch, who holds SASI charter membership No. 3 credentials, routinely attends each of our annual seminars. Of ISASI's growth and success, he says: "I am proud and thrilled with the progress ISASI has made in over 44 years since its birth. It is an honor and pleasure to attend our annual event."

On the international side, Olof Fritsch, who has served as president of ISASI and is a 22-year veteran of ISASI International Council membership and also is a former chief of the ICAO AIG Section (see page 4), recalls when he "flew with a colleague in a T-33 from Ottawa, Canada, to Norton Air Force Base in California to attend the second annual SASI international seminar held in Los Angeles in October 1971." He noted that several other Canadian aviation safety specialists also attended the event and when they returned to Canada they formed the Canadian Society of Air Safety Investigators, which was one of the steps that eventually led to the formation of ISASI in 1978.

Year after year, our Society has continued to move forward in meeting its objective to "promote air safety through improvement of the accident investigation process through lectures, seminars, and publications." The Society's intent is and has always been to "promote the technical advancement of its members; to broaden the professional relationship of its members; and to increase the prestige, standing, and influence of air safety investigators in matters of safety."

Today we stand recognized as the premier organization relative to fostering the aircraft accident investigation processes. Our annual air accident investigation international seminar routinely presents 30 to 20 technical papers on some aspect of the investigation process, to say nothing of the hours made available for 200 to 300 investigators and related professionals to interact on a one-to-one basis. ISASI 2007, held in Singapore, drew 303 delegates from 35 countries; ISASI 2008, held in Nova Scotia, Canada, had attendees numbering 284 from 33 countries.

Our working groups have achieved notable success. For example, in 1997 the Air Traffic Service (ATS) Group developed, published, and distributed the *Guidance for Air Traffic Service Investigators and Investigations* booklet. Its purpose is to assist in identifying and training ATS investigators in the investigation of ATS system performance in the aftermath of an air accident. In 2000 the Cabin Safety Working Group published its *Cabin Safety Investigation Guidelines*. Its aim is to provide air safety investigators tools to investigate the survival aspects of incidents and accidents and to provide guidance in documenting damage to the cabin interior, it equipment, and securing flight attendant and passenger interviews.

ISASI's Reachout Workshops training program has also attained such resounding success that at the recent AIG/08 ICAO meeting delegates voted to adopt the following Recommendation: *"That ICAO and its regional offices continue to cooperate in the organization of the ISASI Reachout Workshops."* (See page 4.)

Throughout the tough economic times that have blighted the aviation industry in the past 10 years, our Society has remained financially stable to the extent that there has been no membership dues increase for the past 15years. A measure of that stability is that in 2008 we had a "mortgage burning" ritual for the ISASI office condominium purchased in 2000. Through the continued support of our members, both individual and corporate, I foresee continued financial stability.

ISASI 1964 2009 45TH ANNIVERSARY

Our organizational structure is also vibrant. The long-time dormant Southeastern Chapter has been reactivated after its merger with the Florida Chapter. The Dallas-Fort Worth Chapter and the Rocky Mountain Chapter have newly installed officers. A new committee has been established: Unmanned Aerial Systems Committee (see page 11), and new chairmen have been named to the following committees: Board of Fellows, Ludi Brenner; Reachout, John Guselli; and Ethics, John Edwards.

Sadly, in February 2008 we lost Ron Chippindale to an automobile accident. He had served ISASI for years in many capacities. He was a founder of the New Zealand Society and its first president. At his death, he was the New Zealand Society councillor and a member of the ISASI International Council. Peter Williams, NZSASI president, assumed the duties of New Zealand Society councillor.

My wishes for a prosperous and happy New Year go to all of you and your family members. ◆

ISASI ACHIEVES GOAL AT

ICAO's AIG/08

(Adapted from a report by Ron Schleede and Olof Fritsch, ISASI AIG representatives.)

ISASI had an important role in the success of the Accident Investigation and Prevention (AIG) Divisional Meeting 2008 (AIG/08) held at ICAO headquarters in Montreal, Quebec, Canada, Oct. 13-18, 2008. The meeting's agenda included discussions on amendments and improvements to Annex 13 to the Chicago Convention and other important topics related to accident investigation and prevention.

The Divisional Meeting was attended by 224 participants and observers from 75 contracting states and 12 international organizations, as well as by advisers and others. The 6-day meeting involved discussions of 14 subjects pertaining to Annex 13, as well as 6 additional subjects.

ISASI was designated an International Observer Organization for AIG/08, and in this role submitted three papers for consideration at AIG/08: Working Paper (WP) No. 42 citing the need for a worldwide safety recommendation repository; WP No. 41 discussing the need for continued support of the ISASI Reachout Workshops, and Information Paper No. 4 on the ISASI Rudolph Kapustin Memorial Fund Scholarship.

The chief observer for ISASI at AIG/08 was Ron Schleede, ISASI vice-president. He was assisted during the meeting by Olof Fritsch, ISASI's former president and a former chief of the ICAO AIG Section. Schleede was also assisted by three other ISASI members during preparation for the meeting: Capt. Dick Stone, who was part of the team at AIG/99 and former ISASI president; Caj Frostell, ISASI international councillor and a former chief of the ICAO AIG Section; and John Purvis, who was part of the ISASI team at AIG/99 and was a member of the U.S. delegation at AIG/92.

ISASI's Working Paper No. 42 discussed the need for states to forward copies of safety recommendations generated by investigations to ICAO, as well as any safety actions taken, or the reasons why safety actions were not taken, for posting on an ICAO website. The intent of the proposal is to create a centralized database of lessons learned and safety actions taken by states for the benefit of other states. ISASI proposed that the meeting agree to make a recommendation for the addition of two new "Recommended Practices" in Annex 13, Chapter 6, requiring states to forward such safety information to ICAO for worldwide dissemination.

For a working paper introduced by an observer organization to be considered by the meeting, delegates of at least two states must support it. There was support from several delegates for the intent of the ISASI proposal, but concerns were raised regarding the resources needed to implement it. In general, the subject was not considered mature enough. It was suggested by some delegates that the scope of the proposal be limited to safety recommendations of global concern. While there was widespread support for this suggestion, some states expressed that it would be difficult for states to determine what constitutes a safety recommendation of a global concern. As a result of the discussions, the meeting agreed to Recommendation 1.6/4 (WP 79-161): "*That ICAO establish a system to make accessible to all stakeholders and the public safety recommendations of global concern issued by states, and the responses to those safety recommendations. Furthermore, that ICAO develop guidelines on what constitutes a safety recommendation of global concern.*"

ICAO will undertake a study of the issues involved with the aim to develop a safety recommendation database system and guidelines for states to follow. Evidently, it will be several years before establishment of a centralized database of safety recommendations as well as safety actions taken or not taken by States as the result of investigations.

ISASI was very successful with Working Paper No. 41, which reviewed the history and success of ISASI Reachout Workshops held around the world with the support of ICAO, states, and the aviation industry. The paper also addressed the need for states and ICAO to continue to support the ISASI Reachout program, which is in direct support of ICAO AIG organized workshops on accident/incident investigation and prevention that have been few and far between in the last several years.

After Working Paper No. 41 was introduced, several delegates spoke in support of the paper, many of whom had hosted Reachout Workshops in the past. The chairman of the Hellenic Air Accident Investigation & Aviation Safety Board, Capt. Akrivos Tsolakis, praised the value of the Workshops held in Greece and Cyprus and said that he planned to organize a future Workshop in Greece. Ladislav Mika of the Czech Republic acknowledged the founders of the Reachout Workshops, the first of which was

The ICAO AIG/08 Meeting in session.

O. Fritsch, left, and R. Schleede at their delegates' table during the AIG Meeting.

held in Prague in 2001. Following a very positive discussion among other delegates, the Meeting agreed to Recommendation 3/2 (WP 79-3): *"That ICAO and its regional offices continue to cooperate in the organization of the ISASI Reachout Workshops."*

This was a significant achievement for ISASI, which will continue and expand the necessary support of ICAO for future Reachout Workshops. The recommendation pertaining to the ISASI Workshops is in direct support of another recommendation, 3/1 (WP 79-3) formulated by the Meeting about ICAO AIG workshops: *"That ICAO revive accident-investigation-related workshops with the assistance of contracting states. States were encouraged to provide support to ICAO in this initiative."*

ISASI's Information Paper No. 4 on the subject of the ISASI Rudolf Kapustin Memorial Fund Scholarship outlined the history and success of the program that provides assistance to students to attend the annual ISASI international seminar. Because of time constraints, information papers were not discussed in the open forum; however, all attendees received copies of the paper, which can be found on the AIG website as Information Paper No. 4.

Processing recommendations

How will the recommendations made by AIG/08 be processed? The recommendations concerning proposals to amend Annex 13 will have priority. The amendment proposals will be consolidated by the ICAO Secretariat and presented to the ICAO Air Navigation Commission (ANC) for preliminary review. Following the ANC's preliminary review, which may result in changes to the proposals, the proposed amendments will be sent to states for comments. The comments from states will then be reviewed and consolidated by the Secretariat and presented to the ANC for its final review. Based on the comments from states and the discussions in the ANC, some changes are possible. After the ANC final review is complete, the ANC will submit the proposed amendments to Annex 13 to the ICAO Council for its consideration and adoption, probably in late 2009 or early 2010. The amendment to Annex 13 will likely take effect November 2010.

The recommendations from AIG/08, other than proposed Annex amendments, will be reviewed by the ICAO Secretariat and presented with proposed actions to the ANC and the Council for their decisions. Some of the actions may involve the establishment of a panel or a study group to assist the Secretariat to undertake the work, and the issuance of state letters to inform states of the actions undertaken to carry out the recommendations.

ISASI's Working Paper No. 42

discussed the need for states to forward copies of safety recommendations generated by investigations to ICAO, as well as any safety actions taken, or the reasons why safety actions were not taken, for posting on an ICAO website. The intent of the proposal is to create a centralized database of lessons learned and safety actions taken by states for the benefit of other states.

For example, Working Paper No. 42 submitted by ISASI that led to Recommendation 1.6/4, pertaining to posting safety recommendations and safety actions on an ICAO website, will likely result in the formation of a group of experts from states to study the issues involved, develop a proposed action, and make recommendations to ICAO about the implementation of the action.

As the Annex amendments have priority, these non-Annex tasks may take months and years to complete, depending on the urgency and complexity of the subjects. The tasks stemming from an AIG Divisional Meeting usually constitute a 5-year work plan for ICAO in accident-investigation-related matters.

Full documentation and reports of the AIG/08 Meeting can be found at www.icao.int/aigdiv08. ISASI members interested in the proposed changes to Annex 13 and other international accident/incident investigation and prevention matters are encouraged to visit the website to review the documentation, including the reports on each agenda item, and the recommendations of the Meeting.

In summary, the recommendations made by AIG/08 are an important first step in a complex process that will likely lead to numerous important amendments to Annex 13 and other safety-related matters that should improve accident/incident investigation and prevention programs in the future. ◆

DHC-6 Twin Otter Accident off the C

By Alain Bouillard, Investigator-in-Charge, Special Advisor to the BEA (Bureau d'Enquêtes et d'Analyses pour

(In the publication of this award-winning technical paper, presented at ISASI 2008 Halifax in Nova Scotia, Canada, on Sept. 9, 2008, Forum *is departing from its usual style format and is publishing it in its "technical paper" format as accepted by the ISASI 2008 seminar technical committee.—Editor)*

Award of Excellence

Alain Bouillard and Arnaud Desjardin earned the ISASI Award of Excellence for development of their paper *DHC-6 Twin Otter Accident off the Coast of Moorea, French Polynesia,* which was judged to be "Best Seminar Paper" of those papers presented at the ISASI 2008 Halifax seminar on aviation accident investigation held in Halifax, Nova Scotia, Sept. 8-11, 2008.

The Award was established through an anonymous donation by an ISASI member who wished to acknowledge a paper at the annual seminar that made an outstanding contribution to the advancement of technical methodologies in aircraft accident investigation. The Excellence selection carries a US$500 prize. The authors announced that they are contributing the $500 to the ISASI Rudolph Kapustin Memorial Scholarship Fund.

The ISASI 2008 judging panel included ISASI members Richard Stone, Jayme Nichols, and Gary R. Morphew. Capt. Stone commented that the criteria used for the selection were, in addition to that mentioned above, the paper had to provide new methodology for accident investigation, had to be useful for a field investigator, and that the paper and graphics had to be professional. ◆

E. MARTINEZ

President Del Gandio presents the Award of Excellence to the BEA team for its "best technical paper." From left are F. Del Gandio, A. Desjardin, M. Del Bono, and A. Bouillard.

***Alain** began his career as an air traffic controller for the French Air Force in 1968. In 1975, he joined the French Civil Aviation Authority working for the Air Navigation Services at the Roissy Charles-de-Gaulle Airport. In his position as an engineer in aeronautical operations and air traffic management, Alain joined the BEA in 1992 and took part in numerous investigations in France and abroad. He was the investigator-in-charge for the Concorde accident in Gonesse (France). In 2003 Alain was appointed regional and airport director in Rennes (France). In 2006 he came back to the BEA and became the special technical advisor to the director of the BEA. Alain is in charge of the investigation on the Twin Otter accident in Tahiti. He is a pilot with multiengine and instrument ratings. He holds the TBM700 and ATR 42 type ratings.*

***Arnaud** has a master's degree in aeronautics from the French National Civil Aviation School (ENAC). He joined the BEA Engineering Department in 2005, after 6 years in the U.S. developing software tools for the FAA's air traffic control system. He is now the head of the Flight Recorder and Performance Division of the BEA. He has participated in major international investigations, including the Air France Airbus A340 in Toronto, the West MD-82 in Venezuela, and the Air Moorea Twin Otter in Tahiti.*

1. Introduction

On Aug. 9, 2007, the DHC-6 Twin Otter registered F-OIQI, making an inter-island flight from Moorea to nearby Papeete in Tahiti, crashed into the sea shortly after takeoff. Nineteen passengers and one pilot were on board this scheduled 7-minute flight, planned at a cruise altitude of 600 ft. There were no survivors. Apart from a few pieces of wreckage, most of the airplane sank within minutes to a depth of about 700 m.

Because of its weight category and the date of its airworthiness certificate, the airplane was not required to have any flight recorders. However, it was in fact equipped with a CVR, which proved to be extremely useful for the investigation.

The BEA undertook two successive search missions: the first was aimed at assessing an area where the flight recorder might be. The second was to recover a maximum number of airplane parts from the sea floor, given the previously determined location. The BEA had had experience in this field, the most recent being assisting in the recovery of the recorders from a B-737 off the coast of Egypt[1] and later from an Airbus A320 off the coast of Russia[2].

2. Signal triangulation

The accident aircraft was equipped with a CVR. Pinger signals transmitted by the underwater locator beacon (ULB) on the recorder were set off on contact with water. A BEA directional hydrophone was used to determine the signal's bearing from several positions. Coupled with a GPS receiver, this allowed the charting

oast of Moorea, French Polynesia

la Sécurité de l'Aviation civile) and Arnaud Desjardin, Safety Investigator, BEA Engineering Department

of numerous measurements. In theory, these would define the zone from which the signal originated.

In reality, acoustic wave propagation depends on various linked parameters, such as salinity and water temperature, which vary with depth. In addition, when an acoustic wave propagates in the sea, it is subject to refraction, which generates multiple trajectories, especially when the sea bed slope is around 40% as is the case between Moorea and Tahiti. This meant that it was sometimes impossible to distinguish between a reflected wave and the direct wave signal. A total of about 40 measurements were made, as shown on in Figure 1.

Commonsense and sound judgment were then necessary to "filter out" unrealistic bearing measurements. First, the ones that were obviously diverging from the others were eliminated. They were probably pointing to a secondary echo and not the direct signal. Secondly, knowing the actual conditions in which the measurements had to be performed, it would not be reasonable to say that the precision on bearing measurements was less than 10°.

Indeed, bearing readings were made with a magnetic compass that had to remain horizontal to be accurate. Six-foot-high waves made this condition difficult, as did the fact that the bearings were determined by listening to the acoustic signal with a headset, adding a degree of subjectivity when it came to finding the direction from which the perceived signal was the loudest. The noise of nearby boats made this task even harder. It was then decided to ignore the intersections of the measurements with bearings that were off by less than 30°, because the 10° accuracy criteria make the range of possible intersections expand rapidly. In the ideal case, all bearings should intersect with a 90° angle.

This method enabled a more precise localization to be defined and limited the search zone to a circle of 260 m in diameter.

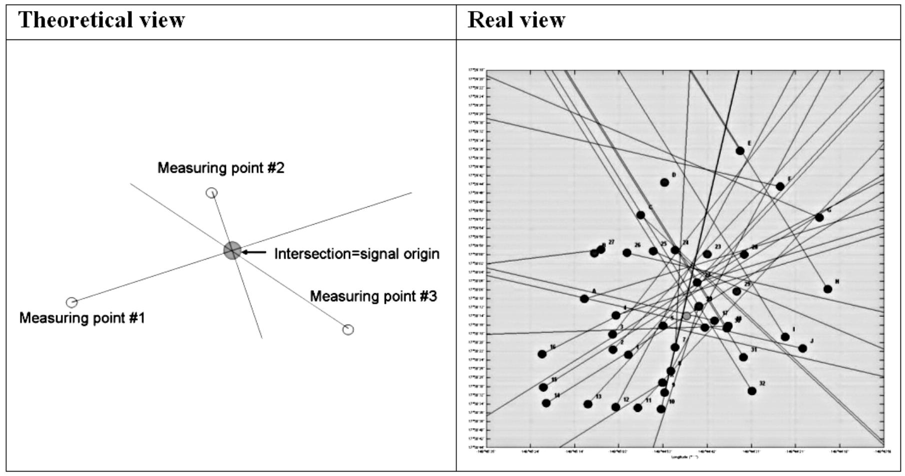


Figure 1

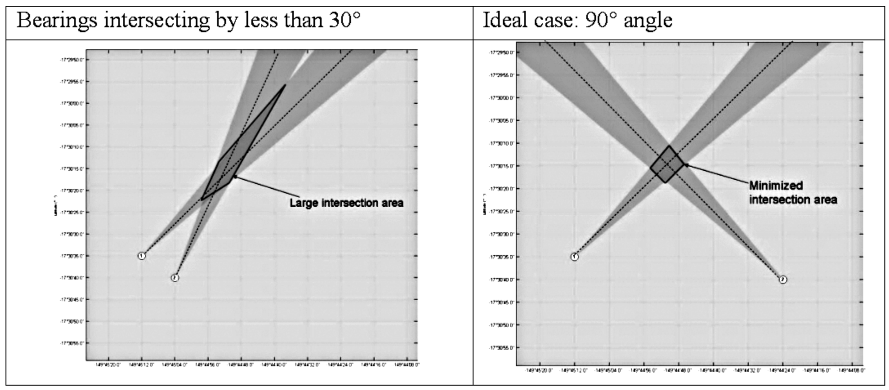


Figure 2

Figure 3

Since the CVR absolutely needed to be recovered, it was decided to cut through the side of the fuselage with the ROV's mounted tools and to just rip the CVR from its rack. After more than 7 hours of hard labor, the CVR was extracted and brought to the surface.

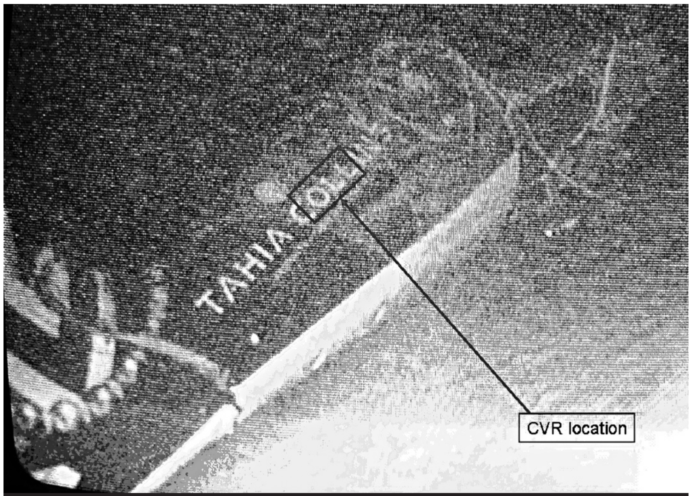


Figure 4

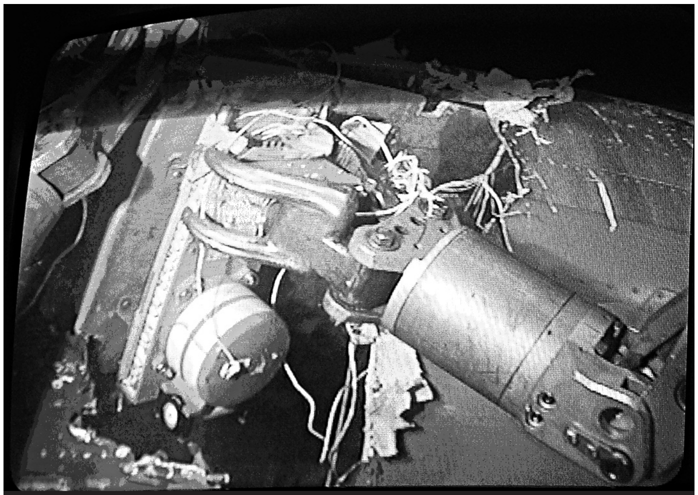


Figure 5

UTC Time	Relative time t (s)	CVR Event
22 h 01 min 08 s	0	
22 h 01 min 09.2 s	1.20	Pilot utterance expressing surprise
22 h 01 min 12.1 s	4.10	EGPWS "Don't sink" alert
22 h 01 min 13.55 s	5.55	EGPWS "Don't sink" alert
22 h 01 min 15.2 s	7.20	EGPWS "Sink Rate" alert
22 h 01 min 15.95 s	7.95	EGPWS "Pull up" warning
22 h 01 min 17.55 s	9.55	EGPWS "Pull up" warning
22 h 01 min 19.15 s	11.15	Partial EGPWS "Pull up" warning
22 h 01 min 20 s	12.00	End of CVR recording–Sound similar to an impact with the surface

Figure 6

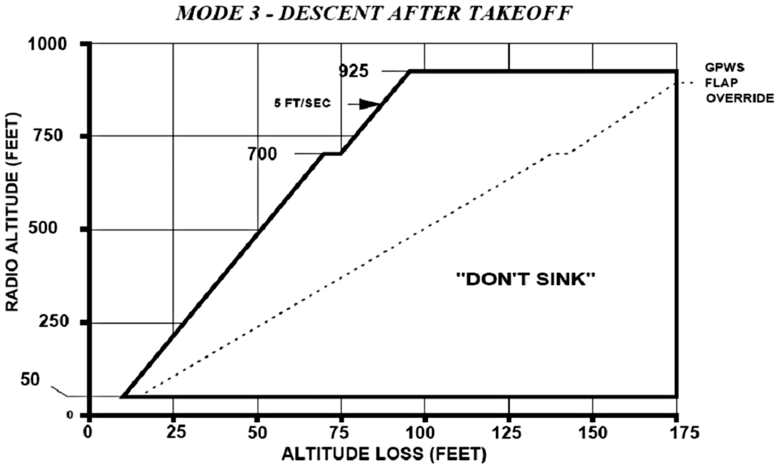


Figure 7

The initial search zone before "filtering" would have been more than 4,000 m in diameter.

3. CVR recovery

The second phase of the marine operations then began to recover the recorder and wreckage from the sea floor. The *Ile de Ré*, a 140-meter-long cable-laying ship was used for this mission. It is adapted to carry a heavy ROV[3] on its deck with its 50 tons of support equipment. The *Ile de Ré* has an advanced dynamic positioning (DP II) system that allows it to work even with unfavorable meteorological conditions and sea currents.

Within minutes of the first ROV dive, the tail section of the aircraft, containing the CVR, was spotted at a depth of 666 m.

The plan was to pierce the fuselage through the rear baggage door with a metal spear carried by the ROV. A cable connected at the spear tip was then passed through the tail section and knotted around a fuselage bulkhead. The ship's crane was used to lift the whole thing out of the water. All seemed to be going as planned until the tail section reached 50 m from the surface. At that moment, the attachment cable cut through the bulkhead that was being used to support the weight. The whole thing sank to the bottom, causing a 36-hour delay.

The tail section was spotted again by the ROV a few hours later. Since the CVR absolutely needed to be recovered, it was decided to cut through the side of the fuselage with the ROV's mounted tools and to just rip the CVR from its rack. After more than 7 hours of hard labor, the CVR was extracted and brought to the surface. The rest of the tail section, including the various flight control cables, was subsequently recovered from the same location.

4. EGPWS

The CVR was sent immediately to the BEA for readout. The aircraft was also equipped with an EGPWS[4], which generated alerts in case of

- excessive rate of descent close to terrain (mode 1)
- loss of altitude after takeoff (mode 3)

Aural alerts from these two modes were recorded on the CVR. A partial vertical profile of the aircraft trajectory was later calculated based on the data obtained relating to the recorded alerts.

4.1 Base data and assumptions

- The EGPWS installed on the aircraft was assumed to have been functioning according to Honeywell's product specification[5] at the time of the accident.
- The following CVR events were used as input for the calculations:
- At relative time t=0 s, it was assumed that the aircraft was still climbing at a vertical speed of 600 ft/min.
- The mode 3 "Don't Sink" alert envelope for turboprop aircraft is based on altitude loss and radio altitude[6]:
- Mode 1 "Sink rate" alert and mode 1 "Pull up" warning envelopes for turboprop aircraft are based on minimum terrain clearance and altitude rate:
- The aircraft was over the water from just after takeoff to the end of the flight. Therefore, for the purpose of this calculation, altitude and radio altitude are the same.

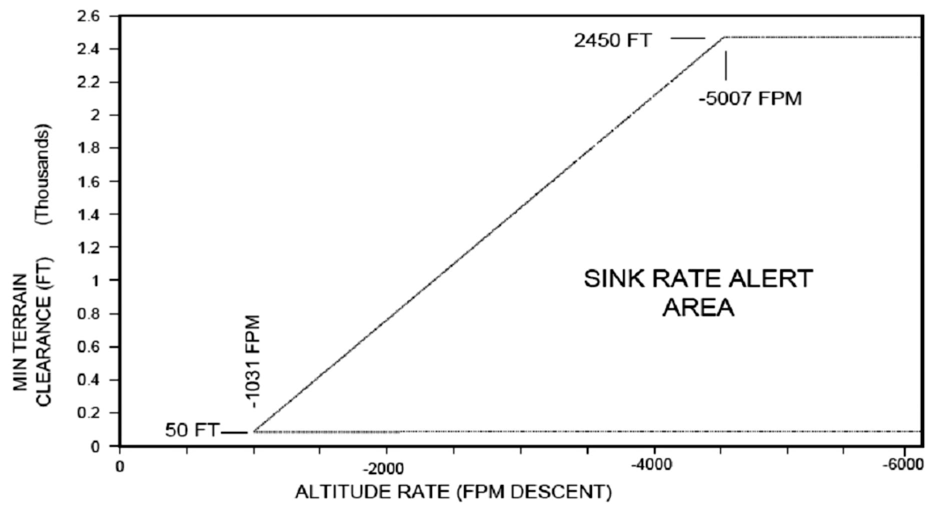


Figure 8

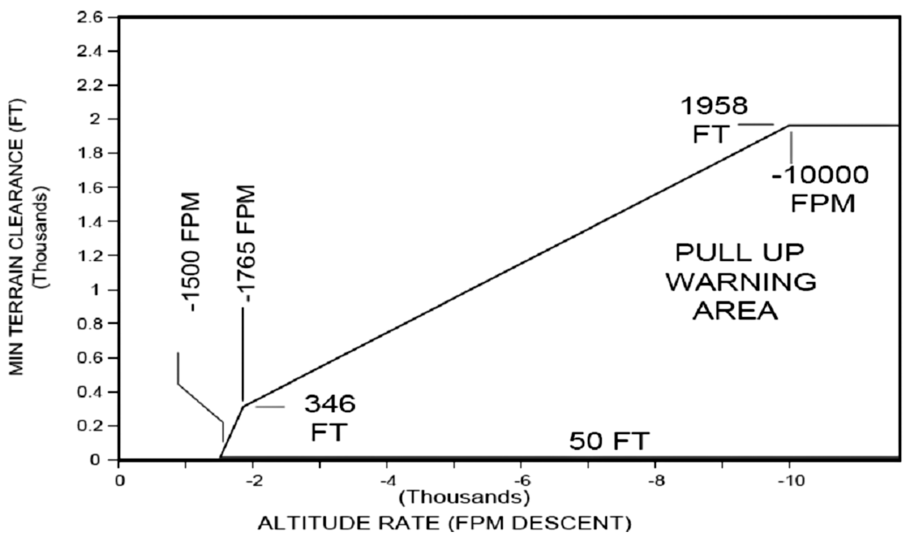


Figure 9

4.2 Method

Altitude as function of time (τ) was modelled by a 4th degree polynomial equation:

$Alt(\tau) = k_0 + k_1 t + k_2 t^2 + k_3 t^3 + k_4 t^4$ (in ft)

Vertical speed is the mathematical derivative of altitude:

$Vz(t) = d\ Alt(t) / dt$

$Vz(t) = k_1 + 2 k_2 t + 3 k_3 t^2 + 4 k_4 t^3$ (in ft/s)

Altitude rate in FPM in descent (for mode 1 envelope equations) can be deduced from vertical speed in ft/s:

Altitude Rate (t) = -60 * Vz (t) (in FPM, or ft/min)

The following equations are based on the base data and assumed conditions of paragraph 4.1. Relative time t1 is the time at which the altitude was the highest.

Since the aircraft was assumed to still be climbing at t=0, we can say that t1

Equation #	Conditions	Equations
(1)	The aircraft was still climbing at a vertical speed of 600 ft/min at t=0	Vz(0) = 10 ft/s
(2)	Altitude max reached at t1	Vz(t1) = 0 ft/s
(3)	1st EGPWS "Don't sink" alert at t=4.1 s	Alt(t1) - Alt(4.1) = 5.4 + 0.092*Alt(4.1)
(4)	EGPWS "Sink Rate" alert at t=7.2 s	Alt(7.2) = [-60*Vz(7.2) – 1031]*0.06036 + 50
(5)	1st EGPWS "Pull up" warning at t=7.95 s	Alt(7.95) = [-60Vz(7.95) – 1500]*1.11698 + 50
(6)	Impact with the surface at t=12 s	Alt(12) = 0

Figure 10

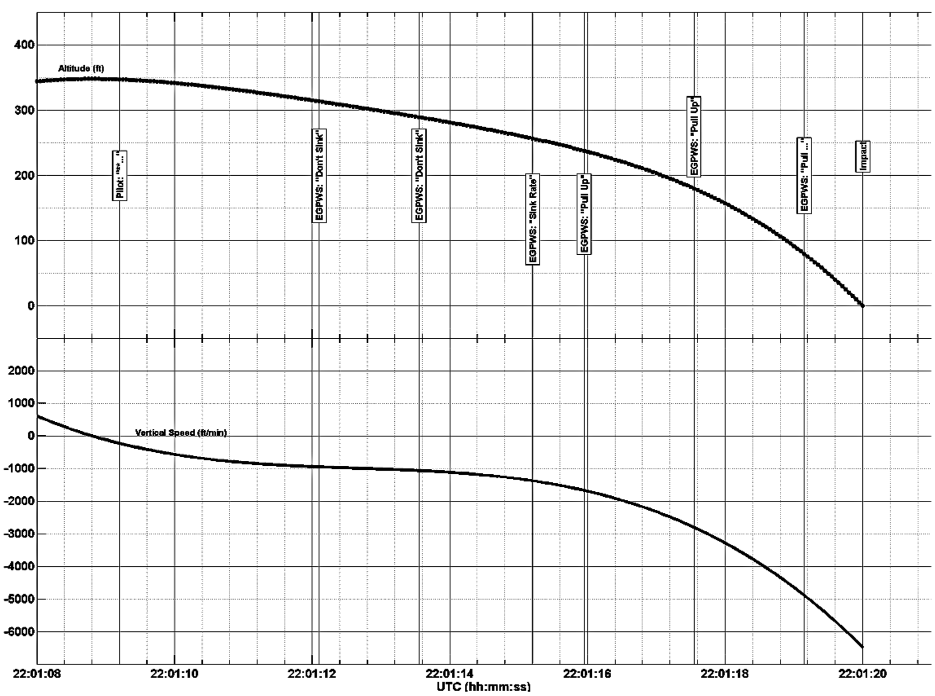


Figure 11

is greater than 0. Furthermore, since a "Don't sink" alert was recorded at t=4.1s, the aircraft was already descending at that time, which means that t1 is less than 4.1 s. Therefore 0<t1<4.1 s.

4.3 Results

The above equations (1) to (6) only have one solution[7] that complies with the condition 0<t1<4.1 s. According to the model, the aircraft reached a maximum altitude of 350 ft at 22 h 01 min 08.8 s. The vertical speed when it struck the water was 6,500 ft/min.

Alerts and warnings generated by a Honeywell GPWS simulator matched the sequence of those recorded on the accident airplane's CVR.

5. Further tests

To understand the airplane's final path, as described by the witnesses and reconstituted on the basis of the GPWS alerts and warnings, a series of flight tests were scheduled. These were designed to validate the calculated flight path in case of a rupture of the elevator cable during flap retraction.

The flight tests confirmed both airplane pitch-down movement at the time of flap retraction and that the airplane's flight path was the same as that predicted by the theoretical method described above. All of the tests performed led to the conclusion that the rupture of the cable was the cause of the loss of pitch control.

The initial examination of the elevator cable recovered from the wreckage showed that it was 50% worn at the location of the rupture. However, the maximum possible pilot input force on the control column could not, in fact, cause a cable rupture, even where there is 50% wear.

It was thus essential to determine the rupture sequence in a step-by-step manner. Extensive further testing was undertaken to try to identify what additional force or forces could have had an impact on the events that led to the fatal rupture.

As of today, most of these tests have been completed and others are still awaiting validation, but the results obtained so far have given us a clear direction to follow for our conclusion of the investigation. ◆

Endnotes

1 B-737-300 registered as SU-ZCF on Jan. 3, 2004, off Sharm El Sheikh, Egypt.

2 A320-211 registered EK-32009 on May 2, 2006, off Sotchi, Russia.

3 Remotely operated vehicle.

4 Model: Honeywell, Mark VI.

5 Document reference: DWG NO. 965-1180-601, Rev A. All equations and envelope diagrams are extracted from this document.

6 Selection of the GPWS flap override function increases the allowable altitude. This allows optional pattern work to be performed without unwanted warnings. It is assumed that it was turned off for the accident flight.

7 t1=0.8 s ; k=344.1897 ; k=10.0443; k_2=-7.3787 ; k_3=0.9733 ; k_4=-0.0523.

ISASI International Council Meets In Halifax, N.S., Canada

(Compiled from Council meeting minutes prepared by Chris Baum, ISASI secretary. The full minutes report is available on ISASI's website, www.isasi.org.—Editor)

The ISASI International Council meeting in Halifax, N.S., Canada, Sept. 7, 2008, affirmed the Jerome Lederer Award selection, accepted a bid for ISASI 2011, completed representation plans at the ICAO AIG/08 Meeting, established a new committee, and received briefings on Society infrastructure changes and a new committee chair appointment. In addition, reports were received from Council executives, working groups, and committees.

President Frank Del Gandio called the meeting to order. Attendees included Dick Stone, Executive advisor; Ron Schleede, vice-president; Chris Baum, secretary; Peter Williams, New Zealand councillor; Barbara Dunn, Canadian councillor; Caj Frostell, international councillor; Rick Sellers, the proxy for Lindsay Naylor, Australian councillor; David King, European National Society president; Graham Braithwaite, Investigator Training and Education Working Group chair; Jayme Nichols, ERAU and chair of ISASI 2009; Marty Martinez, editor of *ISASI Forum*; and Ann Schull, ISASI office manager.

Council Executives

President Frank Del Gandio, in expressing concern about the decline in corporate membership, related that he and Ron Schleede met with representatives of the Air Transport Association (a trade group representing a large number of U.S. airlines) and discovered that ATA appears to have limited knowledge of ISASI.

Ron Schleede commented that ISASI national societies should try to establish a relationship with potential corporate members in their areas. Similarly, the ISASI Corporate Affairs Working Group should be proactive in identifying points of contact, reaching out to potential corporate members, and coordinating with national societies.

Del Gandio noted that although the finances from the Singapore Seminar had not yet been finalized, a portion of any profit will be held, per the seminar manual, to see if the seminar organizers are able to form a local chapter/society. Moreover, the fluctuating exchange rate will affect any final fund distribution. This fact prompted a discussion of whether some standard method of accounting for international exchange rates should be included in the seminar manual. Caj Frostell pointed out that depending on the particular government and banking systems involved in any given seminar, the process for closing the books, adjusting for exchange rates, etc., may vary from country to country, so those differences must be allowed for as well. Barbara Dunn and Chris Baum will review the matter and report to the May meeting.

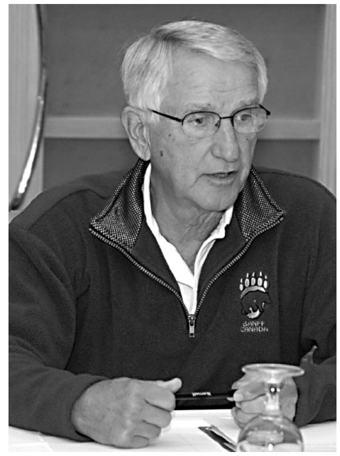
The president then turned to the subject of criminal prosecution of individuals involved in aviation accidents, saying he has received correspondence asking that ISASI assess what role, if any, it should have in the international debate about the criminalization of accident investigations. Accordingly, a 2006 joint resolution, signed by Flight Safety Foundation, CANSO, RAeS, the French National Air & Space Academy, ERA, PAMA, and IFATCA addressing the problem of criminalization was circulated among the Council.

Ensuing discussion pointed out that there is significant variance among the world's legal systems, leading to a variety of state approaches to this issue. Any position ISASI might take must accommodate these differences, and ISASI cannot attempt to limit the statutory authority of a sovereign state. The Council

E. MARTINEZ

David King discusses the Reachout program as, left to right, J. Nichols, P. Williams, and R. Sellers look on.

agreed to continue the discussion at the May meeting. Dave King and Peter Williams will consolidate Council member comments and begin drafting an ISASI Position.



PHOTOS: E. MARTINEZ

Del Gandio briefed the Council members on new appointments within the ISASI structure. He proposed the creation of an Unmanned Aerial Systems Committee with Tom Farrier as its chair. The Council approved. Del Gandio also reported other changes: Ludi Benner is the new chairman of the Board of Fellows, John Edwards is the new Ethics Committee chairman, and John Guselli is the new Reachout chairman. Peter Williams is now the New Zealand councillor, and Dave Harper is now the president of the Rocky Mountain Chapter. The Florida (U.S.) and Southeastern (U.S.) chapters will be combined into a single chapter (name to be determined). Bob Rendzio will be interim president, and Jayme Nichols will be interim vice-president. The members will elect permanent officers and determine the chapter name later in the year. The president noted that it is not necessary for the combined chapter to reaffiliate because the action is a consolidation of existing chapters.

ISASI's Reachout program success has generated questions regarding the security of some Reachout locations, said the president. Consequently, he is considering asking the Reachout Committee to develop guidelines to help Reachout organizers determine whether a particular area of the world is safe at a given time. Similarly, he is researching ISASI's insurance coverage to see if ISASI has any uncovered liabilities.

Vice-President Ron Schleede reported on plans to represent ISASI at the ICAO AIG Meeting in Montreal to be held in October. ISASI will present three papers: a working paper on cooperation between states and ISASI on conducting Reachout seminars, another working paper on the potential need for an ICAO Safety recommendations database, and an information paper on the Kapustin Scholarship (see page 4).

Treasurer Tom McCarthy was absent from the meeting, but his submitted written report showed that ISASI is financially sound but expenses are increasing. The projected 2009 budget clearly reflects ISASI'S reliance on financial earnings from the annual seminar to remain solvent. The consensus among the Council members was that relying on the seminar for solvency is the normal way ISASI does business and if that should change in the future, it will be dealt with then.

Executive Administrator Dick Stone reported the names of the three persons who will receive 2008 Kapustin scholarships (see *Forum* October-December 2008, page 18). He also briefed the Council that there was a substantial number of applications that did not follow the established scholarship guidelines.

Stone also reported on the progress of the international working group on human factors. He said it is not progressing as quickly as the group had hoped. At present, no more than two modules are complete or nearly so. Several of the reviewers are having difficulty finding the time to review existing drafts, and some of the researchers are finding it difficult to reach good stopping points for the research that would enable them to publish what they have rather than continue further study. He recommended that the Council review the group's progress again in May. In closing, Stone noted that the website is running smoothly but asked that anyone who sees errors report them to him and Ann Schull so they can be addressed.

National Societies/Councillors

ASASI—Rick Sellers, the proxy for Lindsay Naylor, reported that the ANZSASI regional seminar was a great success. Lindsay, in a written report, expressed concerns about the status of Council member travel arrangements being made through Omega. He noted that working independently a cheaper fare was secured with less frustration. Sellers commented that councillors, regional presidents, and other ISASI officials must be trusted to seek the most cost-effective solutions for travel expenses. The Council agreed.

CSASI—Barbara Dunn reported that CSASI's subsidizing of registrations for the Halifax seminar offered to its members appeared to have bolstered attendance. CSASI has begun some discussions with the Air Canada Pilots Association (ACPA) about the possibility of a joint seminar on winter flying operations.

The membership goal for 2009 is 200 individual and 10 corporate members. The effort to waive processing fees for individuals joining in conjunction with an ISASI seminar has been successful.

ESASI—David King reported good feedback from the seminar held at Cranfield. He said that the academic atmosphere provided by that venue was a significant advantage (see *Forum* October-December 2008, page 24). ESASI is planning a spring 2009 seminar at Hamburg University.

NZSASI—Peter Williams reported that NZSASI has 80 members and that the ongoing plans for the regional seminar are progressing well.

International Councilor—Caj Frostell said that he has had reports that visas for some of the international delegates to the annual seminar can take as long as 12 months. He recommended that future seminar invitations and announcements should include visa information for the benefit of prospective attendees.

He also said that ISASI's status at ICAO has been the subject of some discussion regarding whether ISASI could or should take



From left: Barbara Dunn, Richard Stone, Ron Schleede, Caj Frostell, Chris Baum, and President Del Gandio.

a more active role at that level. He reminded the Council that ISASI was granted observer status in the mid-1990s with the informal proviso to "wait and see" if it would become evident that ISASI participation merited more of a participant status. The Council would have to decide whether it wants to pursue a more active role in ICAO, bearing in mind that more would be expected of ISASI. President Del Gandio inquired on what it might mean to ISASI to have a more active role. Frostell replied that it could provide greater flexibility in attending ICAO meetings and other formal discussions. There is some precedent with organizations such as IFATCA, CANSO, IATA, IFALPA and others, but those all tend to be larger organizations with more-robust funding.

ISASI Committees

Audit—Michael Hynes, through a report from Del Gandio, stated that the recent audit was complete with no problems noted. The written audit report was presented to the Council.

Awards—Gale Braden expressed a need for more nominations for the Lederer Award.

Membership—Tom McCarthy's written report noted recruiting success in 2008 with 185 new individual and 13 corporate members. Membership now stands at 1,385 individual members, 212 delinquent members, and 133 corporate members with 10 past-due accounts. The 2009 goal is for 200 individual and 10 corporate members. He also noted that the effort to waive processing fees for individuals joining in conjunction with an ISASI seminar has been successful.

Nominating—Tom McCarthy has resigned the position of chairman of the Nominating Committee. Jayme Nichols volunteered to be the chair, and there were no objections from the Council.

Seminar—Barbara Dunn reported that the seminar's "Author's Guidelines" for papers has been revised and provided copies to all Council members. She said the Halifax seminar has 266 delegates attending along with about 50 companions. There have been some cancellations due to weather (Hurricane Hannah). There is strong corporate sponsorship for the seminar, both as cash contributions and "in kind" support such as ticket discounts, etc. In lieu of speaker's gifts, and after consultation with all speakers, the seminar will be making a charitable donation to the Aspotagan Heritage Trust on behalf of the fishermen who did the initial search for survivors of Swissair Flight 111.

Jayme Nichols, chair for ISASI 2009, reported that plans for Orlando are on track. She said the Committee is trying to stimulate student attendance but also noted that the fixed cost per delegate is higher than the student registration, so each student represents an economic loss. There is no implication that student attendance is not worthwhile, only that the economics need to be known and accounted for in the planning. There will be a Rudy Kapustin golf tournament, intended to raise money for the Scholarship Fund on Sunday before the seminar.

Barbara Dunn and Dick Stone presented a bid to host the 2011 seminar in Salt Lake City. They showed a DVD about Salt Lake City and mentioned there are currently three hotel bids being considered, all in the US$149-169 range. There are a number of good venues under consideration for the companion program. The theme proposed is "Investigation—A Shared Process." It was moved, seconded, and unanimously passed to accept the Salt Lake City bid.

Reachout—In discussion, Dave King expressed a feeling that the Council needs to get some clarity on what Reachout has become compared to the original purpose of getting safety information to places in the world that can't afford to go elsewhere for it. Frostell mentioned that the change was deliberate so that having a Reachout seminar does not become associated with identifying the host country as "underdeveloped."

Braithwaite commented that some view Reachout as "ISASI investigator training" that is significantly cheaper than other alternatives, although that is not really its purpose. The Council recognized that there are two ways to reconcile the difference between the current, published definition of Reachout and the practical conduct of the seminars. One is to ensure strict compliance with the current definition; but the Council agreed that the other alternative, updating the definition, is more appropriate.

Ballot Certification—Tom McCarthy submitted a written report outlining the results of the most recent election. All nominees ran unopposed, and only 18 ballots were cast. The Council then discussed ways to stimulate more participation in elections. A major reason for low turnout is that all the races were uncontested. Council members suggested e-mail and messages from chapter/society officers as a means to publicize elections. It was suggested that elections continue through the week of the seminar to allow attendees better opportunities to vote. No action was taken on the suggestion.

Working Groups

Investigator Training and Education—Graham Braithwaite noted that it is difficult to identify the scope of the Working Group and asked for input from the Council. Comments received: "Its purpose is as a forum for individuals who are investigation instructors." "It would be appropriate for the Working Group to be more involved in the tutorials, since that is where a good deal of training takes place." "The Working Group could be used to standardize training concepts." ◆

VERY LIGHT JETS:

The next revolution in aviation markets and aviation safety is under way. The author examines VLJs characteristics, effects, and challenges as they relate to safety, accident investigators, and investigative authorities.

By Robert Matthews, Ph.D., Senior Safety Analyst, Office of Accident Investigation, U.S. Federal Aviation Administration

(*This article was adapted, with permission, from the author's paper entitled* Very Light Jets: Implications for Safety and Accident Investigation *presented at the ISASI 2007 seminar held in Singapore, Aug. 27-30, 2007, which carried the theme "International Cooperation: From Investigation Site to ICAO." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

Very light jets (VLJs), sometimes called micro-jets, mini-jets, or personal jets, are about to revolutionize the air taxi industry and business aviation, and they likely will affect the market for high-performance personal aircraft.

The term "VLJ" generally denotes relatively inexpensive turbofan airplanes that weigh less than 10,000 pounds (most under 7,500 pounds) and cost from US$1.5 million to US$4 million. VLJs typically will have four to six seats, including crew, with service ceilings up to 41,000 feet, and a range of up to 2,000 miles. They will offer the increased reliability of jet engines and will be highly automated, with flight management systems, multifunction displays, real-time weather displays, integrated electronic flight bags, and state-of-the-art avionics and navigation, complete with moving maps, terrain maps, terrain warning and traffic alerting, plus the traditional altimeter, airspeed, heading, vertical speed, and horizon—and all this will be integrated with an autopilot and will be displayed more simply on high-definition flat screens. The first VLJs to reach the market will be twin-engine jets, but they will be followed quickly by the single-engine Diamond DJet and eventually by a single-engine Cirrus Jet.

The Eclipse 500 is the best-known survivor of the early hopefuls. It has been followed by better-known names, including Cessna with its CJ3-Mustang, Diamond with its DJet, Embraer with its Phenom, and HondaJet, while Cirrus and Piper are preparing to enter the field.

Manufacturers estimate that up to 5,000 VLJs could enter service within the next several years. The aviation community has no experience with a new class of aircraft entering the fleet at such a pace. For example, 5 years after air transport jets entered the U.S. airline fleet in December 1958, just 550 were in service. Five years after first-generation business jets entered the fleet, just 440 were in service in the U.S. civil fleet. VLJs are poised to overwhelm the scale at which these once-revolutionary aircraft entered the fleet.

The real revolution with VLJs lies in price and operating costs. Prices now start at US$1.53 million for the Eclipse and are expected to start around $2.25 million for the Adam 700, $2.55 million for the Cessna Mustang, and about $2.85 million for the Embraer Phenom. The single-engine Diamond DJet has a current estimated entry price of just $1.38 million.

As of mid-June 2007, Airclaims, which defines "orders" rather conservatively, identified nearly 1,500 orders from 19 countries for VLJs. Less-demanding definitions produce much higher estimates. About 90 percent of the orders currently come from North America and Western Europe, but operators in other regions likely will soon follow suit in large numbers.

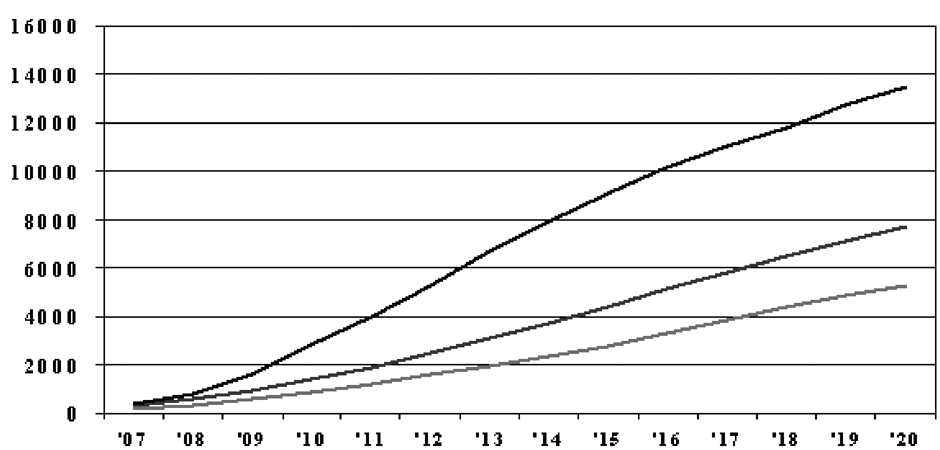
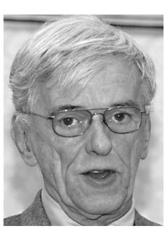


Figure 1. Three conceptual growth rates, very light jets.



***Dr. Robert Matthews** is the senior safety analyst with FAA's Office of Accident Investigation. He has worked 9 years in national transport legislation with the U.S. DOT and several years as an aviation analyst for the Office of the Secretary at the U.S. DOT. He has also worked with the Organization for Economic Cooperation and Development as a consultant. Dr. Matthews earned his Ph.D. at Virginia Tech's Center for Public Administration and Policy Analysis and is an assistant professor, adjunct, at the University of Maryland.*

Implications for Safety and Accident Investigation

The pace of change will be most apparent in air taxi operations. This is the field in which entirely new business models are being discussed. Dayjet is positioned to be the first large operator in the U.S., with more than 300 firm orders for the Eclipse, with long-term plans to operate as many as 1,000 VLJs. Another prospective U.S. operator, MagnumJet, has firm orders for 100 Embraer Phenoms and 100 Adam 700s. Three prospective operators in Europe also have large orders in place: ETIRC Aviation of Luxembourg has 181 orders for the Eclipse; Aviace of Switzerland has 112 firm orders for the Eclipse; and JetBird, also of Switzerland, has 100 Eclipses on order.

Yet, the aviation community continues to debate the size of the VLJ market. Most estimates range from 5,000 units by 2020 to as many as 15,000 units by 2020. Typical estimates also suggest 1,000 to 1,500 VLJs will enter the fleet annually within several years after their introduction.

Common estimates also suggest average rates of use approaching 1,500 or even 2,000 hours per year per VLJ among air taxi operators. Some observers believe this is too high, but with US$1.5 to $4 million invested, these aircraft will be purchased to be flown. The bottom line is clear: the VLJ fleet quickly will reach big numbers and will produce more flight hours per unit than current fleets produce. Figure 1 illustrates the pace of entry that might be expected under three broad scenarios.

If we assume the middle curve on Figure 1, some 8,000 VLJs would be operating by 2020. If we also assume that the majority of VLJs will operate as air taxis or in business aviation, VLJs likely will average something on the order of 750 to 1,000 hours per year, fleetwide. If these numbers are close, they suggest 6 million to 8 million flight hours (or more) per year in 10 years just in the U.S., and these numbers may prove to be low.

This type of fleet will place real pressure on the availability of qualified pilots and mechanics. Some of these pilots and mechanics will come from existing jet segments in the industry, but many will come from non-jet backgrounds.

In sum, aviation has never experienced as rapid a change in the fleet or in business models as VLJs promise to deliver. This unprecedented pace of change is the source of substantial concern about the possibility of new risks being introduced into air taxis, business aviation, and personal operations.

New risks versus positive characteristics of VLJs

VLJs will have both negative and positive effects on safety. Based on their characteristics, the net effect of VLJs should be very positive, but any new class of aircraft has always added some new risk—at least during a learning period, even if the aircraft later significantly improves safety. The most common concerns include the pace at which VLJs will enter the fleet, the daily prospect of thousands of single-pilot jet operations, and fears that too many pilots will upgrade into single-pilot operations before they are properly prepared for the more-demanding environment of jet operations.

New risks

Rapid changes in aircraft fleets have been persistent sources both of new short-term risk and substantial long-term improvements in aviation safety. Whether we speak of air carrier aircraft, business-corporate aircraft, or more broadly based general aviation fleets, each new generation of aircraft has produced accident rates that resemble "elbow" curves, in which rates start out high, fall sharply, and then stabilize at lower levels. Equally important, each new generation of aircraft enters the fleet with a lower initial accident rate than did the preceding generation, and each new generation has a shorter learning curve, with rates stabilizing more quickly and at lower levels than the preceding generation. Large jets operated by major airlines provide the most familiar illustration of this point.

Though documentation is not as well established for lighter aircraft, their experience appears to be comparable to the experience of air transport aircraft. Figure 2 illustrates cumulative accident rates for the Lear 23, which was one of the earliest corporate-type jets to enter the fleet in appreciable numbers, and for the

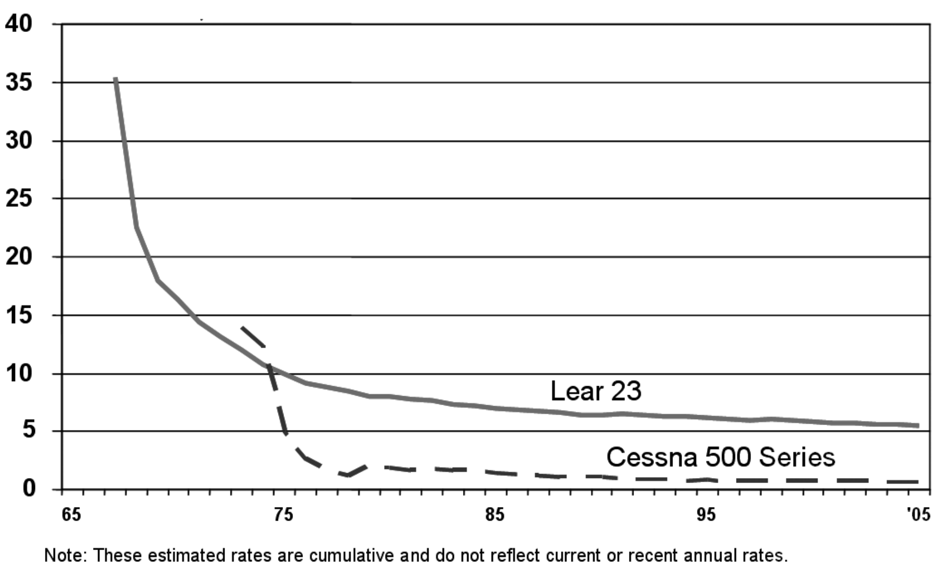


Figure 2: Estimated cumulative accident rates, Lear 23 and Cessna 500 series.

more numerous Cessna 500 series. Both fleets clearly exhibit the "elbow" curve in their cumulative accident rates.

The early accident experience with technologically advanced reciprocating aircraft (TAA) in business and general aviation appears to follow a similar path. Estimated cumulative accident and fatal accident rate lines for the Cirrus SR20 and SR22 follow the same general shape as those experienced by each generation of air carrier jets, as well as the Lear 23 and the Cessna 500 series. Rates were high very early, then fell sharply and stabilized more quickly than did rates for the earlier generation of aircraft illustrated here.

The FAA anticipates similar accident curves for VLJs. Like other new aircraft of earlier eras, VLJs are likely to confront a learning curve with relatively high accident rates at first, but at lower starting points than experienced by earlier generation aircraft. The early high rates are simple to explain. By definition, since it is a new-generation aircraft, all pilots, mechanics, and commercial operators have little or no experience with the aircraft. However, as experience builds and as any residual design issues are resolved, the initially high rate is followed by sharp and sustained improvements, followed by yet lower and stabilized rates that are lower than earlier generation aircraft.

However, the pace at which VLJs are expected to enter the fleet will produce a paradox for air taxis. The sheer size of the VLJ fleet in air taxi operations and their more-intensive use could quickly double total air taxi exposure. Consequently, the total number of accidents and fatal accidents may increase among air taxi operators even while overall rates decrease. The paradox, therefore, will be a "safer" system, as measured by rates, but one that may generate an increase in fatal accidents due to sharp increases in volume. This paradox will not be so apparent in personal flight, where a much larger scale of activity will minimize the effects of VLJs on overall rates.

Single-pilot operations

The core concerns about single-pilot operations is that things happen faster in jets, and pilots must stay further ahead of an airplane traveling at 350 knots than when traveling at 150 knots. Global Aerospace, the insurance underwriter, estimates that accident rates for single pilots in turbine-powered aircraft (including turboprops) are 50 percent greater than for twin-pilot operations. Global adds that the single-pilot issue generally is more important among private pilots rather than among air taxi operators, as private pilots have much higher accident rates in general. A brief review at the FAA of accidents involving the Cessna 500/501, the Cessna 525, and the Raytheon Premier supports these observations from Global Aerospace and may even suggest that the ratio is slightly higher. The Cessna 500 series and the Premier are used here because they are certificated for single-pilot operations, and the Cessna series is well established in the fleet with about 2,800 currently in service in the United States.

The core concerns about single-pilot operations is that things happen faster in jets, and pilots must stay further ahead of an airplane traveling at 350 knots than when traveling at 150 knots. Global Aerospace, the insurance underwriter, estimates that accident rates for single pilots in turbine-powered aircraft (including turboprops) are 50 percent greater than for twin-pilot operations.

The NTSB accident database includes 71 accidents involving those aircraft; just 18 had two-pilot crews. All but 1 of the 53 single-pilot accidents involved personal flights or business flights with non-professional pilots. If we add selected twin-engine turboprops since 1983 (the Metro, Embraer Bandeirante, and the MU-2), the number of accidents reaches 371, of which 207 had single pilots. No data on flight hours for single-pilot operations versus twin-pilot operations are available in the U.S.

However, given the accident numbers cited above, in order for single-pilot operations to have an accident rate that is 50 percent greater than the two-pilot rate, two-pilot operations would have to account for just 55 percent of total hours in the selected fleet. In fact, two-pilot crews probably account for more than 55 percent of this fleet's hours, suggesting that the accident rate for single pilots in turbine-powered aircraft may exceed the rate for two-pilot crews by more than 50 percent.

Factors that explain higher accident rates for single-pilot operations may include differences in the mix of airports used, different rates of IFR flight versus VFR flight, the presence or extent of dispatch support, the presence of structured maintenance programs, pilot training, etc. However, the most significant factor in explaining a higher accident rate for single-pilot operations appears to be the number of pilots on board.

Pilot experience does not appear to be among those factors. In the selected fleet identified above, single pilots averaged 25 percent more total flight hours than did pilots-in-command (or "commanders") and far more flight hours than first officers. The picture changes only modestly when we examine hours in make-model: commanders then have about 25 percent more experience than single pilots, but single pilots again have much more experience than first officers. The bottom line is that single pilots in complex aircraft generally are not inexperienced.

However, the sheer number of VLJs coming into the fleet will lead to thousands of pilots suddenly upgrading into VLJs. The concern is especially acute in air taxi operations, where the sale of seats to the general public substantially increases government interest. Can air taxi operators find enough pilots and mechanics with adequate jet experience? Will the thousands of new pilot positions in the air taxi industry be filled by pilots whose proficiency and knowledge are adequate to operate highly automated jets at high speeds, sometimes near the upper limits of civilian airspace, and do so without another pilot in the right seat? Similarly, will air taxi companies be properly equipped to hire and train this new workforce, and are those companies properly prepared to operate jets?

An additional risk could be introduced for air taxi operators that do not have dispatch functions. The absence of a dispatch function increases pilot workload as pilots must secure their own weather information and determine their own performance specifications for landing distance, fuel burn, weight and balance, etc. In contrast, a dispatch function would include weather support, NOTAMs, and a pilot operating handbook with specifications for every runway. The possible increase in workload could be more intense for single-pilot operations. This risk could be reduced by the flight monitoring and dispatch programs some manufacturers are planning.

Finally, some pilots may place too much faith in the avionics and the improved weather information, or may simply use those tools to expand their envelopes of risk taking. The early accident history in so-called technologically advanced general aviation aircraft clearly indicates that this happens, but it happens less frequently than evolving folklore would suggest. Nevertheless, it will happen to some degree with VLJs, particularly in their early operational history. The bottom line here is obvious: even the best technology can not always save pilots from terrible decisions.

The National Business Aircraft Association (NBAA) has produced a short list of the most important safety issues for which pilots, operators, and regulators must be prepared. (*A synopsis of key items in the NBAA list appears on page 118, column 2, of* ISASI Proceedings 2007*, which can be found on the ISASI website.—Editor)* All the noted issues relate in varying degrees to the experience and knowledge of the pilot and operator, as well as to the provision of air traffic services.

To the NBAA list, we might add the risk of landing at smaller airports with shorter runways and less supporting infrastructure. Though VLJs will be designed to land and take off on short runways, VLJs will operate into many short fields that have no ILS and, therefore, no coupled approaches. This could increase the frequency of unstable approaches, which are a common factor in several categories of typically severe accidents, such as CFIT, approach and landing, loss of control in flight, and high-speed runway excursions.

Similarly, most air taxi, business, and personal flights in VLJs will involve busy urban airspace, even when flights operate to or from satellite airports. Will pilots with limited or no previous experience in jets or with FMS adequately handle potentially high workloads in busy airspace, with ATC barking instructions at them, and with the need to change flightpaths abruptly? Will this invite excessive head-down time for a single pilot? Will the recently upgraded portion of VLJ pilots be ready for this environment? Finally, will new operators face competitive pressure to dispatch an aircraft into marginal environments?

The good news is that most of these risks are well recognized by manufacturers, governments, and the organizations that will operate the first generation of VLJs. Manufacturers and air taxi companies have developed training programs, and the completion of those training programs will be a requirement under the manufacturer's warranty in many cases. Training programs will include Level-D simulators and human resource training for single pilots. Similarly, in the U.S. and elsewhere, most prospective air taxi operators have explicitly identified the need for extensive training programs and have already begun developing such programs, along with required maintenance programs and operational procedures as those companies prepare for certification. Governments also will require jet ratings, with IFR ratings, for all VLJ pilots, plus commercial ratings for VLJ pilots in air taxi operations.

In the air taxi industry, the risks associated with single pilots will be reduced further by customers who will insist on two-pilot operations. Similarly, insurance policies will require two-pilot crews of most air taxi operators and of many corporate operators. Currently all the companies planning to use VLJs in air taxi service in the U.S. are planning to use two-pilot crews.

Some risks noted above for personal and small business operators, such as the absence of support structures, will be at least partly addressed by the marketplace. Price will be the primary factor that limits the penetration of these services between aircraft owners and operators, as these market-based support services will not be free. If price theory has any validity, these services will confront some degree of resistance at any price, regardless of their quality or their net benefits to safety and risk. Nevertheless, all these efforts, plus the aircraft characteristics, will combine to reduce risk among private operators, and they should help to shorten the anticipated learning curve.

Finally, many of the small businesses and private pilots who purchase VLJs are likely to depend on aircraft management companies to maintain their aircraft or will join fractional ownership programs. This will reduce still further some of the risk associated with new-generation fleets.

All these factors will reduce the severity of the learning curve, but they are unlikely to eliminate it, particularly with single-pilot private operators. The bottom line is that the introduction of at least some new risk is inevitable. New risks will be especially high for small business users and for pilots who buy VLJs for their personal use. On average, they will be the least experienced overall, the least experienced in jets, and they will have limited support structures.

Positive effects of VLJs

Several common characteristics of VLJs should produce major improvements in safety that more than offset any new risks. The most important safety characteristics of VLJs include the following.

High-altitude capability means that VLJs will fly above the terrain and above much of the weather, at least in cruise flight. Consequently, VLJs will be much less vulnerable to CFIT accidents and loss of control in flight, which are the biggest killers in air taxi operations, personal flights, and small business flights.

The "J" in VLJ means a turbofan engine. The obvious fact that VLJs will employ jet engines should substantially reduce the frequency of accidents related to power loss and will improve the capacity of multiengine aircraft to maintain altitude if one engine fails.

Flight Information System (FIS) weather should reduce the frequency of accidents related to unanticipated weather encounters.

Other avionics and equipment typically will include an electronic flight information system (EFIS), multifunction display, moving map with terrain depiction and terrain awareness and depiction, terrain and obstacle warning systems, and autopilots with coupled approaches. All this will be accompanied by improved and simpler displays. These characteristics should reduce workload in most environments and will substantially improve pilots' information and situational awareness.

To quantify the positive effects that VLJs should have on safety, each of the above characteristics has been tested against recent fatal accidents in the U.S. involving flight activities that will be major parts of the VLJ market. Those activities include the following airplane operations: cross-country personal flights, air taxi operations, small commuters, corporate aviation, and business aviation. These activities accounted for 850 fatal accidents or 45 percent of all non-airline fatal accidents in the U.S. for FY 2002 through FY 2006, and 55 percent of all fatalities. The scoring excluded fatal accidents involving helicopters, recreational flying, banner towing, aerobatics, most public-use flights, heavy-lift operations, aerial application, instruction, and other activities.

If a characteristic would have had no effect on an accident, the characteristic was assigned a score of zero. Conversely, if a single characteristic would have eliminated the risk of a particular accident, that characteristic would receive a score of 100. Based on the premise that no technological characteristic can ever eliminate all risk, no characteristic received a score of 100 against any accident.

In addition, a simple algorithm was used to ensure that no single accident received a combined score of more than 100, as each characteristic was assessed for its capacity to eliminate the risk that remained in each accident. For example, assume we are assessing the VLJ against a CFIT accident that occurred in cruise flight. The capacity for high-altitude flight might be scored very high against this accident, say 90 percent, while the avionics package might also be scored rather high, say at 75 percent. The two scores can not simply be added because no single accident can be avoided 1.65 times. Instead, the combined score would be 97.5 percent, as the avionics would be scored only against the portion of risk that remained after applying the benefits of high-altitude flight, as follows: (1-90%) + [(1-90%) x 75%] = 90% + 7.5% = 97.5%.

VLJ characteristics scored best against controlled flight into terrain, accidents related to engine failures, enroute icing or other loss of control in flight where aircraft could not climb above weather, accidents in which better weather information in the cockpit would have reduced risk, and accidents in which pilots became lost in flight. Conversely VLJs scored zero against 28 percent of the cases and received only minimal scores against another 5 percent of the accident set. Those cases were dominated by accidents in which aircraft characteristics and performance were irrelevant or nearly irrelevant. These cases included fuel exhaustion, system or component failures, and pilots knowingly accepting high risks, such as knowingly flying into severe weather or knowingly flying with a poorly performing engine. Some zero or minimal scores also involved aircraft that already were equipped with several of the important VLJ characteristics and the addition of several other characteristics would have had either no influence or limited influence.

The review concluded that 49 percent of the fatal accidents and 53 percent of the fatalities among the targeted flight activities would have been averted if those flights had taken place in VLJs. The avionics packages proved to be the most effective characteristic against the accident set. This was especially true for CFIT accidents in which a terrain display or alerting system would have reduced risk significantly. The avionics and automation also proved effective against loss of control in flight, approach-and-landing accidents, and generally against cases in which better navigational awareness would have helped. The avionics packages alone would have averted an estimated 22.8 percent of the risk in the accident set and 28 percent of fatalities in the accident set.

The capacity to operate at higher altitudes was the second-most effective characteristic. Like avionics, altitude would have been particularly effective against enroute CFIT, enroute icing, and some loss-of-control accidents in which the need for maneuvering would have been eliminated. Higher altitude alone would have eliminated an estimated 17.1 percent of risk in the accident set. However, avionics (at 22.8 percent) and altitude (at 17.1 percent) often addressed the same risks. Consequently, the two characteristics combined would have eliminated "only" 34.3 percent of the risk in the accident set. However, because these characteristics addressed the accidents that typically have more severe outcomes, they would have avoided an estimated 39 percent of all fatalities in the accident set.

The presence of a turbine engine was the third-most effective of the four characteristics, based largely on greater reliability and a twin-engine jet's capacity to sustain altitude or a 1 percent climb rate with one engine out. Turbine power also influenced some accidents on takeoff in which engine run-ups were inadequate. By itself, the use of jet engines would have eliminated an estimated 10.7 percent of risk in the accident set. Since the accidents addressed by jet performance had very little overlap with accidents addressed by avionics and altitude, the 10.7 percent was almost entirely additive. When combined with the two characteristics already assessed, jet performance would bring the total risk reduction to 44.7 percent of the accident set.

Finally, the better weather information that will be available in the cockpits of most VLJs had a stand-alone effect that was nearly identical to that of jet performance, at 10.6 percent of the accident set. However, because other characteristics often addressed the same accidents, the net effect increased total risk reduction from 44.7 percent to "only" 49.1 percent.

Figure 3 summarizes the effectiveness of VLJ characteristics against the accident set and shows effectiveness against the three types of activities that account for

All Fatal Accidents in Data Set (850)	Avionics	High Altitude	Jet Engine	Weather	Total
Stand-Alone Total	22.8	17.1	10.7	10.6	N/A
Cumulative	22.8	34.3	44.7	49.1	49.1
Selected Flight Activities (Airplanes)	**Avionics**	**High Altitude**	**Jet Engine**	**Weather**	**Total**
Air Taxi (77)	26.7	16.4	4.4	9.7	45.7
Business (82)	22.0	16.2	10.2	10.8	49.6
Personal Cross-Country (672)	22.6	17.6	11.3	10.6	49.6
Selected Accident Types (Airplanes)	**Avionics**	**High Altitude**	**Jet Engine**	**Weather**	**Total**
CFIT (163)	45.5	50.1	0	15.9	76.9
Loss of Control in Flight (198)	18.2	25.6	6.7	16.2	52.3
Approach-Landing (213)	24.2	1.4	5.6	10.2	33.9
Loss of Control, T/O-Climb-out (160)	11.7	2.4	20.4	5.1	36.2
Emergency Maneuver (68)	0.8	2.6	48.4	1.5	51.2

Figure 3. Positive effects of VLJ characteristics total, selected flight activity and selected accident types.

all but a small share of the accident set. The Figure also shows the effectiveness of VLJ characteristics against selected accident types. The four characteristics had comparable effects on each of the three types of flight activity shown, but each characteristic had significantly different effects on the various accident types.

How VLJs will affect accident investigation

How will the inevitable VLJ accidents affect accident investigation and investigators? The short answer is that the core process of accident investigation will not change in fundamental ways. Nevertheless, some changes will occur in the details of investigations and those changes will be most challenging in countries where VLJs enter the private aviation market in large numbers.

Whether an accident involves a VLJ or any other aircraft, the core purpose of any investigation will remain unchanged. The purpose is well stated by the United Kingdom's AAIB: "to determine the circumstances and causes of an accident" in order to prevent future accidents and thereby preserve life. Similarly, basic investigative procedures will remain in place, regardless of whether an aircraft is a VLJ or not.

However, some important elements will change. The most obvious change may simply be the number of cases involving complex airplanes as VLJs expand in the fleet. Other changes will include more common involvement with composite materials on relatively small aircraft, more involvement with jet engines and, perhaps, more high-energy impacts.

Basic workload and the necessary skill mixes may be among the most apparent changes for investigative agencies in countries with significant VLJ fleets. Particularly early in VLJs' operating history, any VLJ accident is likely to generate broadly based interest among governments, manufacturers, operating companies, pilot unions, mechanics' unions, and others.

Generally, as aircraft complexity increases, investigations ultimately rely more and more on data recorders to understand the accident thoroughly. The typical VLJ will enter service with a capable quick access recorder (QAR). Early QARs evolved for use in large air transports as a less costly alternative to removing flight data recorders (FDR) to gain access to operational data and to system faults. Depending on design, contemporary QARs can transmit data at the end of every flight (upon opening an aircraft door), or data can be stored on board until the QAR's disc or card is removed and downloaded. Finally, QARs can transmit real-time data in flight to a server via satellite communication systems or based on cell phone technology.

Some VLJ manufacturers plan to build extensive data monitoring systems using routine, inflight transmission of QAR data, while others plan to use onboard storage of up to 300 hours, with data being downloaded whenever an aircraft enters a maintenance facility. Either type of approach presents a new opportunity and a new challenge for investigative authorities.

Some VLJ manufacturers plan to build extensive data monitoring systems using routine, inflight transmission of QAR data, while others plan to use onboard storage of up to 300 hours, with data being downloaded whenever an aircraft enters a maintenance facility. Either type of approach presents a new opportunity and a new challenge for investigative authorities. For example, as a practical matter, in any investigation that involves data recorders, investigators must determine the point on the recording at which the data become relevant to the accident. With up to 300 hours of data available, that basic task will become more time consuming.

Similarly, the need or the desire to download and interpret more recorders after accidents could severely tax the capacity of some investigative authorities to conduct this work. While the use of data recorders is routine in air transport accidents and in some business jets, the use of recorders in the investigation of general aviation and business accidents will increase substantially. The bottom line will be more reliance on recorded data and more demand placed upon those professionals who interpret and display the data.

Similarly, because VLJs are complex aircraft and are real jets, the mixture of specialists involved and the distribution of workload will change somewhat. Investigators on the scene will continue to look for evidence that an engine was or was not producing power at impact. However, since investigators will be working with jet engines, in most cases on-scene engine work will be limited to checking fuel and oil filters, evidence of over-temping, scoring, or obvious signs of blade or turbine separation. As with other jet engines, if engine tear-down is required, investigators will need to rely more and more on other professionals who perform the work off site.

Though fatal accident rates may be fairly low for VLJs, when accidents occur they likely will include a higher share of high-energy impacts in which the ability to obtain extensive understanding on scene will be limited. Again, we will find ourselves depending more on the readout and interpretation of data recorders.

Finally, despite lower fatal accident rates, when accidents occur we are far more likely to confront composite materials at the scene. That increases the likelihood of a shattered airframe once the composites are compromised. In the case of fires, composites will reduce the survival of evidence with which to determine the point of origin and whether the fire ignited in flight or after impact. This, again, will make us more dependent upon the readout of data recorders.

Yet, none of these changes suggest any fundamental change in the structure of accident investigations. We will continue to gather evidence, continue to interpret that evidence, and continue trying to understand an accident thoroughly enough to help us prevent future accidents. Instead, the anticipated changes will affect issues like workload and the distribution of workload among various professionals, and will create much greater reliance on data recorders in the investigation of accidents involving small business and personal flights. ◆

Gas Turbines and Ice
The Mysterious Culprit

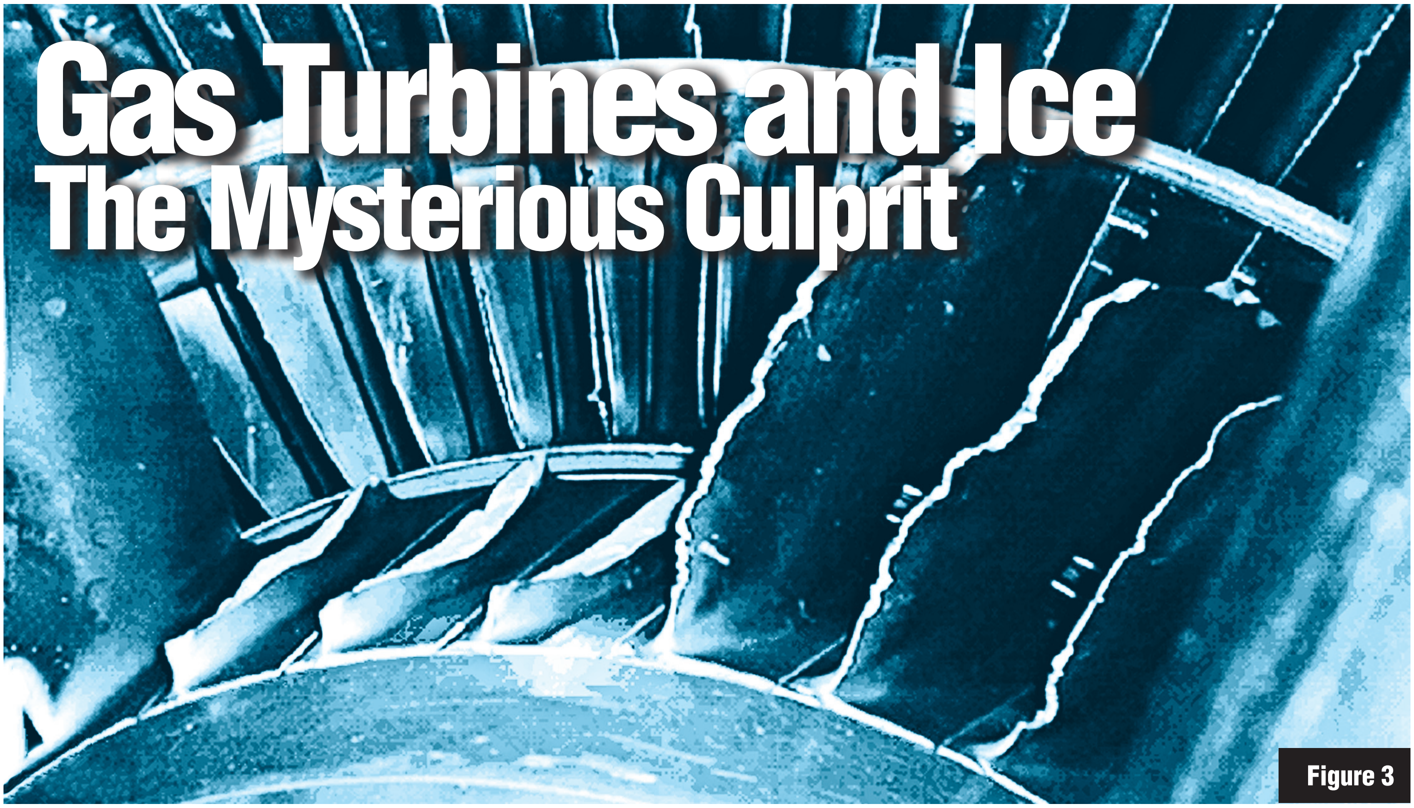


Figure 3

The author brings into focus the various kinds of ice that can affect gas turbine engines, leading to abnormalities and failures. He describes the sources of ice, its symptoms, and the investigative techniques and experience needed to identify probable sources

By Al Weaver (MO4465)

(This article was adapted, with permission, from the author's paper entitled Gas Turbines and Ice—The Mysterious Culprit *presented at the ISASI 2008 seminar held in Nova Scotia, Canada, Sept.8-11, 2008, which carried the theme "Investigation: The Art and The Science." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

The operating environment of a jet aircraft may cause the engine to encounter icing conditions or to face the ingestion of ice from external sources. Post-event investigations have revealed numerous sources of ice that have led to significant damage to the engine(s) and/or to symptoms of abnormal operation requiring pilot action. Of course, ice and gas turbines have been a recognized concern for many years, and current regulations in aircraft and turbine engine design address much of this concern. However, in spite of our general knowledge and assumptions, the operation of the aircraft in flight itself may present environmental conditions not anticipated or adequately controlled. Like other environmental factors, inflight icing is a threat that must be counteracted, balancing the capability of the product to withstand extreme conditions and the need to restrict the acceptable operating environment.

The sources of ice that may threaten an aircraft jet engine can be fundamentally classified as follows:

***Ingested ice*—**refers to ice that has been generated outside the engine, either in the air by accretion to aircraft surfaces or from ground sources. During the event sequence, this ice finds its way into the engine. Examples of ingested ice include

- Slab ice from runway edges or tops of snow banks displaced during reverse operation.
- Taxiway slush ridges on the gear released during gear retraction shortly after rotation.
- Ice left on the top of the fuselage or wings during dispatch and released at rotation during takeoff.
- Ice pooling overnight at the bottom of the engine inlet, released at high power during takeoff.
- Ice formed by leakages from the fuselage (e.g., lavatory potable water).
- Ice accretion on aircraft frontal surfaces (e.g., radomes and engine inlets) released during flight.
- Inflight hail.

***Internally generated ice*—**refers to ice that is generated by the combination of ingested water (including snow/freezing fog, ice crystals, etc.) and engine working cycle conditions at certain power and rotation speed settings. Examples of internally generated ice include

- Probe accretion that either blocks the probe or sheds abnormally causing engine damage.
- Ice accretion on rotating engine spinners shedding and causing damage.
- Ice accretion on fan blades either gen-

Al Weaver *is a Senior Fellow Emeritus having retired from Pratt & Whitney after a long career promoting flight safety initiatives and expertise in accident investigation. He currently teaches the Gas Turbine Accident Investigation Course at the Southern California Safety Institute.*

erating abnormal symptoms of vibration or shedding and causing damage.

- Ice accretion on stator vanes shedding and causing downstream ingestion damage.

Symptoms of ice ingestion

Ice from either source may cause mechanical impact damage to either the engine stationary or rotating parts as well as blockages of air passages or probes affecting the engine stability and response to pilot commands. In some cases, investigators determined that ice ingestion had been so severe that the resulting foreign object damage (FOD) to the engine was beyond its certified blade loss capability in terms of quantity of blades released.

The risk related to such inflight ice encounters is exacerbated by the fact that all engines on an aircraft operate at the same time under the same environmental conditions. Obviously a combination of malfunctions on multiple engines will significantly affect the pilot workload in addressing any of these abnormal conditions.

The following are possible consequences of ice-related events, possibly affecting more than one engine at the same time. Examples of abnormalities include

- Mechanical damage dents/cusps/twist/bends/fractures to both stationary parts as well as rotating parts.
- Vibration either secondary to mechanical damage or simply due to uneven shedding of ice on a rotor.
- Engine inability to recover from stall/surging either from mechanical damage or ice-blocked bleed systems.
- Engine control system effects from ice-blocked probes.

It should be noted that engines can be affected by ice (and in particular by ice particles at altitude) even if no airframe icing is observed by the flight crew. Weather radar and ice detectors installed on aircraft are generally ineffective in detecting ice particles, so the crew may not be able to avoid this kind of engine icing conditions.

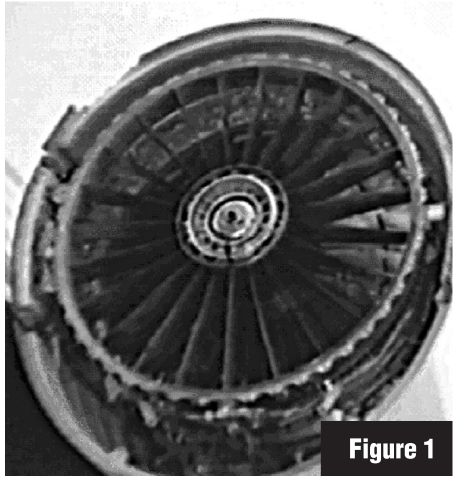


Figure 1

Investigative techniques

The real challenge to the investigator of malfunctioning engine incidents is to recognize that ice in any form was involved. The actual ice has almost always melted by the time that the investigation has even begun. The investigator must then unearth clues and follow a path of inference between cause and effect.

The typical investigation proceeds as an initial collection of facts, many of which are observational such as visible damage to the aircraft and/or engines, location, and relative timing of events. Other information would be obtained from documental evidence such as weather maps and advisories, ATC radar plots, CVR and DFDR readouts, maintenance, and flight logs, etc.

In the case of a hail encounter, the most obvious evidence is the observation of body damage to frontal surfaces of the aircraft, including radomes, windscreens, engine inlets, and/or fan blades.

However, when assessing the possible consequences of such events on the propulsion system, it should be noted that neither a positive nor negative finding of soft-body damage to the frontal surfaces is sufficient to prove or disprove a serious effect on powerplant operation. In fact, there is little historical evidence that visible hail damage on a gas turbine engine has caused a significant power loss.

Instead, as in the case of any weather-related considerations (including ice crystals at altitude), the investigators should consider that primary damage may not be present on the engines. It is important to stress that in this case "primary damage" refers to significant soft-body damage affecting the compressor system. Any thermal damage to the turbine should normally be considered as secondary to

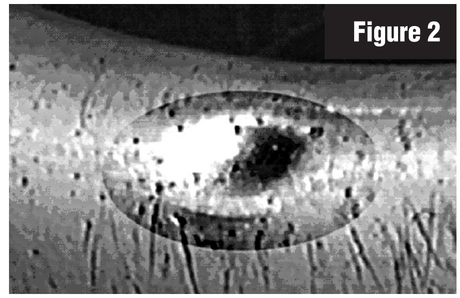


Figure 2

the initial ice-related damage and may well be due to the inability of the crew to recover from the initial malfunction caused by the primary damage.

The analytical results of matching the estimated environmental and operational conditions associated with the accident (quantity of water or hail, altitude, and power being delivered) against the expected engine performance limitations and crew actions would likely lead the investigating team to conclude if an ice-related causal chain is consistent with the findings.

According to the outcome of the investigation, the resulting recommendations would address any unsafe condition in icing weather detection and avoidance, crew response to ice-related powerplant malfunctions, and/or tolerance of the engine to the expected environment.

Summary of relevant investigations

A number of summarized engine ice-related investigations follow. For each event, some factual information is given, along with a description of the observed damage, the probable cause, and possible risk control measures. The primary aim is to help investigators by pointing out some areas of consideration when ice is suspected as a cause and by giving some guidance for the observation of damage on engine parts.

The events presented do not include severe weather (hail/rain) encounters. The discussion of this threat would focus mainly on engine performance and certification issues rather than on damage

In some cases, investigators determined that ice ingestion had been so severe that the resulting foreign object damage (FOD) to the engine was beyond its certified blade loss capability in terms of quantity of blades released.

observation and analysis, which is the subject of this article.

Event 1

Factual information: On an aircraft with tail-mounted engines, the pilot reported a loud bang in cruise, followed by the engine winding down and continued vibration for the remainder of the flight. During approach, a low-fuel warning light occurred. On arrival, fuel was reported leaking down the aft staircase.

Observed damage: Inlet cowl missing, engine nose bullet missing, numerous fan blades missing (see Figure 1). When the inlet cowl was recovered, a dent was observed on the lip (see Figure 2). Investigation revealed streaking along the forward fuselage and logbook writeups of broken landing lights and/or dented inlet cowls.

Probable cause: Ingestion of large block of ice from leaking forward lavatory.

Key pointers: Single engine involvement on the trajectory of the potential fuselage leak. Observation of leading edge damages (wings, stabilizer, inlet cowl, engine nose bullet, etc.) located in line with the leakage source.

Risk control measures: Address potential fuselage leakage if soft-body leading edge damage is found on aircraft surfaces.

Event 2

Factual information: Just after takeoff, as the gear was raised, a loud thump was heard, followed by the engine winding down. The aircraft had taken off several hours after a snow storm at the airport.

Observed damage: After the air-turnback, one engine was observed with crushing damage to the inlet cowl and numerous missing fan blades (see Figure 3, page 20). Dirt was found trapped in soundproofing holes in the fan area (see Figure 4). An engine nose bullet buckle was crushed (see Figure 5), and white stains were observed on the compressor vanes (see Figure 6). The other engine had moderate leading edge dents and curls.

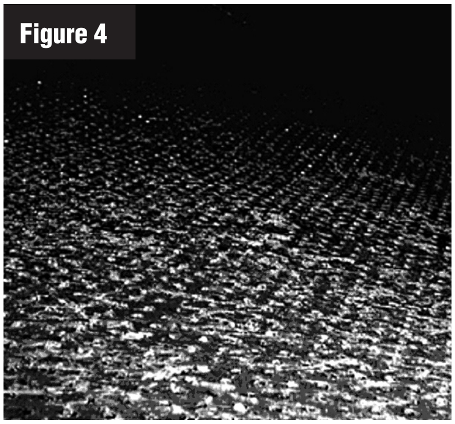


Figure 4

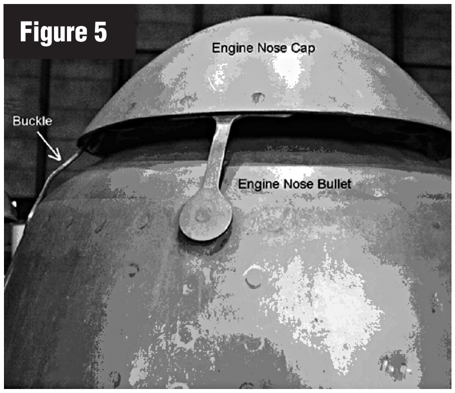


Figure 5

Probable cause: Slush shed off the gear at retraction after takeoff and was ingested by the engine.

Key pointers: Multiple engine involvement in takeoff regime following snowstorm. Crushing damage ahead of fan, dirt and staining in fan compressor area.

Risk control measures: Inspect gear prior to dispatch for slush buildup. Be mindful of taxiway slush ridges.

Event 3

Factual information: This type of event is characterized by several occurrences in the same time frame, often on the same day, in the same aircraft model, usually associated with snowstorm conditions. During takeoff or flight, the flight crew reported engine stall/surging to one or more engines.

Observed damage: Borescope investigations or engine teardown examinations

Figure 6


Figure 7

at scheduled overhaul revealed tip curl/dents/cusp in the forward stages of the aft compressor (high-pressure) spool (see Figure 7).

Probable cause: Ice that formed in front of engine at low power was released at takeoff and was ingested into the high-pressure section, resulting in damage to the blades of the first stages.

Key pointers: Multiple events, involving engines in same fleet and in same time frame. History of operation showed that the engines were run at low power in snowing/icing conditions, typically on ground. Soft-body damage originated in forward stage of high-pressure spool. Onset of symptoms is often associated with takeoff and an inflight stall/surge.

Risk control measures: Adhere to recommended fan spool-ups to shed ice in front of engine before high-power operations.

Event 4

Factual information: Multiple complaints of vibration or fan noise and walk around findings of minor damage at engine inlet. The events involved engines of the same fleet in the same time frame.

Observed damage: Small dents to acoustic


Figure 8

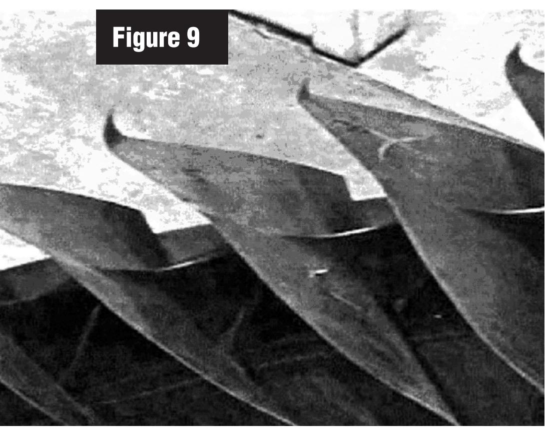


Figure 9

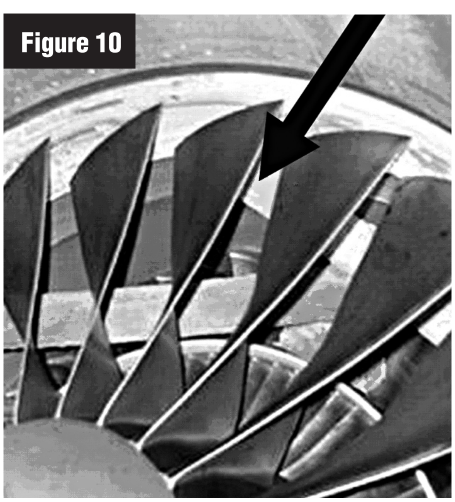


Figure 10

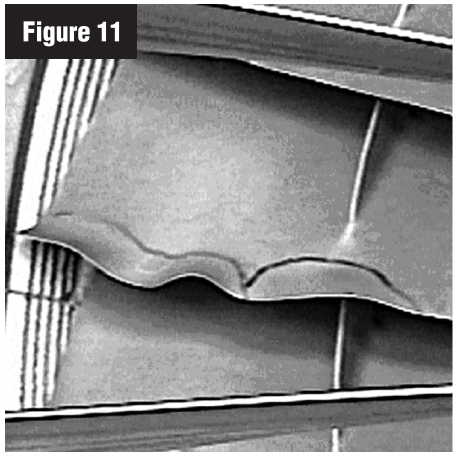


Figure 11

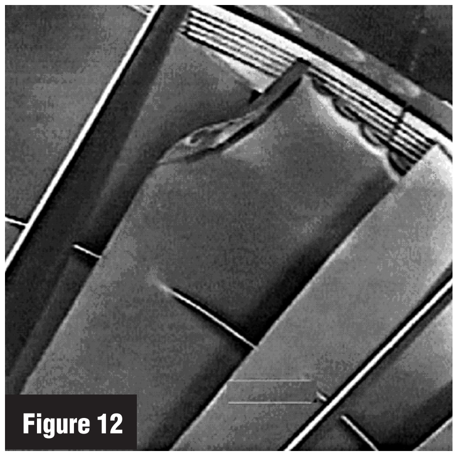


Figure 12

material in front of fan (see Figure 8) and at tips of fan blades (see Figure 9).

Probable cause: Ice accretion on spinner shed during spool-up from low power to high power. The ice impacted the inlet both ahead of and slightly intersecting the fan blades, depending on the local airflow conditions at the instant the ice was shedding.

Key pointers: Soft impacts both ahead of fan and just at fan tips following operations in fresh snow conditions.

Risk control measures: Adhere to recommended procedures regarding periodic spool-ups of fan to shed ice in these conditions.

Event 5

Factual information: During a low-power approach in snowy conditions, the engines were spooled up for landing. All engines initially spooled up but then sustained a permanent power loss.

Observed damage: Pre-impact damage found to outer case liner behind the fan (see Figure 10).

Probable cause: Fan blade ice shed while transitioning from low power to high power in flight. Fan blade ice was pumped rearward due to the twisted shape of the fan blades.

Key pointers: Damage is just aft of fan at the outer wall. The engine had transitioned from low power to higher power while operating in snowy or severe icing conditions.

Risk control measures: Increase the minimum RPM for low-power operation in icing conditions and/or perform more frequent spool ups to shed ice.

Event 6

Factual information: During the first flight of the day, following an overnight layover in near-freezing conditions, multiple engines stalled/surged just after rotation.

Observed damage: All engines were found with moderate random soft-body damage. Ripples (see Figure 11) and corner rubbing (see Figure 12) were observed on fan blades.

Probable cause: Sheet ice ingestion from aircraft surface ahead of engine.

Key pointers: Leading edge ripples, random soft damage, overnight standing in freezing precipitation. Multiple engines involvement.

Risk control measures: Hands-on preflight check after deicing.

Event 7

Factual information: The aircraft was flying above 26,000 feet in icing conditions. On all four engines, the high-pressure spool speed rolled back to 40-45%. The crew shut down Engines 1 and 2 due to rising turbine gas temperature. Engine 2 was restarted and recovered, as did Engines 3 and 4.

Observed damage: No damage was found in the compressor. The turbine section showed thermal damage.

Probable cause: Encounter with ice particles and inadequate tolerance of the engine to such threat.

Risk control measures: Restrictions on the operating environment for unmodified engines. Modifications on the engine to eliminate the phenomenon. ◆

ISASI 2009 Plans Near Completion

The planners for ISASI 2009 report that activity planning for the event is firming up. ISASI's 40th annual international conference on air accident investigation will be conducted September 14-18 and carries the theme "Accident Prevention Beyond Investigations."

The event is being hosted by the Southeast Region Chapter located in Orlando, Fla. Seminar Committee members are Jayme Nichols, chairperson; Anthony Brickhouse and Grant Brophy, technical program; Melody Coleman, companion program; Ron Schleede and Dan McCune, sponsorship program; Kevin Rigby, website; and Ben Coleman and Mike Klasing, serving the Committee in unnamed capacities. Seminar registration is being handled by Sharon Morphew and Gary Morphew.

The Call for Papers has been issued with the following submission schedule: February 1—indication of interest and subject matter (date extended to March 1 for *Forum* readers), May 1—detailed abstract, and July 1—final paper in electronic Microsoft Word format. All submissions may be made electronically to A. Brickhouse at e-mail: anthony. brickhouse@ erau.edu and in hard copy to College of Aviation, 600 South Clyde Morris Blvd., Daytona Beach, Florida, USA, 32114.

The conference will entail a full day of tutorial workshops, 3 days of technical paper presentation and networking activities, and a final optional tour day of the Kennedy Space Center. An added event is the First Annual Kapustin Memorial Scholarship Golf Tournament to be conducted on Sunday, September 13. The proceeds will benefit the ISASI Rudolph Kapustin Memorial Scholarship Fund. Present plans call for an 8 a.m. shotgun start at Disney's Magnolia Golf Course.

The conference hotel is the Coronado Springs Resort in Orlando, Fla. The 3-day technical program will be conducted at that location, which offers exceptional conference facilities in addition to all amenities needed to ensure a productive and pleasurable stay. It is located "a stone's throw from all four Walt Disney World theme parks." Discounted tickets to all Disney parks will be available.

The conference registration fee is expected to be US$525 (subject to change), and the companion fee US$300 (subject to change). The ISASI 2009 website is www.isasi2009.org, and information on seminar registration and hotel registration will be posted shortly.

Full details related to the conference will be published in the next issue of *ISASI Forum.* ◆

Reachout Workshops Travel to Pakistan, Australia

(Adapted from Reachout reports by Caj Frostell and Lindsay Naylor.)

The Safety & Investigation Board (SIB), Civil Aviation Authority (CAA) of Pakistan hosted the 31st ISASI Reachout Workshop on Fundamentals of Aircraft Accident Prevention and Investigation (FAAPI) June 30-July 11, 2008, in Karachi, Pakistan. The Workshop took place under the auspices of the Director General of Civil Aviation Farooq Rahamatullah, who extended his full support to include promoting regional cooperation through his role chairman of the Steering Committee of COSCAP-SA.

CAA Pakistan Deputy Director General, Air Vice-Marshal Sajid Habib opened the 2-week Workshop, which was held at the Pakistan International Airlines (PIA) Training Centre in Karachi. At the closing ceremony, 46 participants received ISASI certificates of completion.

Ret. Wing Commander Syed Naseem Ahmed, SIB technical investigator, served as course director. He designed and planned the Workshop, duplicating the excellent effort he made for the previous Safety Management Systems Reachout Workshop in Hyderabad and Karachi in November 2007. Ahmed is an experienced instructor and an ISASI member. He has been instrumental in promoting and organizing aviation safety training in Pakistan.

The Workshop, unlike the previous one, was designed to provide novice aviation safety professional attendees with a strong understanding and reinforcement of Safety Management Systems and aircraft accident and incident investigation fundamentals. The instruction demonstrated practices, tools, and techniques upon which an aviation safety career can be built. The lead ISASI instructors were Alan Stray (Australian TSB) and Caj Frostell (ISASI international councillor). Also instructing were Air Commodore Abbas Patiwala; Wing Commander Ahmed; Chan Wing Keong, director AAIB, Singapore; and Michael Toft, AAIB, Singapore.

Participants

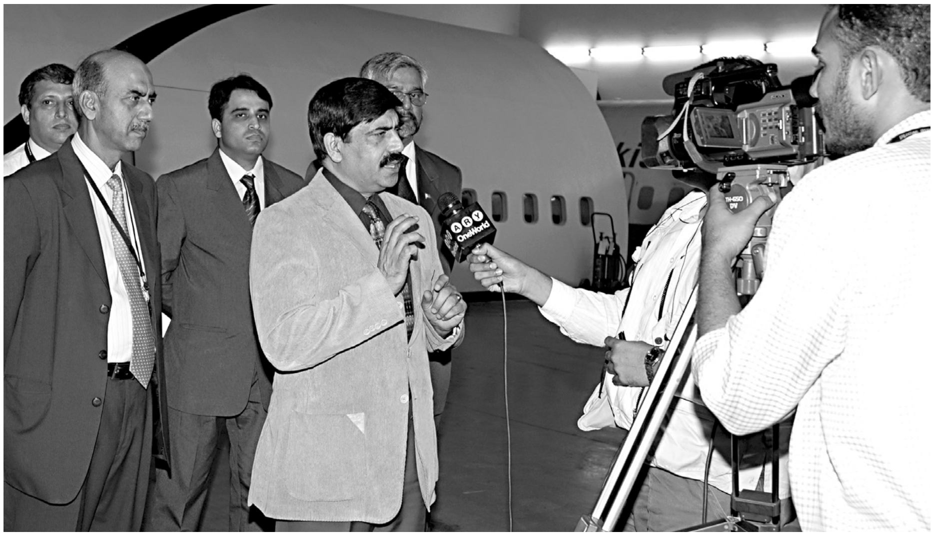
A total of 46 participants attended this Reachout, including 10 from CAA Pakistan. Pakistani operators enrolled 12, representing PIA, Shaheen Air, JS Air, Air Blue, and Star Air. The defense forces (Army, Navy, and Air Force) accounted for 16 attendees. Participation

In Memoriam

Rudolf A. Teymourazov (MO3786), vice-chairman, Interstate Aviation Committee, Moscow, Russia (date unknown)

Jerry T. Dennis (MO0608), Anchorage, Alaska, USA, March 9, 2008

Gerrit J. Walhout (MO0222), Fairfax, Va., USA, Sept. 6, 2008



Air Vice-Marshal Sajid Habib briefs local news media about the benefits of the ISASI Reachout program. Wing Commander Syed Naseem Ahmed, left, looks on.

from neighboring countries included Iran (2), Iraq (4), Syria (2), Thailand (1), and UAE (1).

Several participants mentioned with appreciation that it was a unique opportunity as the total aviation industry, including the military, was brought together to discuss aviation safety issues. From an ISASI instructor's perspective, it was a unique opportunity as many participants were from countries with little or no previous ISASI exposure. The Workshop was a valuable forum to exchange experiences and address the different ways to implement safety strategies, handle emergency situations, conduct investigations and safety actions, and share ideas for the future.

CAA Pakistan sponsored travel and accommodation at the Ramada Plaza Karachi Airport Hotel. The participating organizations, including the airlines and the Pakistan Airline Pilots Association (PALPA), provided significant additional sponsorships.

Brisbane, Australia

The ISASI Australian Society hosted a 4-day Reachout Workshop training session in Brisbane, Australia, in early December 2008. The Australian Transport Safety Bureau (ATSB), the Australian Defence Directorate of Defence Aviation, Air Force Safety (DDAAFS), and Cobham Aviation provided major support.

This, the third Reachout in Brisbane since 2006, mirrored the objective of its predecessors—to deliver investigative-related instruction to assist untrained staff from various organizations to carry out individual incident investigations and to assist in a broader accident investigation process, if necessary.

Topics presented to the 37 participants included a legal overview of accident investigation, Annex 13, and the role of the accredited representative; witness interviewing; human factors; use of field equipment; photography; wreckage mapping; and site survey. Safety Management Systems, accident investigation history, autopsies, and medical aspects of investigations were also included, as was bloodborne pathogen training.

A team of nine experienced investigators from ASASI, ATSB, Aviation Medical Consultants, Cobham Aviation, DDAAFS, the Department of Forensic Medicine NSW, and JCG Aviation Services delivered the program.

Attendees represented many sectors of the Australian and New Zealand aviation industry, generating positive feedback on the nature of the instruction and ISASI's role as the organization of professional air safety investigators. Several applications for membership were received as were queries about the "next one." ◆

Jerome F. Lederer Award Nominations Sought

"The number of nominations for this prestigious award currently stands at zero," said Award Committee Chairman Gale Braden, in his appeal to ISASI members to look for deserving candidates in the various fields of aircraft accident investigation and to nominate those meeting the criteria.

The ISASI Awards Committee is seeking nominations for the 2009 Jerome F. Lederer Award. The Committee chairman must receive nomination letters before May 31, 2009.

He said, "Each year, at our annual seminar, we recognize positive advancements in the art and science of air safety investigation through the Jerome F. Lederer Award. The criteria for the Award are quite simple. The Lederer award recognizes outstanding contributions to technical excellence in accident investigation. Any member of the Society may submit a nomination, and the nominee may be anyone in the world. The Award may be given to a group of people or an organization, as well as an individual, and the nominee does not have to be a Society member. The Award may recognize a single event, a series of events, or a lifetime of achievement. The ISASI Awards Committee considers such traits as duration and persistence,

Coming Events

March 16-18—Flight Safety Foundation EASS 2009 Conference, Location: Nicosia, Cyprus; Hotel: Hilton Cyprus; Conference details and online registration at FSF's website, www.flightsafety.org.

April 21-23—CASS 2009 Corporate Aviation Safety Seminar, Location: Orlando, Fla.; Hotel: Hilton Walt Disney World; Preliminary agenda and registration information can be found on FSF's website home page, www.flightsafety.org.

October 6-7—The ISASI Canadian Society and the Air Canada Pilots Association will co-host a 2-day seminar on winter operations at the Royal York Hotel in Toronto, Ontario. Updates to come.

Sept. 6-9, 2010—ISASI 2010, 41st annual seminar, Location: Sapporo, Japan; Hotel: Royton Sapporo. Theme: "Investigating with ASIA in Mind—Accurate, Speedy, Independent, and Authentic"; Sub-theme: "Over Cultural Differences and Language Barriers." ◆

New Members

CORPORATE

Airways New Zealand
Russ Buckley, Head of Safety and Risk

INDIVIDUAL

Agbon-Ifo, Pullen, I., Lagos, Nigeria
Bates, Paul, E., RD1 Warkworth, New Zealand
Edwards, Todd, M., Fredericksburg, VA, USA
Foley, Daniel, Wellington, New Zealand
Fontaine, Wade, M., Edmonton, AB, Canada
Hanson, Jesse, P., Laurel, MD, USA
Laba, Luiz, C., Bayside, NY, USA
McGee, Frank, J., Berkeley, CA, USA
Milne, Jason, L., Masterton, New Zealand
Rowe, Leif, H., Carson, CA, USA
Sweeney, Richard, B., Overland Park, KS, USA
Tilley, Molly, H., Euless, TX, USA
Tudor, Benjamin, J., Cincinnati, OH, USA
Vincent, Justin, P., Carterton, New Zealand ◆

standing among peers, manner and techniques of operating, and of course achievements."

Each nominee competes for 3 years unless selected. If not selected during that time, the nominee can be nominated after an intervening year for another 3-year period.

This is a prestigious award usually resulting in deserved recognition for the recipient, and with accompanying advantage in career advancement or community standing.

Nomination letters for the Lederer Award must be limited to a single page. Nominations should be mailed or e-mailed to the ISASI office or directly to the Award Committee chairman, Gale Braden, 13805 Edmond Gardens Drive, Edmond, OK 73013, USA; e-mail address, galebraden@cox.net. ◆

ISASI Historical Material Goes Digital with ERAU

A long-term ISASI project to find a home for its historical library records has come to fruition with the placement of its collected Accident Reports dating from 1962 into the Aviation Safety and Security Archive (ASASA) of Embry-Riddle Aeronautical University.

The ASASA is a digitized repository for unique or rare primary materials relating to aviation safety and security. Although ASASA's collections don't circulate like library books, it welcomes researchers to use them both on site and online. The digital library contains digital documents, including thousands of photographs, letters, reports, and other documents, most of which offer full text. The ASASA is a public service that has been made possible by a Congressional Award for an "Archive of Aviation" granted to ERAU, Prescott Campus.

Access to the historical documents is through the ISASI website, www.isasi.org, which links to ASASA. At the ISASI site, click "members only" and on the drop down menu click "isasi collection-digital." From there, follow the directions that will take you to the ERAU ASASA site. Click the "Home" button to see the index of the Archives collection as well as a short video describing the site and how to use its various elements.

In explaining the ASASA site the ERAU librarian writes: "Clicking on 'browse collections' takes you to a page with an icon for each of our collections. More than 4,000 documents have been placed online, with an emphasis on accident reports. So far, the only materials that will be seen in the ISASI collection are accident reports and materials related to particular accidents. Clicking on the 'files' button will reveal documents arranged by the reporting nation, then by the location of the accident. The 'images' button does not respond because to date no ISASI library images have been digitized."

Access to the database is free, but once the Congressional Award funding ends, free access may change. However, ISASI members have special access and will not be charged for access. Should any ISASI member receive a "restricted" message when attempting to access a document, a "Contact Us" button is available to gain access to the message. ◆

Kapustin Scholarship Application Deadline Is April 15, 2009

The ISASI Rudolf Kapustin Memorial Scholarship Fund administrators, Richard Stone, ISASI Executive advisor, and Ron Schleede, ISASI vice-president, have issued the call for scholarship ap-

2008 Annual Seminar Proceedings Now Available

Active members in good standing and corporate members may acquire, on a no-fee basis, a copy of the Proceedings of the 39th International Seminar, held in Nova Scotia, Canada, Aug. 27-30, 2008, by downloading the information from the appropriate section of the ISASI webpage at http://www.isasi.org. The seminar papers can be found in the "Members" section. Alternatively, active members may purchase the Proceedings on a CD-ROM for the nominal fee of $15, which covers postage and handling.

Non-ISASI members may acquire the CD-ROM for a US$75 fee. A limited number of paper copies of ISASI Proceedings 2008 are available at a cost of US$150.

Checks should accompany the request and be made payable to ISASI. Mail to ISASI, 107 E. Holly Ave., Suite 11, Sterling, VA USA 20164-5405.

SPEAKERS AND TECHNICAL PAPERS PRESENTED AT ISASI 2008

DHC-6 Twin Otter Accident off the Coast of Moorea, French Polynesia
By Alain Bouillard, Investigator-in-Charge, Special Advisor to the BEA, and Arnaud Desjardin, Safety Investigator, Engineering Department, BEA

SR 111—Why Did They Die? Why Do We Refuse To Learn? The Swissair MD-11 'Modi-Plus' Program in Today's SFF Environment
By Capt. Timothy Crowch, Advanced System Safety Management, Switzerland

Causation: What Is It and Does It Really Matter?
By Michael B. Walker (MO4093), Senior Transport Safety Investigator, Australian Transport Safety Bureau

Approaches to Accident Investigation by Investigators from Different Cultures
By Wen-Chin Li, Hong-Tsu Young, Thomas Wang, and Don Harris

International Support for Aircraft Accident Investigation and Proposal to Enhance Aviation Safety in States Where It Is in Developing Stage
By Syed Naseem Ahmed, Technical Investigator, Safety Investigation Board, Civil Aviation Authority, Pakistan

What Can We Learn?
By Graham Braithwaite (MO3644), Cranfield Safety and Accident Investigation Centre, Cranfield University, United Kingdom

Accident Investigation—A Complete Service?
By Phil Taylor, Senior Inspector of Air Accidents (Operations), UK AAIB

Managing the Complexities of a Major Aviation Accident Investigation
By Joseph M. Kolly, Bruce G. Coury, Vernon S. Ellingstad, and Aaron S. Dietz, National Transportation Safety Board, Washington, D.C., USA

Weather Risk Management Through a Systematic Approach to the Investigation Of Weather Events
By John W. Dutcher, Dutcher Safety & Meteorology Services, and G. Mike Doiron, Cirrus Aviation Safety Services (M04646)

An Attempt at Applying HFACS to Major Aircraft and Railway Accidents During the Period from 2001 to 2006 in Japan and Some Problems Analyzing Results
By Yukiko Kakimoto, Ph.D., NPO, Aviation and Railways Safety Promotion, Tokyo, Japan

Conversations in the Cockpit: Pilot Error Or a Failure to Communicate?
By Noelle Brunelle, H-53/S-61 Product Safety Lead, Sikorsky Aircraft Corporation, Stratford, Conn., USA

Cockpit Information Recorder for Helicopter Safety
By Roy G. Fox (M03514), Chief, Flight Safety, Bell Helicopter Textron Inc., Fort Worth, Tex., USA

Use of Model Helicopter and Precise Differential GPS on the Occurrence Site Survey
By Wen-Lin, Guan; Ming-Hao, Young; Tien-Fu, Yeh; and Hong T. Young, Aviation Safety Council (ASC), Taiwan, ROC

Gas Turbines and Ice—The Mysterious Culprit
By Al Weaver (MO4465), Senior Fellow Emeritus, Pratt & Whitney, USA

Turbine Engine Risk Management In the U.S. Air Force
By Richard Greenwood, Flight Safety Investigator, Pratt & Whitney, USA

A Review of Rapid Changes in General Aviation and Their Likely Effect on GA Safety in Four Countries
By Robert Matthews, Ph.D., Office of Accident Investigation, Federal Aviation Administration, USA

Bringing the Worldwide Helicopter Accident Rate Down by 80%
By Jack Drake, Helicopter Association International, USA

SMS as an Investigation Tool
By Capt. John Gadzinski, Director of Safety, Southwest Airlines Pilots Association

Investigating Unmanned Aircraft System Accidents
By Thomas A. Farrier (MO3763), Senior Analyst, Aerospace Safety and Operations Analytic Services, Inc., Arlington, Va., USA

Occupant Protection—A Case Study Bombardier Challenger CL-600, Teterboro, N.J., Feb. 2, 2005
By Nora C. Marshall (MO3036), Chief, Survival Factors Division, Office of Aviation Safety, National Transportation Safety Board (Presented by Frank Hilldrup)

Problems in Operating Emergency Evacuation Slides: Analysis of Accidents And Incidents with Passenger Aircraft
By Gerard van Es, Senior Consultant, NLR-Air Transport Safety Institute, Amsterdam, the Netherlands (Presented by Rombout Weaver)

plications to universities and colleges whose students are eligible to participate in the program. According to the Stone, the deadline for applications is April 15, 2009.

Given the lead time to the application deadline, the Fund administrators encourage all ISASI societies, chapters, working groups, and individual members to promote the availability of the ISASI scholarship and its application procedures to students, student groups, and education centers whenever the opportunity presents itself. Fund administrators stress the need for applicants to adhere to the deadline date and to not exceed the 1,000-word limit of the required 1,000-word essay.

The purpose of the scholarship is to encourage and assist college-level students interested in the field of aviation safety and aircraft occurrence investigation. Applicants must be enrolled as full-time students in a recognized (note ISASI-recognized) education program, which includes courses in aircraft engineering and/or operations, aviation psychology, aviation safety and/or aircraft occurrence investigation, etc., with major or minor subjects that focus on aviation safety/investigation. A student who has once received the annual ISASI Rudolf Kapustin Memorial Scholarship is not eligible for a second award.

Continued funding for the Memorial Fund is through donations, which in the United States are tax-deductible. In this regard, ISASI 2009 planners are scheduling a golf tournament to precede the start date of the annual seminar to be held at the Disney World complex in Orlando, Fla. Proceeds from the tournament will benefit the Scholarship Fund. The date of the tournament is September 13.

An award of US$2,000 is made to each student who wins the competitive writing requirement, meets the application requirements, and registers to attend the ISASI annual seminar. The award will be used to cover costs for the seminar registration fees, travel, and lodging/meals expenses. Any expenses above and beyond the amount of the award will be borne by the recipient. ISASI corporate members are encouraged to donate "in kind" services for travel or lodging expenses to assist student scholarship recipients. Students granted a scholarship also receive

- A one year membership to ISASI.
- Tuition-free attendance to ANY regularly scheduled Southern California Safety Institute course. This includes the 2-week Aircraft Accident Investigator Course or any other investigation courses. Travel to/from the course and accommodations are not included. For more information, go to www.scsi-inc.com/.
- A tuition-free course at the Transportation Safety Institute. Travel to/from the course and accommodations are not included. For more information, go to http://www.tsi.dot.gov/.
- Tuition-free attendance at the Cranfield University Safety and Accident Investigation Centre's 5-day Accident Investigation Course that runs as part of its master's degree program at the Cranfield campus, 50 miles north of London, UK. Travel to/from the course and accommodation are not included. For more information, go to www.csaic.net/.

The Fund is administered by an appointed committee and oversight of expenditures is done by the ISASI treasurer. The Committee ensures that the education program is at an ISASI-recognized school and applicable to the aims of the Society, assesses the applications, and determines the most suitable candidate(s). Donors and recipients will be advised if donations are made in honor of a particular individual.

Students who wish to apply for the scholarship may acquire the application form and other information at ISASI's website, www.isasi.org. Students may also request applications by e-mail to isasi@erols.com. The ISASI office telephone number is 1-703-430-9668.

Application requirements

- Applicants must be enrolled as full-time students in a recognized (note ISASI-recognized) education program,

ANZSASI 2009 Planners Open Registration

The Australian and New Zealand Societies of Air Safety Investigators have opened registration for the joint 2009 regional air safety seminar to be held in New Zealand, June 6-7, 2009, at the Distinction Rotorua Hotel, Rotorua. The regional air safety seminars hosted alternately by the New Zealand and Australian Societies of ISASI have been very popular and successful.

Rotorua is at the heart of New Zealand's volcanic and thermal region and is a center of Maori culture. The city has good domestic air connections and is a pleasant 3-hour drive from Auckland.

Registration forms for both the seminar and hotel accommodations are available at the Australian SASI website, www.asasi.org. Seminar registration costs are (in NZ$): Member: $300, after May 1, $350; Non-member: $350, $400. Methods of payment are explained on ASASI's website. No credit card payments are accepted. Hotel registration is open, offering a discounted rate of NZ$120 plus tax until May 15. Full details are on the registration form on ASASI's website.

The Call for Papers was to close February 1; however, requests for late submission of an abstract will be considered. Paper topics include addressing the challenges of modern air safety investigations, operational developments, and current thinking on Safety Management Systems and associated subjects. Contact Peter Williams at p.williams@taic.org.nz; Phone: +64 4 473 3112; Fax: +64 4 499 1510. (Please note that NZ time is UTC+13 hours until April, then UTC+12 hours). ◆

Benefits of Individual ISASI Membership

About You

You are an air safety professional. You may work for an airline, a manufacturer, a government, the military, an operator, or on your own. But you are a person who is dedicated to improving aviation safety and you joined ISASI with the expectation of helping achieve that goal.

About ISASI

ISASI is the only organization specifically for the air safety investigator. Our motto is "Air Safety Through Investigation." We are a growing, dynamic organization with a full range of membership.

- The yearly ISASI seminar has become a focal point for aviation safety professionals throughout the world. Attendance has steadily grown and the presentations are state of the art and meaningful. The 2007 seminar was held in Singapore, Republic of Singapore, and the 2008 seminar was held in Halifax, N.S., Canada.

- The Reachout seminar program was instituted to provide low-cost, subject-oriented seminars in regions of the world with higher accident rates. Since the first Reachout held in Prague, Czech Republic, in May 2001, there have been numerous Reachout seminars, some of which were held in Lebanon, Chile, India, Sri Lanka, Tanzania, and Costa Rica. All have been an unqualified success in attendance and content. These mini-seminars provide our corporate members an opportunity to directly affect safety in those areas where it will have the greatest return.

- The ISASI publication, *Forum,* is a first-class magazine, published in color four times a year. Its editorial content emphasizes accident investigation findings, investigative techniques and experiences, regulatory issues, industry accident prevention developments, and member involvement and information. Each issue also features one of our corporate members in a full back-page "Who's Who" article.

- The annual seminar-published *Proceedings is* provided to individual members at no cost online.

- Individual members have access to past ISASI publications, our library, and accident database.

- ISASI now has an easily accessible website, www.isasi.org, with an extensive "Members Only" information section and a limited general public area.

- Our corporate and individual members are a large and diverse group working in all facets of the industry worldwide. This presents a unique opportunity for personal and online networking.

ISASI is the place for those dedicated to improving aircraft accident investigation and aviation safety.

PREAPPLICATION FOR INDIVIDUAL MEMBERSHIP

(Cut and mail to the address below or otherwise contact ISASI to receive a full membership application.)

PLEASE PRINT

Name (last, first) ______________________________

Date of birth ______________________________

Home address ______________________________

City ______________________________

State, district, or province ______________________________

Country ______________________________

Postal zip/zone ______________________________

Home telephone ______________________________

Citizen of (country) ______________________________

E-mail address (optional) ______________________________

I AM INTERESTED IN APPLYING FOR SOCIETY MEMBERSHIP IN THE MARKED MEMBERSHIP CLASSIFICATION. PLEASE FORWARD TO ME A FULL MEMBERSHIP APPLICATION.

❑ **Member**—A professional membership class requiring at least 5 years' active experience as an air safety investigator.
❑ **Associate Member**—A professional membership class for air safety investigators who do not yet fulfill the requirements for member.
❑ **Affiliate Member**—A public, non-professional membership class for persons who support ISASI's goals and objectives.
❑ **Student Member**—A membership class for students who support ISASI's goals and objectives. (If student, list name of institution where enrolled______________________________.)

Present employer ______________________________

Employer's name ______________________________

Address and telephone ______________________________

Does your position involve aircraft accident investigation? ❑ Yes ❑ No

Your title or position: ______________________________

Dates: from:________________ to ________________

INTERNATIONAL SOCIETY OF AIR SAFETY INVESTIGATORS

Park Center
107 East Holly Avenue,
Suite 11
Sterling, VA 20164

Telephone: 703-430-9668
Fax:703-430-4970
E-mail: isasi@erols.com

which includes courses in aircraft engineering and/or operations, aviation psychology, aviation safety and/or aircraft occurrence investigation, etc., with major or minor subjects that focus on aviation safety/investigation.

- The student is to submit a 1,000 (+/- 10 percent) word paper in English addressing “The Challenges for Air Safety Investigators.”
- The paper is to be the student’s own work and must be countersigned by the student’s tutor/academic supervisor as authentic, original work.
- The papers will be judged on their content, original thinking, logic, and clarity of expression.
- The student must complete the application form and submit it to ISASI with the paper by April 15, 2009.
- Completed applications should be forwarded to ISASI, 107 Holly Ave., Suite 11, Sterling, VA 20164-5405 USA. E-mail address: isasi@erols.com; Telephone: 703-430-9668.
- The Judges’ decision is final. ◆

Reachout Committee Adds Strategic Members

ISASI Reachout has been further enhanced by the addition of two new Committee members whose appointments were recently approved by President Del Gandio. New members are

Syed Naseem Ahmed, technical investigator, Safety and Investigation Board, ***Pakistan*** Civil Aviation Authority, which is based in Karachi and provides substantial operational and engineering experience at all domestic, military, and international levels.

Chan Wing Keong, director of the Air Accident Investigation Bureau of ***Singapore*** also brings a wealth of experience to the Committee, including specialist skills in the fields of airport operations and airworthiness.

Reachout Chairman John Guselli has warmly welcomed the new members to the Committee and expects that their proven and active participation will enable inroads for safety and investigation to be made into the booming Asian regions. ◆

Syed Naseem Ahmed, left, and Chan Wing Keong

MOVING?
Please Let Us Know

Member Number___________________

Fax this form to 1-703-430-4970 or mail to
ISASI, Park Center
107 E. Holly Avenue, Suite 11
Sterling, VA USA 20164-5405

Old Address (or attach label)

Name ___________________________

Address _________________________

City ____________________________

State/Prov. _______________________

Zip _____________________________

Country _________________________

New Address*

Name ___________________________

Address _________________________

City ____________________________

State/Prov. _______________________

Zip _____________________________

Country _________________________

E-mail ___________________________

*Do not forget to change employment and e-mail address.

ISASI Information

OFFICERS

President, Frank Del Gandio (frank.delgandio@faa.gov)
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Vice-President, Ron Schleede (ronschleede@aol.com)
Secretary, Chris Baum (chris.baum@alpa.org)
Treasurer, Tom McCarthy (tomflyss@aol.com)

COUNCILLORS

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European, Anne Evans (aevans@aaib.gov.uk)
International, Caj Frostell (cfrostell@sympatico.ca)
New Zealand, Peter Williams (pgwilliams@clear.net.nz)
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Canadian, Barbara M. Dunn (avsafe@rogers.com)
European, David King (dking@aaib.gov.uk)
Latin American, Guillermo J. Palacia (Mexico)
New Zealand, Peter Williams (pgwilliams@clear.net.nz)
Russian, Vsvolod E. Overharov (orap@mak.ru)
SESA-France Chapter, Vincent Fave (vincent.fave@aviation-experts.com)
United States, Curt Lewis (curt@curt-lewis.com)

UNITED STATES REGIONAL CHAPTER PRESIDENTS

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Arizona, Bill Waldock (wwaldock@msn.com)
Dallas-Ft. Worth, Tim Logan (timlogan@wnco.com)
Great Lakes, Matthew Kenner (mtkenner@esi-il.com)
Los Angeles, Inactive
Mid-Atlantic, Ron Schleede (ronschleede@aol.com)
Northeast, David W. Graham (dwg@shore.net)
Pacific Northwest, Kevin Darcy (kdarcy@safeserve.com)
Rocky Mountain, David Harper (david.harper@kirkland.af.mil)
San Francisco, Peter Axelrod (p_axelrod@compuserve.com)
Southeastern, Robert Rendzio (srca@snowhill.com)

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Award, Gale E. Braden (galebraden@cox.net)
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Seminar, Barbara Dunn (avsafe@uniserve.com)

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Unmanned Aerial Systems, Tom Farrier (Thomas.farrier@anser.org)

CORPORATE MEMBERS

AAIU Ministry of Transport Bulgaria
Accident Investigation Board, Finland
Accident Investigation Board/Norway
Accident Investigation & Prevention Bureau
Aeronautical & Maritime Research Laboratory
AeroVeritas Aviation Safety Consulting, Ltd.
Aerovias De Mexico, S.A.De C.V.
Air Accident Investigation Bureau of Singapore
Air Accident Investigation Unit—Ireland
Air Accidents Investigation Branch—U.K.
Air Canada Pilots Association
Air Line Pilots Association
Air New Zealand, Ltd.
Airbus S.A.S.
Airclaims Limited
Aircraft Accident Investigation Bureau—Switzerland
Aircraft Mechanics Fraternal Association
Aircraft & Railway Accident Investigation Commission
Airservices Australia
AirTran Airways
Alaska Airlines
Alitalia Airlines—Flight Safety Dept.
All Nippon Airways Company Limited
Allied Pilots Association
American Eagle Airlines
American Underwater Search & Survey, Ltd.
AmSafe Aviation
Aramco Associated Company
ASPA de Mexico
Association of Professional Flight Attendants
Atlantic Southeast Airlines—Delta Connection
Australian Transport Safety Bureau
Aviation Safety Council
Avions de Transport Regional (ATR)
BEA-Bureau D'Enquetes et D'Analyses
Board of Accident Investigation—Sweden
Boeing Commercial Airplanes
Bombardier Aerospace Regional Aircraft
Bundesstelle fur Flugunfalluntersuchung—BFU
Cathay Pacific Airways Limited
Cavok Group, Inc.
Centurion, Inc.
Charles Taylor Aviation, Singapore
China Airlines
Cirrus Design
Civil Aviation Safety Authority Australia
Colegio De Pilotos Aviadores De Mexico, A.C.
Comair, Inc.
Continental Airlines
Continental Express
COPAC/Colegio Oficial de Pilotos de la Aviacion Comercial
Cranfield Safety & Accident Investigation Centre
Curt Lewis & Associates, LLC
DCI/Branch AIRCO
Defence Science and Technology Organization (DSTO)
Delta Air Lines, Inc.
Directorate of Aircraft Accident Investigations—Namibia
Directorate of Flight Safety (Canadian Forces)
Directorate of Flying Safety—ADF
Dombroff Gilmore Jaques & French P.C.
Dutch Airline Pilots Association
Dutch Transport Safety Board
EL AL Israel Airlines
Embraer-Empresa Brasileira de Aeronautica S.A.
Embry-Riddle Aeronautical University
Emirates Airline
Era Aviation, Inc.
European Aviation Safety Agency
EVA Airways Corporation
Exponent, Inc.
Federal Aviation Administration
Finnair Oyj
Finnish Military Aviation Authority
Flight Attendant Training Institute at Melville College
Flight Safety Foundation
Flight Safety Foundation—Taiwan
Flightscape, Inc.
Galaxy Scientific Corporation
General Aviation Manufacturers Association
GE Transportation/Aircraft Engines
Global Aerospace, Inc.
Gulf Flight Safety Committee, Azaiba, Oman
Hall & Associates, LLC
Hellenic Air Accident Investigation & Aviation Safety Board
Honeywell
Hong Kong Airline Pilots Association
Hong Kong Civil Aviation Department
IFALPA
Independent Pilots Association
Int'l Assoc. of Mach. & Aerospace Workers
Interstate Aviation Committee
Irish Air Corps
Irish Aviation Authority
Japan Airlines Domestic Co., LTD
Japanese Aviation Insurance Pool
Jeppesen
JetBlue Airways
Jones Day
KLM Royal Dutch Airlines
Korea Air Force Safety Ctr.
Korea Aviation & Railway Accident Investigation Board
Kreindler & Kreindler, LLP
L-3 Communications Aviation Recorders
Learjet, Inc.
Lockheed Martin Corporation
Lufthansa German Airlines
MyTravel Airways
National Aerospace Laboratory, NLR
National Air Traffic Controllers Assn.
National Business Aviation Association
National Transportation Safety Board
NAV Canada
Nigerian Ministry of Aviation and Accident Investigation Bureau
Northwest Airlines
Parker Aerospace
Phoenix International, Inc.
Pratt & Whitney
Qantas Airways Limited
Qatar Airways
Qwila Air (Pty), Ltd.
Raytheon Company
Republic of Singapore Air Force
Rolls-Royce, PLC
Royal Netherlands Air Force
Royal New Zealand Air Force
RTI Group, LLC
Sandia National Laboratories
SAS Braathens
Saudi Arabian Airlines
SICOFAA/SPS
Sikorsky Aircraft Corporation
Skyservice Airlines, Ltd.
Singapore Airlines, Ltd.
SNECMA Moteurs
South African Airways
South African Civil Aviation Authority
Southern California Safety Institute
Southwest Airlines Company
Southwest Airlines Pilots' Association
Star Navigation Systems Group, Ltd.
State of Israel
Transport Canada
Transportation Safety Board of Canada
U.K. Civil Aviation Authority
UND Aerospace
University of NSW Aviation
University of Southern California
Volvo Aero Corporation
WestJet ◆

Honeywell

(Who's Who is a brief profile of, and prepared by, the represented ISASI corporate member organization to enable a more thorough understanding of the organization's role and functions.—Editor)

More than 35 years ago, one of Honeywell's predecessor companies, Garrett AiResearch, was caught unprepared by an aircraft accident and resulting examination and litigation involving one of its engines. Its defense of the lawsuit was unsuccessful. It was then that the company realized it had to form a department with trained employees dedicated to these areas.

Fast forward to today: Honeywell's Product Integrity group has a staff of 15 to handle three areas: 1) aircraft accident investigation, 2) product safety and corrective action, and 3) litigation support. Offices are in four different locations, and include secure forensic investigation laboratories in Phoenix, Ariz., and Olathe, Kans.

Aircraft accident investigation

Product Integrity works as an independent department within Honeywell to improve aviation safety by having its eight engineer investigators assist U.S. and foreign air safety agencies in determining the causes of air accidents and serious incidents. Almost all of the on-scene investigations involve Honeywell's propulsion and turbofan engine products, which since 1994 have also included the former Lycoming turbine engine models T53, T55, ALF502/507, and LT101.

All Honeywell Product Integrity investigators are required to have a 4-year technical degree and approximately 10 years' engineering experience in one or more of the aerospace product lines as minimum qualifications. Additionally, many investigators hold FAA pilot or mechanic licenses. Once hired, all investigators attend the University of Southern California Institute of Aviation Safety certificate program, which is a series of courses specifically designed for those involved in aircraft safety.

Although most on-scene investigations take place within North America, our investigators have traveled to practically every continent on the globe. They have provided on-scene investigation support in locations such as Iceland, the jungles of Colombia and central Africa, the mountains of Peru, the deserts of Jordan, swamps in southeastern America, the eucalyptus forests of Australia, and even the streets of cities worldwide. Product Integrity investigators are on call, and when the hotline number rings they are ready to travel to wherever an accident has occurred and their assistance is requested.

While commercial engine products are the typical focus of investigations, from time to time Product Integrity has also been asked to assist with crashes involving military engines. The entire cycle, from initial testing to the final formal report, may require weeks or months of work, but Honeywell fully supports this function as a manufacturer and a responsible corporate citizen.

Product safety and corrective action

Within Honeywell Aerospace, Product Integrity also helps ensure that the company identifies and takes appropriate actions when it is determined that a product may pose a potential safety risk. It is Honeywell's policy to design, manufacture, and market products that are safe for use and to comply with applicable government standards and regulations as well as customer requirements. With their accident investigation background, Product Integrity air safety investigators are especially qualified to help determine when timely corrective action is needed for products that do not meet those requirements. The product safety and correction action efforts are led by a senior chief engineer who has worked at Honeywell and its predecessor companies of AlliedSignal and Garrett AiResearch for more than 30 years.

Litigation support

The Honeywell Law & Contracts Department turns to Product Integrity for engineering and technical support of any lawsuit involving these same aircraft accidents. The litigation support function is managed by a chief engineer who has testified more than a dozen times at depositions and trials. His expertise is valued by the outside law firms hired to defend Honeywell. Technical support for a case could include analyzing historical data, reviewing component maintenance records, locating key witnesses or preparing trial exhibits. The efforts of Product Integrity and the legal team have produced a positive track record. ◆

AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

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