ISASI FORUM

"Air Safety Through Investigation"

JANUARY–MARCH 2011

A Quarter Century and Still Learning (Page 5)
How Can We Have an Authentic Investigation? (Page 11)
Small Investigation Benefits (Page 16)
Addressing UAS Investigation and Reporting (Page 18)
Mental Health and the Air Safety Investigator (Page 22)

Contents

Features

5 A Quarter Century and Still Learning

By John Purvis (LW3002) and Ron Schleede (WO0736)—*The authors discuss the 1985 JAL 123 accident investigation and relate challenges and personal lessons learned about the profession of accident investigation, ultimately stressing the need to build and maintain relationships.*

11 How Can We Have an Authentic Investigation?

By Guo Fu, Deputy Director, Aviation Safety Office, East China Regional Administration, Civil Aviation Administration of China—*The author poses that the word "authentic" can be looked upon as the "soul" of the investigation. Here he share his perspective on the authentic investigation based on his interpretation and investigation activities.*

16 Small Investigation Benefits

By Vern Berry—*Errors Uncovered and Corrected Can Create a Top-Notch Service Because Failure Definitely Gets Your Attention!*

18 Addressing UAS Investigation and Reporting

By Tom Farrier (MO3763), Chairman, ISASI Unmanned Aircraft Systems Working Group—*The Unmanned Aircraft System (UAS) regulatory landscape continues to evolve, as the NTSB sets reporting criteria and the FAA ponders rulemaking.*

22 Mental Health and the Air Safety Investigator

By Brian R. Dyer, Nevis Disaster Management and Anthony T. Brickhouse, Embry-Riddle Aeronautical University, Daytona Beach, Fla.—*The most important thing in an internationally cooperative investigation is that all the people participating in the investigation build a reliable relationship and have the same objective.*

Departments

2 Contents
3 President's View
4 V.P.'s Corner
26 ISASI RoundUp
30 ISASI Information
32 Who's Who—A brief corporate member profile of Avisure

About the Cover

On Aug. 12, 1985, a Japan Airlines 747SR-100 took off from Haneda on a short internal Japan flight to Osaka. It crashed at Osutaka Ridge, in mountainous territory approximately 100 km northwest of Tokyo, killing 520 of 524 occupants (see Page 5). Shown is the investigating team's transportation helicopter and its landing pad carved out of the side of the mountain. The "pad" was mostly a built-out structure on the side of the mountain. The larger helicopters didn't actually "land," only the rear wheels touched down and the pilot would keep the front end "flying" out in space. The rear ramp would be lowered and supplies and personnel unloaded and outgoing would be reloaded for the return trip. (Photo by the investigating team)

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ISASI Kapustin Scholarship Dividends

By Frank Del Gandio, ISASI President

The most recent dividend our Society has gained from the ISASI Rudolf Kapustin Memorial Scholarship program we instituted in 2002 to memorialize all deceased ISASI members is an eye-opening technical paper presented to the attendees of ISASI 2010 in Sapporo, Japan. An adapted version of that work is displayed in this issue of your *ISASI Forum.* On page 22, you will find an article coauthored by Brian Dyer, one of the three 2009 scholarship recipients.

I bring this to your attention because his work and that of coauthor Anthony Brickhouse shed light on a subject to which all of us are exposed and with which we should be concerned: *Mental Health Aspects of Aircraft Accident Investigation: Protecting the Investigator.* This research study takes a deep look into the mental health aspects of air safety investigation and finds such investigation is inherently psychologically stressful with fatigue, anxiety, and difficulty concentrating being rampant symptoms. I recommend that you read this adapted article.

But the Brian "dividend" is preceded by two other scholarship dividends that have been declared. Michiel Schuurman and Noelle Brunelle, our first two recipients of the Kapustin award, have also delivered papers at our annual seminar. Michiel at ISASI 2005 [see *Proceedings* 2005, "3-D Photogrammetric Reconstruction in Aircraft Investigation," page 118] and Noelle at ISASI 2008 [see *Proceedings* 2008, "Conversations in the Cockpit: Pilot Error or a Failure to Communicate?" page 67]. Other award recipients have gone to work in air safety- and investigation-related fields, and still others are in continuing education programs directed toward aviation systems.

I make a point of showing the "returns" we are receiving from our scholarship program because it is that time of the year when scholarship applications and fundraising come together, and you are key to both endeavors.

To date, 18 students have gained ISASI scholarships since 2002. What began as a single annual selection has become double- and triple-digit selections in the past 3 years, thanks to generous tax-free contributions from our members. Now, application and scholarship availability notices are posted in some 50 college and universities worldwide. You are encouraged to promote the availability of this scholarship to individuals, student groups, parents, and applicable departments of your alma mater. You are encouraged to assist in securing and completing applications for any appropriate student(s).

The deadline for applications is April 15, 2011. Full application details and forms are available on the ISASI website, www.isasi.org. The requirements are that applicants must be enrolled as full-time students in an 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. Also, the student is required to submit a 1,000-word paper in English addressing "The Challenges for Air Safety Investigators."

ISASI presents a US$2,000 award to each student who wins the competitive writing requirement, meets the application requirements, and who registers to attend the ISASI annual seminar. The cash award will be used to cover costs for the seminar registration fees, travel, and lodging/meals expenses. Any expense above and beyond the amount of the award is borne by the recipient. In addition, three other awards consisting of paid tuition to aviation safety- and investigation-related courses are presented, courtesy of the teaching institutions.

And now as Paul Harvey would say, "The rest of the story."

Kapustin Memorial Scholarship Fund DONATION FORM

Help educate in and direct students to aircraft accident investigation. Make a U.S. tax-deductible contribution to the ISASI Rudolph Kapustin Memorial Scholarship Fund (in memory of all ISASI members who have died). Mark your donation in memory of a deceased friend, complete the below form, and mail today to ISASI; 107 E. Holly Ave. Suite #11; Sterling, VA, USA 20164, Contact information—phone: (703) 430-9668, fax: (703) 430-4970, e-mail: isasi@erols.com, website: www.isasi.org. **Make check payable to ISASI Rudolph Kapustin Memorial Scholarship Fund.** (Your contribution will be acknowledged.).

Name ____________________

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Zip/Postal Code ____________________

Country ____________________

Donation Is Made in the Name of ____________________

In the Amount of ____________________

Credit Card: ☐ American Express ☐ MasterCard ☐ Visa

Card Number ____________________

Card Code ____________________ Expiration Date _____

Our program would not exist, much less have its limited growth, without the generous support of our contributing members. Unfortunately, the pool of contributors is not as large as might be expected.

No ISASI dues money is used for the scholarship award. Its total funding is voluntary contribution. Seed funding for the Fund in 2002 was made by the Rudy Kapustin family, and in the first year a total of $3,365 was contributed mostly from ISASI chapters. For several years, donations were less than $1,000 per year. But then the Mid-Atlantic Chapter, Rudy's chapter, began the practice of issuing contribution challenges during its annual spring meeting. The Chapter opens with a $500 donation, and both individuals and other ISASI chapters respond to the challenge and swell the contribution pot. At the 2010 meeting, the Chapter raised $3,775. To date $36,646 has been contributed. For the past 4 years, ISASI members who have been selected to receive the "best seminar paper" award of $500 have contributed their winnings to the Fund. And one member, John Purvis, contributed his ISASI 2010 door prize winnings valued at one 1,000 pounds (British) to the fund. Last year, 13 individuals contributed $1,370.

With the awarding of three scholarships in 2010, the Fund's balance is now only $7,269.90. The positive return our Society receives from it scholarship award is evident. So, I do not hesitate to carry forward to you the challenge the Mid-Atlantic Chapter poses at its meeting.

Won't you assist in furthering our Society's goal of funding the scholarship so multiple awards can continue to be made?

Adjacent to this message is a donation form. Please consider using it and join these members who donated in 2010: Chris Baum, Denise Daniels, Frank and Candy Del Gandio Lucky and Virlene Finch, David J. Haase, Robert (Bob) Hendrickson, Tom and Ginger McCarthy, Richard Newman, Alissa Rojas, John Purvis and Nancy Wright, Kelly Skyles, Ron Schleede, Richard and Ruth Stone, Michael Guan, and Christophe Menez. Jean-Pierre Dagon, director of corporate Safety AirTran Airways, Inc. and Charles Byrnes have started the 2011 challenge with donations. ◆

V.P.'s Corner

Safety Management Systems: A Way of Life

By Paul Mayes, ISASI Vice-President

In the previous issue of the *Forum,* I spoke about my two main aims for my role as VP. The first was to build more membership with members from a wider background in safety-related positions, from the college and university student ranks, and to encourage continued membership. The second aim was the development of air safety investigation as a profession. In this regard, I noted that we are still very much a reactive industry with vast experience in safety investigations of complex accidents and that we have made significant advances in safety through the lessons from accidents. But we cannot continue to accept repeat accidents such as runway excursions, overruns, and loss of control.

If James Reason, through his Swiss Cheese model, was the innovation of the 1980s and 1990s, safety management systems (SMSs) could be considered the next stage in the development of improved safety of operations. For many of us, SMSs have been a way of life. It was not until ICAO defined safety management systems in 2005 that we realized what had become relatively common place for many of us.

It seems we are bombarded with information about SMSs these days in everything we read in the safety press and publications. The classic SMS includes elements of safety occurrence and hazard reporting and safety investigations. It could be argued that without a good reporting culture, the management of "safety" is almost impossible. If we do not know what is happening on the flight line or in the hangar, then we cannot make the necessary improvements to reduce risk and improve safety levels. Managers and supervisors will be in blissful ignorance of the real situation until a serious event occurs that cannot be ignored. The ideal situation is that any safety hazard or safety concern is reported and action is taken to address these before they become an incident or accident. I believe we have the reporting side of this equation under control, but we have not achieved an effective analysis and safety improvement process. This is the utopia of preventive or proactive safety.

The ideal situation is that any safety hazard or safety concern is reported and action is taken to address these before they become an incident or accident. I believe we have the reporting side of this equation under control, but we have not achieved an effective analysis and safety improvement process. This is the utopia of preventive or proactive safety.

However, with SMSs now the modern safety tool, we need to concentrate on how to identify the areas for safety improvements and accident prevention. This is not easy to do in practice, but I believe it is the area in which we can get the best return for aviation safety.

I welcome your comments and feedback on any of these issues or safety matters. I may be reached at candpmayes@bigpond.com. ◆

A QUARTER CENTURY AND STILL LEARNING

By John Purvis (LW3002) and Ron Schleede (WO0736)

The authors discuss the 1985 JAL 123 accident investigation and relate challenges and personal lessons learned about the profession of accident investigation, ultimately stressing the need to build and maintain relationships.

(This article is adapted with permission from the authors' paper entitled A Quarter Century and Still Learning—Lessons From the JAL 123 Accident Investigation *presented at the ISASI 2010 seminar held in Sapporo, Japan, Sept. 6–9, 2010, which carried the theme "Investigating ASIA in Mind—Accurate, Speedy, Independent, and Authentic." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org. —Editor)*

AUTHORS' PERSPECTIVE

The authors were the lead investigators into the JAL 123 accident for their respective organizations, the U.S. NTSB for Schleede and the Boeing Company for Purvis. Readers will be treated to two perspectives of the investigation. Schleede was doing more investigation management, interacting with the Japanese authorities for the NTSB, while Purvis was often at the accident site or in the labs on behalf of Boeing. They saw things from different perspectives so their stories, and those of some others, may not always be in perfect harmony. The authors obviously approached events from different angles, especially during the early days of the on-scene investigation, and, even today, they do not always agree on how the inquiry progressed. This is especially understandable when trying to establish time lines and recreate scenarios 25 years after the fact with fading memories. ◆

Twenty-five years ago, on Aug. 12, 1985, a Japan Airlines 747SR-100 (registration JA8119) took off from Haneda on a short internal Japan flight to Osaka. It crashed at Osutaka Ridge, in mountainous territory approximately 100 km northwest of Tokyo, killing 520 of the 524 occupants.

About 12 minutes after takeoff and during climbout from Haneda, while approaching 24,000 feet, a loud bang was heard on board and the airplane lost cabin pressurization. About 4 minutes later, the crew reported the airplane to be uncontrollable. It continued flying for 32 minutes in phugoid and Dutch roll oscillations with heading and altitude being "controlled" essentially by engine thrust. All of the primary hydraulically powered controls had been disabled.

Ultimately, the primary cause of the accident was determined to be an improperly repaired aft pressure bulkhead in the airplane. The repair, accomplished by Boeing some 7 years earlier, had included replacing the lower half of the bulkhead. This necessitated splicing the upper and lower bulkhead halves. During the repair, it was found there was inadequate edge margin in which to install the usual double row of rivets in the connection between the upper and lower bulkhead sections. A splice plate insert was deemed necessary to accommodate the short edge margin. In order to "fit" the splice plate into the structure, it was cut by the repair team. This resulted in a section of the bulkhead splice joint being fastened with only one row of rivets where two should have existed. (Note: This does not indicate a "missing" row of rivets; it says that only one row went through the load-carrying part of the bulkhead.) After being installed, the incorrect repair could not be detected because all the joints had been hidden by sealant material. Eventually, the loads in this single row of rivets led to multiple site fatigue cracking and eventual rupturing of the bulkhead.

Seven years later, this sudden release of the pressurized air from the passenger cabin into the tail of the airplane overpressurized the aft portion of the airplane. The fuselage pressure relief doors were not sized for this volume of air and some escaped into the vertical fin, splitting it open. The top half of the fin and the entire rudder were lost. All four hydraulic systems were also lost and airplane directional control was essentially gone.

It turned out to be the world's worst single-airplane accident in terms of fatalities. It holds that tragic distinction even now. Some of the lessons learned in that accident are still applicable today. The "technical" lessons have been long since successfully applied, but some of the "softer" lessons can still benefit today's investigators.

At the time of the accident, I [Purvis] was the manager of Boeing's accident investigation group. We covered all events that occurred on Boeing commercial jet aircraft. In hindsight, as manager, I probably should not have been launching on an accident as our team leader, but the magnitude of the accident was not apparent at the time. I was only in my fourth year on the job; but because I firmly believed that in order to lead well, I needed to interact on a level playing field with peers, I planned to do at least one on-site accident annually. Just sitting in the office to "manage" or attend a periodic ISASI seminar won't cut it—you really need to be able to say you've "been there and done that." So I launched myself with the rest of the Boeing team to Japan that evening of August 12, Seattle time.

One of the reasons for choosing to lead this accident was early reports that indicated the accident was probably caused by a bomb in one of the aft lavatories. This was a common opinion among all of the people I was talking to, including the NTSB, in those chaotic hours leading up to our launching. How complicated could the investigation be? How long could this investigation take? A week? Ha! A year later, I was still traveling back and forth across the Pacific. In the early days, on one pair of back-to-back trips, I was in Japan for 6 weeks out of 7 weeks. This accident ultimately consumed the better part of 2 years of my time and it, along with two or three others, defined my career.

Lesson 1

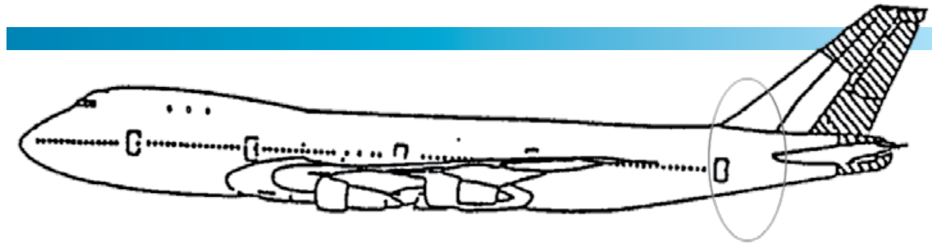
***Avoid speculation*—**Keep an open mind. This lesson goes beyond blindly agreeing with current sources of speculation; it also means to not speculate *inside* your head, lest it lead you to some poor judgments up front.

However, there is a difference between *speculating* and making informed decisions based on your best technical knowledge. For example, you need to do that to send the correct experts. In the case of JAL 123, the line between the two was perhaps somewhat blurred.

Schleede's recollections begin with his memories of the notification, launch, and his subsequent dispatch to Japan. Here is his perspective:

When the NTSB received notification of the accident involving JAL 123, we coordinated with the U.S. Embassy in Tokyo to send a small team of NTSB and FAA personnel to assist the Japanese Aircraft Accident Investigation Commission (JAAIC) with the investigation. At that time, the NTSB did not have direct relationships or contact information to deal directly with the JAAIC. We relied on our State Department personnel in Tokyo to coordinate on our behalf. At the same time the NTSB and FAA team was being dispatched, Boeing was sending a group of engineers to provide a two-prong effort—support the U.S. team led by the NTSB and to respond to its customer, Japan Airlines.

At the time of the notification and dispatch, there were several factors in play that influenced the U.S. team decision-making. One important factor involved an earlier JAL Airbus event in which a bomb had exploded in the aft lavatory area. That aircraft had landed safely and the cause was clearly determined by the Japanese criminal investigators to have been a terrorist event, not requiring NTSB or similar involvement.

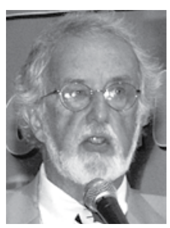


The primary cause of the accident was determined to be an improperly repaired aft pressure bulkhead in the airplane.

Based on that prior occurrence and the initial notification circumstances surrounding the JAL 123 occurrence, there was strong speculation by U.S. aviation senior managers that we had another terrorist event and the traditional safety investigation team would not be necessary. That speculation soon proved to be wrong; however, it slowed the response by the U.S. experts to some degree. It also influenced the manner in which the Japanese approached the investigation. Basically they were focused on a criminal act.

A second complicating factor to the dispatch of a U.S. team to participate in the investigation and the acceptance of the U.S. assistance by the JAAIC was the manner in which Annex 13 to the Chicago Convention was written at the time. Annex 13, which specifies the rights and obligations of States involved in international aviation accident investigations, as well as procedures for cooperation between States during investigations, was "not applicable" to this particular accident. Why? Annex 13 only applied to accidents involving an aircraft registered in one State having an accident in another State, an "international accident." Because the JAL 123 flight was a domestic flight of a Japanese-registered aircraft, Annex 13 did not apply. Thus, the U.S. NTSB had no right to participate in the investigation and the JAAIC had no obligation to invite participation. This factor delayed the formation of the team by the JAAIC to include assistance from the NTSB, the FAA, and Boeing, etc.

The third factor involved was that in April 1985, only months before the crash of JAL 123, an Air India 747 broke up in flight and crashed into the Atlantic Ocean off the coast of Cork, Ireland. Sabotage was strongly suspected in that case; however, it had not been verified. In fact, at the time of the JAL 123 crash, there was a major un-



***John Purvis** is an internationally recognized expert in large aircraft accident investigations. He has been in the aviation field for 54 years, concentrating on airplane safety for the last 28. The last 17 years of his long Boeing career were spent directing its commercial airplane investigation organization, and he led the Boeing team during the JAL 123 investigation. He is currently an aviation safety consultant. John holds ISASI's prestigious Jerome F. Lederer Award for outstanding contributions to technical excellence in accident investigation. He is an ISASI Fellow, AIAA Distinguished Lecturer, professional engineer, and a pilot. He is a docent at Seattle's Museum of Flight and a member of its Board of Trustees.*

***Ron Schleede,** an ISASI past vice-president and present ISASI Atlantic Chapter president, has spent more than 42 years involved in aviation safety, particularly international accident investigation and prevention. He spent more than 28 years with the U.S. NTSB and has worked worldwide as a consultant since he retired in July 2000. He has been a member of ISASI since 1975 and was named an ISASI Fellow in 2009. He was awarded the ISASI Jerome F. Lederer Award in 2002. During most of his career, Ron specialized in major aircraft accident investigation management and international aviation safety affairs. He also represented NTSB senior management during the JAL 123 investigation.*

derwater search and recovery effort being conducted by Canada to recover wreckage from the Air India aircraft to determine the cause of the crash. There was growing news media attention to the possibility of a generic structural or other airworthiness flaw in the Boeing 747 that may have led to both accidents. This placed tremendous pressure on the U.S. team to determine the cause of both accidents.

Lesson 2

Don't let "coincidentally timed" events lull you into thinking they have the same causes. Each accident is unique. You need to investigate. Schleede continues:

It would have been easy for air safety investigators and their managers to "assume" that the two accidents were the result of sabotage and that the investigations would be conducted by criminal investigators, who operate differently than safety investigators. We didn't let that happen with JAL 123. But this factor did influence the manner in which the investigation of JAL 123 was initially conducted by most parties. Basically, the criminal investigators were "in charge," and this situation hampered expeditious safety investigations.

Because of the above factors, the JAAIC was reluctant to grant the NTSB team access to the accident site. The lack of "rights" in Annex 13 for the NTSB team to participate and the leadership of the investigation by criminal authorities in Japan hampered access to the accident information, including CVR and FDR data, and to the wreckage site by the NTSB's team of experts.

Following diplomatic discussions, I was dispatched to Japan to deliver a letter from the chairman of the NTSB to the chairman of the JAAIC requesting permission to join the Japanese team to assist with the investigation. The NTSB team's main theme was its concern about determining if airworthiness factors were involved in the accident. As the State of Manufacture of the Boeing 747, the U.S. was obligated under Annex 8, Continuing Airworthiness, to determine if airworthiness matters were involved.

The U.S. Embassy in Tokyo arranged a meeting with the JAAIC chairman at which I delivered the NTSB chairman's letter. We discussed the need for the NTSB team, including FAA and Boeing experts, to be part of the investigation. After lengthy discussions, the JAAIC agreed to allow NTSB and FAA government investigators to visit the site but excluded Boeing experts. After we detailed the need for the expertise of the Boeing engineers, who designed and built the airplane, to be on site to identify parts, etc., the chairman relented and allowed Boeing personnel to accompany the team. However, both Boeing and NTSB personnel had to be accompanied at all times by JAAIC investigators, which was logical and acceptable. Several trips were made to the accident site, which eventually led to the determination of the causes of the accident, which was not sabotage.

Shown here is a view of the back side of the aft pressure bulkhead as recovered in pieces from the mountain side. It was reassembled into a three-dimensional mockup in the hangar at Chofu.

Lesson 3

Plan ahead. Work to ensure all regulations, agreements, memorandums of understanding, etc., are in good order and reflect the real world. Schleede continues:

The NTSB, the FAA, and Boeing senior managers should have recognized the flaw in Annex 13 provisions for domestic flights well before this accident. In fact, there were other similar domestic accidents in which the State of Manufacture of the airframe was precluded from participating in on-scene investigations involving airworthiness matters. Because of the JAL 123 experience and other cases involving aircraft manufacturing States, in 1992, at the ICAO AIG/92 meeting held in Montreal, Annex 13 was amended to be applicable to all accidents involving aircraft over a specified mass, wherever they occurred, whether on domestic or international flights. These revisions permitted States of Design/Manufacture to participate in all accidents, domestic or international flights, to evaluate any continuing airworthiness matters that may be involved, in accordance with Annex 8.

Besides Lesson 1 of "don't speculate," Purvis learned another early lesson. Some of these lessons are (unfortunately) learned by making mistakes and such was the case in the next lesson.

Lesson 4

Be prepared to talk to the news media— After hearing about the accident in the morning and during a very busy day, we [Boeing] assembled a team and departed SeaTac Airport in Seattle in time for an 11 p.m. departure on a Northwest Airlines 747 to Tokyo. My Boeing team consisted of five people. Our first news media confrontation occurred at the airport lounge. A big disturbance occurred when a local television crew forced its way into the lounge looking for us. The news media crew was adamant about talking to us, using the line "the public has a right to know." As the melee ensued, the airline staff helped us evade the crew via a back door and allowed us to board early.

The lesson learned is expect to be pursued by the local members of the press and be prepared to talk to them. Unfortunately, at the time, I had not received news media training and was woefully unprepared to deal with the passion and furor this tragic crash had caused. In preparation for launch, you must take time with your public relations experts to develop a key statement and have it memorized. If it turns out that you must launch without it, get a local expert to at least give you a quick briefing and help you prepare a statement, even over the phone if necessary. Don't get blindsided by the news media. Our answer to the news media was to flee—a very bad response in every way.

Also, avoid putting identifying stickers on your hand-carry luggage. It only serves to identify you as a target for the press and with your fellow passengers saying, "Talk to me, I'm your guy!"

Lesson 5

Appreciate cultural differences and learn to apply them— This lesson presented itself when our flight arrived in Japan. In those days, the press and news media in Japan seemed to have free reign of the airport, even airside—that is, where the airplanes land and the passengers disembark before customs procedures. When the airplane landed in Tokyo, it was parked at a hard stand, away from the gates. Since we were riding first class, we could have exited at any time; but for some reason, we decided to wait until all the other passengers deplaned. This left us coming down the air stairs alone as a group, an easy and visible target. In hindsight, I should have had the other team members disembark the aircraft one at a time amongst the other passengers where they could have gotten to the terminal unrecognized. Our local technical rep had arranged for a private transport bus to get us to the terminal.

We were besieged by the press and news media as soon as we touched the ground at the foot of the air stairs. This news media group was super aggressive. We got to our "private" bus, which we expected would be a sanctuary, but the media crews forced their way on board. We made the trip to the terminal with TV camera lenses literally inches from our faces and questions coming from all directions. With my lack of news media training, my reaction was to clam up and say nothing. On TV, I looked scared and dumb as I sat there, in stoic silence. That was another mistake. Once again, I should have had a separate key message prepared and memorized for the Japan end of the trip.

I should note here that the statement for the press in the United States would have been quite different from the one required in Japan, should I have had both ready. But I didn't. My lack of news media training was a great hindrance, and I did a disservice to Boeing and the accident investigation community, as well as the Japanese people.

Once we got through immigration and customs, the press was waiting again, but we managed to get to some waiting minivans. Once we got to our hotel, followed by the news media in their own cars, we checked in without further trouble. However, shortly after settling into our rooms, all of the people in my team were approached by the news media in their rooms. We were besieged until I called hotel management personnel, who managed to stop the unwanted intrusions.

PHOTO BY INVESTIGATING TEAM

This is a view looking aft at the aft end of the accident airplane after the pieces were reassembled into a three-dimensional mockup in the hangar at Chofu. The pressure bulkhead would fit toward the aft portion of this. The mockup was made to get a better idea of how things came apart, how the area became pressurized, and how the hydraulic systems were lost.

The news media was also present at the accident site in huge numbers but was well controlled by the on-site authorities. They were there as we landed each day; but once we were at work on the wreckage itself, they were kept away. The news media seemed to have its own fleet of helicopters, nicer and newer than anyone else's, to get them up to and back from the site.

Lesson 6

Be confident in the safety and quality of your transportation. Cheap is not always better. Schleede relates:

Another hamper the NTSB team encountered was that the Japanese could not provide assistance to transport the NTSB team to and from the accident site. Thus, we used U.S. Army helicopters to reach the site, which was remote and in extremely rugged terrain.

This Army helicopter support taught other lessons. The helicopters were old Huey's based in downtown Tokyo and were used primarily for VIP transport of U.S. military and other officials in day, VFR conditions, locally around Tokyo. The mission to transport the NTSB team members to the mountain accident site was not an easy one. The flights came from the Tokyo area in the morning and because of an early sunset behind the mountain, the team had to leave early to avoid being stuck on the mountain overnight. This factor, plus the rugged nature of the terrain, made progress on documenting the wreckage difficult and required multiple visits to the site. Visibility and navigational aids were poor, and the helicopters had to land on a makeshift pad on the side of the mountain.

On one occasion a flight of three U.S. Army helicopters enroute to the accident site became disoriented about the location and had to return to base to refuel, wasting time. On another occasion, when the helicopters returned to pick up the team from the accident site, they had difficulty finding the landing site and the sun had nearly set before they found us.

Lastly, on a return flight that both Purvis and I were on, the crew began to experience some mechanical difficulties. At first, there was an amber light and then a red light dealing with the main rotor transmission gearbox. The pilot made an autorotation to an emergency landing in a dry creek bed in very rugged, mountainous terrain. A replacement helicopter was sent to retrieve us. It turns out that the Army had permitted the helicopter to overfly one of its routine inspection items and a plugged filter had caused the emergency, when fluid bypassed the filter, causing it to overheat.

Lesson 7

Be prepared for the complications of a criminal or judicial investigation—it changes the rules dramatically. Schleede continues:

The criminal investigators were in full control when the NTSB team first arrived at the accident site. They were taking swabs to test for bomb residue and they employed artists to make three-dimensional color drawings of the entire aft pressure bulkhead area. The aft fuselage and empennage were the suspect area because of survivor statements and wreckage that had fallen off early in the flight. We were able to take pictures and handle wreckage, however, not at the critical location of the aft pressure bulkhead. This delayed the NTSB and JAAIC team from examining the wreckage.

Before we had an opportunity to examine the aft pressure bulkhead and empennage in detail, it became known that the accident aircraft had incurred a serious incident years before that involved a tail strike. Subsequent to the tail strike, the lower aft fuselage, the APU area, and the aft pressure bulkhead had been repaired. Therefore, the NTSB team focus was on this area to determine if an incorrect repair had led to the accident. Once we were able to examine the aft pressure bulkhead, it was quickly determined that Boeing had not completed the repair correctly. This finding was significant; it meant that there was no generic flaw in the approximately 700 Boeing 747s flying around the world.

Lesson 8

Linguistic hurdles can be daunting but need to be addressed. Have the ability and funds to hire qualified technical interpreters—Another factor that impacted the investigation involved language. At that time, JAAIC personnel had limited English language capability and the NTSB had no Japanese language capability. Although the U.S. Embassy provided interpreters to support the JAAIC interpreters during high-level meetings in Tokyo, the U.S. Embassy provided no support for the NTSB team members while on scene or during routine group meetings. The NTSB had no funds allocated for such support. The JAAIC did provide an interpreter, who assisted with interpretation between JAAIC and NTSB team members on scene; however, he did not understand technical terms. The NTSB should have had the ability and funds to hire qualified technical interpreters to assist its team to enable it to provide better support to the JAAIC.

Lesson 9

Be prepared to keep the news media, the public, and the families up-to-date on the investigation. Leaks are inevitable and can hurt your credibility. Schleede continues:

Once the actual cause of the accident was determined, that information was relayed clearly to the JAAIC team members. However, because of cultural matters and the ongoing criminal investigation, the factual findings that clearly showed the causes of the accident were not disseminated to the news media by the JAAIC. In accordance with international protocols (Annex 13), the State conducting the investigation was the only entity that could release the findings and progress of the investigation to the news media. The NTSB pressured for a release of information by the JAAIC, but it was not forthcoming.

Because of the worldwide concern about the safety of the Boeing 747 fleet and the JAAIC's refusal to release the facts the inevitable happened; the facts eventually were leaked in the U.S. and became known around the world.

Annex 13 was eventually amended to allow States participating in investigations to release information to support safety recommendations to prevent future accidents, as long as it is coordinated with the State conducting the investigation. Annex 13 still prohibits anyone other than the State of Occurrence conducting the investigation from releasing routine factual findings and progress of the investigation.

Lesson 10

Building and maintaining relationships and trust are keys to a successful investigation, especially in countries foreign to your own. Purvis comments:

Schleede and I have worked together many times in the past, teaching accident investigation management and various other things. Whenever we teach or work together on these jobs, one major theme permeates our entire presentation. It is that of *building and maintaining relationships and trust.*

Relationships and trust are absolutely critical to doing a successful job. Establishing and maintaining them takes work and planning. Attending industry meetings, giving papers, leading panels, participating in industry working groups, and in general being a friendly, positive, and action-oriented person are some of the ways to do this. You should plan on making periodic visits to the major investigative authorities around the world, and especially in your own country. You can never cover all possible scenarios, but having contacts within the government authorities will pay major dividends in the long run.

Once the basic contacts are established, be sure to maintain them by keeping in touch via e-mail, phone, and more visits. If you receive requests, act on them promptly and positively—be a source, not a vacuum. In other words, get to know as many people as possible in the industry and strive to maintain your friendships.

Include in this process people who may be your commercial competitors. Remember that when it comes to safety, you need to cooperate. Safety should not have any business barriers. To build relationships and trust, especially with government agencies, you must always come across as a safety person or an investigator first, with company loyalty a distant second.

Building relationships does not have to be an expensive process, especially with today's communications systems. Face-to-face meetings are always best, especially during the first contact, but you can use your travels to meetings, seminars, or training as ways to visit these agencies and companies. Your range of contacts should go from local to international. On the local level, get to know your NTSB (or equivalent) or FAA. Also, consider joining your local or regional ISASI chapter.

In building these relationships, don't forget about internal relationships within your own organization or company. Good relationships foster respect and internal support, qualities you need to do your job. During this process, you may speak at employee meetings, write articles for internal publications, and support off-hour gatherings.

The important part of all of this is to *do it before you need to*—by then it is too late. Over the years, Ron and I have collected some of the processes and qualities needed to develop and nurture relationships. This list includes the following:

- Be a communicator.
- Be motivated in your task.
- Be a source, not a vacuum; be ready

PHOTO BY INVESTIGATING TEAM

The investigating team's transportation helicopter delivers them to a landing pad carved out of the side of the mountain. The "pad" is mostly a built-out structure on the side of the mountain. The larger helicopters didn't really "land"; only the rear wheels would touch down and the pilot would keep the front end "flying" out in space. The rear ramp would be lowered and supplies and personnel unloaded, and bodies and such would be reloaded for the return trip.

with timely, reliable data whenever you are asked.

• Truly like people and enjoy pleasing them.

• Have common sense.

• Always be yourself (who better than you can do that?).

• Be trustworthy, credible, and have integrity (integrity is not trainable; it is inherent in the person.).

• Be willing to help people.

• Within various cultures, you should consider the following: languages are important; have empathy with other cultures; understand multiple cultures and ethnic origins; understand their history, food, current events, politics, and what is in vogue now.

Conclusions

Many excellent "technical lessons" were learned during this JAL 123 investigation. Many of them led to significant aviation safety improvements, changes to Annex 13, and revisions to operating policies and procedures of many organizations, including the JAAIC, the NTSB, Boeing, and ICAO.

You may ask: Do technical lessons get learned or applied widely enough in the industry? Our answer is not always—we may be able to prevent more accidents by doing a better job.

As Schleede points out:

For example, the structural repair that led to the loss of control of JAL123 highlighted a design feature that placed all four hydraulic systems in a single location. None of the 747's four hydraulic systems was protected by fuses or standpipes. The rupture of the pressure bulkhead led to the loss of the aft portion of the vertical fin, which severed the lines for all hydraulic systems, rendering the airplane virtually uncontrollable. Those design items were fixed to prevent a similar accident in the future.

However, a few years later a DC-10 experienced a fan disk separation that ruptured all three hydraulic systems, and the airplane eventually crashed on landing at Sioux City.

Similarly, several years later, a China Air Boeing 747 broke up in flight near Taiwan because of structural damage in the aft fuselage. That investigation revealed that a tail strike occurrence 20 years before had severely damaged the lower aft fuselage area, which was eventually repaired. The repair was done improperly by the airline and fatigue occurred, under circumstances not unlike the bulkhead situation on JAL 123. A program had been put in place to inspect airplanes that had major structural repairs over the past several years to ensure the integrity of the repairs; however, it had not been implemented in time to identify the improper repair of the China Air airplane.

Another thought to ponder is whether "soft" lessons learned should be more closely scrutinized and perhaps find their way into reports or some other vehicle of record. We believe they are definitely worth documenting and having available for future generations to use, as well as for current investigators to improve their own operations. Better application of all lessons—both the technical ones and the soft ones—can lead to improved safety and better investigations. Technical lessons have been our bread and butter for years and clearly lead to improved safety. The "soft" lessons are more difficult to discover and document, but they can be useful. They can lead to smoother and better investigations overall.

Summary

We have given you a brief look at our involvement in the JAL 123 accident in 1985. Both of us also confessed some of our own shortcomings during the investigation. Can we learn even more lessons from an accident, beyond the technical ones? Our answer is yes, and this is our attempt to document just a few of those "soft lessons."

Perhaps some of my [Purvis] own problems could be justifiably blamed on my lack of experience at the time and lack of formal training, especially on matters dealing with the news media.

My unintentional lack of providing public condolences to the Japanese people and to the bereaved families was surely one. I should have had some cultural sensitivity training, even if it had been a one-hour intensive course before departing for Japan. I should have had a key message statement in my head for the news media. Ron feels the same way about his experience.

Of course, the significance of talking about this accident at this time is that last month [August] was the 25th anniversary of the event. Together, Ron and I would like, in this 25th anniversary year, to say to the families of those lost in the tragedy of JAL 123 25 years ago that we profoundly regret the incorrect repair that eventually led to this accident. We would like to convey once again our heartfelt sympathy to the survivors and to the families of the passengers and crew.

Our obligation to you is to continue to improve the safety of our products and the aviation system as we strive to prevent accidents in the future. ◆

HOW CAN WE HAVE AN AUTHENTIC INVESTIGATION?

(This article is adapted with permission from the author's paper entitled How Can We Have An Authentic Investigation? *presented at the ISASI 2010 seminar held in Sapporo, Japan, Sept. 6–9, 2010, which carried the theme "Investigating ASIA in Mind—Accurate, Speedy, Independent, and Authentic." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org.—Editor)*

The author poses that the word "authentic" can be looked upon as the "soul" of the investigation. Here he share his perspective on the authentic investigation based on his interpretation and investigation activities.

By Guo Fu, Deputy Director, Aviation Safety Office, East China Regional Administration, Civil Aviation Administration of China

Each unsafe event is different and has its own unique features. But as aviation safety investigators, we all clearly understand that our mission is to promote aviation safety by way of providing preventive recommendations based on causes or contributing factors revealed through investigation of the event. Sometimes I ask myself what does a successful investigation mean and how can we achieve it. A successful investigation bears certain features that have been hinted to in the theme of this year's ISASI 2010 seminar "Investigating ASIA in Mind—Accurate, Speedy, Independent, and Authentic." My investigation experiences tell me that the "authentic" is the soul of the investigation. One of the most difficult challenges is how to find or access the root causes, otherwise the recommendations will be just like shooting at random. Here I share with colleagues in the community my perspective on the authentic investigation based on my interpretation and our investigation activities.

Guo Fu *is the deputy director of the Aviation Safety Office of the East China Regional Administration of CAAC. He has been an accident investigator of CAAC for more than 13 years, and has participated in a number of major accident investigations and hundreds of incident investigations. He was graduated in 1982 from the Civil Aviation University of China with a major in avionics and in 2000 from Shanghai No. 2 Polytechnic University with a major in computer technology application. He also holds a masters degree in public administration from Shanghai Jiaotong University, earned in 2005.*

"Accurate" is the key to a successful investigation

"Accurate" means free from error, conforming to fact or truth, and its synonyms are exact, precise, and correct. Safety investigators will always put causes of an event as the "first things first" in our investigations. It is not merely the need for understanding the causes but preventing reoccurrence as well. Our follow-up remedies and recommendations will be more precise and target oriented, and the prevention will surely be effective if we can accurately identify the root causes of an event. The accurate investigation depends on the following components: well-trained and qualified investigators, technical expertise and appropriate equipment, attitude toward the investigation, and sometimes luck.

• ***Well-trained and qualified investigators*** are the primary and indispensible components of the accurate investigation. The investigator's qualification will finally determine the quality of the investigation. Well-trained means he or she has mastered the necessary knowledge for the investigation, including investigative procedures, means of evidence collection, on-scene self-protection, knowledge of the aircraft, etc. Qualified means he or she has both the technical competence and the analytical abilities for in-depth investigation; he or she has personal traits and experience necessary to perform the investigation.

For example, an accident occurred to a foreign cargo flight last November in Shanghai. The airport security cameras recorded the movement of the accident aircraft on the runway. Immediately after the accident, the airport staff screened the recorded segment of the accident flight. They told some of our investigators that they saw fire on one engine before it crashed, or the engine might have exploded before it crashed. Their story quickly got popular within the investigation team. Some of the investigators suggested that we should focus on the engines after they watched the playback of the video themselves. One investigator didn't agree and said that we could never narrow our attention at the early stage of the investigation.

We had a senior investigator review the video carefully with his assistant and checked it with the scene. He reported that while the accident aircraft in the video was very small due to the distance from the runway to the monitor and the low pixel of the camera, they still could see that the "fire on the engine" only appeared at a constant interval. After comparison with other recorded aircraft moving on the runway in the same runway vicinity, they finally concluded that the "fire" was the wingtip strobe light flashes.

The spirit of "never let any trace go without questioning" and "never follow a 'hear-say' without checking" shows an important trait an investigator must have. His or her experience, analytical skills, and comprehensive abilities will make the investigation accurate.

• ***Technical expertise and appropriate equipment*** are the supportive elements to an accurate investigation. Nowadays state-of-art technologies are widely applied in our new aircraft and it becomes more advanced and complicated technologically. We could never conduct a successful investigation if not technically prepared. The preparation not only requires the investigators to have the expertise for investigation, but the suitable equipment for field and laboratory investigation as well. Technical expertise will bring the investigator's knowledge, experience, and insightful judgment into the investigation in a qualitative approach while the equipment will assist the investigators through a quantitative method that will add accurate measurement. The integration of the qualitative and quantitative methods will make the in-depth and accurate investigation a reality.

For example, on April 12, 2009, a helicopter on a ferry flight crashed into water immediately after lifting off from a ship deck. The surviving captain told us that he heard an aural warning of the engine overspeed during his maneuver approach to the port side of the ship, and then the helicopter descend into water, no matter how hard he had lifted his collective level.

Theoretically speaking, the scenario described by the captain was not correct, and we knew that the theory could disprove his explanation. But it would be better if we could collect physical evidence to prove the theory. We should have gotten main rotor speed from the CVR, because our regulation requires that helicopters shall at least record main rotor speed on one track of the CVR, if not FDR equipped. The investigation couldn't find any evidence from the CVR, since it didn't have any recording track for the main rotor speed, and furthermore it didn't work during the accident flight.

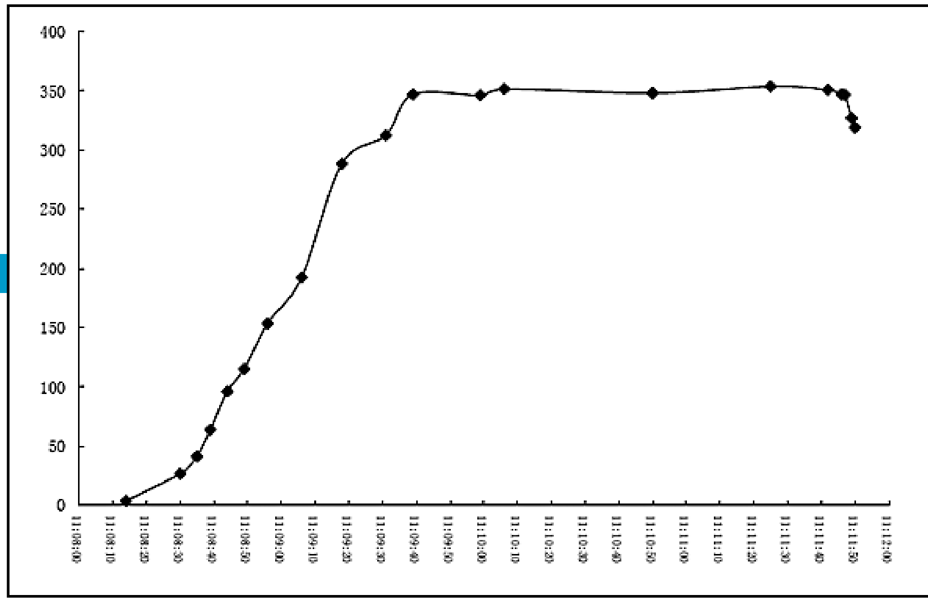


Diagram 1: Main rotor speed chart of the accident flight based on security video camera recording.

There were 25 security cameras on the ship, 3 of which recorded different positions and different phases of the accident flight from helicopter liftoff to falling into water. One video clip shows the whole process of the main rotor rotation from blade starting to turn to the helicopter leaving the deck. Our lab staff technician used his machine and software to count the number of blades within each frame at a fixed time frame, using a special algorithm to calculate the blade rotational speed. His research precisely revealed the main rotor speeds at takeoff phase, and that it reduced to below the underspeed aural warning threshold just 2 seconds after liftoff from the deck, which means what the captain heard was an underspeed warning rather than overspeed (see Diagram 1).

We have reasons to believe that expertise equipped with technology and suitable equipment will be a great assistance to the investigation in revealing or accessing the causes in an accurate way.

• ***Attitude toward the investigation*** means the attitude of individuals, organizations, or authorities involved toward the investigation, which is another important factor concerning achieving an accurate investigation. The attitude varies sometimes in the investigation even though the standards in Annex 13 clearly state the responsibilities of the State to provide relevant information.

I once experienced such an unwillingness to cooperate in our investigation. It was a cargo crash accident; it was my first participation (1999) in a major accident investigation. The only recorded information we had collected were CVR, air-ground communication, and radar plot. We soon got the transcriptions of CVR and air-ground communication, but had difficulty making a complete trajectory chart of the accident flight due to our technical incompetence to retrieve all the data recorded in radar. We knew that the radar should have recorded some other points of the accident flight according to the flight time and radar rotation. We contacted the representatives of the radar manufacturer in Shanghai for assistance. They at first refused to provide the software to download the raw data from the radar. With the help of the investigation authorities and several contacts, the manufacturer finally offered a means (special software) of extracting the data. Further, they told us that the radar had recorded two other targets of the accident flight, but did not show them on the plot because the radar took them as false data due to the high descent rate at the time of recording, though it still kept them in the memory. With all that information, we finally could accurately make the

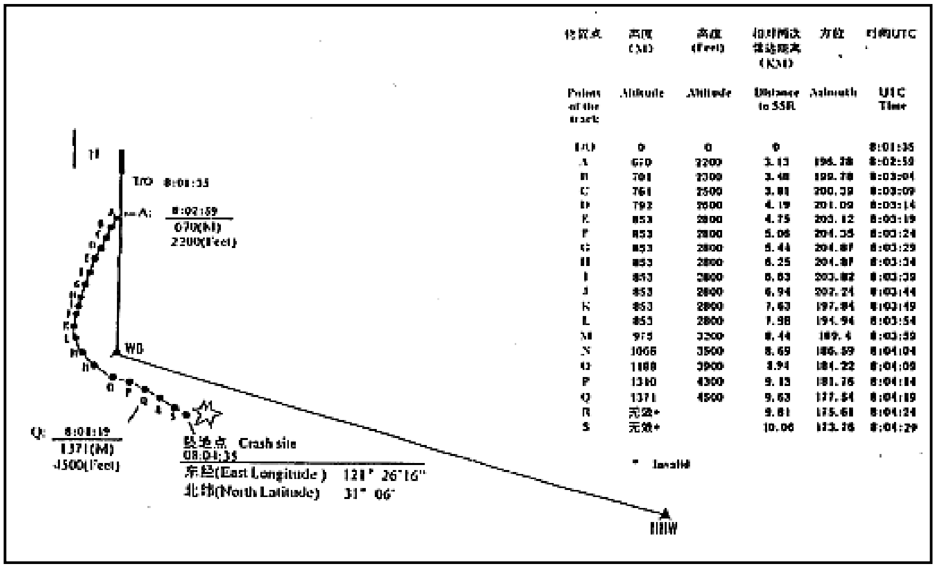


Diagram 2: Accident flight trajectory chart from second surveillance radar.

complete chart (see Diagram 2).

Coordination difficulties in some of our investigations left cases unclosed—those are rare though compared to what we have finished, which reflected the consequence of the negative attitude. We understand that each nation has its own requirements and standards to investigate an occurrence; but the problem is that when something occurs, mainly something concerning non-traditional failure, like software-related control systems issues and the post-event mechanical and functional examination and test are all satisfactory, you just don't understand the failure mechanism. Sometimes you have to take or accept what others give you. Consequently, you will never know how to prevent the occurrence from repeating and don't know when it will appear again.

"Luck" as we use it has nothing to do with the lucky lottery numbers, or hitting a 777 while playing the slot machine, but it does mean you never let slip any clue or evidence and that you make your own "luck" to find or access the causes of an event. It's not a windfall, but a capability that is dependent upon one's analytical skills, comprehensive judgment ability, and experience in addition to his or her knowledge and technical expertise. And if you are observant and conscientious, you will have the luck to find evidence "by chance." Sometimes you are lucky just because the outcome of an occurrence makes your investigation easier.

The investigation with the security camera on the ship is an example of the lucky investigation. The luck was that not only the main rotor rotation was recorded in the previous helicopter falling into water, but that the whole process of the liftoff without hover and passenger compartment overloaded condition were revealed as well by the cameras. We couldn't have had the luck to get all the video information containing the accident process if the ship wasn't equipped with the security cameras. We wouldn't have found the "luck" in the cameras if we hadn't carefully searched the ship deck, and we wouldn't have had the "luck" to find the causes of the accident if we hadn't thoroughly reviewed all the recordings.

This other "lucky" investigation is consequence related and is about pilot incapacitation at landing. It concerns a modern jumbo jet passenger flight in which all phases of the flight were uneventful except landing: A "landing" instruction was given by the captain after an aural "minimum" was alerted. The copilot felt the aircraft had dipped toward his side with an abnormal high descent rate just after "100" was called by the synchronizer. By instinct, the copilot pulled back the stick toward the left (the FDR revealed the copilot control input at 38 ft, 2 seconds before touchdown), then the aircraft touched down and veered off the runway from the side and then back onto the runway.

Astonished, the captain (who had temporarily lost consciousness) asked the copilot why he put his hand on the throttles and why the emergency vehicles were nearby. He never believed what the copilot told him and was 100% sure that he had landed the aircraft himself. Several careful and thorough medical examinations found the captain's incapacitation at low altitude was caused by a transient loss of consciousness resulting from a petit mal epilepsy (absence seizure) due to a tiny insula cavernous hemangioma. His medical record revealed that for 5 years he had a history of hypertension.

We might never have known what had happened if the copilot hadn't pulled the stick and the aircraft had crashed. We wouldn't know the captain had a tiny insula cavernous hemangioma if his incapacitation had occurred at high altitude and he recovered within a short period of time. We have to admit sometimes that luck will help us in some way. Our investigation can never only wait for or rely on "luck," but we will never refuse "luck" when it comes to help us.

Accuracy is the key element that determines an investigation's success, but can be easily affected by some factors including uncertainty.

"Speedy" reflects efficiency of the investigation

I interpret "speedy" with three different meanings from a safety investigator's

Embracing the outlined principles for safety investigations, as part of safety management, will lead to a path of successful investigations by identifying hazards and revealing or accessing the root causes of an unsafe event in a proper way.

point of view, which may vary from the conventional dictionary definitions. My first description of "speedy" is a timely action to collect, by all means, any traceable evidence. During the investigation, we will collect and secure any evidence in the scene search including eyewitness interview while the fresh memory is still there, or in the lab examination without any delay, especially those that will perish quickly or easily with time or in a certain environment. For instance, the marks left on the ground or grassland, fluids from the aircraft systems, recorded information, or people's memory, etc.

My second definition of "speedy" is to immediately issue safety recommendations if something obviously safety related is found at any stage of the investigation. We once issued a safety alert when we found an accident helicopter's CVR without any track for recording the main rotor speed, and it hadn't worked during the accident flight. We keep in mind that we should recommend any preventive action considered necessary to be taken promptly to enhance aviation safety in the investigation.

My third interpretation of "speedy" is efficiency, but this doesn't mean we should jump to the conclusion or work in haste to wrap up a case. Safety investigations are time-consuming activities; they are understood gradually. But that doesn't imply we will waste our time. Actually, we still, at times, have pressures for an early final report not only from the superiors and the public, but from ourselves as well. We investigate incidents in accordance with the provisions of our regulations and Annex 13, which count for the majority of our safety investigation. For us, some incident investigations, such as engine inflight shut down (IFSD), will almost take as long as an accident. It's not only about the investigation itself, because several other factors may influence the progress. One is that its priority gets lower as new events need our immediate response. The other influencing factor is the coordination between the manufacturers, the authorities of the State of manufacturer, even the visa application; factors like expertise and languages will also count.

IFSD's investigations could be quickly finished if one just signed off on the report without further examination and analysis. But the problems wouldn't be solved if the investigation finished in a hurry. Efficiency concerns time spent, but high quality of output means less time spent with greater accuracy.

"Independent" is the guarantee of an objective investigation

The main purpose of an "independent" investigation is to find or access the causes of an event by means of preventing any interested parties from interfering or applying pressure during the investigation. Some elements, such as law, organization, and investigator's traits, are the basic requirements for ensuring an objective investigation. The independent investigation will be legally guaranteed if the relevant rules are set up in law or regulation. They will dominate and protect the investigative activities and people who conduct the investigation. It is better if we can have an "independent organization" since it is the carrier of the investigative activities, which is the second layer of protection from external interferences. The investigators who perform the investigation are the decisive factor. Their personal traits have a great influence over the investigation. Independence and integrity will act as the third layer of prevention and will further guarantee the independence of investigation.

We have many rules to follow if we conduct an air safety investigation in China, which include both international and domestic standards. In addition to Annex 13, provisions of our regulation list four basic principles that must be abided by if an investigation is conducted. These principles are

• *Independent*: Investigation shall be conducted independently; no other organization or individual is allowed to interfere.

• *Objective*: Investigation shall be fact driven, objective, fair, and scientific and cannot have any intent of subjectivity.

• *Detailed*: Investigation shall analyze and determine the causes of the accident or incident and contributing factors, including any defect concerning aircraft design, manufacture, operation, maintenance, personnel training, company's management policies, and regulator's rules and regulations and their implementation.

• *Thorough*: Investigation shall not only analyze and determine the cause of the accident and contributing factors, but also analyze and determine factors that are not directly related to the accident but that have potential impact to flight safety and related issues.

According to our regulations (National Work Safety Accident Report and Investigation, or China Civil Aviation Regulation 395), the investigation function is conducted by different organizations depending on the consequences of an event. To be more specific, the function is shared between the CAAC and the State Council or its authorized department, usually the State Administration of Work Safety (SAWS).

SAWS is an affiliated organization of the State Council and it acts as the executive office of Work Safety Committee of the State Council. One of its major functions is to supervise the national work safety and conduct or coordinate investigation into significant major accidents and major accidents that occurred within the territory of mainland China. As for civil aviation safety investigation, SAWS will mainly investigate significant major air transport accidents, while CAAC investigates major air transport accident, accidents, and incidents. Actually, SAWS has the authority to investigate all the unsafe events, from incident to accident including general aviation accidents and ground aviation accidents if it has interest. I have personally experienced its supervision and involvement in an investigation. SAWS will conduct all types of investigation when it has its own aviation sector and enough professionals in the future. For now, in my point of view we adopt a so-called two-leg investigation system.

The majority of our investigation effort is with incidents. This year up to now [September 2010], we have collected, processed, and reported 585 unsafe events, of which we have investigated 11 incidents, some of which are not yet finished.

We also investigate so-called typical "other unsafe events," which means that unsafe events are not as serious as those of the incident category but still need our close attention. We have benefited a lot in improving aviation safety through incident investigation. Our safety recommendations are issued not only to the operators, service providers, and manufacturers, but also to the regulator in terms of regulation revision or strengthening front line oversight. My investigation practices tell me that we rarely have outside pressure or interference; in fact, our investigators enjoy a healthy environment for the investigation in addition to legal protection. We are always told to follow the four principles and stick to the standards by our superiors. The only pressure we have is time.

Independence is the basic guarantee to find the root causes without outside manipulating. It is very difficult to have an absolute "independence" due to different national institutions and traditions. The most important thing is that we shall have the law as the prerequisite, which provides a legal framework to protect the independent investigation. The investigators who have integrity are the critical force for an independent investigation if an event will be investigated internally. They may have all kinds of influences from different corners even though they have the legal protection.

"Authentic" is the soul of the investigation

When talking about the purposes of the safety investigation, the most popular saying is to prevent recurrence of a similar event by way of investigation and to further promote safety. In reality, the same or similar event does reoccur sometimes. Some of the reasons are 1) Failure to recognize and identify the hazards correctly, 2) Failure to identify root causes in depth, 3) Failure to act appropriately to the causes, and 4) Failure to inform others in a more motivating way. The first two reasons are cause-related issues. It is obvious that we will effectively prevent the event from repeating if we can correctly identify hazards or root causes.

Authentic has the meaning of conforming to fact or origin, worthy of trust. Here I interpret authentic as data driven, no bias, detailed, and thorough; it means "factual" from the theme of the ISASI 2010 seminar. We understand that "accurate, speedy, and independent" are used to describe the requirements for the investigation from different aspects. "Accurate" means fact, truth, precise; "speedy" implies accuracy with less time; "independent" relates to finding root causes, and the result of their combination is "authentic," which shows the true value of the investigation. "Authentic" mainly relies on accuracy, efficiency, and independence and comprehensively represents them as the soul of the investigation.

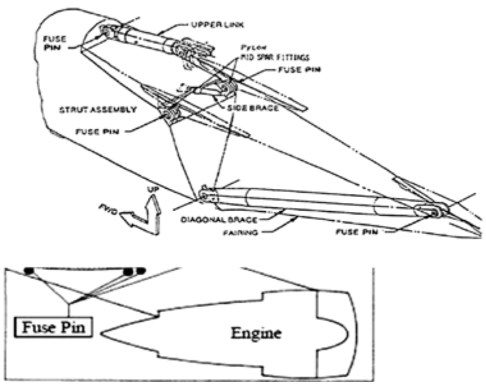
Conclusion

Embracing the outlined principles for safety investigations, as part of safety management, will lead to a path of successful investigations by identifying hazards and revealing or accessing the root causes of an unsafe event in a proper way. This will permit recommendations or remedies that are cause targeted or related and make our industry a reliable system that will provide the public with a safe travelling environment and save people's lives and properties to the greatest extent possible. ◆

Small Investigation Benefits

Errors Uncovered and Corrected Can Create A Top-Notch Service Because Failure Definitely Gets Your Attention!

By Vern Berry



As a quality director for an air cargo carrier, I was the first to know when violations were discovered. These events were not generally welcome. However, the nature of their discovery often resulted in experience that had subsequent benefits to our organizational performance out of proportion to the events themselves.

An example is an event that occurred while we were assisting Boeing with an improved inspection procedure for the B-747 midspar fitting. That inspection had its origins with the crash of an El-Al B-747 freighter in Amsterdam on Oct. 4, 1992. Pylon structure failures allowed separation of the No. 3 and 4 engines as well as severe damage to the right wing structure and controls after takeoff (see diagram). Thereafter, as a result of findings from the accident, a repetitive action airworthiness directive (AD) required frequent non-destructive test (NDT) inspections for cracks on the midspar fittings for each engine pylon. As time progressed, Boeing continued to improve on the NDT inspection techniques supporting this AD, and we often assisted in test development efforts. In this instance, Boeing intended to test a new NDT inspection method on an aircraft that had just arrived at JFK Airport out of heavy check inspection in Hong Kong. This aircraft was selected for Boeing based on the assumption there would be no risk in doing an NDT inspection since the midspar area to be inspected had been previously inspected to the latest AD standards with no findings. Once Boeing was finished, the aircraft would continue in service.

A pylon was opened to allow Boeing engineers access in preparation for their inspection evaluation. Upon gaining access to the midspar fitting, the inspector noticed that the fitting had a noticeable crack. It appeared as a line in the midspar boss radiating from the fuse pin bushing. My office was contacted, and the finding was reported to the FAA. We immediately began preparations for an investigation into the root cause of this event. The first action was to ground the aircraft and begin a repair of the pylon—no mean feat for a line maintenance operation. The removed midspar fitting was examined and found to have a large radial crack that initiated from the midspar bushing as a result of corrosion. The heavy check vendor was notified of the discovery and was as surprised as we were but had no immediate explanation for the error.

Based on discussions with the vendor and our own review of the standards and the fitting damage, our investigation would focus on two areas: the records of work performed and the processes and tooling used by the vendor for NDT. Our preparations included the development of an audit tool as a guideline based on NDT manual requirements applicable to a number of AD-related inspections within the aircraft maintenance program. The scope of the audit tool would reveal the breadth of inspection quality failures. The records were used to set up interviews with the inspection personnel who accomplished the work. I and our manager of quality assurance went to Hong Kong. After a couple of days we had our answers.

Our efforts produced the following findings:

• The inspector who performed the midspar inspection did not use the approved tooling or standards. His ultrasonic scope readings (while using the wrong ultrasonic transducer and fixture) indicated a signal reflection of less than 40% in the crack

__Vern Berry__ began his aviation career in 1979 and has amassed considerable experience within the aviation industry. The last 20 years of his career have been as a director of quality and safety for both maintenance repair organizations and air carrier operations. He has been involved in numerous accident and incident investigations related to maintenance and flight safety. Berry joined ISASI in October 2000 and holds full member status. He and his wife currently reside in upstate New York where he manages a consulting firm while stalking trout part time in Adirondack National Park.

area. A reading of 40% or higher signal strength would have indicated a crack. The area had been cleaned in preparation for the NDT inspection, but he never noticed the physical crack itself.

• The vendor Level 3 NDT technician had made substitutions and modifications to the probes and standards that deviated from instructions in approved data. This was based on a one-to-one comparison of the inventory and our NDT audit guideline. The vendor did not own many of the required NDT probes and fixtures required by approved data in the NDT manual. In substituting the equipment, adjustments to inspection scanning techniques had to be made to accommodate the changed signal outputs.

• Calibration standards did not materially or dimensionally conform to the NDT manual specification. Calibration standards are designed to mimic the area to be scanned using the probes and fixtures described in the inspection procedure. NDT standards and probes are specially designed to accommodate each aircraft type's unique construction and materials. Many calibration standards were manufactured in house by the vendor. There is no problem with this if the material and its dimensional specifications match the NDT manuals. In this case, we found that material specifications and dimensions deviated from approved data, and in some cases standards were wholly substituted from other procedures.

So what happened here? And why? While it had been a costly error, it was an error that in the end resulted in inconvenience—not tragedy. Suddenly, we had a "teachable moment." In pursuing the root causes we learned a great deal about NDT programs and standards that can have direct consequences on the safety of an aircraft. It also became a model for future "small investigations" of this nature.

Our conclusions about the inspection error came down to simple human factors. The inspection was purely non-destructive testing—no visual inspection was required and the expectation of the technician was to clean the area, set up his equipment, lay the ultrasonic wave transducer on the test surface, and watch his scope for flaws. The inspection area, while illuminated from overhead during the day, was not sufficiently illuminated to perform close visual inspection without the aid of a flashlight. The area would have been in dim light with a low-contrast background. No flashlight is needed when all that is required is to position the probe and watch the scope—plenty of light for that. The crack, when discovered at JFK, had been viewed in direct sunlight. The light clearly delineated the edges of the crack when viewed up close. Our conclusion was "misdirection" caused by the inspector's preoccupation with his NDT equipment indication and the low-light environment. In the process, the visible crack "disappeared." However, this was not the root cause of the error. The repair station work record was annotated to show a signal deflection at the area of the crack. The signal was weak, however. Examination of the tooling revealed use of the wrong transducer fixture (called a "shoe," see Figure 1).

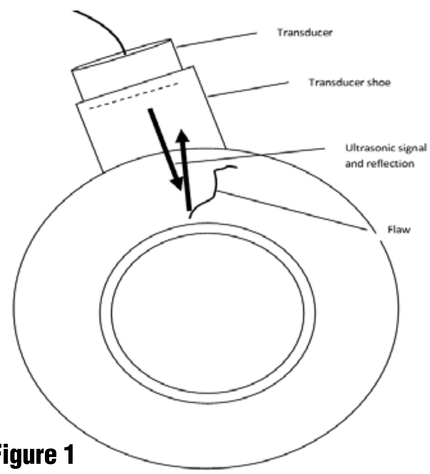


Figure 1

This directed the transducer signal at the wrong angle, reducing the reflectivity strength of the signal. It was the strongest reflection he could have gotten based on the orientation of the crack and the angle of the shoe contact to the surface. If the correct fixture had been used, the reflection would have been well more than the 40% minimum. So why was he using the wrong tools for the job?

The NDT organization was under the supervision of a certified Level 3 NDT technician. Training records indicated a well-trained person with a mechanical engineering degree and a lot of experience on the job. All personnel records were current and provided a clear picture of each technician's experience and qualifications. Level 3s, for the most part, are engineers. In the NDT world beyond aviation, a Level 3 has the authority to design and approve NDT inspections or make necessary changes to existing inspections when needed. This is common in order to accommodate structures such as bridges, pipeline, weldments, etc. In aviation, the Level 3 is limited in what can be done. He can train and certify other NDT technicians from Level 1 through Level 3. He can offer alternate means of compliance for FAA approval but cannot make or approve changes to approved data on his own.

So the presence of substituted standards and tooling tied to instructions that deviated from approved data pointed directly to the person who could drive these changes, approved or not. When this point was raised, the discussion quickly moved to debate. Other quality managers and auditors were invited to participate in the finding, and it became clear that a misperception of authority existed that drove the deviations.

The thought was to reduce cost of tooling. Deviations in non-destructive testing calibration standards manufactured in house were authorized by the Level 3 as equivalent, even though approved data provided no leeway to do so. These substitutions and deviations could, however, result in substantial savings in time and cost. Cost and speed are real factors when it comes to getting NDT inspections accomplished. During the planning phase of a check, standards and probes may have to be ordered when new AD-mandated inspections are scheduled. Lead times for this equipment are often long. Inspections or the "look" phase of heavy checks are done early in the check process so that all discrepancies are noted for the corrective action phase that follows.

AD-related NDT performed late in an inspection drive up risk of late findings that can significantly impact the check schedule. Late tooling drives late inspection activity at the wrong place in the check plan. If one can substitute standards and probes to accomplish the inspection, one can more easily maintain aircraft delivery schedules. It became easy to see that the cost and time to receive new NDT standards was a real bottleneck to operations. So workarounds were devised to relieve the bottleneck. Over time what was once a "one off" event became routine. I call this "tolerance creep"—a small deviation multiplies over time through repetitive use of the original rational for the work around. These rationalizations become institutional. Once a work around is devised, the rational for its continued use becomes more prevalent *(continued on page 30)*

ADDRESSING UAS INVESTIGATION AND REPORTING

The Unmanned Aircraft System (UAS) regulatory landscape continues to evolve as the NTSB sets reporting criteria and the FAA ponders rulemaking.

By Tom Farrier (MO3763), Chairman, ISASI Unmanned Aircraft Systems Working Group

April 2006 Predator crash, Nogales, Ariz.

NTSB

The U.S. National Transportation Safety Board (NTSB) recently published a final rule establishing reporting criteria for Unmanned Aircraft System (UAS) related accidents. This article offers an early look at the course this influential independent safety board is charting in its quest to promote safety in the emerging UAS sector.

Although unmanned aircraft systems (the operational combination of unmanned aircraft and their ground control component) receive extensive and regular news media coverage, operations in shared airspace are still an immature and evolving sector of aviation. This isn't to say that UAS are unsophisticated. On the contrary, many high-end unmanned aircraft are complex and highly capable, and the vast majority of the UAS across the size spectrum are extremely well suited to the missions for which they're built. However, they also are of highly variable reliability from system to system, and the lack of an onboard pilot makes them uniquely vulnerable to failures of the electronic link through which they are controlled. So for at least the next several years, they're unlikely to be operated at will in any airspace where their lack of an equivalent to a "see-and-avoid" capability might put manned aircraft at risk.

Even given the above, the desired end state for UAS operations often is referred to as "integration": the expectation that UAS eventually will be capable of operating in a manner indistinguishable from other aircraft and will be allowed to do so on a file-and-fly basis, in all classes of airspace, and at the users' discretion. Both regulatory and investigative entities in a number of countries are beginning to work toward this outcome. But just as different types of UAS are in different stages of readiness to make such a leap, there are many paths being taken toward it.

Differences between manned and unmanned aircraft

For readers new to UAS issues, it's important to highlight two of the most critical differences between manned and unmanned aircraft. First, by definition, the pilot of an unmanned aircraft is physically separated from that aircraft. So there has to be an electronic connection between the two.

The "control link," also referred to as the "uplink" in some systems, is the path through which the UAS pilot directs the unmanned aircraft's trajectory. Currently, for all but the most sophisticated systems, the control link offers a unique source of single-point failure potential. Even for the high-end systems, safe recovery following loss of control link may require hundreds or even thousands of miles of autonomous flight for a satellite-controlled unmanned aircraft operating beyond line of sight (BLOS) to be in a position to be recaptured through an alternate line-of-sight (LOS) ground control station.

A second electronic link, which may or may not be paired with the control link, typically is necessary to support all BLOS operations, and often is provided for purely LOS-capable UAS as well. This second link is a downlink from the aircraft to the ground that provides the principal source of the UAS pilots' awareness of the performance and the state of their unmanned aircraft.

There are no standards regarding the information contained in UAS downlinks. They may include Global Positioning Satellite (GPS) positional data, heading, airspeed and altitude, engine health, payload temperature, or a host of other parameters deemed necessary to safe operations. This link provides confirmation to the pilot that control commands have been properly executed by the unmanned aircraft. It's also important to note that, for BLOS operations, air traffic control communications normally are routed through the aircraft, meaning the loss of either the uplink or downlink may result in an aircraft that unexpectedly reverts to autonomous operation while simultaneously severing all or part of the connection between pilot and controller.

The second major difference between manned and unmanned aircraft associated with the pilot's remote location is the need to provide an alternate means of compliance with the internationally accepted concept of "see and avoid" as a means of maintaining safe separation between aircraft. Annex 2 to the Convention on International Civil Aviation states, in part, "*Regardless of the type of flight plan, the pilots are responsible for avoiding collisions when in visual flight conditions, in accordance with the principle of see and avoid.*"

This is mirrored in the U.S. Title 14, Code of Federal Regulations, Paragraph 91.113(b): "*When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating* *an aircraft so as to see and avoid other aircraft."*

While the link-related issues described above relate to practical challenges arising from UAS operations, conformity with see-and-avoid obligations represents a fundamental regulatory challenge that has yet to be satisfactorily resolved. Many civil aviation authorities have addressed it by restricting UAS operations to segregated airspace of various types to keep unmanned and manned aircraft from operating alongside each other. The U.S. Federal Aviation Administration (FAA) has taken the approach of authorizing most UAS operations on a case-by-case basis, requiring those wishing to fly unmanned aircraft to provide acceptable alternate means of compliance with the see-and-avoid requirement. This typically takes the form of ground-based or aerial observers charged with the duty of clearing the unmanned aircraft's flight path, providing appropriate direction to the pilot-in-command as necessary.

A variety of proposed alternatives to see-and-avoid requirements have been offered by eager UAS operators, including using surveillance payloads to look around for traffic, among others. But the only viable long-term hardware solution on the horizon most likely will be some kind of as yet undefined "sense and avoid" (S&A) system capable of detecting, warning of, and maneuvering the unmanned aircraft to avoid all types of conflicting aircraft, including those that do not emit any kind of electronic signal.

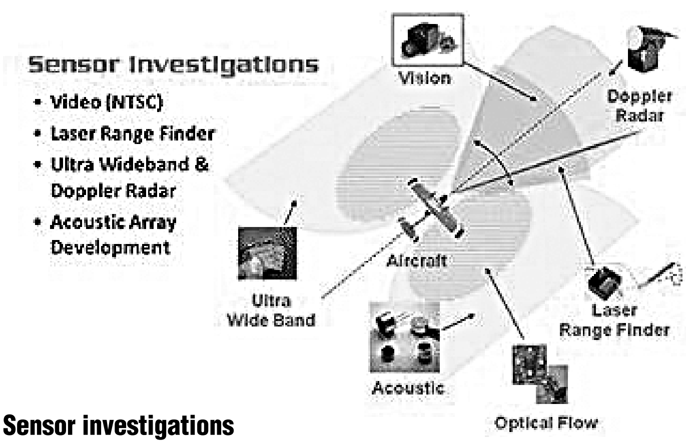
At this point, a reality check seems to be in order. A dedicated S&A capability probably will be expensive, from both a monetary and a payload/performance perspective. This suggests that the smallest of the "small" UAS (a term yet to be consistently defined) is unlikely to incorporate S&A on the basis of the economic penalties it would drive. That, in turn, makes it reasonable to assume that most UAS operators will request relief from existing see-and-avoid regulations (and others applicable to manned aircraft with which they also find it difficult to comply).

What's more, UAS at the small end of the size and weight spectrum are the most capable of supporting simple, LOS-oriented business models affordably. So readers should calibrate their expectations accordingly. In the near-to-mid term, most of the "unmanned aircraft" in the skies are far less likely to look like their supersized, highly capable BLOS military cousins and far more likely to look like model aircraft (perhaps indistinguishably so).

The new NTSB UAS reporting rule

Now let's look at the new NTSB rule on UAS accident reporting. Actually, describing the recently issued change that way is a little misleading. What the NTSB did

MITRE CORPORATION



Sensor investigations

was add a new definition for an "unmanned aircraft accident" to the existing definition of "aircraft accident" as follows: *"For purposes of this part [49 CFR 830.2], the definition of 'aircraft accident' includes 'unmanned aircraft accident,' as defined herein.... Unmanned aircraft accident means an occurrence associated with the operation of any public or civil unmanned aircraft system that takes place between the time that the system is activated with the purpose of flight and the time that the system is deactivated at the conclusion of its mission, in which*

(1) Any person suffers death or serious injury or

(2) The aircraft has a maximum gross takeoff weight of 300 pounds or greater and sustains substantial damage."

The most notable aspects of this rule are

- It represents official acknowledgement that unmanned aircraft are in fact "aircraft," and as such are subject to the same reporting requirements as every other aircraft involved in an accident.
- It puts UAS on a level playing field with all other aircraft regarding operators' responsibility to the public for safe operation.
- It establishes an official structure for mandatory accident reporting for all U.S. "public-use" operators of UAS, as well as civil UAS (for now a tiny percentage of domestic UAS operations).
- It establishes a "floor" threshold, based on unmanned aircraft weight, for accident reporting.
- It creates "intent for flight" boundaries for reporting purposes that are ideally suited for UAS operations (and don't need anybody boarding the aircraft to trigger them).

By placing manned and unmanned aircraft on an equal footing for Title 49 purposes, it makes it clear that U.S. military unmanned aircraft involved in any of the types of accidents that result in NTSB jurisdiction will be subject to the same investigative authority as manned aircraft.

Why are these so important? For starters, there's a healthy chunk of the population, both inside and outside the government, that would like nothing better than to try to treat unmanned aircraft as something less than "real" aircraft, thus not needing to conform to the regulations under which "real" aircraft operate. All kinds of requirements flow from the obligation to follow general flight rules, not to mention pilot and aircraft certification and qualification requirements.

The third bullet above—the establishment of mandatory reporting rules for "public" aircraft—is extremely important in the U.S., where there are a growing number of non-military unmanned aircraft plying the skies every day. The definition of public aircraft is fairly intricate on the printed page but reasonably straightforward in the context of present-day UAS activities. The NTSB's specific reference to them allows a rather large umbrella to be opened over quite a few current UAS activities and also has the additional virtue of not being tied to the presence of passengers to be applicable to them.

The fourth observation above refers to the new 300-pound minimum established for reportability of unmanned aircraft accidents. This particular line in the sand, when paired with the continued applicability of the "death and serious injury"

UAS Accident Investigation Considerations (2011 Edition)

For the foreseeable future, there are likely to be only a handful of NTSB investigators-in-charge with actual experience conducting a UAS accident investigation, and even fewer with expertise specific to technical aspects of unmanned aircraft operational and materiel failures. So the following is offered to support conversations between investigators and UAS pilots and manufacturers toward the goal of increasing our collective body of knowledge on UAS issues and hazards.

The NTSB parses investigation working groups and specialties into eight categories

- Operations,
- Structures,
- Powerplants,
- Systems,
- Air traffic control,
- Weather,
- Human performance, and
- Survival factors.

Every one of the above may be germane to any accident investigation in which an unmanned aircraft system is either the focus of the investigation or suspected of involvement in the accident sequence. However, the knowledge and skill sets necessary to properly evaluate many aspects of UAS accidents against this investigative model need to be nurtured. Also, some "expanding-the-box" (as opposed to "out-of-the-box") thinking should be applied in doing so.

For instance, consider the "survival factors" portion of a UAS-involved accident investigation. (Assume the microchip didn't make it through the crash, shed a tear, and move on.) At first glance, a single-ship unmanned aircraft accident most likely wouldn't occasion much of a requirement for survival factors investigation. However, using exotic fuels and materials, unique propulsion and electrical generation systems, and other innovative technologies has definite implications when it comes to both community emergency planning and on-scene first responder protection. Further, in the case of every midair collision between a manned and an unmanned aircraft, it will be important to assess the extent to which the unmanned aircraft was able to disrupt the survivable volume of the occupied aircraft, whether through the windscreen or the fuselage.

In every UAS-involved investigation, it is easy to envision the need for a few new tasks for some of the established working groups.

1. Operations: Establish the authority under which the unmanned aircraft system is being operated (Part 91, certificate of waiver or authorization, special airworthiness certificate in the experimental category, etc.).
2. Operations/Air Traffic/Human Performance Groups: Determine the interactions taking place at the time of the accident. Was the pilot (and observer, if required) able to perceive relevant system state information (aircraft state, ATC direction, other aircraft potentially affected)?
3. Systems: Study the system logic; consider how primary versus consequent failures might present themselves during the accident sequence (e.g., was lost link a root cause of the accident or was link lost because of other failures?).

Beyond needing to simply apply new thinking to the existing investigative disciplines listed above, serious new knowledge will need to be built in the realm of

requirement, is useful for the following reasons:

(a) It ensures that the time and resources of both the Board and UAS operators won't be wasted on hull loss accidents involving the rapidly proliferating population of small-sized unmanned aircraft.

(b) It positions the Board to keep an eye on the small but growing number of UAS platforms intended to fly for days, weeks, and even months at a time.

(c) It represents tacit acknowledgement that, while velocity is the most important variable in how hard an impact might be, something weighing 300 pounds has the potential to do some pretty impressive damage no matter how fast it's going.

(d) The weight threshold itself is in the general range of the 150-kilogram benchmark being looked at as a starting point for UAS regulation and reportability in other countries.

The fifth bullet above refers to a regulatory gap that was plugged quite elegantly by the new language. On April 25, 2006, an RQ-1B Predator operated by the U.S. Customs and Border Protection's Office of Air and Marine crashed near Nogales, Ariz. Although the aircraft was destroyed, there was no collateral damage or injury suffered on the ground. The NTSB dispatched a team to the site and took charge of the investigation; however, it was later pointed out that, since no one had boarded the aircraft prior to the crash, their legal basis for doing so was a bit of a stretch. Actually, this turned out to be an ideal scenario for issues like that to be surfaced; no one was hurt, there was no collateral damage, and the NTSB had an opportunity to start digging into the kinds of UAS-specific issues that are likely to appear in future unmanned aircraft accident sequences.

Finally, it's important to have jurisdictional issues decided well in advance of a major accident, when emotions run high and there may be a desire to drive an investigation in one direction or another based on politics rather than settled policy. The United States Code sets very specific criteria for when a military accident becomes subject to civil investigation:

"The National Transportation Safety Board shall investigate—(A) each accident involving civil aircraft; and (B) with the participation of appropriate military authorities, each accident involving both military and civil aircraft (49 U.S.C. 1132)." With a definition on the books explicitly designating unmanned aircraft as "aircraft," this authority will be much more straightforward to apply (should the unfortunate need to do so arises).

Implications of the rule

So, what are the likely real-world changes in investigations that we'll see based on the new rule?

1. The reporting threshold should result in newcomers to aviation manufacturing being less frequently brought into the formal investigative process than established members of the aerospace industry are. That should translate into smoother, less adversarial investigations; more often than not, the parties will understand their role and obligations.

UAS-unique systems. UAS avionics are designed to meet specific needs, but for now at least there aren't any applicable technical specification orders (TSO) out there to help guide their development. That means there are a host of as yet unexplored questions regarding the stability of data streams between pilot and aircraft, their vulnerability to accidental (or intentional) disruption, and even the extent to which multiple unmanned aircraft can be safely operated in close proximity to each other without encountering unexpected problems.

One final point—Assessment of the radiofrequency spectrum for its possible involvement in an accident sequence has rarely been required since the early days of fly-by-wire aircraft. However, putting UAS into the aviation environment may renew the need to do so on a regular basis and might require a new or expanded relationship between NTSB investigators and Federal Communications Commission engineers as well. The bottom line is that when it comes to UAS, to quote a time-honored aphorism, "We don't know what we don't know." ◆

2. The reporting threshold will tend to drive investigative resources toward accidents involving higher-value unmanned aircraft. Higher fiscal consequences naturally drive investigators and participants alike toward cooperation in determining causes and corrective actions.

3. For the near term, it's likely that only a handful of non-military public-use UAS accidents will meet the new reportability and investigation requirements, perhaps involving assets of the Department of Homeland Security, the National Aeronautics and Space Administration, or one or two other agencies. That should result in a measured, deliberate expansion of investigator understanding of the similarities and differences between manned and unmanned aircraft accidents, and should help the NTSB identify new skill sets and capabilities it will need to develop ahead of the inevitable wider deployment of civil UAS platforms.

For the most part, the NTSB steers clear of "incident" reporting and investigation, except where it sees a compelling need to gather data about certain types of events. So, for now at least, the NTSB most likely will concentrate on growing its ability to effectively investigate UAS-related accidents.

However, at some point, it is equally likely that it will start identifying specific issues showing up in UAS accidents that will bear closer scrutiny, in a manner similar to the current information-gathering effort on Traffic Collision Alerting System (TCAS) incidents. It's also important to realize that, should a collision between a manned aircraft and a UAS smaller than the 300-pound threshold occur, the same fundamental issues will need to be explored (see sidebar).

Challenges

Now that the NTSB has taken the first steps on the road toward normalizing the investigation of UAS accidents, what needs to happen next? The following issues come immediately to mind.

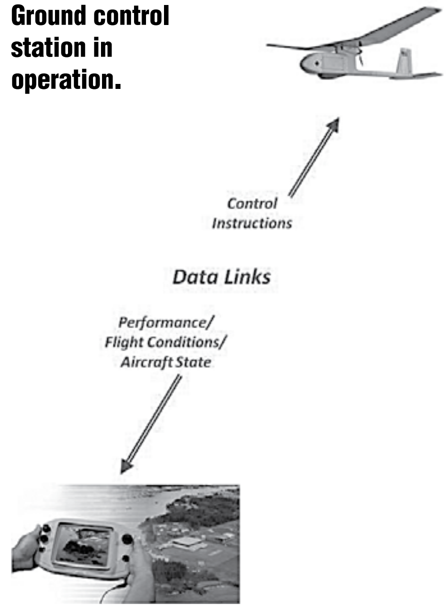
First and foremost, the NTSB (and for that matter, other national investigative authorities as well) should aggressively develop the same kind of relationships with the UAS operations and manufacturing communities that they have fostered over time with manned aircraft operators and prime and major component contractors.

In this, they may have a less-than-straightforward path to follow, since the most prominent trade association for the UAS sector, the Association of Unmanned Vehicle Systems International, is principally oriented toward marketing. Industry associations such as the Aerospace Industries Association or the General Aviation Manufacturers Association, however, count among their many roles facilitation of interactions between the regulators and the regulated.

Second, now that UAS accident reporting criteria are formally a matter of federal regulation, it will be important to ensure that there is broad understanding as to when a reportable accident has occurred, and to whom the report must be submitted. This ties in with a parallel need, which both the NTSB and the FAA will need to proactively pursue to nurture and enforce a reporting culture among UAS operators that (hopefully) will come to rise above the traditional civil/military stovepipes.

Finally, there may be certain challenges associated with locating the operator, pilot,

Ground control station in operation.



and manufacturer of a given unmanned aircraft involved in a reportable accident. For instance, it's not implausible to envision a scenario involving a disabling collision between a manned aircraft and a smaller unmanned aircraft (on either side of the 300-pound threshold) in which the involvement of the latter is not recognized until an on-scene investigation is well under way.

As a practical matter, a fair amount of forensic work may be necessary just to establish the type of powerplant in use by the unmanned aircraft—probably the most likely component to survive significant impact forces—and then use that to try to track down the manufacturer and, eventually, the operator and pilot. In fairness to operators, depending on the nature of both the operation and the accident, they may know they've lost an aircraft, but it may not be immediately obvious that a lost link during BLOS flight resulted in an accident many miles from the point where contact was lost with the unmanned aircraft.

Summing up

With its first steps into the burgeoning field of unmanned aircraft systems, the NTSB has made a commendable and necessary contribution toward normalizing some previously unresolved issues regarding how UAS accidents in the U.S. National Airspace System are to be addressed. The regulatory landscape continues to evolve, and it is welcome indeed to see the NTSB ensuring it is actively engaged in shaping it. ◆

Mental Health and the Air Safety Investigator

A research study takes a deep look into the mental health aspects of air safety investigation and finds such investigation is inherently psychologically stressful with fatigue, anxiety, and difficulty concentrating being rampant symptoms.

By Brian R. Dyer (ST5513), Project Officer, Nevis Disaster Management Department, St. Kitts and Nevis, and
Anthony T. Brickhouse (MO5069), Assistant Professor, Embry-Riddle Aeronautical University, Daytona Beach, Fla.

(This article is adapted with permission from the authors' paper entitled Mental Health Aspects of Aircraft Accident Investigation: Protecting the Investigator *presented at the ISASI 2010 seminar held in Sapporo, Japan, Sept. 6–9, 2010, which carried the theme "Investigating ASIA in Mind—Accurate, Speedy, Independent, and Authentic." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org. —Editor)*

The crash site possesses many challenges for air safety investigators. The site must be surveyed to determine the degree of hazard, and entry/exit points must be established. Some of these challenges include, but are not limited to, hazardous materials, composite materials, serrated edged metals, environmental hazards, wild life, blood-borne pathogens, parachute systems, and aviation fluids. Among these challenges, one has received very little attention, and that is the mental health and resiliency of the air accident investigator. J.W. Ussery and A.J. Waters (2006) noted that mental health and resilience are proven tools for survival.

Aircraft accident investigators generally arrive at the scene of an accident after the emergency services personnel. However, there are instances where the investigators are exposed to the chaotic, traumatic, and emotional situations at the scene of accidents. While exposure to extreme psychological stressors does not always bring about negative reactions in aircraft accident investigators, there is empirical evidence that the exposure to these critical events does pose a challenge. Understanding the cases in which the investigators allow an event to become a traumatic stress maker is important for diagnosis purposes and to provide timely mitigation measures according to C.V. Coarsey-Rader and T. Rockwood (1993).

Medical author R. Dryden-Edwards (2004) described acute stress disorder as the anxiety and behavioral disturbances that develop within a month of exposure to extreme trauma. The symptoms of an acute stress disorder usually begin during or shortly following the trauma. In 1994, the American Psychiatric Association (APA) published a table of common symptoms of psychological trauma and post-traumatic stress disorder. This table described post-traumatic stress disorder (PTSD) as an emotional illness that develops as a result of a terribly frightening, life-threatening, traumatic, catastrophic life experience or otherwise highly unsafe experience.

Individuals affected by post-traumatic stress disorder re-experience the traumatic event or events in some way and are likely to practice avoidance. This occurs when the individual tends to avoid places, people, or other things that remind them of the event. Sufferers may also experience hyper-arousal, a state of being highly sensitive to normal life experiences. Some may experience intrusive recollections of the event via flashbacks, dreams, or recurrent thoughts or visual images. Empirical evidence has found that post-traumatic stress symptoms may develop after a single exposure to a critical event. Coarsey-Rader posited that clinical procedures have been developed primarily for assisting first responders, military personnel, and public safety employees, i.e., police, emergency management technicians (EMT), and firefighters with symptoms of acute distress. However, there is currently no specific program developed for intervention and prevention of distress experienced by aircraft accident investigators.

Purpose of research

The purpose of our research was to assess the traumatic effects of aircraft accidents on aircraft accident investigators. This has received very little attention since the primitive days of early aviation enthusiasts and the Wright Brothers. Additionally, Coarsey-Rader found that there was no specific program developed to address the distress experienced by aircraft accident investigators. Several researchers have highlighted in their work that aviation accidents are sometimes fatal and that aircraft accident investigators often experience graphic exposure to severe injuries, mutilated bodies, mass destruction, and the stench of burnt flesh.

This research examined the feasibility of an annual mental conditioning program for personnel involved in aircraft accident investigation. A methodical program may provide educational awareness topics that include (1) improving coping skills; (2) expectations at an accident site; (3) common stress-related symptoms (disturbed sleep, headaches, fear, decreased appetite, and anxiety); (4) changes in routine to avoid fatigue; (5) importance of teamwork, being social, and family life; (6) importance of seeking assistance; (7) effective communication; and (8) understanding acute stress and post-traumatic stress disorder and the risk factors and prevalence following exposure to trauma. Strengthening the initial defense of the investigators may reduce the effects of exposure and stress.

Brief review of relevant literature

Post-traumatic stress disorder is not the only pathological outcome following traumatic events. R.J. Ursano, B.G. McCaughey, and C.S. Fullerton (1994) and Weisaeth (1994) posited that psychological responses to traumatic events vary depending on the types of disasters and victims. P. Birmes, A. Arrieu, A. Payen, B.A. Warner, and L. Schmitt (1999) suggested that persons who experience a major disaster and concomitant acute stress reactions are at an elevated risk for the subsequent development of post-traumatic stress disorder.

B. Bledsoe (2003) posited that in general, through years of training and experience, mental health professionals learn to isolate their feelings and emotions from their professional work. However, it would be a difficult request to ask volunteers and non-mental health professionals not to become emotionally involved. Notwithstanding this consensus, empirical evidence has shown that on-scene traumatic stressors have indicated significant psychological distress among air accident investigators. M.S. Bilal, M.H. Rana, S. Rahim, and S. Ali (2007) indicated that denial of the impact of work on their well-being and functioning may serve well until it fails. Then they must face up to their vulnerability. Coarsey-Rader and T. Rockwood (1993) found that more than 50% of accident investigators consistently ranked fatal accidents as producing above-average stress. In accidents where children are injured or fatally wounded, M. Cotter (2004) found that 70% of the respondents reported above-average stress, 50% reported being very stressed, and 20% reported these accidents as excessively stressful. Cotter attributed the above-average stress to identification with the victims, as many of the investigators were parents. On the other hand, in accidents in which the investigators knew the deceased or injured crewmembers, Cotter found 62% of the respondents reported above-average stress, 40% reported the accidents being very stressful, and 22% reported the accidents as excessively stressful. These results were attributed to the investigators associating the similarities between their own lives and that of the victims.

Over the years, several treatment models have been developed. These include

- **critical incident stress debriefing (CISD)** developed by Jeffery T. Mitchell to assist emergency responders to quickly recover from a traumatic incident.
- **post action staff support (PASS),** which is a variation of the critical incident stress-debriefing model. This PASS model is used as an activity for team maintenance that can minimize the effect of the disaster experience on individuals within a team.
- **resiliency management (RM),** which is an alternative method of handling the element of post-traumatic stress. Approaches used are designed to encourage natural recovery mechanisms and relationships of support. The evidence-based method that is employed provides practitioners with defensible, ethical, and effective post-crisis intervention services.
- **critical incident stress management (CISM),** another short-term method that is designed to reduce trauma symptoms and has been utilized in a number of first-responder organizations such as police departments, fire departments, and hospitals. Some airlines have also adopted the critical incident stress program to educate members and to help prevent the onset of PTSD among pilots and crewmembers following a critical incident or accident.
- **crisis counseling (CC),** which is defined by the National Mental Health Information Center (NMHIC) as an initiative that supports short-term interventions with individuals and groups experiencing psychological stress to large-scale disasters.
- **psychological first aid (PFA),** which consists of a systematic set of helping actions aimed at initial post-trauma distress and supporting short-and long-term adaptive functioning.

Research design

This research was designed to develop an awareness of the ill effects that may occur with the exposure to trauma on air safety investigators. We made contact via e-mail with several industry professionals with a background in aircraft accident investigation, psychology, or mental health counseling. Invaluable information was obtained from the following professionals who were instrumental to the success of this research. The air safety investigators included Troy Jackson, senior air safety investigator of the Transport Safety Institute; Mary Cotter of the Ireland Aircraft Accident Investigation Branch; Professor Graham Braithwaite, Ph.D., Cranfield University; and Professor Frank Taylor [1998 ISASI Jerome Lederer Award recipient] now retired, formerly of Cranfield University. The industry mental health counselor was Professor Amy Bradshaw, Ph.D., of Embry-Riddle Aeronautical University. The psychologists included Brenda Tillman Ph.D. and Tania Glen Ph.D. of the Readiness Group International LLC, and Carolyn V. Coarsey, Ph.D. of the Higher Resources, Inc.

This research examined the primary clinical treatment options that are applicable to individuals exposed to critical events and trauma during the discourse of their duties. A survey was created and used as the primary research instrument. The refined instrument contained 13 items. It was disseminated via electronic mail using the daily flight safety information services of Curt Lewis and Associates LLC. The instrument was also administered to the delegates attending the ISASI 2009 seminar in Orlando, Fla. The survey questions were categorized into two distinct formats. The first category collected

***Brian Dyer** is project officer in the Nevis Disaster Management Department (NDMD). His responsibilities incorporate the principles of comprehensive disaster management, formulating policies and programs, and risk management. Dyer graduated from Embry-Riddle Aeronautical University, Daytona Beach campus, receiving a bachelor of science in aviation business administration (BSABA) with a minor in safety science in 2008 and a master of science in aeronautics with dual specialization in management and safety science (MSA) in 2009. Dyer received the ISASI Rudy Kapustin Memorial Scholarship in 2009.*

***Anthony T. Brickhouse** is an assistant professor assigned to the Department of Applied Aviation Sciences in the College of Aviation at the Daytona Beach campus of Embry-Riddle Aeronautical University. Before joining the faculty of ERAU, he served as the assistant aviation safety program manager for the Daytona Beach campus. Before joining the aviation safety staff at ERAU, he was assigned to the Vehicle Performance Division of the Office of Research and Engineering at the National Transportation Safety Board (NTSB) in Washington, District of Columbia. During the span of his career, he has investigated numerous aircraft accidents and safety events.*

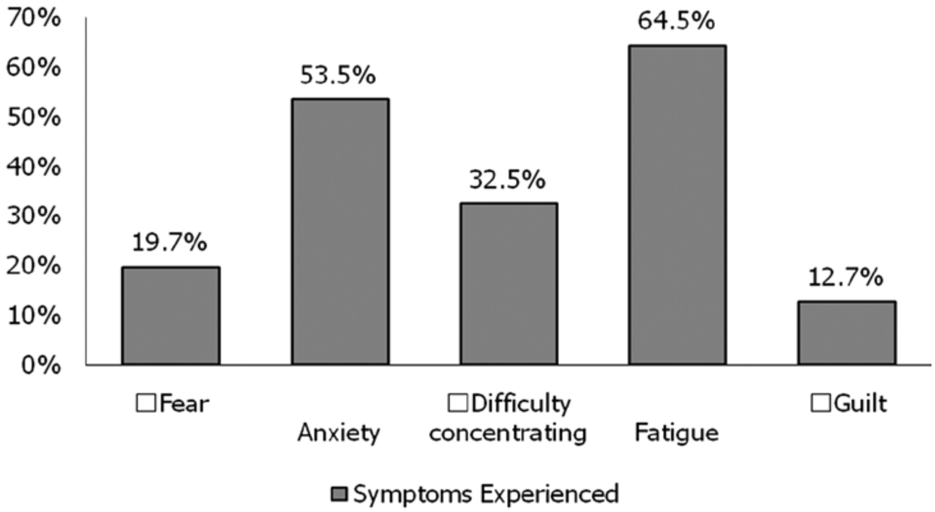


Figure 1. Symptoms experienced by participants.

demographics such as gender, marital status, and employment affiliation. There were some closed-ended questions that required a "yes" or "no" response. The second category collected Likert Scale data based on the attitudes, opinions, and actual experience or behavioral responses of the investigators pre/post accident. Some questions also obtained information about coping skills, as well as social support following investigations.

The survey consisted of 233 participants (n = 233) that were contacted through the flight safety information mail list service and through attendees of the ISASI 2009 seminar. The number of participants, their experience, and the number of exposures to critical events represented a broad spectrum of the aircraft accident investigation population.

Discussion of results

There is sufficient evidence in medical and psychological journals to demonstrate that a strong relationship exists between stressful life events and the emergence of a broad range of physical and mental health disorders. Likewise, aircraft accident investigation is inherently psychologically stressful. The effects of unresolved stressors were manifested in a variety of symptoms expressed by the participants. This study was conducted with a sample of 233 participants of which 97.9% returned completed surveys and 2.1% returned incomplete surveys. Of the 228 completed surveys, 10.1% were females and 89.9% were males. These participants submitted responses to a 13-question survey instrument.

The results of the analysis indicated that the level of the participants' experience did not preclude them from the ill effects of exposure to trauma. The symptoms of anxiety, difficulty concentrating, fatigue, and multiple symptoms of anxiety/fatigue were reported in every experience category. Additionally, there were participants who reported experiencing all four symptoms simultaneously, in four of the five experience categories. The group with 15–19 years' experience was the only exception.

Fatigue, anxiety, and difficulty concentrating were the dominant symptoms manifested in the participants. The analysis revealed that 64.5% were fatigued, 53.5% experienced anxiety, and 32.5% experienced difficulty concentrating. Among the other symptoms, 19.7% experienced fear, and 12.7% experienced guilt.

R.B. Flannery (1999) noted in his work that individuals have a tendency to feel that asking for support is a sign of weakness and results in that person ignoring the side effects, which may have irreversible effects. This behavior may have contributed to the extent of the symptoms experienced among the participants. The results show that 31.6% confided in a colleague or sought professional assistance while 68.4% of the participants did not. One respondent indicated that other problems existed that contribute to the high percentage of individuals who did not find it convenient to confide in a colleague.

In response to a question dealing with voluntarily seeking assistance, 16.4% stated that they were very unlikely to voluntarily seek assistance, while 19.15% of the participants reported that they were unlikely to do so. On the other hand, 32% were likely to voluntarily seek assistance while 13.8% were very likely to do so. There were 18.7% who were undecided to seek voluntary assistance. These results indicate that there is significant resistance among air safety investigators to voluntarily seek assistance even after experiencing the ill effects.

Of those who sought assistance, 50% did so within 1-3 weeks after the event, 27.8% did so between 1-6 months, 5.6% did so between 7-12 months post impact, and 12.5% reported seeking assistance one year post impact. This indicates that some individuals may have been hesitant in seeking assistance while the distress remained persistent, problematic, or a limiting factor in the individual's performance. Others may have ignored the

The symptoms of anxiety, difficulty concentrating, fatigue, and multiple symptoms of anxiety/fatigue were reported in every experience category.

side effects and relied on their natural resilience before being overwhelmed by the psychological distress.

In response to a question on how the exposure to trauma affected the way the safety investigators related to their families, the options available were fear, anger, eating, caring, a change in routine, and other symptoms. Participants were also given an opportunity to provide a brief explanation. Some participants expressed other symptoms that included the following: difficulty sleeping or sleeping disorders, reduced patience with others, valued time with others more, compartmentalization, depression, withdrawal, and lack of interest from fatigue.

One participant reported, "Fear of death of family members or myself." Another participant reported,"[I] lost interest in committed relationships," while another reported "no effect that I noticed. Perhaps you should also ask partners!" This was an important statement as 78.1% of the participants were married, 12.3% were single, 0.9% was engaged, and 2.6% were separated while 5.7% were divorced. Only one individual mentioned that the job might have been a contributory factor

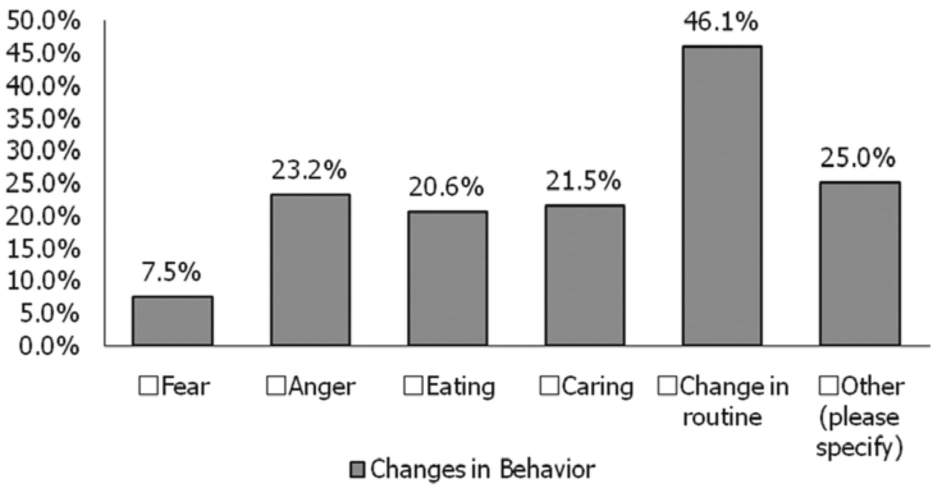


Figure 2. How participants related to their family post exposure.

in the couple's divorce. This creates an avenue for additional research among the spouses or partners of air safety investigators to determine the ill effects of trauma in relationships.

There were individuals who struggled with activities they previously enjoyed. One individual expressed, "When I fly with my husband, I have difficulties with fear and anxiety due to the fact that accidents that I have investigated have [involved] couples. At first I had eating problems, but those have gone away." There were several who reported, "Seeing the death of a parent and child strengthened my appreciation of my own life and family." Another individual stated, "Appreciation increased when the dust settled."

One participant commented, "I am involved in accident investigation via critical incident response, the caring of the well-being of fellow crewmembers and accident investigators." Another reported encountering problems with eating when responding, "No barbeques after dealing with burnt persons for awhile." This confirms the association of barbeque meats with the stench and sight of the burnt flesh at accident sites. One individual expressed, "Constant deployments of course take their toll... I might say I have a constant wall up, but I rather just say I am used to getting shot at." Another reported, "It caused me to get extreme chronic PTSD." While still another expressed that "I wanted to quit my job!"

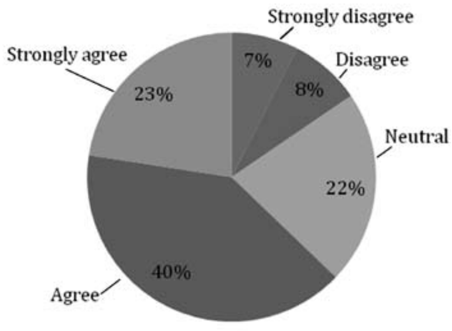


Figure 3. Likert Scale response to annual training program.

Some organizations have taken the initiative and have provided some form of pre/post accident stress/critical incident training for the air safety investigators. The results indicated that 3.6% provided "pre-" accident training, 16.1% provided "post-" accident training, while 42% provided both pre- and post-accident training. The survey results also revealed 38.4% provided neither pre- nor post-accident training. These training programs must be evaluated for their effectiveness at providing conditioning or being capable of mitigating the ill effects of secondary trauma. Once proven adequate, these training programs should be continued and implemented across all air accident investigation units. One participant underscored budgetary constraints as to why pre/post accident stress training may not be offered at some organizations.

In the area of mandatory annual critical incident training programs, the responses showed that 40% agreed and 23% strongly agreed. On the other hand, 22% remained neutral, 7% strongly disagreed, and 8% disagreed.

Conclusions

This study's intent was to take a deeper look into the mental health aspects of air safety investigation in an effort to ultimately better protect investigators. This research found that aircraft accident investigation is inherently psychologically stressful with fatigue, anxiety, and difficulty concentrating being rampant symptoms. Some individuals were hesitant in seeking assistance while the distress remained persistent, problematic, or a limiting factor in the individual's performance. Others ignored the side effects and relied on their natural resilience before being overwhelmed by psychological distresses. Others were forced into different programs by spouses and close friends who recognized differences in behaviors of affected individuals. This confirmed that there is significant resistance among the air safety investigator population to voluntarily seek assistance even after experiencing the ill effects.

A comparison of the level of experience and the number of exposures did not preclude an air safety investigator from the ill effects of exposure to trauma. Symptoms such as anxiety, difficulty concentrating, fatigue, and multiple symptoms anxiety/fatigue were reported in every experience category. Additionally, in four of the five experience categories, there were participants who reported experiencing all four symptoms simultaneously. The 15–19 years' experience category was the only exception. Some organizations have taken the initiative and have provided some form of pre/post accident stress/critical incident training for air safety investigators. The results revealed 42% provided both pre/post accident training while 38.4% provided neither "pre" nor "post" accident training.

This research concluded that regardless of the level of experience or the number of exposures to critical events, secondary trauma is harmful to air safety investigators. Concerns for the emotional and psychological health of these individuals should be given priority to mitigate or correct the ill effects. Strengthening the initial defense of the investigators may reduce the effects of exposure and acute stress.

Recommendations

This research was conducted to increase the awareness of the ill effects attributed to the exposure to trauma on air safety investigators. It was determined that there is a correlation between psychological distress among air safety investigators and exposure to traumatic events. In an *(continued on page 29)*

ISASI 2011 Readies Program

Program details have been released for ISASI 2011, the Society's 42nd annual international conference on air accident investigation to be held in Salt Lake City, Utah, USA, from Monday, September 12 through Thursday, September 15. The conference theme is "Investigation—A Shared Process."

The seminar's website, through which conference and hotel registration will be made, is now open and accessible through the ISASI website, www.isasi.org. It is a well-designed site and extremely user friendly. All areas of delegate interest are easily identified. In general, the traditional schedule of activities will be followed: A day of tutorial workshops, 3 days of the technical seminar, and an optional tour program.

The website shows that the seminar program registration fee (in U.S. dollars) before Aug. 15, 2011, is member $550, non-member $600, and student member $200. One day pass is $200, tutorial only $150, and companion $325. If registration is made after August 15, the fees are members $600, non-members $650, and student member $225. One day pass is $225, tutorial only $175, companion $350. The cost of a single event—Welcome reception $50, Tuesday night dinner $100, and awards banquet $100.

Tutorial subjects

Two half-day tutorial workshops will be conducted on September 12. The first is "Digital Photography for Accident Site Investigation," facilitated by Tony Gasbarro, a graduate of Algonquin College in Ottawa, Ont., Canada, in the science technician (photographic) program. He is a 20-year veteran instructor with USC's Aviation Safety and Security Program specializing in all branches of still and motion imaging. The workshop will delve into the do's and don'ts, needs, and cautions associated with on-site photography.

The second workshop, "Improving Aircraft Integrity with Feedback from Accident/Incident Analysis Information—Closing the Design Loop," features Dr. David Hoeppner as the facilitator. He is a professor of mechanical engineering at the University of Utah. He notes that the importance of failure analysis and determining the root cause of failures of aircraft components, subsystems, and systems has resulted in significant safety enhancements to commercial aviation. These enhancements to fatigue, wear, corrosion and creep design of aircraft and the importance of accident investigation and failure analysis in closing the design loop will be the workshop's topic of study.

Technical program

As of press time, the "Call for Papers" deadline had not passed; hence the technical speakers program is still incomplete. However, seminar planners have said that attendees can expect the normal 25–30 speakers during the 3-day technical program. Presented papers will address the theme of the seminar from the perspective of an international audience. In addition, potential presenters were told they may "focus on any aspect of the investigative and analytical process and may cover any aspect of aviation and should be timely, display technical competence, and reflect your intellectual and personal integrity."

Seminar planners have learned long ago that the "mind can only absorb as much as the seat can endure," so numerous networking coffee breaks are planned throughout the day, along with lunch periods. In addition, when the delegates are released from the seminar hall at day's end, they will enjoy relaxing times as follows:

- **Monday—**Welcome Reception at the Marriott Hotel from 7–9 p.m. Dress: Gentlemen, jacket and tie; ladies, cocktail attire.
- **Tuesday—**Dinner at the La Caille Restaurant, which is housed in an 18th-century French-inspired Chateau. La Caille is a 23-year AAA Four Diamond Award recipient offering contemporary French cuisine. Dress is casual but no jeans.
- **Wednesday—**An open night, which allows delegates to explore the many wonderful restaurants and sites in and around downtown Salt Lake City.
- **Thursday—**Awards banquet to include presentation of the Jerome F. Lederer Award. The banquet is preceded by the President's Reception at 6 p.m. Dress—Gentlemen, jacket and tie; ladies, cocktail attire.

All of the social events are included in the delegate and companion registration fees.

Companion program

An entertaining companion's program awaits delegates' accompanying guests. On Tuesday, from 8:30 a.m. to 1:30 p.m., the group will take the Salt Lake Heritage Tour. It will include a complete look at what makes Salt Lake City so unique: the historic downtown area, stunning views of the Salt Lake Valley, and historic mansions. Lunch will be served at Red Butte Garden with its 20 acres of display gardens. After lunch is the option to walk the beautiful grounds of historic Temple Square, join an organized tour, or stroll back to the hotel. Wednesday brings an all-day tour, including visits to Robert Redford's Sundance Resort, the Swiss village of Midway, the world-famous resort town of Park City, and then to Utah Olympic Park, the site of some of the 2002 Winter Olympic events.

Optional tour

For what may be a first in ISASI seminar planning, the traditional one-day optional tour is being extended to 3 days, which will include visits to some of the most celebrated locations in the southwestern United States. The tour includes two nights' accommodations; round-trip transportation; services of a professional tour guide; three lunches; entrance fees for national parks, monuments, and museums mentioned in the itinerary; all luggage handling (one suitcase per person); and all necessary tips (bellmen, doormen, and for all included

2010 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 41st International Seminar*, held in Sapporo, Japan, Sept. 6–9, 2010, by downloading the information from the appropriate section of the ISASI web page at 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 US$75.

A limited number of paper copies of *Proceedings 2010* 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. ◆

meals.) Not included are meals (other than those mentioned in the itinerary), items of a personal nature (i.e., room service, telephone, liquor, valet, etc.), and the customary end-of-tour gratuity for escort and driver. The price per person (based on a minimum of 20) is single, $820; double, $619; triple, $550.

Full details of the 3-day tour program are available on the ISASI website. In abbreviated form, the program includes visits to Yellowstone, the Tetons, and Jackson Hole as follows:

- September 16—Salt Lake to west Yellowstone: Enter Idaho and travel through the famous potato fields of this "gem" state to overnight accommodations in west Yellowstone, the western gate of the nation's first national park. (Lunch)
- September 17—Yellowstone National Park: Explore Yellowstone and its famous Old Faithful, Fountain Paint Pots, and the spectacular "Grand Canyon of the Yellowstone." Then, view a jewel of mountain scenery: Grand Teton National Park, America's youngest and most rugged mountains. Overnight at the western ski and summer resort town of Jackson and explore the unique shops and saloons. (Lunch).
- September 18—Return to Salt Lake City: The drive is through rugged Snake River Canyon, pastoral Star Valley, and by Bear Lake. Arrive at the hotel about 5:00 p.m. (Lunch).

Hotel reservations

The seminar hotel is the Salt Lake City Marriott Downtown located in the heart of downtown. Planners have secured a room rate of US$175 based on single or double occupancy. Seminar rate reservations may be made as early as September 8 and extended to September 17. This rate includes daily room Internet access and use of the pool, sauna, hot tub, and fitness center. Make hotel reservations through the following website link to ensure the seminar rate: http://www.marriott.com/hotels/travel/slcut?groupCode=airaira&app=resvlink&fromDate=9/8/11&toDate=9/17/11.

The hotel is 15 minutes or a US$20 cab fare from the Salt Lake City International Airport. Public transportation is readily available, as is XPRESS Shuttle of Salt Lake City, which provides hotel service for about $8 per person. Another option is Quicksilver Private Transportation Services. ◆

Lederer Award Nominations Open

Nominations for the prestigious ISASI Jerome F. Lederer Award are now open. Awards Committee Chairman Gale Braden urges ISASI members to look for deserving candidates in the various fields of aircraft accident investigation and nominate those meeting the criteria by the deadline of May 31, 2011.

"Each year, at the Society's annual seminar, we recognize positive advancements in the art and science of air safety investigation through the Jerome F. Lederer Award," Braden said. The criterion for the award is 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 any person 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 an ISASI 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, 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 good publicity for the recipient and might be beneficial in advancing a recipient's career or standing in the community. Full nomination details are available on the ISASI website, www.isasi.org.

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 Awards Committee chairman: Gale Braden, 13805 Edmond Gardens Drive, Edmond, Oklahoma 73013, USA; e-mail galebraden@cox.net. ◆

Kapustin Scholarship Deadline Is April 15

The ISASI Rudolf Kapustin Memorial Scholarship Fund administrators, Richard Stone and Ron Schleede, urge all members to quicken their search for students to apply for the memorial scholarship offered by ISASI. The deadline for applications is April 15, 2011. Full application details and forms are available on the ISASI website, www.isasi.org. Fund administrators stress the need for applicants to adhere to the deadline date and not to exceed the word limit of the required 1,000-word essay.

As noted by President Del Gandio on page 3 of this issue, an award of US$2,000 is made to each student who wins the competitive writing requirement, meets the application requirements, and who registers to attend the ISASI annual seminar. The award will be used to cover costs for the seminar registration fees,

ISASI ROUNDUP

Continued . . .

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 from the Southern California Safety Institute (SCSI) to any regularly scheduled SCSI 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 from the Transportation Safety Institute. Travel to/from the course and accommodations are not included. More information is available at www.tsi.dot.gov/.
- tuition-free attendance from the Cranfield University Safety and Accident Investigation Centre for its 5-day Accident Investigation Course, which runs as part of its masters degree program at the Cranfield campus, 50 miles north of London, UK. Travel to/from the course and accommodation are not included. Further information is available at www.csaic.net/. ◆

NEW MEMBERS

Individual
Amaladoss, Adrian, S., Singapore
Aminhassani, Arash, Tehran
Badiey, Majid, Tehran
Balmori, Miguel, A., Tuxtepec, Oaxaca
Basile, Peter, J., Wichita, KS
Bradbury, Arthur, L., Brea, CA
Curry, David, R., Calgary, ALB
Denis, Francois, Rosemere, QC
Emond, Julie, R., Magny-Les, Villers
Fowler, William, A., Bedford, NS
Garcia, Bautista, Crispin, Orizaba, Veracruz
Grandy, Laurens, B., Carlsbad, CA
Holzner, Juergen, Chapel Hill, NC
Ibrahim, Zuhair, M., Los Angeles, CA
Kettelhut, David, L., Howard Beach, NY
Kohler, John, M., Glenview, IL
Leon, Fermin, San Nicolas de los Garza Nuevo Leon
Monroig, Felix, Daytona Beach, FL
Moran, Raquel, B., Sydney, NSW
Onyeyiri, Clement, Lagos
Otterstrom, Kevin, L., Mesa, AZ
Purohit, Kartik, Merino, VIC
Regnier, JP, L., Rockland, ONT
Shankland, Keith, R., Southlake, TX
Steffey, Brian, T., Davis, CA
Taukave, Harriet, S., Nadi Airport ◆

ESASI 2011 Seminar Set For Lisbon, Portugal

Following the success of its 2010 seminar, the European Society of Air Safety Investigators has set its 4th air safety seminar for Lisbon, Portugal, on April 7–8, 2011. The theme for the 2-day event is "Air Accident Investigation in the European Environment."

Emphasizing current European issues in the investigation and prevention of accidents and incidents, the seminar is aimed at accident investigation professionals. It will provide an opportunity to update professional knowledge and skills as well as to interact with other active air safety investigators.

Presentations will address current issues in the European environment and the challenges of modern air safety investigations. The presentation program will be available soon through a link on the ISASI website, www.isasi.org.

The hotel venue is the Sofitel Lisbon Liberdade where hotel accommodations have also been arranged. The ESASI seminar discounted room rate is 125 Euros single occupancy and 140 Euros double occupancy (taxes and breakfast included).

The hotel should be contacted directly to book accommodations: Avenida Da Liberdade 127, 1269-038 Lisbon, Portugal. Tel: (+351)21/3228300, Fax: (+351)21/3228310, and e-mail: H1319@sofitel.com.

For seminar registration and further details, please contact ESASI Councillor Anne Evans, Tel: +44 (0) 7860516763, e-mail: anne_e_evans@hotmail.com or ESASI Secretary John Dunne, Tel: +44 (0) 7860 222266, e-mail: j.dunne@btinternet.com. ◆

During the Pacific Northwest Regional Chapter's holiday dinner, John Purvis, a docent at the Museum of Flight, provides an overview of what is new at the museum, including a new building being built in the hopes of securing a space shuttle.

Reachout Completes Two Workshops

"In keeping with the rest of our industry, the global financial crisis maintained its

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107 E. Holly Avenue, Suite 11
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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.

Caj Frostell instructs during the Reachout workshop in Istanbul, Turkey.

impact on the Reachout program," noted Reachout Committee Chairman John Guselli.

He said that in spite of this gloomy situation, two Reachout workshops were completed in the closing months of 2010. The first, Reachout 37, was successfully conducted in Istanbul, Turkey, October 18–22 by Caj Frostell and Mike Doiron. The second, Reachout 38, was held in Darwin, Australia, October 25–28. ASASI volunteers included Lindsay Naylor, Rick Sellers, John Guselli, and Paul Mayes.

Frostell reported that the workshop on incident investigation and safety risk management was hosted by Turkish Airlines. Capts. Ahmed Asaf Bora, vice-president of flight operations, Menderes Cakici, director of flight training, and Cem Lutfu Firat, manager of flight training, visited and observed the ISASI workshop.

The program included several interactive case studies and working group assignments. Participants, 21 from Turkish Airlines, represented all operational areas, including pilots involved in company safety management and persons in maintenance and quality engineering and in cabin and ground services.

The arrangements at Turkish Airlines and in Istanbul were accomplished by Ahmet Ozturk and Capts. Mustafa Afacan and Eyup Tursucu. The outstanding assistance rendered to the instructors was invaluable in all repects.

New ground was broken Down Under with Reachout 38. Guselli said, "This 'Outback' environment was significant in that it was well away from the beaten track and in keeping with the Reachout philosophy of taking the training to areas that would otherwise have not been available to many attendees." Twenty delegates represented the breadth of the industry in the Northern Territory.

Peter Renshaw and Mal Christie of the Australian Transport Safety Bureau delivered valuable insights regarding human factors awareness in safety and investigation. The national regulator CASA was also well represented through sponsorship and support from specialist personnel including Glenn Jones. Generous sponsorship from Cobham Aviation also enabled the participation of Paul Mayes.

Analysis of the seminar feedback revealed a high degree of satisfaction from participants across the board and that this type of training is both necessary and well regarded in the more remote areas of Australia. ◆

ANZSASI Annual Seminar Set for June 11

The Australian and New Zealand Societies of Air Safety Investigators 2011 annual regional air safety seminar will be held at the Rydges Hotel in Christchurch, New Zealand, on June 11–12.

Christchurch is the largest city on the south island and has excellent international and domestic air connections. Technical presentation will address the challenges of modern air safety investigation, operational developments, and current thinking regarding safety management systems and associated subjects.

For those who elect to arrive early or stay late, there is a wide range of adventurous activities within easy reach, including early skiing in June.

For further information regarding registration, contact Ian McClelland at i.mcclelland@taic.org.nz or Alan Moselen at moselena@caa.govt.nz. ◆

Mental Health and the Air Safety Investigator, *continued from page 25*

effort to mitigate the ill effects of exposure to these events, and to encourage remedial action by the affected individuals and organizations on a whole, the following recommendations are proposed:

- Universities and other educational institutions preparing individuals for aircraft accident investigative techniques should incorporate mental health aspects and coping skills as subjects in their course content. This would promote mental conditioning, focus, and endurance during the execution of their duties.
- Build resiliency in current and future air safety investigators by helping them to master stress; build vitality; engage in emotion; and focus of the mind through continuous education, training, good practices, and modifications in workplace culture.
- Air safety investigators should be encouraged to monitor their stress levels prior to, during, and post accidents. In addition, they should be encouraged to seek the appropriate care in a timely manner to minimize the ill effects.
- There were 178 married participants in this study. A follow-up study should be conducted among the spouses of the air safety investigators to determine the impact of the secondary trauma in their relationships. This could be accomplished by implementing a program for the spouses of air safety investigators to share information concerning the stress-related issues experienced and the mitigation measures that were applicable.
- Annual critical incident training program similar to the annual bloodborne pathogens training should be developed to provide standard mental conditioning for air safety investigators. ◆

Small Investigation Benefits, *continued from page 17*

with time and circumstance. It eventually becomes a norm.

In this case, systemic violations were based on the technical knowledge of the engineer who directed the deviations based on the science he knew. Cost justification for the proper equipment diminished since the job was getting done by alternate means. The system was unable to correct itself since cost and time pressures were already addressed by an internal solution that provided relief. There was little notice of the activity until the inspection failure was discovered at JFK. Had the vendor's inspector been using the proper tooling when accomplishing the inspection, he would have discovered the cracked fitting.

We determined that the systemic deviations that allowed unapproved tooling substitutions were the root cause. Corrective action to these findings was taken immediately and was systemic in its scope.

We determined that the systemic deviations that allowed unapproved tooling substitutions were the root cause. Corrective action to these findings was taken immediately and was systemic in its scope. The vendor condemned all their tooling with the exception of those that could be proven in detail as compliant. They stopped internal manufacture of their tooling and purchased standards, probes, and fixtures from approved vendors as directed by the NDT manual and the aircraft manufacturer. All NDT inspections were documented on new forms that directed the proper tools and specs to be used directly from approved data. All personnel had training on the new processes, including the Level 3.

I believe to this day that they created the best NDT operation in Asia as a result of their error. Subsequent audits could find little fault in their operations. Failure definitely gets your attention!

As for my company, we added the NDT audit guideline to our audit standards for heavy check and NDT vendors. The process of developing the guideline and its use thereafter brought additional dividends in assessing repair organizations. We also reinspected the pylons on our entire fleet of B-747s. Not a tragedy, but definitely an inconvenience. ◆

Who's Who, *continued from page 32*

national Airports; RAAF Base Williamtown; and Oakey Army Aviation Centre.

Years of hands-on experience and research have contributed to the development of bird strike training workshops specifically for personnel involved in bird and wildlife strike management. From airport operators to safety regulators to airline staff, Avisure training workshops provide cutting-edge solutions essential to effective bird and wildlife control. During the training program Avisure experts will introduce several units, discuss each at length, provide tangible examples, and equip personnel with knowledge about the increasing importance of bird and wildlife controls and implementation of an ongoing management plan.

To contact Avisure's head office, send correspondence to P.O. Box 404, West Burleigh, QLD. 4219 Australia; call 61 7 5508 2046; or e-mail pshaw@avisure.com.au. ◆

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Exponent, Inc.
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ISASI

AIR SAFETY INVESTIGATORS
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WHO'S WHO

Avisure: Mitigating Bird Strike Risk

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

Avisure is a strategic business unit of the renowned environmental management service Ecosure, an organization that has been delivering a range of environmental solutions to national and international clients for more than 15 years.

In 1994 Phil Shaw recognized the industry's need for ecology and wildlife professionals who had a passion for aviation and a solid grounding in aircraft and aerodrome operations. With this in mind, he launched Avisure to service the aviation ecology sector. The company has since built a reputation as the leader in bird strike risk management.

The Avisure team has advised nearly 40 international and regional airports, airlines, and the military on how to reduce bird and wildlife hazards with comprehensive risk-management strategies, staff education, and ongoing implementation and maintenance plans.

Today, Avisure's staff includes ecologists, wildlife veterinarians, endangered species specialists, environmental strategists, ornithologists, and pilots. All are cross-trained as aerodrome safety officers; all are just as much in tune with the complexities of modern airport operations as they are with the subtleties of wildlife behavior and habitat modification.

Dispersal of birds from airport approach and departure paths is of prime concern. More than 90% of bird strikes occur at low altitude in the vicinity of airports. The most common management methods are reducing bird attraction to the aerodrome region and operating a dispersal program to scare birds away from approach and departure paths.

AVISURE
MITIGATING BIRD STRIKE RISK

Avisure is a world-renowned leader in the field of bird and wildlife strike management, and its experienced team of experts has the capacity to carry out an industry-endorsed risk assessment/audit.

A risk assessment/audit involves a site visit by the Avisure team to assess the habitat and survey species present within airport premises and in close proximity of airport boundaries. An audit of current bird and wildlife management practices is followed by an appraisal of bird and wildlife reporting procedures and a review of strike data. This includes the production of charts and tables to demonstrate their effectiveness and ease of interpretation. Finally, the team will rank identified species according to the risk they pose to aircraft.

A vital and strategic step in bird and wildlife strike management is implementing an ongoing management plan following an on-site audit and risk assessment. An Avisure management plan can be adapted and implemented globally, specifically developed to target high and moderate risk species and locations identified on airport. Developed in collaboration with key airport staff, the risk assessment provides management with guidance and detail to maximize a return on its investment.

Avisure was recently awarded the contract to manage bird strikes at Australia's largest and busiest airport in Mascot, Sydney. Other Avisure clients include Sharjah International UAE; Hobart, Cairns, and Gold Coast Inter-

(continued on page 30)