ISASI FORUM

"Air Safety Through Investigation"

APRIL–JUNE 2007

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Red Sea rudder recovery of a Flash Airlines Boeing 737-300. The charter flight crashed on January 3, 2004 (See ISASI Proceedings 2004, pg 60 from which this photo is taken). ISASI 2007 will present a tutorial that will discuss salvage operations and the whole range of planning and logistics issues involved in salvage operations.

ISASI FORUM
"Air Safety Through Investigation"

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

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

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

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

• The annual seminar-published *Proceedings* are provided to individual members at no cost on line.

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

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

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

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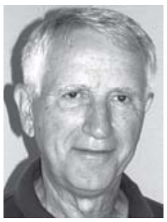
Creating The ISASI International Working Group On Human Factors

IIWGHF is an industrywide effort to create better human factor tools for the accident investigator.

By Richard Stone, ISASI Executive Advisor

In the early 1960s, I helped investigate my first aircraft accident, an FH227 in New Hampshire. I was assigned to the Human Factors Group, which had a military flight surgeon assigned. The primary focus of our group was to assist the coroner in determining the cause of death of the occupants of the aircraft. The subject of the role of the humans in accident causation was left to the Operations Group. However, over the next 20 years, the focus of the Human Factors Group did change and the Group was renamed the Human Performance Group.



Richard Stone

Throughout this period, ISASI was at the forefront, asking, "Why did the accident happen?" and not merely "Who was at fault?"

Both from President Del Gandio's message and Dr. Mumaw's article in the January-March issue of *Forum*, you have received a full background on the initiation and expectations of this Working Group effort. Now here is some detail on the "mechanics" of IIWGHF. Underlying all of the Group's development efforts are these premises:

- It is currently true that accident investigators can begin an investigation by sifting through pieces of aircraft wreckage and have no presumption of a mechanical fault. It should also be true that investigators can gather data on human performance and the conditions of human performance without presuming human error or negligence. The collection of human performance data should not be seen as implying that human error is a working hypothesis for the investigation.
- The identification of "human error"—which simply refers to a deviation between the behavior observed or decisions made by a human (e.g., pilot) and the behavior or decision that, in hindsight, seemed most appropriate—is the starting point of the investigation into precursors of human performance contributions to an accident or incident. The identification of "human error" is not a stopping point.
- Every accident or incident investigation should initiate human performance data collection, as soon as possible, for data are easily lost or tainted with the passage of time. Guidance will be developed on which data should be initially collected.
- The collection of human performance data should not be seen as implying that human error is a working hypothesis for the investigation. Initial interviews of operational personnel involved in the accident or incident (e.g., pilots, air traffic controllers, maintenance technicians) should be conducted in a way to maximize the retrieval of information about the event; they should not focus on finding fault with the actions taken or decisions made.
- Investigations to assess criminal behavior alleged to have occurred in an aircraft accident should be carefully conducted so as not to impact negatively the air safety investigation. States that have attempted to conduct both an air safety and criminal investigation concurrently, particularly where human performance is involved, have found negative effects to both investigations.

Organizational structure

The IIWGHF is structured with a steering committee to organize the work of the project, a Human Performance Module Development Team to develop materials, a "stakeholder's" team to provide feedback on the usefulness of developed material, and an advisory board to perform the oversight responsibility.

The steering committee is composed of me (representing ISASI), Randy Mumaw (Boeing), and Mike Walker (ATSB). The advisory board will approve the overall plan and conduct a final review of guidance materials prior to distribution and has the role of ensuring that the IIWGHF is producing materials that ISASI can be proud to distribute. Sitting on the advisory board with me is Jim Danaher (NTSB, Ret.), Rob Lee (ATSB, Ret.), Ron Schleede (NTSB, Ret.), Dr. Claire Pelegrin (Airbus), Daniel Maurino (ICAO), and Curt Graeber (Boeing).

The IIWGHF objective of improving the existing guidance for investigation of human performance issues in accidents and incidents will be achieved through the following activities:

- Development of standardized guidance modules that provide information to investigators about human performance investigation issues and methods. These guidance modules will be shared broadly with the commercial aviation safety community.
- Development of guidance on the investigation process—specifically, under what conditions a guidance module should be applied.
- Development of position statements regarding investigation of human performance.
- Coordination with ICAO to revise or update ICAO guidance on accident investigation of human performance issues.

The Human Performance Module Development Team will develop the guidance material contained within the module. Human factor experts who will form the core of the Human Performance Module Development Team include Dr. Randy Mumaw, Boeing; Dr. Mike Walker, ATSB; Dr. Graham Braithwaite, Cranfield University; Dr. Evan Byrne, NTSB; Dr. Leo Donati, TSB Canada; Dr. Alan Hobbs, NASA Ames/San Jose State University; Dr. Loukia Loukopoulos, NASA Ames/San Jose State University; Dr. Claire Pelegrin, Airbus; Yann Poliquen, BEA France; and Thomas Wang, ASC, Taiwan.

Subject matter that the modules propose to address is shown below. The goal is to complete modules for at least 15-20 of the listed topics.

Human performance issues—fatigue, spatial disorientation, perceptual illusions, stress, situational awareness, drug effects, crew resource management, decision-making limitations, and recency.

Human performance investigation techniques—speech analysis, discourse analysis, fatigue modeling tools, workload, accuracy of interview information, barrier analysis, and target detectability analysis.

HF investigation fundamentals—investigating human factors (general issues), tests for existence/influence, interviewing, organizational factors (general issues), hu-

(continued on page 30)

Cognitive or Behavioral Approach?

This author presents arguments from both the cognitive and behavior sides and posits that both of these approaches are equally important and should be viewed as complementary rather than disparate.

By Robert Baron (AO4906), the Aviation Consulting Group

As aircraft become more technologically advanced, the causes of accidents are becoming less attributable to mechanical factors. On the other hand, human error continues to be problematic with 60-80 percent of all aircraft accidents having a human error component. According to D.A. Wiegmann and S.A. Shappell (1997): "Although the overall rate of aviation accidents has declined steadily during the past 20 years, reductions in human error-related accidents have not paralleled those related to mechanical and environmental factors." From this, we can surmise that it is much easier to make airplanes safer from a technological approach than from the human approach. This is a truism and the adage "to err is human" is a testament to the problem.

In this article we critically analyze human error and explore error mitigation processes. The word mitigation is purposefully used in this context because it should be clearly understood that we will never be able to completely eliminate human error, only temper it. There are a myriad of human factors that can contribute to error causation in any person at any given time. Some of these factors include fatigue, medication, vision, hearing, memory, information processing, attention, decision-making, communicative ability, assertiveness, etc. Many of the latter have cognitive roots, and indeed much attention has been paid to the cognitive psychological component in aircraft accident investigations.

But while the cognitive paradigm is being widely used to investigate pilot error, it begs to ask the question of whether other approaches might be as effective, or even more effective, in determining the causes of pilot error. R. Fuller (1997) argues that "As cognitive psychology lurches forward, it becomes progressively easier to be dismissive of its behavioral predecessor as being largely irrelevant." In fact, Wiegmann and Shappell (2001), two researchers who have conducted extensive research on pilot error, do not even hint at the behavioral approach as a source of pilot error. They cite five perspectives that include (a) cognitive (b) ergonomics and systems design, (c) aeromedical, (d) psychosocial, and (e) organizational (Wiegmann & Shappell 2001). While these other perspectives are highly relevant and valuable in accident investigations, the clear absence of a reference to behavioral theory should be cause for concern.

__Robert Baron__ is the president of the Aviation Consulting Group, specializing in human factors, judgment/decision-making, human error, CRM, flight operations, group/team dynamics, organizational factors, communication processes, training, failure analysis, accident analysis, aerodynamics, crew performance, records, regulations, certification, corporate/business aviation operations, and Part 135 operations. He is a Ph.D. candidate (dissertation phase) in industrial/organizational psychology (emphasis on organizational psychology in aviation) and holds an M.S. in aeronautical science and a B.S. in professional aeronautics. He has more than 19 years of experience and has worked in many facets of aviation including owning a Part 135 charter business and a flight school. He has thousands of hours of flight time as a corporate captain on Learjets and Citations and has taught the Learjet as a simulator and ground instructor at some of the most recognized Part 142 training academies in the country. He also holds a flight engineer turbojet rating. He can be reached through his website at http://www.tacgworldwide.com.

The cognitive approach

R.L. Solso, in *Cognitive Psychology* (2001), defined cognitive psychology as "the scientific study of the thinking mind and is concerned with (a) how we attend to and gain information about the world, (b) how that information is stored and processed by the brain, and (c) how we solve problems, think, and formulate language." With so much stimuli and the need to make so many decisions during the course of a flight, it is no wonder why so much attention is focused on the cognitive approach when an accident occurs.

Within the cognitive realm lies one of the most problematic areas in terms of pilot error, decision-making. In a study by T.A. Duke in 1991, of 21 airline accidents occurring from 1982 through 1988, it was revealed that decision-making was the number two contributing cause in the accident sample, led only by "procedural behavior." The magnitude of the problem is also inherent in general aviation where studies have shown that 52 percent of fatal general aviation pilot error accidents were caused by faulty decisions (as cited in FAA Advisory Circular 60-22, 1991, p. i). Based on these studies, there is strong support for the need to study pilot error from the cognitive paradigm. Only with an understanding of how pilots make decisions (good or bad) can we begin to improve the process.

Decisions are made as part of a three-stage process. The first stage involves input (stimuli), the second stage involves information processing (making the decision), and the third stage involves the output (performing the action based on the decision). Errors can occur during any one of these stages. As an example of how this all works, let's look at a hypothetical (but not uncommon) pilot who runs off the end of the runway during a night landing. The visual runway clues are misjudged because of a widerthan-normal runway. At night, this can create the illusion that the pilot is lower than he or she actually is, and will try to "compensate" by either climbing or maintaining altitude when in fact he or she is on the correct glidepath and should continue a normal descent. This "overcompensation," due to the visual illusion, can lead to a longer-than-normal landing as the pilot overflies valuable runway while trying to get back on the proper glidepath. If the pilot lands too long, he or she may simply depart the opposite end of the runway due to the higher-than-normal speed and limitations imposed on the braking system.

The above example depicts a problem that began at the input stage and subsequently affected the next two stages. The misjudgment of runway width due to a visual illusion (stimuli) led to a processing error (making the decision), which led to an output error (wrong action selected). This accident had its roots in a perceptual judgment error that propagated throughout the cognitive process.

The cognitive model is but one of a number of taxonomies used to study error causation. The cognitive model is popular because it affords a deeper understanding of how an error is committed by addressing the underlying factors. For instance, an error occurs because the pilot forgets to extend the landing gear. This explains the "what" but not the "why." The "why" is addressed by looking at the underlying cognitive factors such as attention failures or decision errors (Wiegmann & Shappell 2001).

Although it appears that the cognitive model can be used successfully to look at the underlying causes of pilot error, it is not without certain limitations. Since the core of the investigation focuses only on the pilot(s), it creates the illusion of a single-point error when in fact there may have been numerous other contributing factors. These factors may include faulty equipment design, fatigue, management oversight, or organizational deficiencies. Further, framing the entire investigation by use of the cognitive perspective gives the impression that pilots are the major cause of aircraft accidents or the pilot and aircrew are the weak link in the aviation safety chain. Clearly, this may not be the case, and caution needs to be exercised when determining why aircraft accidents occur.

The behavioral approach

The behavioral approach analyzes how organisms learn new behaviors or modify existing ones depending on whether events in their environment reward or punish these behaviors, according to R. Plotnik in *Introduction to Psychology* (1993). B.F. Skinner, in 1989, propelled behavioral psychology into a popular and widely used approach that is used today in a variety of applications. While Skinner's theory focused on what is known as *strict behaviorism*, Albert Bandura challenged this assumption and posited that behaviorism is a combination of both cognitive processes and observable behaviors. Known as the *social learning approach*, Bandura argued that behavior is shaped not only by environmental influences but also by observation, imitation, and thought processes (Bandura 1965).

Based on the theoretical models above, I believe that aircraft accidents can be a result of inappropriate behavioral responses. Support for this position can be subsumed from initial pilot training experiences. For instance, a flight instructor will have a powerful effect as a role model on a student pilot. If the flight instructor models inappropriate (or unsafe) behaviors in a repeatable manner, the student will likely adopt those same practices. These behaviors may become ingrained and lie dormant for months or even years. One day, however, this pilot may revert back to one of these unsafe behaviors and put many lives at risk. Clearly, this is an example of a learned behavior that was negatively transferred from an instructor to a student. If an accident should occur, it would not appear to have the "one-size-fits-all" cognitive label that many openly embrace today. True, the "trigger

"One of the primary aims associated with the introduction of human factors education to the aviation industry was the desire to change attitudes and thereby alter behavior such that unsafe acts were minimized."

—P. Simpson and M. Wiggins

event" might have a cognitive implication, but without understanding what kind of underlying behavioral influences may have played a role, we are not fully able to understand the true cause of an accident.

Why, then, has the behavioral approach been largely ignored in aviation? According to Fuller, one reason is that the behavioral framework has been largely developed in an animal laboratory with limited practical application to humans. Thus, much of this approach's efficacy is based on extrapolation rather than demonstration. Second, the predictive power of the theory has been undermined by problems of definition and circularity. One other reason is the current popularity of the cognitive approach. These seem more like excuses rather than valid reasons for discounting this behavioral approach, particularly where there is strong evidence that the behavioral component is alive and well in aviation.

"One of the primary aims associated with the introduction of human factors education to the aviation industry was the desire to change attitudes and thereby alter behavior such that unsafe acts were minimized," noted P. Simpson and M. Wiggins in *The International Journal of Aviation Psychology,* 9(4), 337-350, 1999. Support for this claim has been revealed through aircraft accident investigations. Thus, it appears that a behavioral component is still an integral part of aviation safety. Changing attitudes implies a change in behavior with a subsequent positive affect on safety. The bottom line is that we want to reinforce safe behaviors and extinguish or modify unsafe behaviors.

Simpson and Wiggins conducted a study that looked at attitudes toward unsafe acts in a sample of Australian general aviation pilots. The participants were 70 general aviation pilots, including 39 private and 31 commercial pilots. Forty-seven percent of the pilots had participated in some form of a human factors training course; 35 percent of pilots had been involved in a human-factors-related accident or incident. The participants filled out a 25-statement attitude questionnaire utilizing a 5-point Likert-type scale. The questionnaire also included open-ended questions for a qualitative component.

The results of the study were consistent with positive behavioral change. From the quantitative results, those pilots who had attended a formal human factors course indicated that a behavioral or attitudinal change had occurred. From the qualitative responses, comments such as "I will hardly take any risks—I ground myself more (i.e., bad weather) and will take no shortcuts" and "I now concentrate on asking factual, open questions, rather than 'reaction seeking' questions" adds further validity to human factors training interventions.

There was a differentiator between those pilots who were involved in human-error-related mishaps and those who were not. Those pilots who were involved in aircraft mishaps recorded higher scores than did pilots who had not been involved in aircraft mishaps. "This suggests that involvement in an aircraft accident or incident is associated with a shift in attitudes toward those characteristics of unsafe acts that mitigate involvement in human-error-related occurrences," wrote the study's authors.

This study did contain certain limitations. First, the sample size was relatively small. Second, the sample was drawn from one geographic location (Australia). Third, it focused only on general aviation and flight training and excluded airline operations. Hence, applicability of this study to the pilot population in general cannot be inferred. Also, it would seem to be common sense that those pilots involved in an accident or incident would be more disposed to changing their behavior in order to prevent an accident from occurring again. This supports the behavioral approach by a reactive versus proactive method (i.e., been there, done that, don't want to do it again). Whether this level of behavioral change can occur when a pilot becomes complacent after many years of accident-free flying is another question. Either way, the behavioral approach should not be dismissed.

Disparate or complementary?

While there is a difference in the underlying theories that make up the cognitive and behavioral approaches, there should not, in this author's view, be a division between the two. Based on the evidence presented in this article, there is clearly the need to continue to use the behavioral approach from not only a training standpoint, but also from an investigative one as well. To say that this approach is "largely irrelevant" and should be "substituted" for the more vogue cognitive approach is an egregiously shortsighted view on the part of researchers and investigators. This is not to say that the cognitive approach is not effective; indeed, it is a useful tool to use to understand why pilots lose situational awareness or make faulty decisions. However, the behavioral approach can further help us understand what types of *behaviors* are conducive to errors, and ultimately try to change those behaviors. Therefore, this author feels strongly that these two approaches should be viewed as complementary.

Analysis and measurement of pilot error: CRM

According to the FAA Advisory Circular 120-51E., 2004, years of aircraft accident investigations have revealed that most crashes are not caused by technical deficiencies in pilot skills, but rather by a breakdown at the interpersonal level. To counter this, crew resource management (CRM) has been developing steadily since the early 1980s, when a number of key accidents highlighted the human fallibility of the aviation system. CRM, now mandatory training for airline pilots, has as its goal to help pilots improve, among other things, their interpersonal (or soft) cockpit skills. Major topics in the program include communication, leadership and followership, and workload management.

CRM training appears to be an effective tool in improving the interpersonal cockpit environment. Robert Helmreich and his colleagues, who are considered to be the most prominent researchers on the subject, have found in an analysis of six empirical and six operational evaluations for airlines strong evidence that CRM programs can help reduce aircrew errors and thereby prevent accidents. In another study (2001), J.M. Beaubien and D.P. Baker, D.P. Baker surveyed 30,000 airline pilots and found that most pilots were satisfied with their CRM training and found it useful.

Since CRM (or lack of) has been the focus of many accident investigations, it makes sense that error prevention strategies and measurements are based, at least in part, on this paradigm. However, CRM has not been free of harsh criticism. In a strongly worded treatise by R.O. Besco in 1998, a number of weaknesses in this methodology were cited that included

- Most of the original psychologists who were instrumental in the design of CRM were from the social and personality theory schools. Very few brought tools and experience from the behavioral sciences. Even fewer were experienced in practical, quantitative scientific methods developed to analyze, study, and measure flight crew performance.
- These psychologists suggested that theories centered on the resolution of interpersonal conflicts, sensitivity to personality differences, and the establishment of functional small group dynamics could solve poor communications and teamwork problems on the flight deck. If the CRM problems could be solved by "fixing the pilots," it was possible for top management to assume that there would be no need to change the systems, the operational practices, or the leadership principles and paradigms then in place.
- There are numerous flaws in the design

of CRM programs. [Many of these programs are developed as a "what," but lack the "why" and "how"] (bracketed item is author added).

- Proponents of the Cockpit Management Attitude Questionnaire (CMAQ; Helmreich 1984; Helmreich & Foushee 1993; Helmreich & Wilhelm 1989) cite positive score shifts and purported customer benefits of their training programs. However, the CMAQ has not been psychometrically evaluated in the open literature for either reliability or validity. Additionally, the literature on the CMAQ contains no information or data relating to development of the initial item pool, test development metrics, or item analyses.
- During initial CRM evaluations, data had been collected from program developers, practitioners, consultants, and CRM experts. All of these evaluators had personal, professional, and economic interests in the outcomes of their own evaluations. This once again raises the question of validity.

While Besco's criticism appears harsh, he does raise some fundamentally valid points. First, the original team of psychologists, with their social and personality theoretical backgrounds, may have put too much emphasis on these theories at the expense of, for instance, cognitive and behavioral approaches. Also, most of these psychologists were from universities and government agencies and lacked a practical background in aviation, per se.

Second, it appears that the original concepts of CRM were developed as a "quick fix" by focusing strictly on the pilots at the expense of other, possibly more causal, components such as organizational leadership, policies, and procedures.

Third, development of CRM programs can be a nebulous undertaking. While the FAA provides some guidance, it is up to each operator to develop a program that is unique to its particular operation. Unfortunately, many operators lack the knowledge or expertise to develop an efficacious CRM program at the local level. This, in turn, can have a negative (or no) effect on training transfer.

Fourth, issues of reliability and validity speak for themselves. Sometimes, haste in the implementation of a measurement instrument (in this case the CMAQ) can be the problem. It might appear so in this case in that during the initial phase of CMAQ development the researchers overlooked reliability and validity issues in order to "get the product to market." Since many of the end users were not psychologists or researchers, Helmreich et al. might have thought this "minor" detail could go unnoticed or unchallenged.

Fifth, the lack of objectivity in the development of the CMAQ can certainly be cause for concern. This can be analogous to a chef providing a food rating to the restaurant where he or she works. This amount of subjectivity can adversely affect the objective intent, and subsequent validity, of the questionnaire.

Analysis and measurement of pilot error: LOSA

Another error classification system that is becoming increasingly popular is called the Line Operations Safety Audit (LOSA), which the FAA defines as "a formal process that requires expert and highly trained observers to ride in the jumpseat during regularly scheduled flights to collect safety-related data on environmental conditions, operational complexity, and flight crew performance. Confidential data collection and non-jeopardy assurance for pilots are fundamental to the process."

As with CRM, airlines are embracing LOSA as a proactive approach to safety (addressing errors before they lead to critical incidents). By creating a database from these line audits, airlines are better able to look for trends or problem areas and initiate countermeasures if required. As an example, if 5 percent of observed crews make a callout error during the approach and landing phase, there may be a problem with those crews. However, if 50 percent of observed crews make the same error, then the evidence suggests a problem with the callout procedure.

Thus, while LOSA can provide useful data on the surface, there are some scientific principles that need to be ironed out in order for the model to become whole. "Without clear definitions, or models of error, error counting amounts to pseudoscience or numerology,"
—S. Dekker

While on the surface it appears that real-time observations by trained observers would be a good idea, the method is not without its limitations. S. Dekker, in *The International Journal of Aviation Psychology,* 13(2), 95-106 (2003), suggests that error classification itself may be too ambiguous and therefore not reliable. He cites that, since 1997, more than half the human errors detected by observers in 1,426 commercial airliner flights were never detected (or classified as errors) by the flight crews themselves. Perceptions of an error can vary widely between two people. What one person sees as a minor error another person can see as a potentially life-threatening mistake. The person who commits the error is going to have a subjective view while an observer will ostensibly have an objective view. Will these two disparate views help or hurt the cause? Could this cause overreporting or underreporting? Are there minimum thresholds established for reporting an error?

Thus, while LOSA can provide useful data on the surface, there are some scientific principles that need to be ironed out in order for the model to become whole. "Without clear definitions, or models of error, error counting amounts to pseudoscience or numerology," noted Dekker.

Another potential problem with the LOSA model is the direct observation method. There will likely be variability and potential bias in the observers. Although Helmreich and Klinect, the primary developers of LOSA, will argue that this is not a factor, as the FAA cited in its Advisory Circular 120-90, it would be hard to assume that observers in the cockpit, who work for the same airline, may not influence the behavior of the pilots in some way (i.e., the pilots might be on their best behavior). What if the pilots are friends with the observer? What if the observer despises the pilots? True objectivity still remains questionable.

Analysis and measurement of pilot error: human factors

Wiegmann and Shappell suggest that although human error is involved in nearly all aviation accidents, most accident reporting systems are not currently designed around any theoretical human error framework. As a result, Wiegmann and Shappell argue that, "Postaccident databases generally are not conducive to traditional human factors analysis, making the identification of interventions extremely difficult."

When a pilot commits an error, and is reported into a database, it then becomes an important piece of information. Errors are reported in an attempt to prevent the same type of error from happening again, possibly to another person. While this method works superficially and can be somewhat effective, there appears to be very little offered in the way of specific theoretical tie-ins to error causation. Numerous taxonomies exist and are used piecemeal depending on the theoretical orientation of the researcher or person interested in the topic, reported J.W. Senders and N.P. Moray in *Human Error: Cause, Prediction, and Reduction* (1991). Regardless of the convoluted taxonomies, Wiegmann and Shappell did identify three prominent frameworks. These included

• a traditional four-stage model of information processing.

• a model of internal human malfunction derived from Rasmussen's Skills-Rules-Knowledge Model (1982).

• a model of unsafe acts as proposed by Reason (1990).

The four-stage model of information processing focuses on stimuli, pattern recognition, decision and response selection, and response execution as cited in Wiegmann & Shappell 1997. This is the cognitive model that was explained earlier and is widely used today to understand pilot error.

J. Rasmussen's (1982) Skills-Rules-Knowledge framework, described in the 1982 *Journal of Occupational Accidents,* 4, 311-333, divides error into three categories: (a) *skill-based*, where a person is able to perform very effectively by using "preprogrammed" sequences of behavior that do not require much conscious thought (that can lead to "complacency-type" errors), (b) *rule-based,* where a person operates from a set of known rules (which *may or not* be correct for a particular task), and (c) *knowledge-based,* where a person has a deficiency, or an improper application of, knowledge to perform a task.

Reason's (1990) model of unsafe acts is based on whether a behavior is intentional or unintentional. Unintentional acts are considered to be slips, lapses, and attentional failures. Intentional acts are classified as either mistakes or violations, and the distinction between the two is important because unintentional acts are considered to be part of "everyday human error" while intentional acts may be indicative of deeper problems such as procedures, training, knowledge, etc.

Space constraints do not allow for a more in-depth discussion of these models. Therefore, the basic concepts were presented in order for the reader to gain at least a rudimentary knowledge of Wiegmann and Shappell's suggested frameworks. This author agrees that their framework tripartite could be useful in understanding pilot behavior when analyzing postaccident data. This would be a better alternative to the analytical methods now in place that appear to meander among various frameworks, some of which may not even be relevant to error causation. In any case, a proper link between accidents, errors, and their theoretical frameworks can help to provide more effective ways to reduce pilot error by providing a better understanding of the otherwise hidden underlying causes.

This article presented two psychological models that can be applied to pilot error. The cognitive approach is the popular choice at the moment, and many accident investigators concentrate on "human information processing" in their search for answers. However, the behavioral approach has not seen as much popularity and has even been labeled as "irrelevant." This author presented arguments from both sides and posits that both of these approaches are equally important and should be viewed as complementary rather than disparate. However, an admonition should be put forth that while both of these approaches look at human error on an individual basis, they do very little to address other factors such as organizational culture, leadership deficiencies, and standard operating procedures. Without considering these important potential influences in the accident chain, an investigation cannot be considered substantive and complete. The cognitive and behavioral approaches only address the pilot and his or her actions; they do not take into account any organizational pathogens that may influence the pilot's erroneous actions.

Finally, this paper looked at analysis and measurement of pilot error from CRM, LOSA, and human factors frameworks. On the surface, these programs appear to be highly effective in quantifying and remediating pilot error. However, evidence suggests that there are inherent limitations in all of these frameworks and a true picture of pilot error is much more difficult to attain than one would be led to believe—the largest cause for concern being error definition and instrument validity.

In sum, any proactive step to improve aviation safety is a step in the right direction. We just need to be aware of the limitations and shortcomings that are associated with scientific research. And most importantly, we need to understand that behavioral psychology is alive and well and should not be considered "irrelevant" when investigating pilot error. ◆

Litigation Can Help Break The Ai

By James T. Crouse

(Aviation attorney James Crouse first appeared in the July/September 2006 issue of Forum*. His article posed the question: Litigation and Aviation Safety: Friends or Foes? In this article, he fulfills his self-appointed task of "writing to help accident investigators better understand the legal process and how it can help reduce aircraft accidents." He may be contacted at jtc@CrouseLaw.com.—Editor)*

This article is this aviation litigator's views on how aircraft accident litigation can be used to break the chain of causation in aircraft accidents. It is based on 27 years of aircraft accident litigation, which in turn has its basis, among other things, on my career as a U.S. Army helicopter maintenance and research and development test pilot. Also meaningful have been the comments of many aircraft accident investigators, as well as defense and plaintiffs' aviation lawyers.

Since aircraft accident litigation occurs only after an accident, any lessons learned from that litigation must necessarily be applied prospectively to help prevent the next accident. Ways must be developed to share what is learned in litigation with aircraft designers, manufacturers, maintainers, operators, and regulators so that the information collected in litigation does not wind up in law firms' file rooms and storage units, where it cannot benefit the flying public. If this information—documents, testimony, and expert reports—is used only to serve a particular litigant and then stored or destroyed, we all lose information that could be critical in preventing the next tragedy.

Role of the aircraft accident attorney

What are the duties of the aircraft accident litigator? As one highly respected aviation attorney recently said at the Embry-Riddle Aviation Law Symposium, the attorney's duty is to the law, to the court, and to his or her client. I agree. If an attorney uses his best efforts in the performance of those three duties, his or her legal ethical obligations will be well-served. These duties must be harnessed, however, to a dedication to the truth, for it is impossible to represent your client ethically under the law and before the court without embracing the truth. As it is with the accident investigator, honesty is the *sine qua non* of the professionally responsible attorney.

Any attorney who does not seek the facts—the truth of what really happened—in any aircraft accident does so at his or her peril, and puts his or her client in real jeopardy. Lawyers must zealously represent their clients, but that means doing their best to find out all that they can to help their client and presenting those facts in the light most favorable to their clients. One can only do that by developing *all* the facts, including the "bad" ones, because leaving it to an opponent to do so means that advice to a client will not be based on *all* the evidence and could leave the client defenseless before the judge and jury.

To the three duties mentioned above, I would add a fourth duty for the aviation attorney: to share what he has learned in any investigation to inform and educate those in the causal chain so that no accident ever again occurs for the reason(s) that caused this one. Aviation litigators operate in an area of the law permeated with public interest and public responsibility—what we discover could save a life. We cannot simply view this information as important solely to the litigants.

Common goals and challenges

The accident investigator and the aviation attorney share a common goal—to find out what really happened. If an attorney ignores the truth, his opponent, the judge, or the jury will confront him; if an accident investigator does so, his colleagues, his peers, and his fellow scientists will point out his errors. Neither the lawyer nor the investigator wants to be wrong—especially when so much is at stake.

Certainly lawyers come with biases, and their work is filled with pressures—including the client's expectations regarding results. Moreover, the adversarial system in which the attorney operates means that the attorney must "take a side." Similarly, I would argue that even the best accident investigators bring biases to an accident investigation—education and professional background, field of expertise, current work assignments, and life's experiences—through which lenses he or she, inextricably and unintentionally, views any set of facts. We are all human. The way to deal with these predispositions in either profession is to constantly re-

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rcraft Accident Chain, *IF...*

mind ourselves that in accident investigation, our professional and moral responsibility extends beyond the immediate to the universal—what you and I do in any one investigation may in the future decide the fate of others.

Helpful tools of the legal process

The litigator has a set of tools that are unavailable to the investigator. Discovery is the information-gathering process and includes many items, like *depositions*, in which sworn testimony is taken before a court reporter just as if one were testifying in court. Depositions may be taken from a party to the litigation, from eyewitnesses, or from other entities not a party to the litigation. The other valuable tools normally employed are interrogatories, questions to the other side, and requests for production, used to obtain any tangible information (documents, reports, electronic filings, pictures, videotapes, CDs, etc.). A party can file motions to compel if there is a discovery dispute, and the court will decide what should be produced. In addition, subject matter experts (pilots, engineers, mechanics, operators, economists, reconstructionists, ATC, etc.) are hired to help the attorney develop the technical issues in the case. This is in addition to the informal investigation performed outside of the litigation—assembling certification data, obtaining copies of the NTSB reports and local law enforcement reports, researching public records on the aircraft and on prior similar occurrences, reviewing industry periodicals, etc.

The collected information is later presented at trial, where it must first pass the scrutiny of the rules of evidence. Then, the verbal testimony undergoes the rigors of examination and cross-examination and the scrutiny of the judge and the jury. The entire process is designed so that only credible evidence is heard and seen by the jury.

Positive litigation discoveries: "the cause of the cause"

One of the benefits of litigation—perhaps the major benefit—is that it can reach areas that government investigators do not reach, due to time, resources, or the unavailability of the compulsory process. This certainly is not meant as criticism of these investigators—I am constantly impressed at the quality of their efforts despite investigating many accidents at the same time. Their dedication is remarkable, and we are all safer because of the results of their work. But the resources and time litigators bring to litigation can frequently go beyond the pure technical cause of the accident and uncover systemic or underlying causal factors, what I call "the cause of the cause." Two examples of this positive litigation discovery process follow.

Tragedy in the North Sea—The first example concerns the crash of a commercial transport helicopter off the coast of Scotland. A problem had developed in service with flexing of the joint in the forward transmission—it was loosening to the point that nuts were falling into the oil sump. A modification was developed consisting of drilling bigger holes, installing bigger bolts, doubling the torque—and replacing a scalloped shim with a nonscalloped shim. After the fielding of this modification, which was rushed through under the DER process, an operator, during normal maintenance, detected an unusual phenomenon in the "bowl" of a forward transmission spiral bevel ring gear. The gear was promptly sent to the manufacturer for inspection, but unfortunately the manufacturer's metallurgical lab was very busy, and the gear was not inspected until *after* the upcoming tragedy.

Within weeks after the damaged gear was sent to the manufacturer, a second modified forward transmission spiral bevel ring gear cracked and split, slowing the rotation of the forward transmission, causing the rear rotor blades to impact the forward blades, with fatal results for all but two on board. The highly capable and talented Air Accidents Investigation Branch (AAIB) of the Department of Transport of the United Kingdom quickly arrived at the conclusion that the crack had originated in the bowl of the gear at the point of the initiation of a process called crevice corrosion. The AAIB discovered that the crevice corrosion had been caused by the change from a scalloped shim to a nonscalloped shim in the gear sandwich of the forward transmission during the rushed modification. The scalloped shim had allowed oil in the forward transmission to flow through the joint and wash away the corrosive salt moisture from the "bowl" of the ring gear; the nonscalloped shim had prevented this washing, allowing the corrosion to develop. The results of the corrosive process found on the accident gear had been foretold by the pattern of corrosion on the pre-accident gear—they were the same.

The AAIB investigation got the cause right as one would assume, knowing the quality of that organization. But what about "the cause of the cause"? Some things were obvious—rushed modification to solve an immediate problem (loosening of the joint), failure of the metallurgical lab to investigate the pre-accident gear, etc. But during discovery, we learned two things that showed *the modification process* was flawed, which helped create the tragedy.

First, we found that earlier investigations by the manufacturer's engineers of similar fractures of the same gear in a prior version of this aircraft showed that an usual phenomenon had been detected in those gears 20 years earlier—in the same location that the crevice corrosion had been found on the two later gears. The similarities were striking—this earlier model also had a solid, unscalloped shim (the only other one we could find with a nonscalloped shim), and the aircraft in those early failures were also used in a humid environment. If there had been a process during the modification through which past configurations were researched, this accident could have been prevented.

Second, when we took the deposition of the FAA drive train ex-

Airline pilot/air safety consultant—1. Skepticism exists among aircraft accident i accident litigation attorneys. 2. Safety is harmed when companies think more abo problem. 3. Litigation can further the investigation (safety) process—if done prop

pert, he became very upset when we showed him the evidence of the past failures. His anger was caused by the fact that although the accident aircraft model had received its civilian certification through similarity, these earlier gear failures had not been given to the FAA as part of the process. Clearly, the FAA thought they should have been (the manufacturer thought otherwise). Had the certification process made clear that these past problems were to be disclosed, or if the manufacturer had given the certification disclosure requirement a broader interpretation, these historical shortcomings could have been brought to everyone's attention. Then, when modifications were made, the memory of past problems could have prevented the same mistake from being made again. We also offered our experts to the AAIB, which consulted with them at the Fatal Accident Inquest and at the review board. The AAIB certainly did not need the assistance of our technical experts, but in terms of professional collegiality and technical discourse, we think these exchanges helped to solidify theories and were generally constructive. The same offer was extended during the investigation of the British Midlands Kegworth B-737-400 accident.

A Night Repositioning Flight Turns Fatal—The investigation of this crash was handled by one of the NTSB's best investigators-in-charge—at least according to my experience—and he got it right. The twin-turbine helicopter's combiner gearbox failed—virtually melted the gear teeth—and the aircraft crashed short after take-off from a hospital, killing the pilot, the only person on board.

A newly overhauled transmission had just been installed and had been operated for 3.5 hours at the time of the failure. Leaving aside for the moment the allegations of operational error (he took off after a lengthy inspection in the field by a company mechanic who wrongly diagnosed the problem as a faulty warning light), the litigation revealed the following, none of which was shared by the overhauler with the NTSB: (a) the oil pump had been overhauled a year earlier and had failed its functional test, but inexplicably sat on the shelf without being retested; (b) the transmission failed several bench tests with the faulty oil pump installed, but the testing procedure was changed and the transmission marginally passed its last test and was sent to the operator for installation; (c) there were new, inexperienced personnel in the overhaul process both in supervisory roles and on the test bench; (d) the oil pump's overhaul records showed that the component that did not meet overhaul specification had been used in the last two oil pump overhauls, including the fatal overhaul; and (e) the person performing the oil pump overhauls was now on the bench after years of being a supervisor. The investigator-in-charge testified during his deposition that he had never seen the documentation on the failed test runs. Here, the litigation process revealed many problems, perhaps the greatest were the failure of the investigative process to mandate that the overhauler provide *all* pertinent information to the investigative authorities, and the fact that the overhauler had no effective oversight system to check the quality of its process or its product—and apparently not even to review overhaul paperwork. Other shortcomings included incomplete and ineffective troubleshooting procedures, transmission system lights instead of gauges, and an entry in the rotorcraft flight manual's emergency section, which indicated the ability of the transmission to operate for a while without oil pressure.

These are only two of many examples that could be cited where litigation not only confirmed the technical findings of the investigative authorities, but also uncovered the systemic, institutional, procedural, and human "causes of the cause."

Negative aspects of the litigation process

This is not to say that the litigation process is all positive—to which anyone involved in litigation will attest. Discovery is frequently long, which drives up the cost of litigation for all parties: larger legal fees, deposition costs, travel, and expert fees. It also takes

INTERVIEW NOTES

The following is a sampling of comments received from some of the people the author interviewed for this article.

FAA engineer—Protective orders adversely affect the flow of valuable information learned in litigation. The FAA should look at all litigated cases to see what needs to be changed in the certification process, maintenance, and operational aspects.

Engineer, pilot, and accident investigator—1. Investigators think aircraft accident lawyers care only about getting rich. 2. A case filed within 10 days after an accident does not indicate that the lawyer is interested in the results of the accident investigation. 3. The U.S. litigation system has done a great deal to keep entities "honest."

Airline pilot/air safety consultant—1. Skepticism exists among aircraft accident investigators about the motives of some accident litigation attorneys. 2. Safety is harmed when companies think more about the litigation than they do about fixing the problem. 3. Litigation can further the investigation (safety) process—if done properly, with objectivity being maintained.

Pilot and aviation information website creator—1. Criminal and civil investigations are disincentives to cooperate 2. The litigation community is doing little to advance aviation safety—besides making it expensive to ignore. But the litigation community is probably best positioned to create the reforms in industry and government that are needed.

Aviation attorney, plaintiff—1. I have never seen an amended

nvestigators about the motives of some ut the litigation than they do about fixing the erly, with objectivity being maintained.

valuable people away from their jobs, which itself can adversely affect safety.

An employee knows that an attorney's examinations could produce testimony that might endanger his or her position, which understandably could have a chilling effect on one's willingness to be forthcoming. Moreover, the rules of evidence, applied with varying results by judges, are sometimes inconsistent and too restrictive, keeping good information and documents out of the process.

There are other problems—

The way attorneys are paid—Defense attorneys are usually paid by the hour, so the longer the litigation drags out, the more the attorney makes. An honored and honorable defense attorney has stated during an address that he has never had an insurer tell him to drag out the litigation or has a client ask him to delay. I believe him, but there is no question that because of the hour fee method defense attorneys are not saddened if the litigation is lengthy. There are numerous examples that cannot be recited here in which the fees greatly exceeded the recovery of the plaintiff.

Generally the plaintiff's attorney prefers a quick settlement since he is usually fronting the costs of litigation, and he does not get paid until the litigation is successfully concluded (contingency fee). But how about the situation where the plaintiff's attorney has a full one-third contract and the cases settles promptly? That could present problems in collecting a full fee for very little work. Maybe if the litigation could go on for a bit longer….One way to handle this is through a sliding scale contract, starting with lower percentages and escalating to higher percentages, each reflecting the amount of work done.

Imperfections of the system—It is no surprise to anyone that there are no perfect lawyers, judges, or juries; and no witness, fact or expert, ever gets it perfectly right. I am sure we all can agree that the legislators who make our laws are also fallible—sometimes culpably so. It is not a perfect system, and no component of the system is perfect. But compare that to systems in other countries, many without juries of peers and where appointed judges—often with no legal background—make decisions. Also consider the countries where there is not even an effort to appear fair, and those where the government has an interest in not paying victims' families, or is unwilling to find its country's citizens or companies at fault. Our legal system works far better than most. Still, it needs improvement.

NTSB report based upon the information that was provided by litigants. 2. Rigorous interrogation in depositions, under oath with cross-examination, does weed out phony theories.

Aviation attorney, plaintiff—1. Civil litigants have greatly increased the knowledge of the cause of an aviation crash. 2. But litigation is a two-edged sword for discovering the facts: it does often advance the investigation beyond simply blaming the pilot, but the fear of litigation results in the erecting of stone walls at many levels. 3. The rules of evidence impede the search—litigation is a highly structured forum that does not allow innovative theories or necessarily lead to the most probable explanation and the fault of machinery or people.

Aviation attorney, defense—1. Litigation has a chilling effect on the investigative process. 2. All information gained in litigation that is safety related should go to the NTSB, the FAA, and any other appropriate authority. 3. The United States should go to a "no fault" process on mass-fatality accidents—damages only litigation for the plaintiffs—and then onto a process involving the airline, manufacturer, government, operator, etc., to determine fault among themselves.

Aviation attorney, defense—1. Very few cases get tried because all involved—victim, operator, attorneys—realize that aviation safety is the only acceptable goal. When a mistake is disclosed, something is done about it without concern of "litigation consequences." As a result, cases are settled quickly in the interests of the innocent victims of the mistake and the concern for aviation safety. ◆

How to "break the chain"?

The imperfect litigation system is not designed for accident prevention—but this should not mean that results of investigations conducted in this system cannot or should not be used to break the chain of aircraft accident causation. Aviation attorneys are privileged to be a part of a profession in which they are given the tools, resources, and time to conduct thorough and effective investigations. We would be callous and irresponsible to simply represent our clients and send the fruits of our investigations to the storage facility.

In this imperfect environment, here are my proposals on how litigation can be used to break the causal accident chain. These recommendations are directed to my fellow attorneys—and I mention them personally and speak about them to other attorneys every chance I get. I respectfully suggest that when you interact with an attorney, you mention these points as well:

1. Do your very best in the investigation. Give it your all. Use your best people. Use your experience, but handle the case with the enthusiasm and interest of your first days in the profession. Think outside the box. Remember that not only your clients, but also the flying public and the aviation community could benefit from your work.

2. Hire the best experts. Hire the people who are best qualified to uncover and analyze the facts. Get away from the shopworn "usual suspects." Find new experts—talk to universities with aeronau-

(continued on page 29)

Accidents & Astrophysics

If an accident investigation is to lead to anything useful, it needs to understand the profile and complexity of the hazard or hazards that were "in play" during the accident process.

By Rick Clarke (MO0891)

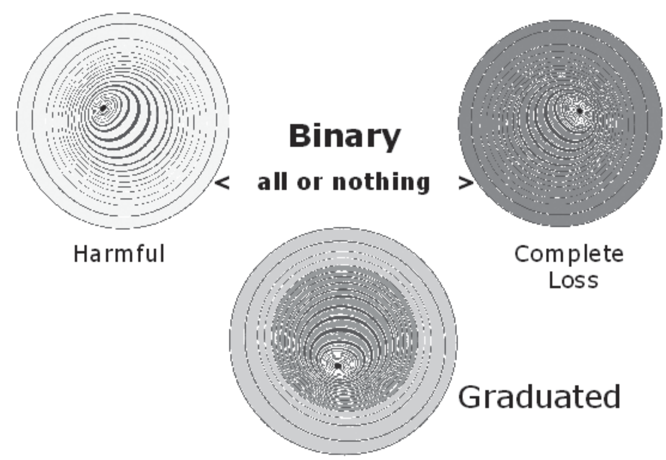

Figure 1: Hazard Characteristics

Accident investigation continues to become more complex. This is not because accidents fundamentally have changed in nature. The complexity stems from two sources: new investigation "tools of the trade" becoming available and more-sophisticated understandings of accidents coming into use. Today we can take advantage of the tools and techniques of system safety as we investigate. We also can take advantage of a bit of astrophysics theory when we seek to understand the accident process.

Over the years, we have developed accident investigation (AI) into a body of sophisticated technical analyses. Since approximately the 1980s, we have come also to include AI human factors insights that range from the technical to the psychological. To this mix, now we've started adding system safety methods and orientation.

System safety ideas benefit AI in many ways, starting with useful technical analytic methods, but the greatest benefit may be in opening up the field of AI to a broader and more complete understanding of accidents. This is not a "revolution," characterized by a radical shift in thinking or philosophy. Instead, it's been described as "the system safety evolution."

__Rick Clarke__, an ISASI member, is a former U.S. Navy aviator and squadron commanding officer. He worked as a safety consultant until 1990, when he began flying for the U.S. air carrier United Airlines. He also was director of the Air Line Pilots Association's (ALPA) Safety Management System Project, participating in SMS applications and training in the U.S. and Canada. He has flown domestic and international routes and is rated in the Boeing 737, 757, 767, and 777; the Convair 580; the Lockheed Constellation; and the Learjet. He holds a master of science degree in safety from the University of Southern California and is a former treasurer and executive vice-president of the System Safety Society.

System safety is a process

System safety brings us the understanding that accidents are not "events." The accident is not just the impact of the airplane with some hard object, nor is it the time when something breaks. The system safety view is that the accident is a "process" that has a starting point in time and place and proceeds through time to a conclusion.

Why is this important? Well, the importance lies in how useful we want our investigations to be. If the object of an investigation is merely to focus on the event, then that means the investigation is aimed only at preventing that particular event in that particular circumstance. This leads one to the question of "What good is this if the particular event continues to occur in other circumstances?" After awhile, and a lot of similar investigations, one begins to wonder, "Is there a root cause of these similar accidents?"

Here's where viewing the accident as a process begins to make sense. What started the process for all this set of similar accidents? From what root cause did they derive? When, where and why did the process begin? If we proceed with this orientation then we have a chance at effective safety efforts instead of Band-Aids.

Using the system safety view of safety and accidents, one needs to understand the basic terms that the discipline uses. System safety is based on only a few key concepts—

Safety—this is defined as "acceptable risk." To be politically correct, some people phrase this as "freedom from unacceptable risk," but it's the same thing. This definition is recognition that safety is not a perfect quality of "zero accidents." While the level of "acceptability" may be argued and adjusted, the concept recognizes the way the world actually works.

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Risk—this is a two-part concept. Risk is a combination assessment of severity and probability. In other words, "How bad can something be?" and "How often might that something happen?"

Hazard—this is the most basic building block of system safety. A hazard is an event, condition, or circumstance that can lead to a loss. Hazards are the "something" of which we assess the risk.

The reason we do AI is to understand the relevant hazard or hazards and find ways to "control" or "mitigate" the hazard(s). An accident board's "recommendations" really are the board's acknowledgement that the existing level of "acceptable risk" is not appropriate. The recommendations are the board's ideas on what sort of controls should be applied to the hazard(s) found via the investigation. The goal is, or should be, preventing recurrence and achieving an acceptable level of risk.

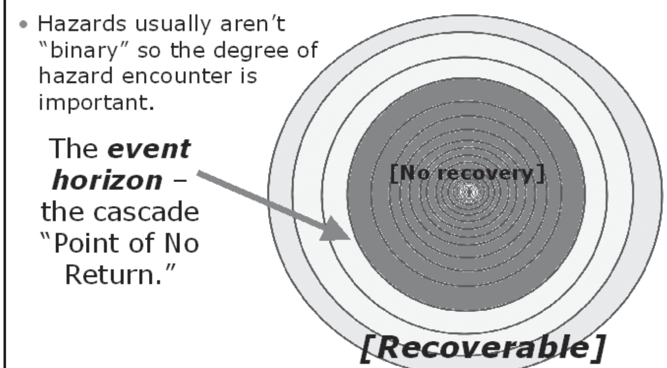
Understanding hazards and black holes

While there's a lot we could discuss regarding the concept of the root cause, our time is better spent gaining an effective, working idea of the qualities of hazards. That brings us to astrophysics.

Remember that a hazard may be an event, a condition, or a circumstance that can lead to a loss. Fine. We understand that…sort of. However let's dig deeper into the idea. Once upon a time, in AI, we figured that an accident had one "cause." If you eliminated the "cause," then you eliminated the accident. Gradually, we grew out of this law enforcement orientation to the understanding that there were multiple "causes" in combination that lead to an accident. There are all sorts of variations on this idea, but the most common one is the Swiss cheese model of accidents.

In the same way that AI has grown beyond the idea of the single-cause concept, we need to understand that hazards are not just one thing. A common view of a hazard is what I would call "binary." The hazard exists or does not exist. If it exists, then its result is catastrophic. If it does not exist, then nothing occurs. It is like the common view of those black holes out in the universe (see Figure 1). If you are clear of the black hole, no problem. If you encounter it, you are a goner. That leads to the idea that your only safety action is simply to eliminate the hazard. Our real-world knowledge and experience runs against that. It is not very likely that we are going to eliminate thunderstorms, among other things. That then leads us to the idea that where "elimination" of the hazard is not possible, we need to apply controls.

Figure 2: Manage Risk—Manage the Hazard



Let's take the view of hazards and black holes one more step up in sophistication, though. On a practical level, we know that all hazards are not equal. Not all hazards result in catastrophe, hull loss, etc. Some are merely "harmful" instead of "fatal." Some result in damage or a trip to the laundry, rather than the loss of a plane and crew. So, our practical experience tells us that we need to learn what the difference is when we have a "near miss" instead of a loss. If an accident investigation is to lead to anything useful, it needs to understand the profile and complexity of the hazard or hazards that were "in play" during the accident process.

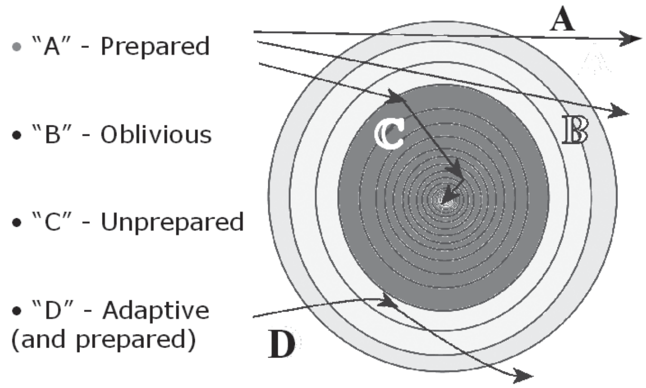
To follow that idea, we need to realize that hazards are not binary…they are graduated. If a hazard exists, then we'd like to

- eliminate it, or lacking the possibility of elimination,
- learn how to avoid it, or
- learn how to recover from an encounter with the hazard.

In recent years, astrophysicists coined a very useful term that AI can benefit from learning, the "event horizon" (see Figure 2). A simple explanation of this concept is that when light, spaceships, or whatever form of matter or energy you want to think of encounters a black hole, there is a point in proceeding into the hole where recovery and exit is possible. Beyond that point, recovery and exit is not possible. It's like entering a funnel that has an increasing slope. At some point, the slope becomes steep enough that no amount of effort will prevent "going down the tube." That point is the event horizon.

What does that have to do with accidents? Well, quite a lot. We know from practical experience that some accidents could have been much worse had not certain things worked in favor of the plane and

Figure 3: Possible Hazard Encounter Responses



crew. Conversely, we have seen many cases where, past a certain point, the accident process could not be recovered from a fatal conclusion. The comparison with black holes and the event horizon becomes clear. In common terms, the event horizon is the "point of no return."

Risk management

Flying planes is an exercise in risk management. We fly through a field of hazards on every flight. Once upon a time, powerplant failure was a real possibility, but the advent of the jet engine nearly has eliminated that hazard. However, many other known hazards remain, and there probably still are unknown hazards out there waiting to be encountered. When we investigate accidents and make recommendations, we need to think in terms of what the recommended "controls" can achieve and which are more effective than others, in view of the risk that goes with the hazard.

As we investigate, it's worth considering the possibilities. The best thing, obviously, is to eliminate the hazard; but, lacking that possibility, to avoid it, and lacking that to make a hazard encounter survivable. To avoid it implies having the means to detect the hazard and take avoidance action in advance. However, in the case of an unexpected hazard encounter, the idea is to provide various "practices, procedures, and/or equipment" that permit the plane and crew to encounter and recover before passing the event horizon. Consider Figure 3 above.

In case "A," you can see that this hazard is encountered but that the encounter never passes the event horizon or even a significant level of severity, so the outcome of the encounter is mild. Weather encounters in flight can easily fit into this classification. It's not unusual to encounter some sort of inclement weather, but equipment, training, and pure chance keep the encounters from being serious.

In case "B," you can see that the encounter is more serious. While the flight may not pass the event horizon, it has passed deep

Sometimes investigators get so far into the accident "forest" that they only see the trees. Accident investigation needs to be about the "forest." Accident investigation is all about "hazards" and the hazard controls that "could have," "should have," and "might be" put in place.

into the hazard encounter. Here, one could expect a good chance for damage or injury, and maybe that trip to the laundry we mentioned earlier. For this level of encounter to occur, the parties involved could be oblivious to

- the existence of the hazard,
- the severity of the hazard.

While the state of being "oblivious" may be the case in civil aviation, this profile would typify many military flight operations. In those "ops," the hazard is known and the point is to intentionally encounter it and survive.

In case "C," the hazard encounter proceeds to its ultimate conclusion. The flight encounters the hazard and proceeds right past the event horizon beyond the possibility of recovery. There are many "controls" for hazards in aviation, and I submit that you could consider this sort of encounter as a matter of being unprepared for the encounter, either through surprise or inadequate preparations such as appropriate equipment, training, policies, and SOPs.

Case "D" might illustrate a hazard encounter that shows every chance in the world of being severe or fatal yet ends without loss. While "luck" might account for this, hazard controls applied at the right time might also explain this. For example, the weather environment can change rapidly. Considering this, it is possible for an aircraft to get together with a microburst without intending that to happen. Improved aircraft performance and crew training make it possible to avert loss where less performance and less training could prove ineffective in avoiding the "worst case" hazard encounter process going to conclusion.

There are other ways to think about the reasons that hazard encounters occur, but these thoughts should provide some useful ways to consider hazards. They also provide some thoughts on how we proceed when we investigate accidents.

Now, let's look at some further insights that investigators can use when trying to understand what went on in the accident process. If you are investigating an accident process, at some point "organizational issues" will come up. Here you look at how a flight, a particular type of flight, a maintenance operation, etc., was planned. This is more important than most people realize, because very few people or organizations plan for fail-

Figure 4: Hazard Controls and the Limits of Control

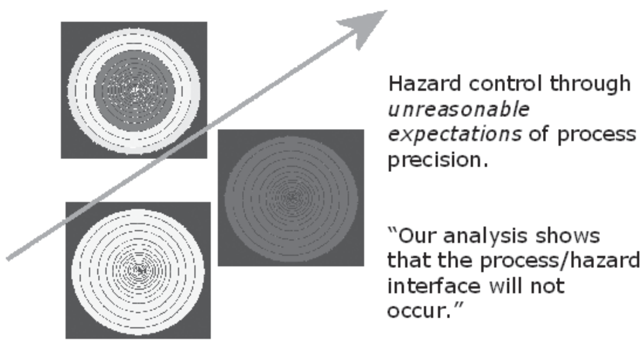


Figure 5: Hazard Controls and the Limits of Control

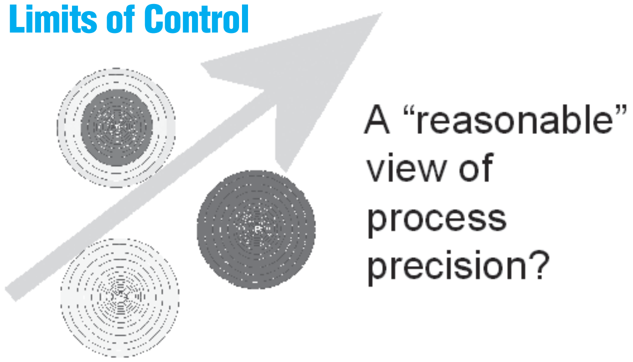
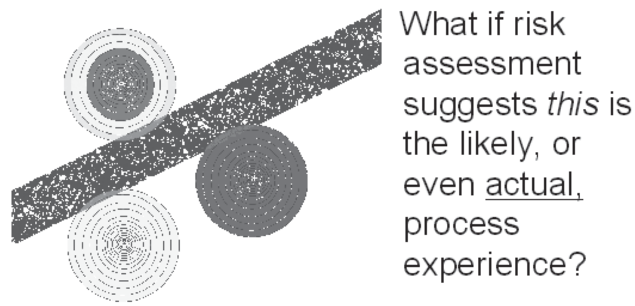


Figure 6: Hazard Controls and the Limits of Control



ure. You get to ask, "What went wrong?" in the organization.

Considering hazards as we have, we know that flights or any other process move through a "field" of hazards that have not been eliminated. Some hazards could be binary, some could be graduated, and some even could be unknown (see Firure 4). The problem with planning an aviation process is the perceptions that influence it. Here you look for signs that the planning took place with an accurate perception of the potential hazard field. Consider the example, above, where planners foresaw that their plan would avoid the hazards that they knew about. You can see that the avoidance "path" is narrow and depends on fairly precise adherence to the plan.

We all know from practical experience that such precision is difficult to achieve. Repetitive transit of the hazard field makes such precision more difficult to sustain. Now look at the illustration, above. Here (Figure 5), we have the same hazard field, but, perhaps, a more accurate illustration of the precision with which the operation is carried out (Figure 6). Note that the operation's process actually brushes up against two of the hazards, with an actual benign encounter with the graduated hazard. This would easily represent real-world circumstances not matching the intentions or perceptions of the planners, be it at the organization or operator level.

Lastly, let's look at where the "disconnect" between planning and execution can lead. While Figure 5 shows minor or near-hazard encounters for the process, the illustration, left, shows a more extreme situation. Here, either the hazards are far more serious than planners knew, or the real-world precision of the process is such that it guarantees hazard encounter.

The organizational issue of planning and hazard control is important for investigators, and it is important for the planners. This is especially true if a "new" process is to be started. If planners do not do a thorough job of hazard identification, hazard analysis, and hazard control, then the process outcome becomes uncertain. In aviation, we have lots and lots of experience and nearly as much information regarding successful and unsuccessful operations. So, in the end, the questions relate to whether the information is available and whether it's acted upon.

New investigation tools are useful, but even more useful are the concepts we have in mind when we use them. In this article we have considered several concepts that may be new to many investigators, and even to aviation operators. Viewing the accident as a process should be a fairly natural concept to investigators. It is a concept that opens investigations to additional and useful directions of inquiry. Likewise, understanding the nature of hazards and how they relate to the accident process can lead investigators "upstream" toward organizational issues. Here, the quest becomes one of determining What are the hazards? What is their nature? What was the understanding of them? and How were they to be controlled?

Sometimes investigators get so far into the accident "forest" that they only see the trees. Accident investigation needs to be about the "forest." Accident investigation is all about "hazards" and the hazard controls that "could have," "should have," and "might be" put in place. ◆

Accident and Incident Investigation in Argentina

The author discusses a non-fatal airliner accident investigation that occurred in Argentina, starting with a technician maintenance error, involving a lack of warning inscriptions in parts and documentation, ineffective exchange of information between different levels in the maintenance organization, and resulting in a worldwide alert issued by the airplane manufacturer.

By Eng. Horacio A. Larrosa (MO4131), Chief of Technical Investigation and Support Department, Junta de Investigaciones de Accidentes de Aviación Civil, Argentina

(This article was adapted, with permission, from the author's presentation entitled Accident and Incident Investigation in Argentina—One View About a Maintenance-Related Case, *presented at the ISASI 2006 seminar held in Cancun, Mexico, Sept. 14-17, 2006, which carried the theme "Incidents to Accidents: Breaking the Chain." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

On Feb. 20, 2004, at 16:15 UTC, the aircraft pilot-in-command of a scheduled flight, on a McDonnell Douglas aircraft, MD-81, registration mark LV-WPY, Serial Number 48024, took off from Jorge Newbery Airport (AER) heading for Iguazú International Airport.

During the takeoff run, when rotating, the internal wheel of the left main landing gear became detached from the axle and went straight onto the runway. First, the wheel hit the localizer antenna (LLZ) of the AER instrument landing system (ILS), then it went through the airport perimeter fence, crossed a public avenue, and continued running until it stopped in the vicinity of some facilities located outside the airport. The flight crew did not notice what was happening and was informed by the personnel of Air Traffic Services. The pilot-in-command interrupted the ascent and asked for a sector in order to hold and consume fuel so that weight could be reduced and the maximum landing weight reached.

When the aircraft touched the runway, everything was under normal conditions until the other wheel of the left main landing gear, after a short run, also detached itself from the axle. The aircraft continued its landing run, putting all its weight on the wheels of the right main landing gear, the nose, and brake assembly components of both wheels of the left main landing gear; finally it stopped 1,690 meters from the runway threshold (see Photo 1).

Left wing and fuselage damage was produced by the metallic parts thrown out of the brake assemblies during the landing run. The left engine (No. 1) showed signs of severe ingestion (see Photo 2).

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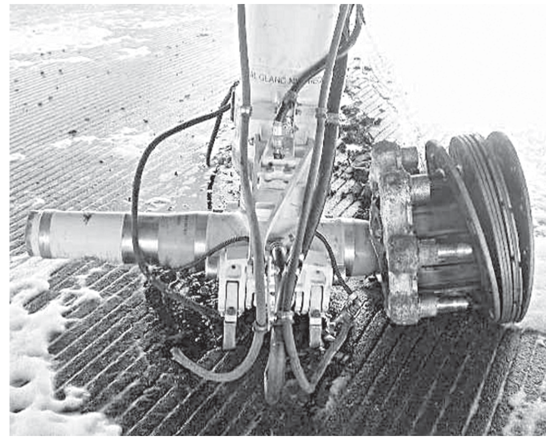


Photo 1. Damaged left main landing gear.

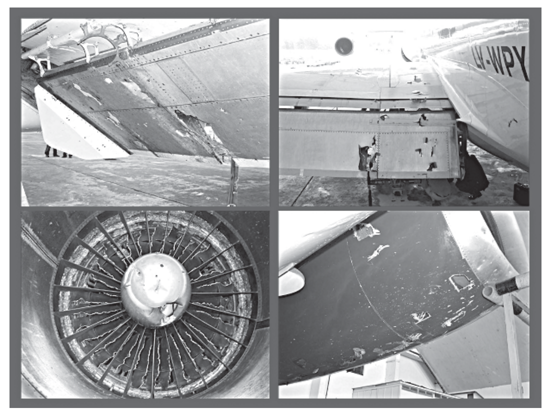


Photo 2. Aircraft damage in left flaps and engine.

Investigations and trials

For the purposes of the technical investigation, the following material corresponding to the left main landing gear was sent to the Material Science and Technique Department of the Armed Forces Scientific and Technical Research Institute (CITEFA): the piston (P/No. SR09320081-9, S/No. CPT0181), the wheels, the brake assemblies, and the axles protecting jackets (or sleeves).

The piston looks like an inverted "T," and is the element that withstands weight and dynamic forces during takeoffs and landings. At the ends of the piston axle, the brake assemblies and wheels are installed. The wheels are inserted and placed not directly on the piston ends but on the jackets that are put to them in order to avoid wear and damage during the change of wheels or under normal operation (see Photo 3).

Both detached wheels presented similar characteristics: Inside the protective cap, fastening and anti-rotating elements were found, almost with no damage and with the corresponding safety wire intact. From what was observed, it was deduced that the axle nut (gray color) that fitted the wheel to the axle had slipped from its housing without rotating and without suffering damage, which would indicate great contact strain between the threads (see Photo 4).

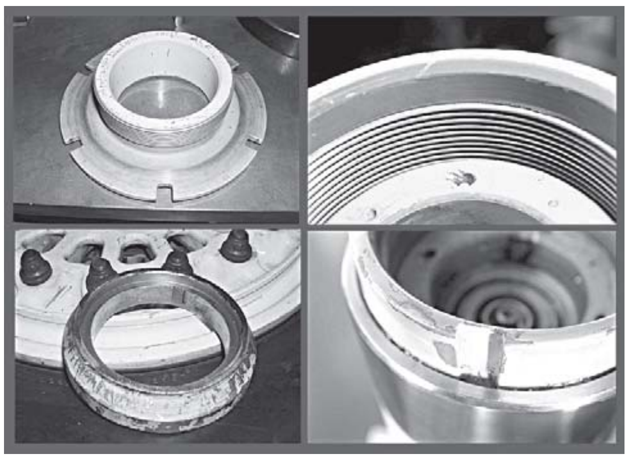


Photo 5. Detail of axle, spacer, and adapter (internal side), above. Photo 6. Detail of axle thread, nut, and anti-rotating devices (no damage), left.

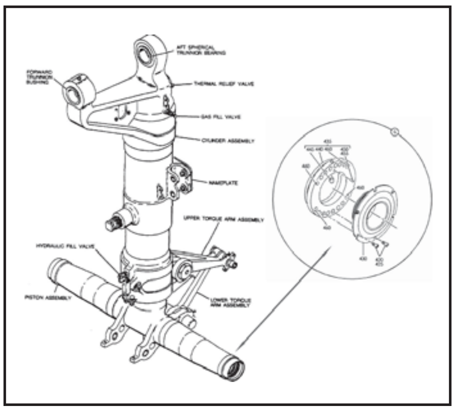


Photo 3. Piston assembly and wheel attachment system.

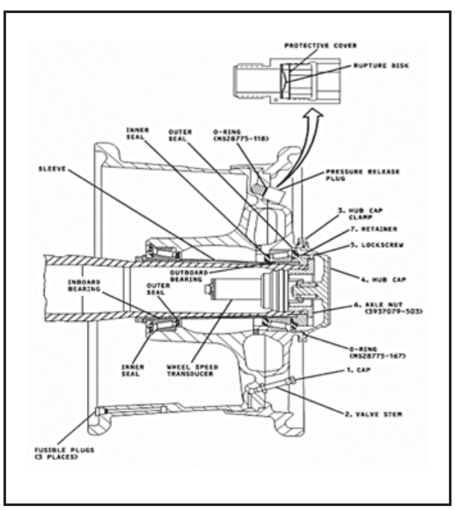


Photo 4. Detailed drawing of wheel attachment assembly.

Material trials at CITEFA laboratory

Three main verifications were carried out: metrology, thermal expansion, and torque.

Metrology and dimensions control—The dimensions of the following elements were verified, and the following results were obtained:

a) Axles ends inner threads: The values correspond to the item indicated in the components maintenance manual (CMM) as "2nd Reworked."

b) External threads of the retaining nuts: The values correspond to the item indicated in the CMM as "Original" (or standard).

c) External threads of the retaining adaptors of the wheel speed transducer ("Adapters"): Internal position (yellow color) and external position (gray color).

According to the CMM, the yellow adaptor corresponds to the dimensions of the "2nd Reworked" and the gray adaptor to "Standard" values.

Torque test—The manual establishes that when mounting the wheel, a pre-torque of 200 foot-pounds should be applied, then it will loosen and the definite of 90 foot-pounds will be provided. A complete wheel was mounted over the damaged piston, and the torque tests were carried out with both damaged retaining nuts and one that had not been used for comparison purposes. In all cases, the reference torque values were reached.

This test showed that although the threads clearance is noticeable when threading the nut, it is not possible to determine that the nut is not the one established by the manual through torque. When checking the nuts after the trial, it was found that they were in perfect condition.

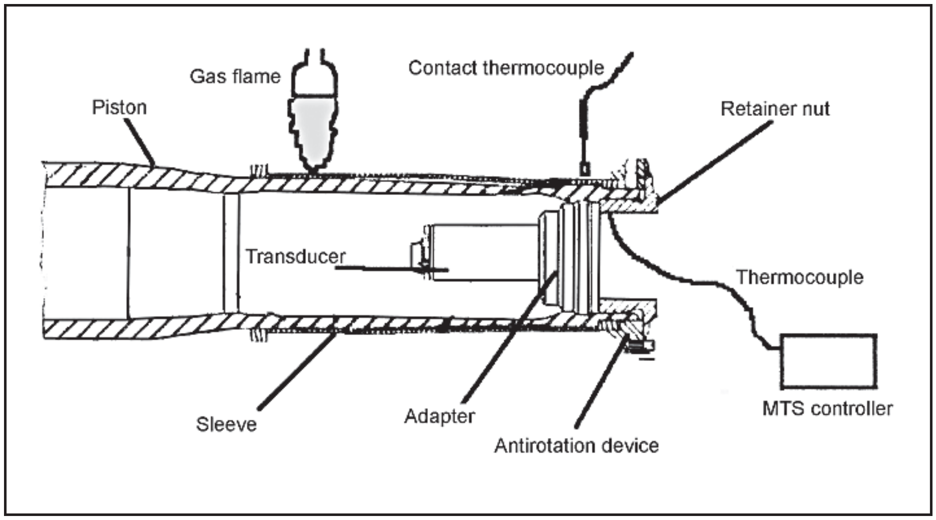
***Thermal trials*—**In order to explain the way in which the retaining nuts were expelled with no deformation or rotation, a test that consisted of inserting the nut into the piston, with a difference of temperature between both pieces that produced a differential expansion, was carried out.

When the retaining nut is matched up with the piston, the transmission of the piston heat to the nut is carried out through all the contact surfaces of the threads. When the nut used is smaller, the heat flow is restricted since the contact surface between threads is reduced. Nevertheless, it was not possible to determine the exact conditions of the heat flow during the accident; however, in order to quantify the phenomenon characteristics, a test that consisted of inserting the nut into the piston end maintaining a difference of temperature between the pieces was carried out. With this purpose, the axle was heated, and it was confirmed that the nut could be placed by being hit slightly with the hand (without rotation) if there was a difference of temperature of about 55° C and higher.

In order to better simulate the operating conditions and be able to assess the thermal effects that could be generated as a result of using the brakes, another trial was undertaken and consisted of heating the axle with the standard axle nut installed with its anti-rotation elements to verify if these pieces had a noticeable differential heating by conduction (see Photo 7).

The temperatures were measured through a thermocouple system for both elements.

At the beginning of the trial, the temperature of both parts was 23° C. After about 80 minutes (there was no equipment available for a quicker heating), the axle temperature reading reached 113.6° C, while the nut record was 83° C (difference: 30.6° C). All the intermediate values were also registered, and the curve "Nut Temperature vs. Axle Temperature" was traced.



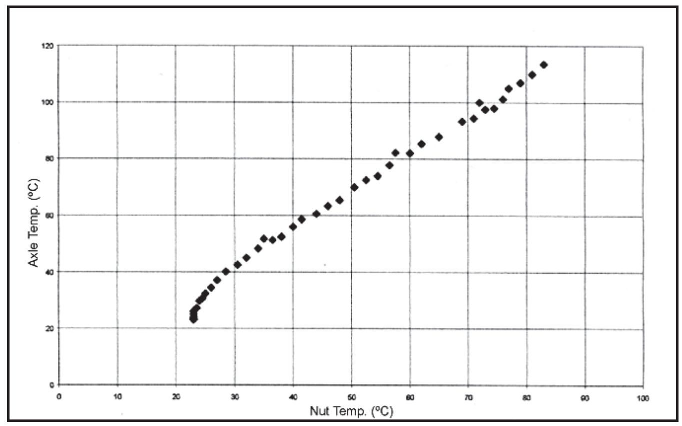


Photo 7. Thermal test: thermocouple system in axle assembly, above. Photo 8. Thermal test: curve "Nut Temp. vs. Axle Temp," right.

If the temperatures increase was even, the graphics should have one pending value, but in this case the value is higher. It was also observed that, at the beginning, when the heating stationary regime had not been entered, the slope was even higher. This supports the hypothesis about the amplification of the quicker heating phenomenon. According to what was verified in the trial, it could be believed that when the axle heats quickly because of the braking effect, the difference of temperature to be reached between the axle and the nut could approach 55 ºC (see Photo 8).

Findings summary

From the way the parts were found and the measurements carried out, it is deduced that the key part is the wheel retaining nut ("axle nut").

After eye observation and inspection with stereoscopic glass, it was revealed that the threads were almost intact. Likewise, it was proved that the clearance with which the nut threaded with the piston was too great—although, the nominal torque values were reached during the tests.

Because of their dimensions, it was confirmed that the nuts were original (standard), while the piston had threads corresponding to a second reworking, which should have matched up retaining nuts of second oversize according to the manual.

All the same, at room temperature, it was impossible to extract them without rotation movements. It was confirmed that the nuts could not have rotated since they were connected to the anti-rotation rings; these were also checked, and they were in perfect conditions as well as the piston insertion slot.

The aircraft manufacturer's information indicates that, under normal operating conditions, temperatures of about 150° C are reached, at approximately 28 cm from the axle end. Such temperatures could be deemed enough to consider the differential expansion as a mechanism highly contributing to expelling the nuts (not matched up), added to the important lateral loads that the landing gear withstands during the taxiing procedures, especially when turning the aircraft.

Background and chronology

After having detected that standard nuts had been used for fastening the wheel, instead of the appropriate oversized nuts specially matched up for the reworked piston, the traceability of the assembly from its manufacture process was followed and studied mainly using the following documentation: FAA Form 8130-3, packing list, supplier invoice, and planning of workshop process ("Shop Traveler").

During the assembling process on another aircraft, the piston Serial Number CPT0181 was damaged in the chrome plating, thus it was removed to be sent to repair at external workshops.

Once removed from the aircraft, it was placed back on its transportation case, in order to be sent to the dispatch sector (parts control). The mechanic executing this task did not put the yellow nuts back in their place, which had been removed and placed on one side before assembling the piston on the aircraft. The inspector intervening on that occasion also failed to detect the omission.

It is worth mentioning that these nuts were painted yellow and serialized with the piston serial number; since both the piston axle and the nuts were reworked at the place of origin they were matched up and were not interchangeable. The operator dispatch sector received the piston with the origin documentation attached, but the latter did not include documentary data indicating the existence of the nuts.

The landing gear installation on the LV-WPY, carried out at the operator's major maintenance hangar, was performed in 2 days. Tasks began on February 16, and the installation was completed—including brakes, wheels, and the subsequent final functional test—on Feb. 17, 2004. The aircraft resumed commercial service on Feb. 18, 2004. The accident took place during the aircraft's third operation cycle, after the installation of the wheels.

From the interviews of the technical area staff at all levels, a general task satisfaction, work appreciation, and commitment, as well as enough experience, were observed. Nevertheless, when consulted if they were aware of the existence of reworked components in the fleet, mechanics from all levels said they did not know about it. It is worth clarifying that the company only has two reworked main landing gear pistons.

Repetitive case

The operator contacted the civil aviation accident investigation board (JIAAC) during the ongoing investigation to request JIAAC technical personnel to be present to verify the conditions under which another overhauled piston from the same provider was received in the warehouse. The piston came with two axle nuts for the wheels and two adaptors for the tachogenerator fastening. All these parts were vibro engraved with the piston serial number, marked as oversize ("O/S") and were painted yellow.

A mistake was verified in the part identification; moreover, task No. 100.0 from the "Shop Traveler" indicated the painting of quarter-of-an-inch black letters on a 1-inch yellow band: "1ST RWK OVERSIZE THREADS" was not carried out. As it was considered that the lack of a clear identification on the part regarding the existence of oversize threads, which warns about the need to use "matched up" nuts, was one of the accident contributing factors, the JIAAC decided to inform the manufacturing country about this situation through a "Safety Alert."

Throughout the investigation carried out by the civil aviation accident investigation board (JIAAC), close contact was maintained with the Airworthiness National Administration (DNA), the U.S. National Transportation Safety Board (NTSB), the manufacturer, and the operator.

Many consultations were carried out seeking similar background information by obtaining data from the manufacturer about various cases of wheels losses in which their axle nuts rotated and gradually became loose until free or in which the anti-rotation cramp was missing. Only one case was recorded—a DC-9 with a reworked axle and an unsuitable nut, which caused a wheel to be lost, leaving the nut with significant damage to the thread.

The manufacturer asserts that a theoretical simulation of the nut expulsion process would not be completely truthful, due to the great number of variables to be considered and which are unknown for this case. As a precautionary measure, the manufacturer included the case of LV-WPY (without its identification) in its website in order to inform all operators of similar aircraft.

The JIAAC issued a Safety Alert to the NTSB Office of International Affairs, with a copy to the DNA, stating the mistakes found in the documentation and in the markings of the piston involved in the accident. These outcomes could also be present in other elements processed by the same company in other parts of the world. Immediately, the NTSB distributed the document to the Federal Aviation Administration (FAA) and to the aircraft manufacturer so that proper measures could be taken.

Operative and technical analysis

Flight recorders were in service and data were obtained. According to the interpretation, landing was carried out in the right way for the present circumstance. Passengers were duly informed about the situation by the pilot-in-command, and, even though some of them were nervous, the situation was controlled by the cabin crew in a correct manner.

The factor triggering the accident was identified as the fact that the wheels axle nuts were original (standard) while the piston had second reworked threads, which should go with matched-up second oversized axle nuts.

The reason to use reworked elements is basically technical-economical, since they are parts that have suffered wear and tear in their threads and thus they fall outside standard tolerance; that is why they are reworked. This procedure is approved by the manufacturer in its CMM and in the case of the pistons is allowed up to a third rework.

The installation error of these standard nuts was mainly due to the following factors:

- Separation of the piston and its matched-

Photo 9. Axle tip vibro engraved inscription, covered by painting (view after painting removal).

up and serialized fastening elements during its removal 8 months before the accident. This action could be understood because the staff was not aware of the existence of reworked elements.

- Inadequate communication was discovered here regarding the information available for lower-level personnel and the lack of consultation of the latter to their supervisors about the existence of an unusual element in the task (a yellow nut).
- During the installation of the wheel with standard nuts on the reworked piston, the personnel did not count on any marks warning about this situation, thus duly carrying out the task and with the usual elements. The markings mentioned—the vibro engraving on the axles tips—were covered by painting, and the yellow band with the relevant inscription was not present (see Photo 9).

The maintenance manual did not warn against this situation. Even though the nut clearance was evident when installing it manually, the threaded joint absorbed the established torque without any problems.

Cause

During the takeoff phase of a scheduled air transport flight, the inner wheel came off the left main landing gear, which caused an emergency landing, during which the external wheel of the same landing gear came off, due to the installation of standard fastening elements for the wheel on a reworked assembly.

Contributing factors

- Lack of warning inscriptions of it being a non-standard element on the landing gear leg by the repair workshop that had carried out the piston overhaul.
- Lack of warning about the existence of reworked elements in the aircraft maintenance manual.
- Ignorance of the operator's mechanics about the installation of reworked parts.

Safety recommendations

To the operator—Consider establishing procedures aimed at improving communication among mechanics, supervisors, inspectors, and higher levels, such as the implementation of working groups in classrooms, the utilization of suitable techniques that enable the strengthening and improving of interpersonal relationships, and the development of maintenance resource management (MRM) programs.

Consider, in order to improve safety levels in the maintenance activity, including the facts leading to the present accident into the technical training program developed by the company to avoid a similar condition in the future.

Consider improving established procedures for receiving parts not listed in the landing gears documentation, regarding all not interchangeable, not storable, serialized/matched-up parts, that form an indivisible part with their corresponding component.

Consider improving communications and information flow between technical managements and the logistics chain common in the business group, when there are supply policies changes, such as the admission of reworked elements into the fleet.

To the National Transportation Safety Board (NTSB, USA)—Consider submitting a recommendation to the FAA so that in Form FAA 8130-3, in the "Remarks" box, indication is given when necessary of the condition of the element as reworked and/or having matched-up or easily removed parts.

Consider submitting a recommendation to the aircraft manufacturer with the following:

- Include in the MD model aircraft maintenance manual (AMM), in the chapter corresponding to wheels installation, a clear warning about the utilization of special elements necessary to mount assemblies with oversized elements. These inscriptions are present in other AMMs. (Accomplished by the manufacturer Feb. 25, 2005: A warning will be added in the upcoming revisions of the AMM affected airplanes).
- A possible change in the design of matched-up parts, such as a variation in the threads pitch of oversized elements, that do not allow the interchangeability with standard ones.
- Consider submitting a recommendation to the landing gear repair workshop with the following: Carry out the corresponding warning markings in a perfectly visible way on the reworked parts. ◆

ISASI 2007 Registration Opens

Chan Wing Keong, AAIB Singapore's seminar chairman of the Society's 38th annual international seminar, ISASI 2007, announces that registration for the event to be held in Singapore from August 27 to August 30 is now open.

The seminar program registration fee (in US dollars) by July 31 is as follows: member $480; student member $200; non-member $525. If registration is made after July 31, the fees are $525, $225 and $570, respectively. Day pass fee for any of the three days is $190 by July 31 and $230 after that date. The member fee for either of the two tutorials set for August 27 is $100 by July 31 and $120 after that date; student member $70 and $90; and non-member $100 and $120. Companion fee is $295 by July 31 and $330 after that date. The fee for the day-long post-seminar function event conducted on August 31 is $100.

ISASI 2007 is being hosted by the Air Accident Investigation Bureau of Singapore (AAIB Singapore) and carries the theme "International Cooperation: From Investigation Site to ICAO." The AAIB has established a detailed and easy-to-manage website at www.isasi07.org. All areas of interest are easily accessed on the site. An interactive seminar registration form may be found on the website. A user need only fill in the blanks and when finished hit the send button for the form to be instantly e-mailed to the AAIB seminar registration office. A copy of the seminar registration form is reprinted on page 24. It may be completed, clipped out, and mailed to ISASI Seminar Registration, P.O. Box 16032, Albuquerque, NM, USA.

The seminar will be held at Swissôtel The Stamford, Singapore. The AAIB Singapore has secured deluxe rooms in the hotel for ISASI delegates and their companions at a nominal room rate of Singapore dollars $230, subject to taxes.

Swissôtel The Stamford is located right in the city center. It is southeast Asia's tallest hotel. It offers a breathtaking view of the Singapore city and even parts of Malaysia and Indonesia. The hotel is located on top of the City Hall Station of the mass rapid transit (MRT) network. This station is linked to the station at the Changi International Airport via the East-West Line of the MRT.

Delegates should liaise with Swissôtel The Stamford directly regarding their accommodations. The hotel registration form will be available on the ISASI 2007 seminar website (www.isasi07.org).

Program plan

The seminar program will follow the established format of past seminars, with 1 day devoted to tutorial workshops and 3 days of technical paper presentations. The technical program will address current safety and investigation issues, including recent air safety occurrences and investigations, with particular emphasis on international cooperation efforts demonstrated during the various investigative endeavors.

The tutorial program will be conducted at the Singapore Aviation Academy (SAA). Tutorial participants will receive a guided tour of the SAA to view its excellent training facilities, which have won many accolades, including the Flight International Aerospace Industry Award in 1996 for training and the prestigious Edward Warner Award by the ICAO Council in 2000.

There are two tutorial topics for participants to choose from: Aftermath of a Sea Crash and ICAO Annex 13 Investigation in a Litigious Environment. These topics have added relevance in view of some recent accidents. Discussion during the Aftermath of a Sea Crash tutorial will not be limited to only salvaging of aircraft wreckage from the sea, but will also aim to cover the whole range of planning and logistics involved in the salvage operation, including

- mobilization of resources to respond to the accident,
- notification to other states,
- coordination with other states (including mobilization of resources in other states or from the private sector),
- mobilization response times,
- sea salvage operation (difficulties, delays, coordination with rescue activities, factors to be considered for termination of operation, etc.),
- post-operation follow-up,
- difficult issues encountered in the entire operation, and
- lessons learned and improvements.

The tutorial on ICAO Annex 13 Investigation in a Litigious Environment is planned to address the following issues:

- drafting of investigation report, including the cause statement,
- disclosure of information gathered in the course of an investigation,
- role of safety recommendations (e.g., they should in no case create a presumption of liability),
- how should the investigators prepare themselves when they are required to give evidence in court,
- how should the investigators handle cross-examinations in court, and
- use or misuse of investigation report—admissibility in evidence of investigation report.

Social programs

The ISASI 2007 welcome reception on Monday evening will offer a panoramic night view of the Singapore city from the top of Swissôtel The Stamford. On Tuesday evening, all the delegates and their companions will have a chance to visit the unique Night Safari at the Singapore Zoo. Dinner will be served before guests venture into the tropical jungle.

While the delegates are attending the seminar's technical program on Tuesday and Wednesday, their companions will be viewing Singapore attractions featuring multicultural and harmonious blends of arts, cuisine, and architecture. The post-seminar optional tour on Friday, August 31, will be of the National Orchid Garden,

(continued on page 25)

38TH ANNUAL

International Society of Air Safety Investigators Seminar

August 27–30, 2007, Swissôtel The Stamford, Singapore

Delegate Registration Form and Fee Summary (US$)

Yes, please register me for the 38th annual International Society of Air Safety Investigators seminar!

You can register by e-mailing, mailing, or faxing this completed form to ISASI. Please complete one form for the primary individual attending. Exhibitors and companions have a separate registration form. **Note:** Please print all information on this form. This form may be reproduced as necessary. Cancellations made before June 27, 2007, will incur a US$10 fee. Cancellations made between June 27, 2007, and July 27, 2007, will incur a US$75 fee. There will be no refund of fees if cancelled after July 27, 2007. However, substitutions are permitted at any time. Make sure to include the fees for any optional programs to the total amount being paid.

Please Complete All Areas as Appropriate Is this your first seminar? ○ Yes ○ No

ISASI Member? ○ Yes ○ No If yes, please complete the member information below:

Member Number:____________ Society, Chapter, or Region: ____________

○ Mr. ○ Mrs. ○ Ms. ○ Dr. ○ Other (If "other," please specify): ____________

First Name:____________ Middle Initial:______ Last Name: ____________

Company or Organization:____________ Position, Title, or Job: ____________

Address (Line 1): ____________

Address (Line 2): ____________

City:____________ State or Province:____________ Country: ____________

ZIP or Postal Code:____________ Telephone Number:____________ Fax Number: ____________

E-mail Address:____________

Note: To accomodate special dietary needs, the seminar hotel will not be serving meals with pork or lard.

Name and Company as you want it on the Badge:

Registration Type	Before July 31	After July 31
○ ISASI Member	US$480	US$525
○ ISASI Student Member	US$200	US$225
○ Not an ISASI Member	US$525	US$570

The above registration includes the Reception (Monday), Fun Night (Tuesday), and Banquet (Thursday). Please check below if attending

☐ Reception ☐ Fun Night ☐ Banquet

○ Day Pass Only (per day)	US$190	US$230

Check Days: ☐ Tuesday ☐ Wednesday ☐ Thursday

☐ Banquet Only (US$100) ☐ Tuesday Fun Night (US$100)

☐ Monday Welcome Reception (US$90)

Optional Programs	Before July 31	After July 31
☐ Tutorial (Monday, August 26)	US$100	US$120
☐ Tutorial (Student)	US$ 70	US$ 90

Please Select One Tutorial: ☐ Tutorial #1: Aftermath of a Sea Crash
☐ Tutorial #2: ICAO Annex 13 Investigation in a Litigious Environment

☐ Friday Tour (per person)	US$100	# of persons ______
☐ Companion Program (per person)	US$295	US$300

Note: Please fill out the companion registration for each companion

# of Companion Programs:____________

Billing Information

Total Registration Fees from Above: US$

Charge my Credit Card

○ American Express ○ VISA ○ MasterCard Name on Card:____________

Card Number:____________ Expiration:______ Card Code:______

Send by Mail

○ Payment by Check

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P.O. #: ____________

Note: Credit card name must be listed on the card. Card billing address must match address listed above in registration. The card code is a four-digit number on the front of an American Express card or a three-digit number on the back of a VISA card or MasterCard.

Mail to ISASI Seminar Registration
P.O. Box 16032, Albuquerque, NM USA
Tel: (888) 292-2129 (U.S. and Canada)
(555) 299-1690

Fax to (505) 292-2017

E-mail to sharon.morphew@scsi-inc.com

Signature *(required for credit card)* ____________

For mail/fax:____________

Australian and New Zealand Societies of Air Safety Investigators

2007 Asia-Pacific Regional Seminar

James Cook Hotel Grand Chancellor, Wellington
Friday–Sunday, June 8–10, 2007

Seminar Registration Form

(Make accommodation reservations directly with the hotel using separate form.)

FAMILY Name: ______________________ First Name: ______________________

Organization: ______________________ E-mail Address: ______________________

Street Address, Suburb: ______________________ City, Post code: ______________________

Country: ______________________

ISASI Member #: ______________________ Spouse/Partner's Name: ______________________

Circle the relevant amounts in table. Note there is no ISASI-style "Partner Program." NZSASI can't accept payment by credit card or direct credit. Payment by cash upon arrival may be approved upon request to e-mail below.

Make checks (NZD or AUD) payable to "NZSASI" and mail with completed form to

ANZSASI 2007 Seminar
8/15 Aotea Drive
Porirua 5024
NEW ZEALAND

Any queries? Please e-mail rc1@xtra.co.nz or pgwilliams@clear.net.nz

PAYMENT	**By May 1, 2007**			**After May 1, 2007**		
in NZ$	Member	Non-member	Student member	Member	Non-member	Student member
All functions	290	350	160	340	400	200
Spouse/partner	120	145	120	150	175	130
Single day	100	125	50	150	175	75
Total NZD paid:						
in Australian $	Member	Non-member	Student member	Member	Non-member	Student member
All functions	*260*	*315*	*145*	*305*	*360*	*180*
Spouse/partner	*110*	*130*	*110*	*135*	*155*	*120*
Single day	*90*	*115*	*45*	*135*	*155*	*65*
Total AUD paid:						

the Singapore Bird Park, and an afternoon on Sentosa Island. ◆

ANZSASI June Seminar Registering Attendees

The 2007 Regional Air Safety Seminar hosted by the New Zealand Society of Air Safety Investigators is being jointly promoted with the Australian Society. It will be held in Wellington, New Zealand, June 8-10, at the James Cook Hotel Grand Chancellor.

Organizers are expecting more than 110 attendees this year. The president of the New Zealand Society, Peter Williams, said that there seems to be a better appreciation in the aviation community of the purpose and importance of safety investigations, and this might explain the interest being shown in the seminar by some smaller operators and organizations that have not previously attended.

The Associate Minister for Transport Safety has been invited to open the seminar, and the chief executive of the Transport Accident Investigation

Committee will present the opening paper. "We have had more papers offered for presentation at this seminar than we usually get, which is probably another indicator that we are in for a very successful seminar," said Williams.

Professional air safety investigators from New Zealand, Australia, and Canada will give presentations, as will airline operational staff. Papers on police disaster procedures and a new confidential reporting scheme will be presented, and one from the chief coroner of New Zealand is expected to attract considerable interest.

The New Zealand Society has more than 60 members, including some student members. Early last year, the Society organized a short seminar on the use of composite material in aircraft. Composites will account for 50% or more by weight of new-generation aircraft such as the Boeing 787. That event, at which very senior executive engineers from both Airbus and Boeing gave presentations alongside senior design engineers from Air New Zealand Engineering Services, was oversubscribed.

"The regional seminars that we share with the Australian Society are highly regarded by investigators, and anyone interested in air safety, as a valuable opportunity for education and networking," said Williams. As an example of the Society's standing, he referred to the participation this year of the prestigious international Flight Safety Foundation.

The seminar in Wellington is open to all persons interested in air safety. Registration to attend is still ongoing and may be accomplished by completing the adjacent registration form. Further information can be obtained by writing to NZSASI, c/o 8/15 Aotea Drive, Porirua 5024, or e-mailing rc1@xtra.co.nz or pgwilliams@clear.net.nz. Information and seminar and hotel registration forms are available through the Australian Society website at http://www.asasi.org. ◆

ISASI Website

The new ISASI website can be accessed at www.isasi.org. When was the last time you visited it and checked to see if your contact information listed in the members-only section was correct? Any changes should be forwarded to Ann Schull at the website address above. The site has new sections like the Reachout Seminars and back issues of *Forum* and also carries the latest information about the upcoming ISASI annual seminar. Remember that you can upgrade your membership with the form on the website. The Society is always happy to receive donations (see the website home page tab).

A **REMINDER—**ISASI annual dues were due on Jan. 31, 2007. For those members who may not have yet made the payment, please contact Ann Schull at isasi@erols.com or call 1-703-430-9668 to make payment arrangements. If payments are not received, the affected member will be placed in inactive status. ◆

Lederer Nominations Deadline May 31

The ISASI Awards Committee reminds readers that the nomination period for the 2007 Jerome F. Lederer Award is open until May 31.

The Committee chairman, Gale Braden, notes that "the purpose of the Jerome F. Lederer Award is to recognize outstanding contributions to technical excellence in accident investigation. The Award is presented each year during our annual seminar to a recipient who is recognized for positive advancements in the art and science of air safety investigation."

The nomination process allows any member of ISASI to submit a nomination. The nominee may be an individual, a group of individuals, or an organization. The nominee is not required to be an ISASI member. The nomination may be for 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. Once nominated, a nominee is considered for the next 3 years and then dropped. After an intervening year, the candidate may be nominated for another 3-year period. ***The nomination letter for the Lederer Award should be limited to a single page.***

Nominations should be mailed or e-mailed to the ISASI office at 107 Holly Ave., Suite 11, Sterling, VA 20164-5405 USA. E-mail address: isasi@erols.com, telephone: 1-703-430-9668. Nominations may also be sent directly to the Awards Committee Chairman, Gale Braden, at 13805 Edmond Gardens Drive, Edmond, OK 73013-7064 USA; e-mail address, alebraden@cox.net. Home phone: 1-405-359-9007, cell: 1-405-517-5665. ◆

2006 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 37th International Seminar*, held in Cancun, Mexico, Sept. 11-14, 2006, by downloading the information from the appropriate section of the ISASI website at http://www.isasi.org. The seminar papers can be found in the "Members" section. Alternatively, active members may purchase the *Proceedings* on a CD-ROM for the nominal fee of $15, which covers postage and handling. Non-ISASI members may acquire the CD-ROM for a US$75 fee.

A limited number of paper copies of *Proceedings 2006* are available at a cost of US$150. Checks should accompany the request and be made payable to ISASI. Mail to ISASI, 107 E. Holly Ave., Suite 11, Sterling, VA USA 20164-5405. ◆

Speakers and Technical Papers Presented at ISASI 2006

LATIN AMERICA DAY—*Tuesday, September 12*
Keynote Address Capt. Gilberto Lopez Meyer, DGCA Mexico
Remarks Stuart Matthews, President and CEO, FSF
Horacio Larrosa, JIAAC, Argentina—*Accident and Incident Investigation in Argentina—One View about a Maintenance Related Case*
Capt. Carlos Limon, ASPA Mexico—*A CFIT Accident: Lessons Learnt*
Claudio Pandolfi, Chile—*The Advanced Qualification Program (AQP) as a Tool to Break the Chain of Accidents*
Fabio Catani, Sergio Rodrigues Pereira, and Umberto Irgang, Embraer, Brazil—*Risk Analysis Methodology Application and Results for Product Safety Monitoring at Embraer*
Richard H. Wood, USA—*Defining and Investigating Incidents*

INTERNATIONAL DAY—*Wednesday, September 13*
Randall J. Mumaw, Boeing, USA—*Industry Working Group for Enhancing the Investigation of Human Performance Issues*
Dr. Joseph Rakow/Dr. Alfred M. Pettinger, Exponent Failure Analysis Associates, USA—*Failure Analysis of Composite*
Materials in Aircraft Structures
Guillaume Aigoin/Guilhem Nicolas, BEA, France—*Solving FDR Readout Problems: A Proactive Approach*
Bert Ruitenberg, Tower & Approach Unit, Schiphol Airport, the Netherlands—*Using the Threat and Error Management (TEM) Framework as an Analytical Tool in ATC*
Michael Walker, ATSB, Australia—*The ATSB Approach to Improving the Quality of Investigation Analysis*
Dr. Kaare Halvorsen/Dr. Grete Myhre, AIB, Norway—*An Investigation as to How Aviation Safety Will Be Maintained in the Light of the Major Change Processes Taking Place in the Norwegian Civil Aviation Sector*
Johann Reuss, BFU, Germany—*Incident Investigation: A Diversion of a Boeing B-747 Resulting in a Serious Low-Fuel Situation*
Wen-Chin Li/Don Harris, Cranfield University, UK—*Breaking the Chain: An Empirical Analysis of Accident Casual Factors by Human Factors Analysis and Classification System (HFACS)*

INVESTIGATOR'S DAY—*Thursday, September 14*
Nick Stoss, Transportation Safety Board of Canada—*Major Investigation Management*
William R. Kemp, TSBC, Canada—*A Safety Issue Investigation into Small Aircraft Accidents Resulting in Post-Impact Fire: The Experience, Techniques, and Lessons Learned*
Gary R. Morphew, SCSI, USA—*Investigation into Turbulence-Related Accidents*
Dana Siewert, UND, USA/**Corey Stephens,** ALPA USA—*Polishing the Apple and the Investigator—Examining the Importance of Investigator Education Prior to an Investigation*
Stéphane Corcos/Alain Agnesetti, BEA, France—*Investigating a 'Minor' Incident Using Lessons Learned from a Major Accident*
Sue Burdekin, University of New South Wales, Australian Defense Force Academy—*Listening to the Specialists: How Pilot Self-Reporting Can Help Break the Accident Chain*

NTSB: Aviation Safety Continues to Improve

The state of civil aviation safety continued to improve in 2006, according to statistics released in early March by the National Transportation Safety Board. The number of accidents in all segments of civil aviation in 2006 were less than in 2005, with general aviation recording the lowest number of accidents and fatal accidents in the 40 years of NTSB record keeping.

"This is very good news," said NTSB Chairman Mark V. Rosenker, "but it is no reason to let down our guard. We need to build on this improving record with a continued emphasis on safety in all phases of aviation."

Major air carriers that operate larger aircraft and carry passengers and cargo between major airports continued to have the lowest accident rates in civil aviation. These commercial carriers, which are officially classified by federal regulations as operating under 14 CFR Part 121, carried 750 million passengers more than 8 billion miles while logging more than 19 million flight hours in 2006. At the same time, these carriers had 31 accidents, down more than 20% from 2005. Only 2 of the 31 accidents were fatal, resulting in 50 fatalities.

Over the years, the number of major air carrier accidents has increased, primarily due to a substantial increase in flight activity. The number of flight hours logged by air carriers has almost doubled since 1987, and the number of departures has increased by 50%. Major air carriers experienced in 2006, on average, only 1 accident every 266 million miles, 630,000 hours flown, or 368,000 departures. Fatal accidents are rare events, occurring only .01 accidents per 100,000 flight hours or .018 accidents per 100,000 departures.

On-demand Part 135 operations that include air taxi, air tour, and air medical operations experienced more accidents than major air carrier operations. These operations typically use much smaller aircraft, including helicopters, and can service smaller airports. In 2006, on-demand Part 135 operators had 54 accidents, down almost 20% from 2005, with 10 of those accidents resulting in 16 fatalities.

These air carriers flew more than 3.6 million flight hours in 2006 and recorded 1.5 accidents and .28 fatal accidents for every 100,000 hours flown. The number of on-demand Part 135 accidents has been steadily decreasing over the past 10 years, while the hours flown by these air carriers has steadily increased, producing a general downward pattern in accident and fatal accident rates.

Commuter operations (officially described as scheduled Part 135 operators) show a similar pattern to on-demand Part 135 air carriers, but account for a very small proportion of the accidents and flight activity. In 2006, commuter operators experienced only three accidents, one of them fatal resulting in two fatalities. However, these operations account for only 1% of air carrier flight hours, resulting in 1.1 accidents and .36 fatal accidents per 100,000 hours flown. These rates are comparable to on-demand Part 135 operations.

The decline in general aviation accidents in 2006 continues an ongoing trend. General aviation accounted for the greatest number of civil aviation accidents and fatal accidents in 2006; a total of 1,515 accidents, 303 of them fatal, resulted in 698 fatalities. Although general aviation accounts for half of all civil aviation flight-hour activity, it produces the highest accident and fatal accident rates. Part of the decline in the number of general aviation accidents was due to a steady decrease in the amount of flight activity. Since 1990, general aviation hours flown has declined 20%, and as a consequence, the general aviation accident rate stayed relatively stable in that period, averaging approximately 7.5 accidents per 100,000 flight hours. (The 2006 statistical tables are available at www.ntsb.gov/aviation/Stats.htm.) ◆

New Members

CORPORATE

Southwest Airlines Pilots' Association
Mr. John Gadzinski
Mr. Shawn Blankenship
SAS Braathens
Mr. Karl M. Rosenlund
Mr. Odd Korslund
Parker Aerospace
Mr. Jeremy D. Katt
Mr. Scott C. Ledbetter
Kreindler & Kreindler LLP
Ms. Christine Negroni
Mr. Andrew Maloney
JONES DAY
John D. Goetz
Dana Baiocco
Irish Aviation Authority
Mr. Kevin Humphreys
Mr. Brian Skehan
Aramco Associated Company
Mr. Gary M. Bain
Mr. Joel J. Docog
AmSafe Aviation
Mr. Thomas H. Barth
Mr. James W. Crupi

INDIVIDUAL

Bahanan, Osama, A., Jeddah, Saudi Arabia
Baig, Mirza, I., Dallas, TX, USA
Batic, Alan, D., Annandale, QLD, Australia
Beams, Trevor, C., Kirwan, QLD, Australia
Behery, Talal, A., Jeddah, Saudi Arabia
Boag-Hodgson, Christine, C., Palmerston, ACT, Australia
Bobst, Steve, W., East Wenatchee, WA, USA
Callaghan, Katherine, A., Eagle River, AK, USA
Carvosso, John, P., Adelaide, SA, Australia
Cook, Thomas, W., Baton Rouge, LA, USA
Cooper, Lance, R., Albany Creek, QLD, Australia
Corcos, Stephane, Le Raincy, France
Cousins, Andrew, W., Prescott, AZ, USA,
Coxon, P.E., Anne, M., Everett, WA, USA
Cushman, Anna, W., Alexandria, VA, USA
Damrongmanee, Pich, Muang, Thailand
De Graaff, Rudi, J., Melton, VIC, Australia
del Castillo, Victor, M., Toluca, Mexico
Delaat, John, H., Elanora, QLD, Australia
Delk, Craig, R., Las Vegas, NV, USA
Flannery, Michael, J., Toowoomba, QLD, Australia
Getley, Ian, L., Wahroonga, NSW, Australia
Goodroe, David, C., Fort Worth, TX, USA
Grady, Michael, G., Cave Creek, AZ, USA
Hamilton, Douglas, C., California, MD, USA
Heaton, Ben, S., Brassall, QLD, Australia
Hull, Stephen, G., Oldsmar, FL, USA
Hutchings, Kris, E., Calgary, AB, Canada
Johnson, Jayme, A., Duluth, MN, USA
Jones, Cavin, J., Locust Grove, V A, USA
Keating, Joseph, P., Simpsonville, KY, USA
Kelly, Paul, Weymouth, MA, USA
Kemp, William, R., Edmonton, AB, Canada
Khider, Mustafa, K., Jeddah, Saudi Arabia
Kim, Seon Joo, Prescott, AZ, USA
Kirkland, Stephen, C., Urraween, OLD, Australia
Kohler, Markus, Grafenort, Switzerland
Latson, Jr., Thomas "Tom," J., Houston, TX, USA
Lawrence, David, A., Reston, VA, USA
Lee, Se Yong, Prescott, AZ, USA
Luke, Glenn, R., Bellbowrie, QLD, Australia
Margetts, Bruce, S., Brisbane, QLD, Australia
McDonell, Patricia, Turner, ACT, Australia
Midmore, Anthony, J.D., Reno, NV, USA
Moffat, Alexander, R., Richmond, BC, Canada
Molina, Omar, Oklahoma City, OK, USA
Moscona, Eran, S., Florence, KY, USA
Nash, Ian, Oakey, QLD, Australia
Novish, Adam, T., Bear, DE, USA
Ocaka, Julius, A., New York, NY, USA
Park, Ji Yeon, Prescott, AZ, USA
Pascall, Steven, J., Toowoomba, QLD, Australia
Pejich, David, J., Canberra, ACT, Australia
Pennington, Shelley, Louisville, KY, USA
Roberts, Rod, M., Greenbank, QLD, Australia
Robertson, Alexander "Bruce," Geraldine, New Zealand
Rogers, Gary, D., Tigard, OR, USA
Rojas, Alissa, Warwick, RI, USA
Rose, Steven, V., Liberty TWP, OH, USA
Ryan, James, F., Owens Cross Road, AL, USA
Scally, Nicole, M., Geelong, VC, Australia
Sennyah, Bernard, A., Calgary, ALB, Canada
Smith, Gregory, M., Easton, MD, USA
Stelman, Dan, J.T., Winnipeg, Canada
Stroube, Hugh, A., Edmond, OK, USA
Tavlin, Linda, J., Chicago, IL, USA
Trout, Paul, R., Sheridan, WY, USA
Turner, David, J., Gungahlin, ACT, Australia
Van Utrecht, A.J., M., Opheusden, GLD, Netherlands
Winfield, Karen, R., Kaleen, ACT, Australia
Wonn, Steven, D., Prescott, AZ, USA
Yelf, Daniel, L., Sydney, NSW, Australia
Zollo, Joseph, E., Los Angeles, CA, USA ◆

Steven R. Chealander Becomes NTSB Member

NTSB announces that Steven R. Chealander was sworn in as a member of the U.S. National Transportation Safety Board on January 3. His term will expire on Dec. 31, 2007. Chealander brings a wealth of both civilian and military aviation experience to the NTSB. Prior to joining the Board, he was with American Airlines, serving since 1991 as a pilot and captain qualified on the DC-10, B-737, MD-80, and F-100 aircraft, and as a chief pilot in Los Angeles. At American, he also was a flight safety manager, performing safety and compliance audits and participating in investigations, and was most recently the manager of flight operations efficiency.

From 1964 to 1991, he served in the U.S. Air Force, with tours of duty in Vietnam and Spain. An F-4 pilot and instructor pilot, and then a USAF Aggressor pilot, he was selected in 1981 to be a member of the USAF Air Demonstration Squadron, the Thunderbirds. He flew with the team until 1985, when he was assigned as a staff officer at Tactical Air Command headquarters at Langley AFB, VA.

In 1986, Chealander was selected as the military aide to U.S. President Ronald Reagan. In this capacity, he performed a variety of ceremonial and emergency preparedness duties, including custody of the President's emergency briefcase, "the football."

Subsequently, Chealander commanded an F-5 tactical fighter squadron at Williams AFB, AZ (1988-89), an F-16 squadron at Luke AFB, AZ (1989-91), and then was appointed assistant deputy commander for operations for the F-16 tactical fighter wing at Luke AFB. He retired from the Air Force in 1991 with the rank of lieutenant colonel.

Chealander received a B.S. degree in business administration from the University of Southern California and pursued graduate studies at the University of Utah. He is married and the father of two daughters. ◆

Who's Who: Air Accident Investigation Bureau Of Singapore (from page 32)

accident investigation agencies;
- national resources for aircraft accident investigation;
- support and facilities available from other countries;
- roles of the state of manufacture, the manufacturers and industry;
- regional cooperation and resource sharing/pooling;
- Training of investigators; and
- ICAO audits, expectations, and remedial actions.

It is hoped that the discussions on these issues will generate significant input to the ICAO AIG Divisional Meeting, which is scheduled for fall of 2008.

The AAIB invites everyone with an interest in aviation and in air safety investigation to join it at the ISASI 2007 seminar as well as at the CAAIP. For updates on the ISASI seminar and for details on registration, programs, etc., please visit the website "www.isasi07.org."

Information on the CAAIP will be made available by the SAA as soon available. In the meantime, please contact the director of the AAIB (e-mail: chan_wing_keogn@ mot.gov.sg) with any questions. ◆

Litigation Can Help Break The Aircraft Accident Chain, *IF…* (from page 13)

tical programs. Stay away from professional witnesses.

3. Find ways to reduce the time and expense of litigation. No more business as usual, please. No more exhaustive, choking objections to discovery. No more wars of attrition. Instead of finding every way in the universe to object to discovery, try to find ways to answer it—even when inartfully drafted. An experienced attorney will know the issues involved in a particular theory, so share information and make full disclosure early. One very experienced attorney just told his audience that he was part of litigation where $10 million was spent to get a recovery of $6 million. Find ways to cooperate rather than to obstruct. You can do it without sacrificing your client's case, and it will save thousands in legal fees—not to mention a few trees. Money saved in litigation could be put toward accident prevention.

4. Evaluate the case early—be realistic. Plaintiffs should make sure their expectations are realistic. Defendants shouldn't defend just to defend. One very experienced defense attorney conducts his own discovery of his client to show the client what might have to be revealed in litigation. Such imaginative and insightful approaches help the process move forward toward conclusion, and thereby assist all in focusing on aviation safety rather than litigation.

5. Offer experts to investigators. Experts should communicate with the investigators to share what they have learned—and it can be one way. Find ways to help the investigator, not pick his brain. Talk to the government investigators. The cooperative effort might just pay off with increased aviation safety. We did this in the North Sea litigation mentioned earlier, and in the British Midlands M-1 motorway crash. The AAIB certainly did not need our help, but this technical discourse helped to confirm and explain theories of causation.

6. Find a way to get the information to the people who need it. Use the information from discovery in depositions of the investigator-in-charge. Seek relief from the court on grounds of public safety and welfare to nullify the disclosure limits of any protective order entered in the case Fight the imposition of oppressive confidentially agreements that will allow exclusions from the restrictive language so that information can be given to the public agencies.

7. Make aviation safety part of your case from the beginning. From the moment you first meet with your client, through discovery and trial, make everyone in the process—clients, opposing attorneys, witnesses, investigative personnel, judges, and juries—know that you believe litigation has a role to play in aviation safety.

This approach must be delivered consistently and with sincerity; otherwise, it will be perceived as hollow grandstanding. But if you mean it, you will change attitudes and perspectives, and might get a convert.

8. Allow for voluntary disclosure without penalty. I suggest changing the FAA regulations to allow for non-punishment if a party to litigation allows an attorney involved in that litigation to report to the FAA regarding facts discovered in litigation. I envision a program similar to the NASA Aviation Safety Reporting System used by pilots.

No magic wand

In my work, like you, I am constantly on airplanes—primarily commercial, but sometimes charter or private. My family, like yours, also takes frequent flights. I don't want anything to happen to me, to them, or to you. I don't want an aviation accident to happen to anybody. If I could wave a magic wand, I would.

But I don't have that wand—nobody does. It is only with our brains, our sweat, and our hearts that we can achieve the ultimate in safety. Aircraft safety is all of our business—and it is too important to be left to any one of us. We must all take our roles seriously—dead seriously. Aircraft safety is too vital to succumb to pressure that has nothing to do with safety.

Four years ago, at trial, I asked a distinguished, retired Marine Corps colonel, who was also a paid consultant for a helicopter manufacturer, and who was testifying on behalf of that manufacturer, a series of questions regarding aircraft safety. His answers were a beautiful example of how to state the truth regardless of who signs your paycheck. I cannot locate the transcript, but the following is close to what happened:

Q: Colonel, you testified that this aircraft has an accident rate of (a very low percentage), and you said that is a very good rate, correct?
A: Yes.
Q: Colonel, is that an acceptable rate?
A: No.
Q: Colonel, what is the only acceptable rate?
A: Zero.

Regardless of our position and regardless of the obstacles inherent in our professions, we must all have the courage and the character to find the truth and tell the truth just as that colonel did. In my view, that's the only way we're going to get to where we need to be—for us, for our families, for our friends, and for those who are counting on us—for those who, in short, are betting their lives on us. ◆

ISASI ROUNDUP

Continued . . .

Creating the ISASI International Working Group on Human Factors

(from page 29)

man performance of the investigator, contributing factors analysis, human error models/taxonomies, and human factors accounts: data vs. speculation, identifying human performance events, and event sequence representation.

Checklists—initial data collection.

The Initial Stakeholder Review Team (ISRT) will provide early feedback about the usefulness of the guidance materials. An early listing of members includes

Union—Capts. Shawn Pruchnicki and Scott Reeves, ALPA; Capt. Gavin McKellar, IFALPA; Dave Supplee (IAM&AW); Bert Ruitenberg, IFATCA; Darren Gaines, NATCA; and John Guselli, ISASI and JCG Aviation Services.

Accident investigation agencies—David King, U.K.; Ken Mathews, New Zealand; Jim Danaher and Caj Frostell, ISASI.

Manufacturer investigators—Simon Lie, Boeing; Paulo Ribeiro and Mike Lowell, Embraer; J. Donnelly, Bombardier; and Thierry Thoreau, Airbus.

As you can see from the message of President Del Gandio (see page 3), Dr. Randall Mumaw's article (in the January–March 2007 *Forum*, page 14), and the information I have provided here, we are involved in a very far-reaching blueprint that can produce highly effective results to aid our investigations; thus, let me share with you the Working Group's vision that is guiding our actions and efforts:

- That all agencies involved in accident investigation around the world endorse the belief that the investigation of human performance can proceed without the presumption of human error or negligence. An investigative process that seeks to ascertain what occurred rather than who was at fault will yield more vital and accurate information.
- That appropriate human factors expertise is brought to bear on all investigations of human performance issues.
- Accident and incident databases worldwide share a common taxonomy for identifying and listing human performance issues so that the databases can be used to track trends over time.
- A standardized and coordinated set of guidance modules that can be distributed to accident investigators around the world (distributed in phases).

Phase 1: Initial set of guidance modules.

Phase 2: Revised/updated set of guidance modules.

Finally, this effort when completed, adopted, and practiced will, in addition to its practical air safety improvements, add considerable luster to the Society's motto "Air Safety Through Investigation." This effort is one of a very few that is designed, and will be accomplished, specifically to address the role of the professional air safety accident investigator. ◆

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Great Lakes, Rodney Schaeffer (reschaeffer@esi-il.com)
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Southeastern, Inactive

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Membership, Tom McCarthy (tomflyss@aol.com)
Nominating, Tom McCarthy (tomflyss@aol.com)
Reachout, James P. Stewart (sms@rogers.com)
Seminar, Barbara Dunn (avsafe@uniserve.com)

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Air Accident Investigation Unit—Ireland
Air Accidents Investigation Branch—U.K.
Air Canada Pilots Association
Air Line Pilots Association
Air New Zealand, Ltd.
Airbus S.A.S.
Airclaims Limited
Aircraft Accident Investigation Bureau—Switzerland
Aircraft Mechanics Fraternal Association
Aircraft & Railway Accident Investigation Commission
Airservices Australia
AirTran Airways
Alaska Airlines
Alitalia Airlines—Flight Safety Dept.
All Nippon Airways Company Limited
Allied Pilots Association
American Eagle Airlines
American Underwater Search & Survey, Ltd.
AmSafe Aviation
Aramco Associated Company
ASPA de Mexico
Association of Professional Flight Attendants
Atlantic Southeast Airlines—Delta Connection
Australian Transport Safety Bureau
Aviation Safety Council
Avions de Transport Regional (ATR)
BEA-Bureau D'Enquetes et D'Analyses
Board of Accident Investigation—Sweden
Boeing Commercial Airplanes
Bombardier Aerospace Regional Aircraft
Bundesstelle fur Flugunfalluntersuchung—BFU
Cathay Pacific Airways Limited
Cavok Group, Inc.
Centurion, Inc.
China Airlines
Cirrus Design
Civil Aviation Safety Authority Australia
Colegio De Pilotos Aviadores De Mexico, A.C.
Comair, Inc.
Continental Airlines
Continental Express
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Directorate of Flying Safety—ADF
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Dutch Transport Safety Board
EL AL Israel Airlines
EMBRAER-Empresa Brasileira de Aeronautica S.A.
Embry-Riddle Aeronautical University
Emirates Airline
Era Aviation, Inc.
European Aviation Safety Agency
EVA Airways Corporation
Exponent, Inc.
Federal Aviation Administration
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Flight Safety Foundation—Taiwan
Flightscape, Inc.
Galaxy Scientific Corporation
GE Transportation/Aircraft Engines
Global Aerospace, Inc.
Hall & Associates, LLC
Hellenic Air Accident Investigation & Aviation Safety Board
Honeywell
Hong Kong Airline Pilots Association
Hong Kong Civil Aviation Department
IFALPA
Independent Pilots Association
Int'l. Assoc. of Mach. & Aerospace Workers
Interstate Aviation Committee
Irish Air Corps
Irish Aviation Authority
Japan Airlines Domestic Co., LTD
Japanese Aviation Insurance Pool
JetBlue Airways
JONES DAY
KLM Royal Dutch Airlines
Kreindler & Kreindler LLP
L-3 Communications Aviation Recorders
Learjet, Inc.
Lockheed Martin Corporation
Lufthansa German Airlines
MyTravel Airways
National Air Traffic Controllers Assn.
National Business Aviation Association
National Transportation Safety Board
NAV Canada
Nigerian Ministry of Aviation and Accident Investigation Bureau
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Phoenix International, Inc.
Pratt & Whitney
Qantas Airways Limited
Qwila Air (Pty) Ltd.
Republic of Singapore Air Force
Rolls-Royce, PLC
Royal Netherlands Air Force
Royal New Zealand Air Force
RTI Group, LLC
Sandia National Laboratories
SAS Braathens
Saudi Arabian Airlines
SICOFAA/SPS
Sikorsky Aircraft Corporation
Skyservice Airlines Ltd.
Singapore Airlines, Ltd.
SNECMA Moteurs
South African Airways
South African Civil Aviation Authority
Southern California Safety Institute
Southwest Airlines Company
Southwest Airlines Pilots' Association
Star Navigation Systems Group, Ltd.
State of Israel
Transport Canada
Transportation Safety Board of Canada
U.K. Civil Aviation Authority
UND Aerospace
University of NSW AVIATION
University of Southern California
Volvo Aero Corporation
WestJet ◆

WHO'S WHO

Air Accident Investigation Bureau Of Singapore

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

The Air Accident Investigation Bureau (AAIB) was established on Oct. 1, 2002, and is the investigation authority in Singapore. It is responsible to the Ministry of Transport for the investigation of air accidents and serious incidents to Singapore and foreign civil aircraft in Singapore. The AAIB also participates in overseas investigations of accidents and incidents involving Singapore aircraft or aircraft operated by Singapore air carriers.

The mission of the AAIB is to promote aviation safety through the conduct of independent and objective investigations into air accidents and incidents consistent with the Convention on International Civil Aviation.

Investigations by the AAIB are conducted in accordance with the Singapore Air Navigation (Investigation of Accidents and Incidents) Order 2003 and Annex 13 to the Convention on International Civil Aviation. The investigation process involves gathering, recording, and analyzing all available information on accidents and incidents; determining the causes and/or contributing factors; identifying safety issues; issuing safety recommendations to address these safety issues; and completing the investigation report.

In carrying out these investigations, the AAIB will adhere to ICAO's investigation philosophy, i.e., that the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents and that it is not the purpose of this activity to apportion blame or liability.

Currently, the AAIB has seven full-time investigators. They are supplemented by a team of 13 volunteer investigators, who are drawn from government institutions and private sectors and are specialists in their own fields.

The AAIB administers an incident reporting program called the Singapore Confidential Aviation Incident Reporting Program (SINCAIR). SINCAIR is a voluntary, nonpunitive confidential reporting system, in line with the recommendation of Annex 13 to the Convention on International Civil Aviation. SINCAIR provides a channel for reporting aviation incidents and safety deficiencies while protecting the reporter's identity.

Recently, the AAIB set up a comprehensive flight recorder readout facility. Investigation agencies and airlines (particularly those in the Asia Pacific region) that may need to have their recorders read out for investigation purposes are welcome to contact the AAIB.

This year, the AAIB will be hosting the annual seminar of the International Society of Air Safety Investigators (ISASI) in Singapore from Monday, August 27 to Thursday, August 30. The theme of the ISASI 2007 seminar is "International Cooperation: From Investigation Site to ICAO."

The ISASI 2007 seminar will follow the established ISASI seminar format. The seminar will be held from Tuesday, August 28 to Thursday, August 30. Pre-seminar tutorial sessions will be held on August 27 at the Singapore Aviation Academy (SAA), which is the training arm of the Civil Aviation Authority of Singa-pore. The tutorial topics are Aftermath of a Sea Crash and ICAO Annex 13 Investigation in a Litigious Environment.

Noting that government investigation officials of the world get together only very rarely to discuss general investigation issues and, therefore, wishing to benefit further from the presence of the many distinguished accident investigation and air safety professionals who will be attending the ISASI seminar, the AAIB is also co-organizing with the SAA a special Chief Aircraft Accident Investigators Program (CAAIP) from Wednesday, August 22 to Friday, August 24, i.e., just before the ISASI seminar. This will allow the seminar participants, especially the government investigation officials, to attend the CAAIP and to meet before attending the ISASI seminar. The CAAIP will discuss organizational and infrastructure issues such as

- establishment of independent aircraft

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AIR SAFETY INVESTIGATORS
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