Efforts to harness advanced safety concepts, information technology and investigator training in aviation accident investigations sometimes have sparked controversy for the Australian Transport Safety Bureau (ATSB). Critics of the innovations found fault last year with the bureau's investigative analysis framework in the context of its first major safety investigation — the May 2005 fatal crash of a Fairchild Metro 23 near Lockhart River in Queensland (*ASW*, 6/07, p. 29).[1]

The Civil Aviation Safety Authority of Australia (CASA), for example, took exception to the framework's *ATSB investigation analysis model* and its standard of proof for determining whether something contributed to an accident. Two independent assessments — by the head of a government review and a state coroner[2,3] — later concluded, however, that most of this criticism was unwarranted, and commended the bureau for implementing comprehensive changes.

This year, a report by Kym Bills, the ATSB's executive director, and Michael Walker, a senior transport safety investigator, explained why the bureau began to develop this "enhanced and more transparent" framework in 2004 and how it works, and invited professionals in the global safety investigation field to consider important safety issues they encountered.[4] The framework introduced substantial changes of terminology; the investigation analysis model, an ATSB adaptation of the Reason model;[5] requirements for all investigators to adhere to a defined analysis process, called the *workflow;* and investigator training on the corresponding policies, guidelines and investigative tools.

"The ultimate aims of the … framework [are] to improve the rigor, consistency and defensibility of investigation analysis activities, and improve the ability of investigators to identify safety issues in the transportation system," the report said.

Defensible Analysis

BY WAYNE ROSENKRANS

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Australian accident investigation framework demonstrates strong standard of proof for determining safety factors worldwide.

The framework was developed in conjunction with replacing an outdated accident/incident database with a software suite, the ATSB Safety Investigation Information Management System, which was launched in April 2007.[6] "A key component is a set of tools for the analysis phase of a safety investigation," the report said.

In an article last year for Flight Safety Foundation, Bills noted the new system's environment and the bureau's pursuit of a more disciplined approach and professional consistency (*ASW*, 9/07, p. 32). He said, "There are new and unusual twists in safety improvements based on different organizational cultures and pressures, regulatory environments and interfaces with other humans and changing systems and technologies." Investigative bodies find the analysis aspect of their work among the most difficult tasks, with complex crash scenarios likely to involve missing, obscure or even deceptive data, the report said.

The current framework brings to the table a higher standard of proof than has been used in Australian coroner inquests — which have influenced the ATSB analytical advances — or civil legal proceedings (Table 1). This statement applies to "factors relatively close in proximity to the occurrence (that is, more than 66 percent [likelihood] versus more than 50 percent)," the report said. "But as an ATSB safety investigation proceeds to identify contributing safety factors more remote from the occurrence, the degree of relationship of the factors to the occurrence itself will generally decrease using the ATSB framework."

Like many independent investigative bodies, the ATSB cannot compel other entities to implement safety recommendations, called *safety actions* in the framework; rather, the method of influencing safety is through reports and other communication, which require "a rigorous analysis process and compelling arguments" to be effective, the report said. The ATSB therefore set out to create a defined analysis process to improve the quality of analysis, to raise credibility and increase the likelihood of safety actions being adopted by government and/or the industry. Analytical frameworks and safety investigation methods of other safety investigation organizations were reviewed, but none met the ATSB's needs, the report said.

The review for the country's minister for infrastructure, transport, regional development and local government on improving some aspects of the functional relationships of ATSB and CASA in 2007

Influential Inquest Findings by Australian Coroners About Aircraft Accidents

Accident Date	Coroner Jurisdiction	Accident Aircraft	Relevance to ATSB Investigative Analysis Framework
May 7, 2005	Queensland	Fairchild Metro 23	The coroner commended the ATSB framework with a few exceptions.[1]
A transport ministry review said that at the inquest after release of the ATSB's final report, "CASA lawyers sought to attack the ATSB's investigation methodology, alleging unintentional bias." The bias allegedly was emphasis on organizational influences, and the ATSB's findings were said to be presented in a distorted, unbalanced and unfair manner. The coroner commented that neither the investigation framework nor the ATSB investigation analysis model were biased, but questioned why the ATSB equated the word *probably* to 66 percent or greater probability when analyzing human behavior as a contributing safety factor. The coroner also said that issues of high relevance and low relevance should not need the same level of proof in identifying safety factors/issues.			
July 28, 2004	New South Wales	Piper PA-31T Cheyenne	The ATSB final report did not cover possible reclassification of airspace.
The aviation industry perceived that the ATSB missed an opportunity to analyze how the adoption of one type of airspace used in the United States could have influenced the outcome, the review said.			
Aug. 11, 2003	Western Australia	Cessna 404	The ATSB final report did not mention any CASA oversight issues.
The coroner's comments and safety recommendations identified CASA oversight deficiencies. A CASA witness at the inquest dismissed the ATSB's findings and raised previously unmentioned, safety-relevant issues, the review said.			
Sept. 26, 2002	Queensland	Piper Cherokee Six	Testimony after the ATSB final report raised additional issues and concerns.
At the inquest after release of the ATSB's final report, CASA raised significant issues about the ATSB's investigation and provided evidence that differed from what its witness had provided during the ATSB safety investigation, according to the ATSB.			

ATSB = Australian Transport Safety Bureau; CASA = Civil Aviation Safety Authority of Australia

Note

1. The Office of the State Coroner, Queensland, cited Flight Safety Foundation publications on approach and landing accident reduction, including those involving controlled flight into terrain, in its findings and comments.

Sources: ATSB; *ATSB/CASA Review 2007*; Office of the State Coroner, Queensland

Table 1

likewise noted, "The selectiveness with which the ATSB chooses accidents and incidents to investigate, the quality of its analysis and conclusions, and the quality and practicality of the reports and safety recommendations it produces have a direct influence on the value of its contribution to the Australian aviation system."

The ATSB was dissatisfied, however, with the slow pace globally of analytical advances. "Despite its importance, complexity and reliance on investigators' judgments, analysis has been a neglected area in terms of standards, guidance and training of investigators in most organizations that conduct safety investigations," the ATSB report said. "Many investigators (from most safety investigation organizations) seem to conduct analysis activities primarily using experience and intuition which are not based on, or guided by, a structured process. It also appears that much of the analysis is typically conducted while the investigation report is being written. As a result, the writing process can become inefficient, supporting arguments for findings may be weak or not clearly presented, and important factors can be missed."

To overcome this, the ATSB framework provides guidance in the form of functional questions, criteria, tables, lists and forms. For example, testing the influence of a potential safety factor requires the investigation team to account for the factor's relative timing, reversibility, relative location, magnitude, plausibility, past influence, enhancers, inhibitors, characteristics as a problem, required assumptions, alternative explanations for the problem and directionality of influence.

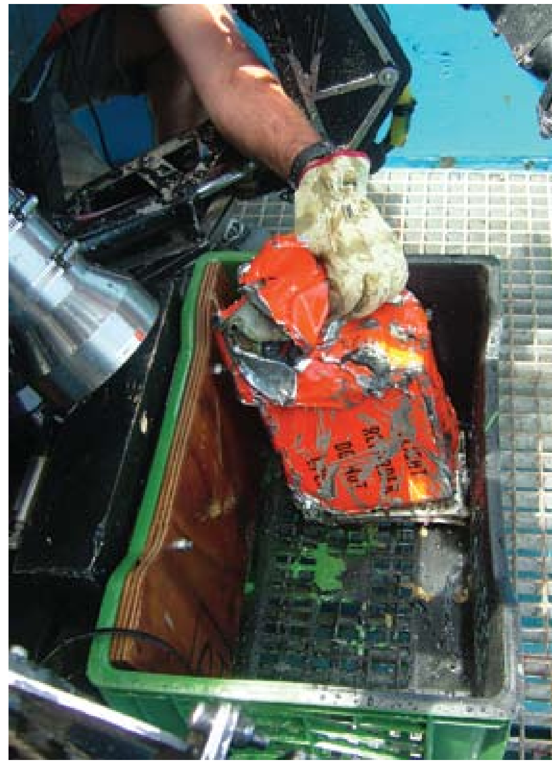
The sequential phases of a safety investigation under the framework are preliminary analysis, safety factors analysis, risk analysis, safety action development and analysis review. "[The risk analysis] phase involves reviewing and evaluating the available data, and converting it into a series of arguments to produce a series of relevant findings," the report said.

For the purpose of identifying *safety factors* — similar to the term *causal factors* in some countries — *contributing safety factors* and *critical, significant or minor safety issues,* the safety factors analysis and risk analysis phases are considered critical because of their relationship to the accuracy and completeness of findings, and to identifying effective safety actions. Careful logical reasoning becomes a key to the defensibility of findings.

"Some aspects of the technical or engineering side of an investigation involve deductive reasoning [with findings derived from premises with logical certainty], particularly when reaching intermediate findings," the report said. "However, the majority of the reasoning conducted in safety investigation involves inductive arguments [with findings expressed with some level of probability but not certainty], particularly when discussing safety factors. This applies to operational, technical and engineering aspects as well as human and organizational aspects."

The framework requires, from the preliminary analysis onward, that investigators ask a set of prepared generic questions, then ask a set of prepared focused questions designed to elicit logical explanations. Some aspects of an accident then may require the investigator to apply experience-based techniques that probe more deeply into some potential safety factors.

"Substantially more emphasis" also goes to its analysis review phase under the framework, the report said. Here, every safety factor identified earlier is subjected to a separate logical test of its existence, influence and importance. A potential safety factor may remain in



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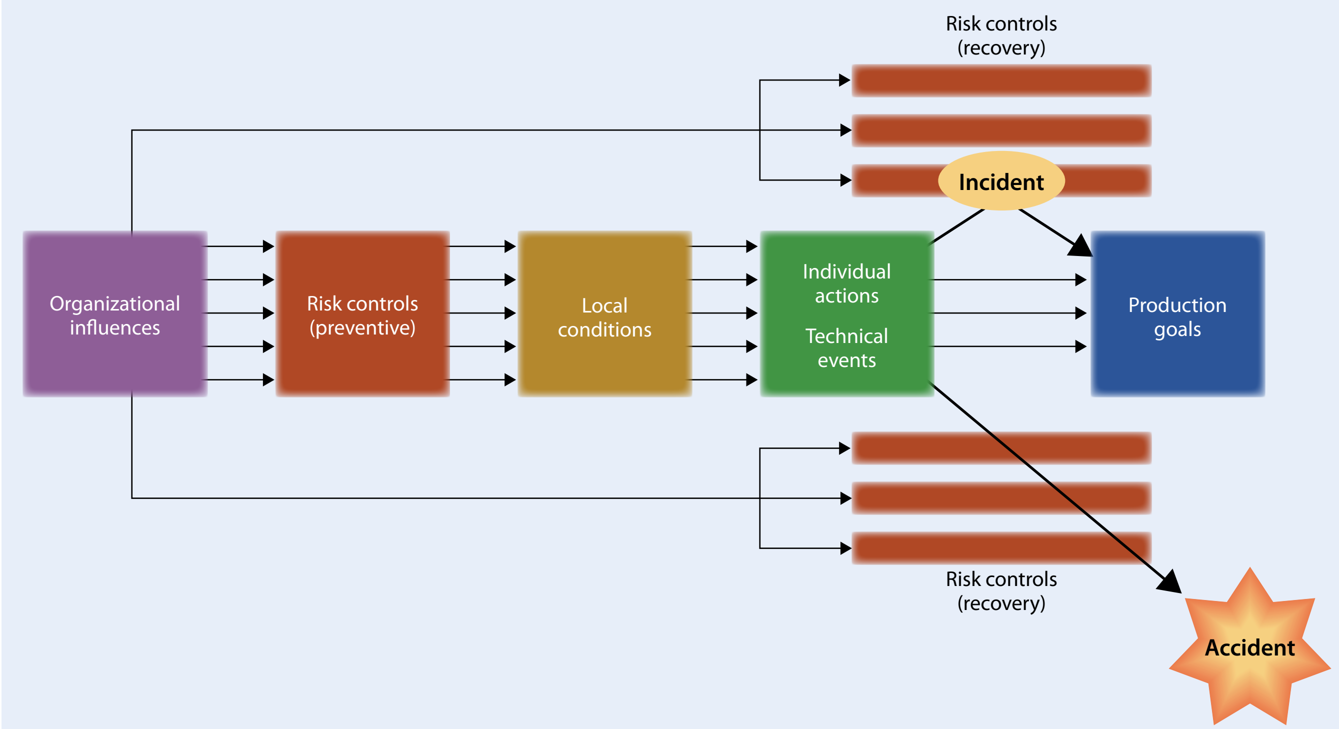
the final report, be reclassified or be dropped as of "no consequence to the investigation" at this phase.

Reason Revisited

The International Society of Air Safety Investigators in recent years has facilitated discussions of the extent to which the accident development model adopted by investigators affects fair/balanced consideration of organizational factors/latent conditions versus individual factors/active errors.

The ATSB's adaptation of the Reason model generated part of the criticism from the outset, but the bureau intended its version to inherently correct for biases.[7] For instance, the adapted model is only one element of a comprehensive process to help identify potential safety factors. "Before any findings are made about whether these potential [organizational] factors contributed to the development of the occurrence, or were otherwise

ATSB Adaptation of the Reason Model



ATSB = Australian Transport Safety Bureau

Note: The Reason model incorporates theories of accident causality by James Reason, a psychologist.

Source: ATSB

Figure 1

important, they need to be tested or verified," the report said. "In the ATSB analysis framework, this involves using a structured process to examine the available evidence and conducting tests for existence, influence and importance."

The adapted model (Figure 1) essentially helps to create a common mental picture of where preventive risk controls and recovery risk controls fit into the normal process of obtaining the production goals, safe flights. During a safety investigation, however, the investigators begin on a simplified vertical version of the chart at the accident/occurrence event label, which includes any technical problems, then work backward through individual actions and technical events, local conditions, preventive risk controls and, finally, organizational influences.

Notes

1. ATSB. "Collision With Terrain, 11 km NW Lockhart River Aerodrome, 7 May 2005, VH-TFU, SA227-DC (Metro 23)." Report 200501977. April 4, 2007.
2. *ATSB/CASA Review 2007: Report to the Minister for Infrastructure, Transport, Regional Development and Local Government.* Dec. 21, 2007.
3. Barnes, Michael. Office of the State Coroner, Brisbane, Queensland, Australia. "Inquest into the Aircraft Crash at Lockhart River." Aug. 17, 2007.
4. Walker, Michael B.; Bills, Kym M. "Analysis, Causality and Proof in Safety Investigations." ATSB Transport Safety Report, Aviation Research and Analysis Report AR-2007-053. March 11, 2008.
5. Reason, J.; Hollnagel, E.; Paries, J. "Revisiting the 'Swiss Cheese' Model of Accidents." EEC Note 13/06, Eurocontrol Experimental Centre, 2006. In 1990, psychologist James Reason, a professor at the University of Manchester, England, proposed a model of accidents resulting from interactions between "real time 'unsafe acts'" by front line personnel and latent conditions.
6. *ATSB/CASA Review 2007.*
7. In response to criticism, the ATSB report said that investigators typically express verbally what they mean and use the word *probably* in discussing whether something is a contributing safety factor. This word corresponds with greater than 66 percent likelihood on a widely adopted scale devised by the Intergovernmental Panel on Climate Change.