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## Book Review

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## BOOK REVIEW

**AIR CRASH INVESTIGATION OF GENERAL AVIATION AIRCRAFT** BY GLENN ELLIS, WITH CONTRIBUTIONS FROM C.O. MILLER AND J.M. RAMSDEN. GREYBULL, WYOMING: CAPSTAN PUBLICATIONS INC., 1984, PP. 239.

A recent article in Harper's Magazine listed 76 "how to" book titles, culled from the Denver public library, which included "You can be a carpenter," "You can be a printer," and "You can learn to fly." However, to the relief of those accident investigators who read the article, the title "You can investigate an aircraft accident," could not be found. Investigators should be relieved because no one can learn how to investigate aircraft accidents by simply reading a book. However, a book can provide some understanding of the accident investigation processes and the problems that confront an investigator. This book by Glenn Ellis does exactly that, and more. In the book, the general aviation pilot is provided with some well-chosen safety lessons; the lawyer can find a well-written chapter on legal implications of aircraft investigations; the sometimes frustrated accident investigator can find some well put recommendations regarding the management and practices of federal accident investigations; and the airline passenger can find the mysteries of financial liability briefly, but clearly, explained.

Accident investigation is the least desirable form of accident prevention. Ideally, the hazards or deficiencies, revealed in an accident investigation as causes, should have been eliminated or avoided before the accident occurred. However, once an accident does happen it is essential that all causes of the accident be established and that recommendations be made to eliminate or avoid the deficiencies which contributed to the accident.

The investigation of aircraft accidents is similar to most other investigations: gathering facts, analyzing those facts, drawing conclusions and making recommendations. That sounds simple enough in theory. In practice, however, the investigator standing next to a smoking hole in the ground sometimes thinks: "What should I do next?", "What does this piece of evidence mean?" and "I wish someone would chase away that reporter." This may be particularly true in general aviation accidents which sometimes are investigated by only one person.

In the preface to his book, Ellis provides the reader with general aviation injury statistics: during the decade of the 1970s there were 14,000 fatalities, 30,000 serious injuries, 7,000 aircraft destroyed and 45,000 aircraft damaged. Ellis contends that the majority of general aviation accidents are inadequately investigated. Many investigators in North America agree with this conclusion. For example, a paper by Professor "Skee" Parker of the University of Southern California raises the question of whether general aviation accident investigations prevent accidents. The paper concludes that because certain accidents, such as those related to weather, are repeated, accident investigations must not prevent accidents.

In the first of the book's eight chapters, Ellis sets the stage for what follows by describing in some detail an in-flight breakup. In the following chapters he describes the initial action at the crash site; the "paper chase" or investigation of crew, aircraft and Air Traffic Controller documentation; and witness interviews. The book also discusses considerations regarding inaccessible wreckage; wreckage analysis (such as structural failures, fatigue, fire, engine and system analysis, aircraft performance and flight instruments); and analysis and determination of accident causes. The last two chapters address financial liability (by J.M. Ramsden of Flight International) and legal implications (by C.O. Miller of System Safety, Inc.) of aircraft investigations.

The chapters discussing witness interviews and engi-

neering and maintenance considerations of an investigator are particularly useful and practical. The book devotes considerable attention to those engine failures related to fuel exhaustion and contamination. This is a particularly fertile field because twenty percent of all engine failures relate to these factors.

The chapter on financial liability, prompted by the DC-10 accident near Paris in 1974, is brief and to the point. It recommends, *inter alia*, that the Warsaw theory of presumed airline liability in exchange for limited liability be recognized as a sound principle. The author further recommends that the presumed liability should, as in the case of nuclear power stations, be attributed primarily to the operator, who may later have recourse against his supplier or another party.

A chapter on legal implications of accident investigations briefly traces the legislative history of aviation safety in the United States, including the various organizations and laws involved. This survey precedes a detailed scrutiny of the current rules and procedures of the National Transportation Safety Board (NTSB) and the internal practices of the Federal Aviation Administration (FAA), as they apply to accident investigation.

The problems inherent in the term "probable cause" as used by the NTSB are discussed at length. First, because the NTSB uses this expression in the singular and practically all accidents have more than one cause, use of terms like "contributing causes" becomes necessary. The cause selected for the label of "probable cause" is thus given the highest status and will, in the mind of the reader, become the most important (or "primary") cause. That cause becomes the focus for safety recommendations while other causes may not receive the scrutiny they deserve. The deliberations surrounding selection of the "probable" cause from all actual causes of an accident have been known to develop into a task of major proportions. Much time and money are spent in making this se-

lection, sometimes with detrimental effect to the ultimate objective of preventing accidents.

Secondly, the term "probable cause" has a specific meaning in the legal context ("an apparent state of facts to exist upon reasonable inquiry. . . which would induce a reasonably intelligent and prudent man to believe, in a criminal case, that the accused person had committed the crime charged. . ."). To the accident investigator it means something else, usually something like "events, conditions or circumstances which could induce an accident." This latter definition is confusingly similar to the legal definition of "proximate cause." For these and other reasons, Miller recommends that an "all cause" concept be introduced by the NTSB. Such a system is currently used by the United States Air Force and was first introduced by the Royal Canadian Air Force in the 1960s. With the "all cause" concept, *all* causes would be listed in the accident report, usually in chronological order, and examined for possible preventive action.

In the remaining chapters of the book many other aspects of FAA-NTSB practices are discussed, such as "International Considerations; Cause versus Fault; Problems during the Investigative Process; Availability and Use of Information Derived during NTSB Investigations; and Scope, Depth and Accuracy of Investigations." The final chapter includes several recommendations regarding NTSB management and practices.

This is a good book which could have been better if the editor had paid more attention to using correct terminology. Given the title of the book, the reader is sometimes taken by surprise. For instance, very few general aviation aircraft have afterburners or LOX systems, although both features are discussed. Sometimes unusual terminology slips into the text such as Vertical Velocity Indicator to refer to a Vertical Speed Indicator.

From the pure accident investigation point of view, the analysis of the in-flight break-up in chapter one proves puzzling. The author's discussion of wreckage trajectory

is unusual. Normally, the parts of an aircraft with the greatest density, such as engine, or batteries, etc., will travel the farthest. The parts of lesser density, such as the tail, ailerons, or rudder, will travel a shorter distance. The break-up discussed in the book did not occur in this fashion. The author should have explained the circumstances which led to the engine and cabin travelling the shortest distance and the rudder the farthest (perhaps a nearly vertical dive angle and a very strong tail wind?).

From an overall perspective, the author accomplished what he set out to do, and he has been especially successful with respect to his discussion of the engineering and maintenance aspects of aircraft investigation. I do not hesitate in recommending this book to anyone with an interest in general aviation accident investigation.

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\* Chief of Accident Investigation and Prevention Section, International Civil Aviation Organization ("ICAO"). The opinions expressed by O. Fritsch are entirely his own and do not represent ICAO policy.

