FLIGHT SAFETY FOUNDATION

DECEMBER 1994

FLIGHT SAFETY
DIGEST

The Dollars and Sense of Risk Management And Airline Safety

ICARUS Committee Report

Flight Safety Digest

Vol. 13 No. 12 DECEMBER 1994

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About the Cover: The cover is reprinted from the November 1992 *Flight Safety Digest*, which pictures a reproduction of "The Fall of Icarus" by the 18th-century illustrator, Picaret, courtesy of the Smithsonian Institution's National Air & Space Museum, Washington, D.C., U.S.

Flight Safety Foundation is an international membership organization dedicated to improving aviation safety. Nonprofit and independent, the Foundation was launched in 1945 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce a positive influence on aviation safety. Today, the Foundation provides leadership to nearly 600 member organizations in 75 countries.

The Dollars and Sense of Risk Management And Airline Safety

Risk management programs are essential tools for airline management to achieve acceptable safety standards while pursuing production objectives, reports Flight Safety Foundation ICARUS Committee.

ICARUS Committee

Responsibility for aviation safety begins at the very top of an airline company. History has demonstrated repeatedly that without the complete commitment of the highest management levels within a company, operational safety margins are seriously eroded. This does not suggest that a company *will* have an accident, but it does suggest that the risk of having an accident is high — the laws of probability will prevail.

Management has great leverage in affecting operational safety within a company. Through its attitudes and actions, management influences the attitudes and actions of all others within a company: Management defines the safety culture of an organization. This safety culture extends all the way to the maintenance shop floor, to the ramp, to the cabin and to the cockpit. Furthermore, the public and government authorities are increasingly recognizing management's role in air safety by holding management accountable for a serious incident or accident; this accountability is magnified many-fold if a company suffers several such incidents or accidents during the course of a few years.

The following information is designed to provide insight into the costs, causes and prevention of aviation accidents — to be a practical guide for management, not a theoretical treatise.

Safety Fits into Production Objectives

Accidents and incidents are preventable through effective management; doing so is cost-effective. An airline is formed to achieve practical objectives. Although frequently so stated, safety is not, in fact, the primary objective. The airline's objectives are related to production: transporting passengers or transporting goods and producing profits. Safety fits into the objectives, but in a supporting role: to achieve the production objectives without harm to human life or damage to property. Management must put safety into perspective, and must make rational decisions about where safety can help meet the objectives of the organization. From an organizational perspective, safety is a method of conserving all forms of resources, including controlling costs. Safety allows the organization to pursue its production objectives without harm to human life or damage to equipment. Safety helps management achieve objectives with the least risk.

Although risk in aviation cannot be eliminated, risk can be controlled successfully through programs to identify and correct safety deficiencies before an accident occurs. Such risk management programs are essential tools for management to achieve acceptable levels of safety while pursuing the production goals of the organization.

The airline has to allocate resources to two distinct but interrelated objectives: the company's primary production goals and safety. In the long term, these are clearly compatible objectives, but because resources are finite, there are on many occasions short-term conflicts of interest. Resources allocated to the pursuit of production objectives could diminish those available for safety and vice versa. When facing this dilemma, it may be tempting to give priority to production management over safety or risk management. Although a perfectly understandable reaction, it is ill-advised and it contributes to further safety deficiencies that, in turn, will have long-term adverse economic consequences.

1. Safety is of major concern to the aviation industry and to the public. When compared with other transportation industries — maritime, rail or road transportation — the aviation industry enjoys a superior safety record. Safety consciousness within the industry and the resources that aviation organizations devote to safety are among the reasons for this record.

Nevertheless, there are continuing concerns about maintaining, and improving, the favorable aviation safety record. The ever-increasing capacity of transport aircraft and the growth of global air traffic justify these concerns. For example, transport aircraft seating 300 to 500 passengers are now common, and plans for larger aircraft are under way; congestion in air traffic at complex hubs is also commonplace.

These are but two examples of what can become a statistician's — and an airline manager's — nightmare considering the potential for economic catastrophe to the industry. Newspaper headlines and extensive television coverage of aircraft accidents will become more sensational and more frequent even if safety levels remain the same. Simply put, as a consequence of growth, accident rates deemed acceptable in the past will be inappropriate in the future.

2. All those involved in aviation operations at every level have some responsibility for the safe outcome of such operations. There are, of course, different levels of human involvement and intervention. The physical proximity of a particular level to operational settings does not have a straight-line relationship with the potential for influencing risk in such operations.

Conventional wisdom allocates safety responsibilities almost exclusively to those at the operational end: flight crews, air traffic controllers, technicians and others.

Safety responsibilities often have been perceived to diminish as one moves away from the cockpit and toward the executive suite. Nevertheless, this notion does not hold true when viewed through the wider lens of systems safety.

From a top-down perspective, within any aviation organization there are at least four levels of human intervention that can greatly affect the level of risk:

- Senior management;
- Line management;
- Inspectors and quality control personnel; and,
- Operational personnel.

Within any civil aviation system, there are at least four major institutions to which these personnel might report:

- Civil aviation administration;
- Safety/accident investigation agency;
- Operators; and,
- Training, maintenance and other support organizations.

3. Each organizational and institutional level has unique opportunities to contribute to safety within the air transport industry, and overall system safety is determined by the interdependent actions of each. There are decisions that senior management — and only senior management — can take (or refrain from taking) that will directly affect safety. No other level can fully compensate for flaws in these decisions after they are implemented; they can only attempt to minimize the adverse consequences of flawed decisions.

By the same token, there are risky or unsafe decisions by operational personnel over which senior management has little or no direct control. And there are inherent limitations to the effectiveness of safety measures that operators can take when facing, for example, flawed regulations.

Simply put, as a consequence of growth, accident rates deemed acceptable in the past will be inappropriate in the future.

These flawed regulations may, in turn, result from the failure of an accident investigation agency to uncover fundamental safety deficiencies underlying accidents. Such deficiencies may be traced to deficient training of the investigators or may be fostered by flawed national legislation.

Actions and decisions within the exclusive domain of each organization can greatly affect the ability of the other organizations to discharge their safety responsibilities. Strong and sometimes complex interactions exist among the decisions and actions taken by various levels within and between air transportation organizations and institutions.

4. Historically, safety activities have focused on the organizational and institutional levels in closest temporal or physical proximity to an accident, i.e., operators and operational personnel. Improving the performance of operational personnel, primarily through high-quality training, has greatly enhanced aviation safety.

The industry, however, has reached a point of diminishing returns from this approach; it has reached the stage where a greater expenditure of resources at the operational end of the system will not result in proportionate safety benefits.

New methods of accident prevention emphasize looking at the total picture and taking into account accident prevention strategies in all industrial activities.

Another objective is to develop a perspective that views safety, or risk management, in the context of the primary production goals of civil aviation organizations. Because risk management activities, and the failure to manage risk, involve the expenditure of resources, it is critical that such a perspective be developed.

How Much Does It Cost To Have an Accident?

5. There are two basic categories of accident costs: (1) insured costs, generally including hull losses, property damage and personal liability; and (2) uninsured costs. Insured costs — those covered by paying premiums to insurance companies — can be recovered to a greater or lesser extent. Uninsured costs cannot be recovered, and they may double or triple the insured costs. Typical uninsured tangible and intangible costs of an accident include:

- Insurance deductibles;
- Increased operating costs on remaining equipment;
- Loss of spares or specialized equipment;
- Fines and citations;
- Legal fees resulting;
- Lost time and overtime;
- Increased insurance premiums;
- Cost of the investigation;
- Liability claims in excess of insurance;
- Morale;
- Corporate manslaughter/criminal liability;
- Cost of hiring and training replacements;
- Reaction by crews leading to disruption of schedules;
- Loss of business and damage to reputation;
- Loss of productivity of injured personnel;
- Cost of corrective action;
- Cost of restoration of order;
- Loss of use of equipment; and,
- Cost of rental or lease of replacement equipment.

6. The costs of accidents vary greatly from country to country, and although such costs may be quantified, the monetary value is not always the most critical factor. Some uninsured costs can acquire greater importance than the direct financial effect measured by accounting methods.

The economic and political context largely determines the relative importance of the monetary costs of an accident, as opposed to other factors. In industrialized nations, monetary costs of an accident may be the overriding consideration. In other countries, avoiding damage to the public's confidence in the nation's air transportation system may be a more important consideration. Where airlines are flag carriers, perceived damage to the national image among the international community may be the central consideration. In some situations, the loss of equipment in an accident might disrupt regular international services, a consideration that also might override the monetary costs. The fundamental message is twofold: first, there are economic consequences of aviation safety; second, the costs and benefits of safety cannot be measured only in economic terms.

7. "Unwanted outcomes" other than accidents also incur significant costs for an airline. Maintenance and ramp incidents, for example, present safety issues that can have significant costs, and must be considered as part of a global strategy for safety management. Ramp and ground-handling operations have the potential to cause a major accident, such as through unreported ground-handling damage to aircraft. Costs in maintenance and ramp operations should be a major concern, because aircraft and other equipment are easy to damage and expensive to repair. Indirect costs also include schedule disruption following damage of aircraft or equipment. The ramp and the hangar are also dangerous environments in which to work, given the risk of accidental death or disabling injury. As with flight accident prevention, responsibility for hangar and ramp safety resides at four levels within an organization:

- Senior management;
- Individual supervisors;
- Quality control personnel; and,
- Operational personnel.

Human Errors Occur at Management Level Too

8. Human error is the primary cause for hull losses, fatal accidents and incidents. To devise the appropriate countermeasures, human error must be put into context. Human error in aviation has been almost always associated with operational personnel (pilots, mechanics, controllers, dispatchers, etc.), and measures aimed at containing such error have usually been directed to them. Nevertheless, during the last decade or so, a significant shift toward a substantially different perspective on human error has developed. It has considerable implications in terms of prevention measures and strategies.

9. The aviation system includes numerous safety defenses. Accidents in such a system are usually the result of an unfortunate combination of several enabling factors, each one necessary, but in itself not sufficient, to breach the multiple

layers of system defenses. Because of constant technological progress, equipment failures rarely cause aviation accidents. Likewise, operational personnel errors — although usually the precipitating factors — are seldom root causes of accidents and incidents.

The analysis of recent major accidents both in aviation and in other high-technology industries suggests that it is necessary to look beyond operational personnel errors, into another level of human error: human decision-making failures that occur primarily in managerial sectors.

10. Depending on how immediate their consequences are, human failures can be viewed either as active failures — errors having an immediate adverse effect and generally associated with operational personnel (pilot, controller, technician, etc.) — or latent failures, which are decisions that may not generate visible consequences for a long time.

Latent failures become evident when combined with active failures, technical problems or other adverse conditions, resulting in a break-through of system defenses, thus producing accidents. Latent failures are present in the system well before an accident, and are originated most likely by decision makers and other personnel far removed in time and space from the event. Examples of latent failures include poor equipment design, improper allocation of resources to achieve the declared goals of the organization and defective communications between management and operational personnel. Through their actions or inaction, operational personnel unknowingly create the conditions under which these latent failures become apparent, often with tragic and costly consequences.

The implication for accident prevention strategies is clear. Safety management will be more successful and cost less if directed at discovering and correcting latent failures rather than at focusing only on the elimination of active failures. While it is vital to minimize them, active failures are only the proverbial tip of the iceberg.

11. Even in the best-run organizations, some important high-level decisions are less than optimum because they are made subject to normal human limitations. Typical latent failures in line management include inadequate operating procedures, poor scheduling and neglect of recognized hazards. Latent failures like these may lead to inadequate work-force skills, inappropriate rules or poor knowledge; or they may result in poor planning or workmanship.

12. Management's appropriate response to latent failures is vital. Response may consist of denial, by which operational personnel involved in accidents are dismissed or otherwise punished and the existence of the underlying latent failures is denied; repair, by which operational personnel are disciplined and equipment modified to prevent recurrence of a specific observed active failure; or reform, by which the problem is acknowledged and global action taken, leading to an in-depth reappraisal and eventual reform of the system as a whole. Only the last response is fully appropriate.

To Err Is Normal

13. Error must be accepted as a normal component of human behavior. Humans, be they pilots, engineers or managers, will from time to time commit errors. Exhortations to "be professional" or to "be more careful" are generally ineffective, because most errors are committed inadvertently by people who are already trying to do their job professionally and carefully. They did not intend to commit the errors.

Typical latent failures in line management include inadequate operating procedures, poor scheduling and neglect of recognized hazards.

The solution is to devise procedures and equipment that resist human error. Because technology or training cannot prevent all errors, an equally vital step is to introduce error tolerance into equipment and procedures, so when an error does occur, it is detected and is corrected before there is a catastrophic outcome. Error resistance and error tolerance are important strategies in accident prevention. Of fundamental importance, however, is the recognition that human error must be treated as a symptom, rather than a cause, of accidents and incidents.

14. Psychological factors underlie human error. Often, personnel assigned to tasks do not possess the basic traits or fundamental skills needed to successfully perform them. While formal personnel selection techniques provide some degree of protection, it is impossible to guarantee that all candidates will be able to perform satisfactorily in line operations. The issue is further complicated because proper performance under unsupervised conditions — such as during line operations — rests essentially on proper motivation, and although most professional aviation personnel are highly motivated, other factors can adversely affect such motivation.

Even with these limitations, proper selection techniques constitute an important line of defense. If an organization uses inadequate personnel screening and selection techniques, a latent failure exists within that organization, and may only become manifest through a serious incident or accident.

15. Training deficiencies frequently underlie human error. Training aims at developing basic knowledge and skills required for on-the-job performance; deficient training will obviously foster deficient performance and pave the way for error. Other potential sources of human error include poor ergonomic design of equipment or deficient procedures for using such equipment. Training deficiencies and flawed operational procedures are

latent failures, and thus usually do not have immediate consequences. But, when combined with active failures in operational settings, these latent failures can lead to accidents.

16. Selection, training and equipment design focus on the performance of individuals in the system. Big dividends are obtained by addressing individual performance, but the biggest dividends require a larger frame of reference. Human performance does not take place in a social vacuum, but it is strongly influenced by the environmental, organizational and institutional context in which it occurs. The socioeconomic and legal environment, the way in which the organization is designed and the institutions to which personnel belong, all influence human performance. These are also the breeding grounds for latent failures. From a monetary viewpoint, it makes sense to address latent failures. Canceling one latent failure (for example, training deficiencies) will eliminate multiple active failures, and thereby have a major effect on risk. By focusing on identifying and correcting latent failures, management leverages its ability to control risk.

With the Proper Tools, Human Error Is Manageable

17. The primary message here is that human error is manageable. Error management requires understanding the individual as well as organizational and institutional factors. Human-error accidents, which most accidents are, can then be controlled cost-effectively.

18. Education is an essential prerequisite for effective management of human error. The concepts of accident causation, human error and error management discussed in this brief are the bedrock of such education. Implementing training systems that develop knowledge and skills among operational personnel consistent with organizational objectives, and operational procedures that are compatible with human capabilities and limitations, is fundamental. A quality control system that is oriented toward quality assurance rather than pointing fingers and allocating blame completes the necessary feedback loops to ensure effectiveness of training and procedure development programs.

19. An active management role in safety promotion involves:

Allocation of resources. Management's most obvious contribution to safety is allocating adequate resources to achieve the production objectives of the organization (transporting people, maintaining aircraft, etc.) at acceptable levels of risk.

Safety programs and safety feedback systems. Such programs should include not only flight safety, but also maintenance safety, ramp safety, etc.

Internal feedback and trend monitoring systems. If the only feedback comes from the company's accident statistics, the information arrives too late to be useful for controlling risk, because the events that safety management seeks to eliminate have already occurred. Identification of latent failures provides a much greater opportunity for proactive enhancement of safety.

Incident reporting programs. It has been estimated that for each major accident (involving fatalities), there are as many as 360 incidents that, properly investigated, might have identified an underlying problem in time to prevent the accident. In the past two decades, there has been much favorable experience with nonpunitive incident and hazard reporting programs. Many countries have such systems, including the Aviation Safety Reporting System (ASRS) in the United States and the Confidential Human Factors Incident Reporting Program (CHIRP) in the United Kingdom. In addition to the early identification and correction of operational risks, such programs provide much valuable information for use in safety awareness and training programs.

Besides the national programs, many airlines have found it useful to add their own internal incident reporting systems. These systems can range in complexity and cost from simple and inexpensive telephone "hot lines" to more complex (and usually more cost-effective) systems involving computer data bases, trend identification and monitoring programs, and other sophisticated safety management tools. Some of these systems have been made available to the airline community at a modest cost by their developers.

One notable system is the British Airways Safety Information System (BASIS), which allows active tracking of many different kinds of safety-related information. A similar system, "Safety Manager's Tool Kit," is available from the International Air Transport Association (IATA). Systems like these have tended to show a positive short-term economic benefit in addition to improved operational safety.

Standardized operating procedures. Standardized operating procedures (SOPs) have been recognized as a major contribution to flight safety. Procedures are specifications for conducting actions; they specify a progression of steps to help operational personnel perform their tasks in a logical, efficient and, most important, error-resistant way. Procedures must be developed with consideration for the operational environment in which they will be used. Incompatibility of the procedures with the operational environment can lead to the informal adoption of unsafe operating practices by operational personnel. Feedback from operational situations, through observed practices or reports from operational personnel, is essential to guarantee that procedures and the operational environment remain compatible.

Risk management. The purpose of internal feedback and trend monitoring programs is to allow managers to assess the risks involved in the operations and to determine logical approaches to counteract them. There will always be risks in aviation operations. Some risks can be accepted; some — but not all — can be eliminated; and others can be reduced to the point where they are acceptable. Decisions on risk are managerial; hence the term "risk management."

Risk management decisions follow a logical pattern. The first step is to accurately assess hazards. The second step is to assess the risk involved in such hazards and determine whether the organization is prepared to accept that risk. The crucial points are the will to use all available information and the accuracy of the information about the hazards, because no decision can be better than the information on which it is based. The third step is to find which hazards can be eliminated and proceed to eliminate them. If none of the identified hazards can be eliminated, then the fourth step is to look for the hazards that can be reduced. The objective is to reduce the probability that a particular hazard will occur, or reduce the severity of the effects if it does occur. In some cases, the risk can be reduced by developing means to cope safely with the hazard.

20. In large organizations, such as airlines, the costs associated with loss of human life and physical resources mean that risk management is essential. To produce recommendations that coincide with the objectives of the organization, a systems approach to risk management must be followed. Such an approach, in which all aspects of the organization's objectives and available resources are analyzed, offers the best option for ensuring that recommendations concerning risk management are realistic.

Resources Are Required

21. The safety monitoring and feedback programs should be administered by an independent company safety officer, reporting directly to the highest level of corporate management. The company safety officer and his or her staff must be quality control managers, looking for ways to correct corporate safety deficiencies, rather than pointing fingers at individuals who commit errors.

To discharge their responsibilities for the company and the industry, they need information that may originate through several sources: internal safety audits that identify potential safety hazards, internal incident reporting systems, internal investigations of critical incidents and performance monitoring programs. Armed with information, the safety officer can implement a program for dissemination of safety critical information to all personnel. The stage is then set for a safety-oriented organizational climate.

22. Management attitudes can be translated into concrete actions by the provision of well-equipped, well-maintained and standardized cockpits and other workstations; the careful development and implementation of, and rigid adherence to, SOPs; and a thorough training and checking program that ensures that operational personnel have the requisite skills to operate the aircraft safely. These actions build the foundation on which everything else rests.

Resources Are Available

23. Honest and forthright self-examination is one of the most powerful, and cost-effective, risk-management tools available, and should be performed regularly by all organizations. To help airline managers identify risks and hazards in their organizations, an "ICARUS Self-audit Checklist" is in final development and will be available from Flight Safety Foundation in mid-1995. Its questions are designed to identify specific areas of vulnerability and potential latent failures within a company so that appropriate corrective and preventive measures may be taken. Various sections should be completed by the appropriate organizational elements within a company.

24. Flight Safety Foundation is a valuable and affordable risk management resource. In addition to sponsoring a variety of safety workshops, seminars and other meetings, the Foundation also has a group of operations and safety experts available to conduct independent aviation safety audits. These audits are comprehensive and confidential, and are conducted by senior personnel who have direct experience in airline operations and management.

25. Aircraft and equipment manufacturers also can be a valuable resource for risk identification and management. Manufacturers can be particularly helpful in providing guidance for the development of operating procedures, operating manuals, maintenance and personnel training. Often, they can provide experienced operational and maintenance personnel to help carriers operate their equipment safely and efficiently.

26. Many valuable safety publications are available from government and research organizations to assist managers and decision makers in their safety objectives. Some of the most prominent of these sources of information are:

- Accident investigation reports from national authorities;
- Flight Safety Foundation reports and publications;
- International Civil Aviation Organization (ICAO);
- International Air Transport Association (IATA) ; and,
- U.S. National Aeronautics and Space Administration (NASA).

No matter what resources are available, they will be of the greatest value in a company that demonstrates that aviation safety begins at the very top of its management. ♦

[Editorial note: The preceding article was adapted from a briefing prepared by the ICARUS Committee and presented in a workshop in Geneva, Switzerland, in October 1994.]

Human Factors in Aviation: A Consolidated Approach

The Flight Safety Foundation ICARUS Committee's first two years have resulted in 18 findings and 10 recommendations for actions based on discussion of the findings.

Jean Pinet and John H. Enders
Co-chairmen, ICARUS Committee

The ICARUS Committee was created more than two years ago by former Flight Safety Foundation (FSF) Vice Chairman John H. Enders and FSF Board of Governors Member Jean Pinet to explore ways to reduce human factors–related aviation accidents. Although the analysis of human factors in aviation safety was already being pursued in many places in the world, the Foundation believed that it was important to initiate additional action to synthesize what had been learned. The intent was, and is, to augment and enhance — not to replace — the Foundation's core activities, by posing questions and suggesting actions to the board and, through the governors, to the worldwide aviation community.

Despite the increasing general level of understanding of accidents and their causes, the emergence of new technologies for aircraft design, the development of training methods and equipment, and the growing ability to analyze human behavior and decision-making factors, aviation accidents and serious incidents continue to occur. They include events that were the direct result of decisions and actions of well-trained and highly experienced pilots, although these decisions and actions may have been enabled by other human decisions within the system. The fact that the accident and incident rate has not declined proportionately to the advances in technique that the industry is making on many levels, is the problem that the ICARUS Committee was formed to address.

The FSF ICARUS Committee has received support from major aircraft and equipment manufacturers, airlines, research organizations and regulatory agencies worldwide.

The committee comprises a small, informal group of recognized international experts in aviation who have extensive experience in the human aspects of design, manufacturing, flight operations, maintenance, operating environments and research. These individuals represent a cross-section of current human-factors thinking in the international aviation community. While some of the world's regions are not directly represented, members of the committee are generally familiar with the many industrial, educational and social cultures that intersect aviation operations worldwide.

One international aviation leader recently applauded the committee's efforts as a "small group of wise people" addressing questions that are very important to the aviation community and its customers. He urged the committee to keep itself "lean" in numbers so as not to lose the ability to cut quickly to the cores of issues.

Achieving this required a team limited in number, but representative of all the players in the field. The challenge was to keep the group small enough to enable vigorous and candid debate, yet broad enough to bring as many viewpoints as possible into the discussions. Additional participants with special expertise are routinely invited to join the core committee to augment specific discussions.

The name ICARUS was chosen for its symbolic value. [In Greek mythology, Icarus, who flew with wings made by his father, Daedalus, was such a "bold pilot" that he ventured too near the sun. The wax in Icarus' wings melted, plunging him into the sea.] Icarus was the first to suffer an "accident" because of his incorrect behavior, ignorance of the operational environment and design deficiencies, thus giving the ICARUS Committee a perfect counterexample and a reminder of its objectives.

Although the committee has gathered together competitors and potentially oppositional bodies, the respected rule for its deliberations has been to speak with the greatest objectivity

Flight Safety Foundation ICARUS Committee

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and openness. This makes its meetings extremely productive. The neutral context of the Flight Safety Foundation facilitates the committee's work.

ICARUS Discussion Results In 18 Findings

In 1992, the first ICARUS Committee meeting addressed the basic question of "Why do experienced and well-trained aircrews sometimes act against their experience and training and have accidents?" The members were urged to range broadly in their thinking and discussion. This provoked a wide spectrum of thinking about enabling factors, latent factors and what lies behind mistaken actions. ["The Dollars and Sense of Risk Management and Airline Safety" includes some of the ideas that emerged.]

The meeting resulted in 18 findings, some of which may seem obvious, but they present a thought-provoking picture of aviation operations today. Taken as a whole, the findings provide a means of focusing finite resources on those problems whose solution will result in the greatest savings of life and property.

1. Cockpit behavior is the product of many factors.

Individual and group behavior of crewmembers forms the "tone" of cockpit operations. Crew coordination, communication (intracockpit as well as external), and decision making all flow from the degree of harmony that exists in the cockpit. Crew often bring into the cockpit extraneous matters that can be distracting to themselves and others. The operating philosophy of the organization, whether it is an airline or corporate operator, affects attitudes that prevail in the cockpit. Personal factors often intrude. Personality clashes may not be manageable by some individuals. The availability of critical information (e.g., airplane condition, air traffic control [ATC], weather, and air and ground communications efficacy) can affect the functioning of the crew. The degree of self-discipline and procedural discipline affect the overall cockpit environment and, in turn, determines the level of risk at which the flight crew operates.

These and many other factors, and their potential effect on sound and timely decision making, must be taken into account by management at the organizational and operational levels.

2. Sound aircrew decisions need support and encouragement that the system does not always provide.

The organizational and infrastructure system must give the aircrew sufficient training, direction, information and assistance during critical situations to maximize the integrity of crew decisions. Any failure to do so erodes the safety margin and increases risk, not only to the airplane and its occupants, but to the system and its components. Such support entails, among other things, consistent organizational behavior; ample training for the particular operation undertaken and the equipment to be used; an understanding of shortcomings of the infrastructure so that alternatives may be provided; and reliable weather and facility information. Each of these support factors, and others, are missing in one situation or another, and crews often have to devise last-minute strategies to work around them in dealing with a potentially troublesome situation.

3. Management commitment is vital to support changes in corporate culture.

Much is said about the corporate culture, by which is meant the way in which an organization deals with its day-to-day challenges and strategic initiatives. The current move toward changing the corporate culture to provide a lower risk for those in its care, and in the organization itself, is threatened by managements that fail to actively commit themselves to effective support and productive changes.

A healthy attitude toward safety among employees cannot be achieved unless the organization's leadership is visibly committed and seen to be engaged in risk management. In the words of current management gurus: "Walk like you talk."

4. Operational directives should be realistic and should be supported by consistent management attitudes and behavior.

It is surprising to find many organizations where operational directives are frequently unrealistic and inconsistent. Just as bad laws do not inspire compliance, neither do management attitudes, decisions and behavior that undercut the foundation of a professional, efficient and low-risk operation. Although many of these shortcomings may be caused by carelessness, rather than intent, the effect is the same. Morale suffers, and if not remedied, these situations may put at high risk the flight operation and the continued viability of the organization itself.

5. Peer influence is of great importance in maintaining safe practices.

Social and organizational behavior is greatly influenced by the peer group, as has been demonstrated repeatedly. The aviation operation is influenced heavily by peer behavior, whether a crew tries to outperform a rival company's attempts to land in risky conditions, or an individual overcomes a personal weakness with the support of colleagues. Peer influence has been responsible for fatal accidents and for raising the professional standards of a company's crewmembers. Peer influence is a powerful tool, and should be encouraged to support professional behavior and sound decision making.

6. Professional standards must be given high priority by pilot associations and groups. They have significant opportunity to affect pilot behavior and performance.

This is a corollary to Finding 5. Pilot associations exert strong peer influence, over their members and over other elements in the organization. The professional standards committees, found in many pilots' associations and unions, can be a powerful tool to ensure that operational risk is minimized. The lack of an identifiable professional standards entity within an organization correlates strongly with the perception of higher-risk operations. To be effective, however, the fostering of professional standards must avoid petty organizational politics.

7. The root causes of errors may remain dormant for a long time and only may become evident when triggered by active failures, technical problems or adverse system conditions.

Systems safety analysis often reveals the presence of factors, distant in time or place from the accident/incident event, that "set up" the operator (aircrew, industrial plant operator, ground transportation vehicle, etc.) for the failure. This is the "accident chain of events" that links the initial event to later events that eventually reach the pilot.

Training can overcome most of these situations; however, everyone in the system must find and eliminate such latent problems. This is the foundation of the quality movement, and organizations that effectively apply this approach lower risk to life and property.

8. Crew resource management is an embedded operational behavior. It should be introduced at the earliest (**ab initio*****) stage of a pilot's education and then integrated into the routine of training throughout the pilot's career.***

Experience with crew resource management (CRM) has demonstrated its value in reducing operational risk, when properly taught and applied. Some cultural factors may require special adaptation of CRM techniques, but overall, the use of all resources to operate with high safety levels is the desired goal.

The early assimilation of CRM philosophy into a pilot's behavior and subsequent reinforcement through recurrent training effectively counteracts the carelessness and complacency that are part of the human condition.

9. Firm operational directives are necessary to ensure that modern high-technology cockpit features and options are used effectively.

Modern transport and business aircraft employ technologies that have drastically altered the cockpit environment. Notable among the changes is the increase in modes available to the pilot to control the airplane, either directly or through automation. Some of these modes may be more appropriate to a particular operational scenario than others, and the organization should provide unambiguous directives governing the use of the operationally desired features. Lacking this, the aircrews are subject to non-standard operations that might create additional and subtle opportunities for error.

10. New aircraft technologies surpass the capabilities of the present ATC system. This situation promotes potential cockpit work-load conflicts.

The ability to precisely navigate with modern aircraft equipment and systems gives to the crew capabilities that cannot be used effectively with the present ATC system. Conforming to ATC capabilities, the crew cannot take advantage of the workload-reducing features of the aircraft and its systems.

11. Continued effort and research is necessary to ensure flight crew vigilance and alertness on long-range flights and extended duty time.

The U.S. National Aeronautics and Space Administration's (NASA's) leadership role in fatigue research has yielded new understanding of fatigue during long-range transmeridional flights that can make possible more rational decisions in balancing extended duty times with crew fitness for duty. The prospect for additional value from continued research in this area argues against any lessening of effort. Continuing this research can yield cockpit design, layout and fixtures that promote efficient and low-risk human duty cycles.

12. While total flight time is an important determinant of experience for pilots, the* quality *of past experience must be considered too.

Experience has traditionally been measured by total flight time, time in type, etc. It is also evident that large amounts of hours are not necessarily an accurate indicator of experience. The *type* of experience in accumulating a given number of hours may be more indicative of a pilot's experience level, and should be considered during selection and evaluation.

13. There is a need for professional flight operations management, recognized as a career path with appropriate focused training.

Individuals promoted to management responsibilities should be given the appropriate training, especially when coming from a cockpit position. Establishing a career path for professional flight operations management signals the intent of the organization to provide the individual with the tools that will be needed to deal with the very different world of managing a flight operation instead of flying in it. This practice adds to the efficiency of the organization's operations and minimizes risk of errors that could result in loss of life and property.

14. As aircraft technology becomes more sophisticated, more "disciplined" training is needed to ensure that technical and human-factors needs are met.

Technological advances in aircraft and systems designs promise greater efficiency and reliability. Training operators and maintenance technicians at a level of sophistication commensurate with the technologies introduced is essential. Training is the beneficiary of new technologies that provide alternative means of transferring information in ways that are more easily learned. Ensuring that the level of human performance is linked to the systems' capabilities is essential to achieving the promised efficiencies and reduced risk.

15. The financial health of a corporation is related not only to the direct cost of potential accidents, but also to the public's perception of its commitment to safety.

The financial well-being of an organization affects its ability to conduct operations in a way that meets the industry standard for level of risk. Public perception of a carrier's safety levels affects its ridership and profits. Accident potentials are affected not only by financial problems, but also by managements that are not committed to an operating philosophy that values minimization of accident risk.

16. Safety initiatives will continue to be challenged until their benefits can be determined in financial terms.

New technologies, new procedures, new equipment, additional training, etc., all of which have the potential for improving safety levels, have a cost that will be evaluated against the financial benefit of safety. Managing risk appears to be a more feasible and quantitative approach to this problem, and may offer a means of evaluating the true safety benefits of a particular initiative.

17. Attention should be given to desired attributes and characteristics of pilots, enabling improved preparation for such careers and improved screening of candidates.

Traditional criteria for screening and selecting pilots may not meet future aviation requirements. These criteria should be examined carefully to ascertain what new capabilities exist for evaluating the future performance of candidates for aviation piloting careers and to define new criteria that may or may not include those of today.

18. Language communication difficulties are an important contributor to stress and should be dealt with in preparing pilots for flight-related duties. Some problem areas are: English ATC for those to whom English is not a native language; differing English accents used by ATC in different geographical areas (even within countries); and flight crews comprising individuals with differing language abilities.

Effective communication has been a topic of discussion for many years. With the increasing globalization of air carriers and corporate operators, and with the increased hiring of crew members whose native language may not be that of the employing organization, the potential for misunderstanding and miscommunication is great. In addition, some ATC controllers' lack of fluency in English contributes to the communications barrier. Although pilots and controllers can function effectively in standard phraseology, they may not be able to communicate effectively in an emergency. The problem ranges from difficulty in understanding heavily accented English to a total lack of comprehension. While evidence of accidents and serious incidents caused by language difficulties is elusive, the heavy dependence of the system on the quick and efficient voice transfer of information is at greater risk if this information is miscommunicated, misunderstood or not transmitted at all.

Findings Lead to Recommendations for Action

The ICARUS Committee converted the substance of these findings into 10 recommendations for action by such groups as the Foundation, International Civil Aviation Organization (ICAO), International Federation of Air Line Pilots Associations (IFALPA), industry, governments and academia.

Recommendation 1

Flight Safety Foundation should provide to top management briefings on safety issues and recommendations. Topics would include the:

- Support and encouragement for sound aircrew decisions;
- Importance of visible management commitment to safety and to support operational and technical management;
- Need for professional flight operations/maintenance management training as distinct career paths;
- Encouragement of peer influence on safety attitudes;
- Awareness of latent failures in the system, coupled with their financial risk to the company;
- Necessity for firm operational directives to ensure effective use of modern high-technology cockpit features and options. Manufacturers should encourage operators in this regard; and,
- Need to couple aircraft technologies with disciplined training to bridge human-machine interfaces.

These briefings should be in two forms:

- Traveling "road shows" with small teams of respected experts (no more than two per team) to convey safety concerns to operators' top managements, worldwide, especially to smaller operators (commuter/regional) and operators in less developed countries; and,
- Short, concise (one page or less) written communications sent to top managements, calling attention to one or two safety issues and FSF's recommendations, based on aviation community expertise. Written communications should be simple and frequent, rather than complex and lengthy, to encourage reading and assimilation by busy CEOs and top management.

Recommendation 2

The study by L.G. Lautman and P.L. Gallimore ("Control of Crew-caused Accidents," in *Proceedings of the 40th Annual International Air Safety Seminar*, Flight Safety Foundation, Arlington, Virginia, U.S., 1987, p. 81) should be updated. Although it originally covered customers of only one manufacturer, the update should include all manufacturers' customers.

Recommendation 3

FSF should press countries to provide legal protection of identities in flight operational quality assurance (FOQA) programs to encourage nonpunitive discussions of incidents and to promote the use of FOQA programs among worldwide operators.

Recommendation 4

Prepare and distribute to the aviation community a "yes-no" self-audit questionnaire that will indicate to the user the presence of latent factors that present an unsafe situation for the air carrier (including commuter/regional and corporate operators).

Recommendation 5

Universities and research organizations should continue to promote safety among educators to facilitate assimilation of safety philosophies by their students, who will take their own places in the operational world. Regulatory authorities and manufacturers should encourage embedding crew resource management (CRM) into training programs in accordance with ICAO (Annex I) to achieve more standardization and to address cultural aspects of CRM implementation.

Recommendation 6

Airlines operating advanced technology aircraft should minimize crew confusion by selecting the automation options and methods best suited to their own operations, and training for those options/methods as *preferred* methods. Line flight crews should be involved in the selection of the preferred methods. Command pilots should be permitted to deviate, but only with appropriate briefings to their crews on the reasons for the deviations. Furthermore, authorities should require appropriate principal operations inspector (POI) training with regard to evaluating crews on preferred options.

Recommendation 7

Airlines should improve their air traffic controller familiarization programs. Authorities of all countries should ensure that their controllers are included in flight familiarization programs.

Recommendation 8

Industry and government research should address the problem of crew fatigue, including *quality* of rest at home and at en route overnight stops, to ensure fitness for duty.

Recommendation 9

Operators should attend to the problem of mixed-language flight crews who do not have sufficient language proficiency to deal effectively with nonstandard situations. Managements and pilot associations should evolve a creditable management framework (communications, “bottom-driven” program) to deal with this issue.

Recommendation 10

The principal character profiles and the methods used to determine the current entry-level pilot requirements of major worldwide airlines and corporate operations should be validated. This validation should include consultation with *ab initio* schools and universities to evaluate the selection processes that lead to producing a professional airline or corporate pilot.Work is well underway on Recommendations l and 4. [The first of the briefings to top management on issues outlined in Recommendation #1 is this issue’s lead article: “The Dollars and Sense of Risk Mangement and Airline Safety.”]

The remaining recommendations have been assigned to working groups that will present action plans and time lines at the next ICARUS Committee meeting in early 1995.

As the committee continues to work toward realizing its recommendations, it will consider other safety issues and recommend actions. The committee will continue to involve the expertise of the international aviation community in its deliberations. ♦

[Editorial note: The preceding material was adapted from information presented by John H. Enders and Jean Pinet at an ICARUS Committee workshop held in Geneva, Switzerland, in October 1994.]

Landing Gear Topped List of Aircraft Systems Involved in Accidents During 35-year Period

Control-problem accidents were most often pilot-induced or weather-induced.

Editorial Staff

Commercial Jet Transport Safety Statistics 1993 examines commercial aviation's safety record for 1993, as well as the span from 1958 to 1993— essentially the entire jet transport era. In some cases, the 1992 numbers are also shown.

The study, published by McDonnell Douglas, subdivides its accident statistics in various ways. Among the areas it frames are accidents analyzed according to aircraft systems involved in them; engine-related accidents; and control-problem accidents.

An accident is defined by the study as an occurrence "between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, if between those times any person suffers death or serious injury as a result of being in or upon the aircraft, or by direct contact with the aircraft or anything attached thereto, or the aircraft sustains substantial damage." Accidents were excluded if neither the aircraft's equipment, crew, nor flight operational procedures were at fault.

In the breakdown of accidents by aircraft system (Figure 1, page 14), the statistics are shown for 1958-1993 and also for 1992 and 1993 individually. In all three of those periods, landing-gear problems were a factor in the highest number of accidents. (More than one system could be involved in any event.) There were 456 landing-gear-related accidents during the 35-year period, or an average of about 13 per year; that average was exceeded both in 1992 and 1993, with landing gear playing a role in 21 and 23 accidents, respectively.

For the longest period, an engine was involved in the second highest number of accidents (192, or an average of about 5.5 per year). The corresponding figure for 1992 was 14; for 1993, seven. Although variations from one single year to another are not statistically significant as evidence of a trend, there were impressive decreases between 1992 and 1993 in wing-related accidents (from 11 to four) and flight-control-related accidents (from 15 to three).

Among engine-related accidents (Figure 2, page 15), uncontained engine failure was the largest category in the 35-year period, with 62 events for an average of about 1.8 per year. Next most common in that period were engine fire/warning (47 events total), power loss (43 events total) and foreign object damage (FOD, 39 events total). In 1992 there were five engine fire/warning accidents and five in which the engine departed the aircraft, both well above the 35-year average. In both those categories, the 1993 number dropped to one.

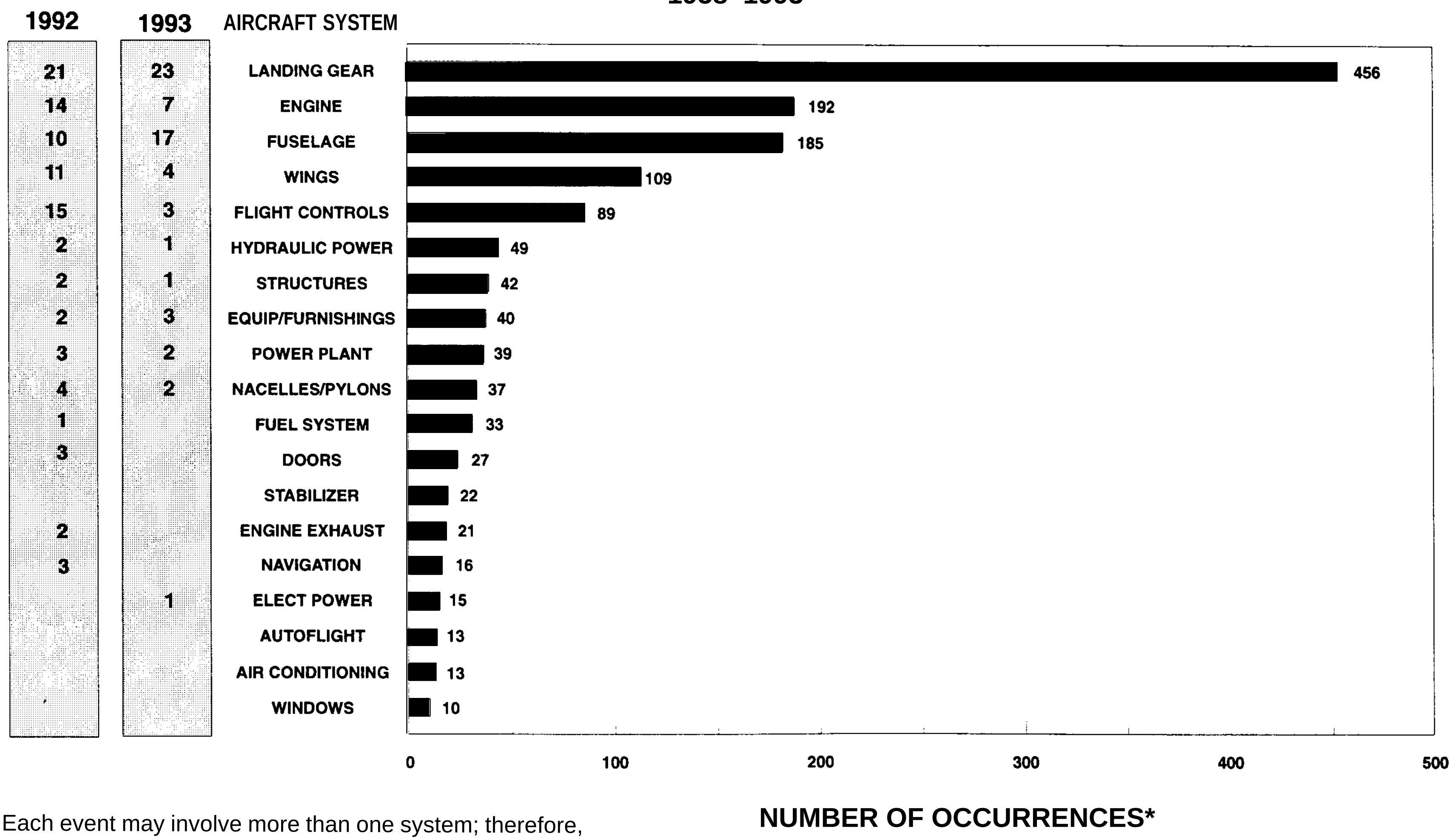
The highest incidences of control-problem accidents over the period 1958-1993 (Figure 3, page 16) were pilot-induced (124) and weather-induced (72). Pilot-induced, and also weather-induced, control-problem accidents are further subdivided in the study. Improper use of flight controls (39 events), hard landings (34 events) and failure to maintain directional control (31 events) were the largest categories.

Weather was accounted responsible for failure to compensate for wind (27 events), failure to maintain directional control (16 events) and hard landings (16 events).

The study includes only Western-built jet airliners, and does not state whether there were any retrictions on country of registration. ♦

Accidents by Aircraft System

Commercial Jet Transport Aircraft
1958–1993

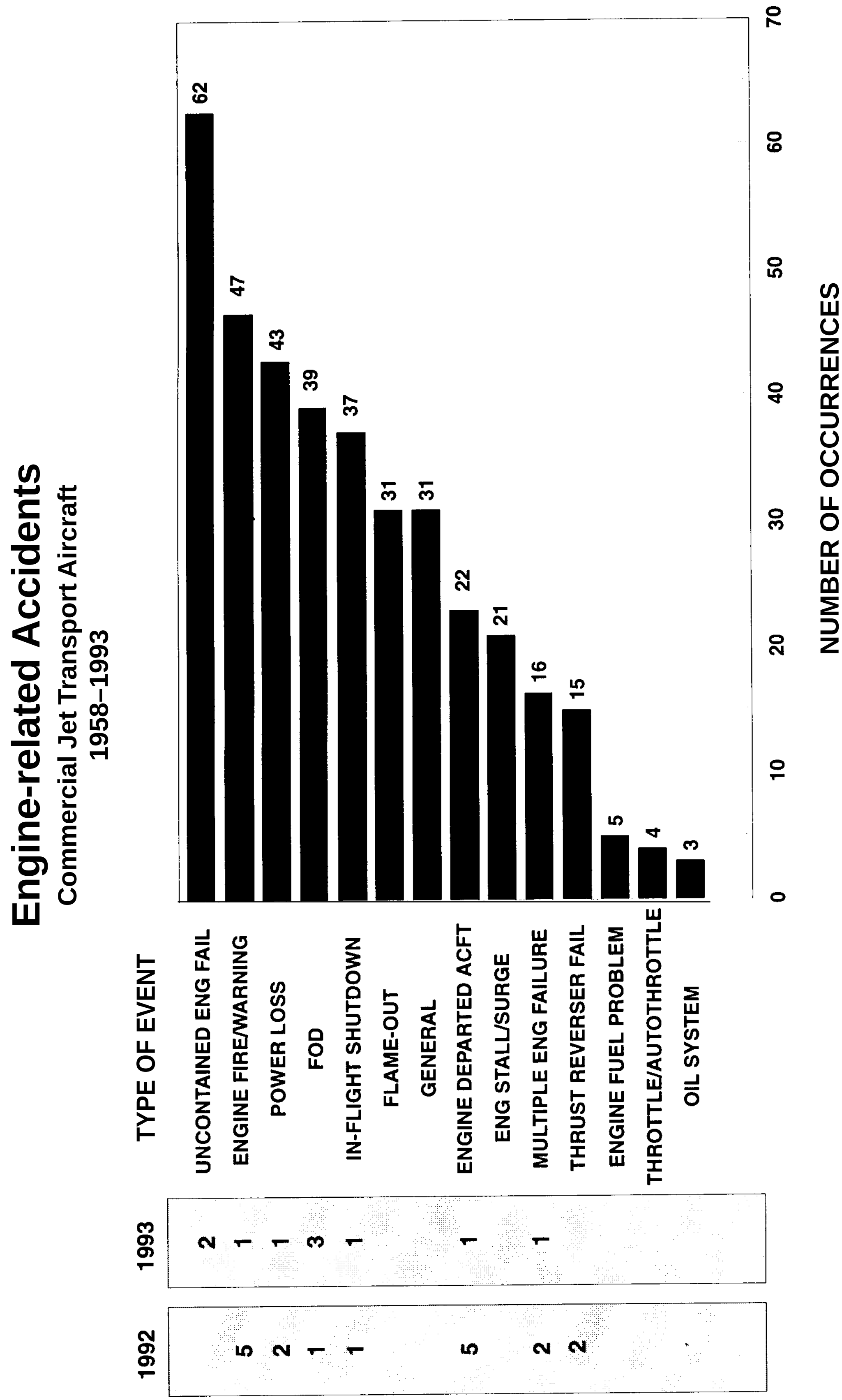


Each event may involve more than one system; therefore, the sum of the items may be more than the total accidents of this type.

Source: McDonnell Douglas

* Chronological sequence of systems' involvement in accidents, shown on original, could not be reproduced here for technical reasons.

Figure 1

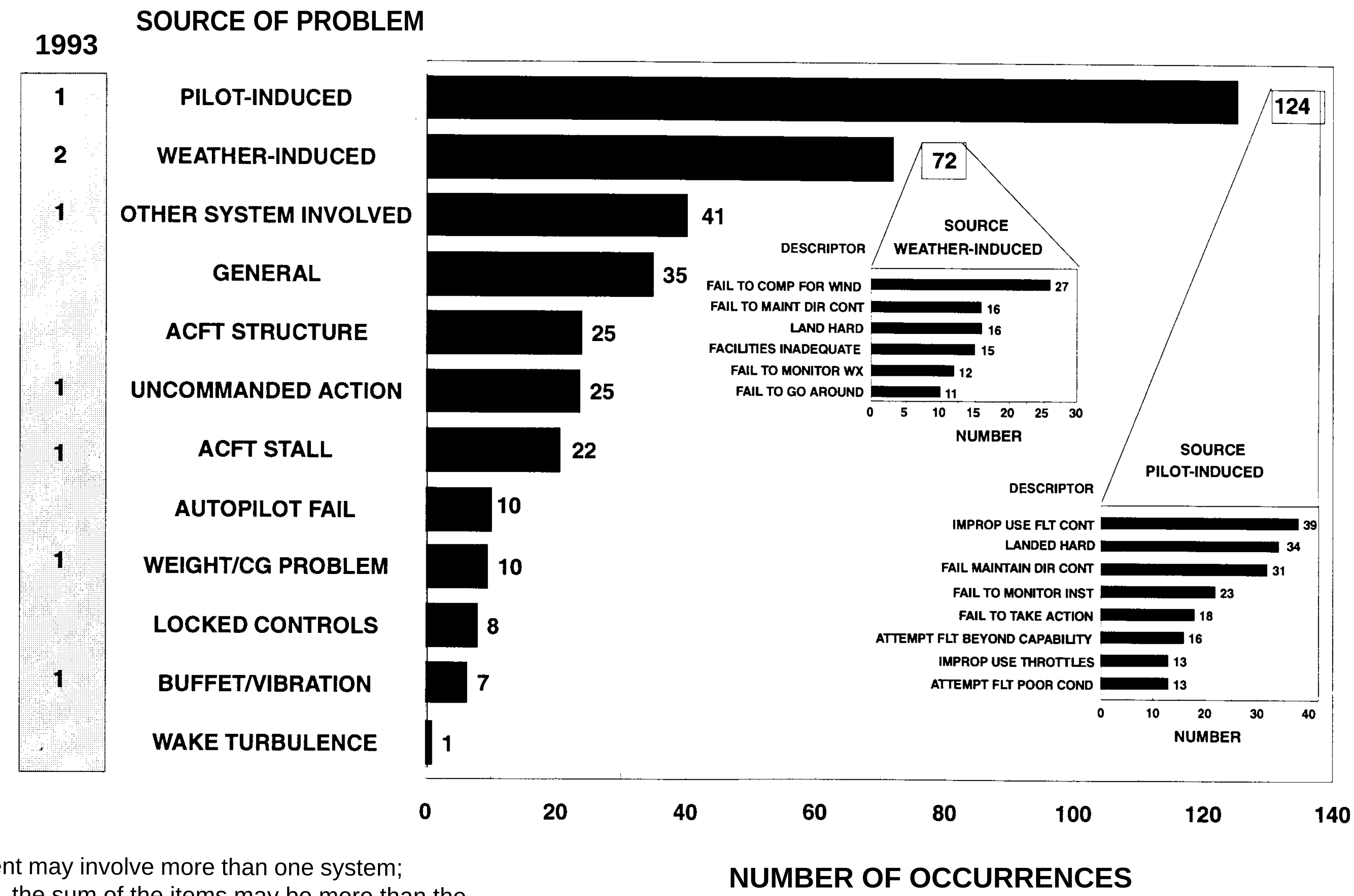


Each event may involve more than one system; therefore, the sum of the items may be more than the total accidents of this type.

Source: McDonnell Douglas

Figure 2

Control-problem Accidents
Commercial Jet Transport Aircraft
1958–1993



Each event may involve more than one system; therefore, the sum of the items may be more than the total accidents of this type.

Source: McDonnell Douglas

Figure 3

Publications Received at FSF Jerry Lederer Aviation Safety Library

U.S. FAA Advisory Circular Offers Guidance On Preventing Misuse of Unsalvageable Aircraft Parts

Another U.S. report provides text of testimony to U.S. Senate on proposed ATC corporation.

Editorial Staff

Recent Reports Cataloged

Disposition of Unsalvageable Aircraft Parts and Materials. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) No. 21-38. July 1994. 4 p.

Summary: Owners of aircraft parts commonly dispose of unsalvageable parts and materials by selling them, discarding them or transferring them. These parts have sometimes appeared for sale and in active parts inventories in the aviation industry.

Aimed at people who are involved in selling, maintaining or disposing of aircraft parts, this AC provides guidance and information to prevent unsalvageable aircraft parts and materials from being sold as usable.

The Aircraft Certification Systems Evaluation Program. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) No. 21-39. August 1994. 5 p.

Summary: The U.S. Federal Aviation Act of 1958 charges the FAA with making inspections to determine that aircraft, aircraft engines, propellers and appliances can provide safe operation. Resulting from its experience with Quality Assurance Systems Analysis Review (QASAR) audits and observations made during Operation SNAPSHOT, and to ensure continued safety in the constantly changing aircraft manufacturing environment, the FAA has reviewed its certificate management process and implemented new initiatives in its policies and operations.

The Aircraft Certification Systems Evaluation Program (ASCEP) is a comprehensive evaluation program used by the Aircraft Certification Service in its certificate management and continued airworthiness regulatory program. ASCEP has replaced QASAR to meet the new initiatives. This AC provides information and guidance about ASCEP.

Crewmember Training on In-flight Radiation Exposure. U.S. Federal Aviation Administration (FAA). Advisory Circular No. 120-61. May 1994. 2 p.

Summary: In their work, crews are exposed to low doses of ionizing radiation from cosmic radiation and air shipments of radioactive materials. The FAA has provided information concerning in-flight radiation. [See "Effects of Radiation Exposure on Air Carrier Crew Members Examined," *Cabin Crew Safety,* July–August 1993.]

A 1987 U.S. presidential document recommended that workers and their managers be instructed on the possible health effects of the radiation, and on protective measures if the workers are exposed to ionizing radiation. This AC recommends subjects that should be covered in such programs.

The AC provides an outline of courses, but says that actual subject material should be gathered by the air carriers.

Advisory Circular Checklist (and Status of Other FAA Publications for Sale by the U.S. Government Printing Office (GPO). U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) No. 00-2.8. June 1994. 75 p.; appendices.

Summary: This checklist, which includes a revised list of U.S. Federal Aviation Agency (FAA) advisory circulars (ACs) and the status of other FAA publications sold by the U.S. Government Printing Office (GPO), is normally issued each October. The 1994 list was issued earlier because of an increase in the number of updated ACs.

Primary Category Aircraft. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) No. 21-37. 13 p. This AC provides guidance for complying with the Code of Federal Regulations (CFR) certification procedures for products and parts (Part 21, Subchapter C, Chapter 1, Title 14 of CFR) by explaining one acceptable means to ensure compliance with Federal Aviation Regulations (FARs) Part 121 §21.24 ("Issuance of Type Certificate: Primary Category Aircraft"). The AC discusses type, production, airworthiness certification, maintenance procedures and operating limitations, but does not discuss other general certification requirements common to aircraft and applicable to primary category aircraft. [from purpose].

Gas Turbine Prediffuser-Combustor Performance During Operations with Air-Water Mixture. Laing, P.; Murthy, S.N.B. Report No. DOT/FAA/CT-93/52. A special report prepared for the U.S. Federal Aviation Administration (FAA) Technical Center. August 1994. 139 p.; ill., appendices. Available through the National Technical Information Service (NTIS)*.

Keywords:
1. Water Ingestion
2. Hail Ingestion
3. Turbofan Engine
4. Combustor Performance

Summary: Commonly reported events include the loss of power and difficulty maintaining a flame in the burner of a bypass jet engine during a rain or hail storm; the report says that both are direct results of changes in prediffuser-combustor performance because of water in the air. The report chronicles an investigation to establish how water ingestion changes the performance of an aircraft gas turbine engine. The report says that the investigation was carried out on a sector of an annular prediffuser-combustor of a typical bypass jet engine with a core engine and a supercharger.

Low-dose Alcohol Effects on Human Behavior and Performance: A Review of Post-1984 Research. Holloway, Frank A. Report No. DOT/FAA/AM-94/24. A special report prepared for the U.S. Federal Aviation Administration (FAA) Civil Aeromedical Institute (CAMI). 50 p. Available through the U.S. National Technical Information Service (NTIS)*.

Keywords:
1. Alcohol
2. Human Performance
3. Low Dose
4. Low BAC
5. Reviews
6. Subjective Effects
7. Performance Tasks

Summary: This report surveys literature that examines the effects of low doses of alcohol on human behavior and performance. The survey examined 155 empirical studies dating from 1985 through mid-1993. The report says that conclusions drawn from the survey largely agreed with conclusions of previous reviews: The kinds of performance most sensitive to the effects of alcohol in low doses depended on the analysis of skills or abilities (selective attention), the kind of task (divided-attention tasks), task characteristics (multiple tasks with high demand and/or complexity) and categories of alcohol effects (negative subjective effects and controlled performance).

Aviation System Indicators. U.S. Federal Aviation Administration (FAA) Office of Safety Information. September 1994. 94 p.; ill.

Summary: This report presents aviation system and environmental indicators developed by the FAA to provide a comprehensive view of the U.S. national aviation system and operation through June 30, 1994. Data for 23 aviation system indicators and 12 aviation environment indicators are included; three additional system indicators are under development.

Blink Rate as a Measure of Fatigue: A Review. Stern, J. A.; Boyer, D. Schroeder, D.J. Report No. DOT/FAA/AM-94/17. A special report prepared at the request of the U.S. Federal Aviation Administration (FAA) Office of Aviation Medicine. August 1994. 16 p. Includes references. Available through NTIS.

Keywords:
1. Blink Rate
2. Fatigue
3. Performance
4. Vigilance

Summary: Fatigue can affect the performance of pilots and air traffic controllers, and blink rate is one psychophysiological measure proposed to assess fatigue associated with time on task (TOT). This report, a literature review, is an outgrowth of a study about the relationship between several gaze measures and TOT performance of subjects on an air traffic controller monitoring task. Evidence is presented that variables other than TOT also affect blink rate. ♦

Accident/Incident Briefs

Boeing 737 Takes Off on Taxiway in Darkness, Low Visibility and Rain

Airliner barely clears taxiing commuter aircraft.

Editorial Staff

The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

Air Carrier

Distractions Contribute to Taxiway Departure

Boeing 737. No damage. No injuries.

Paperwork arrived late in the cockpit for the flight, and the crew was under time pressure to complete weight calculations and other inputs for an on-time departure.

It was the first flight of the day for the crew and the first officer's third leg of line training.

Preparations were being completed in the predawn darkness, with low visibility and rain.

The tower cleared the flight to proceed by the inner taxiway to Runway 36R. During taxi, the aircraft was stopped briefly while the captain again updated weight figures. The tower then cleared the aircraft to line up for takeoff and takeoff clearance quickly followed. The crew finished the final checklist items as the aircraft turned the corner for a rolling takeoff. The first officer was the pilot flying.

During the takeoff roll, the captain's attention was diverted to correcting a thrust imbalance. Neither the captain nor the first officer realized that they had taken off from the outer taxiway (located between the inner taxiway and Runway 36R) instead of Runway 36R until they saw a commuter aircraft taxiing toward them at the far end of the taxiway. The B-737 became airborne and cleared the commuter aircraft.

Hard Landing Buckles Landing Gear

Fokker F28. Substantial damage. No injuries.

The twin-engine F28 made a hard daylight landing in severe gusting winds. The aircraft touched down first on the left main gear, followed by the right main gear.

After touchdown, the right main gear unlocked, was forced inward and collapsed. The aircraft slid to a stop on its right wing. An emergency evacuation was begun and all 71 passengers and five crew members escaped injury.

Air Taxi Commuter

Commuter Crashes After Risky Approach

L410 Turbolet. Aircraft destroyed. One fatality. Eleven serious injuries.

The Czech-made, twin-engine turboprop commuter was on approach to a Russian airport in poor weather when it crashed into a hillside.

Investigators determined that the pilot had elected to continue a visual approach without visual contact with the ground. One passenger was killed and nine passengers and one crew member were seriously injured.

Other General Aviation

Drunken Joyride Proves Fatal

Beech 55 Baron. Aircraft destroyed. One fatality.

The pilot was observed drinking alcoholic beverages from about 1600 hours until just after midnight. A taxi drove the pilot to the small airport about 0200. The twin-engine Beech aircraft was reported missing during a ramp check at 0600.

Witnesses reported seeing the aircraft making low passes over a village between 0235 and 0305 hours. The wreckage was located two days later at the 10,600-foot (3,233 meter) level of a mountain about 12 miles (19 kilometers) southeast of the airport.

Corporate Executive

Four Killed After Airplane Descends Below Glideslope

Cessna 401. Aircraft destroyed. Four fatalities.

The aircraft attempted to land at its destination airport but the weather prevented a visual flight rules (VFR) approach and the pilot diverted to an airport equipped for instrument flight rules (IFR) approaches.

After a missed instrument landing system (ILS) approach, the aircraft collided with terrain. An investigation determined that the pilot had allowed the aircraft to descend below the glide slope and the aircraft impacted terrain on the runway heading.

The pilot and three passengers were killed.

Rotorcraft

Flight into Instrument Meteorological Conditions Kills Three

Bell 206. Aircraft destroyed. Three fatalities.

The helicopter, operating as an air taxi, was en route at about 1,500 feet (457 meters) mean sea level (MSL) at night when the pilot reported that he was concerned about deteriorating weather conditions.

The pilot radioed another company helicopter that he intended to climb to 2,000 feet (610 meters) MSL and reassess the weather. After reaching 2,000 feet, the pilot said that he intended to continue the flight. A few minutes later the pilot reported that he was inverted. The helicopter crashed into trees and was destroyed by the impact and post-crash fire. The pilot and two passengers were killed. Weather at the time of the accident was visual meteorological conditions (VMC) with 1,000 feet (305 meters) scattered and visibility five miles. ♦

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presents the

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FLIGHT SAFETY DIGEST
 ISSN 1057-5588

Staff: Roger Rozelle, director of publications; Girard Steichen, assistant director of publications; Kate Achelpohl, editorial assistant; Rick Darby, editorial consultant; and Jean H. Zephir, production consultant.

Subscriptions: US$95 (U.S.-Canada-Mexico), US$100 Air Mail (all other countries), twelve issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 2200 Wilson Boulevard, Suite 500, Arlington, VA 22201-3306 U.S. • telephone: (703) 522-8300 • fax: (703) 525-6047

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