Probabilistic Risk Assessment And Aviation System Safety

The author describes some of the work the Flight Safety Foundation has performed in examining current and leading safety indicators, emphasizing probabilistic risk assessment and the treatment of human performance issues in risk assessment.

by
Dr. Leonard A.Wojcik
Director of Research
Flight Safety Foundation

(Based upon a paper presented at the Fifth International Symposium on Aviation Psychology at Ohio State University, April 17-20, 1989)

Last year, the Flight Safety Foundation (FSF) was contracted by the U.S. Federal Aviation Administration (FAA) to begin an attempt to develop quantitative safety indicators for the U. S. air transportation system. The air transportation system was divided into: the air traffic system, consisting mainly of airport and air traffic control personnel, facilities, equipment and procedures; and operations, consisting mainly of airline, general aviation and military aviation activities.

Current and leading safety indicators were to be developed for both components, starting with the air traffic system. Current indicators apply to the present, and leading indicators apply to the future. The current indicators could be used by the public and by the U.S. Congress to make sense out of safety and accident statistics that are difficult to interpret. The leading indicators could be used by government regulatory authorities, airlines and other parties to anticipate safety-related problems and, hopefully, reduce the accident and fatality rate. Although the sponsored work on safety indicators was specific to the U.S. air transportation system, FSF is pursuing related work under FSF sustaining member support to extend the indicator concept to the worldwide air transportation system.

Our basic finding from the preliminary work is that attempting to develop quantitative safety indicators is worthwhile, regardless of whether the final objective is reached, because the effort will focus needed attention on aviation safety from a system-wide viewpoint. This paper describes progress to date on developing safety indicators, with two emphases: a promising approach to quantitative indicators based on probabilistic risk assessment, and treatment of human performance issues in risk assessment through management and organizational factors.

Safety and performance indicator systems have been developed before in aviation and other industries. The U.S. Department of Transportation's Transportation System Center developed the Air Carrier Analysis System (ACAS) for the U.S. Department of Defense following the 1985 Gander, Newfoundland, accident that killed 248 U.S. soldiers. ACAS scores candidate air charter operations in five categories, and includes software and data to permit users to analyze the air charter operations in more detail.

In the U.S. nuclear power industry, the Institute for Nuclear Power Operations (INPO) and the Nuclear Regulatory Commission (NRC) have performance indicator systems for individual nuclear plants. Both INPO and NRC distinguish between "overall" indicators, which require relatively little interpretation but are subject to time lags compared to subjective evaluations of nuclear plant safety levels, and "process" indicators, which are more timely but require more interpretation.

NRC developed three major safety management goals (low frequency of transients, high availability of safety systems, and inherent design features and low potential for cognitive error) to guide its performance indicator system and applies a total of seven "overall" indicators to measure performance with respect to the goals. NRC uses the seven indicators as an initial screen in its deliberations to determine which plants merit increased regulatory attention (3). Both INPO and NRC are acutely aware of the limitations of quantitative performance indicators and use the indicators in conjunction with other methods, including plant inspections. More recent NRC work includes a search for "leading" indicators that show changes several months in advance of the overall indicators (11).

Defining Three Safety Goals

The initial approach we at FSF tried, in our effort to develop quantitative safety indicators for the air traffic system, was to define a set of three safety goals, in analogy to NRC's safety goals for nuclear plants. The goals were based on knowledge of safety factors and future developments expected in aviation. The approach would then require that quantitative "overall" indicators be found that measure how well the system is doing (or is expected to be doing, for leading indicators) with respect to each of the goals.

The first goal is: Low Frequency of Accidents and Incidents. This goal is perhaps obvious, and the types of current indicators that would apply to this goal would be counts of accidents and incidents involving the air traffic system. Fortunately, accidents are rare, so a fairly long time interval for counting them would be necessary, and an indicator based on accident rates would not be sensitive to recent changes. Incidents are more common, but they suffer from observation and reporting problems. Also, the goal does not provide any guidance on leading indicators. Hence, the first goal by itself is not sufficient.

The second goal is: Adequate Capability to Meet Demand. Perhaps the greatest challenge the air traffic system will face in the future is increased demand, and it is prudent to monitor the present and projected future demand/system-capability situation for signs of trouble spots. Indicators for this goal would include measures of demand such as departures, normalized against various measures of system capability and capacity, such as airport capacity, air traffic controller staffing levels and equipment technician staffing levels. Projections of these quantities could be used to generate leading indicators.

The third goal is: Limited Potential for Serious Human Error. This goal was selected for two reasons: first, most accidents involve human error at some level and second, automated technologies raise questions about human error in both the present and future system. Quantitative indicators (especially leading indicators) are difficult to develop for this goal, but current indicators might include some subset of operational errors for air traffic controllers.

The air traffic system safety goals provide guidance on the types of indicators needed and how the indicators could be organized to address specific safety issues. Thus, the safety-goal method is a top-down way of looking at indicators. The other necessary component of safety indicator development is more bottom-up, and addresses the qualities that any individual quantitative indicator should have. We derived the following set of desired attributes of any individual air traffic system safety indicator:

- Related to accidents and incidents;
- Measurement and reporting of high quality;
- Data readily available; and,
- Desired attributes for special cases.

A study of existing measures identified no set of measures that quantifies how well the system is doing (or will be doing) with respect to all three safety goals and is strong in each desired attribute for every individual measure. All measures have their own strengths and weaknesses.

Probabilistic Risk Assessment

The safety-goal approach described above could be used to produce a safety indicator system, but it would be limited by the weaknesses of the individual measures. Also, the safety goals themselves might not adequately address system problems. These limitations, along with an interest in entirely new types of measures, led us to consider risk itself as a safety measure and a possible basis for quantitative safety indicators.

The major limitation of risk as a safety measure is that it is not completely observable, so subjective estimates must be made at some level of analysis. Probabilistic risk analysis necessarily entails uncertainty, and is controversial in the nuclear industry for this reason, but useful risk assessment systems have been developed for providing insight into nuclear plant operations and maintenance (4). Risk assessors need a flexible system that reflects actual system operations, so they can vary assumptions and develop operational insight. These considerations must be kept in mind when modeling air traffic system risk.

The air traffic system is enormously complex, so choosing an appropriate level of detail for risk modeling is important. Too much detail would be prohibitively expensive and time-consuming, and too little detail would not yield a useful model. An air traffic system risk model almost certainly needs to deviate from classical risk modeling, which attempts to model and estimate the probability of every possible failure mode. Also, the model should be structured to permit a simple initial implementation with potential for upgrade to a more sophisticated and detailed model.

A nodal model of traffic flow, similar to National Airspace System Performance Analysis Capability (NASPAC) models developed by the FAA, together with an aircraft risk model based on numbers of aircraft in each node, is a good starting point. Risk at any instant could be determined from the traffic levels at that instant, and risk over a time interval could be determined by integration over time. Individual aircraft risk would include risk from one-aircraft accidents based on past history of accident rates, and two-aircraft accidents based on past history and number of potential collision pairs in each node. Other factors that influence risk, such as weather conditions, unusual traffic patterns, controller staffing levels, working conditions at air traffic control facilities and so on, could be gradually incorporated into the model. Also, as new technologies, such as Traffic Alert and Collision Avoidance System (TCAS), provide more risk information and change risk levels, the initial model must be refined. This approach to air traffic system risk modeling would capture the basic dynamic of the system, which is traffic flow, and could be used to identify potential safety hot spots in the future as traffic levels grow.

A simplified version of this model puts the entire U.S. National Airspace System in one node and represents traffic by annual departures for each type. These simplifications wash out spatial and temporal variation in traffic levels, which may be crucial, but the simplified model is useful anyway for illustration. If some (probably reasonable) estimates of risk per potential collision pair are made based on past accident rates, it is possible to obtain a value for an indicator of safety for Part 121 scheduled traffic as a function of year. The indicator is proportional to an estimate of expected number of departures per fatal accident and normalized to 100 in 1986.

Under these assumptions, the value of the indicator for 1981 is 99.4; in other words, a scheduled Part 121 flight in 1986 was 0.6 percent "safer" than in 1981. The reason is that in 1981 there was more general aviation traffic and more unscheduled Part 135 traffic than in 1986, which produce a greater collision risk for scheduled Part 121 traffic in the model for 1981 than 1986. The difference in estimated risk levels between 1981 and 1986 is miniscule and would take centuries to confirm in a controlled experiment involving the entire airspace system. The practical impossibility of confirmation illustrates both the danger (reaching conclusions that cannot be rigorously confirmed) and the power (reaching conclusions that are beyond the purview of rigorous statistics) of risk assessment. Small risk level changes are typical when traffic levels change by small amounts from year to year; but, collision risk is proportional to the product of traffic levels of potential collision pairs, so collision risk may increase faster than traffic levels.

Management and Organizational Factors

More detailed air traffic system risk modeling requires understanding and modeling of operations and conditions at individual air traffic control facilities, including possibilities for human error. Human performance in aviation operations, including airline, general aviation and military aviation activities, presents an even greater challenge. It is probably not reasonable, however, to attempt to model the behavior of individual humans in the system, for two reasons. First, any reasonable attempt to do so in a system as complex as the air transportation system is bound to be unwieldy. Second, models would be hard-pressed to incorporate human resourcefulness in potential accident situations. A better approach is to model conditions that are conducive (or not conducive) to the right kinds of behavior.

Some of the conditions have been studied by psychologists and are reasonably well understood, such as work schedules that allow adequate sleep. Other conditions related to management and organizational factors are more difficult to observe and quantify. These are the conditions for safe operations, including "self-organizing" behavior, in the language of systems analysis, where individuals and organizations adapt to changing and unforeseeable conditions (10). Accident causal factors cited by investigative authorities usually, though not always, emphasize technology, the physical environment and human factors at present, an emphasis partly due to "stop rules" of investigators searching for accident causes (7).

There is a growing awareness of the role of management and organizational factors in aviation accidents (1,6). Following the general perspective of Simon's *Administrative Behavior* (9), human performance issues in organizations can be addressed through explicit relationships between organizational conditions and individual and group psychological factors affecting safety performance. These relationships would hold regardless of the details of organizational structure and cultural context.

Many models and factor analyses of organizations and management exist, including some specific to aviation safety. One model is a set of 14 system safety tasks that constitute a comprehensive, specialized accident prevention effort (6). Another model is the Boeing Commercial Airplane Company's extensive list of primary elements of safe airline operations (5). Boeing's list is an excellent beginning for detailed evaluation of airlines, and similar lists could be constructed for air traffic control facilities, as well as higher levels of organization, such as the entire air traffic control system and the triad of airlines, manufacturers and regulators.

The list can also be supplemented by additional proactive safety management programs for accident prevention, safety information and emergency response preparation (8). Yet another model is the set of four factors important to airline safety (pilot competence, maintenance quality, financial stability and management attitude) developed by the U.S. Congress' General Accounting Office (2). This set of four factors is a fine summary of concerns among experts, but is not really comprehensive and the factors seem to be at various distances from actual safe operations — pilot competence is very close to safe operations, while financial stability is indirectly related through a series of causal connections which might not apply in all cases.

Connecting Individual and Group Psychological Factors

This paper suggests another model of management and organizational factors for safety based on four factors — discipline, awareness, communication and skill — which can be used to organize the key elements of safe operations in the Boeing study and relate the key elements to individual and group psychological factors. The model is certainly subject to revision, but may be a useful starting point as is. The four factors can be understood in ways that permit a connection to individual and group psychological factors that influence safety. For example, discipline in this case does not refer to punishment, or even rigidity with respect to rules, but something close to simplification. That is, exercise of discipline is attention to detail appropriate to a situation without unneeded complication.

The discipline of limiting conversation between crew members in the cockpit during critical portions of flights simplifies the situation for pilots so they can devote their attention to flying the aircraft. The discipline of following standard operating procedures simplifies choices for pilots to those appropriate to the situation. Discipline is necessary for safety because, as we know from personal experience and from numerous psychological experiments, human performance suffers at some level of complexity. However, rigidity for its own sake is not discipline in the sense described here if it does not simplify or is not appropriate to the situation.

The other three factors, awareness, communication and skill, can be discussed in similar terms. Briefly, awareness is a larger perspective, beyond the immediate details, and includes intellectual activity, such as putting knowledge together to guide useful action. Communication is a group activity that develops out of discipline and awareness in social situations. Skill is refined from basic capabilities. The next step is to understand how the factors operate in aviation organizations and to incorporate the factors into an overall risk assessment.

The Building of an Awareness

Probabilistic risk assessment is a promising avenue to aviation system safety indicators, if not used too rigidly, because good risk assessment constantly prompts questions about what factors or events could come together in one place to cause an accident. Risk assessment must acknowledge both human performance limitations and human resourcefulness; perhaps the best way is through management and organizational factors that influence behavior. A comprehensive aviation risk assessment capability, incorporating operational, management and organizational factors, is clearly a long-term goal, but efforts to achieve it could help increase awareness of incipient safety problems. ♦

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About the Author

Dr. Leonard A. Wojcik joined the Flight Safety Foundation in July 1988, where he has worked on the FAA-sponsored Safety Indicators project, the General Accounting Office (GAO) air traffic controller survey, FSF Sustaining Members-enabled development projects (including the Safety Audit Review and the Crew-Associated Accident Study), the technical development of the Lederer Library, and assorted statistical analyses. His special interests include organizational and human factors, the impact of automation on safety, government aviation policy and aviation weather safety.

Prior to joining the FSF staff, he was a policy analyst at the Office of Technology Assessment of the U.S. Congress, specializing in transportation policy. He co-authored the reports Safe Skies for Tomorrow *and* Construction and Materials Research and Development for the Nation’s Public Works.

A Coincidence of Adverse Circumstances And Poor Decisions?

The author enumerates various adverse factors affecting modern-day aviation safety and calls for an improved interrelationship between the aircraft, the crews and the operational and natural environments in which they operate.

by
Laurie Taylor, OBE, FRAeS.

Aviation accident investigators are familiar with the concept of unrelated but coincident circumstances combining to cause an accident, but it is now apparent that these mechanisms are present on a larger scale in current operations of the international civil air transport industry — and to a degree that may require new and coordinated efforts if the present barely-acceptable rate of accidents/incidents is not to regress to the unacceptable rate of 20-30 years ago. Although these circumstances first manifested themselves in the United States, they are present to some degree in other regions, particularly in Western Europe.

These adverse factors arise from a recent rapid growth of air transport; an economic environment that depresses profit margins and leads to airline leadership by marketing men instead of the technically qualified; a tendency for governments to distance themselves from regulatory activity for reason of fashionable political philosophy and — somewhat contrarily — a technical excellence in aircraft design and manufacture that may be the cause of a reduced standard of human performance from engineers and flight crews.

The Effects of Growth

Growth in air traffic has resulted in shortages of experienced managers, engineers, pilots and air traffic controllers, with recruitment inevitably leading to a reduced average level of experience in employees who have a direct responsibility for air safety.

The same growth of air traffic has outpaced provision of a suitable operational environment, causing nearly unacceptable pressures on air traffic control service in the air and on the surface of airports, leading to delays at best, or to "near hits" or collisions. A major cause of these increased pressures upon air traffic services is the widespread adoption within the U.S. of a hub-and-spoke route network system that requires air journeys to be routed through congested major airports that most passengers would prefer to avoid. These hub and spoke networks may proliferate in Western Europe after 1992, when most obstacles to a single and largely deregulated European civil air transport industry seem likely to be removed. (In Western Europe, air traffic control is still a national responsibility with fragmented airspace leading to massive and unresolved problems of coordination.)

The adverse effect of ATC delays on air safety cannot be quantified but are believed to be real with flight crew duty periods extended to the limits permitted by state regulations, causing cumulative fatigue and disrupted sleep patterns. At the same time, too few air traffic controllers are working obsolescent systems to their traffic flow limits, again resulting in stress and fatigue that threaten air safety.

Carefully constructed aircraft servicing and maintenance schedules of airline engineering departments are disrupted, creating hidden pressures to "get that airplane back in the air," perhaps with more airplane defects being carried forward than is proper. Aircraft maintenance problems are greatly increased by continuing operation of an aging fleet, as a result of the combined effects of a 20-year plateau of aircraft performance, and low fuel costs, causing airlines — for the first time — to use airplanes beyond their original design lives. The fearsome consequences of "geriatric" airplanes, inadequate maintenance and an absence of effective supervision by the regulatory authority are being shown on the front pages of world newspapers causing intending passengers to ask travel agents, for the first time, "How old is the plane on which I will fly?"

In a catch-22 situation, airlines planning to replace their aging airplanes find manufacturers quoting a three year waiting list for the most popular models, and are therefore faced with a choice of continuing to operate an aging fleet or to reduce service and accept a lesser market share. As the leadership of airlines now rests with marketing and not operations or engineering types, that is not much of a choice. (Are there any remaining airlines with chief engineers and chief pilots who are in a position to tell the chief executive, "You cannot do that?")

The Economic Environment

Studies in both the United Kingdom and the United States have caused regulatory authorities to link together money-losing airlines and an increased threat to air safety. This is why, in both countries, increased surveillance by the authorities follows upon a detected slide to unprofitability with the reason being that major elements of expenditure under the direct control of an airline are aircraft maintenance, training and man-power levels — all likely to directly affect safety.

With direct airline subsidies and national ownership being out of favor, the choices left to a struggling airline are few, resulting in corporate decisions being taken that would have been resisted some years ago. Extended range operations (EROPS — operation of two-engined aircraft over routes formerly the preserve of three- or four-engined aircraft) and the use of so-called combi-aircraft with passengers and potentially dangerous cargo sharing the same cabin atmosphere and greatly reduced possibilities of detecting and containing a fire or other hazardous condition, are only two of these decisions.

Other examples are corporate decisions to await airworthiness directives (ADs) being issued by regulatory authorities before taking action on structural repair recommendations made by aircraft manufacturers, and the removal of two emergency exits from Boeing 747 aircraft, by some non-U.S. airlines.

In earlier years, national airworthiness and operational requirements were regarded as a "last resort" safeguard, but they now have become a corporate objective for many airlines. The passenger-carrying capacity of airliners has been increased by reducing the "seat pitch" to only 28-29 inches in some operations, with adverse consequential effects on emergency evacuation times, an effect worsened when combined with an aisle width of only 20 inches.

Problems of Regulatory Authorities

Whenever a national economy is weak or a political philosophy of allowing market forces to predominate is in vogue, "expensive" mechanisms of government are attacked. It is paradoxical that an industry with a worldwide growth rate in excess of five percent, has static, or even reduced, levels of funding provided to the agencies that regulate it. In these circumstances, it is almost impossible to train, hire or retain qualified persons who are the technical equal of those they are to supervise.

Civil service pay structures are almost always inappropriate for application to highly technically qualified persons, and when combined with inadequate overall funding result in a severe shortage of inspectors and managers. This is a worldwide problem and is probably most acute in developing countries that see state-trained engineers and air traffic controllers leave government employment to join industry or commerce so as to enjoy better rewards. The end result of all these factors in both developing and developed countries is that the agencies that are supposed to regulate manufacturers and operators of aircraft do not have the qualified personnel and other resources to do so. The safety consequences of this failure of government are real and growing.

The Machine Progresses

Each successive aircraft type has been better designed and constructed than preceding types, and can be operated by a two-pilot flight crew and require fewer maintenance man hours per available seat mile. However, these improvements have not yet resulted in realization of the near-perfect safety levels of which the aircraft are capable, and in some cases this may be a result of a mismatch between the machine and the men who operate and maintain them.

The boundary of authority between flight crews and automatic systems may not yet be optimum, and it seems probable that an argument on what is to be displayed to the pilot or to be hidden on a "there is no need to know" basis will continue for some time to come. Some features of glass cockpits and automated systems may need to be changed if the possibility of human error in operations is to be reduced. By way of example it can be argued that a system design aimed at the lowest possible work load in normal operations may not be the best way to ensure error-free and fast human performance in adverse circumstances. A secondary, but related, consequence of an excess of automation is a reduced level of technical knowledge of aircraft systems by the pilot-crews which is likely to prove to be a significant disadvantage when the inevitable unforeseen event occurs.

The latest aircraft are not designed to make inspection as easy as it should be, as is shown by failures of well-equipped maintenance organizations to detect significant cracks and areas of corrosion in aircraft structures. Perhaps the excellent designs and construction techniques of the aircraft manufacturers have reduced the troubleshooting and anticipatory qualities of the engineers?

Possible Solutions To The Situation

The present, somewhat uneasy relationship between the International Civil Aviation Organization (ICAO), member states, national regulatory bodies, aircraft and system manufacturers, airline operators and organiza tions representing professional engineers, pilots and air traffic controllers needs review and improvement. All these organizations should jointly study and improve the interrelationship between the machines, their human operators and the operational and natural environments in which they operate. An improved distribution of safety-related information is essential to this task and human factors is likely to be the most rewarding of all these studies. Finally, the national regulatory bodies should be given appropriate terms of reference and resources adequate to ensure that all airworthiness and operational regulations are enforced. ♦

About The Author

Laurie Taylor flew with the British Royal Air Force in World War II and later with British Overseas Airways Corp. (BOAC) and its successor, British Airways. Taylor was chairman of the British Air Line Pilots Association (BALPA) and served as principal vice president, and later executive secretary of the International Federation of Air Line Pilots Associations. He has sat on the council of the U.K. Air Registration Board and was a member of the Airworthiness Committee of the International Civil Aviation Organization (ICAO) and of the Flight Time Limitations Committee of the U.K. Civil Aviation Authority (CAA).

He was awarded the Order of the British Empire (OBE), is a member of the Association of British Aviation Consultants and is a fellow of the Royal Aeronautical Society.

Taylor is the author of "Air Travel, How Safe Is It?" published by BSP Professional Books.

Exit Row Seating Survey

Passengers assigned the emergency exit row seats must have the maximum capability to react to crisis situations.

by

Allen K. Mears
Director of Special Projects
Flight Safety Foundation

Civil aviation is not only for the able-bodied adult. Throughout the world, commercial air transportation is open, to varying degrees, to a cross section of passengers that mirrors the demographics of society. Many people and many countries regard scheduled air carriers as a necessity in conducting business and in conducting the daily routine of life.

In the United States, the Air Carrier Access Act of 1986 requires, among other provisions, that handicapped persons not be discriminated against when passenger seating assignments are made. The intent of the act is to provide for equal access for all individuals as long as passenger safety is not compromised. Comments on that act led the Department of Transportation (DOT) to issue Notice of Proposed Rulemaking (NPRM) number 88-9, titled *Nondiscrimination on the Basis of Handicap in Air Travel.* While NPRM No. 88-9 was out for comment, offices within the Federal Aviation Administration (FAA) grew concerned about one aspect of possible rulemaking that had the potential of developing into a safety hazard. The concern was that new rulemaking might require the airlines to seat their passengers without regard to a passenger's location relative to emergency and normal exits. This would mean that handicapped and disabled passengers could be seated at emergency exits. In what amounted to a tentative advance notice of proposed rulemaking, the Congressional Relations office of the FAA asked the Flight Safety Foundation to consider if existing guidance was sufficient to allow handicapped access to commercial carriers but without impacting on the safety of the other passengers and crew, especially during emergency egress.

The Foundation elected to offer an opinion based on the input from as many of our members as wanted to participate with us. To accomplish that membership opinion, we conducted a survey of all our members. We mailed out 485 surveys and received 115 responses. Not overwhelming perhaps but our 24 percent response is enough to be statistically valid. Figure 1 shows the questions and responses that can be most easily quantified. The responses don't always total the precise number because some individuals did not answer all questions. Airlines and corporate aviation responded quite heavily (Figure 2), and the overall response, as shown in Figure 3, reflects our worldwide membership. When that response is tabulated for only the airlines, our international diversity becomes more apparent (Figure 4).

Survey Results

As a FSF member, your group classification is.

- 49 ☐ Airline
- 5 ☐ Manufacturer
- 3 ☐ Education or Training Institute
- 8 ☐ Energy Company
- 32 ☐ General or corporate
- 8 ☐ Government
- 3 ☐ Insurance Company or Bank
- 7 ☐ Professional

Your primary geographic region of operations is

- 61 ☐ North America
- 3 ☐ Central America
- 2 ☐ South America
- 26 ☐ Europe
- 5 ☐ Africa
- 4 ☐ Asia
- 4 ☐ Middle East
- 12 ☐ SE Asia/Australia

Does your organization have a policy on the seating of handicapped or disabled persons in exit rows?

- 57 ☐ Yes - written
- 19 ☐ Yes - oral or by common practice
- 37 ☐ No

For Airlines

- 47 ☐ Yes - written
- 1 ☐ Yes - oral or by common proctice
- 0 ☐ No

If you answered yes - written, or yes - oral or by common practice, to the above, what is that policy?

- 1 ☐ No restrictions to exit row seating.
- 11 ☐ No handicapped or disabled seating in seat adjacent to exit.
- 36 ☐ No handicapped or disabled seating in the row adjacent to exit.
- 2 ☐ Other.

Figure 1

Respondents by Category

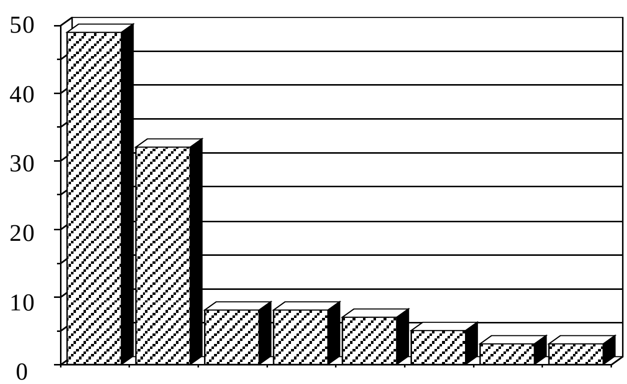

Figure 2

Respondents by Area of Operation

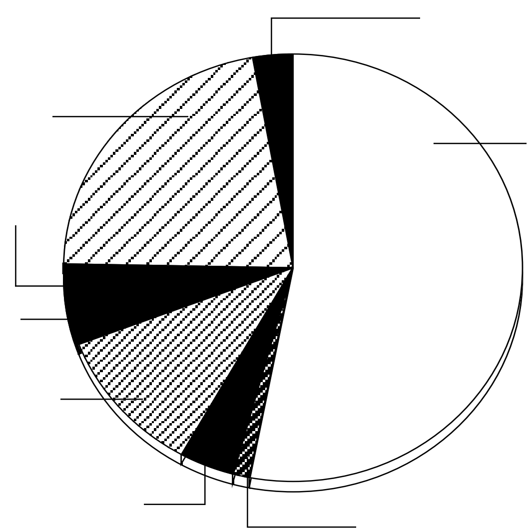

Figure 3

Part of our investigative process included a series of inquires to, and discussions with individuals representing several disabled and handicapped organizations and special interest groups. These discussions were enlightening, frequently intense, and showed that a broad range of issues were in need of resolution. The issue of equal access has many sides to it, including equal exit concerns and treatment for passengers that does not lead to embarrassment or ridicule.

Our survey showed a strong consistency among U.S. and other air carriers where exit row seating policy is concerned, and a consistency with previous FAA reviews of air carriers procedures. Of all the airlines in our survey, 98 percent have a written policy on the seating of handicapped or disabled persons. Of that airline group, 98 percent limit or restrict the seating to some degree.

Airlines By Areas of Operation

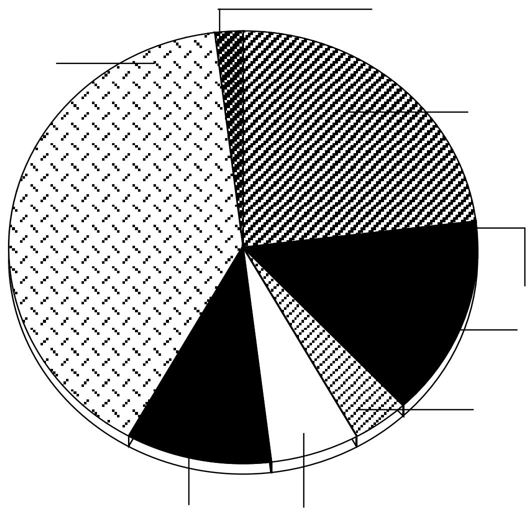

Figure 4

From a strict aviation safety standpoint, the Flight Safety Foundation supports the argument that handicapped individuals not be seated in rows adjacent to normal and emergency exits. We support the position that Federal Aviation Regulations should clearly prohibit the seating of handicapped persons in exit row seats . We also support the position that exit row seating should be denied to individuals, in addition to the handicapped, who would not be reasonably expected to be able to operate the exit openings during the crisis that an emergency egress would engender. Our position on these matters reflects the nearly unanimous consensus of our international membership.

During our research and survey, we often received responses worded in a manner that really did not quantify the answer. When asked to "define or give examples of what your organization regards as 'handicapped' or 'disabled,'" many responded by indicating that such a person was one who "needed help exiting the aircraft" or one who "needed assistance not extended to other passengers." This concept is a major concern to many disabled persons because they feel they do not "need help exiting the aircraft."

The Flight Safety Foundation agrees on that point with many disabled individuals, and has great empathy for their high level of self-confidence and abilities. We greatly respect the human spirit many disabled people exhibit in their desire to be treated equally. Even as we applaud and admire the perseverance and assertiveness of handicapped individuals, we do not support the proposal that the handicapped individual be the one to determine if he or she is able to operate the emergency exits in a crisis, in which such actions may affect the survivability of others, in addition to themselves. People assigned to exit rows must be able to respond to the entire spectrum of emergency scenarios and need to be able to receive instructions from the cabin crew by any and all sensory means.

For the safety of the individuals and the flying public, people with certain disabilities, including the legally blind, should not be given the responsibility to act a certain, correct, way during a crisis. There are blind people who may be capable of easily operating emergency exits and who might aid the flight crew in conducting an emergency evacuation. However, neither the flight crew nor ticketing personnel can tell who those individuals are.

There is another issue buried within this topic that the Foundation wants to address. Many disabled people perceive a dual standard practiced by some airlines. This is not a designed dual standard but, even though accidental, it creates substantial tension and bad press. The issue here is one of denying exit row seating to people with classic handicaps, while allowing other people, of often lesser physical capabilities, to occupy those same seats.

Our study and research revealed several instances where such people were seated in exit tows. There were cases where small children were placed next to exits. Also noted were cases where very frail or elderly people were seated in exit rows. As groups, neither one would likely be able to help in an emergency. Furthermore, there is a great possibility that they would exacerbate the problem. Individuals such as children or very frail people should be included in the list of those who are not seated immediately adjacent to an exit.

Another contentious issue is the serving of alcoholic beverages to individuals seated in exit rows. How many drinks can any given individual consume before his mental faculties are degraded to the point where he will impede the emergency egress of the airplane? If exit row seating is important, should passengers assigned there be allowed to drink? This is a very old issue but one that keeps generating turmoil for the airlines and one that makes handicapped people wonder why they can't sit in exit rows. We support limiting alcohol consumption to two drinks per passenger, no matter where they sit, but especially to those sitting in exit rows.

The Flight Safety Foundation believes that a coordinated program should exist between airline safety managers, flight crew personnel and ticketing agents (including travel agencies) to restrict exit row seating to those individuals who can reasonably be expected to be able to physically and emotionally respond to the responsibilities attendant to operating an emergency exit during a crisis situation. Pre-airport arrival seat assignments enjoyed by many passengers makes it difficult to ensure such restrictions. Although the issues of access for handicapped passengers and exit row seating are highly sensitive, we recommend avoiding seating the following individuals in emergency exit rows:

- Those whose mental or physical condition requires them to travel with an escort:
- Stretcher cases;
- Nonambulatory;
- Blind;
- Deaf;
- Extremely obese;
- Pre-teen children;
- Frail;
- Very elderly; and,
- Inebriated

As with many situations, people do not always fit neatly into these categories. As time goes by however, criteria should be developed on which type of passenger can sit in exit rows as the industry does further testing on seat spacing, hull width and aisle width as they affect ease of emergency egress.

The Foundation offers two observations. First: Whatever seating policy is adopted should be consistent with protecting the lives of the greater number of passengers. Second: Though we found no evidence that lives have been lost because a handicapped person impeded traffic flow, we believe this is because most airlines already restrict exit row seating.

With the rapid expansion of air travel that has increased access to flight for a much broader spectrum of the public, it is especially important to ensure that passengers assigned to emergency exit row seats have the maximum capability to react to a broad range of emergency situations.

Our survey and discussions with special interest groups show a need for closure between the various positions and that many avenues are available to do that. As with any sensitive issue, there are misperceptions at work and dialog between regulatory agencies, air carriers and passenger groups needs to continue. ♦

Reports Received at FSF Jerry Lederer Aviation Safety Library

Books:

Air Travel, How Safe Is It? Laurie Taylor. Oxford: BSP Professional Books, 304p. 1988. ISBN: 0632023325. LC Call No: TL553.5 .T28 1988.

Table of Contents: The role of international organizations; human factors; machines and air safety; the natural environment; the operational environment; flight operations and air safety; costs versus air safety; the accident record; accident investigation; international law, security and aviation crime; military interception of civil aircraft; advanced technology.

Future development of the U.S. airport network: preliminary report and recommended study plan. National Research Council, U.S. Transportation Research Board. Sponsored by the Federal Aviation Administration of the U.S. Department of Transportation. 46p. 1988. ISBN: 0309046718. LC Call No: TL726.2.N29.

Jane's All the World's Aircraft 1988-1989. Compiled and edited by John W. R. Taylor. Jane's Information Group Limited, Surrey, U.K. ISBN: 0710608675. LC Call No. TL501 .J32.

Current products of the world's aircraft manufacturers, civil and military. "The annual record of aviation development and progress."

Reports:

Injuries to Seat Occupants of Light Airplanes. Eugene J. Colangelo and Julie C. Russell. Civil Aeromedical Institute. U.S. Federal Aviation Administration. Report No. DOT/FAA/AM-89/3. February, 1989. 26 p. Available: NTIS*.

A series of 55 light-airplane accidents was examined in an effort to demonstrate the role of seats in the genesis of injury in seat occupants. Case selection attempted to include only those events in which significant but not extreme accelerations occurred. Ten of the 55 cases involved joint failure of seats and restraint systems. No reliable marker of energy level was found in the data collected to control the finding that large accelerations tend to injure people and damage seats as well as most other structures regardless of the other interrelationships that might be involved. The existence of seat damage does little, by itself, to define the seat's role in injury causation. Interpretation of injuries established by clinical and autopsy observations suggests that the large majority of injuries are caused by mechanisms which can proceed independently of seat failure. Restraint systems likely play the more important role.

Aviation Safety: [U.S.] FAA action plan for Chicago O'Hare International Airport. U.S. General Accounting Office. Report No. GAO/RCED-89-114. April, *FAA Statistical Handbook of Aviation. Calendar Year 1987.* (U.S.) Federal Aviation Administration. 182p. 1987. Available: NTIS* — Order #ADA200917.

This report presents statistical information pertaining to the FAA, The National Airspace System, Airports, Airport Activity, U.S. Civil Air Carrier Fleet, U.S. Civil Air Carrier Operating Data, Airmen, General Aviation Aircraft, Aircraft Accidents, Aeronautical Production and Imports/Exports, and a Glossary of the terms used. 1989. 19p.

GAO reviewed U.S. FAA's action plan to address air traffic control problems at O'Hare. GAO reports that FAA is making a concerted effort to improve the situation at O'Hare. Recruiting, retaining, and training controllers at O'Hare have been longstanding problems, and much of the equipment that supports these operations at O'Hare is aging or difficult to maintain. FAA actions have resulted in some immediate relief to O'Hare's personnel problems. However, the impact of all action plan initiatives to improve staffing, training, and equipment will not be known for some time. More specifically, staffing has increased at O'Hare as a result of action plan initiatives, but FAA believes the key to further improvement rests with the success of FAA's project to increase pay at O'Hare and other facilities. FAA actions to improve training are not complete or fully implemented, but actions such as simulator enhancement should improve O'Hare's capability to train developmental controllers. Distinct from the action plan, FAA has taken other steps to improve operations at O'Hare by monitoring and controlling the number of aircraft arriving in the Chicago airspace. According to FAA, controls over arrivals to Chicago will continue even after the action plan is fully implemented.

Statistical Summary of Commercial Jet Aircraft Accidents. Worldwide Operations, 1959-1988. Boeing. Report No. 4-U80070-1. 1989. 36p.

The accident statistics presented in this document are applicable to worldwide commercial jet operators for aircraft heavier than 60,000 pounds maximum gross weight, but do not include turboprop aircraft, Russian-manufactured or -operated, or military operators of commercial-type aircraft.

Aeronautical Decision Making — Cockpit Resource Management. Richard S. Jensen. Prepared for Systems Control Technology by Ohio State University Research Foundation Aviation Psychology Laboratory. Contract No. DTFA01-80-C-10080. Report No. DOT/FAA/PM-86/46. January 1989. 190p. Available: FSF Jerry Lederer Aviation Safety Library, $20 U.S., Canada and Mexico, $30 all other countries.

This manual is designed to explain the risks associated with flying activities involving multi-crew aircraft, the underlying behavioral causes of typical accidents, and the effects of stress on pilot decision-making. The objective of this material is to enhance interpersonal communication and to facilitate effective leadership and coordination between crew members. It provides a sophisticated approach to developing concerted action based on optimal decision-making. Several Cockpit Resource Management (CRM) principles are presented in the manual; included are delegation of responsibilities, prioritization, vigilance and monitoring, joint discussion and planning, and receptive leadership techniques. This manual is one of a series on Aeronautical Decision Making of which several are available in the library.

National Plan to Enhance Aviation Safety Through Human Factors Improvements. Prepared by the Human Factors Task Force in Cooperation with Industry and Government. Air Transport Association of America, Washington, D.C. April 1989. 23p.

Presents a national plan for a (U.S.) government and private sector effort to reduce human error on the flight deck and air traffic control environments. The overall goal of the five-year program is to enhance aviation safety by developing and implementing human factors technology capable of reducing, by 50 percent, the rate of incidents and accidents caused by human error, and to provide a basis for preventing such events in the future. The plan addresses nine program elements which are discussed in detail.

Aviation Occurrence Report. Aeroflot Ilyushin IL 86 86075, Gander, Newfoundland, 19 March 1987. Canadian Aviation Safety Board. Report No. 87-A74916. 13 September 1988.

The aircraft was landing in Gander after a scheduled flight from Havana, Cuba. As the captain initiated the flare, the aircraft entered an area of reduced visibility in fog. The aircraft touched down, moved to the left, and tracked along the edge of the runway for 1,082 feet before returning to the center line. The landing gear broke four runway lights and four taxiway lights, and a cowling was torn off the number one engine pod when it struck a snowbank 42 feet to the left of the runway edge. The CASB determined that, while attempting to land from an unstabilized approach, the pilot brought the aircraft below the altitude prescribed by the standards of the USSR Civil Aviation Ministry for the performance of the missed approach manoeuvre. The pilot was unable to maintain the aircraft on the runway center line because of the lack of adequate visual references when dense fog was encountered during the landing flare. Contact with a snowbank that was parallel to the runway and that was higher than specified by Transport Canada guidelines contributed to the aircraft damage.

Aviation Occurrence Report. Aeroflot Ilyushin IL 86 86074, Gander, Newfoundland, 19 March 1987. Canadian Aviation Safety Board. Report No. 87-A74917. 13 September 1988.

Aeroflot Flight 345B was on a ferry flight from Moscow to pick up passengers stranded from Aeroflot flight 346 at Gander. After completing an instrument approach and landing in instrument meteorological conditions at Gander, the aircraft ran off the right-hand side of runway 13. The aircraft tracked through the snow for 1,444 feet before it returned to the runway. During this excursion, the aircraft sustained minor damage to the lower engine cowlings on the numbers one and four engines. The CASB determined that, while attempting to land from an unstabilized approach, the pilot brought the aircraft below the altitude prescribed by the standards of the USSR Civil Aviation Ministry for the performance of the missed approach maneuvre. The pilot was unable to maintain the aircraft on the runway center line because of the lack of adequate visual references when dense fog was encountered during the landing flare.

Aircraft Accident Report — Continental Airlines, Inc., Flight 1713, McDonnell Douglas DC-9-14, N626TX, Stapleton International Airport, Denver, Colorado, November 15, 1987. U.S. National Transportation Safety Board. Report No. NTSB/AAR-88/09. September 27, 1988. 93p. Available: NTIS*, Order No. PB88-910411.

Continental Airlines Flight 1713 was operating as a regularly scheduled, passenger-carrying flight between Denver, Colorado, and Boise, Idaho. The airplane was cleared to take off following a delay of approximately 27 minutes after deicing. The takeoff roll was uneventful, but following a rapid rotation, the airplane crashed off the right side of runway 35 left. Both pilots, one flight attendant, and 25 passengers sustained fatal injuries. Two flight attendants and 52 passengers survived. The NTSB determined that the probable cause of this accident was the captain's failure to have the airplane deiced a second time after a delay before takeoff that led to upper wing surface contamination and a loss of control during rapid takeoff rotation by the first officer. Contributing to the accident were the absence of regulatory or management controls governing operations by newly qualified flightcrew members and the confusion that existed between the flightcrew and air traffic controllers that led to the delay in departure. The safety issues discussed in the report include pilot training, aircraft deicing procedures, and wingtip vortex generation and lifespan.

Hazardous Materials Incident Report — In-Flight Fire, McDonnell Douglas DC-9-83, N569AA, Nashville Metropolitan Airport, Nashville, Tennessee, February 3, 1988. U.S. National Transportation Safety Board. Report No. NTSB/HZM-8802. September 13, 1988. 69p. Available: NTIS, Order No. PB88-917006.

American Airlines Flight 132 departed Dallas/Fort Worth International Airport, Texas, for Nashville Metropolitan Airport, Tennessee, with a 104-pound fiber drum of textile treatment chemicals loaded in the midcargo compartment along with passenger luggage. Undeclared and improperly packaged hazardous materials inside the fiber drum included five gallons of hydrogen peroxide solution and 25 pounds of a sodium orthosilicate-based mixture. While in flight, a flight attendant and a deadheading first officer notified the cockpit crew of smoke in the passenger cabin. The passenger cabin floor above the ceiling of the midcargo compartment was hot and soft, and the flight attendants had to move passengers from the affected area. The captain, who was aware of a mechanical discrepancy with the auxiliary power unit on an earlier flight which resulted in in-flight fumes, was skeptical about the flight attendant's report of smoke. No in-flight emergency was declared. After landing, the captain notified Nashville Ground Control about the possibility of fire in the cargo compartment, and he requested fire equipment. The flight attendants then initiated procedures to evacuate the airplane on the taxiway. Shortly thereafter, the 120 passengers and six crew members evacuated the airplane. After the plane was evacuated, crash/fire/rescue personnel extinguished the fire in the cargo compartment. The report discusses several safety issues including the undeclared and improperly prepared hazardous materials, the performance of the cargo compartment, the performance of the flight crew and flight attendants after smoke was discovered, and factors that affected the survivability of the passengers, flight crew, flight attendants, and ground crew.

Aircraft Accident Report — Horizon Air, Inc. deHavilland DHC-8, Seattle-Tacoma International Airport, Seattle, Washington, April 15, 1988. U.S. National Transportation Safety Board. Report No. NTSB/AAR-89/02. March 6, 1989. 65p. Available: NTIS, Order No. PB89-910402.*

On April 15, 1988, a deHavilland DHC-8 took off from the Seattle-Tacoma International Airport. Shortly after takeoff, the aircrew noted a power loss on the right engine and decided to return to Seattle for a precautionary landing. After the crew lowered the landing gear on final approach, a massive fire broke out in the right engine nacelle. Because all directional control and braking ability was lost, the aircraft crossed a grass median area, entered the paved ramp area, and struck a runway designator sign, several baggage carts, and two jetways. The airplane came to rest against another jetway. Four of the 37 passengers sustained serious injuries. The airplane was destroyed by the fire and impact. The safety issues discussed in this report include: the nacelle cowl design of the DHC-8, design and maintenance practice concerning the generator brush access cover and electrical lead-in port on P&W PW120A engines, shoulder harness/jump seat hold-up strap wear on the DHC-8, and design and use of the closet/wardrobe on the DHC-8.

*U.S. Department of Commerce, National Technical Information Service (NTIS), Springfield, VA 22161 U.S. Telephone: 703-487-4780

Regulations/Advisories:

AC 20-133. Cockpit Noise and Speech Interference Between Crewmembers. (U.S.) Federal Aviation Administration. 3/22/89. 19p.

This AC provides information about the relationship between flight crew cockpit voice communication and cockpit noise levels. Guidance on speech interference levels, noise measurement and measurement systems, and methods to improve cockpit communication is provided for those manufacturers, owners or operators who believe cockpit noise may be a problem on their aircraft. This guidance material is relevant to the operation of all types of civil aircraft.

AC 121-30. Guidelines for Developing an Anti-Drug Plan for Aviation Personnel. (U.S.) Federal Aviation Administration. 3/16/89. 15p.

This AC provides guidelines for developing an anti-drug plan as required by the final rule entitled "Anti-Drug Program for Personnel Engaged in Specified Aviation Activities" (53 FR 47024; 14 CFR 61, 63, 65, 121, and 135). The anti-drug plan format is shown in Appendix 1. ♦

Aviation Statistics

An Update of U.S. Transportation Fatalities Calendar Year 1988

Statistics recently released by U.S. National Transportation Safety Board (NTSB) reveal that fatal injuries in all forms of transportation rose by 213 persons, to 49,550, in 1988. This is the fifth consecutive year that all transportation fatalities show an increase. Over the past five years, the annual increase of transportation fatalities average about one percent. The figure on page 15 shows the transportation fatalities as compared with the increase of highway fatalities and the decrease of aviation fatalities.

Highway fatalities accounted for 94 percent of all transportation fatalities, increasing to 46,730 in 1988 from 46,390 in 1987. This made 1988 the worst year for highway fatalities since 1981, when 49,301 persons died. Since the number of fatalities involving aviation, marine and rail in 1988 is lower than those in 1987, the overall increase in transportation fatalities in 1988 is primarily attributed to the increase of highway fatalities. In calendar year 1988, the biggest increase in highway fatalities involved passenger cars and pickup trucks/van. Passenger car deaths rose by 207 and pickup truck/van by 141 persons. There were 218 fewer deaths, however, from motorized cycles and 44 less in pedalcycle. The increase of highway traffic fatalities in recent years, as revealed by the statistics of the U.S. Federal Highway Traffic Administration, is attributable to driving while under the influence of drugs or alcohol. Of all drivers killed in highway fatal accidents, more than 20,000 fatalities in 1987 and more than 24,000 in 1988 were alcohol-related.

In 1988, aviation fatalities decreased by 8 to 1,160. General aviation fatalities accounted for 796 persons, which were a record low; commuter air carrier and air taxi operators recorded only 79 fatalities which were 44 fewer or one-third less than in 1987. Airlines, however, recorded three fatal accidents accounting for 285 fatalities, which were 53 more than in 1987.

Marine fatalities declined, by 88, to 1,066 persons, of which 120 were in commercial operations. The death toll from recreational boating last year fell from 1,036 in 1987 to 946, the lowest annual total since the first such statistics were first compiled in 1961.

Rail fatalities decreased in all segments, by 52, to 564 persons, of which 18 were on-board passengers and

515, or 91 percent of total fatalities were pedestrians. Grade crossings in highway and rail accounted for 689 fatalities, up 65 from 1987. Fatalities related to pipeline transportation rose from 9 to 30, with all but two involving natural gas. The table below is a breakdown of fatalities for all forms of transportation. ♦

U.S. Transportation Fatalities[a]

			1987	1988	Changes
Highway[b]	Passenger Cars		25,132	25,339	+207 (.8%)
	Pedestrians		6,745	6,823	+78 (1.1%)
	Pickup Trucks and Vans		8,058	8,199	+141 (1.7%)
	Large Trucks		852	899	+47 (5.5%)
	Motorized Cycles		3,836	3,618	-218 (5.7%)
	Pedalcycles		948	904	-44 (4.2%)
	Other Highways		819	948	+129 (15.8%)
	Total		46,390	46,730	+340 (0.7%)
Grade Crossing[c]			(624)	(689)	+65 (10.4%)
Rail[d]	Intercity:	Passengers	16	2	-14 (87%)
		Employees	37	29	-8 (21.6%)
		Pedestrians & Others	529	515	-14 (2.7%)
	Rail Rapid Transit:	Passengers	28	16[e]	-12 (42.8%)
		Pedestrians & Others	6	2	-4 (66.6%)
	Total		616	564	-52 (9.2%)
Marine	Commercial		118	120[e]	+2 (1.6%)
	Recreational		1,036	946	-90 (8.6%)
	Total		1,154	1,066	-88 (7.6%)
Aviation	Airlines		232	285	+53 (22.8%)
	Commuter & Air Travel		123	79	-44 (35.7%)
	General Aviation		813	796	-17 (2.1%)
	Total		1,168	1,160	-8 (0.7%)
Pipeline	Natural Gas		8	28	+20 (250%)
	Liquid		1	2	+1 (100%)
	Total		9	30	+21 (233%)
Grand Total			**49,337**	**49,550**	**+213 (0.4%)**

(a) Except for aviation, all fatality statistics are from the Department of Transportation. Data for 1988 are preliminary and subject to update.
(b) Fatality figures include only occupants of each type of vehicle.
(c) The grade crossing fatalities are counted in the highway or rail categories as appropriate.
(d) The nontransportation-related rail employee fatalities included in the Federal Railroad Administration annual report, have been omitted from this report.
(e) Projected, based on partial year reporting.

Accident/Incident Briefs

The following information on accidents and incidents is intended to provide an awareness of problem areas through which such occurrences may be prevented in the future.

A Dangerous Combination

United Kingdom - January 1987 (Final Report)

Fokker F-27 Friendship: Aircraft destroyed. Fatal injuries to all aboard (number not specified).

The aircraft had been engaged on a crew training mission. It crashed during the final stages of a simulated asymmetric thrust instrument approach to a landing at East Midlands Airport. The aircraft was destroyed and all crew members were killed.

After the accident, one inch of ice was found on the leading edges of the wings and tail surfaces of the aircraft.

According to investigators, the probable cause of the accident was that the aircraft became uncontrollable at an airspeed well above both its minimum control speed and its stall speed because its handling and flying characteristics were degraded by an accumulation of ice. An underlying cause was considered the decision by the training captain to not operate the airframe de-icing system, although it was stated in the final accident report that he could not have been expected to foresee this at the time. A contributing factor was that the operating crew allowed the airspeed to fall below the normal approach speed for the aircraft during the latter stages of the approach.

Wrong Runway

United States - March

McDonnell Douglas MD-80: Slight damage. No injuries.

The aircraft had been cleared for takeoff from William P. Hobby Airport, Houston, Texas, with instructions to use Runway 12 Right. However, the pilot took off from Runway 17 Right, where construction crews were at work.

During the takeoff, the aircraft struck a metal barrier, a type of sawhorse at the end of the runway, where the construction work was in progress. There were no injuries on board or on the ground, but the aircraft suffered some damage.

The flight continued on to its destination of Dallas, Texas. The aircraft landed safely approximately an hour later and was taken out of service until repairs could be made.

Slid on Mushrooms

Peru - April

Boeing 737-200: Substantial damage to aircraft. Minor injuries to four; no fatalities.

The airliner, carrying a crew of six and 133 passengers, was attempting to land during torrential rain and high winds at the international airport serving Iquitos. The runway, already slick from the severe rainstorm, reportedly was made even more slippery by clusters of fast-growing tropical mushrooms, according to an airport official.

After touching down, the jetliner's pilot lost directional control and the aircraft skidded violently, spun in circles and then departed the runway. The starboard main landing gear collapsed, the right underwing engine was torn from its mountings and a fire developed.

No one was injured until the aircraft came to rest, after which four passengers jumped to the ground instead of using the emergency chutes. The fire was brought under control by airport emergency equipment.

The airport was closed until the damaged aircraft could be recovered. Initial estimates placed the cost of the accident at $3 million in aircraft damage and loss of revenue during repairs.

Accident/incident briefs are based upon preliminary information from government agencies, aviation organizations, press information and other sources. The information may not be accurate.

Blown Tires

United States - March

McDonnell Douglas DC-10: Slight damage. No injuries

The wide-body airliner had just arrived at McCarran International Airport, Las Vegas, Nevada after an uneventful flight from Dallas, Texas. Upon touchdown, however, four tires were blown and the aircraft was unable to be taxied from the runway.

There were no injuries to the 208 passengers or the crew. Since the aircraft could not be moved, a shuttle bus had to be sent from the terminal to remove the occupants and take them to the terminal to resume their travel.

Heavy Weather — Heavy Landing

Portugal - February

Type unidentified: Damage to tires. No reported injuries.

The airliner was arriving at Lisbon Airport at midday during heavy weather that had enveloped France, Spain and Portugal at the time.

The aircraft was reported to have been buffeted severely by the extreme weather during the approach and two tires were blown simultaneously during landing. During the four hours it took to move the stricken aircraft from Lisbon's Runway Three, all air traffic to and from the airport was halted.

Rainy Overshoot

Fiji - April

de Havilland DH114 Riley Heron: Aircraft substantially damaged. No fatal injuries reported.

The four-engine commuter aircraft was landing at Lakemba airstrip. A large tropical storm was passing about 300 miles southeast of Fiji and was affecting the weather in the area. There were slippery runway conditions and a strong tail wind.

After touchdown, the aircraft ran off the end of the runway and ended up on a country club golf course, stopping approximately 50 feet short of a dense section of pine forest. The aircraft was reported to have nosed over and was damaged, but information on number of occupants and injuries was not available.

Observant Controllers

United Kingdom - May

Hawker Siddeley HS 748: Fire damage to starboard engine and surrounding areas. No injuries.

The twin-engine aircraft bound for Jersey was accelerating along the runway at Leeds on its takeoff roll when air traffic controllers observed heavy smoke issuing from the starboard engine. They immediately radioed the pilot to abandon the takeoff and alerted fire services.

As soon as the aircraft came to rest, the flight crew and 46 passengers evacuated using the emergency chutes. Airport firefighters sprayed foam onto the thick, black smoke that was pouring from the burning engine.

Asymmetric Thrust

United Kingdom - April 1987 (Final Report)

Cessna 411 Conquest: Aircraft Destroyed. Fatal injuries to all aboard (number not specified).

The corporate twin-engine turboprop aircraft had made a go-around after a landing attempt to Runway 26 at Blackbushe Airport.

The Cessna appeared to begin the go-around maneuver normally, but was seen by observers to bank to the left and then begin a turn in that direction. The left turn continued through a heading change of 135 degrees at a low altitude. The bank angle increased progressively until the aircraft crashed into trees, semi-inverted, about 1,000 feet beyond the threshold of the runway.

The reason for the go-around was an unsafe main landing gear indication found to be from a defective microswitch. The reason for the loss of control could not be found.

Aside from the faulty gear microswitch, investigators found no evidence of pilot incapacitation that could have explained the accident. Thorough examination of the aircraft wreckage unearthed no control or flap mechanism malfunction and there was no evidence of failure of either engine or propeller control mechanism.

According to the accident report, the curved flight path of the aircraft along with the progressive nature of the increase in bank angle, indicated that an asymmetric power condition was the most probable cause of the accident.

Expensive Overrun

United States - February

Dassault Falcon 20: Substantial damage. Two injuries.

The executive jet with only a crew of two on board, had just landed at Binghamton, N.Y.

After touchdown, the pilot was unable to stop on the remaining runway and the aircraft ran off the end. By the time the aircraft came to a stop, the fuselage reportedly had broken into two. One of the crew members suffered serious injuries and the other received minor injuries.

End of Celebration

U.S.S.R. - April

Antonov An-2: Aircraft destroyed. Fatal injuries to five.

The large biplane with its single radial engine was being used to distribute leaflets during a May Day celebration in the village of Sechenovo, southeast of Gorky.

As the aircraft was making a low pass over the village square at the request of local officials, it clipped a treetop and exploded. Three crew members and two passengers died when the aircraft crashed to the ground.

Stall after Go-around

United States - April

Grumman-American Trainer: Aircraft destroyed. Fatal injuries to one.

The aircraft had just returned from a cross-country flight to Rochester, Indiana, and was approaching to land at Bluffton, Indiana.

The private pilot, who had approximately 200 hours total time and 30 hours in type, made an attempted landing to the west on an east-west runway with a seven-mph tailwind. According to witnesses, the aircraft travelled westbound on the runway about 100 feet after touchdown, after which it accelerated and became airborne again.

The aircraft was then seen turning to a northeast heading at about 200 to 300 feet above the ground, when it made a steep banking maneuver to the right. The trainer stalled and dropped to the ground in a plowed field about two-thirds of a mile past the runway. The right wing hit the ground first and was torn from the fuselage, after which the aircraft rolled inverted and came to rest upside down.

The pilot was pinned under the aircraft and was pronounced dead from injuries at the scene. The aircraft was considered a total loss, with major damage to wings, fuselage and engine.

Midair in the Traffic Pattern

United Kingdom - January

Cessna 182R: Aircraft destroyed. Serious injuries to two. Cessna F152: Aircraft destroyed. Serious injuries to two.

The 152 was being flown on a mid-afternoon training mission, by a low-time student pilot and an experienced instructor, at Wycombe Air Park. Runway 25 was in use and there was intensive sailplane activity to the south of the runway.

The aircraft had completed a training exercise to the north of the airport and was returning to the field. It entered the right-hand traffic pattern on base leg. Because of a conflict with another aircraft, the 152 pilot made a go-around into a standard traffic pattern. The instructor reported later that he believed he made a call on downwind, as was his practice, that a touch-and-go landing would be made on that approach.

After the aircraft landed, the instructor raised the flaps and set the carburetor heat to cold and power was applied. The aircraft accelerated and took off, climbing at what was later described as a fairly steep angle. The two pilots heard a loud bang and lost control of the aircraft as it pitched nose-down and rolled left. It hit the ground in a grassy area south of the runway in a left-wing-low, nose-down attitude, coming to rest mostly inverted.

The 182 had left Wycombe just after noon for a flight to Cardiff and back. The pilots took turns flying each leg. When the aircraft returned, the operating pilot entered the traffic pattern for Runway 25 on downwind. The pilot later stated that he widened his pattern because he was catching up with the aircraft in front of his. On final approach leg the 182 was still gaining on the aircraft in front of it, which was almost halfway along the runway.

The pilot later stated that he initiated a go-around at a point about even with the runway threshold by applying full power. He set the carburetor heat to cold and left the flaps at the 30-degree setting and turned the aircraft only slightly to the right because they were close to the ground. After he had opened the throttle, the pilot saw an aircraft wing coming up toward his aircraft from the left side, felt an impact and remembered nothing after a roll to the left.

According to witnesses, power was applied to the 182, but the aircraft then flew level or in only a slow climb. The 152 was climbing after a touch-and-go and was ahead of the 182 which was flying relatively level at a height of between 50 and 100 feet above the ground. The two aircraft collided at the far end of the runway, rolled left together and descended steeply nose-down before they separated and crashed about 80 feet south of the runway. There was no fire.

The airport flight information service officer, who had just instructed the 182 to go-around, heard a radio call asking where the other aircraft was when she witnessed the collision and alerted rescue services. The four seriously injured occupants of the two aircraft were removed from the aircraft under the supervision of two doctors who had been flying gliders at the field.

A Weighty Problem

United Kingdom - March

Luscombe 8E: Aircraft damaged extensively. Minor injuries to two.

The pilot lined the aircraft up to take off from Runway 24 on Old Sarum Airfield. The wind was from the south at five to eight mph, and the runway surface was short, dry grass. The aircraft accelerated to about 40 mph and the pilot moved the control column forward to raise the tail. He later reported that the aircraft accelerated to 50 mph, but that he had trouble keeping the tail up and thought that the takeoff run seemed longer than normal. When the airspeed reached 55 mph, the pilot decided to take off, although he realized that the air speed was five mph slower than recommended.

The aircraft became airborne, but the pilot was unable to maintain control. It soon struck the ground to the right of the extended runway centerline, impacting first on the right wingtip and then the nose area. The Luscombe came to rest right side up and the two occupants, who suffered only minor injuries, were able to evacuate through the left door.

The pilot later said that he had recently bought the aircraft and had not yet received the log books. He had calculated the takeoff weight from the pilot's handbook and used 850 pounds as a basic weight. When the log books were received after the accident, the pilot discovered that the basic weight of his aircraft had been 997 pounds. From this information, he figured that the takeoff weight at the time of the accident was 1,530 pounds, 130 pounds above the 1,400-pound maximum. The temperature at the time of the accident was reported at 15 degrees C.

Soft Landing

United Kingdom - March

Rockwell Commander 112: Substantial damage to aircraft. No injuries.

The pilot had requested permission the evening before to land at the farm strip, and the land owner gave directions on the location of the field.

On the day of the flight, the pilot, along with a passenger and another pilot, departed Manchester Airport with sufficient fuel to return in case he was unable to land at the farm strip. Arriving over the area of the destination, the pilot circled but neither pilot on the aircraft could locate the intended landing spot. A call to air traffic control produced a suggested new location about three miles north of their position. The pilots located a field that seemed to match the description given by the land owner.

The pilot made a low pass to inspect the strip, and satisfied, landed. The touchdown was normal until the nose wheel was lowered. When it contacted the soft ground, the nosewheel dug in and the aircraft pitched over and came to rest inverted. The aircraft sustained substantial damage to the propeller, nose gear, cabin, wings and tail fin. There was no fire. All three occupants had been wearing shoulder harnesses and were uninjured. However, the doors were jammed shut and it took about five minutes for the occupants to break a window with their feet so they could evacuate the aircraft.

Fog and Water Don't Mix

Italy - March

Agusta A109: Aircraft sunk. Fatal injuries to one.

The chartered helicopter was on a flight from Rome's Urbe airport to pick up three charter passengers waiting on the island of Ischia.

The north shore of the island reportedly was blanketed by fog when the rotorcraft approached the heliport, at the port of Casamicciola, shortly before noon. The pilot flew around for approximately 10 minutes before attempting to land, and then made an approach to the heliport.

When it was 100 yards short of the heliport, the helicopter crashed into the sea and sank in 20 feet of water. The pilot, the only person on board, was killed immediately.

Faulty Ground Grounds Helicopter

United Kingdom - December

Aerospatiale AS332L: Minor damage to lower front of fuselage and antennas. No injuries.

There were three crew members aboard the helicopter when it left Aberdeen Airport on a ferry flight. A short time after takeoff, a problem was encountered with the area navigation equipment; while it was being checked out, it was noticed that the landing gear was indicating "down" despite the fact that the gear selector was in the "up" position.

The pilot decided to return to the departure airport at this time, selecting gear down and getting three green lights.

Landing checks were accomplished and the touchdown was made at about five knots ground speed. The pilot experienced some nosewheel shimmy so he lifted off and landed again, this time with zero ground speed. As the aircraft touched down this time, it pitched forward and a crunching sound was heard. The pilot immediately lifted the rotorcraft into a hover and the gear selector and indications were re-checked. This time only the nose gear indicator glowed green, although the amber in-transit light was also lit. The situation was not consistent with what had happened during the touchdown. The crew operated the emergency override and got three gear lights. The next landing was without incident.

The rotorcraft was placed on jacks, and inspection revealed damage to the forward underbelly of the aircraft that was limited to skin panels and antennas. No problems were found after a full functional check of the landing gear system, so the landing gear control circuit card was removed for analysis. When the card was removed, it was noticed that a heat sink had detached from it and that there was a bad grounding connection within the wiring on the back of the card. The card was returned to the helicopter manufacturer, which later reported that the unit worked properly despite the separation of the heat sink. The cause of the incident was placed on the faulty ground connection.

Reversal Had Its Reverses

United States - March

Bell 206B: Substantial damage. No injuries.

The helicopter was being flown on a personal mission. During the course of the trip, the pilot decided to reverse the direction of flight.

During the maneuver, the cyclic control and tail rotor pedals began to give the pilot feedback and the aircraft seemed to lose directional control.

The pilot elected to land. The nose and main gear collapsed during the touchdown and the tail rotor hit the runway. There was extensive damage to the aircraft but the pilot and his one passenger were able to exit the helicopter without injury.

United States - July

Hughes 369D: Substantial damage. No injuries to one.

During takeoff from a remote site, the helicopter rolled to the left and hit the ground. The aircraft was substantially damaged, but there were no injuries.

The pilot later stated that he was operating with the lateral trim motor stuck to the left because of an earlier failure of that unit. He stated that he also was not sure whether the left skid of the rotorcraft had left the grassy ground during the takeoff attempt. ♦