A Holistic Approach To Aviation Safety

The flight operations manager or chief pilot must be conscious of the consequences of an accident. Further, says the author, it must be instilled in each employee that errors will not be tolerated.

by

Raoul Castro

Much attention is given to aviation safety in one way or another, yet accidents continue to occur. Are we guilty of trying to eliminate the disease, without first treating the symptoms?

Safety has to be the primary objective of every employee in a flight operation, because every activity and function has a direct relationship to safety. Likewise, it is essential that management integrate a holistic approach to safety in the air, as well as on the ground. The goal is the complete elimination of accidents.

Accidents don't just happen, they manifest themselves from a sequence of minor incidents. The causes of accidents are many. Accidents have resulted from such varied situations as poor operational actions, switching on the wrong fuel tank, tuning the wrong frequency, fueling the aircraft with the wrong fuel, a bolt left unsafetied, improper part installation, poor pilot-copilot coordination and lack of altitude awareness, et cetera.

Management must recognize contributing elements to an effective safety program such as:

Employee/management relations
Personnel morale
Duty/flight time schedules
Financial planning

The holistic approach to aviation safety requires that the flight operations manager or chief pilot be conscious of the consequences of an accident. Further, it must be instilled in each employee that errors will not be tolerated. Remember, if low safety standards are tolerated, people will work toward that standard. Consider three consequence "arousers":

1. <u>Cost-benefit</u>

Here, safety is related to cost efficiency; the cost of a comprehensive maintenance program versus the cost of a maintenance-induced accident. In other words, does the potential loss of a human hand warrant the installation of a safety device on the company's band saw? Cost-benefit is the potential use of capital resources to achieve certain safety goals whose benefits outweigh the cost of an accident.

2. <u>Human Life Value</u>

This varies with different societies, consequently the acceptance of fatalities varies from society to society. Human life value also varies with a person's level in society and earning power.

All financial and human loss consequences of an accident must be considered, plus the fact that insurance premiums are adjusted to liability settlements. . .that is a statistical fact. But, how do you measure the loss of a human life to a loving family, or to a company? Consider that the injury or death may irrevocably affect the company's functioning, to say nothing of the family's. And what bearing will the accident have on the acceptance of similar mishaps in the future? Case in point is the shuttle tragedy, which shut down

America's shuttle program after seven astronauts perished. That same year, over 300 persons perished in airline accidents, but the airlines continued to fly.

3. Inculcate in Employees a Positive Attitude Toward Safety

The holistic approach says that every activity and function has a bearing on safety. Therefore, every person involved with the performance of those functions and activities must be made to appreciate how valuable their contributions are.

Their presence has a direct impact on safety, both for the operation and the safety of the aircraft and people involved.

It can be said that humans possess a self-destructive behavior. The proof is everywhere, from high-wire walkers, to everyday drivers on the highway. Conversely, we possess a self-preservation instinct or mode of behavior that reduces the potential for self-inflicted harm.

With the built-in instincts man can control some risks. The question is, under what conditions will the self-preservation instinct prevail vis-a-vis destructive behavior? The probability is that surrounding circumstances can control the instinct or behavior of each individual. For that reason, management has to be aware of each individual's behavior pattern and act according to it.

Accident Vocabulary

When referring to accidents, the words that most frequently arise are safety, safe, risk, danger, hazard, and luck. The six words must be defined and distinguished in order to adequately explain the required tasks necessary for the successful implementation of accident prevention.

1. Safety: (definition) Maximum freedom from injury or risk.

"Safety" is an abstract idea, at best. It has no quantitative meaning for employees. How would you differentiate between too much safety, and too little safety? The term "safety" can not mean total freedom from injury or risk, as there is no such thing.

2. Safe: (definition) Secure from liability to injury or risk.

Consider that a pilot reduces the liability to injury or risk if he abides by safe operational practices and procedures.

Likewise, a baseball player is "safe" on base as long as he remains there, his moving away from base makes him liable to be tagged.

3. Risk: (definition) Exposure to the chance of injury or loss.

"Risk" implies that exposure to injury or loss is ever present. The chance implies that the exposure can be controlled or managed.

4. Danger: (definition) Liability to harm or injury.

The possibility exists that harm or injury may result in the execution of a "dangerous" exercise.

5. Hazard: (definition) Something which causes danger.

There is an element of hazard in the flying of an aircraft, or the lighting of a gas barbecue.

6. Luck: (definition) The force that seems to operate for good or ill in one's life.

When a star basketball player shoots ten consecutive baskets in a game, few would call that luck. However, if a novice was to accomplish the same thing, it would certainly be called "luck." In the same vein, if a novice pilot has an accident and survives, it is luck. But if a professional pilot has an accident, he survives because of his skill. Is there a relationship between skill, chance and tolerance for error?*

(*See Dennet, Daniel C., Elbow Room, MIT, 1984)

In distinguishing the six definitions, it is found that risk has a relative value that can be identified, evaluated, managed and controlled. Therefore, for operational purposes, "risk management" is a term that can be rationally accepted.*

(*See "Economics and Air Safety" Jerome Lederer, Flight Safety Foundation Safety Digest, May, 1987)

Risk management is the control of risk through the application of skill, knowledge and sound operational practices. The skill necessary to achieve the reduction of the hazard is acquired through study, practice and experience. Knowledge is possessing and understanding all operational functions. Sound operational practices are those strategies that have been proven effective in reducing risk. When instituted, these practices result in the acceptable reduction of a given hazard.

In order to organize for risk management, two types of accidents must be considered by management:

1. The industrial-type accident.

2. The accident which occurs during the operation of an aircraft.

In an industrial-type accident, a person might be injured or perhaps killed in the workplace in the performance of duties. In yet another case, equipment might be damaged while it is being worked on. Witness these cases:

The injury to an individual who falls off a ladder, might have been the result of a poor ladder, or the ladder was not properly positioned.

A mechanic was crushed to death when attempting to repair the landing gear system on an airplane without first jacking the airplane. The gear retracted, killing him and damaging the airplane.

Another case involved an airplane jacking operation in which the jack was misplaced, and went through the wing.
An accident which occurs during the operation of the aircraft becomes the responsibility of the pilot, once the aircraft leaves the chocks. Be it on the ground, or in the air, this is the pilot in charge. Again, accidents are the result of multiple incidents that occur in a sequential manner, to produce the eventual mishap. "Accidents don't just happen, they manifest themselves in a series of incidents." Any number of accident reports will attest to the validity of this statement:

Case in point, the taxi accident where a pilot shut the engines and relied on the accumulator pressure for brakes. Unfortunately, lack of pressure in the accumulator resulted in the airplane colliding with a fuel truck.

It should be noted that many accidents are maintenance induced, e.g., the Japan Airlines Boeing 747 that was lost due to incorrect pressure-dome repair. The repair was necessary because a previous tail-dragging accident had damaged the pressure-dome.

An American Airlines DC-10 crashed in Chicago due to the left engine becoming loose from its mount and dropping onto the runway. The loss of hydraulic pressure on the left side created an asymmetrical control condition that the pilot could not cope with.

It can be seen from the actual accidents how the sequential series of incidents can cause accidents.

The three elements in risk management are:

1. The Human Element.

2. The Element of Anticipation.

3. The Operational Element.

1. The Human Element

The majority of accidents are attributed to the human element, and rightly so. By virtue of their psychological makeup, there are many factors which are bound to affect employee performance. The following matrix indicates the human element areas to be considered. (Figure 1)

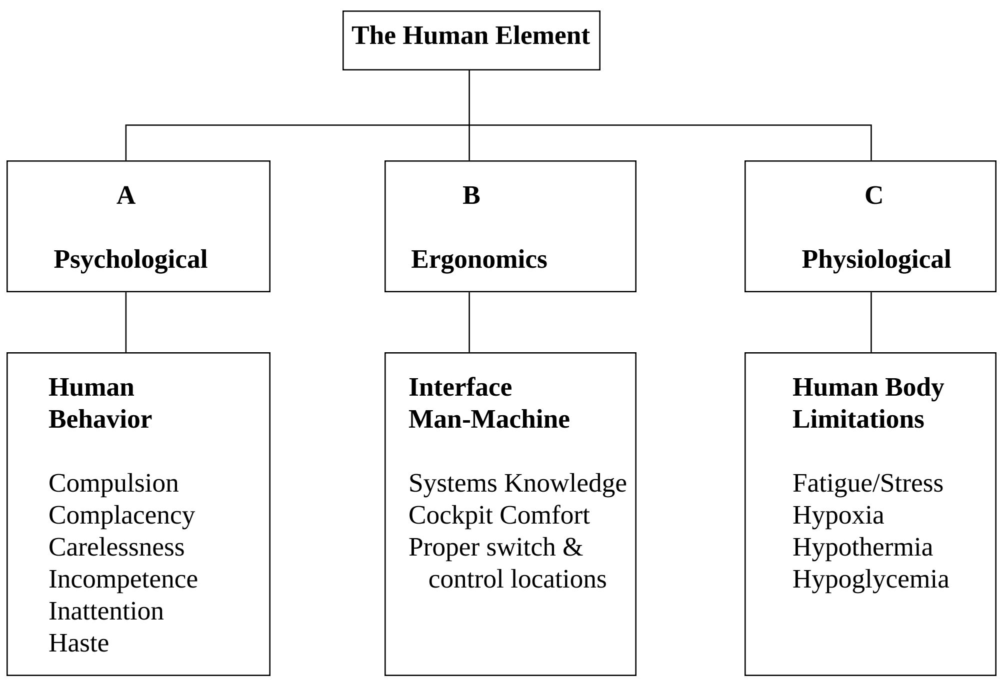

Figure 1

A. <u>The psychological element encompasses two human behavior areas</u>

1. Management must accept the responsibility for minimizing risk situations, as well as nurturing the employee's self-preservation instinct.

2. Each person must learn to identify his or her own psycho-

logical behavior patterns, in order to control those tendencies which are potentially dangerous; compulsion, complacency, carelessness, incompetence, inattention, haste, et cetera.

B. Ergonomics: The Interface of Man and Machine

And what of the interface of man and machine? Ergonomics, as it relates to our discussion of risk management in aviation, states that an aircraft, its flight characteristics and operating systems, should not increase the normal accident risk potential. Management should therefore be confident that operating systems and cockpit configuration are state-of-the-art. They should also be easy to operate, easy to understand, and as similar as possible to other airplanes operated by the company.

C. Physiological Human Body Limitations

The human body is limited by deviations from the normal environment:

1. Fatigue and stress compounded by lack of nutritional food can cause degraded pilot performance.

2. Hypoxia, the inadequate amount of oxygen, is incapacitating and is conducive to headaches, loss of consciousness, and fatigue.

3. Hypothermia is an abnormal drop in body temperature below the normal 98.6 degrees F. A person becomes confused and uncoordinated. If the body temperature drops below a level of around 80 degrees F. a person may die.

4. Hypoglycemia is the indication of an inadequate level of glucose in the body. It can cause faintness, weakness and nervousness among other symptoms.

The above conditions must be “self recognizable” by the pilot; however, management must be aware of these , and prevent working conditions or schedules that can cause a deviation from normal body limitations.

2. The Element of Anticipation

If every act and procedure could be planned so that all possible risks would be anticipated, then once a problem arose, an alternate plan to meet all possible contingencies could be constructed. A safe alternative to the problem would be provided, or the flight would be cancelled. By this definition, anticipation becomes a functional part of risk management.

3. The Operational Element

The operational element is in coordination with the human element to implement a program that will diagram an airplane’s flight. Starting with the flight schedule, the plan flows through the whole flight, chocks in place and paperwork completed.

Operational areas that require risk management attention:

HANGAR AND SHOPS

a. Hangar cleanliness
b. Stands and ladders
c. Flammable liquids
d. Fire prevention
e. Shop machine safety guards and glasses
f. Aircraft towing procedures
g. Markings for position of safety equipment
h. Condition of rolling stock

AT THE RAMP

a. Passenger boarding, deplaning and emergency evacuation
b. Safety of vehicles around aircraft
c. Ramp personnel, pilot coordination and signals
d. Proper positioning of aircraft
e. Safety of personnel in aircraft circle
f. Removing baggage and cargo
g. Clearing engines for start

TAXI AND TAKEOFF PROCEDURES

a. Alert to taxi instructions
b. Proper taxi procedures
c. Alert to takeoff instructions
d. Proper takeoff procedures

FLIGHT

a. Proper rest, mental and physical conditions
b. Crew qualifications and current physical
c. Adequate schedule and passenger information
d. Aircraft mechanical condition
e. Proper weather briefing
f. Proper flight planning
g. Required fuel quantity
h. Crew coordination
i. Abide by standard operating procedures
j. Attention to passenger requirements

In order to involve every department in risk management, a committee must be formed. The risk management committee should include the persons as presented in the following matrix (Figure 2):

Risk Management Committee

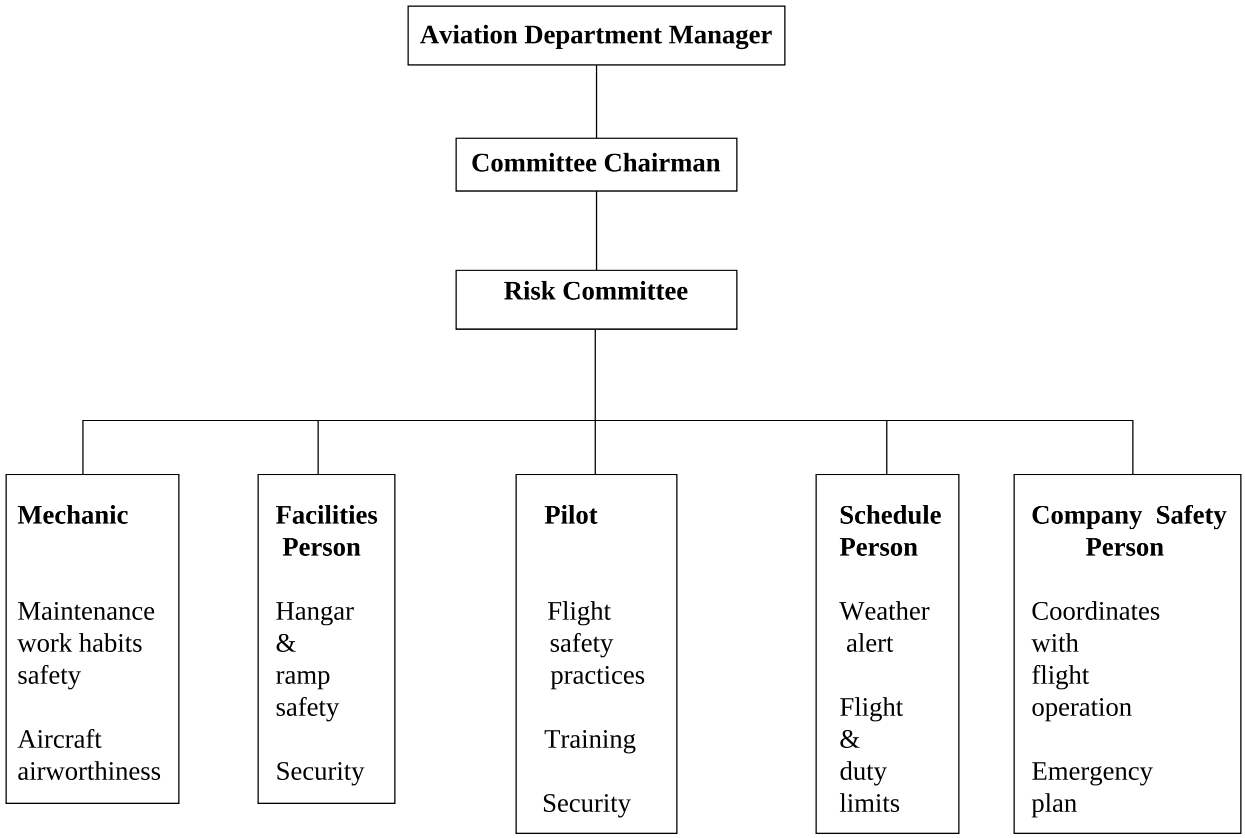

Figure 2

The objective of a risk management program is to establish the ground work for action that will prevent and eventually eliminate accidents. Every person in the organization must be involved in the risk program.

The four basic elements of a risk management program are:

1. Education
2. Communication
3. Inspection
4. Investigation and Prevention

1. Education

The purpose of the education element of risk management is to increase personnel awareness to factors that may cause accidents, and to condition people to "think" risk prevention.

2. Communication

From the communication standpoint, operational information for risk management should be networked among all departments, as well as aircraft manufacturers, Flight Safety Foundation and U.S. National Transportation Safety Board (NTSB).

Flight safety literature, as well as crew and maintenance safety literature should be made available to all personnel. The risk committee is the forum for planning all risk management requirements.

3. Inspection

The inspection element of a risk program includes continual review of all operations, and inspection of all facilities to determine if they meet Occupational Safety and Health Administration (OSHA) and company safety requirements. All employees will be encouraged to note problem areas for corrective measures. The reports should use the following format:

a. Gather data and information
b. Analyze data
c. Define the problem
d. Draw conclusions
e. Develop recommendations
f. Follow corrections

4. Investigation and Prevention

The purpose of accident and incident investigation is to determine causal factors, and then, attempt to prevent a recurrence.

This investigation procedure should be used solely for the purpose of enhancing risk management, and not for disciplinary action toward individuals.

It must be kept in mind that risk management is largely dependent upon human judgments and reactions. Consequently, people are the driving force behind any risk-management effort. In fact, they are the paramount factor in any risk-management program. When all else fails, it is people who must compensate. Human performance is really the controlling factor in risk management. Ironically, human performance presents the most difficulty because it cannot be predicted, nor can it be programmed to be fail-safe with duplication or even triplication. ♦

(Article is an excerpt from "Corporate Aviation Management" a book being published by Southern Illinois University Press.)

Notes

Excerpts from safety bulletins. Flight Safety Foundation, 5510 Columbia Pike, Arlington, VA 22204, U.S.

Elbow Room. Dennett, Daniel C. PhD. MIT/Bradford. 1984

Fallacies in Aviation Safety Concepts. Lederer, Jerome F. Adjunct Professor. Institute of Safety and System Management. University of Southern California.

Reports Received At FSF

AC 150/5050-7. *Establishment of Airport Action Groups.* FAA Advisory Circular. 23 June 1987. AAS-300, FAA Hq., Washington, DC 20591 U.S.

Summary: This advisory circular has been developed to encourage and provide guidance on the establishment of airport action groups, in the interest of promoting and providing helpful suggestions to airport officials; users and airport tenants; community businessmen and leaders; civic organizations; and the general public for establishing action groups to increase community support for airports and the aviation industry.

The types of action groups include airport community support councils and committees organized to promote the economic benefits of an airport and proposed improvements, airport safety committees organized to enhance the safety of an airport and to reduce the potential for future hazards, and friends of the airport, e.g. community organizations and civic groups that from time to time volunteer to undertake short term projects to enhance the beauty, safety, acceptance or compatibility of the airport with the neighboring environment. The AC discusses participation, how to establish an action group and some of the activities that can be undertaken.

AC 25-11. T*ransport Category Airplane Electronic Display Systems.* FAA Advisory Circular. 16 July 1987. ANM-110, FAA Hq. Washington, DC 20591 U.S.

Summary: This extensive circular provides guidance for certification of cathode ray tube (CRT) based electronic display systems used for guidance, control, or decision-making by the pilots of transport category airplanes. The guidance is related to pilot displays and specifications for CRTs in the cockpit of commercial transport airplanes. The content is limited to statements of general certification considerations, including display function criticality and compliance considerations; color, symbology, coding, clutter, dimensionality and attention-getting requirements; display visual characteristics; failure modes; information display and formatting; specific integrated display and mode considerations, including maps, propulsion parameters, warning, advisory, checklist, procedures and status displays.

AC 120-46. *Use of Advanced Training Devices (Airplane Only).* FAA Advisory Circular. 12 June 1987. AFS-250, FAA Hq., Washington, DC 20591 U.S..

Summary: This sets forth an acceptable means of showing compliance for the use of airplane Advanced Training Devices (ATDs) in training conducted under Part 135 of the FARs. Technical requirements and criteria for ATD evaluations is discussed in AC 120-45.

Near Midair Collision Incidents and Midair Collision Accidents

A near midair collision (NMAC), is defined as an incident in which a collision hazard exists between two or more aircraft because the separation of all aircraft involved is less than 500 feet, or because one or more of the pilots reports that a collision hazard existed. After a report is received, the Federal Aviation Administration (FAA) will initiate investigations and analyze all related events for the purpose of developing recommendations to reduce the number of occurrences. After NMAC incidents are investigated, the FAA classifies the incidents into the following categories by its severity:

Critical -A situation where collision avoidance was due to chance rather than an act on the part of pilot. Less than 100 feet separation would be considered critical.

Potential - An incident which probably would have resulted in a collision if no action had been taken by either pilot.

No hazard - When direction and altitude would have made a midair collision improbable regardless of evasive action.

Unclassified -An incident in which no hazard was assigned.

Table 1 presents the distribution of near midair collision reports by severity of hazard since 1981.

Table 1 - Distribution of Near Midair Collisions by Severity of Hazard

	Critical	Potential	No Hazard	Unclassified	Total	Monthly Average
1981	84	233	76	0	375	31
1982	56	191	64	0	311	26
1983	97	284	85	9	476	40
1984	127	316	116	31	589	49
1985	170	395	136	76	777	65
1986	162	473	197	8	840	70
1987	181	582	259	37	1,059	88

In the beginning of the decade, only about 375 NMAC incidents were reported. The annual reports increased to 777 in 1985 and jumped to 1,059 in 1987. Annually, an average of 75-80 percent of the reports were classified in the ‘critical’ and ‘potential’ categories and about 20-25 percent in the ‘no hazard’ category. Although the NMAC reports in recent years increased substantially, it should be noted that at least a portion of the increase in NMAC reports can be attributed to improvements in the NMAC reporting procedures and a renewed emphasis on reporting of NMAC incidents.

The ratio of involvement of air carrier, military, and general aviation aircraft in the NMAC reports differs annually. On the average, near midair collisions involving two air carrier aircraft accounts for about 4 percent, between two military aircraft accounts for about 6 percent; involving one air carrier and one military aircraft about 5 percent. The conflict involving two general aviation aircraft, or one general aviation and one airline aircraft, or one general aviation and one military aircraft accounts for about 85 percent.

Because of the possibility of a near midair collision turning to a real collision, the substantial increase of NMAC incidents stimulated the public concern over the possible increase of midair collision accidents. Annual frequency of midair collision accidents occurred before or after 1981 air traffic controller strike, as shown in Table 2, were fluctuating between 12 and 35. It appears that there is no obvious upward or downward trends.

However, an analysis of the five-year rolling average of total midair collisions shows that midair collision accidents declined from 30 in the 1976-1980 period, to 23 in the 1983-1987 period. The fatal midair collision accidents declined from 19 to 13 in the corresponding periods. Apparently, the frequency of NMAC incidents and the midair collision accidents was not in positive proportion.

Note that midair collision accidents involving two general aviation aircraft accounted for 87 percent; the collisions in which general aviation aircraft were involved accounted for

98 percent. The last midair collision in the United States involving a large U.S. air carrier aircraft was over San Diego, Calif., in 1978; the last midair collision in the United States involving a foreign airline was over Cerritos, Calif., in 1986. In these two years, the fatalities involving midair collision accidents were exceptionally high.

Table 2 - Mid-Air Collision Accidents
U.S. Civil Aviation
1975 - 1987

	Accidents			No. of Accidents by Segments of Aviation Involved								
Year	Total	Fatal	Total Fatalities	121 and GA	S135 and S135	S135 and GA	N135 and N135	N135 and GA	GA and GA	GA and USMil	GA and Forgn	GA and Not Reg
1975	29	13	47			1		1	26	1		
1976	31	24	64			1		2	27	1		
1977	34	17	41					1	33			
1978	35	23	189	1					33	1		
1979	26	14	34		1			3	21	1		
1980	24	19	55				1	2	20	1		
1981	30	13	47			1	1	2	25	1		
1982	29	18	59			1	1	1	25		1	
1983	12	7	22					1	19		1	
1984	25	14	47			1			24			
1985	25	14	36				2		19	2	1	1
1986*	29	17	136						27	1	1	
1987*	23	11	35			3		2	17	1		
	352	204	511	1	1	8	5	15	307	10	4	1

121 - FAR Part 121 operators, including all national and regional airlines
S135 - FAR Part 135 operations, all scheduled service, including all commuters
N135 - FAR Part 135 operators, all non-scheduled service, including all on-demand air taxi
GA - general aviation
US Milt - U.S. military
FORGN - Foreign aircraft
Source: NTSB *Preliminary

To reduce the danger of midair collision, the FAA recently adopted a new rules requiring increased use of altitude-reporting (Mode C) transponders in the airspace around 138 of the nation's busiest airports. The Mode C transponder is an electronic device on an aircraft that transmits its position and altitude to the air traffic controller.

Effective July 1, 1989, a Mode C transponder will be required:

- Above 10,000 feet mean sea level.
- Within a 30-mile radius of the 27 airports in 23 terminal control areas (TCAs), regardless of altitude and regardless of whether the aircraft is flying inside the TCA.
- In all airspace from the ceiling of a TCA up to 10,000 feet.

Effective December 30, 1990, Mode C equipment also will be required:

- Within and above all 109 Airport Radar Service Areas (ARSAs).
- Within a five-mile radius of certain other designated airports (only two at present) from the surface to 10,000 feet, and within a radius of five to 10 miles from 1,200 feet to 10,000 feet.

According to FAA estimates based on the most recent survey, there are about 35 percent or 95,000 of all general aviation aircraft, including air taxi and commuter air carrier aircraft, equipped with Mode C transponders. Balloons, gliders and airplanes without electrical systems which cannot support a Mode C transponder, will not be allowed to operate in a TCA or ARSA or in the airspace above those areas up to 10,000 feet mean sea level.

Accident/Incident Briefs

Bomb Scare

France - May

Boeing 747: Minor injuries to 40.

A bomb alert forced the Boeing 747 en route from New York to Milan with more than 400 persons aboard to make an emergency landing at Nantes, France. All passengers and crew evacuated the aircraft via emergency chutes after landing. Of the 40 people injured, eight were treated in a hospital and later released; all passengers reportedly returned to the airport later for another flight to their destination. No bomb was found during a search of the airplane by bomb experts.

Slide Slid Out

Kuwait - January

Boeing 767: Minor damage, no injuries.

A door warning light for the passenger evacuation slide over the left wing illuminated immediately after takeoff. A visual inspection by a ground engineer on board disclosed nothing abnormal; later, the light went out and all appeared to be normal. Near the outer marker inbound to the destination, the warning light again went on. After the aircraft reached the parking ramp, a visual inspection showed that the left slide compartment was open and the slide was missing. A number of trailing hoses were seen hanging out of the empty compartment.

Corrective action included replacing the escape slide, door opening latch and door opening actuators.

For Lack Of Hydraulic Pressure

Kuwait - No date noted

A-300: No damage, no injuries.

What started out as a relatively simple mechanical failure could have ended up as a complex emergency situation.

During cruise flight at FL280, the oil clog light for the No. 2 engine came on. The engine was shut down and a drift down to FL160 was initiated. As the airplane descended through FL180, a complete loss of hydraulic pressure was experienced because of a fast leak. Multiple system failure procedures were initiated, an emergency was declared and the decision was made to land at the nearest appropriate airfield.

With the loss of hydraulic pressure, the pilots faced an overweight landing on a wet runway, with no normal brake anti-skid. Failure of the alternate anti-skid was caused by loss of the normal system due to the shutdown of the No. 2 engine. More than half of the ground spoilers were inoperative, only one thrust reverser was available, and effectiveness of the trailing-edge flaps was questionable because of decaying airspeed.

After considering options the decision was made to restart the No. 2 engine. The landing was made with no further incident.

It was later found that the green hydraulic pump had failed and fluid entered the drive cavity causing failure of the carbon seal of the engine drive shaft. This allowed hydraulic fluid into the engine oil system, resulting in breakdown of the engine oil and clogging of the oil filter. The progressive leaking of hydraulic fluid resulted in the loss of the green system. The yellow hydraulic system pressure was lost because of the No. 2 engine shutdown.

Cat Played Rough

Atlantic Ocean - No date noted

A-310: Minor damage, serious injuries to three, minor injuries to 30.

Data reported in the accident/incident briefs on this and the following pages are based upon preliminary information obtained from agencies and organizations participating in the FSF Accident Prevention Program, as well as the news media. They are subject to future revision.

Three hours into a flight from New York to Caracas at FL330, the aircraft encountered severe clear air turbulence. Five of the eight flight attendants were injured. Twenty-eight passengers were not injured.

Because of the injuries, the flight diverted to Miami International where it landed without further problems.

After landing, an aircraft inspection showed that no structural damage had occurred to the airplane, but that 28 seat armrests had been damaged in the coach section; 30 locations in the overhead storage bins and three seat backs also received damage.

Wrong Rudder

United States - September 1985

DC-9: Aircraft destroyed, fatal injuries to 31.

The final report stated that the probable cause of this accident was the flight crew's "improper use of the flight controls in response to the catastrophic failure of the right engine during a critical phase of flight, which led to an accelerated stall and loss of control of the airplane." Contributing to the loss of control, according to the National Transportation Safety Board, was a lack of crew coordination during the emergency, which was caused by the uncontained rupture of the 9th to 10th stage sleeve spacer in the high-pressure compressor due to a fatigue crack.

Just prior to the accident, the aircraft had taken off from General Billy Mitchell Field, Milwaukee, Wisconsin. Climbing through FL 450, there was a loud noise and immediate loss of power in the right engine. Ground witnesses reported one or more loud bangs, similar to shotgun reports, and smoke and flames coming from the right engine. The aircraft was seen to climb to about 700 feet and roll to the right to an almost wings-vertical attitude when it entered an accelerated stall and control was lost.

The majority of witnesses reported that the DC-9 made one to one and a-half rotations in a nose-low spin to the right before it crashed approximately 1,700 feet southwest of the departure end of the runway. All 27 passengers, two flight crew members and two flight attendants were killed.

The National Transportation Safety Board (NTSB) accident investigation used data from wreckage examination, ATC radar tracking, flight data and cockpit voice recorders and statements of eye witnesses. A number of factors contributed to the accident:

• The fatigue crack in the engine spacer was found to have propagated to a length that should have allowed detection during the last overhaul of the high-pressure compressor and spacer rework in 1981.

*Although the pilot applied corrective left rudder and lowered the nose in his initial response to the loss of power in the right engine, communications between him and the first officer, who also was a check pilot, indicated that he was unsure of the exact nature of the emergency.

• The crew response to the problem was not coordinated and communications between the pilots was possibly hampered by the unwritten "silent cockpit" philosophy that recommends against unnecessary callouts or even verbalizing the nature of an emergency between the point that the airplane exceeds 100 kts airspeed and reaches 800 feet altitude.

• The pilot switched from the initially correct left rudder application and incorrectly deflected the rudder control to the right about five seconds after engine failure, possibly prompted by a partial drop in thrust on the left engine, his apparent confusion over the nature of the emergency and his possible dependence upon kinesthetic cues for aircraft.

• Within another five seconds, the yaw generated by the improper rudder deflection combined with high G loading caused the airplane to enter an accelerated stall and loss of control at too low an altitude for recovery.

Recommendations included improved verbal crew communications during emergencies, and emphasis on use of engine and flight instruments for primary aircraft control and for flight and engine instrument analysis "rather than hasty action based upon kinesthetic cues."

Some Crust

New Zealand - October

Cessna 185: Substantial damage, no injuries to five.

According to the final report on this accident, the pilot flew four skiers to the Tasman Saddle, and landed smoothly on the snowslope of a 20-degree upward angle. The conditions of the snow were icy and hard, and near the end of the landing run the outside edge of the airplane's left ski broke through the crust, causing the aircraft to yaw. The pilot tried to keep the Cessna straight but the ski sank deeper into the snow. The left gear leg was subsequently torn off and collapsed under the fuselage, followed by the left wing tip striking the surface. The airplane briefly pitched down to a vertical position with the tail in the air, and then fell back to the surface. The tailwheel ski assembly crashed through the icy surface and, along with the left stabilizer and elevator, was damaged.

Since the landing was made in a direction slightly across the fall-line of the slope, this was considered a contributing factor in the accident.

Other General Aviation

Realistic Demonstration

United Kingdom - May

Cessna 152: Some damage, no injuries to two.

During a local training flight in the traffic pattern at Redhill Airport, the instructor was simulating an engine failure when the engine actually failed. During the subsequent emergency landing, the engine mounts were distorted and there was some damage to the tail section of the airplane. There were no injuries to the two persons aboard.

Door Distraction?

United States - June

Beech V35 Bonanza: Aircraft destroyed, one killed in aircraft, three killed and five seriously injured on the ground.

Investigation of a Beechcraft Bonanza that crashed into a Phoenix backyard while a family picniced there, pointed to the possibility that the pilot apparently had unbuckled her seat belt and was reaching across the cabin to close an open door when the airplane crashed. The airplane was demolished by fire after it impacted, killing the pilot and three members of the picnicking family, plus seriously injuring five people on the ground.

Evidence in the wreckage indicated that damage to the right-hand door was "not consistent" with its being closed at the time of the crash and pieces of the pilot's seat belt assembly indicated that it was not fastened at the time. The pilot was less than five feet tall, and would have had to unfasten the belt to reach across to close an open door. Other evidence indicated that the throttle was open and that the speed of the airplane had increased from 105 kts to 130 kts during the final five seconds of the flight. The engine had been producing normal power and the control cables all were accounted for; no mechanical defects were found.

Flaps Down And Stuck

United Kingdom - March

Cessna 150: No damage, no injuries to two.

The lesson was touch-and-goes. During takeoff, after a landing with full (40 degrees) flaps, the instructor told the student to apply full throttle and return the carburetor heat to cold. He next tried to put the flap control up into the 20-degree position and found that the flaps remained in the full down position. The airplane became airborne with the student still in control. The instructor took over, told the tower what was happening and advised he would land downwind on the same runway. By this time the airplane was 200 feet in the air and the airspeed was between 40 mph and 45 mph. The landing was successful.

It was found later that the flap fuse had blown and that the flap selector switch was faulty. Investigators also criticized the continuation of the takeoff with full flaps on this airplane. It was noted that there had been numerous instances where Cessna 150 flaps had stuck at 40 degrees or ran to full 40 degrees when an intermediate setting was selected.

Magnet Stowaway Fools Compass

United Kingdom - January

Piper PA-38: No damage, no injuries.

As part of its 50-hour check, the airplane was being ferried to its maintenance base. The gyro direction indicator was inoperative and the radio intermittent. The pilot was navigating by headings on the magnetic compass. Suddenly, the pilot noticed he had infringed upon the airspace of Luton Airport and changed course to leave the area and realized that his compass was giving inaccurate readings.

After landing, the pilot discovered that there was an extremely strong magnet in a technician's toolbox in the rear of the airplane. When it was removed, the magnetic compass operated normally.

Rotorcraft

High Wire, Low Light

New Zealand - No date

Hughes 269: Helicopter destroyed, fatal injuries to pilot, seriousinjuries to crewman.

The helicopter was following a river valley at various heights between 500 feet and treetop levels surveying for deer and moss concentrations. The pilot intended to follow the river to its mouth and then trace the coastline to return to the takeoff point.

A powerline spanned the river about 1.25 miles prior to its mouth. About 4.5 miles upriver the pilot descended to observe gravel flats north of the river and then continued flying downstream along the northern edge of the river at treetop level at speeds the crewman in the right-hand seat estimated at between 70 kts and 80 kts.

Just before the accident, when they were flying towards the setting sun, the pilot descended over the river bed and, according to the surviving crewmember "just ran straight into the power wires." The crewman had no recollection of any evasive action taken by the pilot prior to hitting the wires, and said he believed the aircraft spun around before hitting the dry riverbed. The time was nearly 8 p.m., 42 minutes after official sunset and six minutes after the end of evening civil twilight.

The crewmember was thrown clear when the helicopter hit the ground and, although bruised and in shock, he was able to find the pilot who also had been thrown clear but had been fatally injured. He retrieved the survival kit, flares and a flashlight, covered himself with a survival blanket and remained by the wreckage to await rescue. The helicopter was reported missing and the wreckage was located about midnight, with the injured crewman taken to a hospital by ambulance the next morning.

Investigation indicated that the pilot flared the helicopter just before the collision and that the leading edge of the lower vertical fin struck the top of three power lines. As a result, the tail rotor and gearbox separated and the tailboom and tail rotor shaft were severed. The resulting loss of control caused the helicopter to rotate to the right and descend to the ground.

The probable cause of the accident was attributed to the pilot's decision to descend to a low altitude in visual conditions that prevented him from seeing the power lines in time to avoid hitting them.

Chemicals and Fatigue

United Kingdom - February

Hughes 269C: Major damage to the aircraft, fatal injuries to the pilot.

It was after 7 p.m. and the pilot was spraying a small area of steeply sloping ground when the helicopter struck an electric power line. The main rotor mast was broken off and the aircraft fell to the ground, killing the pilot on impact.

Here is the combination of ingredients that helped produce this accident: The highly experienced pilot had worked a long day, possibly more than 12 hours, before accepting the late-evening spray job. The chemical he was using is highly toxic and is banned in the United States and the United Kingdom. According to his colleagues, the pilot had been showing signs of stress, fatigue or chemical poisoning. In addition, he had appeared to have personal problems and non-flying commitments.