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FEDERAL AVIATION ADMINISTRATION AIR SAFETY PROGRAM

BY DONALD E. KEMP†

I. INTRODUCTION

AVIATION SAFETY is the Federal Aviation Administration's primary mission—a mission it shares with other federal, state, and local governmental agencies and with the aviation community in general. Complete success in this mission, the elimination of death or injury from aviation operations, is the end toward which the agency must strive. Such an achievement on a sustained basis, however idealistic, is the challenge the FAA faces in the decade ahead.

To give you an idea of the operational environment in which the FAA mission is carried out, there are approximately 118 air carriers today; they fly 2,379 aircraft, about 6 million flight hours per year, and carry some 128 million passengers. In general aviation, there are approximately 107,000 aircraft flying 21 million flight hours. Records show some 700,000 airmen certificated. Included also in the aviation community are about 80 prime manufacturers, 396 subsidiary manufacturers, 260 manufacturers who produce items under the Technical Standard Order system and 275 approved parts manufacturers. There are approximately 1,400 pilot and mechanic schools and 2,725 repair stations. To complete the picture, the government provides such services as flight inspection and maintenance of some 7,200 aids to navigation, and provides air traffic control service through some 310 airport traffic control towers, 330 flight service stations and 28 ARTC's.

A doubling, tripling, and even quadrupling of major indicators of aviation activity in the United States by 1979 are forecast by the Federal Aviation Administration. Airline passengers will more than triple—from 128 million in fiscal year 1967 to 444 million in 1979. Revenue passenger miles flown by the airlines will nearly quadruple—from 86 billion in 1967 to 342 billion in 1979. The airline fleet will increase from 2,379 aircraft to 3,860. General aviation (non-airline) flying will show similar increases. The general aviation fleet will almost double from 107,000 aircraft as of 1 January 1967, to 203,000 at the beginning of 1979. General aviation flying hours will increase from 21.0 million hours to 40.5 million hours. Use of jet fuel and aviation gasoline in the United States will more than triple, increasing from a total of 5,403 million gallons in 1967 to 17,700 million gallons in 1979. Jet fuel consumption will increase from 4,697 million gallons to 16,890 million. Use of aviation gasoline will increase from

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706 million gallons to 810 million. Airline transport production will decrease from 372 to 280 aircraft, while general aviation aircraft production will increase from 14,799 aircraft to 32,200 by 1979. Aircraft engine production will increase from 20,812 units to 46,300 in the same time period.

Efforts in accident prevention in recent years, despite an occasional headline-making accident, have shown encouraging results. For example, the trend of the accident rate continues to be down, and the fluctuation that occurs in the rate over a stretch of years has been reduced to a very narrow range. Some fluctuation of this kind rather than a steady downward movement of the accident rate is almost inevitable; for, though human error and mechanical failure are the causes to which most accidents are traceable, the pattern in which these causes operate, along with others, is the irregular one of chance. The trend of the rate over a period of years, therefore, is more significant than the rate for any single year. But on either count the latest accident statistics indicate that safety programs have been effective.

II. THE ROLE OF THE FAA

To give you some idea of how the FAA's air safety responsibilities are carried out, look at the air carrier operations. Starting first with the airplane itself, our interest begins with the design standards and requirements. The approval of an aircraft design is the responsibility of our engineering and manufacturing personnel. They assure that provision is made for proper design materials, workmanship, construction, and equipment. This approval procedure is accomplished through a series of board meetings which are composed of the various elements of engineering, such as structures, power-plant, systems, flight test engineers and pilots with representation from air carrier operations and maintenance specialists. Use of this procedure assures that the aircraft meets not only design requirements and necessary ground and flight testing, but also the needs of the air carriers from both the operating and maintenance standpoints. The FAA operations specialist is concerned not only with the cockpit layout, but with pilot training, loading procedures, and weight and balance information, while the maintenance specialist assures the establishment of initial inspection and overhaul times for the aircraft structures and components.

Concurrent with the type certification process, an FAA Maintenance Review Board is active in the development of maintenance and inspection procedures for the aircraft. This Board works closely with the manufacturers of the aircraft and accessories in testing, sampling, and analyzing to determine appropriate inspection intervals and maintenance support programs. The FAA operational pilot specialist assigned to certification program also serves as a member of the Flight Operations Evaluation Board which assists in developing the operational procedures and limitations set forth in the airplane flight manual. He is also a member of the Flight Standardization Board which has the primary responsibility to develop proper training and flight checking standards and procedures for the air

carrier crew members.

Immediately following the time when an airline makes application to place this aircraft on their operational specification, a series of proving flights are required by the Federal Aviation Regulations to be conducted over the intended routes under the FAA's supervision to determine the adequacy of line station facilities, crew capabilities, airport facilities, and so forth. Once the aircraft has been placed in air carrier operation our Flight Standards function then becomes a continuous one in the form of overall surveillance.

As the agency responsible for certification and continued airworthiness of the airplane, the FAA requires the air carrier operators to report certain significant failures, malfunctions or defects daily through a report called Mechanical Reliability Report. An analysis of these reports may result in a maintenance or operation wire alert, an advisory circular, a manufacturer's service bulletin or if a design change is mandatory the FAA will issue an airworthiness directive. Safety is not restricted to the mechanical aspect, nor do all undesirable or potential hazards of a mechanical nature come within the scope of the Mechanical Reliability Report. To assure complete coverage the incident report is used to report any occurrence or observation believed to be other than normal.

III. SAFETY AND A SPECIFIC AIRCRAFT

At this point I would like to discuss a specific aircraft—the Boeing B-727, which had enjoyed an exceptional record for the first 2 years in operation and then in a very short period of time had 3 fatal accidents. The first fatal 727 accident occurred 16 August 1965, to a United Air Lines B-727 on a descent into Chicago at night under VFR conditions. The aircraft descended below the clearance altitude and impacted in a flat attitude approximately 20 miles short of the airport. In this particular case, the flight recorder was not recovered, thus a very valuable piece of information was not available for the investigation. The second fatal accident occurred 8 November 1965, to an American Airlines B-727 making a circling approach at night to a landing at Greater Cincinnati Airport. In this accident the weather had just dropped below VFR conditions due to local rain showers. The third accident occurred 3 days later, on 11 November 1965, to a United Air Lines B-727 making an approach under night VFR conditions landing at Salt Lake City. The aircraft impacted 335 feet short of the runway threshold.

An early assessment of these accidents revealed that there were some common facts. All of the accidents occurred at night, with visual flight rules weather conditions, during an approach for landing, and there were no visual cues (lights) on the ground and water during the approach. In order to determine just what corrective measures were necessary to assure safety in the B-727, the following actions were taken:

- (1) Our engineering and manufacturing personnel in the Western Region, in conjunction with the Boeing Aircraft Company, began

assessing all the known facts related to these accidents.

(2) A meeting of all lead B-727 specialists was ordered by our Deputy Administrator to be held in Los Angeles, 15 November 1965, to discuss IFR and VFR landing approach techniques. This meeting was chaired by Mr. James F. Rudolph, who was then chief of our Operations Division and is now the director of Flight Standards Service.

Mr. Rudolph met with the Air Transport Association and ALPA to discuss the same subject. He met again with the lead B-727 specialists in Seattle on 12 and 13 January 1966. As a result of these meetings, the following actions were taken to ensure descent rate management and altitude awareness:

(1) Each region was directed to take the necessary action to assure that air carrier manuals and training programs applicable to the 727 adequately cover:

- (a) the maximum useful rate of descent for approach and landing (1000-1200 fpm);
- (b) the desired rate of descent for approach and landing (600-800 fpm);
- (c) the corrective action the pilot must take whenever the rate of descent is excessive within 1 mile of the landing runway;
- (d) procedures for recovery from high rates of descent; and
- (e) engine spin-up times and the use of engine spin-up curves.

(2) The principal operations inspectors assigned to turbojet operators were instructed to be sure that the manuals and training programs applicable to turbojet aircraft included the following requirements:

- (a) During descent the pilot not flying will call out:
 1. approaching 20,000 feet,
 2. 1,000 feet above assigned altitude,
 3. approaching 10,000 feet,
 4. approaching 5,000 feet (if appropriate), and
 5. 1,000 feet above initial approach altitude or 1,000 feet above field elevation for VFR approaches.
- (b) On final approach upon reaching a designed altitude (not less than 500 feet above field elevation) the pilot not flying will call out altitude, airspeed, and rate of descent. Thereafter, he will call out significant deviations from programmed airspeed and descent rates.
- (c) Pilots-in-command must have at least 100 hours in the aircraft type prior to permitting co-pilots to takeoff, approach, or land, except when safety requires otherwise.
- (d) Each operator's training program should be amended to

require a demonstration of recovery from high rates of descent at low altitude to pilots-in-command initially transitioning to turbojet aircraft and to pilots-in-command transitioning from a turbojet aircraft with wing-mounted engines to ones with aft-mounted engines.

- (e) Each operator's training program should be amended to require each pilot-in-command transitioning to a type turbojet aircraft to accomplish at least 35 landings in that type before being used as pilot-in-command on the line. At least 6 of these landings must be normal day VFR full stop landings without reference to a visual or electronic glide slope. Five of these must be made at night under VFR conditions to a full stop without using a visual or electronic glide slope.
- (f) Training should be required in the use of artificial horizons and flight directors to assure pilot familiarity of their normal and abnormal characteristics. Special emphasis will be placed on attitudes necessary to hold level flight in various thrust and airplane configurations.

(3) On 7 through 9 February 1966, a team of specialists from Washington met with the Boeing Aircraft Company and vendor representatives at Renton, Washington. The approach taken was to assume not only probable, but improbable type failures of any part of the airplane or its components and determine the resulting effects. It was concluded that there was no information available that indicated that the airworthiness of the airplane, along with its systems, instruments, and equipment could have contributed to the B-727 accidents.

(4) On 17 February 1966, a meeting was held in the FAA Washington headquarters with both domestic and foreign air carriers who operated the B-727 to determine what failures they had encountered and if any unusual operational occurrence had been experienced. Again no information developed that indicated that the airplane, its systems, instruments, or equipment could have contributed to the B-727 accidents.

In a related connection with the Flight Control and Performance Characteristics Group established following the American Airlines accident at Cincinnati, the Allied Pilot's Association circulated a questionnaire to their members on the B-727. The general opinion of these pilots was that the B-727 was a good easy-to-fly operational aircraft. On 7 June 1966, the Civil Aeronautics Board (CAB) issued the official report on the Salt Lake City, Utah, accident and stated, "The Board determines the probable cause of this accident was the failure of the captain to take timely action to arrest an excessive descent rate during the landing approach." On 7 October 1966, the CAB issued the official report on the Cincinnati acci-

dent and stated, "The Board determines that the probable cause of this accident was the failure of the crew to properly monitor the altimeters during a visual approach into deteriorating visibility conditions." On 10 January 1968, the National Transportation Safety Board (NTSB) issued the official report on the Lake Michigan accident and stated, "The Board is unable to determine the reason for the aircraft not being leveled off at its assigned altitude of 6,000 feet."

IV. NEW RULES

Looking now to the future, on 27 October 1967, the FAA issued a comprehensive set of updated crashworthiness rules designed to substantially improve passenger survivability in the event of an accident. The FAA's new *Crashworthiness and Passenger Evacuation Standards for Transport Category Airplanes* require extensive safety improvements in both airline equipment now in service and in designs of new planes not yet type certificated. In general, the new rules went into effect 24 October 1967. Large capacity jets, smaller, shorter range planes and other transport category aircraft not yet type certificated will have to meet most of the new requirements to qualify for type certificates, regardless of when type certification was originally applied for. Aircraft now in service or already type certificated will have to meet most of the retrofit changes required under the new rules by 1 October 1969. This lead time will give airlines enough time to make the required modifications. There are some required modifications which must be made within 12 to 18 months. Stretched versions of current jet transports are likewise subject to the new rules.

For the first time, airplane manufacturers will have to demonstrate a 90-second emergency evacuation using a full and representative passenger load before they will be issued type certificates. Present FAA rules require the airlines to demonstrate passenger evacuations, allowing two minutes for complete evacuation. Under the new rules, carriers will have to conduct 90-second evacuation demonstrations when they introduce new or significantly modified equipment into service or when passenger seating capacity is increased by five percent or more.

Some of the improvements required in passenger transports now in service include:

- (1) By 24 October 1967:
 - (a) ready accessibility of all emergency exits for passenger evacuation regardless of the number of occupants present on any particular flight;
 - (b) all passenger seatbacks in upright position for takeoffs and landings;
 - (c) flight attendants stationed near floor level exits and uniformly spaced during takeoff and landing;
 - (d) the passenger briefing instruction cards on emergency evacuation procedures (located in pocket of seatback facing passenger) will describe only the specific type aircraft.

- (2) By 24 October 1968:
 - (a) better access to overwing exits by eliminating interference from seatback in the immediate area of exit;
 - (b) cabin linings with self-extinguishing properties for improved resistance to fire; planes not yet type certificated by 24 October 1967, will have such materials installed before leaving the factory; airline transports now in service which do not already have interiors with self-extinguishing qualities must have them in after this date with their first major cabin overhaul or refurbishing of passenger cabin interior.
- (3) By 24 April 1969:
 - (a) restraints for stowing carry-on baggage to prevent baggage from creating a hazard in the event of an accident.
- (4) By 1 October 1969:
 - (a) automatic self-supporting, 10-second escape slide from each floor level exit in the cabin higher than six feet above the ground (slides manufactured on or after 24 October 1967 will have to meet new standards calling for automatic inflatability in not more than 10 seconds after actuation).
 - (b) slip-resistant and clearly marked escape routes from each overwing exit;
 - (c) emergency lighting control switch installed in passenger cabin for operation by flight attendants—this to be an additional switch to one now installed in pilot compartment; this requirement also applies to planes not yet type certificated;
 - (d) all floor level exits must meet new emergency exit requirements.

Airplanes which have not yet received FAA type certification must meet the airworthiness requirements specified for transports now in service, as appropriate. In addition, they must also satisfy various additional requirements. Emergency exits in future planes must be uniformly distributed. In the case of very large transports, increased exit-to-passenger ratios are specified. For aircraft with 300 seats or more, side exits must be either Type I, floor level exits, which require openings at least 24 inches wide by 48 inches high, or Type A, floor level exits, which are at least 42 by 72 inches, larger than any present emergency exits. Type A exits must have double-width slides fully deployable in 10 seconds.

Manufacturers seeking FAA certification of additional passenger seating capability on the basis of their aircraft being equipped with ventral exits or tail cone exits must fully qualify such exits for passenger emergency evacuation purposes to receive such authorization.

Improved landing gear design requirements must be met for type certification, to minimize rupture of fuselage fuel lines in the event of landing

gear failure or crash. Associated with this requirement are new rules for better protection of fuel lines and electrical cables against fuel leakage. Fuel lines must have sufficient flexibility and strength to allow some stretching without leaking. Power cables must likewise have added flexibility and strength and, in addition, be isolated from the fuel lines.

The new rules are based on the FAA *Notices of Proposed Rule-Making* (Notices 66-26 and 66-26A) dated 29 July and 2 September 1966. These notices were issued as a result of a public conference, extensive government industry discussions, and special studies by FAA's *Task Force for Crash-worthiness and Passenger Evacuation*.

FAA will consider additional revisions of the regulations, as advances in the state of the art allow, to further increase the probability of passenger survivability during accidents. To this end, follow-on government and industry development programs have been established to devise new techniques, designs, and equipment.

In progress now are programs to develop more effective self-extinguishing characteristics for aircraft interior materials, cabin fire suppressant systems, protection from smoke and fumes, gelled fuels, improved emergency lighting and exit conspicuity, and improved evacuation facilities and techniques.

I believe another example of proposed improved safety is in the flight recorder area. The FAA is encouraging the development of multi-parameter (150-300) sophisticated recorders which could serve as a maintenance and operations tool to monitor airborne performance of airplane powerplants and systems, provide a basis for operational performance analysis, and ensure recording of information essential for accident investigation purposes. The FAA, in fact, welcomes information and specific recommendations for technically and economically feasible integration of the various presently available and planned airborne recorder systems.

V. CONCLUSION

In summary, to improve safety for our new fleet of airplanes—the air bus, jumbo jet and supersonic transport, as well as the current fleet—the agency and all segments of the aviation industry must work together to achieve this goal.