THE IMPACT OF AIRLINE PILOT AGE AND FLIGHT EXPERIENCE FACTORS ON THE INCIDENCE OF COMMERCIAL AIR CARRIER ACCIDENTS ATTRIBUTED TO PILOT ERROR

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LIST OF ABBREVIATIONS

ADIZ	Air Defense Identification Zone
AOPA	Airplane Owners and Pilots Association
ALPA	Air Line Pilots Association
AME	Aviation Medical Examiner
CAMI	Civil Aeromedical Institute
CFR	Code of Federal Regulations
EEOC	Equal Employment Opportunity Commission
FAA	Federal Aviation Administration
FAF	Fixed Approach Fix
FAR	Federal Aviation Regulation
IAF	Initial Approach Fix
IATA	International Air Transport Association
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IOM	Institute of Medicine
MAP	Missed Approach Point
MVFR	Marginal Visual Flight Rules
NAS	National Airspace System
NIA	National Institute on Aging

LIST OF ABBREVIATIONS

NIH	National Institute of Health
NORAD	North American Aerospace Defense Command
NTSB	National Transportation Safety Board
VFR	Visual Flight Rules

CHAPTER I

INTRODUCTION

Background Information

In 1997, there were a total of 2,001 aviation accidents throughout the National Airspace System (NAS) which accounted for 740 fatalities (FAA Aviation Safety Statistical Handbook, 1998). Although these figures were lower than those for 1996 (by nearly 5%), they still represented a substantial cost in terms of human lives lost. While the vast majority of the total aviation accidents occurred in the General Aviation segment (approximately 93%), the impact of commercial aviation losses were no less important. Overall, the total system accident rate in 1997 experienced a drop to 4.64 accidents per 100,000 flight hours from the 1996 mark of 4.80. Moreover, the rate of fatal accidents also fell from .92 (per 100,000 flight hours) in 1996 to an .87 mark in 1997.

While these statistics may lead one to believe that aviation, especially commercial aviation, has never been safer, other figures were not so encouraging. Another indices, that of Pilot Deviations, revealed some significant and disturbing information. As defined in the Aviation Safety Statistical Handbook, Pilot Deviations were those "actions of a pilot that results in the violation of a Federal Aviation Regulation or a North American Aerospace Defense Command (NORAD) Air Defense Identification Zone (ADIZ) tolerance." In other words, these incidents possessed strong aviation accident potential.

The only missing ingredient was perhaps some form of intervention or, simply, the element of chance. Data on this area revealed 1,509 pilot deviations in 1997. This mark was up significantly (18%) from the 1,281 experienced in 1996.

The Issue of Airline Pilot Age

Since the inception of the original Federal Aviation Administration's Age-60 rule in 1959, many concerned aviation industry professionals and organizations have vigorously opposed placing arbitrary age restrictions on commercial airline pilots. Part 121 of the Federal Aviation Regulations specifically prohibited the operation of aircraft with 20 or more passengers by anyone age 60 or older (Appendix A).

Several legal cases have been filed in recent years challenging the rule, officially known as Federal Aviation Regulation (FAR) 121.383(c), with most plaintiff's usually claiming unjustified age discrimination (Baker v. F.A.A., 1990). Moreover, "the Air Line Pilots Association [initially] opposed the rule, administratively and with lawsuits, until 1981 when younger members, who want faster access to better-paying top jobs, prevailed" ("Grounding Pilots," 1995).

Interestingly, the FAA's own Age 60 Project Report (Kay, et al, 1993), as well as other scientific research, failed to show conclusive medical or performance data to support continuance of the Age-60 Rule ("Ground the," 1995), or " . . . a general rule based on age alone." ("AOPA Opposes," 1995). It was noted that while ". . . not all individuals experience equivalent age-related deterioration in health and performance, it was nevertheless concluded that an age-60 limitation was prudent on the grounds that performance decrements could not be reliably and objectively measured or predicted on an individual pilot basis" (Kay et al, 1993, p. 1.1).

Human Factors in Aviation

Since the 1950s, when the airline industry introduced safer and more reliable turbojet aircraft, the focus of commercial aviation accidents has shifted from failures of airframes and engines to the question of flightcrew, or "pilot" error. As shown in Figure 1, between 1959 and 1989 ". . . flightcrew actions were causal in more than 70% of worldwide accidents involving aircraft damage beyond economical repair." (Wiener, Kanki, and Helmreich, 1993, p. 5).

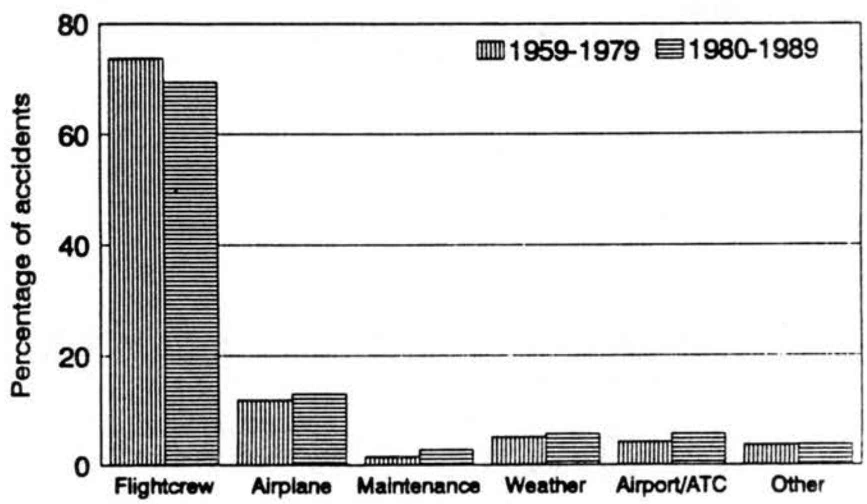

Figure 1. Primary Causes of Hull Loss Accidents (Excluding Military and Sabotage): Worldwide Commercial Jet Fleet, 1959-1989. Data From Boeing Aircraft Company. (From Wiener, Kanki, and Helmreich, 1993, p. 5)

This finding was in step with the work of the German researcher Meier Muller who estimated as early as 1940 "...that about 70% of aircraft accidents could be attributed to the performance of man." (Orlady, 1987, p. 32). Later, in the mid 1970s, the International Air Transport Association (IATA) illustrated this point once more (Figure 2) and underscored the central theme that human performance played a "dominant role...in civil aircraft accidents" (Orlady, 1987, p. 32).

Figure 2. Diagram Illustrating the Dominant Role Played by Human Performance in Civil Aircraft Accidents (I.A.T.A., 1975) (From Orlady, 1987, p. 32).

Without question, aircraft accidents have occurred in all sectors of aviation with many having been attributed to the pilot, or the flightcrew, taking unnecessary risks or having been otherwise distracted. Still, no conclusive link between the occurrence of these accidents and the age or the number of hours of flight experience of the pilots has ever been established. Despite this fact, the common assumption that has endured over time was that a more experienced airline pilot, in terms of age, flying hours, or overall experience, was generally a safer pilot. To be sure, a great many authors have continued to arbitrarily cite the overall safety record of senior airline captains as evidence to support this fact. But, is this indeed the case?

Statement of the Problem

The principle aim of this study was to determine the impact of specific human and operational factors on the incidence of a certain classification of air carrier aircraft accidents, i.e. those attributable to pilot error. This information was not fully known prior to this particular research. Moreover, this study addressed age-related issues regarding the legal rights and value of commercial airline pilots to continue their aviation employment past the age of 60. The age to which an airline pilot could legally work was restricted to 59 years of age at a time when the demand for experienced pilots was reaching a peak in commercial aviation. Airline pilot hiring was estimated to exceed 12,000 in 1997 alone; with this trend expected to continue well into the future (Bradley, 1997, p. 78). This study questioned the rationale of the Age-60 Rule in light of current age-related research which has realistically supported adjustment of the retirement age to age 63 or, perhaps, even beyond. Finally, it evaluated the historical gathering methods and use of flight experience data by air carrier accident investigators and questioned its present value in predicting accidents.

Significance of the Study

Results of research in this area could have profound implications for future aviation safety through longer retention of experienced airline, commercial, and corporate pilots; an increased awareness by pilots of the detrimental effects of the aging process; and the inclusion of an integrated program of cognitive functions evaluation by cockpit resource and human factors research professionals within the airline and aviation industry. Moreover, this research could highlight factors regarding the flight experience of the pilots and whether or not crews have been teamed in a way which best matches their differing levels of experience. Of key importance here was the element of risk and the degree to which it could be predicted and ameliorated. Finally, this research could further support the need for clarifying the present ambiguity surrounding the logging and maintaining of pilot flight time. Thus, possibly increasing the utility of pilot experience records. Future accident investigators could then have better tools with which to establish the experience and fitness levels of pilots involved in an aircraft mishap.

Purpose of the Study

The purpose of this study was to determine the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. Specifically, the factors of; airline pilot age, total flight experience, flight experience in a specific aircraft (time in type), the phase of flight when the accident occurred, and the prevailing meteorological conditions at the time of the accident were evaluated based on their possible effect on the incidence of a commercial air carrier accident occurring due to pilot error.

This study investigated a vitally important area of airline operations related to commercial air carrier safety. Moreover, it served to critique the historical gathering methods of flight experience data by air carrier accident investigators, and presented recommendations for future improvements in their analyses and use.

These are important aspects of human factors research related to airline flight operations and pilot retention policies which offered a rich opportunity for aviation-related investigation. Moreover, the issues addressed in this study directly affected a growing segment of the commercial airline pilot population. Just over 1,000 airline pilot retirements were reported for 1996 (Bradley, 1997, p. 80). This number was forecast to exceed 1,600 by the year 2000 and double the 1996 mark by 2007 (p. 80).

The physical and cognitive aspects of the problem of age-related hazards have received widespread attention in prior literature on aviation, but their relationship to decision-making and risk-propensity has largely been understated. Since little research was found that specifically examined the possible behavioral interaction between airline pilot age and experience factors, and increases in the overall risk of being involved in an accident, this study served to add to the body of knowledge on the subject.

A major strength of this particular research project was founded in the way in which it focused on significant core human and operational factors relevant to a select number of air carrier accidents.

Research Questions

Certain questions, related to the age, flight experience, and operational issues in commercial aviation, were considered relevant in the conduct of this study. Based upon evidence extracted from National Transportation Safety Board (NTSB) accident investigation reports, the following questions were asked:

1. Was the chronological age of the airline pilots involved a factor in any of the accident cases studied?
2. Were the total flight hours of the pilots a factor in any of the accident cases studied?
3. Were the total flight hours of experience in a particular aircraft (time in type) of the pilots a factor in any of the accident cases studied?
4. Was there a particular phase of flight where the majority of aircraft accidents studied were more likely to occur?
5. Were the accident cases studied more likely to occur during prevailing Instrument Meteorological Conditions (IMC) or Visual Meteorological Conditions (VMC)?

Scope

This study was directed toward investigating the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. The specific cohort group was all airline pilots engaged in commercial air carrier operations under Title 14 CFR Part 121 of the Federal Aviation Regulations of the United

States. The exact size of the accessible population was unknown, but was estimated to average 61,118 first officers and 75,704 captains annually. This was based on data presented in Table I. Here, it was assumed that airline first officers and captains would hold at least half of the Commercial and the overwhelming majority (75%) of Airline Transport Pilot certificates held by pilots between age 23 and 59. (Note: In addition to specific flight hour and experience requirements, FAR Part 61 also required a minimum age of 23 in order to qualify for issuance of an Airline Transport Pilot certificate).

TABLE I

AVERAGE ACTIVE COMMERCIAL AND AIRLINE PILOT CERTIFICATES HELD BY CATEGORY AND AGE 1986-1996

	Type of Pilot Certificate 1/		
Age Group	Commercial	Airline Transport	Total
20-24	10,090	382	10,472
25-29	19,213	6,104	25,317
30-34	16,889	15,139	32,028
35-39	15,877	18,142	34,019
40-44	17,746	18,709	36,455
45-49	17,274	18,137	35,411
50-54	14,087	14,444	28,531
55-59	11,061	9,882	20,943
Total	122,237	100,939	223,176

Note: 1/ Includes pilots with an airplane only certificate. Also includes those with an airplane and a helicopter and/or glider certificate.

The actual group studied, and for which data were collected, was composed of those captains and first officers involved in a commercial air carrier accident between 1986 and 1996. Moreover, only operations conducted under FAR Part 121, as well as, only those accidents where pilot or flightcrew error was cited as the probable cause were included for study in this research.

Definition of Terms

The following terms will be used in this study:

Air Carrier - A person, or corporation, who undertakes directly by lease, or other arrangement, to engage in air transportation operating under FAR Parts 121, 127, or 135 (also see Large Air Carrier).

Airline Transport Pilot Certificate - A certificate issued by the FAA authorizing the holder to engage as the pilot in command in air carrier operations under FAR Part 121.

Captain - The pilot in command responsible for the operation and safety of an aircraft during flight time.

Commercial Pilot Certificate - A certificate issued by the FAA authorizing the holder to engage as the second in command in air carrier operations under FAR Part 121.

Federal Aviation Administration (FAA) - The agency of the Federal Government responsible for the formulation and enforcement of regulations concerning all non-military aviation operations in the United States. The FAA also licenses all U.S. civil pilots.

Federal Aviation Regulations (FARs) - The general name for the body of rules governing civil aircraft and airmen in the United States under Title 14 of the Code of Federal Regulations (CFR). Various parts and subparts of the FARs concern certification of pilots for Commercial and Air Transport operations, as well as, regulating the operations of air carriers.

FAR Part 61 – This part prescribes the requirements for issuing pilot, flight instructor, and ground instructor certificates and ratings; the conditions under which those certificates and ratings are necessary; and the privileges and limitations of those certificates and ratings. It also prescribes the requirements for the logging of pilot flight time.

FAR Part 91 – This part prescribes rules governing the operation of aircraft (other than moored balloons, kites, unmanned rockets, and unmanned free balloons, which are governed by part 101 of this chapter, and ultralight vehicles operated in accordance with part 103 of this chapter) within the United States, including the waters within 3 nautical miles of the U.S. coast.

FAR Part 121 - This part prescribes rules governing the domestic, flag, and supplemental operations of each person who holds or is required to hold an Air Carrier Certificate or Operating Certificate under Part 119.

FAR Part 135 - This part prescribes rules governing the commuter or on-demand operations of each person who holds or is required to hold an Air Carrier Certificate or Operating Certificate under Part 119.

First Officer - The pilot who is designated as second in command of an aircraft during flight time.

First Class Medical Certificate - A certificate issued by the FAA certifying that the holder is medically qualified for operations requiring an airline transport pilot certificate.

Instrument Flight Rules (IFR) – Rules governing the procedures for conducting instrument flight.

Instrument Meteorological Conditions (IMC) – Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima specified for Visual Meteorological Conditions (VMC). Considered any ceiling lower than 1,000 feet AGL and/or any visibility less than 3 statute miles requiring the use of Instrument Flight Rules (IFR).

Large Air Carrier – Scheduled and nonscheduled aircraft operating under Parts 121 or 127 of the Federal Aviation Regulations. (Note: Part 129 operations [foreign air carriers] are not included in the NTSB accident database, nor are hour and departure data available for these air carriers.)

Phase of Operation – The phase of the flight or operation is the particular phase of flight in which the first occurrence or circumstance occurred:

Standing – From the time the first person boards the aircraft for the purpose of flight until the aircraft taxies under its own power. Also, from the time the aircraft comes to its final deplaning location until all persons deplane.

Taxi – From the time the aircraft first taxies under its own power until power is applied for takeoff. Also, when the aircraft completes its landing ground run until it parks at the spot of engine shutoff.

Takeoff – From the time the power is applied for takeoff up to and including the first airborne power reduction, or until reaching VFR traffic pattern altitude, whichever occurs first. Includes ground run, initial climb, and rejected takeoff.

Climb – From the time of initial power reduction (or reaching VFR traffic pattern altitude) until the aircraft levels off at its cruise altitude. Also includes enroute climbs.

Cruise – From the time of level-off at cruise altitude to the beginning of the descent.

Descent – From the beginning of the descent from cruise altitude to the IAF, FAF, outer marker, or VFR pattern entry, whichever occurs first. Also includes enroute descents, emergency descent, and uncontrolled descent.

Approach – From the time the descent ends (either IAF, FAF, outer marker, or VFR pattern entry) until the aircraft reaches the MAP (IMC) or the runway threshold (VMC). Includes missed approach (IMC) and go-around (VMC).

Landing – From either the MAP (IMC) or the runway threshold (VMC) through touchdown or after touchdown off an airport, until the aircraft completes its ground run. Also includes aborted landing where touchdown has occurred and landing is rejected.

Maneuvering – Includes the following: Aerobatics, low pass, buzzing, pull-up, aerial application maneuver, turn to reverse direction (box canyon-type maneuver), or engine failure after takeoff and pilot tries to return to runway.

Other – Any phase that does not meet the criteria of any of the above.

Unknown – The phase of flight could not be determined.

Pilot Deviation - The actions of a pilot that result in the violation of a Federal Aviation Regulation or a North American Aerospace Defense Command (NORAD) Air Defense Identification Zone (ADIZ) tolerance.

Second Class Medical Certificate - A certificate issued by the FAA certifying that the holder is medically qualified for operations requiring an commercial pilot certificate.

Visual Flight Rules (VFR) – Rules governing the procedures for conducting flight under visual conditions.

Visual Meteorological Conditions (VMC) – Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima. Considered any conditions with a minimum ceiling of at least 1,000 to 3,000 feet AGL and/or a visibility between 3 to 5 statute miles under marginal conditions (MVFR).

Assumptions

The following assumptions applied to this study:

1. All airline pilots involved in the accidents examined by this study were between 23 and 59 years of age as required by FAR Part 61.
2. All airline pilots involved in the accidents examined by this study were appropriately rated and possessed at least the minimum level of recent experience in the aircraft to perform flight duties in accordance with applicable sub-parts of FAR Parts 61 and 121.
3. The research procedures were precisely followed and introduced no unwanted or confounding variables.
4. The appropriate research statistics were applied to the data and all computations were mathematically correct.

Limitations

Several confounding variables could have easily jeopardized the validity of the results of this research. This research was handicapped by the multitude of factors and differences between types and categories of aircraft flown, a wide variety and level of experience among pilots, as well as, the many human factors and behavioral differences already assumed to exist between subjects. Furthermore, the fact that the subjects were not randomly selected, nor randomly assigned to groups, naturally prevented accurate generalization of the results of this research to other pilot populations.

Statement of the Hypothesis

The hypothesis of this research was that a statistically significant relationship was believed to exist between specific human and operational factors and the occurrence of an air carrier accident due to pilot error.

The predictor variable of pilot age was examined for a possible correlational relationship to the factors of: total pilot flight hours and total pilot time in aircraft type. In this study, age was considered as it related to the assumed continuum of experience and competence a pilot gained in the cockpit environment over a number of years. Comparisons between the phase of flight during which the accident occurred and the prevailing meteorological conditions (IMC or VMC) that existed at the time of the accident were also examined for possible interdependence.

Overview of the Study

The following overview describes the remaining chapters of this research study. Chapter II, Review of Selected Literature: Discusses some of the significant research previously conducted in the areas of pilot aging and flight experience. It further addresses some of the important issues regarding the Age-60 rule and incorporates some of the current opinions expressed by airline pilots on this rule. Chapter III, Methodology: Describes the purpose and design of the study, the characteristics of the population of pilot crewmembers studied, how data were collected and analyzed, and what particular considerations were made regarding the population studied and data collected. Chapter IV, Findings: Presents the data collected in various forms to better aid in evaluation and understanding, and provides statistical summaries of the results. Chapter V, Summary, Conclusions and Recommendations: Discusses the significance of the research findings including whether or not the hypothesis was confirmed. Conclusions drawn from analysis of the research data are presented and recommendations made for further research in this area of study.

CHAPTER II

REVIEW OF SELECTED LITERATURE

General

The purpose of this study was to determine the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. Specifically, the factors of; airline pilot age, total flight experience, flight experience in a specific aircraft (time in type), the phase of flight when the accident occurred, and the prevailing meteorological conditions at the time of the accident were evaluated based on their possible effect on the incidence of a commercial air carrier accident occurring due to pilot error.

Relatively little prior research was found which specifically addressed the concept that airline pilot age or other experience factors, working singularly or in combination, contributed to an air carrier accident. Most authors tended to focus their attention on the relationships between age and medical or cognitive function in pilots as they grew older rather than on simply age or the cumulative effect of multiple human factors on accident statistics.

One aspect of the present research addressed a representative cross section of the available information on age-related physical and cognitive detriments in human development and how these detriments could effect pilot performance, judgment, and the overall propensity of the pilots to take risk. The primary focus of this study was on a single cohort group, that being commercial airline pilots. Reference to the FAA Age-60 Rule was made in light of its implications for at least a portion of this particular group as they approached the federally-mandated end of their airline pilot careers.

Aviation Human Factors Research

The failure to adequately manage risk in aviation has been a topic often addressed in flight publications, newspapers, journals and books, and discussed during human factors sessions at aviation safety seminars. Authors have been quick to describe an aircraft accident scenario where a pilot or flightcrew made a serious, and often fatal, mistake. They would proceed to reconstruct the series of events which led up to the accident or incident in question and would usually wax lyrical over what the pilots should or should not have done in each particular situation. Generally, these after the fact exposés have been moderately interesting and somewhat informative. However, they have seldom been very successful in preventing future air carrier accidents, since pilots rarely again faced the identical set of circumstances described by the author. On the other hand, of greater utility have been the research and journal articles that have focused attention on the root causes of accidents. This type of research has properly viewed the flightcrew in the proper perspective as human beings, with all of their associated faults and failings.

Collins (1992) wrote in reference to one of the various ways pilots seem to put themselves at risk. He stated that pilots often make "that extra effort to get back to the familiar hearth" (p. 71). He went on to speculate that "more airplanes are lost on the way home than are lost on the way to somewhere else" (p. 71). Airline pilot and author Barry

Schiff (1992) described this behavior as "focusing so intently on reaching a destination that a pilot loses his safety perspective . . . " (p. 97). He further suggested that "although seldom cited in accident reports as a probable cause," this overwhelming urge to arrive at the planned destination airport "undoubtedly is an underlying reason for a great number of [aviation] tragedies" (p. 97).

While Collins' and Schiff's remarks were aimed more at the general pilot population, this fact was certainly no less true for commercial airline flightcrews. The pressure to depart on time and arrive at the planned destination were only a few of the basic operational demands routinely required. The fact remained that the commercial airline pilot "lives a life of deadlines" (Orlady, 1987, p. 100). Research has long shown that this kind of "affective stress can produce certain characteristic types of pilot error" (Davis in Orlady, 1987, p. 100).

After compiling data over a seven year period, Billings (1984) declared that "human error has repeatedly been found to cause or contribute to well over half of all aviation accidents" (p. 960). He went on to reveal that the aviation community has "not thus far been uniformly successful in devising strategies to cope with human errors in aviation, largely because--despite a long-standing tradition of careful investigation of all serious mishaps--our understanding of why such errors occur has been deficient" (p. 961).

Some authors have claimed that the physical decrements of increased age have been a causal factor in many aviation accidents. Gerathewohl (1978a) cited a 1977 study by Booze in which he " . . . analyzed the effects of age and experience on general aviation pilots involved in fatal weather-related accidents with spatial disorientation as a cause/factor" (Quekemeyer, 1995). Here, the author claimed that a correlation existed between increased age and the accident rate of disoriented pilots (p. 12).

On a more positive note, in 1981 the Institute of Medicine (Institute of Medicine [IOM], 1981) completed a study of cardiovascular disease among airline pilots. The IOM concluded that although cardiovascular disease remained "a major health problem among airline pilots, being the leading cause of medical retirement . . . the age-related increase in cardiac mortality in airline pilots" was no greater than that for the general population (p. 7). Interestingly enough, "the cardiac mortality remains lower for airline pilots at least through age 60" (p.7).

Cognitive Risk Factor Research in Aviation

Some authors have expressed the opinion that it was not as much the chronological age or physical health of the pilot which determined the capacity to effectively perform safely past age 60, as it was his or her individual propensity to assume greater or lesser risk while flying. One author (Collins 1981) argued that pilots tended to pass through phases throughout their aviation careers where they were more, or less, likely to have an accident than at other times. Here, Collins described undocumented research which attempted to show a relationship between pilot chronological age and aviation safety. He indicated that "there are some things in the record to suggest a relatively minor relationship between a pilot's age and the ability to operate airplanes safely" (p. 241-242). Collins also identified several age groups which were believed to represent periods during which pilots were either more or less safe.

Unfortunately, in his book, Collins provided few clues as to the specific source of the accident statistics cited and little information on the exact population in question or the size of the sample. He did, however, make some interesting comparisons between pilot chronological age and aviation safety. Although not substantiated by documented research, his conclusions did seem to indicate that there were identifiable periods throughout a pilot's aviation career when distinct behavioral changes occurred. During these phases certain factors were more likely to have an effect on pilot performance and flight safety. For instance, he stated that "the youngest pilots tend to do the best" (p. 242), with the 16 to 19 year old age group experiencing "fatal accidents at a rate of about one-half the percentage of this group's representation in the total number of pilots" (p. 242). Furthermore, these favorable statistics continued through the next phase in the early twenties, before they began to wane among pilots in their early thirties. Next, pilots between age 40 to 44 seemed to indicate the highest risk, with this group having demonstrated the worst accident rate. Beyond this age group the situation seemed to improve, and indications were that pilots in their early fifties tended to do somewhat better. The best record, however, as indicated by Collins, was seen with pilots in their mid to late fifties. Finally, "the senior pilots, those over sixty, had more problems than...expected in this sample" (p. 245). Although his report lacked strict scientific research methodology, Collins did seem to indicate a possible curvilinear relationship between chronological age and a pilot's ability to operate an aircraft safely. However, here again, the implications were postulated for the pilot population in general and not specifically aimed toward the air carrier environment.

Government Studies Relating to Risk Factor Research

Research into pilot behavioral factors has received only sporadic attention in the past, with most emphasis the result of some catastrophic aviation event. Parker (1988) expressed the following in response to this apparent lack of concern:

> A plan to develop cockpit resource management, as the training is called, was written by the FAA in 1983 after a rash of pilot-caused crashes in the late 1970's, but the project was never funded. Research was nearly at a standstill until the Detroit accident, in which 156 people perished, jolted the FAA into resurrecting the concept. (no page number cited)

While little prior research has been found which specifically supported the theory that certain factors, such as a pilot's propensity to take risk were directly or indirectly related to age, a few authors have cited some interesting concepts that related to the air carrier cockpit environment. Several have come to the conclusion that " . . . when a decision is made by a group, it is likely to involve a greater element of risk than if it is made by an individual" (Baron et al. in Orlady, 1987, p.179). This concept holds significance since it can be legitimately said that the captain-first officer team was certainly considered to possess strong group dynamics. "Another hypothesis is that individuals who hold higher risk attitudes tend to be more dominant and persuasive in the group . . . they thus have a disproportionate influence over their fellow members" (Orlady, 1987, p.180).

The Federal Aviation Administration (FAA) action announcing its decisions on a number of issues regarding the Age 60 Rule cited Petersen's "concepts of 'age-related cognitive decline' or 'age-associated memory impairment' . . . " (FAA Docket No. 27264, 1995). Here, Petersen viewed the decline of certain cognitive functions as the normal consequence of the aging process. " . . . attention; language; some visuospatial skills; and, particularly, memory" (p.7) all could be expected "to describe a longitudinal decline in performance that is age appropriate . . . " (p.7).

Moreover, most research specifically aimed at determining the cognitive effects of aging indicated a remarkable decline with age in the pilot's cognitive functions of "intelligence, resource reduction, attention, memory, problem solving, reaction time, and competency" (Quekemeyer, 1995, p. 21). However, despite the considerable effort devoted to this area of human research, experts have yet to develop an appropriate diagnostic instrument capable of adequately measuring or predicting cognitive decline in individuals. Furthermore, despite the fact that a thorough physical examination has long been required every six months of commercial airline pilots operating under specific Federal Aviation Regulations, testing of the pilot's ". . . cognitive function is currently not the responsibility of the aviation medical examiner" (APA, 1993, p. 17).

The Age-60 Rule

What has commonly become known as the Age-60 Rule was not a recent phenomenon. It was originally promulgated in 1959 in response to public concerns over the utilization by many air carriers of an aging force of post World War II era pilots. The FAA cited "a progressive deterioration of certain important physiological and psychological functions with age, that significant medical defects attributable to this degenerative process occur at an increasing rate as age increases, and that sudden incapacity due to such medical defects becomes more frequent in any group reaching age 60" (FAA Docket No. 27264, 1995). While the initial focus of the rule was on the aspect of sudden incapacitation (presumably of the captain), the FAA also pointed to a general slowing of both physical and cognitive abilities as the pilot approached 60 years of age. Here, they pointed to the "loss of ability to perform highly skilled tasks rapidly, to resist fatigue, to maintain physical stamina, to perform effectively in a complex and stressful environment, to apply experience, judgment and reasoning rapidly in new, changing and emergency situations, and to learn new techniques, skills and procedures" (FAA Docket No. 27264, 1995). The Agency determined that, while many of these physical and cognitive losses started well before the age 60 mark, it was considered an unacceptable risk to part 121 air carrier operations to allow individuals to fly as pilots past age 59. They did concede, however, to not mandating actual retirement of pilots, but allowing those individuals to retain other positions both within and outside the airline cockpit. "A pilot may work as a flight engineer or flight instructor in operations conducted under part 121 or may work as a pilot in operations outside of part 121. The pilot also may function as an instructor or evaluator in simulators . . . " (FAA Docket No. 27264, 1995).

In response to both legal challenges, airline pilot interest group outcries, and individual petitions for exemption or waiver, the FAA has on a few occasions explored possible changes to the rule. As early as 1980, Congress directed the National Institute of Health (NIH) to conduct a study regarding " . . . the desirability of mandatory age retirement for certain pilots" (P.L. 96-171). The NIH assigned the National Institute on Aging (NIA) as the primary agency responsible for conducting the research. In their report, "Report of the National Institute on Aging Panel on the Experienced Pilot Study" (August 1981) (NIH report), the NIA " . . . recommended that the age 60 limit be retained. Among other things, the panel concluded that, while no medical significance could be attached to age 60 as a mandatory retirement age, age-related health changes endanger aviation safety and no medical or performance appraisal system could be identified that would single out pilots who would pose a hazard to safety" (FAA Docket No. 27264, 1995). The final conclusion reached by this research was that there existed ". . . an inability to distinguish those persons who, as a consequence of aging, present a threat to air safety from those who do not" (FAA Docket No. 27264, 1995).

In late 1990, the FAA once more addressed the issue by contracting for further research. Over a two year period, the Hilton Study, attempted "to consolidate accident data and correlate it with flying experience and age of pilots" (FAA Docket No. 27264, 1995). While the major focus of this research was on pilots engaged in part 121 operations, the study also investigated accident rates for pilots operating under parts 91, 121, and 135. The results indicated no increase in the accident rate for pilots operating for scheduled air carriers as they approached age 60. They also "noted that there were no data available on scheduled air carrier pilots beyond age 60," since of course, that was not permitted by the regulation. Their observations did notice a slight increase in accident rates for some pilots older than 63 years of age. These represented pilots operating with the lowest class (Class III) of medical certificate, and under the rules usually associated with Private Pilot flight operations. Ultimately, the Hilton Study concluded that the retirement age could "cautiously" be increased to age 63 (FAA Docket No. 27264, 1995).

Legal Challenges to the Age-60 Rule

In his lawsuit, Baker (1990) attempted appeal of the FAA's refusal to issue a waiver for him to continue to act as a commercial airline pilot past his sixtieth birthday.

He claimed that those "pilots age 60 or older" who met the FAA's "proposed battery of physical and psychological tests [the protocol], were no more likely to cause accidents due to sudden incapacitation or undetected deterioration of piloting skills than other pilots" (Baker v. F.A.A., 1990). Moreover, "that the flying experience gained by allowing pilots age 60 or older to fly offset any increased risk of an accident due to sudden incapacitation or skill deterioration, and that granting limited exemptions effectively produced a net increase or, at least, no net declines in safety" (Baker v. F.A.A., 1990). The FAA's response was that "it was not in the public interest to grant exemptions when petitioners' protocol did not surely reduce all incremental risks associated with the aging process" (Baker v. F.A.A., 1990).

Here, as with similar cases, the court decided for the FAA. However, it claimed that "the FAA's distinctions and exemption practices are inconsistent" and that it should have published what it considered qualifying proof for an exemption to the age-60 rule (Baker v. F.A.A., 1990).

Public Comment and Opinion on the Age-60 Rule

Over and above the many legal challenges to the Age-60 Rule have been the clamor of comment and opinion from both the pilot community and the flying public at large. Ever since the original regulation was promulgated many have stepped forward to debate the pros and cons of the issue.

Some have made formal comments in FAA deliberations addressing the proposed disposition of a number of Age-60 Rule issues. They point to the remarkable progress that has been made in medicine and the increases in general health and longevity since the original rule was enacted over 37 years ago. Conversely, others point to insurance company statistics which " . . . show a dramatic rise in cardiovascular disease in people over age 50" (FAA Docket No. 27264, 1995). The debate has seemed to always center on the issue of the greater experience and better performance of the older airline pilot. Here to, some have rebuffed this notion with comments such as:

> First, age does not necessarily imply quantity or quality of experience. Experience is valuable, but it does not offset all risks or decrements associated with aging. Also, at some point, the law of diminishing returns comes into play. Once a pilot achieves a certain level of expertise, additional flight time will not significantly improve pilot performance. (FAA Docket No. 27264, 1995).

Opinions have remained, and will likely continue, divided on this issue. With those against the rule professing a more militant viewpoint. Many have not considered the FAA to be the major culprit either. This point of view was best summed up by one pilot this way:

> Many who advocate mandatory retirement at age 60 have ulterior motives. No one has proven we get "slow in the head" at 60. The Air Line Pilots Assn. is caught up in union fervor to get more pilots hired. Management prefers inexpensive new pilots to high-priced veterans. Many pilots prefer to retire and not work longer for the same annuity. Some, however, want to continue flying longer. If safety is an issue, allow pilots to fly as long as they show physical and professional competency (Biegalski, Aviation Week & Space Technology, p. 8, May 12, 1997).

Limitations of Previous Age-Related Research

One significant limitation of previous research, at least among the general population, has been the widely divergent age groups used in many studies. Young adult subjects have been limited to college undergraduates in nearly all major studies. In addition, the few researchers who have correlated risk-taking to aging have used an elderly sample, generally with subjects older than 70 years of age (Kogan and Wallach, 1961; Botwinick, 1966, 1969).

In aviation, studies have largely focused on age in relation to overall pilot performance (Eyraud and Borowsky, 1985) or a specific physical ability (Morris and Temme, 1989). Prior subject populations usually included more younger pilots (22 to 44 years old). Presumably, in the military aviation organizations where several of these studies were conducted, pilots in this age range were generally more accessible.

Such limited and inharmonious samples have unfortunately placed limitations upon the potential generalizations which can be made regarding changes either over the life span of subjects or in the determination of differences among and between the younger and older pilot cohort groups. A broader sampling of subjects across the life span and within and between groups was necessary before any solid conclusions could have been reached.

The Factor of Flight Hours of Experience

The obsession by the aviation community on total flying hours has led to its solid standing as the benchmark for determining of the level of flight experience and overall competency a pilot was assumed to possess. Today, airline, commercial, and corporate pilot job applications routinely ask the applicant to list his or her total number of hours flown. Moreover, the aviation insurance industry has long supported the theory of a relationship between experience and risk, with this relationship reflected in higher or lower aviation insurance premiums. Generally, these premiums have been considerably lower for the pilot who had, or the air carrier whose pilots had, greater experience in terms of flying hours.

While much emphasis has historically been placed on the number of flying hours a pilot accumulated over the span of a career, there has been little governmental interest in requiring pilots to actually maintain extensive records. The Federal Aviation Regulations (Part 61) merely required that the pilot log only the time necessary " . . . for a certificate or rating . . . " or in order to "satisfy the recent flight experience of this part" (FAR Part 61.51(c)(1) and (2)). In other words, the vast majority of a pilot's aviation career could, theoretically, go unrecorded.

The significance of this discontinuity, between what has been viewed by many as a measure of a pilot's experience and competence with what was required to be maintained, cannot be understated. Another federal agency, the National Transportation Safety Board (NTSB), has routinely reported the flying hours of the pilots involved in an accident. In their Accident Reports, they have consistently reported both the total flying hours, as well as, the hours flown in the particular type of aircraft involved in the accident. However, they have not been so consistent in recording other flight hour data. Information on the amount of recent flight experience that the pilots may have had within a number of hours and days prior to the accident has received inconsistent attention, at best. Records have shown a variety of periods being reported from 24 hours to 30, 60, 90, and 365 days, as well as, various combinations thereof. Moreover, the guidance offered in the NTSB Aviation Investigation Manual seemed quite vague, directing that the " . . . investigation should include a review of background . . . " and " . . . airman records." (NTSB Aviation Investigation Manual, Vol. II, p.II-F-27).

Summary

As suggested in the literature, the physical and cognitive effects of the aging process have played a significant role in the determination of a pilot's overall health and ability to safely operate an aircraft. However, further study and investigation is needed to determine whether increasing age in commercial airline pilots poses a linearly increasing risk to air safety. And, if not the case, is there sufficient rationale and benefit in proposing that the retirement age be increased to 63 or beyond?

Moreover, the historical importance placed on a pilot's total number of hours flown may have been misguided, since the regulations have never required that the pilot maintain a complete accounting of every hour flown. Thus, doubt could logically be placed on the legitimacy of claims by some pilots to having logged many thousands of flight hours. Furthermore, under the present regulations, flying hour data observed and recorded by the NTSB during air carrier accident investigations could be best viewed simply as anecdotal evidence.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to determine the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. Specifically, the factors of; airline pilot age, total flight experience, flight experience in a specific aircraft (time in type), the phase of flight when the accident occurred, and the prevailing meteorological conditions at the time of the accident were evaluated based on their possible effect on the incidence of a commercial air carrier accident occurring due to pilot error.

Based upon evidence extracted from National Transportation Safety Board (NTSB) accident investigation reports, the following questions were asked:

1. Was the chronological age of the airline pilots involved a factor in any of the accident cases studied?
2. Were the total flight hours of the pilots a factor in any of the accident cases studied?
3. Were the total flight hours of experience in a particular aircraft (time in type) of the pilots a factor in any of the accident cases studied?

4. Was there a particular phase of flight where the majority of aircraft accidents studied were more likely to occur?

5. Were the accident cases studied more likely to occur during prevailing Instrument Meteorological Conditions (IMC) or Visual Meteorological Conditions (VMC)?

The following sections of this chapter detail the process used to establish the design of the study, develop appropriate data collection procedures, analyze the data, as well as, interpret and report the significance of the data. The procedures described in this study were outlined in the Oklahoma State University Institutional Review Board (IRB) research application and were subsequently approved (see Appendix B).

Design of the Study

This study was based on the analysis of data collected from National Transportation Safety Board (NTSB) aircraft accident reports covering a period of eleven years between 1986 through 1996. During this period, twenty reports met the basic research criteria of the study that: 1) only FAR Part 121 operations would be investigated, and 2) only those final accident reports where pilot, or flightcrew, error was identified as the probable cause would be used.

The scope of this study was restricted to the assessment of accident reports involving only captain and first officer pilot positions of domestic and flag air carriers based within and governed by the aviation regulations of the United States. Moreover, only two-pilot crew operations were considered. Data that referred to other airline cockpit positions, such as Flight Engineer or Flight Navigator, were not considered or used in any comparison. Likewise, routine flight instruction or other single-pilot commercial operations allowed under FAR Part 121 were excluded from this study.

Definition of the Population

The population of this study included all airline pilots, ages 23 through 59, engaged in commercial air carrier operations under Federal Aviation Regulation (FAR) Part 121 and involved in twenty accidents reportable under National Transportation Safety Board regulation NTSB Part 830. The exact size of the accessible population for this study was unknown, but was believed to consist of the majority of the average number of annual Airline Transport (100,938) and Commercial pilot (122,237) certificates held during the time frame of this study. No assumptions were made regarding the applicability of this research to any other airline pilot population.

No differentiation was made in terms of gender, race, or between major or regional air carriers, pilots, or accidents. Data collected on these factors were used solely as a source to better identify the demographic characteristics of the accessible population.

Although lacking the advantages of random selection, the sample studied in this research was believed to represent an accurate cross-section of the target population and offered the variety and range of age and experience required to adequately test the null hypothesis.

Data Collection Instrument

A data entry log was designed to record information from each NTSB Accident Report. Data gathered from the reports were divided into five areas.

1. Age of each airline pilot involved.
2. Reported hours of total flight time of each pilot involved in the accident.
3. Reported hours of flight experience of each pilot in the specific type aircraft involved in the accident (time-in-type).
4. Phase of the flight during which the accident occurred.
5. Prevailing meteorological conditions at the time of the accident (IMC or VMC).

Additionally, a multiplicity of background data was deemed informative and appropriate for this research. Information regarding the air carrier company name, date of the accident, type of aircraft involved, accident report executive summary, and probable cause of the accident were photocopied directly from the NTSB Accident Investigation Reports. This ancillary information is presented for each NTSB Accident Report as the: 1) report abstract, 2) report executive summary, and 3) accident probable cause (see Appendix C).

Identifying information such as pilot names, pilot certificate/Social Security Numbers, or addresses were not usually available in the NTSB reports. However, in several older cases where this demographic data were provided, none were solicited or recorded by the researcher. Thus, the ability to positively identify an individual pilot based solely on information provided in this report would be difficult, if not impossible.

Description of Data Collection Procedures

Data gathering for this study was conducted during the late Fall of 1998 with interpretation and statistical analysis accomplished during the early months of 1999. Specific research information was collected during multiple visits to the Federal Aviation Administration Library located at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. Additional and supplemental information was gathered from FAA and NTSB Internet databases, as well as, microfiche and printed material maintained at the Oklahoma State University Library in Stillwater, Oklahoma.

Ethical and Legal Considerations

Procedures for this research were designed with the legal rights and privacy of the subject population as a primary concern. These procedures were implemented in accordance with the principles established by the American Psychological Association (APA, 1973). Specifically, those principles which addressed the areas of responsibility, moral and legal standards, confidentiality, test interpretation, and research precautions were emphasized (APA, 1973). Other principles listed under Ethical Standards of Psychologists, when applicable, were also considered in the conduct of this research.

The potential for physical, psychological, and emotional harm as a result of this research was considered to be negligible. All data-gathering procedures incorporated within this study were designed with the confidentiality of the subject as a primary concern. Close control and security of all personal data were maintained during the data gathering, analysis, and post-research phases. At no time were individuals, other than those specifically designated by the researcher, permitted to view data contained on any research data instrument or record. Names or other items of personal identification, although available on some of the NTSB accident reports, were not recorded and therefore could not be made public solely through reference to this research.

Analysis of the Data

Data extracted from NTSB Accident Reports were recorded on a data entry log and entered into a computer-based statistical program. All entries were checked for accuracy prior to being loaded. The data were summarized and analysis was accomplished.

A combination of statistical methods were used in analyzing and interpreting all data depending upon the nature of the specific variables involved. Methods for analyzing both qualitative and quantitative data were used in this study. Data analysis to test the hypotheses was accomplished using the Pearson coefficient of correlation, chi-square test, and descriptive statistics.

All statistical procedures were performed in accordance with the established methods outlined in selected reference documents (Ary, Jacobs, & Razavich, 1985; Hawley, 1996; Shalvelson, 1995).

CHAPTER IV

FINDINGS

Introduction

The purpose of this study was to determine the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. Specifically, the factors of: airline pilot age, total flight experience, flight experience in a specific aircraft (time in type), the phase of flight when the accident occurred, and the prevailing meteorological conditions at the time of the accident were evaluated based on their possible effect on the incidence of a commercial air carrier accident occurring due to pilot error. For those factors analyzed using the Pearson coefficient of correlation, statistical significance for this study was claimed to exist if the .05 level of correlation was reached. Moreover, the .05 level was also used for determining the critical value of the Chi-square distribution when that statistical method was used. This level was selected since it represented that level of significance generally used in similar human behavioral research studies.

The findings of the study are presented in four sections. The first section reports the findings regarding the correlation coefficient for the comparison made between the ages of the captains and the mean age of all Airline Transport Pilots in each particular year studied. This section also reports the same data for the respective first officer positions as compared to all Commercial pilot certificate holders in each particular year studied. The second section reports the correlation coefficient for the comparison made between the ages of the pilots involved (both captain and first officer positions are presented independently) and their respective total flight hours of experience. The third section reports the correlation coefficient for the comparison made between the ages of the pilots and their total hours in the type of aircraft (time-in-type) involved in the accident. Again, both captain and first officer positions are presented separately. The fourth section reports results of the analysis of the interdependence of the phase of flight with the prevailing meteorological conditions that existed at the time of the accident.

Airline Pilot Age and Mean Age

This section reported the correlation coefficient for the comparison made between the ages of the pilots involved in the air carrier accidents and the mean age of all Airline Transport and Commercial pilots holding certificates during each particular year studied. A Pearson coefficient of correlation was used to measure for the level of correlation between variables. Here, the chronological age of the captains and first officers involved in the air carrier accident cases was compared to the mean age of the pilots holding the same FAA certificate during each particular year in which an accident occurred.

Captain Age and Mean Age

The results indicated a low coefficient of correlation (0.2195) between the mean age of captains investigated in this research and the mean of all Airline Transport Pilot certificate holders. Moreover, the mean age of captains studied in this research was 47.4

years compared to an overall mean of 42.5 years for all Airline Transport pilots (Table II). This result was interesting since it showed that, during the years included in this study, the captains involved in the accident cases were considerably older than the average of the accessible population.

TABLE II

CAPTAIN AGE AND MEAN AGE

Accident Year	NTSB Report #	Captain Age	Population Mean (By Year)
1987	88-05	57	41.75
1987	88-09	43	41.75
1988	89-04	48	41.94
1989	90-03	36	42.14
1989	90-04	40	42.14
1990	91-02	39	42.27
1990	91-05	52	42.27
1991	91-09	44	42.32
1992	92-05	59	42.41
1992	93-02	44	42.41
1993	94-01	59	42.62
1993	94-04	54	42.62
1994	95-01	57	42.86
1994	95-03	No data reported	42.86
1995	96-04	53	43.07
1995	96-05	38	43.07
1996	96-07	43	43.15
1996	97-01	50	43.15
1996	97-03	48	43.15
	Overall Average	47.4	42.50

Note: $\alpha = .05$, $r = 0.2195$

First Officer Age and Mean Age

The results indicated a low negative coefficient of correlation (-0.2400) between the mean age of first officers investigated in this research and the mean of all Commercial pilot certificate holders. Moreover, the mean age of first officers studied in this research was 37.3 years compared to an overall mean of 39.2 years for all Commercial pilots (Table III). This result indicated that, during the years included in this study, the first officers involved in the accident cases were nearly two years younger than the average age of the accessible population.

Airline Pilot Age and Total Flight Hours of Experience

This section reported the correlation coefficient for the comparison made between the ages of the pilots involved in the air carrier accidents and their total flight hours of experience. A Pearson coefficient of correlation was used to measure the level of correlation between variables. Here, the chronological ages of the captains and first officers involved in the air carrier accident cases were compared to their respective total hours of flight experience as cited in the NTSB air carrier accident reports.

Captain Age and Total Flight Hours of Experience

The results indicated a moderate coefficient of correlation (0.7205) between the age of captains investigated in this research and their respective total flight hours of experience. Again, the mean age of captains studied in this research was 47.4 years. The mean total hours of flight experience for the twenty accident reports examined was

TABLE III

FIRST OFFICER AGE AND MEAN AGE

Accident Year	NTSB Report #	First Officer Age	Population Mean (By Year)
1986	87-08	29	39.85
1987	88-05	35	39.91
1987	88-09	26	39.91
1988	89-04	37	39.7
1989	90-03	29	39.44
1989	90-04	38	39.44
1990	91-02	28	39.05
1990	91-05	43	39.05
1991	91-09	28	38.58
1992	92-05	37	38.46
1992	93-02	30	38.46
1993	94-01	40	38.47
1993	94-04	49	38.47
1994	95-01	47	38.84
1994	95-03	No data reported	38.84
1995	96-04	56	39.22
1995	96-05	39	39.22
1996	96-07	42	39.43
1996	97-01	37	39.43
1996	97-03	38	39.43
	Overall Average	37.5	39.2

Note: $\alpha = .05$, $r = -0.2400$

13,612 hours. The median was 12,344 hours. The results indicated a normally increasing number of flight hours of experience as compared with advancing age (Table IV).

TABLE IV

CAPTAIN AGE AND TOTAL FLIGHT HOURS OF EXPERIENCE

NTSB Report #	Captain Age	Total Flight Hours
87-08	37	10,000
88-05	57	20,859
88-09	43	12,125
89-04	48	17,000
90-03	36	5,525
90-04	40	14,300
91-02	39	12,000
91-05	52	23,000
91-09	44	10,505
92-05	59	16,382
93-02	44	9,820
94-01	59	12,562
94-04	54	20,727
95-01	57	23,000
95-03	No data reported	8,065
96-04	53	16,455
96-05	38	8,000
96-07	43	4,381
97-01	50	17,500
97-03	48	10,024
Overall Average	47.4	13,612

Note: $\alpha = .05$, $r = 0.7205$

First Officer Age and Total Flight Hours of Experience

The results indicated a moderate to strong coefficient of correlation (0.8391) between the age of first officers investigated in this research and their respective total flight hours of experience. Again, the mean age of first officers studied in this research was 37.3 years. The mean total hours of flight experience for all accident reports examined ws 7,042 hours. The median was 5,091 hours. As with the data presented for the captain position, the results indicated a normally increasing number of flight hours of experience as compared with advancing age (Table V).

Airline Pilot Age and Time in Aircraft Type Experience

This section reported the correlation coefficient for the comparison made between the ages of the pilots and their total hours in the type of aircraft (time-in-type) involved in the accident. A Pearson coefficient of correlation was used to measure the level of correlation between variables. Here, the chronological ages of the captains and first officers involved in the air carrier accident cases were compared to their respective total hours in the type of aircraft involved in the accident.

Captain Age and Total Flight Hours in Aircraft Type

The results indicated a very low negative coefficient of correlation (-0.0756) between the age of captains investigated in this research and their respective total flight hours in the type of aircraft involved in the accident. The mean total flight experience in the particular type of aircraft cited in the accident reports examined was 2,717 hours. The

TABLE V

FIRST OFFICER AGE AND TOTAL FLIGHT HOURS OF EXPERIENCE

NTSB Report #	First Officer Age	Total Flight Hours
87-08	29	4,100
88-05	35	8,044
88-09	26	3,186
89-04	37	6,500
90-03	29	3,287
90-04	38	7,500
91-02	28	1,800
91-05	43	4,685
91-09	28	3,820
92-05	37	5,082
93-02	30	4,507
94-01	40	4,454
94-04	49	15,350
95-01	47	16,000
95-03	No data reported	12,980
96-04	56	17,734
96-05	39	5,100
96-07	42	7,707
97-01	37	2,200
97-03	38	6,800
Overall Average	37.3	7,042

Note: $\alpha = .05$, $r = 0.8391$

median was 2,291 hours of experience. The results indicated a very low number of flight hours of experience in the specific type of aircraft involved in the accidents as compared with the ages of the captains (Table VI).

TABLE VI

CAPTAIN AGE AND TOTAL FLIGHT HOURS
IN AIRCRAFT TYPE

NTSB Report #	Captain Age	Time In Type
87-08	37	2,500
88-05	57	1,329
88-09	43	166
89-04	48	7,000
90-03	36	2,625
90-04	40	2,000
91-02	39	6,400
91-05	52	4,000
91-09	44	505
92-05	59	2,382
93-02	44	2,200
94-01	59	555
94-04	54	1,527
95-01	57	6,000
95-03	No data reported	1,970
96-04	53	2,905
96-05	38	4,230
96-07	43	1,061
97-01	50	1,219
97-03	48	3,756
Overall Average	47.4	2,717

Note: $\alpha = .05$, $r = -0.0756$

First Officer Age and Total Flight Hours in Aircraft Type

The results indicated a low coefficient of correlation (0.05629) between the age of first officers investigated in this research and their respective total flight hours in the type of aircraft involved in the accident. The mean total flight experience in the particular type of aircraft cited in the accident reports examined was 1,340 hours. The median was only 505 hours of experience. The results indicated no significant statistical correlation between the number of flight hours of experience in the specific type of aircraft involved in the air carrier accidents and the ages of the first officers (Table VII).

Phase of Flight and Prevailing Meteorological Conditions

This section reported findings on the factor of the possible interdependence of the phase of flight with the prevailing meteorological conditions that existed at the time of the accident. For this comparison, prevailing weather conditions at the time of each accident were considered as being either Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC). Descriptions of these conditions appear in Definition of Terms section in Chapter I of this report. Binary numbers (0 or 1) were assigned to each meteorological condition to facilitate statistical manipulation.

Phases of flight were identified using the criteria listed in the 1998 Nall Report (AOPA Air Safety Foundation, 1998, p. 27). This report identified eleven phases of flight or operation where ". . . the first occurrence or circumstance occurred" (p. 27). Sequential numbers, as appropriate to each comparison, were assigned to each phase to

TABLE VII

FIRST OFFICER AGE AND TOTAL FLIGHT HOURS
IN AIRCRAFT TYPE

NTSB Report #	First Officer Age	Time In Type
87-08	29	500
88-05	35	1,604
88-09	26	36
89-04	37	4,000
90-03	29	8
90-04	38	2,300
91-02	28	80
91-05	43	185
91-09	28	510
92-05	37	1,143
93-02	30	29
94-01	40	376
94-04	49	492
95-01	47	2,400
95-03	No data reported	3,180
96-04	56	4,804
96-05	39	2,281
96-07	42	205
97-01	37	450
97-03	38	2,220
Overall Average	37.3	1,340

Note: $\alpha = .05$, $r = 0.5629$

aid in statistical manipulation. A listing and description of these phases are presented in the Definition of Terms section in Chapter I of this report.

Based upon the qualitative nature of the available data, the nonparametric technique of Chi-square (χ^2) was selected for use. This statistic did not require that normal distribution or variance assumptions be made regarding the accessible population. The goal here was to determine the extent to which the qualitative variables of phase of flight and prevailing meteorological conditions were dependent upon each other. That is, was there a statistically significant relationship between these two qualitative factors within the air carrier accident cases investigated?

Based on the calculated value of 10.640 ($\chi^2_{critical}$ = 30.144), the results indicated no significant (α = .05) likelihood that the phase of flight and prevailing meteorological conditions were dependent factors during the air carrier accidents investigated in this research (Table VIII).

TABLE VIII

PHASE OF FLIGHT AND PREVAILING METEOROLOGICAL CONDITIONS

NTSB Report #	Phase of Flight	Meteorological Conditions
87-08	4	1
88-05	2	0
88-09	2	1
89-04	2	0
90-03	2	1
90-04	3	1
91-02	3	1
91-05	1	1
91-09	2	1
92-05	3	1
93-02	2	1
94-01	4	1
94-04	3	0
95-01	2	1
95-03	3	1
96-04	2	1
96-05	4	0
96-07	4	0
97-01	4	0
97-03	4	1

Note: $\alpha = .05$, $df = 19$, $\chi^2 = 10.640 < \chi^2_{critical} = 30.144$

Table key: Phase of Flight 1 = Taxi, 2 = Takeoff, 3 = Approach, 4 = Landing; Meteorological Conditions 0 = VMC, 1 = IMC

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the impact of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. Specifically, the factors of; airline pilot age, total flight experience, flight experience in a specific aircraft (time-in-type), the phase of flight when the accident occurred, and the prevailing meteorological conditions at the time of the accident were collected and analyzed. These factors were then compared and evaluated in terms of their effect on the likelihood of a commercial air carrier accident occurring due to pilot error.

Secondly, this study addressed age-related issues regarding the legal rights and value of commercial airline pilots to continue their aviation employment past the age of 60. This research questioned the rationale of the FAA Age-60 Rule in light of current age-related research that realistically supported adjustment of the retirement age to age 63 or beyond. Finally, it evaluated the historical gathering methods and utility of flight experience data used by NTSB air carrier accident investigators and questioned the present value of these methods in predicting accidents.

The actual group studied, and for which data were collected, was composed of 40 airline captains and first officers involved in 20 commercial air carrier accidents between

1986 and 1996. Moreover, only operations conducted under FAR Part 121, as well as, only those accidents where pilot or flightcrew error was cited as the probable cause were included for study in this research.

Certain questions, related to the age, flight experience, and operational issues in commercial aviation, were considered relevant in the conduct of this study. Based upon evidence extracted from National Transportation Safety Board (NTSB) accident investigation reports, the following questions were asked:

1. Was the chronological age of the airline pilots involved a factor in any of the accident cases studied?
2. Were the total flight hours of the pilots a factor in any of the accident cases studied?
3. Were the total flight hours of experience in a particular aircraft (time in type) of the pilots a factor in any of the accident cases studied?
4. Was there a particular phase of flight where the majority of aircraft accidents studied were more likely to occur?
5. Were the accident cases studied more likely to occur during prevailing Instrument Meteorological Conditions (IMC) or Visual Meteorological Conditions (VMC)?

Data gathering for this study was conducted during the late Fall of 1998 with interpretation and statistical analysis accomplished during the early months of 1999. Specific research information was collected during multiple visits to the Federal Aviation Administration Library located at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. Additional and supplemental information was gathered from FAA and

NTSB Internet databases, as well as, from microfiche and printed material maintained at the Oklahoma State University Library in Stillwater, Oklahoma.

Data extracted from the NTSB Accident Reports were recorded on a data entry log and entered into a computer-based statistical program. For those analyses using the Pearson coefficient of correlation, statistical significance for this study was claimed to exist if the $\alpha = .05$ level of correlation was reached. Moreover, the $\alpha = .05$ level was also used for determining the critical value of the Chi-square distribution when that statistical method was used.

Conclusions

This study was designed to assess the impact of a number of selected human and operational factors on the incidence of air carrier aircraft accidents attributable to pilot error. On the basis of this analysis, and from the review of literature, certain conclusions were drawn relative to the research questions asked.

First, that the low coefficient of correlation between the mean age of captains involved in the accident cases studied and the mean of all Airline Transport Pilot certificate holders may be of significance. Here, the captains involved in these accidents averaged nearly five years older (47.4) than the average of the accessible population (42.5). From this, one could conclude that this may have been a contributing factor in the incidence of one, or more, of the accidents studied.

Moreover, that the low negative coefficient of correlation between the mean age of first officers investigated in this research and the mean age of all Commercial pilot certificate holders may likewise be significant. Here, the first officers involved in the accident cases studied averaged nearly two years younger (37.3) than the average of the accessible population of commercial pilots (39.2). While this factor alone may not be of great significance, when combined with the factor of older than average captains, it does raise the issue as to the significance of the pairing of captains with first officers in the cockpit.

Second, that, within this particular research, no significance could be found in the relationship between the ages of airline pilots and their total hours of flight experience. While the results did indicate a moderate to strong coefficient of correlation between age and total hours of experience for both the captain and first officer positions, these comparisons were made solely within the accident cases studied. No reliable data on other pilot populations could be found in government, airline, or general aviation sources. Thus, no comparisons to the accessible population could be made.

Third, that there was a very low negative coefficient of correlation between the age of captains investigated in this research and their respective total flight hours in the particular type of aircraft involved in the accident. The results indicated a very low number of flight hours of experience in the specific type of aircraft involved in the accidents compared to the ages of the captains. Similar results were attained with respect to the first officer positions.

Based upon the analysis of data from the accident cases studied, it was observed that many airline pilots gain considerable flight time and experience as they age. However, it could also be concluded that greater total flight experience does not substantially mitigate the accident potential posed by pilots with relatively low experience in a specific type of aircraft.

Fourth, that there were particular phases of flight where the majority of the aircraft accidents studied were more likely to occur. The results indicated that, of the eleven phases of flight identified in the 1998 Nall Report (AOPA Air Safety Foundation, 1998, p. 27) and listed in Chapter I of this report, the air carrier accidents analyzed by this research occurred during only four phases of flight. These were; taxi, takeoff, approach, and landing. Moreover, the accident cases were nearly divided evenly between the takeoff and landing phases, with accidents having occurred in 8 and 6 cases respectively in those phases. Accidents occurred during these phases in an overwhelming 70% of the twenty accident cases studied.

Fifth, that in the cases studied in this research, an air carrier accident was more likely to occur during prevailing Instrument Meteorological Conditions (IMC) than during Visual Meteorological Conditions (VMC). Here, accidents occurred during Instrument Meteorological Conditions in 14 of the 20 (70%) accident cases studied.

Moreover, based upon a chi-square analysis of data concerning the phase of flight during which the accident occurred versus the prevailing meteorological conditions existing at the time, it was concluded that these factors operated independently of each other during the cases studied in this research.

Recommendations

General Recommendations

It is hoped that this research may provide valuable insight into some of the behavioral characteristics of air carrier pilots. Results of this project may also help fill some of the gaps in knowledge that now exist in the area of pilot human factors within the aviation behavioral science research community.

The results of this research are important for aviation human factors reasons in that continued research may help identify periods of enhanced human or situational risk. In terms of the age of airline pilots, these periods could be translated into milestones that may serve to mark periods in an airline pilot's aviation career when he or she may pose a greater risk to self or others. Moreover, this information could be used by aviation training specialists to enhance pilot awareness through flight safety seminars or within airline training programs.

Specific Recommendations

Based on the conclusions reached in this research, as well as, the issues and opinions expressed in the review of selected literature, the following recommendations are made:

1. That commercial air carriers consider giving greater attention to policies regarding the pairing of captains and first officers. This could be done in terms of differing age, levels of total flight experience, or experience in a particular aircraft type.
2. That the Federal Aviation Administration expand the requirements of FAR Part 61.51(c)(1) and (2), or include new ones in Part 121, to encourage greater accuracy in the recording and tracking of the flight experience attained by air carrier pilots.

3. That the NTSB examine the suitability of the present system of gathering relevant age and flight experience data relative to air carrier accident investigations. Here, improvement is considered essential in collecting consistent, complete, and usable human factor data. This would ultimately assist future investigators and researchers in reaching valid and reliable conclusions regarding the probable cause of an air carrier accident.
4. The establishment of a central database for the tracking of pilot flight time and aircraft experience. Initially, this could be compiled using existing individual air carrier databases. Later, this system could be maintained by the FAA as is presently done for pilot flight and medical certification records.

Recommendations for Future Research

1. A needs assessment survey by the aviation human factors community on the feasibility of closer tracking and logging of pilot flight hours throughout the airline industry.
2. The use of an accessible population that more closely represents the characteristics of the specific airline population in question.
3. Future investigations should aim to study the problems examined in the present study longitudinally. That is, across the entire life-span of the airline pilot population.

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APPENDIXES

APPENDIX A

FAR PART 121, SUBPART M AIRMAN AND

CREWMEMBER REQUIREMENTS

Sec. 121.381 Applicability.

This subpart prescribes airman and crewmember requirements for all certificate holders.

Sec. 121.383 Airman: Limitations on use of services.

(a) No certificate holder may use any person as an airman nor may any person serve as an airman unless that person--

(1) Holds an appropriate current airman certificate issued by the FAA;

(2) Has any required appropriate current airman and medical certificates in his possession while engaged in operations under this part; and

(3) Is otherwise qualified for the operation for which he is to be used.

(b) Each airman covered by paragraph (a)(2) of this section shall present either or both certificates for inspection upon the request of the Administrator.

(c) No certificate holder may use the services of any person as a pilot on an airplane engaged in operations under this part if that person has reached his 60th birthday. No person may serve as a pilot on an airplane engaged in operations under this part if that person has reached his 60th birthday.

[Doc. No. 6258, 29 FR 19212, Dec. 31, 1964, as amended by Amdt. 121-144, 43 FR 22646, May 25, 1978]

APPENDIX B

INSTITUTION REVIEW BOARD

APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

DATE: 11-24-98 **IRB #: ED-99-043**

Proposal Title: THE IMPACT OF AIRLINE PILOT AGE AND FLIGHT EXPERIENCE FACTORS ON THE INCIDENCES OF COMMERCIAL AIR CARRIER ACCIDENTS ATTRIBUTED TO PILOT ERROR

Principal Investigator(s): Kenneth E. Wiggins, Gilbert E. Schnabel

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Signature: Date: November 24, 1998

Carol Olson, Director of University Research Compliance
cc: Gilbert E. Schnabel

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

APPENDIX C

NATIONAL TRANSPORTATION SAFETY BOARD AIRCRAFT ACCIDENT REPORTS

NTSB/AAR-87/08

EXECUTIVE SUMMARY

On October 25, 1986, Piedmont Airlines flight 467, a Boeing 737-222, N752N, was a regularly scheduled flight operating under 14 CFR 121 from Newark International Airport to Myrtle Beach, South Carolina, with an en route stop at Charlotte Douglas International Airport, Charlotte, North Carolina. There were 114 passengers and 5 crewmembers on board. The flight was routine until its arrival into the Charlotte area, where instrument meteorological conditions prevailed. At 2004:17, the flight was cleared for the instrument landing system approach (ILS) to runway 36R. The airplane touched down at 2007:19 and about 2007:43 it departed the runway. The airplane struck the localizer antenna array located about 300 feet from the departure end of the runway, struck a concrete culvert located 18 feet beyond the localizer, and continued through a chain link fence. It came to rest upon the edge of railroad tracks located 440 feet from the departure end of the runway. The airplane was destroyed, 3 passengers sustained serious injuries, and 3 crewmembers and 28 passengers sustained minor injuries in the accident.

The safety issues in this accident concern flightcrew nonadherence to operating procedures. The evidence indicates that the airplane was not configured for a landing, as required, upon crossing the final approach fix. Rather, the final flap setting was attained about 500 feet above ground level. In addition, several issues relating to postaccident survivability were identified. These include removing obstacles located beyond the runway safety area, and serving alcohol to intoxicated passengers.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's failure to stabilize the approach and his failure to discontinue the approach to a landing that was conducted at an excessive speed beyond the normal touchdown point on a wet runway. Contributing to the accident was the captain's failure to optimally use the airplane decelerative devices. Also contributing to the accident was the lack of effective crew coordination during the approach. Contributing to the severity of the accident was the poor frictional quality of the last 1,500 feet of the runway and the obstruction presented by a concrete culvert located 318 feet beyond the departure end of the runway.

As a result of its investigation, the Safety Board issued a recommendation to the Federal Aviation Administration (FAA) to require airport managers, at the earliest opportunity, to repair or remove obstacles, such as concrete culverts, that are adjacent to airport operating areas. The Safety Board also issued recommendations to the FAA urging it to issue operations bulletins to principal operations inspectors of air carriers operating aircraft with flight attendants informing them of the need to cease providing alcohol to passengers who are in, or appear that they are about to be in, an intoxicated state; and to require a one-time inspection of flight attendant seat pan roller assemblies. In addition two recommendations concerning the measurement of runway friction were issued to the FAA.

Two recommendations to the American Association of Airport Executives and the Airport Operators Council International, Inc., requested their memberships to repair or remove obstacles adjacent to airport operating areas, to identify deficient runways conditions, to use approved friction measuring devices to measure dry runway coefficients of friction, and to correct runway conditions that do not meet the FAA-recommended criteria.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the captain's failure to stabilize the approach and his failure to discontinue the approach to a landing that was conducted at an excessive speed beyond the normal touchdown point on a wet runway. Contributing to the accident was the captain's failure to optimally use the airplane decelerative devices. Also contributing to the accident was the lack of effective crew coordination during the approach. Contributing to the severity of the accident was the poor frictional quality of the last 1,500 feet of the runway and the obstruction presented by a concrete culvert located 318 feet beyond the departure end of the runway.

DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NTSB/AAR-87/08	PB87-910410	

4. Title and Subtitle Aircraft Accident Report—Piedmont Airlines Flight 467, Boeing 737-222, N752N, Charlotte Douglas International Airport, Charlotte, North Carolina, October 25, 1986

5. Report Date September 1, 1987

6. Performing Organization Code

7. Author(s)

8. Performing Organization Report No.

9. Performing Organization Name and Address

National Transportation Safety Board
Bureau of Accident Investigation
Washington, D.C. 20594

10. Work Unit No. 4528-A

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20594

13. Type of Report and Period Covered

Aircraft Accident Report
October 25, 1986

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On October 25, 1986, Piedmont Airlines flight 467, a Boeing 737-222, N752N, was a regularly scheduled flight operating under 14 CFR 121 from Newark International Airport to Myrtle Beach, South Carolina, with an en route stop at Charlotte Douglas International Airport, Charlotte, North Carolina. There were 114 passengers and 5 crewmembers on board. The flight was routine until its arrival into the Charlotte area, where instrument meteorological conditions prevailed. At 2004:17, the flight was cleared for the instrument landing system approach (ILS) to runway 36R. The airplane touched down at 2007:19 and about 2007:43 it departed the runway. The airplane struck the localizer antenna array located about 300 feet from the departure end of the runway, struck a concrete culvert located 18 feet beyond the localizer, and continued through a chain link fence. It came to rest upon the edge of railroad tracks located 440 feet from the departure end of the runway. The airplane was destroyed, 3 passengers sustained serious injuries, and 3 crewmembers and 28 passengers sustained minor injuries in the accident.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's failure to stabilize the approach and his failure to discontinue the approach to a landing that was conducted at an excessive speed beyond the normal touchdown point on a wet runway. Contributing to the accident was the captain's failure to

17. Key Words

Boeing 737; antiskid system; crew coordination; cockpit resource management; runway friction; spoiler; air/ground safety sensor

18. Distribution Statement

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optimally use the airplane decelerative devices. Also contributing to the accident was the lack of effective crew coordination during the approach. Contributing to the severity of the accident was the poor frictional quality of the last 1,500 feet of the runway and the obstruction presented by a concrete culvert located 318 feet beyond the departure end of the runway.

NTSB/AAR-88/05

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-88/05	2. Government Accession No. PB 88-910406	3. Recipient's Catalog No.
4. Title and Subtitle: Aircraft Accident Report--Northwest Airlines, Inc., McDonnell Douglas DC-9-82, N312RC, Detroit Metropolitan Wayne County Airport, Romulus, Michigan, August 16, 1987		5. Report Date May 10, 1988
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 4717C
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Accident Report August 16, 1987
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract About 2046 eastern daylight time on August 16, 1987, Northwest Airlines, Inc., flight 255 crashed shortly after taking off from runway 3 center at the Detroit Metropolitan Wayne County Airport, Romulus, Michigan. Flight 255, a McDonnell Douglas DC-9-82, U.S. Registry N312RC, was a regularly scheduled passenger flight and was en route to Phoenix, Arizona. According to witnesses, flight 255 began its takeoff rotation about 1,200 to 1,500 feet from the end of the runway and lifted off near the end of the runway. After liftoff, the wings of the airplane rolled to the left and the right about 35° in each direction. The airplane collided with obstacles northeast of the runway when the left wing struck a light pole located 2,760 feet beyond the end of the runway. Thereafter the airplane struck other light poles, the roof of a rental car facility, and then the ground. It continued to slide along a path aligned generally with the extended centerline of the takeoff runway. The airplane broke up as it slid across the ground and postimpact fires erupted along the wreckage path. Three occupied vehicles on a road adjacent to

17. Key Words airplane configuration; flaps and slats retraction; central aural warning system; supplemental stall recognition systems; circuit breaker; flightcrew standardization; cockpit discipline		18. Distribution Statement This document is available to the public through the National Technical Information Service Springfield, Virginia 22161	
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the airport and numerous vacant vehicles in a rental car parking lot along the airplane's path were destroyed by impact forces and/or fire. Of the persons on board flight 255, 148 passengers and 6 crewmembers were killed; 1 passenger, a 4-year-old child, was injured seriously. On the ground, two persons were killed, one person was injured seriously, and four persons suffered minor injuries.

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's failure to use the taxi checklist to ensure that the flaps and slats were extended for takeoff. Contributing to the accident was the absence of electrical power to the airplane takeoff warning system which thus did not warn the flightcrew that the airplane was not configured properly for takeoff. The reason for the absence of electrical power could not be determined.

EXECUTIVE SUMMARY

About 2046 eastern daylight time on August 16, 1987, Northwest Airlines, Inc., flight 255 crashed shortly after taking off from runway 3 center at the Detroit Metropolitan Wayne County Airport, Romulus, Michigan. Flight 255, a McDonnell Douglas DC-9-82, U.S. Registry N312RC, was a regularly scheduled passenger flight and was en route to Phoenix, Arizona, with 149 passengers and 6 crewmembers.

According to witnesses, flight 255 began its takeoff rotation about 1,200 to 1,500 feet from the end of the runway and lifted off near the end of the runway. After liftoff, the wings of the airplane rolled to the left and the right about 35° in each direction. The airplane collided with obstacles northeast of the runway when the left wing struck a light pole located 2,760 feet beyond the end of the runway. Thereafter the airplane struck other light poles, the roof of a rental car facility, and then the ground. It continued to slide along a path aligned generally with the extended centerline of the takeoff runway. The airplane broke up as it slid across the ground and postimpact fires erupted along the wreckage path. Three occupied vehicles on a road adjacent to the airport and numerous vacant vehicles in a rental car parking lot along the airplane's path were destroyed by impact forces and/or fire.

Of the persons on board flight 255, 148 passengers and 6 crewmembers were killed; 1 passenger, a 4-year-old child, was injured seriously. On the ground, two persons were killed, one person was injured seriously, and four persons suffered minor injuries.

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3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's failure to use the taxi checklist to ensure that the flaps and slats were extended for takeoff. Contributing to the accident was the absence of electrical power to the airplane takeoff warning system which thus did not warn the flightcrew that the airplane was not configured properly for takeoff. The reason for the absence of electrical power could not be determined.

NTSB/AAR-88/09

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-88/09	2. Government Accession No. PB88-910411	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report–Continental Airlines, Inc., Flight 1713, McDonnell Douglas DC-9-14, N626TX, Stapleton International Airport, Denver, Colorado, November 15, 1987		5. Report Date September 27, 1988
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 4772A
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Accident Report November 15, 1987
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract: On November 15, 1987, Continental Airlines, Inc., flight 1713, a McDonnell Douglas DC-9-14, N626TX, 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, 1 flight attendant, and 25 passengers sustained fatal injuries. Two flight attendants and 52 passengers survived.

The National Transportation Safety Board determines 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.

17. Key Words:	18. Distribution Statement
icing; deice; Continental Airlines, Inc.; vortex; pairing	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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UNCLASSIFIED	UNCLASSIFIED	93	

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EXECUTIVE SUMMARY

On November 15, 1987, Continental Airlines, Inc., flight 1713, a McDonnell Douglas DC-9-14, N626TX, 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, 1 flight attendant, and 25 passengers sustained fatal injuries. Two flight attendants and 52 passengers survived.

The National Transportation Safety Board determines 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 this report include:

- pilot training;
- aircraft deicing procedures; and
- wingtip vortex generation and lifespan.

Recommendations concerning these issues were addressed to the Federal Aviation Administration, the National Fire Protection Association, the American Association of Airport Executives, the Airport Operators Council International, and Continental Airlines, Inc.

3.2 Probable Cause

The National Transportation Safety Board determines 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 flight crewmembers and the confusion that existed between the flightcrew and air traffic controllers that led to the delay in departure.

NTSB/AAR-89/04

Oklahoma City, OK 73125

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.
NTSB/AAR-89/04

2. Government Accession No.
PB89-910406

3. Recipient's Catalog No.

4. Title and Subtitle Aircraft Accident Report--
Delta Air Lines, Inc. Boeing 727-232, N473DA,
Dallas-Fort Worth International Airport, Texas
August 31, 1988

5. Report Date
September 26, 1989

6. Performing Organization Code

7. Author(s)

8. Performing Organization Report No.

9. Performing Organization Name and Address

National Transportation Safety Board
Bureau of Accident Investigation
Washington, D.C. 20594

10. Work Unit No.
4965A

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20594

13. Type of Report and Period Covered
Highway Accident Report
August 17, 1988

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report examines the crash of Delta flight 1141 while taking off at the Dallas-Forth Worth, Texas on August 31, 1988. The safety issues discussed in the report include flightcrew procedures;wake vortices; engine performance; airplane flaps and slats; takeoff warning system; cockpit discipline; aircraft rescue and firefighting; emergency evacuation; and survival factors. Recommendations addressing these issues were made to the Federal Aviation Administration, the American Association of Airport Executives, the Airport Operations Council International, and the National Fire Protection Association.

17. Key Words

18. Distribution Statement
This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	135	

NTSB Form 1765.2 (Rev. 5/88)

EXECUTIVE SUMMARY

About 0901 central daylight time on August 31, 1988, Delta Air Lines, Inc., flight 1141, crashed shortly after lifting off from runway 18L at the Dallas-Fort Worth International Airport, Texas. The airplane, a Boeing 727-232, U.S. Registry N473DA, was a regularly scheduled passenger flight and was en route to Salt Lake City, Utah, with 101 passengers and 7 crewmembers.

The flightcrew reported that the takeoff roll appeared to be normal in all respects, with no warning lights, audible warnings, or unusual engine instrument conditions. The captain stated that the rotation was initially normal, but as the main gear wheels left the ground he heard "two explosions." He said it felt as though the airplane was experiencing "reverse thrust." The captain stated that the airplane began to "roll violently."

The airplane struck the instrument landing system (ILS) localizer antenna array approximately 1,000 feet beyond the end of runway 18L, and came to rest about 3,200 feet beyond the departure end of the runway. The flight was airborne approximately 22 seconds from liftoff to the first ground impact near the ILS localizer antenna. The airplane was destroyed by impact forces and the postcrash fire.

Of the persons on board flight 1141 12 passengers and 2 crewmembers were killed, 21 passengers and 5 crewmembers were seriously injured, and 68 passengers sustained minor or no injuries.

The National Transportation Safety Board determines that the probable cause of this accident to be (1) the Captain and First Officer's inadequate cockpit discipline which resulted in the flightcrew's attempt to takeoff without the wing flaps and slats properly configured; and (2) the failure of the takeoff configuration warning system to alert the crew that the airplane was not properly configured for the takeoff.

Contributing to the accident was Delta's slow implementation of necessary modifications to its operating procedures, manuals, checklists, training, and crew checking programs which was necessitated by significant changes in the airline following rapid growth and merger.

Also contributing to the accident was the lack of sufficiently agressive action by the FAA to have known deficiencies corrected by Delta and the lack of sufficient accountability within the FAA's air carrier inspection process.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident to be (1) the Captain and First Officer's inadequate cockpit discipline which resulted in the flightcrew's attempt to takeoff without the wing flaps and slats properly configured; and (2) the failure of the takeoff configuration warning system to alert the crew that the airplane was not properly configured for the takeoff.

Contributing to the accident was Delta's slow implementation of necessary modifications to its operating procedures, manuals, checklists, training, and crew checking programs which were necessitated by significant changes in the airline following rapid growth and merger.

Also contributing to the accident was the lack of sufficiently aggressive action by the FAA to have known deficiencies corrected by Delta and the lack of sufficient accountability within the FAA's air carrier inspection process.

NTSB/AAR-90/03

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-90/03	2. Government Accession No. PB90-910403	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report--USAir, Inc., Boeing 737-400, LaGuardia Airport, Flushing, New York, September 20, 1989		5. Report Date July 3, 1990
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Office of Aviation Safety Washington, D.C. 20594		10. Work Unit No. 5204A
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Accident Report September 20, 1989
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594		
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report explains the crash of USAir flight 5050 on September 20, 1989 at New York City's LaGuardia Airport. The safety issues discussed in the report are the design and location of the rudder trim control on the Boeing 737-400, air crew coordination and communication during takeoffs, crew pairing, and crash survivability. Safety Recommendations addressing these issues were made to the Federal Aviation Administration and the Port Authority of New York and New Jersey.

17. Key Words		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 98	22. Price

NTSB Form 1765.2 (Rev. 5/88)

EXECUTIVE SUMMARY

On September 20, 1989, USAir, Inc. flight 5050 was departing New York City's LaGuardia Airport, Flushing, New York, for Charlotte Douglas International Airport, Charlotte, North Carolina. As the first officer began the takeoff on runway 31, he felt the airplane drift left. The captain noticed the left drift also and used the nosewheel tiller to help steer. As the takeoff run progressed, the aircrew heard a "bang" and a continual rumbling noise. The captain then took over and rejected the takeoff but did not stop the airplane before running off the end of the runway into Bowery Bay. Instrument flight conditions prevailed at the time and the runway was wet.

The National Transportation Safety Board determines that the probable cause of this accident was the captain's failure to exercise his command authority in a timely manner to reject the takeoff or take sufficient control to continue the takeoff, which was initiated with a mistrimmed rudder. Also causal was the captain's failure to detect the mistrimmed rudder before the takeoff was attempted.

The safety issues discussed in this report were the design and location of the rudder trim control on the Boeing 737-400, air crew coordination and communication during takeoffs, crew pairing, and crash survivability.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the captain's failure to exercise his command authority in a timely manner to reject the takeoff or take sufficient control to continue the takeoff, which was initiated with a mistrimmed rudder. Also causal was the captain's failure to detect the mistrimmed rudder before the takeoff was attempted.

NTSB/AAR-90/04

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-90/04	**2. Government Accession No.** PB90-916404	**3. Recipient's Catalog No.**
4. Title and Subtitle Aircraft Incident Report-- USAir Flight 105, Boeing 737-200, N283AU, Kansas City International Airport, Missouri, September 8, 1989		**5. Report Date** September 11, 1990
		6. Performing Organization Code
7. Author(s)		**8. Performing Organization Report No.**
9. Performing Organization Name and Address National Transportation Safety Board Office of Aviation Safety Washington, D.C. 20594		**10. Work Unit No.** 5226A
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Incident Report September 8, 1989
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594		**14. Sponsoring Agency Code**

15. Supplementary Notes

16. Abstract

This report explains the premature descent below minimum descent altitude of USAir flight 105 on approach to Kansas City International Airport, Missouri, on September 8, 1989. The aircraft struck and severed four electronic transmission cables, located about 75 feet above the ground, approximately 7,000 feet east of the runway threshold. The safety issues discussed in the report are identification of potentially confusing features near runways on instrument approach charts; FAA oversight of air traffic control quality assurance; FAA training of and guidance to operations inspectors; application of visual descent points to training in and execution of nonprecision instrument approaches, and incorporation of requirements for visual descent points in FAR Part 135 operations; communications of weather information between air traffic control and the National Weather Service; and revision of minimum safe altitude warning inhibit areas. Safety Recommendations addressing these issues were made to the FAA and the National Weather Service.

17. Key Words	**18. Distribution Statement** This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classification (of this report) UNCLASSIFIED	**20. Security Classification (of this page)** UNCLASSIFIED	**21. No. of Pages** 191	**22. Price**

NTSB Form 1765.2 (Rev. 5/88)

EXECUTIVE SUMMARY

On September 8, 1989, N283AU, a Boeing 737-200 operated as USAir flight 105 was a regularly scheduled revenue passenger flight conducted under 14 Code of Federal Regulations Part 121 from Pittsburgh, Pennsylvania, to Wichita, Kansas, with an en route stop in Kansas City, Missouri. Fifty-eight passengers, two flight crewmembers and four flight attendants were onboard. A Federal Aviation Administration inspector who was performing an en route inspection occupied the cockpit observer's seat. The flight from Pittsburgh to the Kansas City area was uneventful.

The captain was the pilot flying and the first officer was performing the communications with air traffic control. USAir 105 was cleared to execute the localizer back course approach to runway 27 at 2129:41. At 2134:23, the local controller told USAir 105 "I can't tell for sure but it appears we have lost the lighting on the south side of the airport." The flightcrew later described seeing a bright flash about this time. Subsequent inspection revealed that the airplane struck and severed four electronic transmission cables, located about 75 feet above the ground, approximately 7,000 feet east of the runway 27 threshold. The flightcrew executed a missed approach and landed uneventfully in Salina, Kansas. None of the passengers or crew was injured, but the airplane sustained minor damage in the incident.

The National Transportation Safety Board determines that the probable cause of this incident was the flightcrew's failure to adequately prepare for and execute a nonprecision approach and their subsequent premature descent below minimum descent altitude. Contributing to the cause of the incident was the inadequate and deficient services provided to the flightcrew by air traffic control personnel.

The safety issues raised in this report include:

- Identification of potentially confusing features near runways on instrument approach charts.
- FAA oversight of air traffic control quality assurance.
- FAA training of and guidance to operations' inspectors.
- Application of visual descent points to training in and execution of nonprecision instrument approaches, and incorporation of requirements for visual descent points in FAR Part 135 operations.
- Communication of weather information between air traffic control and the National Weather Service.
- Revision of minimum safe altitude warning inhibit areas.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this incident was the flightcrew's failure to adequately prepare for and execute a nonprecision approach and their subsequent premature descent below minimum descent altitude. Contributing to the cause of the incident was the inadequate and deficient services provided to the flightcrew by air traffic control personnel.

NTSB/AAR-91/02

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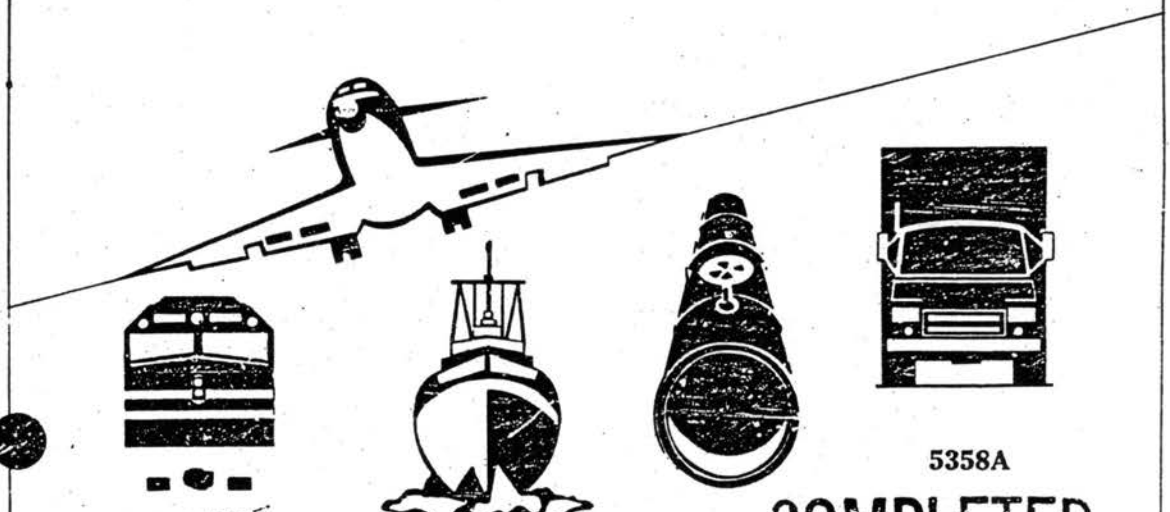
PB91-910402
NTSB/AAR-91/02

NATIONAL TRANSPORTATION SAFETY BOARD

AIRCRAFT ACCIDENT REPORT

MARKAIR, INC.
BOEING 737-2X6C, N670MA
CONTROLLED FLIGHT INTO TERRAIN
UNALAKLEET, ALASKA
JUNE 2, 1990



5358A

COMPLETED

NTSB Report No.: NTSB/AAR-91/02
NTIS No.: PB91-910402
Report Date: January 23, 1991
Notation No.: 5358A

Title: Aircraft Accident Report: MarkAir, Inc., Boeing 737 2X6C, N670MA, Controlled Flight into Terrain, Unalakleet, Alaska, June 2, 1990

Organization: National Transportation Safety Board
Office of Aviation Safety
Washington, D.C. 20594

Type of Report: Aircraft Accident Report
Period Covered: June 2, 1990

Abstract: This report explains the crash of a MarkAir Boeing 737-2X6C at Unalakleet, Alaska, on June 2, 1990. The safety issues discussed in the report are cockpit resource management and approach chart symbology. Recommendations addressing these issues were made to Federal Aviation Administration and MarkAir, Inc.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable cause of accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation.

The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews. Copies of these documents may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. Details on available publications may be obtained by contacting:

National Transportation Safety Board
Public Inquiries Section, RE-51
800 Independence Avenue, S.W.
Washington, D.C. 20594
(202)382-6735

EXECUTIVE SUMMARY

On June 2, 1990, at 0937 Alaskan Daylight Time, MarkAir, Inc., flight 3087, a Boeing 737-2X6C, registered in the US as N670MA, crashed about 7.5 miles short of runway 14, Unalakleet, Alaska, while executing a localizer approach to that runway. The flight originated at 0828 at Anchorage International Airport, Anchorage, Alaska. Instrument meteorological conditions existed at the time, and the flight was on an IFR flight plan. The captain, the first officer, and a flight attendant sustained minor injuries. Another flight attendant sustained serious injuries. There were no passengers on board, and the airplane was destroyed. The flight was operated under FAR Part 121.

The National Transportation Safety Board determines that the probable cause of this accident was deficiencies in flightcrew coordination, their failure to adequately prepare for and properly execute the UNK LOC Rwy 14 nonprecision approach and their subsequent premature descent.

The safety issues discussed in this report include cockpit resource management and approach chart symbology. The Safety Board issued a safety recommendation on approach chart standardization to the Federal Aviation Administration. Safety recommendations were also issued to MarkAir, Inc., on the subjects of cockpit resource management and checklist usage.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was deficiencies in flightcrew coordination, their failure to adequately prepare for and properly execute the UNK LOC Rwy 14 nonprecision approach and their subsequent premature descent.

NTSB/AAR-91/05

NTSB/AAR-91/05 PB91-910405

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

NORTHWEST AIRLINES, INC.
FLIGHTS 1482 AND 299
RUNWAY INCURSION AND COLLISION
DETROIT METROPOLITAN/WAYNE COUNTY AIRPORT
ROMULUS, MICHIGAN
DECEMBER 3, 1990

ADOPTED: June 25, 1991
NOTATION 5416B

Abstract: This report explains the runway collision of two Northwest Airlines aircraft on a runway at the Detroit Metropolitan/Wayne County Airport, Romulus, Michigan, on December 3, 1990. The safety issues discussed in the report are airport marking and lighting, cockpit resource management, air traffic control procedures in low-visibility conditions, flight attendant procedures during evacuations; and design of the DC-9 tailcone emergency release system. Safety recommendations concerning these issues were made to the Federal Aviation Administration, the Detroit Metropolitan/ Wayne County Airport, and Northwest Airlines, Inc..

EXECUTIVE SUMMARY

On December 3, 1990, at 1345 eastern standard time, Northwest Airlines flight 1482, a McDonnell Douglas DC-9, and Northwest Airlines flight 299, a Boeing 727, collided near the intersection of runways 09/27 and 03C/21C in dense fog at Detroit Metropolitan/Wayne County Airport, Romulus, Michigan. At the time of the collision, the B-727 was on its takeoff roll, and the DC-9 had just taxied onto the active runway. The B-727 was substantially damaged, and the DC-9 was destroyed. Eight of the 39 passengers and 4 crewmembers aboard the DC-9 received fatal injuries. None of the 146 passengers and 10 crewmembers aboard the B-727 were injured.

The National Transportation Safety Board determines that the probable cause of this accident was a lack of proper crew coordination, including a virtual reversal of roles by the DC-9 pilots, which led to their failure to stop taxiing their airplane and alert the ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.

Contributing to the cause of the accident were (1) deficiencies in the air traffic control services provided by the Detroit tower, including failure of the ground controller to take timely action to alert the local controller to the possible runway incursion, inadequate visibility observations, failure to use progressive taxi instructions in low-visibility conditions, and issuance of inappropriate and confusing taxi instructions compounded by inadequate backup supervision for the level of experience of the staff on duty; (2) deficiencies in the surface markings, signage, and lighting at the airport and the failure of Federal Aviation Administration surveillance to detect or correct any of these deficiencies; and (3) failure of Northwest Airlines, Inc., to provide adequate cockpit resource management training to their line aircrews.

Contributing to the fatalities in the accident was the inoperability of the DC-9 internal tailcone release mechanism. Contributing to the number and severity of injuries was the failure of the crew of the DC-9 to properly execute the passenger evacuation.

The safety issues raised in this report include:

1. Airport marking and lighting;
2. Cockpit resource management;
3. Air traffic control procedures in low-visibility conditions;
4. Flight attendant procedures during evacuations;
5. Design of the DC-9 tailcone emergency release system.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was a lack of proper crew coordination, including a virtual reversal of roles by the DC-9 pilots, which led to their failure to stop taxiing their airplane and alert the ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.

Contributing to the cause of the accident were (1) deficiencies in the air traffic control services provided by the Detroit tower, including failure of the ground controller to take timely action to alert the local controller to the possible runway incursion, inadequate visibility observations, failure to use progressive taxi instructions in low-visibility conditions, and issuance of inappropriate and confusing taxi instructions compounded by inadequate backup supervision for the level of experience of the staff on duty; (2) deficiencies in the surface markings, signage, and lighting at the airport and the failure of Federal Aviation Administration surveillance to detect or correct any of these deficiencies; and (3) failure of Northwest Airlines, Inc., to provide adequate cockpit resource management training to their line aircrews.

Contributing to the fatalities in the accident was the inoperability of the DC-9 internal tailcone release mechanism. Contributing to the number and severity of injuries was the failure of the crew of the DC-9 to properly execute the passenger evacuation.

NTSB/AAR-91/09

NTSB/AAR-91/09 PB91-910410

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

RYAN INTERNATIONAL AIRLINES
DC-9-15, N565PC
LOSS OF CONTROL ON TAKEOFF
CLEVELAND-HOPKINS INTERNATIONAL AIRPORT
CLEVELAND, OHIO
FEBRUARY 17, 1991

Adopted: November 16, 1991
Notation 5499A

Abstract: This report explains the crash on takeoff of Ryan International Airlines flight 590 at Cleveland, Ohio, on February 17, 1991. The safety issues discussed in the report are the dissemination of information regarding precautions to be taken when operating in conditions conducive to airframe ice and the particular susceptibility of DC-9 series 10 airplanes to control problems during takeoff when a minute amount of ice is on the wing. Recommendations concerning these issues were made to the Federal Aviation Administration.

EXECUTIVE SUMMARY

About 0019, Sunday, February 17, 1991, Ryan International Airlines flight 590 (Ryan 590), a DC-9 series 10 airplane, crashed while taking off from Cleveland-Hopkins International Airport. The flightcrew consisted of two pilots. There were no other crewmembers or passengers on the flight, which was contracted to carry mail for the U.S. Postal Service. Both pilots were fatally injured, and the airplane was destroyed as a result of the accident.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to detect and remove ice contamination on the airplane's wings, which was largely a result of a lack of appropriate response by the Federal Aviation Administration, Douglas Aircraft Company, and Ryan International Airlines to the known critical effect that a minute amount of contamination has on the stall characteristics of the DC-9 series 10 airplane. The ice contamination led to wing stall and loss of control during the attempted takeoff.

The safety issues discussed in this report include the dissemination of information regarding precautions to be taken when operating in conditions conducive to airframe ice and the particular susceptibility of DC-9 series 10 airplanes to control problems during take off when a minute amount of ice is on the wing.

Probable Cause

THE FAILURE OF THE FLIGHTCREW TO DETECT AND REMOVE ICE CONTAMINATION ON THE AIRPLANE'S WINGS, WHICH WAS LARGELY A RESULT OF A LACK OF APPROPRIATE RESPONSE BY THE FEDERAL AVIATION ADMINISTRATION, DOUGLAS AIRCRAFT COMPANY, AND RYAN INTERNATIONAL AIRLINES TO THE KNOWN CRITICAL EFFECT THAT A MINUTE AMOUNT OF CONTAMINATION HAS ON THE STALL CHARACTERISTICS OF THE DC-9 SERIES 10 AIRPLANE. THE ICE CONTAMINATION LED TO WING STALL AND LOSS OF CONTROL DURING THE ATTEMPTED TAKEOFF. (NTSB REPORT AAR-91/09)

NTSB/AAR-92/05

NTSB/AAR-92/05 PB92-910406

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AIR TRANSPORT INTERNATIONAL, INC., FLIGHT 805
DOUGLAS DC-8-63, N794AL
LOSS OF CONTROL AND CRASH
SWANTON, OHIO
FEBRUARY 15, 1992

Adopted: November 19, 1992
Notation 5718B

Abstract: This report explains the loss of control and crash of Air Transport International, Inc., flight 805, a Douglas DC-8-63, near Toledo Express Airport, Ohio, after executing a second missed approach to runway 7, on February 15, 1992. The safety issues discussed in the report include unusual attitude recovery training for flightcrews, crew fatigue, and cockpit resource management.

EXECUTIVE SUMMARY

On February 15, 1992, at 0326 eastern standard time, Air Transport International flight 805 crashed about 3 miles northwest of the Toledo Express Airport after executing a second missed approach to runway 7. Night instrument flight conditions prevailed. The airplane was destroyed, and the flightcrew of three and a passenger onboard received fatal injuries. The airplane had departed Seattle, Washington, at 2145 and was operating as a scheduled domestic air freight carrier under 14 Code of Federal Regulations Part 121.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to properly recognize or recover in a timely manner from the unusual aircraft attitude that resulted from the captain's apparent spatial disorientation, resulting from physiological factors and/or a failed attitude director indicator.

The safety issues raised in this report include unusual attitude recovery training for flightcrews, crew fatigue, and cockpit resource management.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to properly recognize or recover in a timely manner from the unusual aircraft attitude that resulted from the captain's apparent spatial disorientation, resulting from physiological factors and/or a failed attitude director indicator.

NTSB/AAR-93/02

NTSB/AAR-93/02 PB93-910402

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

TAKEOFF STALL IN ICING CONDITIONS USAIR FLIGHT 405 FOKKER F-28, N485US LAGUARDIA AIRPORT FLUSHING, NEW YORK MARCH 22, 1992

Adopted: February 17, 1993
Notation 5732A

Abstract: This report explains the crash of USAir flight 405, a Fokker 28-4000, after an attempted takeoff from runway 13 at LaGuardia Airport, Flushing, New York, on March 22, 1992. The safety issues in the report focus on the weather, USAir's deicing procedures, industry airframe deicing practices, air traffic control aspects of the flight, USAir's takeoff and preflight procedures, and flightcrew qualifications and training. The airplane's impact with the ground, postaccident survivability, and crash/fire/rescue activities are also discussed. Safety recommendations concerning these issues are addressed to the Federal Aviation Administration, the Port Authority of New York and New Jersey, the Department of Transportation, and the New York City Health and Hospitals Corporation.

EXECUTIVE SUMMARY

On Sunday, March 22, 1992, about 2135 eastern standard time, a Fokker 28-4000 (F-28), N485US, operating as USAir flight 405, crashed during an attempted takeoff from runway 13 at LaGuardia Airport, Flushing, New York. Flight 405 was operating under Title 14, Code of Federal Regulations, Part 121, as a scheduled passenger flight from Jacksonville, Florida, to Cleveland, Ohio, with a stopover at LaGuardia Airport. There were 47 passengers, 2 flightcrew members and 2 cabincrew members on board. The captain, one of the cabincrew members, and 25 passengers received fatal injuries. The airplane was destroyed by impact forces and subsequent fire.

The National Transportation Safety Board determines that the probable causes of this accident were the failure of the airline industry and the Federal Aviation Administration to provide flightcrews with procedures, requirements, and criteria compatible with departure delays in conditions conducive to airframe icing and the decision by the flightcrew to take off without positive assurance that the airplane's wings were free of ice accumulation after 35 minutes of exposure to precipitation following deicing. The ice contamination on the wings resulted in an aerodynamic stall and loss of control after liftoff. Contributing to the cause of the accident were the inappropriate procedures used by, and inadequate coordination between, the flightcrew that led to a takeoff rotation at a lower than prescribed air speed.

The safety issues in this report focused on the weather affecting the flight, USAir's deicing procedures, industry airframe deicing practices, air traffic control aspects affecting the flight, USAir's takeoff and preflight procedures, and flightcrew qualifications and training. The dynamics of the airplane's impact with the ground, postaccident survivability, and crash/fire/rescue activities were also analyzed.

Safety recommendations concerning these issues were addressed to the Federal Aviation Administration, the Port Authority of New York and New Jersey, the Department of Transportation, and the New York City Health and Hospitals Corporation.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the failure of the airline industry and the Federal Aviation Administration to provide flightcrews with procedures, requirements, and criteria compatible with departure delays in conditions conducive to airframe icing and the decision by the flightcrew to take off without positive assurance that the airplane's wings were free of ice accumulation after 35 minutes of exposure to precipitation following deicing. The ice contamination on the wings resulted in an aerodynamic stall and loss of control after liftoff. Contributing to the cause of the accident were the inappropriate procedures used by, and inadequate coordination between, the flightcrew that led to a takeoff rotation at a lower than prescribed air speed.

NTSB/AAR-94/01

EXECUTIVE SUMMARY

On April 14, 1993, about 0659:43 central daylight time, American Airlines flight 102, a McDonnell Douglas DC-10-30, departed runway 17 left, following landing at Dallas/Fort Worth International Airport, Texas, after a nonstop, overnight flight from Honolulu International Airport, Hawaii. It was raining at the time of the landing, and there were numerous thunderstorms in the area. There were 189 passengers, 3 flightcrew members and 10 cabincrew members aboard the airplane. Two passengers received serious injuries, and 35 passengers, 1 flightcrew member, and 2 cabincrew members received minor injuries during the evacuation of the airplane. The airplane sustained substantial damage.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the captain to use proper directional control techniques to maintain the airplane on the runway.

The safety issues in this report focused on weather conditions affecting the flight, flightcrew and air traffic control training and procedures, airplane emergency evacuation lighting, and runway maintenance.

Safety recommendations concerning these issues were addressed to the Federal Aviation Administration, Dallas/Fort Worth International Airport, and American Airlines, Inc.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the captain to use proper directional control techniques to maintain the airplane on the runway.

NTSB/AAR-94/01 PB94-910402

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

RUNWAY DEPARTURE FOLLOWING LANDING
AMERICAN AIRLINES FLIGHT 102
McDONNELL DOUGLAS DC-10-30, N139AA
DALLAS/FORT WORTH INTERNATIONAL AIRPORT, TEXAS
APRIL 14, 1993

Adopted: February 14, 1994
Notation 6109B

Abstract: This report explains the runway departure of American Airlines flight 102, a DC-10-30, after landing at Dallas/Fort Worth International Airport, Texas, on April 14, 1993. The safety issues discussed in the report include weather conditions affecting the flight, flightcrew and air traffic control training and procedures, airplane emergency evacuation lighting, and runway maintenance. Recommendations concerning these issues were made to the Federal Aviation Administration, Dallas/Fort Worth International Airport, and American Airlines, Inc.

NTSB/AAR-94/04

EXECUTIVE SUMMARY

On August 18, 1993, at 1656 eastern daylight time, a Douglas DC-8-61 freighter, N814CK, registered to American International Airways, Inc., doing business as Connie Kalitta Services, Inc., and operating as AIA flight 808, collided with level terrain approximately 1/4 mile from the approach end of runway 10, after the captain lost control of the airplane while approaching the Leeward Point Airfield at the U.S. Naval Air Station, Guantanamo Bay, Cuba. The airplane was destroyed by impact forces and a postaccident fire, and the three flight crewmembers sustained serious injuries. Visual meteorological conditions prevailed, and an instrument flight rules flight plan had been filed. The flight was conducted under 14 Code of Federal Regulations, Part 121, Supplemental Air Carriers, as an international, nonscheduled, military contract flight.

The National Transportation Safety Board determines that the probable causes of this accident were the impaired judgment, decision-making, and flying abilities of the captain and flightcrew due to the effects of fatigue; the captain's failure to properly assess the conditions for landing and maintaining vigilant situational awareness of the airplane while maneuvering onto final approach; his failure to prevent the loss of airspeed and avoid a stall while in the steep bank turn; and his failure to execute immediate action to recover from a stall.

Additional factors contributing to the cause were the inadequacy of the flight and duty time regulations applied to 14 CFR, Part 121, Supplemental Air Carrier, international operations, and the circumstances that resulted in the extended flight/duty hours and fatigue of the flightcrew members. Also contributing were the inadequate crew resource management training and the inadequate training and guidance by American International Airways, Inc., to the flightcrew for operations at special airports, such as Guantanamo Bay; and the Navy's failure to provide a system that would assure that the local tower controller was aware of the inoperative strobe light so as to provide the flightcrew with such information.

Safety issues discussed in the report focused on crew scheduling by American International Airways, Inc., the effects of fatigue on flightcrew performance, training on special airports by American International Airways, Inc., and the lack of dissemination of information about special airports by the Department of Defense. Safety recommendations concerning these issues were made to the Federal Aviation Administration, American International Airways, Inc., and the Department of Defense.

NTSB/AAR-94/04 PB94-910406

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

UNCONTROLLED COLLISION WITH TERRAIN

AMERICAN INTERNATIONAL AIRWAYS FLIGHT 808
DOUGLAS DC-8-61, N814CK
U.S. NAVAL AIR STATION
GUANTANAMO BAY, CUBA
AUGUST 18, 1993

Adopted: May 10, 1994
Notation 6182A

Abstract: This report explains the crash of American International Airways Flight 808, a DC-8-61, about 1/4 mile from the approach end of runway 10 at Leeward Point Airfield, U.S. Naval Air Station, Guantanamo Bay, Cuba, on August 18, 1993. The safety issues discussed in the report include flightcrew scheduling, the effects of fatigue on flightcrew performance, training on special airports, and the dissemination of information about special airports. Safety recommendations concerning these issues were made to the Federal Aviation Administration, American International Airways, Inc., and the Department of Defense.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the impaired judgment, decision-making, and flying abilities of the captain and flightcrew due to the effects of fatigue; the captain's failure to properly assess the conditions for landing and maintaining vigilant situational awareness of the airplane while maneuvering onto final approach; his failure to prevent the loss of airspeed and avoid a stall while in the steep bank turn; and his failure to execute immediate action to recover from a stall.

Additional factors contributing to the cause were the inadequacy of the flight and duty time regulations applied to 14 CFR, Part 121, Supplemental Air Carrier, international operations, and the circumstances that resulted in the extended flight/duty hours and fatigue of the flightcrew members. Also contributing were the inadequate crew resource management training and the inadequate training and guidance by American International Airways, Inc., to the flightcrew for operations at special airports, such as Guantanamo Bay; and the Navy's failure to provide a system that would assure that the local tower controller was aware of the inoperative strobe light so as to provide the flightcrew with such information.

NTSB/AAR-95/01

NTSB/AAR-95/01 PB95-910401

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

RUNWAY OVERRUN FOLLOWING REJECTED TAKEOFF CONTINENTAL AIRLINES FLIGHT 795 McDONNELL DOUGLAS MD-82, N18835 LaGUARDIA AIRPORT FLUSHING, NEW YORK MARCH 2, 1994

Adopted: February 14, 1995
Notation 6521

Abstract: This report explains the accident involving Continental Airlines flight 795, an MD-82 airplane, which experienced a runway overrun following a rejected takeoff from runway 13 at LaGuardia Airport, Flushing, New York, on March 2, 1994. Safety issues discussed in the report include the availability of takeoff performance data for flightcrews, the proper functioning of pitot/static heat systems, the duration of cockpit voice recordings, and problems associated with passenger evacuations from airplanes. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration and to Continental Airlines, Inc.

EXECUTIVE SUMMARY

On March 2, 1994, about 1759:46 eastern standard time, Continental Airlines flight 795, a McDonnell Douglas MD-82, registration N18835, sustained substantial damage when the captain rejected the takeoff from runway 13 at LaGuardia Airport, Flushing, New York. The airplane continued beyond the takeoff end of Runway 13 and came to rest on the main gear wheels with the nose pitched downward, so that the fuselage was balanced on top of a dike. The underside of the nose lay on a tidal mud flat of Flushing Bay. There were 110 passengers, 2 flightcrew members and 4 flight attendants aboard the airplane. There were no fatalities, and no serious injuries were reported. There were 29 minor injuries to passengers, all of which were sustained during the evacuation, and 1 minor injury to a flightcrew member. There was no postcrash fire.

The National Transportation Safety Board determines that the probable causes of this accident were the failure of the flightcrew to comply with checklist procedures to turn on an operable pitot/static heat system, resulting in ice and/or snow blockage of the pitot tubes that produced erroneous airspeed indications, and the flightcrew's untimely response to anomalous airspeed indications with the consequent rejection of takeoff at an actual speed of 5 knots above V1.

Safety issues discussed in the report include the availability of takeoff performance data for flightcrews, the proper functioning of pitot/static heat systems, the duration of cockpit voice recordings, and problems associated with passenger evacuations from airplanes. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration and to Continental Airlines, Inc.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the failure of the flightcrew to comply with checklist procedures to turn on an operable pitot/static heat system, resulting in ice and/or snow blockage of the pitot tubes that produced erroneous airspeed indications, and the flightcrew's untimely response to anomalous airspeed indications with the consequent rejection of takeoff at an actual speed of 5 knots above V1.

NTSB/AAR-95/03

NTSB/AAR-95/03 PB95-910403

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

FLIGHT INTO TERRAIN DURING MISSED APPROACH
USAIR FLIGHT 1016, DC-9-31, N954VJ
CHARLOTTE/DOUGLAS INTERNATIONAL AIRPORT
CHARLOTTE, NORTH CAROLINA
JULY 2, 1994

Adopted: April 4, 1995
Notation 6413A

Abstract: This report explains the accident involving USAir flight 1016, a DC-9-31, which crashed near the Charlotte/Douglas International Airport, Charlotte, North Carolina, on July 2, 1994. Safety issues in the report include standard operating procedures for flightcrews and air traffic controllers, the dissemination of weather information to flightcrews, and flightcrew training. Safety recommendations concerning these issues were made to the Federal Aviation Administration, USAir, and the National Weather Service.

EXECUTIVE SUMMARY

On July 2, 1994, about 1843 eastern daylight time, a Douglas DC-9-31, N954VJ, operated by USAir, Inc., as flight 1016, collided with trees and a private residence near the Charlotte/Douglas International Airport, Charlotte, North Carolina, shortly after the flightcrew executed a missed approach from the instrument landing system approach to runway 18R. The captain, first officer, one flight attendant, and one passenger received minor injuries. Two flight attendants and 14 passengers sustained serious injuries. The remaining 37 passengers received fatal injuries. The airplane was destroyed by impact forces and a postcrash fire. Instrument meteorological conditions prevailed at the time of the accident, and an instrument flight rules flight plan had been filed. Flight 1016 was being conducted under 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Columbia, South Carolina, to Charlotte.

The National Transportation Safety Board determines that the probable causes of the accident were: 1) the flightcrew's decision to continue an approach into severe convective activity that was conducive to a microburst; 2) the flightcrew's failure to recognize a windshear situation in a timely manner; 3) the flightcrew's failure to establish and maintain the proper airplane attitude and thrust setting necessary to escape the windshear; and 4) the lack of real-time adverse weather and windshear hazard information dissemination from air traffic control, all of which led to an encounter with and failure to escape from a microburst-induced windshear that was produced by a rapidly developing thunderstorm located at the approach end of runway 18R.

Contributing to the accident were: 1) the lack of air traffic control procedures that would have required the controller to display and issue airport surveillance radar (ASR-9) weather information to the pilots of flight 1016; 2) the Charlotte tower supervisor's failure to properly advise and ensure that all controllers were aware of and reporting the reduction in visibility and the runway visual range value information, and the low level windshear alerts that had occurred in multiple quadrants; 3) the inadequate remedial actions by USAir to ensure adherence to standard operating procedures; and 4) the inadequate software logic in the airplane's windshear warning system that did not provide an alert upon entry into the windshear.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of the accident were: 1) the flightcrew's decision to continue an approach into severe convective activity that was conducive to a microburst; 2) the flightcrew's failure to recognize a windshear situation in a timely manner; 3) the flightcrew's failure to establish and maintain the proper airplane attitude and thrust setting necessary to escape the windshear; and 4) the lack of real-time adverse weather and windshear hazard information dissemination from air traffic control, all of which led to an encounter with and failure to escape from a microburst-induced windshear that was produced by a rapidly developing thunderstorm located at the approach end of runway 18R.

Contributing to the accident were: 1) the lack of air traffic control procedures that would have required the controller to display and issue ASR-9 radar weather information to the pilots of flight 1016; 2) the Charlotte tower supervisor's failure to properly advise and ensure that all controllers were aware of and reporting the reduction in visibility and the RVR value information, and the low level windshear alerts that had occurred in multiple quadrants; 3) the inadequate remedial actions by USAir to ensure adherence to standard operating procedures; and 4) the inadequate software logic in the airplane's windshear warning system that did not provide an alert upon entry into the windshear.

NTSB/AAR-96/04

NTSB/AAR-96/04 PB96-910404

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

RUNWAY DEPARTURE DURING ATTEMPTED TAKEOFF TOWER AIR FLIGHT 41 BOEING 747-136, N605FF JFK INTERNATIONAL AIRPORT, NEW YORK DECEMBER 20, 1995

Adopted: December 2, 1996
Notation 6671A

Abstract: This report explains the runway departure during attempted takeoff of Tower Air flight 41, N605FF, a Boeing 747-136 at John F. Kennedy International Airport, New York, on December 20, 1995. The safety issues discussed in this report include the adequacy of Boeing and air carrier procedures for B-747 operations on slippery runways; adequacy of flight simulators for training B-747 pilots in slippery runway operations; security of galley equipment installed on transport category aircraft; role of communications among flight attendants and between the cabin crew and the flightcrew; adequacy of Tower Air galley security training; compliance of Tower Air's maintenance department with its established procedures; failure of the FDR system to function during the accident; adequacy of the Tower Air operational management structure; adequacy of FAA surveillance and workload imposed on POIs; adequacy of runway friction measurement requirements, including correlation of runway friction measurements with aircraft braking and ground handling performance. Safety recommendations concerning these issues were made to the Federal Aviation Administration (FAA) and Tower Air, Inc.

EXECUTIVE SUMMARY

On December 20, 1995, at 1136, Tower Air flight 41, a Boeing B-747, veered off the left side of runway 4L during an attempted takeoff at John F. Kennedy International Airport (JFK), Jamaica, New York. The flight was a regularly scheduled passenger/cargo flight conducted under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121. Of the 468 persons aboard (451 passengers, 12 cabin crewmembers, 3 flightcrew members, and 2 cockpit jumpseat occupants), 24 passengers sustained minor injuries, and a flight attendant received serious injuries. The airplane sustained substantial damage. The weather at the time of the accident was partially obscured, with a 700-foot broken cloud ceiling, 1½ mile visibility, light snow, and fog.

The National Transportation Safety Board determines that the probable cause of this accident was the captain's failure to reject the takeoff in a timely manner when excessive nosewheel steering tiller inputs resulted in a loss of directional control on a slippery runway. Inadequate Boeing 747 slippery runway operating procedures developed by Tower Air, Inc., and the Boeing Commercial Airplane Group and the inadequate fidelity of B-747 flight training simulators for slippery runway operations contributed to the cause of this accident. The captain's reapplication of forward thrust before the airplane departed the left side of the runway contributed to the severity of the runway excursion and damage to the airplane.

The safety issues discussed in this report include the adequacy of Boeing and air carrier procedures for B-747 operations on slippery runways; adequacy of flight simulators for training B-747 pilots in slippery runway operations; security of galley equipment installed on transport category aircraft; role of communications among flight attendants and between the cabin crew and the flightcrew; adequacy of Tower Air galley security training; compliance of Tower Air's maintenance department with its established procedures; failure of the FDR system to function during the accident; adequacy of the Tower Air operational management structure; adequacy of FAA surveillance and workload imposed on POIs; adequacy of runway friction measurement requirements, including correlation of runway friction measurements with aircraft braking and ground handling performance.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the captain's failure to reject the takeoff in a timely manner when excessive nosewheel steering tiller inputs resulted in a loss of directional control on a slippery runway.

Inadequate Boeing 747 slippery runway operating procedures developed by Tower Air, Inc., and the Boeing Commercial Airplane Group and the inadequate fidelity of B-747 flight training simulators for slippery runway operations contributed to the cause of this accident.

The captain's reapplication of forward thrust before the airplane departed the left side of the runway contributed to the severity of the runway excursion and damage to the airplane.

NTSB/AAR-96/05

NTSB/AAR-96/05 PB96-910405

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

**COLLISION WITH TREES ON FINAL APPROACH
AMERICAN AIRLINES FLIGHT 1572
McDONNELL DOUGLAS MD-83, N566AA
EAST GRANBY, CONNECTICUT
NOVEMBER 12, 1995**

**Adopted: November 13, 1996
Notation 6638B**

Abstract: This report explains the accident involving American Airlines flight 1572, an MD-83 airplane, which was substantially damaged when it impacted trees in East Granby, Connecticut, while on approach to runway 15 at Bradley International Airport, Windsor Locks, Connecticut, on November 12, 1995. Safety issues in the report include tower shutdown procedures, non-precision approach flight procedures, precipitous terrain and obstruction identification during approach design, the issuance of altimeter settings by air traffic control, low level windshear system maintenance and recertification, and emergency evacuation issues. Recommendations concerning these issues were made to the Federal Aviation Administration.

EXECUTIVE SUMMARY

On November 12, 1995, at 0055 eastern standard time a McDonnell Douglas MD-83, N566AA, owned by American Airlines and operated as flight 1572, was substantially damaged when it impacted trees in East Granby, Connecticut, while on approach to runway 15 at Bradley International Airport (BDL), Windsor Locks, Connecticut. The airplane also impacted an instrument landing system antenna as it landed short of the runway on grassy, even terrain. Flight 1572 was being conducted under Title 14 Code of Federal Regulations, Part 121, as a scheduled passenger flight from Chicago, Illinois, to Bradley International Airport.

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's failure to maintain the required minimum descent altitude until the required visual references identifiable with the runway were in sight. Contributing factors were the failure of the BDL approach controller to furnish the flightcrew with a current altimeter setting, and the flightcrew's failure to ask for a more current setting.

The safety issues in the report focused on tower shutdown procedures, non-precision approach flight procedures, precipitous terrain and obstruction identification during approach design, the issuance of altimeter settings by air traffic control, low level windshear alert system maintenance and recertification, and emergency evacuation issues. Recommendations concerning these issues were made to the Federal Aviation Administration.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's failure to maintain the required minimum descent altitude until the required visual references identifiable with the runway were in sight. Contributing factors were the failure of the BDL approach controller to furnish the flightcrew with a current altimeter setting, and the flightcrew's failure to ask for a more current setting.

NSTB/AAR-96/07

NTSB/AAR-96/07 PB96-910407

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

GROUND SPOILER ACTIVATION IN FLIGHT/HARD LANDING
VALUJET AIRLINES FLIGHT 558
DOUGLAS DC-9-32, N922VV
NASHVILLE, TENNESSEE
JANUARY 7, 1996

Adopted: December 11, 1996
Notation 6781

Abstract: This report explains the ground spoiler activation in flight and subsequent hard landing of ValuJet Airlines flight 558, N922VV, a Douglas DC-9-32 at Nashville International Airport, Nashville, Tennessee. The safety issues discussed in the report include the adequacy of ValuJet's operations and maintenance manuals, specifically winter operations nosegear shock strut servicing procedures; the adequacy of ValuJet's pilot training/crew resource management training programs; flightcrew actions/decisionmaking; the role of communications (flightcrew/flight attendants/ operations/dispatch/air traffic control); ValuJet's flightcrew pay schedule; Federal Aviation Administration (FAA) oversight of ValuJet; and the adequacy of cockpit voice recorder (CVR) duration and procedures. Safety recommendations concerning these issues were made to the FAA and ValuJet Airlines.

EXECUTIVE SUMMARY

About 1620 central standard time, on January 7, 1996, a Douglas Aircraft Company DC-9-32, N922VV, operated by ValuJet Airlines, Inc., as flight 558, touched down hard in the approach light area short of runway 2R at the Nashville International Airport in Nashville, Tennessee. Flight 558 was operating under the provisions of Title 14 Code of Federal Regulations Part 121, as a scheduled, domestic passenger flight from Atlanta, Georgia, to Nashville. The flight departed the William B. Hartsfield Atlanta International Airport at approximately 1540, with five crewmembers and 88 passengers on board. The flight attendant who occupied the rear cabin jumpseat and four passengers reported minor injuries; no injuries were reported by the remaining 88 occupants. The airplane sustained substantial damage to the tail section, nosegear, aft fuselage, flaps, slats, and both engines. Visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan.

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's improper procedures and actions (failing to contact system operations/dispatch, failing to use all available aircraft and company manuals, and prematurely resetting the ground control relay circuit breakers) in response to an in-flight abnormality, which resulted in the inadvertent in-flight activation of the ground spoilers during the final approach to landing and the airplane's subsequent increased descent rate and excessively hard ground impact in the runway approach light area.

Contributing factors in the accident were ValuJet's failure to incorporate cold weather nosegear servicing procedures in its operations and maintenance manuals, the incomplete procedural guidance contained in the ValuJet quick reference handbook, and the flightcrew's inadequate knowledge and understanding of the aircraft systems.

The safety issues discussed in this report include the adequacy of ValuJet's operations and maintenance manuals, specifically winter operations nosegear shock strut servicing procedures; the adequacy of ValuJet's pilot training/crew resource management training programs; flightcrew actions/decisionmaking; the role of communications (flightcrew/flight attendants/operations/dispatch/air traffic control); ValuJet's flightcrew pay schedule; Federal Aviation Administration oversight of ValuJet; and the adequacy of cockpit voice recorder duration and procedures.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's improper procedures and actions (failing to contact system operations/dispatch, failing to use all available aircraft and company manuals, and prematurely resetting the ground control relay circuit breakers) in response to an in-flight abnormality, which resulted in the inadvertent in-flight activation of the ground spoilers during the final approach to landing and the airplane's subsequent increased descent rate and excessively hard ground impact in the runway approach light area.

Contributing factors in the accident were ValuJet's failure to incorporate cold weather nosegear servicing procedures in its operations and maintenance manuals, the incomplete procedural guidance contained in the ValuJet quick reference handbook, and the flightcrew's inadequate knowledge and understanding of the aircraft systems.

NTSB/AAR-97/01

NTSB/AAR-97/01 PB97-910401

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

**WHEELS-UP LANDING
CONTINENTAL AIRLINES FLIGHT 1943
DOUGLAS DC-9 N10556
HOUSTON, TEXAS
FEBRUARY 19, 1996**

**Adopted: February 11, 1997
Notation 6804**

Abstract: This report explains the wheels-up landing of Continental Airlines flight 1943, N10556, a Douglas DC-9 at Houston Intercontinental Airport, Houston, Texas. The safety issues discussed in the report include checklist design, flightcrew training, adherence to standard operating procedures, adequacy of Federal Aviation Administration (FAA) surveillance, and flight attendant tailcone training. Safety recommendations concerning these issues were made to the FAA.

EXECUTIVE SUMMARY

On February 19, 1996, at 0902 central standard time, Continental Airlines (COA) flight 1943, a Douglas DC-9-32, N10556, landed wheels up on runway 27 at the Houston Intercontinental Airport, Houston, Texas. The airplane slid 6,850 feet before coming to rest in the grass about 140 feet left of the runway centerline. The cabin began to fill with smoke, and the captain ordered the evacuation of the airplane. There were 82 passengers, 2 flightcrew members, and 3 flight attendants aboard the airplane. No fatalities or serious injuries occurred; 12 minor injuries to passengers were reported. The airplane sustained substantial damage to its lower fuselage. The regularly scheduled passenger flight was operating under Title 14 Code of Federal Regulations Part 121 and had originated from Washington National Airport about 3 hours before the accident. An instrument flight rules flight plan had been filed; however, visual meteorological conditions prevailed for the landing in Houston.

The National Transportation Safety Board determines that the probable cause of this accident was the captain's decision to continue the approach contrary to COA standard operating procedures that mandate a go-around when an approach is unstabilized below 500 feet or a ground proximity warning system alert continues below 200 feet above field elevation. The following factors contributed to the accident: (1) the flightcrew's failure to properly complete the in-range checklist, which resulted in a lack of hydraulic pressure to lower the landing gear and deploy the flaps; (2) the flightcrew's failure to perform the landing checklist and confirm that the landing gear was extended; (3) the inadequate remedial actions by COA to ensure adherence to standard operating procedures; and (4) the Federal Aviation Administration's (FAA) inadequate oversight of COA to ensure adherence to standard operating procedures.

Safety issues discussed in this report include checklist design, flightcrew training, adherence to standard operating procedures, adequacy of FAA surveillance, and flight attendant tailcone training. Safety recommendations concerning these issues were made to the FAA.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the captain's decision to continue the approach contrary to Continental Airlines (COA) standard operating procedures that mandate a go-around when an approach is unstabilized below 500 feet or a ground proximity warning system alert continues below 200 feet above field elevation. The following factors contributed to the accident: (1) the flightcrew's failure to properly complete the in-range checklist, which resulted in a lack of hydraulic pressure to lower the landing gear and deploy the flaps; (2) the flightcrew's failure to perform the landing checklist and confirm that the landing gear was extended; (3) the inadequate remedial actions by COA to ensure adherence to standard operating procedures; and (4) the Federal Aviation Administration's inadequate oversight of COA to ensure adherence to standard operating procedures.

NTSB/AAR-97/03

NTSB/AAR-97/03 PB97-910403

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

DESCENT BELOW VISUAL GLIDEPATH AND COLLISION WITH TERRAIN DELTA AIR LINES FLIGHT 554 MCDONNELL DOUGLAS MD-88, N914DL LAGUARDIA AIRPORT, NEW YORK OCTOBER 19, 1996

Adopted: August 25, 1997
Notation 6785B

Abstract: This report explains the descent below visual glidepath and collision with terrain of Delta Air Lines flight 554 at LaGuardia Airport on October 19, 1996. The safety issues in this report focused on the possible hazards of monovision contact lenses, visual illusions encountered during the approach, non-instantaneous vertical speed information, the weather conditions encountered during the approach, the guidance in air carrier's manuals regarding flightcrew member duties, the stabilized approach criteria in air carrier's manuals, emergency evacuation procedures, special airport criteria and designation, and LaGuardia Airport issues/runway light spacing. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration and to optometric associations.

EXECUTIVE SUMMARY

About 1638 eastern daylight time, on October 19, 1996, a McDonnell Douglas MD-88, N914DL, operated by Delta Air Lines, Inc., as flight 554, struck the approach light structure and the end of the runway deck during the approach to land on runway 13 at the LaGuardia Airport, in Flushing, New York. Flight 554 was being operated under the provisions of 14 CFR Part 121, as a scheduled, domestic passenger flight from Atlanta, Georgia, to Flushing. The flight departed the William B. Hartsfield International Airport at Atlanta, Georgia, about 1441, with two flightcrew members, three flight attendants, and 58 passengers on board. Three passengers reported minor injuries; no injuries were reported by the remaining 60 occupants. The airplane sustained substantial damage to the lower fuselage, wings (including slats and flaps), main landing gear, and both engines. Instrument meteorological conditions prevailed for the approach to runway 13; flight 554 was operating on an instrument flight rules flight plan.

The National Transportation Safety Board determines that the probable cause of this accident was the inability of the captain, because of his use of monovision contact lenses, to overcome his misperception of the airplane's position relative to the runway during the visual portion of the approach. This misperception occurred because of visual illusions produced by the approach over water in limited light conditions, the absence of visible ground features, the rain and fog, and the irregular spacing of the runway lights.

Contributing to the accident was the lack of instantaneous vertical speed information available to the pilot not flying, and the incomplete guidance available to optometrists, aviation medical examiners, and pilots regarding the prescription of unapproved monovision contact lenses for use by pilots.

The safety issues in this report focused on the possible hazards of monovision contact lenses, visual illusions encountered during the approach, non-instantaneous vertical speed information, the weather conditions encountered during the approach, the guidance in air carrier's manuals regarding flightcrew member duties, the stabilized approach criteria in air carrier's manuals, emergency evacuation procedures, special airport criteria and designation, and LaGuardia Airport issues/runway light spacing.

Safety recommendations concerning these issues were addressed to the Federal Aviation Administration and to optometric associations.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the inability of the captain, because of his use of monovision contact lenses, to overcome his misperception of the airplane's position relative to the runway during the visual portion of the approach. This misperception occurred because of visual illusions produced by the approach over water in limited light conditions, the absence of visible ground features, the rain and fog, and the irregular spacing of the runway lights.

Contributing to the accident was the lack of instantaneous vertical speed information available to the pilot not flying, and the incomplete guidance available to optometrists, aviation medical examiners, and pilots regarding the prescription of unapproved monovision contact lenses for use by pilots.

VITA

Gilbert Elgin Schnabel, Jr.

Candidate for the Degree of

Doctor of Education

Thesis: THE IMPACT OF AIRLINE PILOT AGE AND FLIGHT EXPERIENCE FACTORS ON THE INCIDENCE OF COMMERCIAL AIR CARRIER ACCIDENTS ATTRIBUTED TO PILOT ERROR

Major Field: Applied Educational Studies

Biographical:

Personal Data: Born in Morristown, New Jersey, February 14, 1948, the son of Gilbert E., Sr., and Mary R. Schnabel. Married Anne R. Thillmann from Haselmuhl, Germany in 1970; two sons, Pete and daughter-in-law Adrienne, and Josh.

Education: Graduated from Boonton High School, Boonton, New Jersey, in June 1965; received Bachelor of Education degree in Health, Physical Education, and Recreation from the University of Miami, Coral Gables, Florida in January of 1970; received Master of Science degree, Occupational and Adult Education, from Oklahoma State University, Stillwater, Oklahoma, in May of 1992; completed the requirements for the Doctor of Education degree at Oklahoma State University in May of 1999.

Professional Experience: Adjunct Faculty Member, Aviation & Space Education Program, Oklahoma State University, January 1996 – May 1999; Independent Contract Flight Instructor and Safety Officer, United States Air Force Academy Aero Club, Colorado Springs, Colorado, May 1995 – January 1996; Director, Technical Trades Institute, Colorado Springs, Colorado, January 1994 – October 1994; Lieutenant Colonel, United States Air Force; Supreme Headquarters Allied Powers Europe (SHAPE), Belgium, Project Officer, NATO Crisis Management Exercise Program, August 1991 – 1993; Chief, Aircrew Scheduling & Support Division, 379th Bombardment Wing, Wurtsmith AFB, Michigan, July 1988 – July

1992; B-52G Instructor Pilot, 379th Bombardment Wing, Wurtsmith AFB, Michigan, October 1986 – June 1988; Assistant Operations Officer, 966th Airborne Warning & Control Training Squadron, Tinker AFB, Oklahoma, September 1983 – September 1986.; Chief, Current Operations Branch, 43rd Strategic Wing, Andersen AFB, Guam, June 1982 – August 1983; B-52 D Instructor Pilot, 60th Bombardment Squadron, Andersen AFB, Guam, June 1980 – May 1982; Corporate Pilot, Guerdon Industries, Inc., Louisville, Kentucky, January 1978 – May 1980; Weapons Controller, 25th NORAD Region, McChord AFB, Washington, July 1977 – December 1977; B-52D Pilot, 60th Bombardment Squadron, Seymour Johnson AFB, North Carolina, July 1972 – June 1974; United States Air Force Officer 1970 – 1993.

Professional Memberships: Order of Daedalians, Life Member, Fraternity of Military Pilots; University Aviation Association Member.