UCRL-ID-124837

DATA DEVELOPMENT TECHNICAL SUPPORT DOCUMENT FOR THE AIRCRAFT CRASH RISK ANALYSIS METHODOLOGY (ACRAM) STANDARD

Chris Y. Kimura
Ronald E. Glaser
Richard W. Mensing
Tom Lin
Timothy A. Haley
Andrew B. Barto
Martin A. Stutzke

August 1, 1996

Lawrence Livermore National Laboratory

Work performed under the auspices of the Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

ABSTRACT

The Aircraft Crash Risk Analysis Methodology (ACRAM) Panel has been formed by the U.S. Department of Energy Office of Defense Programs (DOE/DP) for the purpose of developing a standard methodology for determining the risk from aircraft crashes onto DOE ground facilities. In order to accomplish this goal, the ACRAM Panel has been divided into four teams, the data development team, the model evaluation team, the structural analysis team, and the consequence team. Each team, consisting of at least one member of the ACRAM plus additional DOE and DOE contractor personnel, specializes in the development of the methodology assigned to that team. This report documents the work performed by the data development team and provides the technical basis for the data used by the ACRAM Standard for determining the aircraft crash frequency.

This report should be used to provide the generic data needed to calculated the aircraft crash frequency into the facility under consideration as part of the process for determining the aircraft crash risk to ground facilities as given by the DOE Standard Aircraft Crash Risk Assessment Methodology (ACRAM). Some broad guidance is presented on how to obtain the needed site-specific and facility specific data but this data is not be provided by this document.

DATA DEVELOPMENT TECHNICAL SUPPORT DOCUMENT FOR THE AIRCRAFT CRASH RISK ANALYSIS METHODOLOGY (ACRAM) STANDARD

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

DATA DEVELOPMENT TECHNICAL SUPPORT DOCUMENT FOR THE AIRCRAFT CRASH RISK ANALYSIS METHODOLOGY (ACRAM) STANDARD

by

Chris Y. Kimura, Ronald E. Glaser, Lawrence Livermore National Laboratory (LLNL)
Richard W. Mensing, Logicon RDA
Tom Lin, Sandia National Laboratories (SNL)
Timothy A. Haley, Andrew B. Barto, Martin A. Stutzke, Science Application International Corporation (SAIC)

1. INTRODUCTION

The Aircraft Crash Risk Analysis Methodology (ACRAM) Panel has been formed by the U.S. Department of Energy Office of Defense Programs (DOE/DP) for the purpose of developing a standard methodology for determining the risk from aircraft crashes onto DOE ground facilities. In order to accomplish this goal, the ACRAM Panel has been divided into four teams, the data development team, the model evaluation team, the structural analysis team, and the consequence team. Each team, consisting of at least one member of the ACRAM Panel plus additional DOE and DOE contractor personnel, specializes in the development of the methodology assigned to that team. This report documents the work performed by the data development team and provides the technical basis for the data used by the ACRAM Standard [Ref. 1.1] for determining the aircraft crash frequency.

Aircraft crash risk analysis, like all transportation risk analyses, is highly dependent on the initiating event frequency, that is the liklihood of the accident happening. This is because transportation risk analyses, unlike nuclear power plant Probablistic Risk Assessments (PRAs) do not analyze the mitigating features on the transportation system which might serve to prevent or mitigate the effects of the transportation accident. Therefore, the development of accident data, operational data, and characterization of the accident becomes paramount in the transportation risk analyses. Fortunately, for aircraft crash risk analysis, the availability and quality of accident data and operational data, at least for the general aviation and commercial aviation sector, are relatively good due to the efforts of the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA).

This document is divided into the following chapters. Chapter One presents introductory material. Chapter Two presents the accident rates and the crash parameter distributions developed for Commercial Aviation (Air Carriers and Air Taxi). Chapter Three presents the accident rates and the crash parameter distributions developed for General Aviation. Chapter Four presents the accident rates and the crash parameter distributions for Military Aviation. Chapter Five discusses the development of Aircraft Operation data. Each chapter is followed by applicable appendices.

This chapter presents the definition of important terms used throughout this document in Section 1.1. It also discusses how to use this report in Section 1.2 Section 1.3 presents the references used in this chapter.

1.1 DEFINITIONS OF TERMS

As the first step in the development of data for the ACRAM Standard [Ref. 1.1], it is important that common definitions are understood for several significant terms which are used throughout this report. The defined terms are listed in **boldface** and in alphabetical order. Where possible, the source of the definition has been identified. In addition, where a defined term has been used as part of a definition, it is capitalized.

Active Aircraft: As defined by the Federal Aviation Administration (FAA), all legally registered civil aircraft which flew one or more hours during the time period under consideration.

Air Carrier: As defined by the Federal Aviation Administration (FAA), the commercial system of air transportation consisting of the Certificated Air Carriers, Air Taxis (including commuters), Supplemental Air Carriers, Commercial Operators of Large Aircraft, and Air Travel Clubs. As defined by air traffic controllers in tabulating air traffic activity, aircraft in general commercial service capable of carrying 70 or more passengers irrespective of the the aviation flight rules under which the flight occurs.

Aircraft Accident: As defined by the National Transportation Safety Board (NTSB), an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, and in which any person suffers a fatal or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, or in which the aircraft receives substantial damage.

Aircraft Crash: For Commercial Aviation, see Commercial Aircraft Crash. For General Aviation, see General Aviation Crash. For Military Aviation, see Military Aircraft Crash.

Aircraft/Aviation Category: The broadest, most general classification of aircraft and aviation used in the ACRAM Standard [Ref. 1.1]. These categories are: 1) Air Carrier, 2) Air Taxi, 3) General Aviation, and 4) Military Aviation.

Aircraft Operation: As defined by the Federal Aviation Administration (FAA) near an airport, the number of arrivals and departures from the airport at which an airport traffic control tower is located. Operations include aircraft which: 1) operate in the local traffic pattern or within sight of the airport, 2) are known to be departing for, arriving from flight in the local practice areas located within a 20-mile radius of the airport, or 3) execute simulated instrument approaches or low passes at the airport. See also Airport Operation.

Aircraft/Aviation Subcategory: The next level of classification for aircraft and aviation used by the ACRAM Standard [Ref. 1.1]. For Air Carriers and Air Taxis, no subcategories are defined. For General Aviation, seven subcategories of aircraft/aviation are defined: 1) Single-engine piston powered, fixed-wing, 2) Multi-engine piston powered, fixed wing, 3) Turboprop powered, fixed-wing, 4) Turbojet/turbofan powered, fixed-wing, 5) Piston-engine powered, rotary wing, 6) Turboshaft powered, rotary wing, and 7) Other. For Military Aviation, three subcategories of aircraft/aviation are defined: 1) Large (which includes most Bombers, Cargo or transports), 2) Small (which includes most Fighters, Attack aircraft, and Trainers), and 3) Helicopters.

Aircraft Type: As defined by 14 CFR 1.1 [Ref. 1.2], a specific make and basic model of aircraft, including modifications that do not change its handling or flight characteristics. As used with respect to the certification of aircraft, those aircraft which are similar in design. Examples include the Douglas DC-7 and the DC-7C, the Lockheed 1049G and 1049H, and the Fokker F-27 and F-27F.

Airport: As defined by the Federal Aviation Administration (FAA), an area of land or water that is used or intended to be used for the landing and takeoff of aircraft, and includes its buildings and facilities, if any. Airports include heliports, STOLports, and seaplane bases.

Airport Approach Flight Phase: The Flight Phase which consists of the time the aircraft intercepts the initial navigation fix defined by U.S. terminal approach procedures for that specific airport, runway and

approach, until the aircraft crosses the outer marker defined by U.S. terminal approach procedures for that specific airport, runway and approach.

Airport Operation: For the ACRAM Standard [Ref. 1.1], an Aircraft Operation which occurs in the Near Airport Environment. As defined by the Federal Aviation Administration (FAA), the number of arrivals and departures from the airport at which the Airport Traffic Control Tower is located. Airport Operations are classified as either Local or Itinerant Operations. See also Aircraft Operation.

Airport Traffic: As defined by the Federal Aviation Administration (FAA), aircraft operating in the air or on an airport surface exclusive of loading ramps and parking areas.

Airport Traffic Control Tower (ATCT): As defined by the Federal Aviation Administration (FAA), a central operations facility in the terminal air traffic control system, which consists of a tower cab structure, including an associated IFR room if radar equipped, and uses air/ground communications, radar, visual signaling, and other services to provide safe and expeditious movement of terminal air traffic.

Air Route Traffic Control Center (ARTCC): The FAA air traffic control facility responsible for providing air traffic control service to aircraft operating on IFR flight plans in controlled airspace, primarily Class A Airspace. ARTCCs are the central authority for issuing IFR clearances, and provide nationwide monitoring of each IFR flight, usually during the Enroute Flight Phase.

Air Taxi: As defined by the Federal Aviation Administration (FAA), a classification of air carriers which transports in accordance with 14 CFR 135 [Ref. 1.12], persons, property, and mail using small aircraft (under 30 seats or a maximum payload capacity of less than 7,500 pounds). As defined by air traffic controllers in tabulating air traffic activity, aircraft in general commercial service that carry less than 70 passengers. As this classification includes small single-engine aircraft, the flight must usually be identified as an air taxi flight in its flight plan or the aircraft carries a commercial livery in order for the flight to be counted as an Air Taxi flight.

Airway: The system of designated routes between VOR or VORTAC stations. Included within the definition of Airway are High Altitude (Jet) Routes, Low Altitude (Victor) Routes, and Military Training Routes.

Armed Forces: As defined by 14 CFR 1.1 [Ref. 1.2], the United States Air Force (USAF), United States Army (USA), United States Navy (USN), United States Marine Corps (USMC), and the United States Coast Guard (USCG), including their regular and reserve component and members serving without component status.

Certificated Air Carrier: As defined by the Federal Aviation Administration (FAA), an Air Carrier holding a Certificate of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT) to conduct scheduled services interstate. Nonscheduled or charter operations may also be conducted by these carriers. These carriers operate large aircraft (30 seats or more or a maximum payload of 7,500 pounds or more) in accordance with 14 CFR 121 [Ref. 1.7].

Class A Airspace: As defined by by 14 CFR 71.33 [Ref. 1.3], that airspace of the United States, including that airspace overlying the waters within 12 nautical miles of the coast of the 48 contiguous States, from 18,000 feet Mean Sea Level to and including FL600 (60,000 feet mean sea level) excluding the states of Alaska and Hawaii, Santa Barbara Island, Farallon Island, and the airspace south of latitude 25° 04' 00" North. All operations are conducted under instrument flight rules (IFR) and are subject to ARTCC clearances and instructions. Aircraft separation and safety advisories are provided by the ARTCC. Formerly called Positive Control Areas (PCAs).

Class A Mishap: As defined by the United States Air Force (USAF), any mishap incidental to flight which results in the total cost of property damage, injury and/or illness of $1,000,000 or more, or USAF aircraft destruction, or fatality.

Class B Airspace: Generally the airspace from the surface to 10,000 feet mean sea level (MSL) surrounding U.S. airports with more than 150,000 annual instrument flight rule (IFR) operations or

650,000 annual passenger enplanements. The configuration of each Class B Airspace is individually tailored and consists of a surface area, usually 5 nautical miles in radius from the primary airport, and two or more layers extending laterally from the core at 3 to 10 nautical mile increments (typically) to a radius of approximately 20 nautical miles, with each layer having a prescribed altitude floor. Class B Airspace is designed to contain all published instrument procedures once an aircraft enters the airspace. Operations may be under either IFR or visual flight rules (VFR) with all aircraft subject to air traffic control clearances and instructions. Air traffic control provides aircraft separation and safety advisories. Formerly called Terminal Control Areas (TCAs).

Class B Mishap: As defined by the United States Air Force (USAF), any mishap incidental to flight which results in the total cost of property damage, injury and/or illness of $200,000 or more, but less than $1,000,000.

Class C Airspace: Generally, the airspace from the surface to approximately 4,000 feet mean sea level (MSL) surrounding U.S. airports with more than 75,000 annual instrument flight rule (IFR) operations at the primary airport, or 100,000 annual IFR operations at the primary and secondary airports in the terminal hub area, or 250,000 annual passenger enplanements at the primary airport. The configuration of each Class C Airspace is individually tailored and consists of a surface area of 5 nautical miles radius from the primary airport, and another layer with a prescribed altitude floor, extending laterally from the core to a radius of 10 nautical miles. Operations may be under either instrument flight rules (IFR) or visual flight rules (VFR), with all aircraft subject to air traffic control clearances and instructions. Air traffic control provides aircraft separation between IFR/IFR and IFR/special VFR (SVFR) aircraft. VFR operations are given traffic advisories and, upon request, collision resolution instructions. Formerly called Airport Radar Service Areas (ARSAs).

Class C Mishap: As defined by the United States Air Force (USAF), any mishap incidental to flight which results in the total cost of property damage of $10,000 or more, but less than $200,000 or injury or occupational illness resulted in a lost workday case involving days away from work.

Class D Airspace: The airspace from the surface to 2,500 feet above ground level (AGL) within a 5 statute mile (4.3 nautical mile) radius of the center of the airport. Operations may be under either instrument flight rules (IFR) or visual flight rules (VFR), with all aircraft subject to air traffic control clearances and instructions. Air traffic control separation service is provided to IFR aircraft only, but all aircraft will be given traffic advisories and, upon request, conflict resolution instructions. Formerly called Airport Traffic Areas (ATAs) and Control Zones (CZs).

Climb to Cruise Flight Phase: The Flight Phase which consists of the time after the Takeoff Flight Phase when the aircraft landing gear is retracted and all aircraft flaps are in their normal cruise configuration until the aircraft has reached its initial assigned cruising or enroute altitude.

Commercial Aircraft Crash: Any Aircraft Accident involving an aircraft type generally used for commercial service during flight operations (defined as the beginning of takeoff roll to landing touchdown) which results in the destruction of or substantial damage to the aircraft. Fatal or serious injury sustained as a result of the Aircraft Accident itself, without related destruction or substantial damage to the aircraft is not a criterion for consideration as a Commercial Aircraft Crash.

Commercial Airport: As defined by the Federal Aviation Administration (FAA), a Public Airport which is determined to enplane 2,500 or more passengers annually and receive scheduled passenger service of aircraft.

Commercial Aviation: All aspects of aviation involving aircraft operated under 14 CFR 121 [Ref. 1.7], 125 [Ref. 1.8], 127 [Ref. 1.9], 129 [Ref. 1.10], and 135 [Ref. 1.12] regulations.

Commercial Operator: As defined by the Federal Aviation Administration (FAA), a person who, for compensation or hire, engages in the intrastate carriage of aircraft in air commerce of persons or property other than as an air carrier or foreign air carrier.

Commercial Operator of Large Aircraft: As defined by the Federal Aviation Administration (FAA), a Commercial Operator operating aircraft with 30 seats or more or a maximum payload capacity of 7,500 pounds or more.

Commuter Air Carrier: As defined by the Federal Aviation Administration (FAA), an Air Taxi operator which performs at least five round trips per week between two or more points and publishes flight schedules which specify the times, days of the week, and points between which such flights are performed. Also called Scheduled Air Taxis.

Crash Location Distribution: The normalized conditional probability distribution (i.e., given that the aircraft crash occurs) in terms of x, y coordinates as a function of the location of the facility relative to the airport.

Cruise Flight Phase: See Enroute Flight Phase.

Descent from Cruise Flight Phase: The Flight Phase which consists of the time when the aircraft begins its descent from its final assigned cruising or enroute altitude until the aircraft intercepts the initial navigation fix defined by U.S. terminal approach procedures for that specific airport, runway and approach,

Destroyed: As defined by the United States Air Force (USAF), sufficient damage sustained by the aircraft in the accident such that it is uneconomical to repair. It is further defined by the number of man-hours estimated as need to repair the aircraft to flight status and depends on the aircraft type.

Demand Air Taxi: As defined by the Federal Aviation Administration (FAA), an Air Taxi operator which performs charter air service or less than five round trips per week between two or more points. Also called Nonscheduled Air Taxis.

Enroute: For the ACRAM Standard [Ref. 1.1], Enroute includes the Climb to Altitude Flight Phase, Enroute or Cruise Flight Phase, and the Descent from Cruise Flight Phase.

Enroute Analysis: The aircraft crash frequency analysis for Aircraft Operations outside of the Near Airport and TRACON Environments. See also In-Flight Analysis.

Enroute Environment: The airspace outside of the Near Airport and TRACON Environments. See also In-Flight Environment.

Enroute Flight Phase: For Air Carriers and Air Taxis, the Flight Phase which consists of the time when the aircraft has reached its initial assigned cruising or enroute altitude until the time the aircraft begins its descent from its final assigned cruising or enroute altitude. Minor adjustments in assigned cruising or enroute altitude are considered to be part of the Enroute Flight Phase. For Military Aviation, the Flight Phase from the point where the aircraft altitude is not affected by its proximity to the runway. For Military Aviation, also called In-Flight Phase.

Fatal Injury: As defined by the National Transportation Safety Board (NTSB), any injury which results in death within 30 days of the accident.

Flight Mishap: As defined by the United States Air Force (USAF), a mishap involving a U.S. Air Force aircraft when intent for flight exists.

Flight Phase: The parts of flight which are distinctly different for each due to the configuration of the aircraft and/or the conditions under which the flight is taking place. The following flight phases are generally defined: Ground operations, Taxi, Takeoff, Initial Climb, Climb to Altitude, Enroute or Cruise, Descent from Cruise, Airport Approach, Runway Approach, Landing, and Other.

Flight Related: As defined by the United States Air Force (USAF), a mishap with little or no damage to the aircraft and which does not affect the Mishap Rate.

14 CFR 91: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter F, Air Traffic and General Operating Rules, Part 91, General Operating and Flight Rules [Ref. 1.4].

14 CFR 103: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter F, Air Traffic and General Operating Rules, Part 103, Ultralight Vehicles [Ref. 1.5].

14 CFR 105: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter F, Air Traffic and General Operating Rules, Part 105, Parachute Jumping [Ref. 1.6].

14 CFR 121: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 121, Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft [Ref. 1.7].

14 CFR 125: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More [Ref. 1.8].

14 CFR 127: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 127, Certification and Operations of Scheduled Air Carriers with Helicopters [Ref. 1.9].

14 CFR 129: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage [Ref. 1.10].

14 CFR 133: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 133, Rotorcraft External-Load Operations [Ref. 1.11].

14 CFR 135: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 135, Air Taxi Operators and Commercial Operators [Ref. 1.12].

14 CFR 137: Flight operations conducted under Title 14 (Aeronautics and Space) of the Code of Federal Regulations, Subchapter G, Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 137, Agricultural Aircraft Operations [Ref. 1.13].

General Aviation: All aspects of aviation involving aircraft operated under 14 CFR 91 [Ref. 1.4], 103 [Ref. 1.5], 105 [Ref. 1.6], 133 [Ref. 1.11], and 137 [Ref. 1.13] regulations.

General Aviation Airport: As defined by the Federal Aviation Administration (FAA), any Airport which is used or to be used for public purposes, under the control of a public agency, the landing area of which is publicly owned.

General Aviation Crash: As defined by the NTSB for Aircraft Accidents.

High Altitude (Jet) Routes: The designated air routes based on radials from VOR or VORTAC stations extending from 18,000 feet Mean Sea Level (MSL) and up to and including 45,000 feet Mean Sea Level (MSL) (Flight Level 450).

IFR Aircraft Handled: As defined by the Federal Aviation Administration (FAA), the number of IFR Departures multiplied by two plus the number of IFR Overs. Assumes that the number of departures (acceptances, extensions, and originations of IFR flight plans) is equal to the number of landings (IFR flight plans closed).

IFR Departures: As defined by the Federal Aviation Administration (FAA), IFR Flights originating in the ARTCC's area, accepted by the ARTCC under the Sole Enroute clearance procedures, and extended by the ARTCC.

IFR Flight: As defined by the Federal Aviation Administration (FAA), flight conducted in accordance with instrument flight rules.

IFR Overs: As defined by the Federal Aviation Administration (FAA), IFR Flights that originate outside the ARTCC area and passes through the area without landing.

ILS: Instrument Landing System.

In-Flight: For the ACRAM Standard [Ref. 1.1], In-Flight includes the Climb to Altitude Flight Phase, Enroute or Cruise Flight Phase, and the Descent from Cruise Flight Phase. For Military Aviation only, the Flight Phase where the aircraft altitude is not affected by its proximity to the runway. See also Enroute.

In-Flight Analysis: The aircraft crash frequency analysis for Aircraft Operations outside of the Near Airport and the TRACON Environments. See also Enroute Analysis.

In-Flight Environment: The airspace outside of the Near Airport and TRACON Environments. See also Enroute Environment.

Initial Climb Flight Phase: The Flight Phase which consists of the time the aircraft wheels leave the ground until the aircraft landing gear is retracted and all aircraft flaps are in their normal cruise configuration.

Instrument Landing System: A precision instrument approach system which normally consists of a localizer to provide course guidance to the runway, a glide slope to provide vertical guidance during the approach, and a marker beacon to provide aural and/or visual identification of a specific position along an instrument approach landing.

Instrument Operation: An aircraft operation in accordance with an IFR flight plan or an operation where IFR separation between aircraft is provided by a terminal control facility or an Air Route Traffic Control Center.

Itinerant Operation: As defined by the Federal Aviation Administration (FAA), all aircraft operations other than Local Operations. See Airport Operations.

Jet Routes: See High Altitude Routes.

Landing: For ACRAM Standard [Ref. 1.1] for Air Carriers, Air Taxis, and General Aviation, Landing includes the Airport Approach Flight Phase, the Runway Approach Flight Phase, and the Landing Flight Phase. For Military Aviation, Landing will be considered as the Flight Phase from the point where the aircraft altitude is affected by its proximity from the approach runway to its departure from the runway under a controlled taxi.

Landing Flight Phase: The Flight Phase which consists of the time the aircraft wheels initially make contact with the runway or landing surface until the aircraft leaves the runway or landing surface onto the designated taxiway.

Local Operation: As defined by the Federal Aviation Administration (FAA), operations performed by aircraft which 1) operate in the local traffic pattern or within sight of the airport; 2) are known to be

departing for, or arriving from flight in local practice areas located within a 20-mile radius of the airport; or 3) execute simulated instrument approaches or low passes at the airport. See Airport Operations.

Low Altitude (Victor) Airway: The designated routes based on radials from VOR or VORTAC stations extending from a minimum of 1200 feet above ground level, up to but not including 18,000 feet Mean Sea Level (MSL).

Military Aircraft Crash: All Class A and Class B Mishaps.

Military Aviation: All aspects of aviation involving the Armed Forces of the United States. Military Aviation does not include charter flights performed for the Armed Forces.

Military Training Routes: The system of designated routes used by the Armed Forces of the United States.

Mishap Rate: As defined by the United States Air Force (USAF), the number of Flight Mishaps per 100,000 flying hours.

Near Airport Analysis: The aircraft crash frequency analysis for Aircraft Operations in the Near Airport Environment.

Near Airport Environment: The airspace area extending from the center of the airport outwards to a radius of approximately 5 miles to 35 miles depending on the presence (or absence) of a TRACON and other air traffic control considerations. The airspace near an Airport which encompasses the local airport traffic pattern, the airport runway approach pattern(s), and the airport initial climb departure pattern(s). This is generally the airspace near an airport where the aircraft are in the Runway Approach Flight Phase, Landing Flight Phase, the Takeoff Flight Phase, and the Initial Climb Flight Phase.

Nonairport Environment: The TRACON and the Enroute/In-Flight Environments. The airspace outside of the Near Airport Environment.

Nonprecision Approach Procedure: As defined by 14 CFR 1.1 [Ref. 1.2], a standard instrument approach procedure in which no electronic glide slope is provided.

Nonscheduled Air Taxi: See Demand Air Taxi.

PAR: Precision Approach Radar.

Precision Approach Procedure: As defined by 14 CFR 1.1 [Ref. 1.2], a standard instrument approach procedure in which an electronic glide slope is provided, such as ILS and PAR.

Public Aircraft: As defined by 14 CFR 1.1 [Ref. 1.2], aircraft used only in the service of a government, or a political subdivision. It does not include any government-owned aircraft engaged in carrying persons or property for commercial purposes.

Public Airport: See General Aviation Airport.

Operator: As defined by the National Transportation Safety Board (NTSB), any person who causes or authorizes the operation of an aircraft, such as the owner, leasee, or bailee of an aircraft.

Rotary Wing Aircraft (Rotorcraft): As defined by 14 CFR 1.1 [Ref. 1.2], a heavier-than-air aircraft that depends principally for its support in flight on the lift generated by one or more rotors. More commonly known as helicopters.

Runway Approach Flight Phase: The Flight Phase which consists of the time the aircraft crosses the outer marker defined by U.S. terminal approach procedures for that specific airport, runway and approach, until the aircraft wheels initially make contact with the runway.

Scheduled Air Taxi: See Commuter Air Carrier.

Serious Injury: As defined by the National Transportation Safety Board (NTSB) in 49 CFR 830.2 [Ref. 1.13] , any injury which 1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; 2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); 3) involves lacerations which cause severe hemorrhages, nerve, muscle, or tendon damage; 4) involves injury to any internal organ; or 5) involves second- or third-degree burns, or any burns affecting more than 5 percent of body surface.

Substantial Damage: As defined by the National Transportation Safety Board (NTSB) in 49 CFR 830.2 [Ref. 1.13].

(1) Except as provided in subparagraph (2) of this paragraph, substantial damage means damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component.

(2) Engine failure, damage limited to an engine, bent fairings or cowling, dented skin, small punctured holes in the skin of fabric, ground damage to rotor or propeller blades, damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage".

Supplemental Air Carrier (Charter): As defined by the Federal Aviation Administration (FAA), an Air Carrier which holds Certificates of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT), authorizing performance of passenger and cargo interstate charter services supplementing the scheduled service of the Certificated Air Carriers. The authority of Supplemental Air Carriers to engage in military charters is of an indefinite period. In Addition, they can perform on an emergency basis, as may be authorized by the DOT, scheduled operations including the transportation of individually ticketed passengers and individually waybilled cargo.

TACAN: Tactical Air Navigation. A UHF electronic rho (distance)-theta (azimuth) air navigation aid which provides suitably equipped aircraft (primarily military) with a continuous indication of bearing and distance to the TACAN facility.

Takeoff: For the ACRAM Standard [Ref. 1.1] for Air Carriers, Air Taxis and General Aviation, Takeoff includes the Takeoff Flight Phase, and the Initial Climb Flight Phase. For Military Aviation, Takeoff will be considered as the Flight Phase from the application of takeoff power on the runway to the point where the aircraft altitude is not affected by its proximity from the departure runway.

Takeoff Flight Phase: The Flight Phase which consists of the beginning of the aircraft takeoff roll to the moment the aircraft wheels leave the ground.

TRACON: Terminal Radar Control. The air traffic control facility responsible for providing approach/departure aircraft separation, especially for IFR operations, for the airspace area approximately 5 miles radius from the primary airport extending outwards to approximately 35 miles from the primary airport.

TRACON Analysis: The aircraft crash frequency analysis for Aircraft Operations in the TRACON Environment.

TRACON Environment: The airspace outside of the Near Airport Environment and inside and beneath the Enroute/In-Flight Environment in which all air traffic is under the control of the local TRACON.

VFR Flight: As defined by the Federal Aviation Administration (FAA), flight conducted in accordance with visual flight rules.

Victor Airway: See Low Altitude Airway.

VOR: Very high frequency Omnidirectional Radio range. Used as a basis for navigation in the national airspace system.

VORTAC: Colocated VOR and TACAN navigation aids. An air navigation aid providing azimuth and distance measuring equipment at one site.

1.2 HOW TO USE THIS REPORT

This report should be used to provide the generic data needed to calculated the aircraft crash frequency into the facility under consideration as part of the process for determining the aircraft crash risk to ground facilities as given by the DOE Standard Aircraft Crash Risk Assessment Methodology (ACRAM) [Ref. 1.1]. Some broad guidance will be offered on how to obtain the needed site-specific and facility specific data but this data will not be provided by this document.

The frequency that an aircraft will hit a particular building or facility is generally calculated using the the following formula which incorporates the following four factors: (1) the number of flights or operations near the area of interest, (2) the probability that an aircraft will crash or the expected crash rate, (3) the liklihood that the aircraft will hit the particular location where the building or facility is located (crash density function), and finally (4) the effective area of the building or facility. This expression is given as:

$$F = \sum_{ijk} N_{ijk} * P_{ijk} * f(x,y)_{ijk} * A_j \qquad (1.1)$$

where:

- F = estimated total annual aircraft crash impact frequency for the facility of interest (no./year);
- $\sum_{ijk}$ = site-specific summation over each applicable flight phase, "I", aircraft category or subcategory, "J", and flight source, "k";
- N_{ijk} = annual number of estimated site-specific aircraft operations near or affecting the building or facility for each applicable summation parameter (no./year);
- P_{ijk} = generic aircraft crash probability during landing, takeoff, and enroute phases for each applicable category/subcategory and flight source;
- $f(x,y)_{ijk}$ = generic aircraft crash location probability density function (pdf) evaluated at the facility location for each applicable summation parameter;
- AF = the site-specific effective target area for facility of interest that includes both the skid and structural areas.

Tables 1.1 correlates the data needed for the factors of the four-factor formula with the data tables of this document. While guidance is given as to the general location of needed data both in this document and in the Modeling Technical Support Document [Ref. 1.15], the analyst is cautioned that interpretation and understanding of the data is required in order to assure that the correct data is being used for the correct purposes.

TABLE 1.1

FREQUENCY SCREENING ANALYSIS,
NEAR AIRPORT ENVIRONMENT

CATEGORIES	N, Operations	P, Aircraft Crash Probability/Flight	f(x,y), Aircraft Crash Location Distribution	AF, Facility Effective Target Area
Air Carrier (AC)	N_{ACk} Airport Specific Section 1.3	$P_{AC, TO}$ $P_{AC, L}$ Section 2.2, Table 2.8	$f(x,y)_{Com., TOk}$ $f(x,y)_{Com., Lk}$ Runway Specific Section 2.3, Tables 2.10, 2.11	AF_{AC} Facility Specific $LSK_{Com.}$ Section 2.3, Table 2.12
Air Taxi (AT)	N_{ATk} Airport Specific Section 1.3	$P_{AT, TO}$ $P_{AT, L}$ Section 2.2, Table 2.9	$f(x,y)_{Com., TOk}$ $f(x,y)_{Com., Lk}$ Runway Specific Section 2.3, Tables 2.10, 2.11	AF_{AT} Facility Specific $LSK_{Com.}$ Section 2.3, Table 2.12
General Aviation (GA)	N_{GAk} Airport Specific Section 1.3	$P_{GA, TO}$ $P_{GA, L}$ Section 3.4, Table 3.37	$f(x,y)_{GA, TOk}$ $f(x.y)_{GA, Lk}$ Runway Specific Section 3.6, Tables 3.45, 3.46	AF_{GA} Facility Specific LSK_{GA} Section 3.6, Figure 3.1
Military Aviation (MA)	N_{MAk} Airport Specific Section 1.3	$P_{MA, TO}$ $P_{MA, L}$ Section 4.2, Table 4.7	$f(x.y)_{MA, TOk}$ $f(x,y)_{MA, Lk}$ Runway Specific Section 4.3, Tables 4.9 - 4.12	AF_{MA} Facility Specific LSK_{MA} Section 4.3, Table 4.20

Notes:
TO = Takeoff
L = Landing
Com. = Commercial Aviation = Air Carriers (ACs) and Air Taxis (ATs)
Each parameter with the subscript "k" must be determined specifically for that site with respect to the kth airport.

1.3 REFERENCES

[1.1] DOE Standard Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE-STD-3014-96, U.S. Department of Energy, Washington, DC, July 1996.

[1.2] "Definitions and Abbreviations", Title 14 Aeronautics and Space, Code of Federal Regulations, Part 1 (14 CFR 1), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.3] "Designation of Class A, Class B, Class C, Class D, and Class E Airspace Areas; Airways; Routes; and Reporting Points, ", Title 14 Aeronautics and Space, Code of Federal Regulations, Subchapter E-Airspace, Part 71 (14 CFR 71),), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.4] "Air Traffic and General Operating and Flight Rules", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 91 (14 CFR 91), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.5] "Ultralight Vehicles", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 103 (14 CFR 103), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.6] "Parachute Jumping", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 105 (14 CFR 105), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.7] "Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 121 (14 CFR 121), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.8] "Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload of 6,000 Pounds or More", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 125 (14 CFR 125), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.9] "Certification and Operations of Scheduled Air Carriers with Helicopters", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 127 (14 CFR 127), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.10] "Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-

Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 129 (14 CFR 129), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.11] "Rotorcraft External-Load Operations", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 133 (14 CFR 133), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.12] "Air Taxi Operators and Commercial Operators", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 135 (14 CFR 135), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.13] "Agricultural Aircraft Operations", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 137 (14 CFR 137), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[1.14] "Notification Reporting of Aircraft Accidents or Incidents and Overdue Aircraft, and Preservation of Aircraft Wreckage, Mail, Cargo, and Records", Title 49 Transportation, Chapter VIII-National Transportation Safety Board, Part 830 (49 CFR 830), U.S. National Archives and Record Administration, Washington, DC, October 1, 1995.

[1.15] ACRAM Modeling Technical Support Document, LA-UR-96-2460/TSA-11-95-R12, C. Bolig, D. Sanzo, D. Stack, R. Mensing, and R. Glaser, Los Alamos National Laboratory, Los Alamos, NM, July 1996.

2. COMMERCIAL AVIATION

2.1 INTRODUCTION

Commercial aviation is the broad categorization of aviation activities which are performed for commercial purposes. Such activities include passengers flights performed by scheduled airlines, cargo flights by freight airlines, charter flights by nonscheduled airlines, etc. Because of the evolutionary development of aviation, and the related evolutionary development of the Federal aviation regulations, several classification schemes are currently in existence for classifying commercial aviation activities.

The Federal Aviation Administration (FAA) tabulates operations data for U.S. Air Carriers according to the economic classification under which the operator of the aircraft is classified. Under this classification arrangement, U.S. Air Carriers includes Certificated Air Carriers, Supplemental Air Carriers, Commercial Operators of Large Aircraft, and Air Taxis (including commuters) [Ref. 2.1]. This classification arrangement can usually be correlated with the flights conducted under 14 CFR 121 [Ref. 2.1], and 14 CFR 135 [Ref. 2.2], respectively. The definition of these terms will be expanded in Section 2.2 for 14 CFR 121 Air Carriers, and in Section 2.3 for 14 CFR 135 Air Carriers.

Air Traffic Controllers use another classification scheme in tabulating their data on airport operations. As discussed in Ref. 2.3 and from discussions with the FAA staff which compiles the data on airport traffic activity, air carriers are defined as aircraft in general commercial service capable of carrying 70 or more passengers, regardless of whether that particular flight is being flown under 14 CFR 121 or 14 CFR 91 rules [Ref. 2.4]. All other aircraft in general commercial service that carry less than 70 passengers are classified as air taxies. However, since many air taxis operate small single-engine aircraft, air controllers often count these flights as general aviation flights unless the flight is identified by a flight plan or a commercial livery is carried by the aircraft.

To estimate an accident rate, one must obtain the number of accidents that occurred during the performance of some number of operational measures. The National Transportation Safety Board (NTSB) defines an aircraft accident as an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, and in which any person suffers a fatal or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, or in which the aircraft receives substantial damage. Operational measures could be defined in terms of number of departures or flights, number of aircraft hours flown, or the distance the aircrafts have flown (in terms of miles, nautical miles, kilometers, etc.).

The National Transportation Safety Board (NTSB) tabulates accident data for U.S. Air Carriers according to the regulations under which the flight was conducted. Under this classification arrangement, U.S. Air Carriers include flights conducted under 14 CFR 121 [Ref. 2.1], and 135 [Ref. 2.2].

For the ACRAM standard, the aircraft accidents of interest are those accidents which result in the destruction or substantial (major) damage to the aircraft. The reasoning behind this is that unless the aircraft suffered destruction or major damage, then the impact forces imposed on the aircraft were probably not very substantial, and therefore, the impact forces imposed on anything that aircraft hit, such as a building, would not be very substantial. For commercial aviation, i.e. air carriers and air taxis, a substantial portion of the accidents involve fatal or serious injuries but minor or no damage to the aircraft. Examples of such accidents include ground accidents involving ramp personnel, or severe air turbulence accidents involving passengers or crew members. Therefore, for the ACRAM standard, it is necessary to define commercial aircraft crashes differently from commercial aircraft accidents. More formally, a commercial aircraft crash is defined as any aircraft accident involving an aircraft type generally used for commercial service during flight operations (defined as the beginning of takeoff roll to landing touchdown) which results in the destruction or substantial damage to the aircraft. Fatal or serious injury sustained as a result of the accident itself, without related destruction or substantial damage to the aircraft is not a criterion for consideration as a commercial aircraft crash. Based on this definition for commercial aircraft crashes, a crash rate for air carriers and air taxis can be calculated based on the number of aircraft destroyed or substantially damaged per operational measure.

For the ACRAM Standard [Ref. 2.5], commercial aviation will be considered to consist of two categories of aviation: 1) Air Carriers and 2) Air Taxis. Air Carriers and Air Taxis will be defined in accordance with the general practice used by air traffic controllers in classifying Air Carrier and Air Taxis operations.

The development of commercial aviation data for the ACRAM Standard is discussed in the following sections: 2.2 Air Carrier (14 CFR 121) Accident and Crash Rates, 2.3 Air Taxi (14 CFR 135) Accident and Crash Rates, 2.4 Commercial Aviation Crash Parameter Distributions, 2.5 Commercial Aviation Aircraft Characteristics, and 2.6 References.

2.2 AIR CARRIER (14 CFR 121) ACCIDENT AND CRASH RATES

A Certificated Air Carrier is defined as an Air Carrier holding a Certificate of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT) to conduct scheduled services interstate. Nonscheduled or charter operations may also be conducted by these carriers. These carriers operate large aircraft (30 seats or more or a maximum payload of 7,500 pounds or more) in accordance with 14 CFR 121 [Ref. 2.1].

A Commercial Operator of Large Aircraft is defined as a Commercial Operator operating aircraft with 30 seats or more or a maximum payload capacity of 7,500 pounds or more [Ref. 2.1].

A Supplemental Air Carrier or a charter Air Carrier is defined as an Air Carrier which holds Certificates of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT), authorizing performance of passenger and cargo interstate charter services supplementing the scheduled service of the Certificated Air Carriers. The authority of Supplemental Air Carriers to engage in military charters is of an indefinite period. In addition, they can perform on an emergency basis, as may be authorized by the DOT, scheduled operations including the transportation of individually ticketed passengers and individually waybilled cargo [Ref. 2.1]

The NTSB has been granted the authority to investigate all aviation accidents that occur in the United States except for those involving military aircraft only and for certain public-use aircraft only. In addition, the NTSB investigates other accidents as requested, e.g. U.S. air carrier accidents in foreign airspace, foreign air carriers in foreign airspace involving U.S. built aircraft and involving special circumstances, etc. The NTSB tabulates accident data annually for U.S. Air Carriers according to the regulations or part under which the flight was conducted, i.e. 14 CFR 121 [Ref. 2.1] , and 14 CFR 135 [Ref. 2.2]. Flights conducted 14 CFR 121 involved aircraft capable of carrying 30 or more passengers or a maximum payload of 7,500 pounds or more. Tables 2.1 to 2.3 taken from the NTSB Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations [Ref. 2.6 to 2.26] and the NTSB News Annual Press Release on U.S. Airline Accidents [Ref. 2.27 and 2.28] presents the following information for the years 1973 to 1995:

1. The number of fatal accidents,
2. The total number of accidents,
3. The number of passenger fatalities aboard the aircraft flying under that part,
4. The number of crew fatalities aboard the aircraft flying under that part,
5. Other fatalities associated with the accident including ground fatalities and fatalities aboard aircraft involved in the accident but not flying under that part, i.e. collisions,
6. The total number of fatalities,
7. The number of aircraft flying under that part involved in the accidents that were destroyed,
8. The number of aircraft flying under that part involved in the accidents that were substantially (major) damaged,
9. The number of aircraft flying under that part involved in the accidents that suffered minor or no damage,
10. The total number of aircraft flying under that part involved in the accidents,
11. The number of aircraft hours flown by aircraft flying under that part,
12. The number of aircraft miles by thousands flown by aircraft flying under that part,
13. The number of aircraft departures performed by aircraft flying under that part,
14. The average speed of aircraft flying under that part, calculated by dividing the number of aircraft miles flown by the number of aircraft hours flown,
15. The average number of aircraft miles flown by aircraft flying under that part per flight or departure, calculated by dividing the number of aircraft miles flown by the number of departures,
16. The average amount of time flown by aircraft flying under that part per flight or departure, calculated by dividing the number of aircraft hours flown by the number of departures,
17. The fatal accident rate per aircraft hour, aircraft mile, and departure, determined by dividing the number of fatal accidents by the number of aircraft hours, aircraft miles, and departures, respectively,

18. The total accident rate per aircraft hour, aircraft mile, and departure, determined by dividing the total number of accidents by the number of aircraft hours, aircraft miles, and departures, respectively.
19. The crash rate per aircraft hour, aircraft mile, and departure, determined by dividing the number of crashes (defined as aircraft flying under that part involved in the accident that were destroyed or substantially damaged) by the number of aircraft hours, aircraft miles, and departures, respectively.

The total, average, and standard deviation for each of the above categories of information were calculated for those years in which information was available, except for the calculated average speed, distance and time per departure (14. to 16.) and calculated fatal accident, total accident and crash rates (17. to 19.) which had only the average and standard deviation calculated. Table 2.1 presents data for the scheduled U.S. air carriers operating under 14 CFR 121. Table 2.2 presents data for the nonscheduled or charter U.S. air carriers operating under 14 CFR 121. Table 2.3 presents data for total U.S. air carriers operating under 14 CFR 121 and is the sum of Tables 2.1 and 2.2.

While Tables 2.1 to 2.3 were taken from NTSB documents [Refs. 2.6 to 2.28], only the accident data and the aircraft damage data were compiled by the NTSB. All operations data are tabulated by the F.A.A. It should be emphasized that all of the accidents, aircrafts involvement, and operations given in Tables 2.1 to 2.3 were tabulated on the basis of the part or regulation under which the flight was conducted and that the accident and crash rates are calculated on a consistent basis.

Because the data of Tables 2.1 to 2.3 were tabulated on the basis of the part or regulation under which the flight was conducted, certain caveats should be associated with these tables when used in conjunction with the ACRAM standard. As the final result desired by the frequency analysis of the ACRAM standard is the aircraft crash frequency into the facility, the analysis should be based on the total number of aircraft operations near the facility, regardless of the part or regulations under which the flight is conducted. This is exactly how air traffic controllers tabulate aircraft operations near airports and is consistent with the requirements of the ACRAM Standard [Ref. 2.5]. The crash rate needed by the crash frequency analysis however, is determined by the part under which the flight is conducted which is inconsistent with the requirements of the ACRAM Standard. The result of using crash rate based solely on the part or regulation under which the flight is conducted is that other flights such as repositioning flights and training flights, flown by the same aircraft are conducted under Part 91 rules and are not counted in the NTSB tables. The resultant error introduced by this inconsistency is probably not large, but it is there nevertheless.

Another caveat associated with Tables 2.1 to 2.3 is that accidents by foreign air carriers in U.S. airspace are not included. This is because foreign air carriers conduct their flights in U.S. airspace under 14 CFR Part 129 rules [Ref. 2.29]. As the foreign air carrier operations in U.S. airspace are also not counted in Tables 2.1 to 2.3, no error is introduced. However, for the ACRAM Standard [Ref. 2.5], an aircraft crash is equally damaging to a facility whether by a U.S. air carrier or foreign air carrier. This factor is compensated to some degree by the fact that accidents by U.S. air carriers in foreign airspace are counted by the NTSB and the operations by U.S. air carriers in foreign airspace are included. Again, this is because these flights are conducted under Part 121 rules even while in foreign airspace. Whether these two factors are comparable and therefore one can consider them to cancel each other out is unknown at this time.

The solution to this dilemma posed by these caveats would be to determine the crash rate regardless of the part or regulation under which that the flight is conducted. This would required determining the number of U.S. and foreign air carrier accidents and operations which occurred in U.S. airspace only, under all flight rules. It would be possible to develop this information but this would require additional research.

Accident data compiled by the NTSB and operations data compiled by the FAA prior to 1980 were gathered on the basis of the economic classification of the air carrier, i.e. certificated route air carriers, supplemental air carriers, commercial operators of large aircraft, and all cargo air service. Flights performed by these air carriers were further broken down into scheduled and nonscheduled service, domestic and international service, passenger and other operations. The change in the way the NTSB

and the FAA compiled their accident and operation data was due to the deregulation of the U.S. airline industry in 1978. One of the result of the deregulation of the U.S. airline industry in 1978 was that many of the economic classifications were now obsolete and that classificatiion of operations and accidents under the previous classification system was no longer desired. This is the main reason for the changeover in 1980 by the NTSB and FAA to gather accident and operations data on the basis of the economic classification of the air carriers to flight rules under which the flight was conducted. The result of this changeover is that accident and operations data compiled prior to 1980 may be inconsistent with accident and operations data compiled after 1980. Certain assumptions must be made regarding accident and operations data compiled before 1980 if this data is included with accident and operations data compiled after 1980. One of these assumptions is that the operations of U.S. Air Carriers operating on scheduled certificated route operations are comparable to the Scheduled U.S. Air Carriers operated under 14 CFR 121 for the 1973-1979 time period. Another assumption is that the operations of U.S. Air Carriers operating on nonscheduled certificated route operations are comparable to the Nonscheduled U.S. Air Carriers operated under 14 CFR 121 for the 1973-1979 time period.

In order to calculate an accident and crash rate that is reasonably conservative and yet incorporates recent data, it is necessary to include data over a reasonably long period of time that is complete and current. For U.S. air carriers operating under 14 CFR 121, the years 1973 to 1994 were selected. This enabled the accident and crash rates for 121 air carriers to be determined for a 22 year periods.

The accident and crash rates given by Tables 2.1 to 2.3 for 121 air carriers represent the accident and crash rates over the entire flight. As experience and numerous past studies on commercial aviation safety has shown, accidents do not occur with equal probability during the course of the flight. Certain flight phases, e.g. landing and takeoff, experience significantly higher number of accidents and crashes. To determine accident and crash rates by flight phase, it is necessary to determine the number of accidents and crashes that occur in each flight phase.

Table 2.4 presents the total number of aircraft flying under 14 CFR 121 regulations involved in accidents by flight phase for the 1973-1994 time period. From the number of 14 CFR 121 aircraft involved in accidents given by Table 2.4, and assuming 1.4 hour average flight duration, 570 miles average distance flown per flight, and 407 miles/hour average velocity for each flight, for the 140,872,105 departures (flights) flown by all U.S. Air Carriers (scheduled and nonscheduled) for 1973 to 1994, the accident rates by flight phases are determined in Table 2.5. The adjusted number of accidents by flight phase in Table 2.5 (the 4th column from the left) are the number of accidents minus the accidents which occurred in the taxi, ground accident, and unknown flight phases. The adjusted percentage by flight phase in Table 2.5 (the 5th column from the left is the adjusted number of accidents for that flight phase divided by the total adjusted number of accidents. The ACRAM Standard [Ref. 2.5] defines three flight phases, takeoff, landing and in-flight or enroute. Takeoff is defined as encompassing the actual takeoff roll and the initial climb phase. Landing is defined as including the landing approach, and the actual landing roll. Enroute or in-flight is defined as including the climb to cruise, cruise or enroute, and the descent from cruise flight phases. To meet the needs of the ACRAM Standard, crash rates for the flight phases used by the ACRAM Standard must be determined. This is also done by combining the accidents occurring in the takeoff and initial climb phases into the ACRAM takeoff accident rate. The ACRAM in-flight accident rate was determined by combining the accidentss occurring during the climb to cruise, cruise/enroute, and descent from cruise flight phases. The ACRAM landing accident rate was determined by combining the accidents occurring during the landing approach and landing flight phases.

Table 2.6 presents the number of aircraft flying under 14 CFR 121 regulations involved in crashes (accidents resulting in destruction or major damage to the airframe) by flight phase for the 1973-1994 time period. The crash rates of Table 2.7 are calculated from the number of crashes determined in Table 2.6 by the procedure used in Table 2.5. Similar operations assumptions are also used in the calculation. Crash rates by ACRAM defined flight phases are determined in the last four columns of Table 2.7.

Table 2.8 presents the number of aircraft flying under 14 CFR 121 regulations involved in crashes which resulted in destruction or such major damage to the airframe that the aircraft is written off (major-w.o.) by flight phase for the 1973-1994 time period. The crash rates of Table 2.9 are calulated from the number of crashes determined in Table 2.8 by the procedure used in Table 2.5. Similar operations assumptions are

also used in the calculation. Crash rates by ACRAM defined flight phases are also determined in the last four columns of Table. 2.9.

Among the primary assumptions used by the ACRAM Standard [Ref. 2.5] is that the facility under consideration is located far enough from the airport that only aircraft impacts (crashes) located off the runway need be considered. Unfortunately, the information available on 14 CFR 121 Air Carrier accidents in many instances allows only the identification of whether the accident occurred on or off the airport. In most cases, the accident which occurs on the airport also occurs on the runway. For these reasons, a sort was performed on the 14 CFR 121 Air Carrier accidents to screen those events which occurred on the airport.

Table 2.10 presents the total number of aircraft flying under 14 CFR 121 regulations involved in accidents which occurred off the airport by flight phase for the 1973-1994 time period. The accident rates of Table 2.11 are calculated from the number of accidents determined in Table 2.10 by the procedure used in Table 2.5. Similar operations assumptions are also used in the calculation. Crash rates by ACRAM defined flight phases are determined in the last four columns of Table 2.11.

Table 2.12 presents the number of aircraft flying under 14 CFR 121 regulations involved in crashes (accidents resulting in destruction or major damage to the airframe) which occurred off the airport by flight phase for the 1973-1994 time period. The accident rates of Table 2.13 are calculated from the number of crashes determined in Table 2.12 by the procedure used in Table 2.5. Similar operations assumptions are also used in the calculation. Crash rates by ACRAM defined flight phases are determined in the last four columns of Table 2.13.

Table 2.14 presents the number of aircraft flying under 14 CFR 121 regulations involved in crashes which result in destruction or such major damage to the airframe that the aircraft is written off (major-w.o.) which occurred off the airport by flight phase for the 1973-1994 time period. The accident rates of Table 2.15 are calculated from the number of crashes determined in Table 2.14 by the procedure used in Table 2.5. Similar operations assumptions are also used in the calculation. Crash rates by ACRAM defined flight phases are determined in the last four columns of Table 2.15.

Finally, Table 2.16 presents a comparison of the total number of aircraft flying under 14 CFR 121 regulations involved in accidents/crashes with the number of aircraft flying under 14 CFR 121 regulations involved in off airport accidents/crashes. Note that for the taxi, takeoff, landing, and ground flight phases, the number of 14 CFR 121 aircraft involved in off airport accidents/crashes are, be definition, zero.

Table 2.1
Scheduled U.S. Air Carriers Operating Under 14 CFR 121
[References 2.6 to 2.28]

Year	Fatal Acc.	Fatalities 121 Pass.	Fatalities 121 Crew	Fatalities Other	Fatalities Total	Total Acc.	121 Aircraft Damage Dest.	Damage Major	Damage Minor/ None/ Unkn.	Damage Total	121 Aircraft Hours Flown	121 Aircraft Miles (000)	121 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/ Departure	Average AC Hours/ Departure	Fatal Accident Rate (/AC hour)	Fatal Accident Rate (/AC mile)	Fatal Accident Rate (/Departure)	Total Accident Rate (/AC hour)	Total Accident Rate (/AC mile)	Total Accident Rate (/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	Crash (Dest. + Major Dam.) Rate (/AC mile)	Crash (Dest. + Major Dam.) Rate (/Departure)
1972																									
1973	8	198	23	1	222	35	7	10	18	35	5,898,575	2,448,114	5,133,816	415.03	476.86	1.15	1.36E-06	3.27E-09	1.58E-06	5.93E-06	1.43E-08	6.82E-06	2.88E-06	6.94E-09	3.31E-06
1974	6	418	39	0	457	39	6	4	30	40	5,474,495	2,258,136	4,725,783	412.48	477.83	1.16	1.10E-06	2.66E-09	1.27E-06	7.12E-06	1.73E-08	8.25E-06	1.83E-06	4.43E-09	2.12E-06
1975	2	116	9	0	125	31	6	10	15	31	5,422,665	2,240,505	4,704,052	413.17	476.29	1.15	3.69E-07	8.93E-10	4.25E-07	5.72E-06	1.38E-08	6.59E-06	2.95E-06	7.14E-09	3.40E-06
1976	2	36	2	0	38	22	4	6	12	22	5,587,601	2,319,967	4,835,138	415.20	479.81	1.16	3.58E-07	8.62E-10	4.14E-07	3.94E-06	9.48E-09	4.55E-06	1.79E-06	4.31E-09	2.07E-06
1977	3	65	5	9	79	19	2	5	12	22	5,800,843	2,418,652	4,934,094	416.95	490.19	1.18	5.17E-07	1.24E-09	6.08E-07	3.28E-06	7.86E-09	3.85E-06	1.72E-06	4.13E-09	2.03E-06
1978	5	141	11	14	166	20	6	2	12	20	6,031,743	2,520,165	5,015,939	417.82	502.43	1.20	8.29E-07	1.98E-09	9.97E-07	3.32E-06	7.94E-09	3.99E-06	1.33E-06	3.17E-09	1.59E-06
1979	4	323	25	3	351	23	4	11	9	24	6,713,094	2,791,120	5,399,652	415.77	516.91	1.24	5.96E-07	1.43E-09	7.41E-07	3.43E-06	8.24E-09	4.26E-06	2.23E-06	5.37E-09	2.78E-06
1980	0	0	0	0	0	15	4	4	7	15	7,069,000	2,929,000	5,567,000	414.34	526.14	1.27	0.00E+00	0.00E+00	0.00E+00	2.12E-06	5.12E-09	2.69E-06	1.13E-06	2.73E-09	1.44E-06
1981	4	1	1	2	4	25	1	11	13	25	6,834,000	2,811,000	5,420,000	411.33	518.63	1.26	5.85E-07	1.42E-09	7.38E-07	3.66E-06	8.89E-09	4.61E-06	1.76E-06	4.27E-09	2.21E-06
1982	3	210	11	12	233	15	3	7	5	15	6,697,770	2,808,885	5,162,346	419.38	544.11	1.30	4.48E-07	1.07E-09	5.81E-07	2.24E-06	5.34E-09	2.91E-06	1.49E-06	3.56E-09	1.94E-06
1983	4	8	6	1	15	22	4	10	8	22	6,914,969	2,920,909	5,235,262	422.40	557.93	1.32	5.78E-07	1.37E-09	7.64E-07	3.18E-06	7.53E-09	4.20E-06	2.02E-06	4.79E-09	2.67E-06
1984	1	1	3	0	4	13	2	4	7	13	7,736,037	3,258,910	5,866,076	421.26	575.16	1.37	1.29E-07	3.07E-10	1.76E-07	1.68E-06	3.99E-09	2.29E-06	7.76E-07	1.84E-09	1.06E-06
1985	4	174	22	1	197	17	6	6	5	17	8,265,332	3,452,753	6,068,893	417.74	568.93	1.36	4.84E-07	1.16E-09	6.59E-07	2.06E-06	4.92E-09	2.80E-06	1.45E-06	3.48E-09	1.98E-06
1986	1	0	1	0	1	20	2	6	12	20	9,495,158	3,829,129	6,928,103	403.27	552.70	1.37	1.05E-07	2.61E-10	1.44E-07	2.11E-06	5.22E-09	2.89E-06	8.43E-07	2.09E-09	1.15E-06
1987	4	213	17	2	232	32	5	15	15	35	10,115,407	4,125,874	7,293,025	407.88	565.73	1.39	3.95E-07	9.69E-10	5.48E-07	3.16E-06	7.76E-09	4.39E-06	1.98E-06	4.85E-09	2.74E-06
1988	3	256	18	11	285	28	7	8	13	28	10,521,052	4,260,785	7,347,575	404.98	579.89	1.43	2.85E-07	7.04E-10	4.08E-07	2.66E-06	6.57E-09	3.81E-06	1.43E-06	3.52E-09	2.04E-06
1989	8	122	8	1	131	24	7	8	9	24	10,597,922	4,337,234	7,267,341	409.25	596.81	1.46	7.55E-07	1.84E-09	1.10E-06	2.26E-06	5.53E-09	3.30E-06	1.42E-06	3.46E-09	2.06E-06
1990	5	8	5	24	37	22	4	6	13	23	11,524,726	4,711,542	7,928,357	408.82	594.26	1.45	4.34E-07	1.06E-09	6.31E-07	1.91E-06	4.67E-09	2.77E-06	8.68E-07	2.12E-09	1.26E-06
1991	4	50	11	1	62	25	5	9	12	26	11,258,579	4,584,582	7,672,367	407.21	597.54	1.47	3.55E-07	8.72E-10	5.21E-07	2.22E-06	5.45E-09	3.26E-06	1.24E-06	3.05E-09	1.82E-06
1992	4	26	5	2	33	17	4	0	13	17	11,880,929	4,815,632	7,717,408	405.32	624.00	1.54	3.37E-07	8.31E-10	5.18E-07	1.43E-06	3.53E-09	2.20E-06	3.37E-07	8.31E-10	5.18E-07
1993	1	0	0	1	1	21	1	8	13	22	12,189,525	4,966,025	7,935,743	409.04	628.30	1.54	8.20E-08	2.01E-10	1.26E-07	1.72E-06	4.21E-09	2.65E-06	7.36E-07	1.81E-09	1.13E-06
1994	4	228	11	0	239	18	3	5	10	18	12,472,810	5,102,814	8,041,799	409.12	634.54	1.55	3.21E-07	7.84E-10	4.97E-07	1.44E-06	3.53E-09	2.24E-06	6.41E-07	1.57E-09	9.95E-07
1995P	2	152	8	6	166	33	N.A.	N.A.	N.A.	N.A.	12,648,000	5,269,000	8,220,000	416.59	641.00	1.54	1.58E-07	3.80E-10	2.43E-07	2.61E-06	6.26E-09	4.01E-06	N.A.	N.A.	N.A.
1996																									
Total	82	2746	241	91	3078	536	93	158	263	514	197,150,232	81,200,713	144,219,789	411.87	563.03	1.37	4.16E-07	1.01E-09	5.69E-07	2.72E-06	6.60E-09	3.72E-06	N.A.	N.A.	N.A.
Avg.	3.57	119.39	10.48	3.96	133.83	23.30	4.23	7.18	11.95	23.36	8,571,749	3,530,466	6,270,425	412.80	553.30	1.34	4.60E-07	1.11E-09	5.94E-07	3.01E-06	7.28E-09	3.88E-06	1.49E-06	3.61E-09	1.92E-06
Std.	2.04	118.29	9.69	6.11	127.36	6.88	1.90	3.38	5.21	6.99	2,597,419	1,043,891	1,286,019	5.36	54.29	0.14	3.21E-07	7.73E-10	3.74E-07	1.49E-06	3.59E-09	1.55E-06	6.77E-07	1.63E-09	7.51E-07

P = Preliminary Data
N.A. = Information not available when table prepared.

1973-1979 Scheduled U.S. Air Carriers operated under 14 CFR 121 assumed equal to U.S. Air Carriers operating on Scheduled Certificated Route Operations.

For 1973-1994																									
Total	80	2594	233	85	2912	503	93	158	263	514	184,502,232	75,931,713	135,999,789	411.55	558.32	1.36	4.34E-07	1.05E-09	5.98E-07	2.73E-06	6.62E-09	3.70E-06	1.36E-06	3.31E-09	1.85E-06
Avg.	3.64	117.91	10.59	3.86	132.36	22.86	4.23	7.18	11.95	23.36	8,386,465	3,451,442	6,181,808	412.63	549.32	1.33	4.73E-07	1.15E-09	6.10E-07	3.03E-06	7.33E-09	3.88E-06	1.49E-06	3.61E-09	1.92E-06
Std.	2.06	120.85	9.90	6.24	130.16	6.71	1.90	3.38	5.21	6.99	2,498,130	995,555	1,242,329	5.42	52.00	0.14	3.21E-07	7.74E-10	3.74E-07	1.52E-06	3.66E-09	1.58E-06	6.77E-07	1.63E-09	7.51E-07

Table 2.2
Nonscheduled U.S. Air Carriers Operating Under 14 CFR 121
[References 2.6 to 2.28]

Year	Fatal Acc.	Fatalities 121 Pass.	Fatalities 121 Crew	Fatalities Other	Fatalities Total	Total Acc.	121 Aircraft Damage Dest.	121 Aircraft Damage Major	121 Aircraft Damage Minor/ None/ Unkn.	121 Aircraft Damage Total	121 Aircraft Hours Flown	121 Aircraft Miles (000)	121 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/ Departure	Average AC Hours/ Departure	Fatal Accident Rate (/AC hour)	Fatal Accident Rate (/AC mile)	Fatal Accident Rate (/Departure)	Total Accident Rate (/AC hour)	Total Accident Rate (/AC mile)	Total Accident Rate (/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	Crash (Dest. + Major Dam.) Rate (/AC mile)	Crash (Dest. + Major Dam.) Rate (/Departure)
1972																									
1973	1	3	3	0	6	3	1	1	1	3	231,890	107,618	84,161	464.09	1278.72	2.76	4.31E-06	9.29E-09	1.19E-05	1.29E-05	2.79E-08	3.58E-05	8.62E-06	1.86E-08	2.38E-05
1974	1	1	3	0	4	2	1	0	1	2	202,842	92,670	76,063	456.86	1218.33	2.67	4.93E-06	1.08E-08	1.31E-05	9.86E-06	2.16E-08	2.63E-05	4.93E-06	1.08E-08	1.31E-05
1975	1	0	3	0	3	8	4	2	2	8	184,794	84,126	72,132	455.24	1166.28	2.56	5.41E-06	1.19E-08	1.39E-05	4.33E-05	9.51E-08	1.11E-04	3.25E-05	7.13E-08	8.32E-05
1976	0	0	0	0	0	2	2	0	0	2	218,126	99,192	87,363	454.75	1135.40	2.50	0.00E+00	0.00E+00	0.00E+00	9.17E-06	2.02E-08	2.29E-05	9.17E-06	2.02E-08	2.29E-05
1977	2	560	26	0	586	5	3	1	2	6	240,849	106,451	108,446	441.98	981.60	2.22	8.30E-06	1.88E-08	1.84E-05	2.08E-05	4.70E-08	4.61E-05	1.66E-05	3.76E-08	3.69E-05
1978	0	0	0	0	0	2	0	2	0	2	202,883	88,197	96,351	434.72	915.37	2.11	0.00E+00	0.00E+00	0.00E+00	9.86E-06	2.27E-08	2.08E-05	9.86E-06	2.27E-08	2.08E-05
1979	1	0	3	0	3	6	3	3	0	6	165,817	68,018	86,311	410.20	788.06	1.92	6.03E-06	1.47E-08	1.16E-05	3.62E-05	8.82E-08	6.95E-05	3.62E-05	8.82E-08	6.95E-05
1980	1	0	0	1	1	4	0	3	1	4	310,000	115,000	162,000	370.97	709.88	1.91	3.23E-06	8.70E-09	6.17E-06	1.29E-05	3.48E-08	2.47E-05	9.68E-06	2.61E-08	1.85E-05
1981	0	0	0	0	0	1	0	1	0	1	292,000	109,000	155,000	373.29	703.23	1.88	0.00E+00	0.00E+00	0.00E+00	3.42E-06	9.17E-09	6.45E-06	3.42E-06	9.17E-09	6.45E-06
1982	1	0	1	0	1	4	0	3	1	4	342,555	131,628	188,787	384.25	697.23	1.81	2.92E-06	7.60E-09	5.30E-06	1.17E-05	3.04E-08	2.12E-05	8.76E-06	2.28E-08	1.59E-05
1983	0	0	0	0	0	2	0	1	1	2	383,830	148,409	209,112	386.85	709.71	1.84	0.00E+00	0.00E+00	0.00E+00	5.21E-06	1.35E-08	9.56E-06	2.61E-06	6.74E-09	4.78E-06
1984	0	0	0	0	0	4	1	3	0	4	429,087	169,153	232,776	394.22	726.68	1.84	0.00E+00	0.00E+00	0.00E+00	9.32E-06	2.36E-08	1.72E-05	9.32E-06	2.36E-08	1.72E-05
1985	3	312	17	0	329	5	5	0	0	5	444,562	176,264	237,866	400.99	749.43	1.87	6.75E-06	1.68E-08	1.26E-05	1.12E-05	2.80E-08	2.10E-05	1.12E-05	2.80E-08	2.10E-05
1986	1	0	3	0	3	3	1	0	2	3	480,948	188,497	273,924	391.93	688.14	1.76	2.08E-06	5.31E-09	3.65E-06	6.24E-06	1.59E-08	1.10E-05	2.08E-06	5.31E-09	3.65E-06
1987	1	1	0	0	1	4	1	2	1	4	529,785	234,647	308,348	442.91	760.98	1.72	1.89E-06	4.26E-09	3.24E-06	7.55E-06	1.70E-08	1.30E-05	5.66E-06	1.28E-08	9.73E-06
1988	0	0	0	0	0	1	0	0	1	1	619,621	242,641	368,486	391.60	658.48	1.68	0.00E+00	0.00E+00	0.00E+00	1.61E-06	4.12E-09	2.71E-06	0.00E+00	0.00E+00	0.00E+00
1989	3	137	9	1	147	4	2	1	1	4	676,621	267,849	378,153	395.86	708.31	1.79	4.43E-06	1.12E-08	7.93E-06	5.91E-06	1.49E-08	1.06E-05	4.43E-06	1.12E-08	7.93E-06
1990	0	0	0	0	0	2	1	0	1	2	625,390	258,545	296,545	413.41	871.86	2.11	0.00E+00	0.00E+00	0.00E+00	3.20E-06	7.74E-09	6.74E-06	1.60E-06	3.87E-09	3.37E-06
1991	0	0	0	0	0	1	0	1	0	1	641,444	266,287	313,263	415.14	850.04	2.05	0.00E+00	0.00E+00	0.00E+00	1.56E-06	3.76E-09	3.19E-06	1.56E-06	3.76E-09	3.19E-06
1992	0	0	0	0	0	2	0	2	0	2	627,689	272,091	366,645	433.48	742.11	1.71	0.00E+00	0.00E+00	0.00E+00	3.19E-06	7.35E-09	5.45E-06	3.19E-06	7.35E-09	5.45E-06
1993	0	0	0	0	0	0	0	0	0	0	723,966	313,402	352,503	432.90	889.08	2.05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	0	0	0	0	0	4	0	2	2	4	833,675	366,618	418,101	439.76	876.86	1.99	0.00E+00	0.00E+00	0.00E+00	4.80E-06	1.09E-08	9.57E-06	2.40E-06	5.46E-09	4.78E-06
1995P	1	0	2	0	2	2	N.A.	N.A.	N.A.	N.A.	861,000	392,100	447,000	455.40	877.18	1.93	1.16E-06	2.55E-09	2.24E-06	2.32E-06	5.10E-09	4.47E-06	N.A.	N.A.	N.A.
1996																									
Total	17	1014	70	2	1086	71	25	28	17	70	10,269,372	4,300,403	5,319,336	418.76	808.45	1.93	1.66E-06	3.95E-09	3.20E-06	6.91E-06	1.65E-08	1.33E-05	N.A.	N.A.	N.A.
Avg.	0.74	44.09	3.04	0.09	47.22	3.09	1.14	1.27	0.77	3.18	446,494	186,974	231,275	419.16	856.65	2.03	2.24E-06	5.30E-09	4.79E-06	1.01E-05	2.39E-08	2.17E-05	8.35E-06	1.98E-08	1.78E-05
Std.	0.92	132.29	6.34	0.29	138.51	1.86	1.46	1.12	0.75	1.94	219,154	95,578	122,963	29.61	183.51	0.31	2.66E-06	6.26E-09	5.92E-06	1.06E-05	2.42E-08	2.51E-05	9.42E-06	2.20E-08	2.12E-05

P = Preliminary Data

N.A. = Information not available when table prepared.

1973-1979 Nonscheduled U.S. Air Carriers operated under 14 CFR 121 assumed equal to U.S. Air Carriers operating on Nonscheduled Certificated Route Operations.

For 1973-1994																									
Total	16	1014	68	2	1084	69	25	28	17	70	9,408,372	3,908,303	4,872,336	415.41	802.14	1.93	1.70E-06	4.09E-09	3.28E-06	7.33E-06	1.77E-08	1.42E-05	5.63E-06	1.38E-08	1.09E-05
Avg.	0.73	46.09	3.09	0.09	49.27	3.14	1.14	1.27	0.77	3.18	427,653	177,650	221,470	417.51	855.72	2.03	2.29E-06	5.42E-09	4.90E-06	1.04E-05	2.47E-08	2.25E-05	8.35E-06	1.98E-08	1.78E-05
Std.	0.94	135.05	6.48	0.29	141.41	1.88	1.46	1.12	0.75	1.94	204,357	86,461	116,289	29.21	187.77	0.32	2.71E-06	6.38E-09	6.03E-06	1.07E-05	2.44E-08	2.54E-05	9.42E-06	2.20E-08	2.12E-05

Table 2.3
Total (Scheduled and Nonscheduled) U.S. Air Carriers Operating Under 14 CFR 121
[References 2.6 to 2.28]

Year	Fatal Acc.	Fatalities 121 Pass.	Fatalities 121 Crew	Fatalities Other	Fatalities Total	Total Acc.	121 Aircraft Damage Dest.	Damage Major	Damage Minor/None/Unkn.	Damage Total	121 Aircraft Hours Flown	121 Aircraft Miles (000)	121 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/Departure	Average AC Hours/Departure	Fatal Accident Rate (/AC hour)	Fatal Accident Rate (/AC mile)	Fatal Accident Rate (/Departure)	Total Accident Rate (/AC hour)	Total Accident Rate (/AC mile)	Total Accident Rate (/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	Crash (Dest. + Major Dam.) Rate (/AC mile)	Crash (Dest. + Major Dam.) Rate (/Departure)
1972																									
1973	9	201	26	1	228	38	8	11	19	38	6,130,465	2,555,732	5,217,977	416.89	489.79	1.17	1.47E-06	3.52E-09	1.72E-06	6.20E-06	1.49E-08	7.28E-06	3.10E-06	7.43E-09	3.64E-06
1974	7	419	42	0	461	41	7	4	31	42	5,677,337	2,350,806	4,801,846	414.07	489.56	1.18	1.23E-06	2.98E-09	1.46E-06	7.22E-06	1.74E-08	8.54E-06	1.94E-06	4.68E-09	2.29E-06
1975	3	116	12	0	128	39	10	12	17	39	5,607,459	2,324,631	4,776,184	414.56	486.71	1.17	5.35E-07	1.29E-09	6.26E-07	6.96E-06	1.68E-08	8.17E-06	3.92E-06	9.46E-09	4.61E-06
1976	2	36	2	0	38	24	6	6	12	24	5,805,727	2,419,159	4,922,501	416.68	491.45	1.18	3.44E-07	8.27E-10	4.06E-07	4.13E-06	9.92E-09	4.88E-06	2.07E-06	4.96E-09	2.44E-06
1977	5	625	31	9	665	24	5	9	14	28	6,041,692	2,525,103	5,042,540	417.95	500.76	1.20	8.28E-07	1.98E-09	9.92E-07	3.97E-06	9.50E-09	4.76E-06	2.32E-06	5.54E-09	2.78E-06
1978	5	141	11	14	166	22	6	4	12	22	6,234,626	2,608,362	5,112,290	418.37	510.21	1.22	8.02E-07	1.92E-09	9.78E-07	3.53E-06	8.43E-09	4.30E-06	1.60E-06	3.83E-09	1.96E-06
1979	5	323	28	3	354	29	7	14	9	30	6,878,911	2,859,138	5,485,963	415.64	521.17	1.25	7.27E-07	1.75E-09	9.11E-07	4.22E-06	1.01E-08	5.29E-06	3.05E-06	7.34E-09	3.83E-06
1980	1	0	0	1	1	19	4	7	8	19	7,379,000	3,044,000	5,729,000	412.52	531.33	1.29	1.36E-07	3.29E-10	1.75E-07	2.57E-06	6.24E-09	3.32E-06	1.49E-06	3.61E-09	1.92E-06
1981	4	1	1	2	4	26	1	12	13	26	7,126,000	2,920,000	5,575,000	409.77	523.77	1.28	5.61E-07	1.37E-09	7.17E-07	3.65E-06	8.90E-09	4.66E-06	1.82E-06	4.45E-09	2.33E-06
1982	4	210	12	12	234	19	3	10	6	19	7,040,325	2,940,513	5,351,133	417.67	549.51	1.32	5.68E-07	1.36E-09	7.48E-07	2.70E-06	6.46E-09	3.55E-06	1.85E-06	4.42E-09	2.43E-06
1983	4	8	6	1	15	24	4	11	9	24	7,298,799	3,069,318	5,444,374	420.52	563.76	1.34	5.48E-07	1.30E-09	7.35E-07	3.29E-06	7.82E-09	4.41E-06	2.06E-06	4.89E-09	2.76E-06
1984	1	1	3	0	4	17	3	7	7	17	8,165,124	3,428,063	5,898,852	419.84	581.14	1.38	1.22E-07	2.92E-10	1.70E-07	2.08E-06	4.96E-09	2.88E-06	1.22E-06	2.92E-09	1.70E-06
1985	7	486	39	1	526	22	11	6	5	22	8,709,894	3,631,017	6,308,759	416.88	575.73	1.38	8.04E-07	1.93E-09	1.11E-06	2.53E-06	6.06E-09	3.49E-06	1.95E-06	4.68E-09	2.70E-06
1986	2	0	4	0	4	23	3	6	14	23	9,976,104	4,017,626	7,202,027	402.72	557.85	1.39	2.00E-07	4.98E-10	2.78E-07	2.31E-06	5.72E-09	3.19E-06	9.02E-07	2.24E-09	1.25E-06
1987	5	214	17	2	233	36	6	17	16	39	10,645,192	4,360,521	7,601,373	409.62	573.65	1.40	4.70E-07	1.15E-09	6.58E-07	3.38E-06	8.26E-09	4.74E-06	2.16E-06	5.27E-09	3.03E-06
1988	3	258	18	11	285	29	7	8	14	29	11,140,673	4,503,426	7,716,061	404.23	583.64	1.44	2.69E-07	6.66E-10	3.89E-07	2.60E-06	6.44E-09	3.76E-06	1.35E-06	3.33E-09	1.94E-06
1989	11	259	17	2	278	28	9	9	10	28	11,274,543	4,605,083	7,645,494	408.45	602.33	1.47	9.76E-07	2.39E-09	1.44E-06	2.48E-06	6.08E-09	3.66E-06	1.60E-06	3.91E-09	2.35E-06
1990	5	8	5	24	37	24	5	6	14	25	12,150,116	4,970,067	8,224,902	409.06	604.27	1.48	4.12E-07	1.01E-09	6.08E-07	1.98E-06	4.83E-09	2.92E-06	9.05E-07	2.21E-09	1.34E-06
1991	4	50	11	1	62	26	5	10	12	27	11,900,023	4,850,849	7,985,630	407.63	607.45	1.49	3.36E-07	8.25E-10	5.01E-07	2.18E-06	5.36E-09	3.26E-06	1.26E-06	3.09E-09	1.88E-06
1992	4	26	5	2	33	19	4	2	13	19	12,508,618	5,087,723	8,084,053	406.74	629.35	1.55	3.20E-07	7.86E-10	4.95E-07	1.52E-06	3.73E-09	2.35E-06	4.80E-07	1.18E-09	7.42E-07
1993	1	0	0	1	1	21	1	8	13	22	12,913,491	5,299,427	8,288,248	410.38	639.39	1.56	7.74E-08	1.89E-10	1.21E-07	1.63E-06	3.96E-09	2.53E-06	6.97E-07	1.70E-09	1.09E-06
1994	4	228	11	0	239	22	3	7	12	22	13,306,485	5,469,432	8,459,900	411.04	646.51	1.57	3.01E-07	7.31E-10	4.73E-07	1.65E-06	4.02E-09	2.60E-06	7.52E-07	1.83E-09	1.18E-06
1995P	3	152	10	6	168	35	N.A.	N.A.	N.A.	N.A.	13,509,000	5,661,100	8,667,000	419.06	653.18	1.56	2.22E-07	5.30E-10	3.46E-07	2.59E-06	6.18E-09	4.04E-06	N.A.	N.A.	N.A.
1996																									
Total	99	3760	311	93	4164	607	118	186	280	584	207,419,604	85,501,116	149,539,105	412.21	571.76	1.39	4.77E-07	1.16E-09	6.62E-07	2.93E-06	7.10E-09	4.06E-06	N.A.	N.A.	N.A.
Avg.	4.30	163.48	13.52	4.04	181.04	26.39	5.36	8.45	12.73	26.55	9,018,244	3,717,440	6,501,700	413.06	561.41	1.36	5.33E-07	1.29E-09	6.98E-07	3.26E-06	7.92E-09	4.29E-06	1.75E-06	4.23E-09	2.28E-06
Std.	2.48	174.25	12.19	6.06	185.83	6.95	2.66	3.51	5.37	7.16	2,810,564	1,136,705	1,402,463	5.17	54.10	0.14	3.59E-07	8.62E-10	4.31E-07	1.60E-06	3.85E-09	1.69E-06	8.44E-07	2.02E-09	9.44E-07

P = Preliminary Data
N.A. = Information not available when table prepared.

For 1973-1994																									
Total	96	3608	301	87	3996	572	118	186	280	584	193,910,604	79,840,016	140,872,105	411.74	566.76	1.38	4.95E-07	1.20E-09	6.81E-07	2.95E-06	7.16E-09	4.06E-06	1.57E-06	3.81E-09	2.16E-06
Avg	4.36	164.00	13.68	3.95	181.64	26.00	5.36	8.45	12.73	26.55	8,814,118	3,629,092	6,403,278	412.78	557.24	1.35	5.47E-07	1.32E-09	7.14E-07	3.31E-06	8.00E-09	4.30E-06	1.75E-06	4.23E-09	2.28E-06
Std.	2.50	178.33	12.45	6.19	190.18	6.85	2.66	3.51	5.37	7.16	2,696,562	1,079,608	1,351,723	5.12	51.45	0.13	3.61E-07	8.66E-10	4.34E-07	1.63E-06	3.92E-09	1.73E-06	8.44E-07	2.02E-09	9.44E-07

Table 2.4
TOTAL 14 CFR 121 AIRCRAFT INVOLVED IN ACCIDENTS BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	3	3	3	4	6	1	2	4	5	2	1	2	0	2	8	5	4	4	8	7	2	3	79	13.5%
Takeoff (TO)	3	3	3	2	3	2	1	1	2	2	2	1	2	1	4	2	1	5	3	2	0	2	47	8.0%
Initial Climb (IC)	2	1	4	0	2	2	3	0	0	2	2	2	6	1	5	1	2	1	1	0	0	1	38	6.5%
Climb to Cruise (CC)	2	4	0	1	1	2	3	1	1	1	4	0	1	3	2	2	2	1	0	1	3	4	39	6.7%
Cruise/En Route (ER)	15	10	10	5	7	6	4	3	5	3	1	5	4	5	9	10	4	4	7	1	4	4	126	21.6%
Initial Descent (ID)	3	8	4	3	3	0	1	3	3	1	1	2	1	3	3	3	2	4	0	3	2	2	55	9.4%
Airport Approach (AA)	1	3	0	0	2	1	1	0	0	0	1	0	2	0	0	0	3	0	1	0	1	1	17	2.9%
Runway Approach (RA)	4	3	7	1	0	2	1	1	1	3	4	1	3	0	1	0	1	1	2	1	2	0	39	6.7%
Landing (L)	4	2	6	6	1	2	10	6	3	3	6	3	3	5	7	4	5	2	3	1	6	3	91	15.6%
Grd. Accident (G)	1	5	2	2	3	4	3	0	6	1	2	0	0	3	0	2	4	2	2	1	2	2	47	8.0%
Unknown (?)	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	2	0	0	6	1.0%
Total:	38	42	39	24	28	22	30	19	26	19	24	17	22	23	39	29	28	25	27	19	22	22	584	100.0%

Table 2.5
Total (Scheduled and Nonscheduled) 14 CFR 121Aircraft Involved In Accident Rate by Flight Phase

Flight Phases	No. of Accidents	Pct.	Adjusted No. of Accidents	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Accident Rate by Flight Phases Accidents /Departure	Accidents /AC Hour	Accidents /Mile	Accidents /Knot	Combined ACRAM Flight Phases Accident Rates Accidents /Departure	Accidents /AC Hour	Accidents /Mile	Accidents /Knot
Taxi	79	13.53%																
Takeoff (TO)	47	8.05%	47	10.40%	1.00%	0.014	100.00	86.90	1.40	1.22	3.336E-07	2.383E-05	2.383E-07	2.742E-07	6.034E-07	2.155E-05	1.305E-07	1.502E-07
Initial Climb (IC	38	6.51%	38	8.41%	1.00%	0.014	230.16	200.00	3.22	2.80	2.697E-07	1.927E-05	8.372E-08	9.634E-08				
Climb to Cruise (CC)	39	6.68%	39	8.63%	13.00%	0.182	356.74	310.00	64.93	56.42	2.768E-07	1.521E-06	4.264E-09	4.907E-09				
Cruise/ Enroute (ER)	126	21.58%	126	27.88%	60.00%	0.840	477.57	415.00	401.16	348.60	8.944E-07	1.065E-06	2.230E-09	2.566E-09	1.682E-06	1.292E-06	3.055E-09	3.516E-09
Initial Descent (ID)	55	9.42%	55	12.17%	10.00%	0.140	356.74	310.00	49.94	43.40	3.904E-07	2.789E-06	7.817E-09	8.996E-09				
Airport Approach (AA)	17	2.91%	17	3.76%	10.00%	0.140	247.42	215.00	34.64	30.10	1.207E-07	8.620E-07	3.484E-09	4.009E-09				
Runway Approach (RA)	39	6.68%	39	8.63%	4.00%	0.056	247.42	215.00	13.86	12.04	2.768E-07	4.944E-06	1.998E-08	2.299E-08				
Landing (L)	91	15.58%	91	20.13%	1.00%	0.014	100.00	86.90	1.40	1.22	6.460E-07	4.614E-05	4.614E-07	5.310E-07	9.228E-07	1.318E-05	6.049E-08	6.961E-08
Ground Accident (G)	47	8.05%																
Unknown (?)	6	1.03%																
TOTAL:	584	100.00%	452	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	3.209E-06	2.292E-06	5.624E-09	6.472E-09	3.209E-06	2.292E-06	5.624E-09	6.472E-09

Bases for Total 14 CFR 121 Accident Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.14 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.6
14 CFR 121 CRASHES (ACCIDENTS WITH DESTROYED OR MAJOR DAMAGE TO AIRFRAME)
BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	2	1	2	3	6	0	0	3	4	2	1	2	0	2	7	4	1	1	6	0	2	1	50	16.4%
Takeoff (TO)	2	0	3	1	2	1	1	1	2	1	2	1	2	1	2	1	1	3	3	2	0	2	34	11.2%
Initial Climb (IC)	2	0	3	0	2	1	3	0	0	2	2	2	6	1	2	1	2	1	1	0	0	1	32	10.5%
Climb to Cruise (CC)	1	1	0	0	0	0	3	0	1	0	2	0	1	0	1	1	1	1	0	0	1	0	14	4.6%
Cruise/En Route (ER)	3	2	0	1	1	1	1	1	1	0	0	2	0	0	3	4	2	0	0	1	0	0	23	7.6%
Initial Descent (ID)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.3%
Airport Approach (AA)	1	2	0	0	1	1	1	0	0	0	1	0	2	0	0	0	3	0	1	0	0	0	13	4.3%
Runway Approach (RA)	4	2	7	1	0	2	1	1	1	3	2	1	3	0	1	0	1	1	2	1	1	1	36	11.8%
Landing (L)	4	2	6	6	1	2	9	5	3	3	5	2	3	5	7	4	5	2	2	1	5	3	85	28.0%
Grd. Accident (G)	0	1	1	0	1	2	1	0	1	1	0	0	0	0	0	0	2	1	0	0	0	1	12	3.9%
Unknown (?)	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	4	1.3%
Total:	19	11	22	12	14	10	21	11	13	13	15	10	17	9	23	15	18	11	15	6	9	10	304	100.0%

Table 2.7
14 CFR 121 Crash (Accidents with Destroyed or Major Damage to Airframe) Rates by Flight Phase

Flight Phases	No. of Crashes	Pct.	Adjusted No. of Crashes	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases: Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates: Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Taxi	50	16.45%																
Takeoff (TO)	34	11.18%	34	14.29%	1.00%	0.014	100.00	86.90	1.40	1.22	2.414E-07	1.724E-05	1.724E-07	1.984E-07	4.685E-07	1.673E-05	1.014E-07	1.166E-07
Initial Climb (IC	32	10.53%	32	13.45%	1.00%	0.014	230.16	200.00	3.22	2.80	2.272E-07	1.623E-05	7.050E-08	8.113E-08				
Climb to Cruise (CC)	14	4.61%	14	5.88%	13.00%	0.182	356.74	310.00	64.93	56.42	9.938E-08	5.460E-07	1.531E-09	1.761E-09				
Cruise/ Enroute (ER)	23	7.57%	23	9.66%	60.00%	0.840	477.57	415.00	401.16	348.60	1.633E-07	1.944E-07	4.070E-10	4.684E-10	3.620E-07	2.781E-07	6.574E-10	7.566E-10
Initial Descent (ID)	1	0.33%	1	0.42%	10.00%	0.140	356.74	310.00	49.94	43.40	7.099E-09	5.070E-08	1.421E-10	1.636E-10				
Airport Approach (AA)	13	4.28%	13	5.46%	10.00%	0.140	247.42	215.00	34.64	30.10	9.228E-08	6.592E-07	2.664E-09	3.066E-09				
Runway Approach (RA)	36	11.84%	36	15.13%	4.00%	0.056	247.42	215.00	13.86	12.04	2.556E-07	4.563E-06	1.844E-08	2.123E-08				
Landing (L)	85	27.96%	85	35.71%	1.00%	0.014	100.00	86.90	1.40	1.22	6.034E-07	4.310E-05	4.310E-07	4.960E-07	8.589E-07	1.227E-05	5.630E-08	6.479E-08
Ground Accident (G)	12	3.95%																
Unknown (?)	4	1.32%																
TOTAL:	304	100.00%	238	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	1.689E-06	1.207E-06	2.961E-09	3.408E-09	1.689E-06	1.207E-06	2.961E-09	3.408E-09

Bases for Total 14 CFR 121 Crash Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.14 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.8
14 CFR 121 CRASHES WITH DESTROYED/MAJOR-W.O. AIRFRAMES
BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1.7%
Takeoff (TO)	1	0	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	1	2	2	0	0	14	11.6%
Initial Climb (IC)	2	0	2	0	1	1	3	0	0	2	1	1	6	1	1	1	1	1	1	0	0	1	26	21.5%
Climb to Cruise (CC)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	5	4.1%
Cruise/En Route (ER)	0	2	0	0	1	0	0	0	0	0	0	2	0	0	2	2	2	0	0	0	0	0	11	9.1%
Initial Descent (ID)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.8%
Airport Approach (AA)	0	2	0	0	1	1	0	0	0	0	1	0	1	0	0	0	3	0	0	0	0	1	10	8.3%
Runway Approach (RA)	4	2	4	1	0	2	1	1	0	0	1	0	2	0	1	0	1	1	1	1	0	0	23	19.0%
Landing (L)	3	1	3	4	0	1	1	3	1	1	1	0	1	2	1	2	0	0	1	1	1	0	28	23.1%
Grd. Accident (G)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.8%
Unknown (?)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Total:	10	7	10	6	5	6	7	4	1	3	4	3	11	3	6	7	10	5	5	4	1	3	121	100.0%

Table 2.9
14 CFR 121 Crashes with Destroyed/Major-W.O. Airframe Rates by Flight Phase

Flight Phases	No. of Crashes	Pct.	Adjusted No. of Crashes	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Taxi	2	1.65%																
Takeoff (TO)	14	11.57%	14	11.86%	1.00%	0.014	100.00	86.90	1.40	1.22	9.938E-08	7.099E-06	7.099E-08	8.169E-08	2.839E-07	1.014E-05	6.143E-08	7.069E-08
Initial Climb (IC	26	21.49%	26	22.03%	1.00%	0.014	230.16	200.00	3.22	2.80	1.846E-07	1.318E-05	5.728E-08	6.592E-08				
Climb to Cruise (CC)	5	4.13%	5	4.24%	13.00%	0.182	356.74	310.00	64.93	56.42	3.549E-08	1.950E-07	5.467E-10	6.291E-10				
Cruise/ Enroute (ER)	11	9.09%	11	9.32%	60.00%	0.840	477.57	415.00	401.16	348.60	7.809E-08	9.296E-08	1.946E-10	2.240E-10	1.917E-07	1.472E-07	3.481E-10	4.005E-10
Initial Descent (ID)	1	0.83%	1	0.85%	10.00%	0.140	356.74	310.00	49.94	43.40	7.099E-09	5.070E-08	1.421E-10	1.636E-10				
Airport Approach (AA)	10	8.26%	10	8.47%	10.00%	0.140	247.42	215.00	34.64	30.10	7.099E-08	5.070E-07	2.049E-09	2.358E-09				
Runway Approach (RA)	23	19.01%	23	19.49%	4.00%	0.056	247.42	215.00	13.86	12.04	1.633E-07	2.916E-06	1.178E-08	1.356E-08				
Landing (L)	28	23.14%	28	23.73%	1.00%	0.014	100.00	86.90	1.40	1.22	1.988E-07	1.420E-05	1.420E-07	1.634E-07	3.620E-07	5.172E-06	2.373E-08	2.731E-08
Ground Accident (G)	1	0.83%																
Unknown (?)	0	0.00%																
TOTAL:	121	100.00%	118	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	8.376E-07	5.983E-07	1.468E-09	1.689E-09	8.376E-07	5.983E-07	1.468E-09	1.689E-09

Bases for Total 14 CFR 121 Crash Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.14 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.10
TOTAL OFF AIRPORT ONLY 14 CFR 121 ACCIDENTS BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Takeoff (TO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Initial Climb (IC)	2	0	3	0	2	1	3	0	0	2	0	0	4	0	1	0	1	1	1	0	0	1	22	8.0%
Climb to Cruise (CC)	2	4	0	1	1	2	3	1	1	1	3	0	1	1	1	1	2	1	0	1	2	4	33	12.0%
Cruise/En Route (ER)	15	10	10	5	7	6	4	3	5	3	1	4	4	5	7	10	3	3	7	1	4	4	121	43.8%
Initial Descent (ID)	3	8	3	3	3	0	1	3	3	1	1	2	1	3	3	3	2	3	0	3	2	2	53	19.2%
Airport Approach (AA)	1	3	0	0	2	1	1	0	0	0	1	0	2	0	0	0	2	0	1	0	1	1	16	5.8%
Runway Approach (RA)	2	3	4	1	0	2	1	1	0	2	3	1	1	0	1	0	1	1	2	1	1	0	28	10.1%
Landing (L)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Grd. Accident (G)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Unknown (?)	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	3	1.1%
Total:	25	28	20	10	15	12	14	8	9	9	9	8	13	9	13	14	11	9	11	7	10	12	276	100.0%

Table 2.11
Total (Scheduled and Nonscheduled) Off Airport Only 14 CFR 121 Accident Rates by Flight Phase

Flight Phases	No. of Accidents	Pct.	Adjusted No. of Accidents	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Accident Rate by Flight Phases: Accidents /Departure	Accidents /AC Hour	Accidents /Mile	Accidents /Knot	Combined ACRAM Flight Phases Accident Rates: Accidents /Departure	Accidents /AC Hour	Accidents /Mile	Accidents /Knot
Taxi	0	0.00%																
Takeoff (TO)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.562E-07	5.578E-06	3.379E-08	3.888E-08
Initial Climb (IC	22	7.97%	22	8.06%	1.00%	0.014	230.16	200.00	3.22	2.80	1.562E-07	1.116E-05	4.847E-08	5.578E-08				
Climb to Cruise (CC)	33	11.96%	33	12.09%	13.00%	0.182	356.74	310.00	64.93	56.42	2.343E-07	1.287E-06	3.608E-09	4.152E-09				
Cruise/ Enroute (ER)	121	43.84%	121	44.32%	60.00%	0.840	477.57	415.00	401.16	348.60	8.589E-07	1.023E-06	2.141E-09	2.464E-09	1.583E-06	1.216E-06	2.875E-09	3.308E-09
Initial Descent (ID)	53	19.20%	53	19.41%	10.00%	0.140	356.74	310.00	49.94	43.40	3.762E-07	2.687E-06	7.533E-09	8.669E-09				
Airport Approach (AA)	16	5.80%	16	5.86%	10.00%	0.140	247.42	215.00	34.64	30.10	1.136E-07	8.113E-07	3.279E-09	3.773E-09				
Runway Approach (RA)	28	10.14%	28	10.26%	4.00%	0.056	247.42	215.00	13.86	12.04	1.988E-07	3.549E-06	1.435E-08	1.651E-08				
Landing (L)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.988E-07	2.839E-06	1.303E-08	1.499E-08
Ground Accident (G)	0	0.00%																
Unknown (?)	3	1.09%																
TOTAL:	276	100.00%	273	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	1.938E-06	1.384E-06	3.397E-09	3.909E-09	1.938E-06	1.384E-06	3.397E-09	3.909E-09

Bases for Total 14 CFR 121 Accident Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.14 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.12
OFF AIRPORT ONLY 14 CFR 121 CRASHES (ACCIDENTS WITH DESTROYED OR MAJOR DAMAGE TO AIRFRAME), BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Takeoff (TO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Initial Climb (IC)	2	0	2	0	2	1	3	0	0	2	0	0	4	0	0	0	1	1	1	0	0	1	20	22.2%
Climb to Cruise (CC)	1	1	0	0	0	0	3	0	1	0	1	0	1	0	1	0	1	1	0	0	0	0	11	12.2%
Cruise/En Route (ER)	3	2	0	1	1	1	1	1	1	0	0	1	0	0	2	4	1	0	0	1	0	0	20	22.2%
Initial Descent (ID)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.1%
Airport Approach (AA)	1	2	0	0	1	1	1	0	0	0	1	0	2	0	0	0	2	0	1	0	0	1	13	14.4%
Runway Approach (RA)	2	2	4	1	0	2	1	1	0	2	1	1	1	0	1	0	1	1	2	1	0	0	24	26.7%
Landing (L)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Grd. Accident (G)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Unknown (?)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.1%
Total:	9	7	6	2	4	5	10	2	2	4	3	2	8	0	4	4	6	3	4	2	0	3	90	100.0%

Table 2.13
Off Airport Only 14 CFR 121 Crash (Accidents with Destroyed or Major Damage to Airframe) Rates by Flight Phase

Flight Phases	No. of Crashes	Pct.	Adjusted No. of Crashes	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Taxi	0	0.00%																
Takeoff (TO)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.420E-07	5.070E-06	3.072E-08	3.535E-08
Initial Climb (IC	20	22.22%	20	22.47%	1.00%	0.014	230.16	200.00	3.22	2.80	1.420E-07	1.014E-05	4.406E-08	5.070E-08				
Climb to Cruise (CC)	11	12.22%	11	12.36%	13.00%	0.182	356.74	310.00	64.93	56.42	7.809E-08	4.290E-07	1.203E-09	1.384E-09				
Cruise/ Enroute (ER)	20	22.22%	20	22.47%	60.00%	0.840	477.57	415.00	401.16	348.60	1.420E-07	1.690E-07	3.539E-10	4.073E-10	3.194E-07	2.453E-07	5.801E-10	6.676E-10
Initial Descent (ID)	1	1.11%	1	1.12%	10.00%	0.140	356.74	310.00	49.94	43.40	7.099E-09	5.070E-08	1.421E-10	1.636E-10				
Airport Approach (AA)	13	14.44%	13	14.61%	10.00%	0.140	247.42	215.00	34.64	30.10	9.228E-08	6.592E-07	2.664E-09	3.066E-09				
Runway Approach (RA)	24	26.67%	24	26.97%	4.00%	0.056	247.42	215.00	13.86	12.04	1.704E-07	3.042E-06	1.230E-08	1.415E-08				
Landing (L)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.704E-07	2.434E-06	1.117E-08	1.285E-08
Ground Accident (G)	0	0.00%																
Unknown (?)	1	1.11%																
TOTAL:	90	100.00%	89	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	6.318E-07	4.513E-07	1.107E-09	1.274E-09	6.318E-07	4.513E-07	1.107E-09	1.274E-09

Bases for Total 14 CFR 121 Crash Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.143 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.14
OFF AIRPORT ONLY 14 CFR 121 CRASHES WITH DESTROYED OR MAJOR-W.O. AIRFRAMES
BY FLIGHT PHASE
[Refs. 2.6 to 2.28]

FLIGHT PHASES	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Pct.
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Takeoff (TO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Initial Climb (IC)	2	0	2	0	1	1	3	0	0	2	0	0	4	0	0	0	1	1	1	0	0	1	19	30.6%
Climb to Cruise (CC)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	4	6.5%
Cruise/En Route (ER)	0	2	0	0	1	0	0	0	0	0	0	2	0	0	1	2	2	0	0	0	0	0	10	16.1%
Initial Descent (ID)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.6%
Airport Approach (AA)	0	2	0	0	1	1	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	1	9	14.5%
Runway Approach (RA)	3	2	3	1	0	2	1	1	0	0	1	0	1	0	1	0	1	0	1	1	0	0	19	30.6%
Landing (L)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Grd. Accident (G)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Unknown (?)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Total:	5	6	5	1	3	4	6	1	0	2	2	2	6	0	2	2	7	2	2	1	0	3	62	100.0%

Table 2.15
Off Airport Only 14 CFR 121 Crashes with Destroyed/Major-W.O. Airframe Rates by Flight Phase

Flight Phases	No. of Crashes	Pct.	Adjusted No. of Crashes	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Taxi	0	0.00%																
Takeoff (TO)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.349E-07	4.817E-06	2.918E-08	3.358E-08
Initial Climb (IC	19	30.65%	19	30.65%	1.00%	0.014	230.16	200.00	3.22	2.80	1.349E-07	9.634E-06	4.186E-08	4.817E-08				
Climb to Cruise (CC)	4	6.45%	4	6.45%	13.00%	0.182	356.74	310.00	64.93	56.42	2.839E-08	1.560E-07	4.373E-10	5.033E-10				
Cruise/ Enroute (ER)	10	16.13%	10	16.13%	60.00%	0.840	477.57	415.00	401.16	348.60	7.099E-08	8.451E-08	1.770E-10	2.036E-10	1.704E-07	1.309E-07	3.094E-10	3.560E-10
Initial Descent (ID)	1	1.61%	1	1.61%	10.00%	0.140	356.74	310.00	49.94	43.40	7.099E-09	5.070E-08	1.421E-10	1.636E-10				
Airport Approach (AA)	9	14.52%	9	14.52%	10.00%	0.140	247.42	215.00	34.64	30.10	6.389E-08	4.563E-07	1.844E-09	2.123E-09				
Runway Approach (RA)	19	30.65%	19	30.65%	4.00%	0.056	247.42	215.00	13.86	12.04	1.349E-07	2.408E-06	9.734E-09	1.120E-08				
Landing (L)	0	0.00%	0	0.00%	1.00%	0.014	100.00	86.90	1.40	1.22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.349E-07	1.927E-06	8.841E-09	1.017E-08
Ground Accident (G)	0	0.00%																
Unknown (?)	0	0.00%																
TOTAL:	62	100.00%	62	100.00%	100.00%	1.400	407.53	354.14	570.55	495.79	4.401E-07	3.144E-07	7.714E-10	8.877E-10	4.401E-07	3.144E-07	7.714E-10	8.877E-10

Bases for Total 14 CFR 121 Crash Rates by Flight Phase, 1973-1994 Totals:

1.4 Hours Average Flight Duration
570 Miles Average Flight Distance
407.14 Miles/Hour Average Flight Velocity
140,872,105 Departures

Table 2.16

Comparison of All 14 CFR 121 Aircraft Involved in Accidents/Crashes with 14 CFR 121 Aircraft Involved in Off Airport Accidents/Crashes

Flight Phases	Total All Accidents No. of Accidents	Total Off Airport No. of Accidents	Pct. Off Airport/ All Acc.	All Accidents Destroyed or Major Damage No. of Crashes	Off Airport Destroyed or Major Damge No. of Crashes	Pct. Off Airport/ All Acc.	All Accidents Destroyed/ Major-W.O. Airframe No. of Crashes	Off Airport Destroyed/ Major-W.O. Airframe No. of Crashes	Pct. Off Airport/ All Acc.
Taxi	79	0	0.0%	50	0	0.0%	2	0	0.0%
Takeoff (TO)	47	0	0.0%	34	0	0.0%	14	0	0.0%
Initial Climb (IC)	38	22	57.9%	32	20	62.5%	26	19	73.1%
Climb to Cruise (CC)	39	33	84.6%	14	11	78.6%	5	4	80.0%
Cruise/ Enroute (ER)	126	121	96.0%	23	20	87.0%	11	10	90.9%
Initial Descent (ID)	55	53	96.4%	1	1	100.0%	1	1	100.0%
Airport Approach (AA)	17	16	94.1%	13	13	100.0%	10	9	90.0%
Runway Approach (RA)	39	28	71.8%	36	24	66.7%	23	19	82.6%
Landing (L)	91	0	0.0%	85	0	0.0%	28	0	0.0%
Ground Accident (G)	47	0	0.0%	12	0	0.0%	1	0	0.0%
Unknown (?)	6	3	50.0%	4	1	25.0%	0	0	0.0%
TOTAL:	584	276	47.3%	304	90	29.6%	121	62	51.2%

2.3 AIR TAXI (14 CFR 135) ACCIDENT AND CRASH RATES

An Air Taxi is defined as a classification of Air Carriers which transports in accordance with 14 CFR 135 [Ref. 2.2], persons, property, and mail using small aircraft (under 30 seats or a maximum payload capacity of less than 7,500 pounds). A Commuter Air Carrier is defined as an Air Taxi operator which performs at least five round trips per week between two or more points and publishes flight schedules which specify the times, days of the week, and points between which such flights are performed.

Tables 2.16 to 2.18 taken from the NTSB Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations [Ref. 2.6 to 2.26] and the NTSB News Annual Press Release on U.S. Airline Accidents [Ref. 2.27 and 2.28] presents the following information for the years 1975 to 1995:

1. The number of fatal accidents,
2. The total number of accidents,
3. The number of passenger fatalities aboard the aircraft flying under that part,
4. The number of crew fatalities aboard the aircraft flying under that part,
5. Other fatalities associated with the accident including ground fatalities and fatalities aboard aircraft involved in the accident but not flying under that part, i.e. collisions,
6. The total number of fatalities,
7. The number of aircraft flying under that part involved in the accidents that were destroyed,
8. The number of aircraft flying under that part involved in the accidents that were substantially (major) damaged,
9. The number of aircraft flying under that part involved in the accidents that suffered minor or no damage,
10. The total number of aircraft flying under that part involved in the accidents,
11. The number of aircraft hours flown by aircraft flying under that part,
12. The number of aircraft miles by thousands flown by aircraft flying under that part,
13. The number of aircraft departures performed by aircraft flying under that part,
14. The average speed of aircraft flying under that part, calculated by dividing the number of aircraft miles flown by the number of aircraft hours flown,
15. The average number of aircraft miles flown by aircraft flying under that part per flight or departure, calculated by dividing the number of aircraft miles flown by the number of departures,
16. The average amount of time flown by aircraft flying under that part per flight or departure, calculated by dividing the number of aircraft hours flown by the number of departures,
17. The fatal accident rate per aircraft hour, aircraft mile, and departure, determined by dividing the number of fatal accidents by the number of aircraft hours, aircraft miles, and departures, respectively,
18. The total accident rate per aircraft hour, aircraft mile, and departure, determined by dividing the total number of accidents by the number of aircraft hours, aircraft miles, and departures, respectively.
19. The crash rate per aircraft hour, aircraft mile, and departure, determined by dividing the number of crashes (defined as aircraft flying under that part involved in the accident that were destroyed or substantially damaged) by the number of aircraft hours, aircraft miles, and departures, respectively.

The total, average, and standard deviation for each of the above categories of information were calculated for those years in which information was available, except for the calculated average speed, distance and time per departure (14. to 16.) and calculated fatal accident, total accident and crash rates (17. to 19.) which had only the average and standard deviation calculated. Table 2.17 presents data for the scheduled or commuter U.S. air carriers operating under 14 CFR 135. Table 2.18 presents data for the nonscheduled or air taxi U.S. air carriers operating under 14 CFR 135. Table 2.19 presents for total U.S. air carriers operating under 14 CFR 135 and is the sum of Tables 2.17 and 2.18.

While Tables 2.17 to 2.19 were taken from NTSB documents [Refs. 2.11 to 2.28], only the accident data and the aircraft damage data were compiled by the NTSB. All operations data are tabulated by the F.A.A. It should be emphasized that all of the accidents, aircraft involvment, and operations given in Tables 2.17 to 2.19 were tabulated on the basis of the part or regulation under which the flight was conducted and that

the accident and crash rates are conculated on a consistent basis.

The caveats stated for 14 CFR 121 Air Carriers in Section 2.2 generally apply to the 14 CFR 135 Air Carriers (Air Taxis), i.e., repositioning or ferry flights, and training flights are not counted as part of the operations, and operations by foreign air carriers in U.S. airspace are not counted. The errors introduced by these restrictions on the data are not known but are assumed to be small. The number of air taxi flights by foreign air carriers in U.S. airspace are expected to be particularly small because of the distances involved and the range limitation of air taxi aircraft types.

In order to calculate an accident and crash rate that is reasonably conservative and yet incorporates recent data, it is necessary to include data over a reasonably long period of time that is complete and current. For U.S. air carriers operating under 14 CFR 135, the years 1980 to 1993 were selected. This enabled the accident and crash rates for 135 air carriers to be determined for a 14 year periods.

The accident and crash rates given by Tables 2.17 to 2.19 for 135 air carriers represent the accident and crash rates over the entire flight. As experience and numerous past studies on commercial aviation safety has shown, accidents do not occur with equal probability during the course of the flight. Certain flight phases, e.g. landing and takeoff, experience significantly higher number of accidents and crashes. To determine accident and crash rates by flight phase, it is necessary to determine the number of accidents and crashes that occur in each flight phase.

Table 2.20 presents the total number of accidents involving aircraft flying under scheduled 14 CFR 135 regulations by flight phase and by aircraft damage state for the 1980 to 1993 time period except for 1981 [Refs. 2.13 to 2.26]. From the number of accidents involving Scheduled 14 CFR 135 aircraft given by Table 2.20, and assuming 0.7 hour average flight duration, 127.5 miles average distance flown per flight, and 179.5 miles/hour average velocity for each flight, for the 36,582,419 departures (flights) flown by Scheduled 14 CFR 135 Air Carriers for 1980 to 1993, the accident and crash rates are determined in Table 2.21. The ACRAM Standard [Ref. 2.5] defines three flight phases, takeoff, landing and in-flight or enroute. Takeoff is defined as encompassing the actual takeoff roll and the initial climb phase. Landing is defined as including the landing approach, and the actual landing roll. Enroute or in-flight is defined as including the climb to cruise, cruise or enroute, and the descent from cruise flight phases. To meet the needs of the ACRAM Standard, crash rates for the flight phases used by the ACRAM Standard must be determined. This is also done by combining the crashes occurring in the takeoff and initial climb phases into the ACRAM takeoff crash rate. The ACRAM in-flight crash rate was determined by combining the crashes occurring during the climb to cruise, cruise/enroute, and descent from cruise flight phases. The ACRAM landing crash rate was determined by combining the crashes occurring during the landing approach and landing flight phases.

Table 2.21 has a column (2nd from the left) which lists the calculated number of accidents. This was determined by taking the flight phase percentages determined in Table 2.20 and applying the percentages to the total number of Scheduled 14 CFR 135 accidents for the 1980-1993 time period determined from Table 2.17. This was done because the number for Scheduled 14 CFR 135 accidents by flight phase for 1981 was not available at the time Table 2.20 was prepared. It is hope that this data can be obtained and that these tables can be revised to present the actual 1981 data in the calculations.

Finally, applying the assumption used by the ACRAM Standard [Ref. 2.5] that facilities considered by the ACRAM Standard are located far enough from the airport that only aircraft impacts (crashes) located off the runway need be considered, cannot be done for 14 CFR 135 aircraft due to unavailability of that data. Therefore, the crash rates presented by Table 2.21 represent all Scheduled 14 CFR 135 accidents, both on and off the airport. A possible factor which could be applied to the crash rates of Table 2.21 is to apply the off airport/total accident percentages of 14 CFR 121 Air Carriers determined in Tables 2.16 to the

Scheduled 14 CFR 135 Air Carrier crash rates. It should be noted that there are significant differences in the type of aircrafts used in 14 CFR 121 operations versus Scheduled 14 CFR 135 operations. In addition, the type of operations performed under 14 CFR 121 differ significantly from the type of operations performed under 14 CFR 135 except for the largest Scheduled 14 CFR 135 Air Carriers flying the larger aircraft types. Another possible factor which could be applied to the crash rates of Table 2.21 is to apply the off runway/total accident percentages for General Aviation determined in Chapter 3 to the

Scheduled 14 CFR 135 Air Carrier crash rates.

Table 2.17
Scheduled U.S. Air Carriers Operating Under 14 CFR 135 (Commuters)
[References 2.11 to 2.28]

Year	Fatal Acc.	Fatalities 135 Pass.	Fatalities 135 Crew	Fatalities Other	Fatalities Total	Total Acc.	135 Aircraft Damage Dest.	135 Aircraft Damage Major	135 Aircraft Damage Minor/ None/ Unkn.	135 Aircraft Damage Total	135 Aircraft Hours Flown	135 Aircraft Miles (000)	135 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/ Departure	Average AC Hours/ Departure	Fatal Accident Rate (/AC hour)	Fatal Accident Rate (/AC mile)	Fatal Accident Rate (/Departure)	Total Accident Rate (/AC hour)	Total Accident Rate (/AC mile)	Total Accident Rate (/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	Crash (Dest. + Major Dam.) Rate (/AC mile)	Crash (Dest. + Major Dam.) Rate (/Departure)
1974																									
1975	12	N.A.	N.A.	N.A.	28	48	N.A.	N.A.	N.A.	N.A.	936,312	N.A.	N.A.	N.A.	N.A.	N.A.	1.28E-05	N.A.	N.A.	5.13E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1976	9	N.A.	N.A.	N.A.	27	35	N.A.	N.A.	N.A.	N.A.	965,296	N.A.	N.A.	N.A.	N.A.	N.A.	9.32E-06	N.A.	N.A.	3.63E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1977	9	N.A.	N.A.	N.A.	32	44	N.A.	N.A.	N.A.	N.A.	1,150,250	N.A.	N.A.	N.A.	N.A.	N.A.	7.82E-06	N.A.	N.A.	3.83E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1978	14	34	14	0	48	61	20	41	0	61	1,302,136	N.A.	N.A.	N.A.	N.A.	N.A.	1.08E-05	N.A.	N.A.	4.68E-05	N.A.	N.A.	4.68E-05	N.A.	N.A.
1979	15	50	16	0	66	52	20	32	0	52	1,169,921	192,493	1,883,705	164.54	102.19	0.62	1.28E-05	7.79E-08	7.96E-06	4.44E-05	2.70E-07	2.76E-05	4.44E-05	2.70E-07	2.76E-05
1980	8	27	10	0	37	38	9	27	3	39	1,175,588	192,200	1,776,999	163.49	108.16	0.66	6.81E-06	4.16E-08	4.50E-06	3.23E-05	1.98E-07	2.14E-05	3.06E-05	1.87E-07	2.03E-05
1981	9	21	11	2	34	31	10	20	1	31	1,240,764	193,001	1,835,144	155.55	105.17	0.68	7.25E-06	4.66E-08	4.90E-06	2.50E-05	1.61E-07	1.69E-05	2.42E-05	1.55E-07	1.63E-05
1982	5	8	6	0	14	26	8	17	2	27	1,299,748	222,355	2,026,691	171.08	109.71	0.64	3.85E-06	2.25E-08	2.47E-06	2.00E-05	1.17E-07	1.28E-05	1.92E-05	1.12E-07	1.23E-05
1983	2	9	1	1	11	17	6	9	2	17	1,510,908	253,572	2,328,430	167.83	108.90	0.65	1.32E-06	7.89E-09	8.59E-07	1.13E-05	6.70E-08	7.30E-06	9.93E-06	5.92E-08	6.44E-06
1984	7	38	8	2	48	22	7	15	0	22	1,745,782	291,460	2,676,590	166.95	108.89	0.65	4.01E-06	2.40E-08	2.62E-06	1.26E-05	7.55E-08	8.22E-06	1.26E-05	7.55E-08	8.22E-06
1985	7	28	8	1	37	21	9	12	0	21	1,737,106	300,817	2,561,463	173.17	117.44	0.68	4.03E-06	2.33E-08	2.73E-06	1.21E-05	6.98E-08	8.20E-06	1.21E-05	6.98E-08	8.20E-06
1986	2	3	1	0	4	15	1	13	2	16	1,724,586	307,393	2,798,811	178.24	109.83	0.62	1.16E-06	6.51E-09	7.15E-07	8.70E-06	4.88E-08	5.36E-06	8.12E-06	4.55E-08	5.00E-06
1987	10	42	15	2	59	33	11	18	3	32	1,946,349	350,879	2,809,918	180.28	124.87	0.69	5.14E-06	2.85E-08	3.56E-06	1.70E-05	9.40E-08	1.17E-05	1.49E-05	8.26E-08	1.03E-05
1988	2	17	4	0	21	19	3	15	1	19	2,092,689	380,237	2,909,005	181.70	130.71	0.72	9.56E-07	5.26E-09	6.88E-07	9.08E-06	5.00E-08	6.53E-06	8.60E-06	4.73E-08	6.19E-06
1989	5	25	6	0	31	19	5	13	1	19	2,240,555	393,619	2,818,520	175.68	139.65	0.79	2.23E-06	1.27E-08	1.77E-06	8.48E-06	4.83E-08	6.74E-06	8.03E-06	4.57E-08	6.38E-06
1990	4	3	1	2	6	16	2	12	1	15	2,336,952	450,067	3,159,763	192.59	142.44	0.74	1.71E-06	8.89E-09	1.27E-06	6.85E-06	3.56E-08	5.06E-06	5.99E-06	3.11E-08	4.43E-06
1991	8	64	13	22	99	22	9	13	0	22	2,171,829	381,464	2,647,876	175.64	144.06	0.82	3.68E-06	2.10E-08	3.02E-06	1.01E-05	5.77E-08	8.31E-06	1.01E-05	5.77E-08	8.31E-06
1992	7	13	8	0	21	23	7	16	0	23	2,210,576	442,107	2,911,168	200.00	151.87	0.76	3.17E-06	1.58E-08	2.40E-06	1.04E-05	5.20E-08	7.90E-06	1.04E-05	5.20E-08	7.90E-06
1993	4	19	4	1	24	16	4	10	2	16	2,428,102	505,481	3,322,041	208.18	152.16	0.73	1.65E-06	7.91E-09	1.20E-06	6.59E-06	3.17E-08	4.82E-06	5.77E-06	2.77E-08	4.21E-06
1994	3	20	5	0	25	10	N.A.	N.A.	N.A.	N.A.	2,601,823	610,408	3,615,888	234.61	168.81	0.72	1.15E-06	4.91E-09	8.30E-07	3.84E-06	1.64E-08	2.77E-06	N.A.	N.A.	N.A.
1995P	2	7	2	0	9	12	N.A.	N.A.	N.A.	N.A.	2,580,000	622,000	3,506,000	241.09	177.41	0.74	7.75E-07	3.22E-09	5.70E-07	4.65E-06	1.93E-08	3.42E-06	N.A.	N.A.	N.A.
1996																									
Total	144	428	133	33	681	580	131	283	18	432	36,567,252	6,089,553	45,588,012												
Avg.	6.86	23.78	7.39	1.83	32.43	27.62	8.19	17.69	1.13	27.00	1,741,296	358,209	2,681,648	184.15	129.55	0.70	4.88E-06	2.11E-08	2.47E-06	1.98E-05	8.30E-08	9.71E-06	1.70E-05	8.80E-08	1.01E-05
Std	3.89	16.79	4.92	5.10	22.46	14.09	5.44	8.65	1.09	13.37	549,025	135,725	563,768	24.20	23.62	0.06	3.91E-06	1.94E-08	1.94E-06	1.53E-05	6.82E-08	6.66E-06	1.30E-05	6.75E-08	6.57E-06

P = Preliminary Data

N.A. = Information not available when table prepared.

For 1980-1993																									
Total	80	317	96	33	446	318	91	210	18	319	25,861,514	4,664,652	36,582,419	180.37	127.51	0.71	3.09E-06	1.72E-08	2.19E-06	1.23E-05	6.82E-08	8.68E-06	1.16E-05	6.45E-08	8.23E-06
Avg.	5.71	22.64	6.86	2.36	31.86	22.71	6.50	15.00	1.29	22.79	1,847,251	333,189	2,613,030	177.88	125.28	0.70	3.35E-06	1.95E-08	2.34E-06	1.36E-05	7.90E-08	9.36E-06	1.29E-05	7.50E-08	8.90E-06
Std	2.67	16.84	4.44	5.72	24.90	6.98	3.11	4.59	1.07	7.08	421,410	98,186	466,605	14.27	17.74	0.06	2.02E-06	1.29E-08	1.35E-06	7.49E-06	4.86E-08	4.80E-06	7.19E-06	4.67E-08	4.62E-06

Table 2.18
Nonscheduled U.S. Air Carriers Operating Under 14 CFR 135 (Air Taxis)
[References 2.11 to 2.28]

Year	Fatal Acc.	Fatalities 135 Pass.	Fatalities 135 Crew	Fatalities Other	Fatalities Total	Total Acc.	135 Aircraft Damage Dest.	Major	Minor/ None/ Unkn.	Total	135 Aircraft Hours Flown	135 Aircraft Miles (000)	135 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/ Departure	Average AC Hours/ Departure	Fatal Accident Rate (/AC hour)	(/AC mile)	(/Departure)	Total Accident Rate (/AC hour)	(/AC mile)	(/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	(/AC mile)	(/Departure)
1974																									
1975	24	N.A.	N.A.	N.A.	69	152	N.A.	N.A.	N.A.	N.A.	2,526,271	N.A.	N.A.	N.A.	N.A.	N.A.	9.50E-06	N.A.	N.A.	6.02E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1976	31	N.A.	N.A.	N.A.	100	137	N.A.	N.A.	N.A.	N.A.	2,703,203	N.A.	N.A.	N.A.	N.A.	N.A.	1.15E-05	N.A.	N.A.	5.07E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1977	31	N.A.	N.A.	N.A.	118	158	N.A.	N.A.	N.A.	N.A.	3,304,220	N.A.	N.A.	N.A.	N.A.	N.A.	9.38E-06	N.A.	N.A.	4.78E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1978	54	99	53	3	155	198	74	125	1	200	3,545,753	N.A.	N.A.	N.A.	N.A.	N.A.	1.52E-05	N.A.	N.A.	5.58E-05	N.A.	N.A.	5.61E-05	N.A.	N.A.
1979	30	39	34	4	77	160	40	118	3	161	3,684,321	N.A.	N.A.	N.A.	N.A.	N.A.	8.14E-06	N.A.	N.A.	4.34E-05	N.A.	N.A.	4.29E-05	N.A.	N.A.
1980	46	62	41	2	105	171	52	118	2	172	3,617,724	N.A.	N.A.	N.A.	N.A.	N.A.	1.27E-05	N.A.	N.A.	4.73E-05	N.A.	N.A.	4.70E-05	N.A.	N.A.
1981	40	57	35	2	94	157	54	102	2	158	2,895,827	N.A.	N.A.	N.A.	N.A.	N.A.	1.38E-05	N.A.	N.A.	5.42E-05	N.A.	N.A.	5.39E-05	N.A.	N.A.
1982	31	45	27	0	72	132	47	83	4	134	3,008,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.03E-05	N.A.	N.A.	4.39E-05	N.A.	N.A.	4.32E-05	N.A.	N.A.
1983	27	27	30	5	62	141	33	106	4	143	2,378,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.14E-05	N.A.	N.A.	5.93E-05	N.A.	N.A.	5.85E-05	N.A.	N.A.
1984	23	22	30	0	52	146	40	104	3	147	2,843,000	N.A.	N.A.	N.A.	N.A.	N.A.	8.09E-06	N.A.	N.A.	5.14E-05	N.A.	N.A.	5.07E-05	N.A.	N.A.
1985	35	39	36	1	76	154	50	104	3	157	2,570,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.36E-05	N.A.	N.A.	5.99E-05	N.A.	N.A.	5.99E-05	N.A.	N.A.
1986	31	26	35	4	65	117	38	77	3	118	2,690,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.15E-05	N.A.	N.A.	4.35E-05	N.A.	N.A.	4.28E-05	N.A.	N.A.
1987	30	31	32	2	65	96	34	62	4	100	2,657,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.13E-05	N.A.	N.A.	3.61E-05	N.A.	N.A.	3.61E-05	N.A.	N.A.
1988	28	22	33	4	59	101	37	62	2	101	2,632,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.06E-05	N.A.	N.A.	3.84E-05	N.A.	N.A.	3.76E-05	N.A.	N.A.
1989	25	46	35	2	83	110	32	80	0	112	3,020,000	N.A.	N.A.	N.A.	N.A.	N.A.	8.28E-06	N.A.	N.A.	3.64E-05	N.A.	N.A.	3.71E-05	N.A.	N.A.
1990	26	20	28	2	50	106	38	68	2	108	2,249,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.24E-05	N.A.	N.A.	4.71E-05	N.A.	N.A.	4.71E-05	N.A.	N.A.
1991	27	35	31	4	70	87	31	53	4	88	2,241,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.20E-05	N.A.	N.A.	3.88E-05	N.A.	N.A.	3.75E-05	N.A.	N.A.
1992	24	43	22	3	68	76	26	49	1	76	2,009,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.19E-05	N.A.	N.A.	3.78E-05	N.A.	N.A.	3.73E-05	N.A.	N.A.
1993	19	20	22	0	42	69	26	44	0	70	1,809,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.05E-05	N.A.	N.A.	3.81E-05	N.A.	N.A.	3.87E-05	N.A.	N.A.
1994	26	N.A.	N.A.	N.A.	62	85	N.A.	N.A.	N.A.	N.A.	1,993,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.30E-05	N.A.	N.A.	4.26E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1995P	24	N.A.	N.A.	N.A.	52	76	N.A.	N.A.	N.A.	N.A.	2,000,000	N.A.	N.A.	N.A.	N.A.	N.A.	1.20E-05	N.A.	N.A.	3.80E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1996																									
Total	634	633	524	38	1596	2629	652	1355	38	2045	56,376,319	N.A.	N.A.	N.A.	N.A.	N.A.	1.12E-05	N.A.	N.A.	4.66E-05	N.A.	N.A.	N.A.	N.A.	N.A.
Avg.	30.19	39.56	32.75	2.38	76.00	125.2	40.75	84.69	2.38	127.8	2,684,587	N.A.	N.A.	N.A.	N.A.	N.A.	1.13E-05	N.A.	N.A.	4.62E-05	N.A.	N.A.	4.54E-05	N.A.	N.A.
Std.	8.08	20.40	7.35	1.59	26.33	36.26	12.32	26.67	1.36	36.98	546,569	N.A.	N.A.	N.A.	N.A.	N.A.	1.92E-06	N.A.	N.A.	8.10E-06	N.A.	N.A.	8.20E-06	N.A.	N.A.

P = Preliminary Data
N.A. = Information not available when table prepared.

For 1980-1993																									
Total	414	495	437	31	963	1663	538	1112	34	1684	36,619,551	N.A.	N.A.	N.A.	N.A.	N.A.	1.13E-05	N.A.	N.A.	4.54E-05	N.A.	N.A.	4.51E-05	N.A.	N.A.
Avg.	29.57	35.36	31.21	2.21	68.79	118.8	38.43	79.43	2.43	120.3	2,615,682	N.A.	N.A.	N.A.	N.A.	N.A.	1.13E-05	N.A.	N.A.	4.52E-05	N.A.	N.A.	4.48E-05	N.A.	N.A.
Std.	7.00	13.76	5.31	1.63	18.95	31.91	9.17	24.10	1.40	32.11	465,035	N.A.	N.A.	N.A.	N.A.	N.A.	1.70E-06	N.A.	N.A.	8.31E-06	N.A.	N.A.	8.23E-06	N.A.	N.A.

Table 2.19
Total (Scheduled and Nonscheduled) U.S. Air Carriers Operating Under 14 CFR 135
[References 2.11 to 2.28]

Year	Fatal Acc.	Fatalities 135 Pass.	Fatalities 135 Crew	Fatalities Other	Fatalities Total	Total Acc.	135 Aircraft Damage Dest.	135 Aircraft Damage Major	135 Aircraft Damage Minor/ None/ Unkn.	135 Aircraft Damage Total	135 Aircraft Hours Flown	135 Aircraft Miles (000)	135 Aircraft Departures	Average Speed (miles/hr.)	Average AC Miles/ Departure	Average AC Hours/ Departure	Fatal Accident Rate (/AC hour)	Fatal Accident Rate (/AC mile)	Fatal Accident Rate (/Departure)	Total Accident Rate (/AC hour)	Total Accident Rate (/AC mile)	Total Accident Rate (/Departure)	Crash (Dest. + Major Dam.) Rate (/AC hour)	Crash (Dest. + Major Dam.) Rate (/AC mile)	Crash (Dest. + Major Dam.) Rate (/Departure)
1974																									
1975	36	N.A.	N.A.	N.A.	97	200	N.A.	N.A.	N.A.	N.A.	3,462,583	N.A.	N.A.	N.A.	N.A.	N.A.	1.04E-05	N.A.	N.A.	5.78E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1976	40	N.A.	N.A.	N.A.	127	172	N.A.	N.A.	N.A.	N.A.	3,668,499	N.A.	N.A.	N.A.	N.A.	N.A.	1.09E-05	N.A.	N.A.	4.69E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1977	40	N.A.	N.A.	N.A.	150	202	N.A.	N.A.	N.A.	N.A.	4,454,470	N.A.	N.A.	N.A.	N.A.	N.A.	8.98E-06	N.A.	N.A.	4.53E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1978	68	133	67	3	203	259	94	166	1	261	4,847,889	N.A.	N.A.	N.A.	N.A.	N.A.	1.40E-05	N.A.	N.A.	5.34E-05	N.A.	N.A.	5.36E-05	N.A.	N.A.
1979	45	89	50	4	143	212	60	150	3	213	4,854,242	N.A.	N.A.	N.A.	N.A.	N.A.	9.27E-06	N.A.	N.A.	4.37E-05	N.A.	N.A.	4.33E-05	N.A.	N.A.
1980	54	89	51	2	142	209	61	145	5	211	4,793,312	N.A.	N.A.	N.A.	N.A.	N.A.	1.13E-05	N.A.	N.A.	4.36E-05	N.A.	N.A.	4.30E-05	N.A.	N.A.
1981	49	78	46	4	128	188	64	122	3	189	4,136,591	N.A.	N.A.	N.A.	N.A.	N.A.	1.18E-05	N.A.	N.A.	4.54E-05	N.A.	N.A.	4.50E-05	N.A.	N.A.
1982	36	53	33	0	86	158	55	100	6	161	4,307,748	N.A.	N.A.	N.A.	N.A.	N.A.	8.36E-06	N.A.	N.A.	3.67E-05	N.A.	N.A.	3.60E-05	N.A.	N.A.
1983	29	36	31	6	73	158	39	115	6	160	3,888,908	N.A.	N.A.	N.A.	N.A.	N.A.	7.46E-06	N.A.	N.A.	4.06E-05	N.A.	N.A.	3.96E-05	N.A.	N.A.
1984	30	60	38	2	100	168	47	119	3	169	4,588,762	N.A.	N.A.	N.A.	N.A.	N.A.	6.54E-06	N.A.	N.A.	3.66E-05	N.A.	N.A.	3.62E-05	N.A.	N.A.
1985	42	67	44	2	113	175	59	116	3	178	4,307,106	N.A.	N.A.	N.A.	N.A.	N.A.	9.75E-06	N.A.	N.A.	4.06E-05	N.A.	N.A.	4.06E-05	N.A.	N.A.
1986	33	29	36	4	69	132	39	90	5	134	4,414,586	N.A.	N.A.	N.A.	N.A.	N.A.	7.48E-06	N.A.	N.A.	2.99E-05	N.A.	N.A.	2.92E-05	N.A.	N.A.
1987	40	73	47	4	124	129	45	80	7	132	4,603,349	N.A.	N.A.	N.A.	N.A.	N.A.	8.69E-06	N.A.	N.A.	2.80E-05	N.A.	N.A.	2.72E-05	N.A.	N.A.
1988	30	39	37	4	80	120	40	77	3	120	4,724,689	N.A.	N.A.	N.A.	N.A.	N.A.	6.35E-06	N.A.	N.A.	2.54E-05	N.A.	N.A.	2.48E-05	N.A.	N.A.
1989	30	71	41	2	114	129	37	93	1	131	5,260,555	N.A.	N.A.	N.A.	N.A.	N.A.	5.70E-06	N.A.	N.A.	2.45E-05	N.A.	N.A.	2.47E-05	N.A.	N.A.
1990	32	23	29	4	56	122	40	80	3	123	4,585,952	N.A.	N.A.	N.A.	N.A.	N.A.	6.98E-06	N.A.	N.A.	2.66E-05	N.A.	N.A.	2.62E-05	N.A.	N.A.
1991	35	99	44	26	169	109	40	66	4	110	4,412,829	N.A.	N.A.	N.A.	N.A.	N.A.	7.93E-06	N.A.	N.A.	2.47E-05	N.A.	N.A.	2.40E-05	N.A.	N.A.
1992	31	56	30	3	89	99	33	65	1	99	4,219,576	N.A.	N.A.	N.A.	N.A.	N.A.	7.35E-06	N.A.	N.A.	2.35E-05	N.A.	N.A.	2.32E-05	N.A.	N.A.
1993	23	39	26	1	66	85	30	54	2	86	4,237,102	N.A.	N.A.	N.A.	N.A.	N.A.	5.43E-06	N.A.	N.A.	2.01E-05	N.A.	N.A.	1.98E-05	N.A.	N.A.
1994	29	N.A.	N.A.	N.A.	87	95	N.A.	N.A.	N.A.	N.A.	4,594,823	N.A.	N.A.	N.A.	N.A.	N.A.	6.31E-06	N.A.	N.A.	2.07E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1995P	26	N.A.	N.A.	N.A.	61	88	N.A.	N.A.	N.A.	N.A.	4,580,000	N.A.	N.A.	N.A.	N.A.	N.A.	5.68E-06	N.A.	N.A.	1.92E-05	N.A.	N.A.	N.A.	N.A.	N.A.
1996																									
Total	778	1034	650	71	2277	3209	783	1638	56	2477	92,943,571	N.A.	N.A.				8.37E-06	N.A.	N.A.	3.45E-05	N.A.	N.A.	N.A.	N.A.	N.A.
Avg.	37.05	64.63	40.63	4.44	108.43	152.8	48.94	102.4	3.50	154.8	4,425,884	N.A.	N.A.	N.A.	N.A.	N.A.	8.41E-06	N.A.	N.A.	3.49E-05	N.A.	N.A.	3.35E-05	N.A.	N.A.
Std.	10.45	29.10	10.45	5.93	38.50	47.70	16.07	32.75	1.86	47.18	412,279	N.A.	N.A.	N.A.	N.A.	N.A.	2.30E-06	N.A.	N.A.	1.16E-05	N.A.	N.A.	9.90E-06	N.A.	N.A.
For 1980-1993																									
Total	494	812	533	64	1409	1981	629	1322	52	2003	62,481,065	N.A.	N.A.	N.A.	N.A.	N.A.	7.91E-06	N.A.	N.A.	3.17E-05	N.A.	N.A.	3.12E-05	N.A.	N.A.
Avg.	35.29	58.00	38.07	4.57	100.64	141.5	44.93	94.43	3.71	143.1	4,462,933	N.A.	N.A.	N.A.	N.A.	N.A.	7.94E-06	N.A.	N.A.	3.19E-05	N.A.	N.A.	3.14E-05	N.A.	N.A.
Std	8.39	22.91	7.66	6.36	32.51	35.50	10.73	26.15	1.86	35.95	335,581	N.A.	N.A.	N.A.	N.A.	N.A.	1.92E-06	N.A.	N.A.	8.43E-06	N.A.	N.A.	8.36E-06	N.A.	N.A.

P = Preliminary Data
N.A. = Information not available when table prepared.

Table 2.20
Scheduled 14 CFR 135 Aircraft Accidents by Damage and Flight Phase [Refs. 2.13-2.26]

Flight Phases	1980 Dest.	1980 Major	1980 Minor/ None	1980 Total	1981 Dest.	1981 Major	1981 Minor/ None	1981 Total	1982 Dest.	1982 Major	1982 Minor/ None	1982 Total	1983 Dest.	1983 Major	1983 Minor/ None	1983 Total	1984 Dest.	1984 Major	1984 Minor/ None	1984 Total	1985 Dest.	1985 Major	1985 Minor/ None	1985 Total	1986 Dest.	1986 Major	1986 Minor/ None	1986 Total	1987 Dest.	1987 Major	1987 Minor/ None	1987 Total
Taxi	0	8	0	8	N.A.	N.A.	N.A.	N.A.	0	3	0	3	0	2	0	2	0	4	0	4	0	1	0	1	0	1	1	2	0	2	0	2
Takeoff (TO)	0	2	0	2	N.A.	N.A.	N.A.	N.A.	0	4	0	4	0	2	0	2	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0
Initial Climb (IC)	3	5	0	8	N.A.	N.A.	N.A.	N.A.	1	3	0	4	1	1	0	2	1	1	0	2	1	2	0	3	0	1	0	1	3	0	0	3
Climb to Cruise (CC)	0	0	0	0	N.A.	N.A.	N.A.	N.A.	0	1	0	1	0	0	0	0	2	1	0	3	0	0	0	0	0	2	0	2	0	0	1	1
Cruise/ Enroute (ER)	1	2	0	3	N.A.	N.A.	N.A.	N.A.	2	2	0	4	3	1	0	4	0	0	0	0	0	1	0	1	0	1	1	2	1	0	0	1
Initial Descent (ID)	1	0	1	2	N.A.	N.A.	N.A.	N.A.	1	0	0	1	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	4	0	4
Landing Approach (LA)	3	1	1	5	N.A.	N.A.	N.A.	N.A.	3	2	0	5	1	2	0	3	3	4	0	7	6	4	0	10	1	2	0	3	5	3	0	8
Landing (L)	0	7	0	7	N.A.	N.A.	N.A.	N.A.	0	2	0	2	0	1	0	1	0	5	0	5	0	4	0	4	0	3	0	3	0	6	0	6
Ground (G)	0	2	1	3	N.A.	N.A.	N.A.	N.A.	0	1	1	2	1	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Other/Unkn./ Not Reported	1	0	0	1	N.A.	N.A.	N.A.	N.A.	1	0	0	1	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	1	2	2	1	5
Total	9	27	3	39	N.A.	N.A.	N.A.	N.A.	8	18	1	27	6	10	2	18	7	15	0	22	9	12	0	21	1	13	2	16	11	18	3	32

Flight Phases	1988 Dest.	1988 Major	1988 Minor/ None	1988 Total	1989 Dest.	1989 Major	1989 Minor/ None	1989 Total	1990 Dest.	1990 Major	1990 Minor/ None	1990 Total	1991 Dest.	1991 Major	1991 Minor/ None	1991 Total	1992 Dest.	1992 Major	1992 Minor/ None	1992 Total	1993 Dest.	1993 Major	1993 Minor/ None	1993 Total	1994 Dest.	1994 Major	1994 Minor/ None	1994 Total	1995 Dest.	1995 Major	1995 Minor/ None	1995 Total	1980, 1982-1993 Total Dest.	1980, 1982-1993 Total Major	1980, 1982-1993 Total Minor/ None	1980, 1982-1993 Total Total	1980, 1982-1993 Total Pct.	Adjstd. Pct.
Taxi	0	5	0	5	0	7	0	7	0	2	0	2	0	0	0	0	0	3	0	3	0	1	0	1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	39	1	40	13.7%	
Takeoff (TO)	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	15	0	15	5.2%	7.1%
Initial Climb (IC)	2	0	0	2	0	0	0	0	0	1	0	1	0	1	0	1	1	3	0	4	2	1	0	3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	15	19	0	34	11.7%	16.2%
Climb to Cruise (CC)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2	5	1	8	2.7%	3.8%
Cruise/ Enroute (ER)	0	2	1	3	3	0	0	3	2	1	0	3	2	1	0	3	1	2	0	3	1	0	0	1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	16	13	2	31	10.7%	14.8%
Initial Descent (ID)	0	1	0	1	0	1	0	1	0	1	0	1	2	0	0	2	1	1	0	2	0	1	0	1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6	10	1	17	5.8%	8.1%
Landing Approach (LA)	1	0	0	1	1	1	0	2	0	2	0	2	2	0	0	2	4	4	0	8	1	1	0	2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	31	26	1	58	19.9%	27.6%
Landing (L)	0	4	0	4	0	1	0	1	0	5	0	5	0	5	0	5	0	2	0	2	0	2	0	2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	47	0	47	16.2%	22.4%
Ground (G)	0	1	0	1	0	2	1	3	0	0	1	1	1	1	1	3	0	1	0	1	0	0	2	2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2	9	10	21	7.2%	
Other/Unkn./ Not Reported	0	1	0	1	1	0	0	1	1	0	0	1	2	5	0	7	0	0	0	0	0	0	0	0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	10	9	1	20	6.9%	
Total	3	15	1	19	5	13	1	19	3	12	1	16	9	13	1	23	7	16	0	23	4	10	2	16	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	82	192	17	291	100.0%	100.0%

N.A. = Information not available at time of table preparation.

Table 2.21
Scheduled 14 CFR 135 Crash Rates by Flight Phase

Flight Phases	Calc. No. of Accs.	Pct.	Calc. No. of Accs.	Adjusted Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Knots	Calculated Average Distance Miles	Knots	Crash Rate by Flight Phases Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Departure	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Taxi	44	13.70%																
Takeoff	17	5.20%	17	7.10%	1.13%	0.008	86.31	75.00	0.69	0.60	4.520E-07	5.650E-05	6.547E-07	7.534E-07	1.469E-06	6.121E-05	5.409E-07	6.225E-07
Initial Climb	37	11.70%	37	16.20%	2.25%	0.016	126.59	110.00	2.03	1.76	1.017E-06	6.357E-05	5.022E-07	5.779E-07				
Climb to Cruise	9	2.70%	9	3.80%	18.73%	0.133	155.35	135.00	20.66	17.96	2.347E-07	1.765E-06	1.136E-08	1.307E-08				
Cruise/ Enroute	34	10.70%	34	14.80%	31.41%	0.223	224.40	195.00	50.04	43.49	9.301E-07	4.171E-06	1.859E-08	2.139E-08	1.669E-06	3.406E-06	1.553E-08	1.536E-08
Descent from Cruise	18	5.80%	18	8.10%	26.48%	0.188	195.63	170.00	36.78	31.96	5.042E-07	2.682E-06	1.371E-08	1.578E-08				
Landing Approach	63	19.90%	63	27.60%	18.87%	0.134	126.59	110.00	16.96	14.74	1.730E-06	1.291E-05	1.020E-07	1.174E-07				
Landing	52	16.20%	52	22.40%	1.13%	0.008	46.03	40.00	0.37	0.32	1.408E-06	1.760E-04	3.824E-06	4.401E-06	3.138E-06	2.210E-05	1.811E-07	2.084E-07
Ground	23	7.20%																
Other/Unkn./ Not Reported	22	6.90%																
TOTAL:	318	100.00%	230	100.00%	100.00%	0.710	179.62	156.08	127.53	110.82	6.276E-06	8.840E-06	4.921E-08	5.663E-08	6.276E-06	8.840E-06	4.921E-08	5.663E-08

Bases for Scheduled 14 CFR 135 Crash Rates by Flight Phase, 1980-1993 Totals:

0.71 Hours Average Flight Duration
127.5 Miles Average Flight Distance
179.58 Miles/Hour Average Flight Velocity
36,582,419 Departures

2.4 COMMERCIAL AVIATION CRASH PARAMETER DISTRIBUTIONS.

Calculation of the impact frequency for near airport crashes by means of the four factor methodology given by the ACRAM Standard [Ref. 2.5] requires the probability distribution of impact location, as well as representative values of impact angle and skid distance. These distributional quantities may readily be extracted from results from a more general methodology derived in LLNL report UCRL-ID-122512 [Ref. 2.32], which provides frequency estimates of hitting a facility at or above a specified velocity, and models both off-runway impacts and runway run-offs and overruns. Since in DOE applications the facility of interest will by assumption be located sufficiently far from any runway that the contribution from runway run-offs or overruns is negligible, the relevant probability distributions for the LLNL evaluation are those which model the off-runway impact location, angle, and velocity, and the heading and deceleration after impact. Reasonable parametric families of distributions and associated parameter settings have been obtained from the examination and analysis of a large data base extracted from published reports of commercial aircraft accidents. The data base is essentially complete for accidents that occurred between 1950 and 1990 and which involved large commercial jets. The runway is a contributor to the model only through its role in orienting the coordinate system. Locations are measured in reference to the runway; only the runway's length, q, and width, 2l, are pertinent. The prototypical runway has length q=10000 feet and width 2l=150 feet. The origin in the LLNL development, unlike the Standard's origin which is at the center of the runway, is at the center of the threshold end of the runway for a landing; the point (-q, 0) is at the center of the departure end for a takeoff. Successful takeoffs and landings are assumed to go from right to left. [In the Standard the intended direction of travel is the opposite: left to right.] See Figure 2.1.

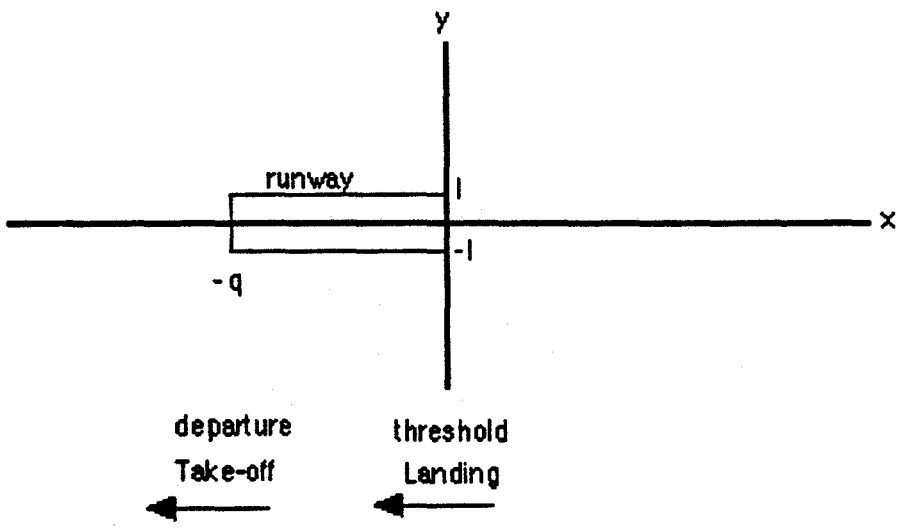

Figure 2.1 Coordinate system and direction of travel of Ref. 2.32.

Most quantities modeled have finite ranges. Beta distributions have been successfully applied in cases of limited ranges, e.g. heading angles. In cases of finite but essentially open-ended variables, e.g. impact locations, velocities, and decelerations, truncated versions of common distributions with infinite range (lognormal and Weibull) have been successfully fitted to the data.

All results should be viewed as preliminary. Additions and revisions of data will undoubtedly lead to improved parameter estimates. More detail than required by the Standard is presented here for the sake of faithfulness to the LLNL approach.

The units used are (feet, seconds, radians) for (distance, time, angle).

2.4.1. OFF-RUNWAY IMPACT LOCATION DISTRIBUTIONS.

Consider the location of an impact caused by a crash on takeoff. The x-coordinate measures the position along the extended runway center line, the intended direction of travel is right to left, and the origin is at the right extreme (threshold end) of the runway. Since the data base shows a dependency between x and y, the joint pdf $f_{X,Y}(x, y)$ is derived as

$$f_{X,Y}(x, y) = f_X(x)\, f_{Y|X}(y|x). \tag{2.1}$$

The data base shows no accidents with x-coordinate larger than 0, as this would require the aircraft to impact at a point behind where it commenced its takeoff run down the runway. In addition, all impacts have x-coordinates greater than -90000 (about 15 miles beyond the departure end of the runway), since impacts less than this figure would occur only if the aircraft is beyond the takeoff/climb phase of flight. A truncated lognormal distribution has been found to adequately fit the x-coordinate of takeoff impacts. Specifically, the pdf $f_X(x)$ is given by

$$f_X(x) = \frac{h(x)}{1 - H(x_l)}, \tag{2.2}$$

$$\text{where } h(x) = \frac{1}{-x\sqrt{2\pi}\sigma} \exp\left(-\frac{1}{2\sigma^2}[\ln(-x) - \mu]^2\right), -\infty < x < 0, \tag{2.3}$$

$$\text{and } H(t) = \int_{-\infty}^{t} h(x)\, dx, \tag{2.4}$$

with $x_l = -90000$, $\mu = 9.3663$, and $\sigma = 0.4913$. Essentially ln(-X) is normally distributed with mean 9.3663 and standard deviation 0.4913, with truncation on the left at x = -90000. The mean of this distribution is around -13200, implying that a typical impact occurs about 3200 feet beyond the departure end of the runway. See Figure 2.2. The distribution of the y-coordinate of impact depends on the value of the x-coordinate, since the distance from the extended runway center line tends to increase as the flight progresses and a jetway is followed toward a destination. A Weibull log linear regression that employs maximum likelihood techniques on exact, censored, and interval data has produced a satisfactory fit. The conditional pdf $f_{Y|X}(y|x)$ is determined as follows:

- Y | x is distributed as $W_X + 75$ with probability 1/2, and as $-W_X - 75$ with probability 1/2, if $-10000 \le x \le 0$
- Y | x is distributed as W_X with probability 1/2, and as $-W_X$ with probability 1/2, if $-90000 \le x < -10000$
- W_X is Weibull with scale parameter

  $\alpha(x) = \exp(4.9576 - 0.00009955\, x)$ and shape parameter c = 0.5381,

  i.e., W_X has pdf

$$g(w) = \frac{c}{\alpha(x)}\left(\frac{w}{\alpha(x)}\right)^{c-1} \exp\left(-\left[\frac{w}{\alpha(x)}\right]^c\right). \tag{2.5}$$

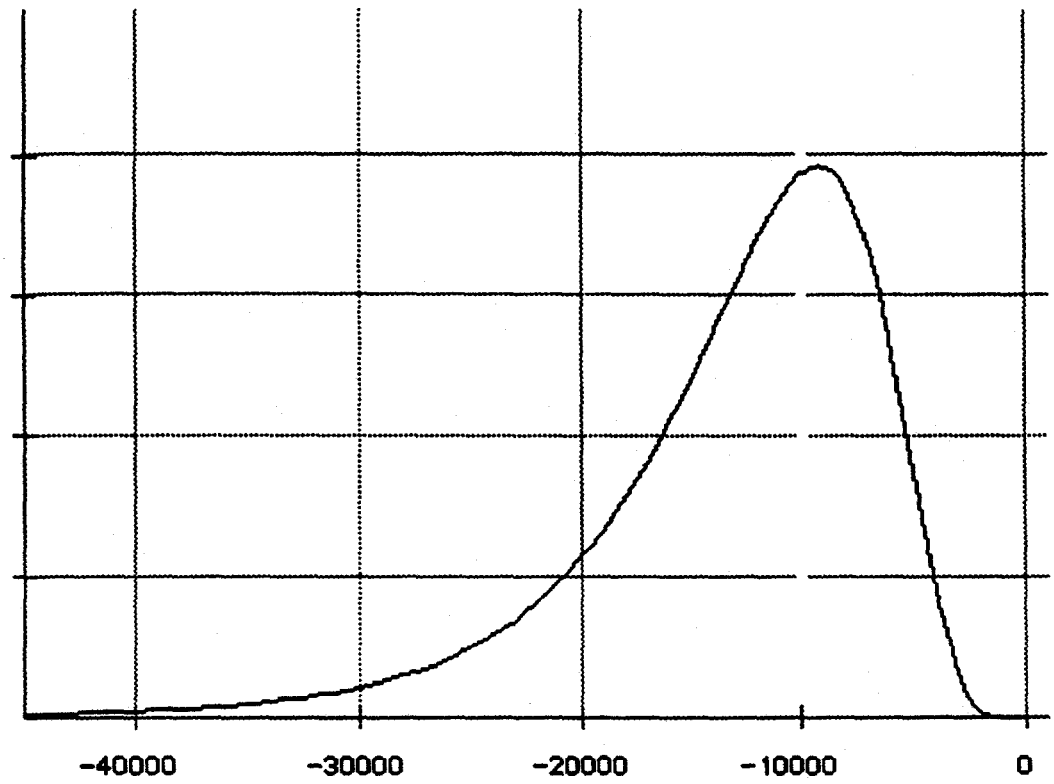

Figure 2.2 The truncated lognormal pdf for the x-coordinate of off-runway takeoff crashes.

A feature of the dependency of Y on x is shown in Figure 2.3 in which the median y-coordinate is plotted against x for impacts above the runway. The mirror image is valid for impacts below the runway.

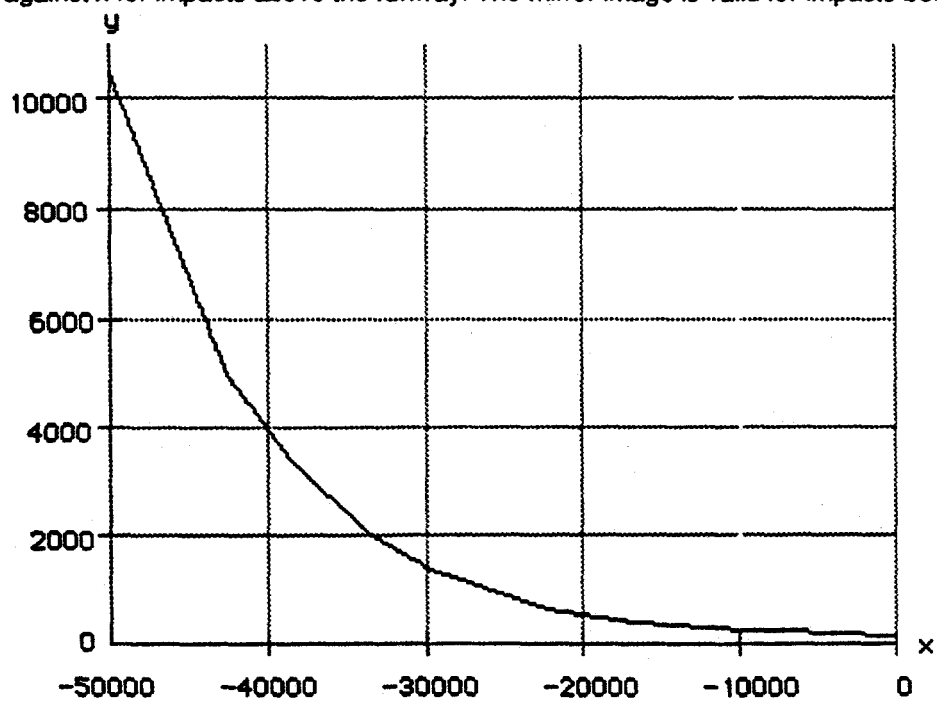

Figure 2.3 The median y-coordinate of impact for off-runway takeoff crashes above the runway.

A similar approach can be used to model the location of off-runway landing impacts. Landing phase crashes tend to occur short of the runway. Since no data base crashes occurred beyond the runway departure end, and crashes with x-coordinate greater than 105000 (about 20 miles before the runway threshold) are not viewed as landing/landing approach phase accidents, an x-coordinate range from -10000 to 105000 seems appropriate. A truncated lognormal distribution provides an adequate fit for the x-coordinate of landing impacts. Specifically, the pdf $f_X(x)$ is given by

$$f_X(x) = \frac{k(x)}{K(x_u)}, \tag{2.6}$$

$$\text{where } k(x) = \frac{1}{(x - x_0)\sqrt{2\pi}\sigma} \exp\left(-\frac{1}{2\sigma^2}\{\ln[x - x_0] - \mu\}^2\right), \; x > x_0, \tag{2.7}$$

$$\text{and } K(t) = \int_{x_0}^{t} k(x)\, dx, \tag{2.8}$$

with $x_u = 105000$, $x_0 = -10000$, $\mu = 9.6607$, and $\sigma = 0.4947$. Thus $\ln(X + 10000)$ is normally distributed with mean 9.6607 and standard deviation 0.4947, with truncation on the right at $x = 105000$. The mean of this distribution is around 7600, implying that a typical impact occurs about 7600 feet short of the threshold end of the runway. See Figure 2.4. The distribution of the y-coordinate of impact depends on the x-coordinate, since typical landing patterns involve turning toward the extended runway center line. The Weibull log linear regression methodology employed for the takeoff data has been used to fit the landing data with comparable success. Landing phase impacts tend to fall closer to the extended runway center line as the flight progresses and the approach to the runway is executed.

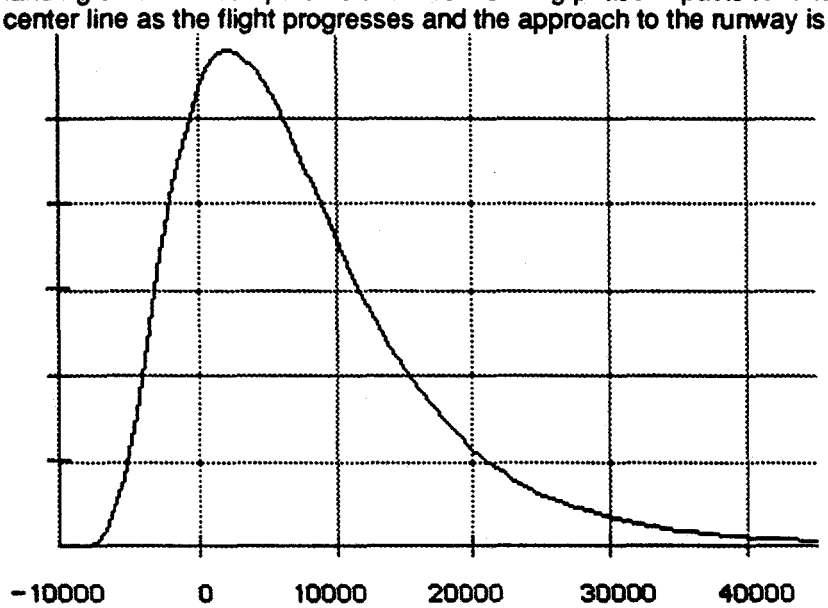

Figure 2.4 The truncated lognormal pdf for the x-coordinate of off-runway landing crashes.

The conditional pdf $f_{Y|X}(y|x)$ is determined as follows:

- $Y \mid x$ is distributed as W_X with probability 1/2, and as $-W_X$ with probability 1/2, if $0 \le x \le 105000$
- $Y \mid x$ is distributed as $W_X + 75$ with probability 1/2, and as $-W_X - 75$ with probability 1/2, if $-10000 \le x \le 0$
- W_X is Weibull with scale parameter $\alpha(x) = \exp(5.8542 + 0.000056063\, x)$ and shape parameter $c = 0.82406$, i.e., W_X has pdf (2.5).

In Figure 2.5 the median y-coordinate is plotted against x for impacts above the runway. The mirror image is valid for impacts below the runway.

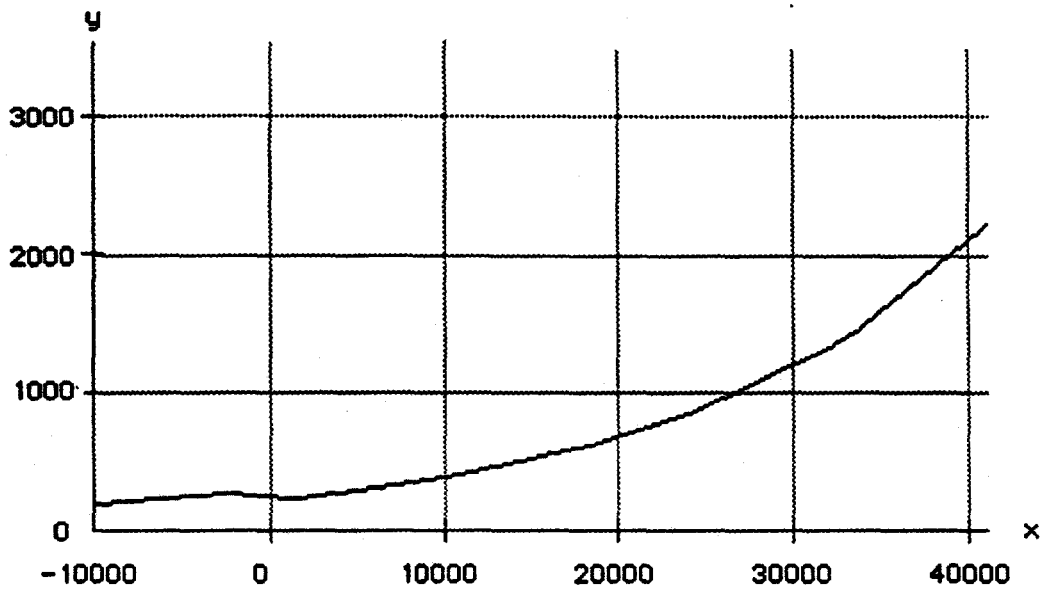

Figure 2.5 The median y-coordinate of impact for off-runway landing crashes above the runway.

Crash frequency screening requires a grid of impact location probabilities for takeoff and landing crashes. Such grids are provided in Table 2.22 (Takeoffs) and Table 2.23 (Landings). Abbreviated versions are given in the ACRAM Standard [Ref. 2.5]. It is important to note that the ACRAM Standard screening uses a different origin, namely the *center* of the runway, rather than the *threshold end* of the runway used in the LLNL report. Moreover, the direction of flight is left to right in the Standard, as opposed to right to left in the LLNL report. The entry in Table 2.22, ($x \in [2,3]$, $y \in [1,2]$), is seen to be 3.818E-03. This number is the conditional probability, given a takeoff crash occurs, that the impact will take place within the one square mile area characterized by $\{(x, y): 2 \le x \le 3, 1 \le y \le 2\}$, where (x, y) denotes the impact coordinates based on the origin situated at the runway center and the intended direction of travel being left to right. [For a runway of length 2 miles, the corresponding region in the coordinate system having origin at the runway threshold and flight from right to left would be $\{(x, y): -4 \le x \le -3, 1 \le y \le 2\}$.] The entries in Tables 2.22 and 2.23 were computed by integrating the appropriate joint densities (2.1).

2.4.2. OFF-RUNWAY HEADING DISTRIBUTIONS.

The aircraft's heading after an off-runway impact is not explicitly given in accident reports. The resting location of the wreckage is however reported, and the heading is estimated by calculating the angle, relative to the extended runway center line, of the line from the impact point to the center of the main wreckage segment. The heading distribution is not used in the ACRAM Standard [Ref. 2.5].

The heading of the aircraft after a takeoff crash depends on the impact location. Because typical takeoff flight patterns tend to require a turn away from the extended runway center line, the heading is usually greater than the arc tangent of the position of the aircraft. See Figure 2.6.

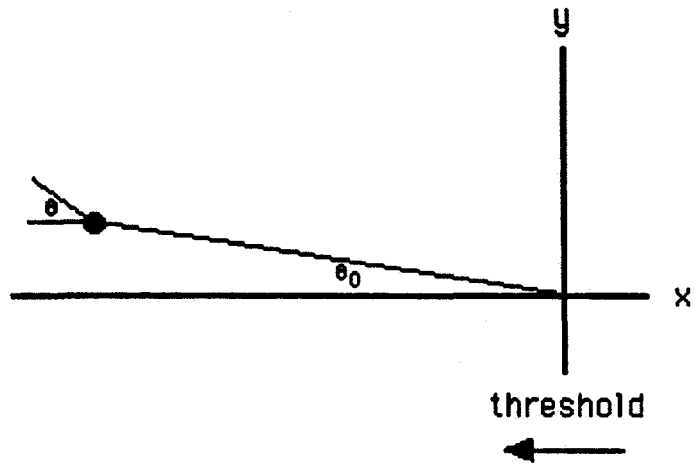

Figure 2.6 The heading θ of the aircraft on takeoff is typically greater than the arc tangent $\theta_0 = \tan^{-1}(|y|/|x|)$ of its position.

A regression on headings in off-runway takeoff impacts has found the mean heading θ_0^* to satisfy the log linear relation

$$\theta_0^* = 0.97126 + 0.16906 \ln(\theta_0), \tag{2.9}$$

where θ_0 marks the nominal heading on impact, i.e.,

$$\theta_0 = \tan^{-1}(|y|/|x|), \tag{2.10}$$

and the heading itself to be fit adequately as

$$\Theta = \theta_0^* + 2\pi(B - 1/2), \tag{2.11}$$

where B denotes a symmetric beta distributed random variable with parameter 132. That is, B has pdf

$$g_B(x\,;a,b) = \frac{\Gamma(a+b)}{\Gamma(a)\,\Gamma(b)}\, x^{a-1}\,(1-x)^{b-1},\ 0 < x < 1, \tag{2.12}$$

with a = b = 132. Therefore the conditional pdf $f_{\Theta|X,Y}$ used in calculations of crash frequency is given by

$$f_{\Theta|X,Y}(\theta \mid x,y) = \frac{1}{2\pi} g_B\left(\frac{\theta - \theta_0^* + \pi}{2\pi}; 132, 132\right), \quad \theta_0^* - \pi < \theta < \theta_0^* + \pi.. \tag{2.13}$$

The mean heading θ_0^* as a function of nominal heading θ_0 is shown in Figure 2.7.

The headings in off-runway landing impacts do not appear from the data base to depend on the location. A beta distribution with a modest tendency for headings away from the extended runway center line

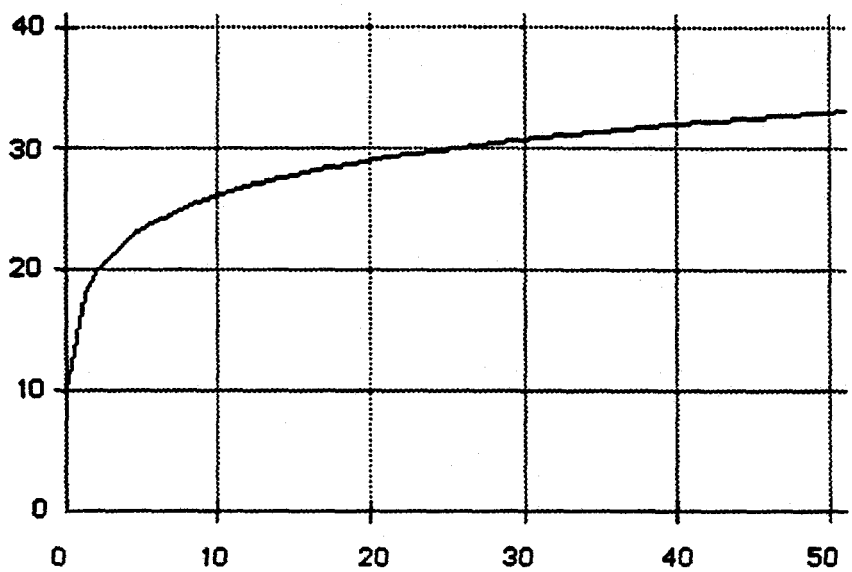

Figure 2.7 The mean heading, in degrees, at impact for off-runway takeoff crashes as a function of the nominal heading, in degrees.

provides a satisfactory fit. Specifically, Θ is distributed as

$$\Theta = 2\pi\left(B - \frac{1}{2}\right), \tag{2.14}$$

where B has pdf (2.12) with a=61.18 and b=56.76, so that the conditional pdf $f_{\Theta|X,Y}$ used in calculations is given by

$$f_{\Theta|X,Y}(\theta \mid x, y) = \frac{1}{2\pi} g_B\left(\frac{\theta+\pi}{2\pi}; 61.18, 56.76\right), \quad -\pi < \theta < \pi. \tag{2.15}$$

This density is plotted in Figure 2.8. The mean value is 6.75 degrees.

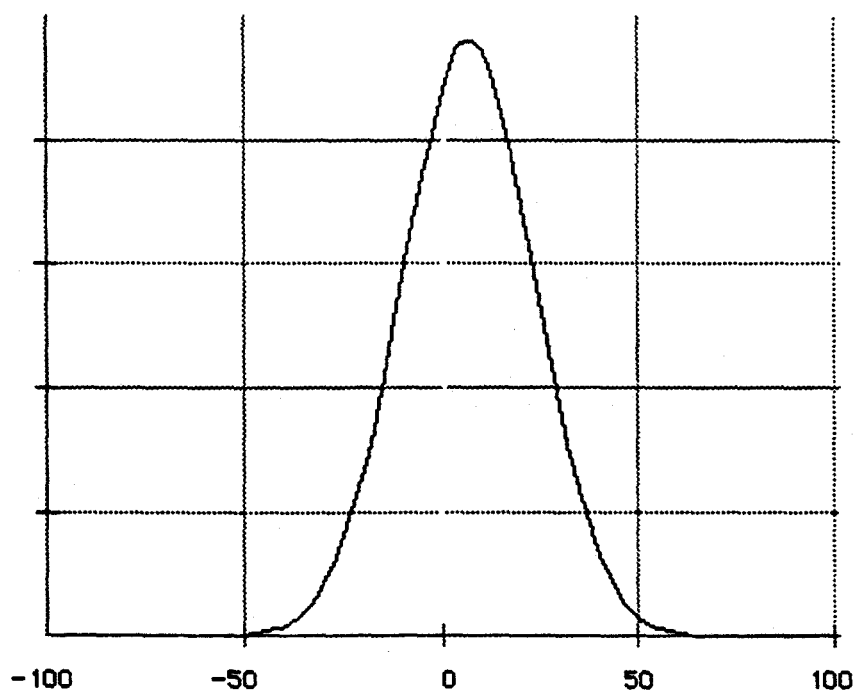

Figure 2.8 The beta pdf of heading, in degrees, for off-runway landing crashes.

2.4.3. OFF-RUNWAY IMPACT VELOCITY, IMPACT ANGLE, AND DECELERATION DISTRIBUTIONS.

The ACRAM Standard [Ref. 2.5] requires the mean cotangent of the impact angle and the mean skid distance in its impact frequency calculation. The cumulative distribution function of impact velocity is used in the structural response calculations. The LLNL development models deceleration after impact, rather than skid distance, because of the apparent independence of deceleration, a ground related quantity, and impact velocity/angle, pilot related quantities.

Although impact velocities and angles are provided in accident reports, decelerations after impact are not. Nonetheless, since the resting point of the main wreckage is reported, the deceleration rate may be calculated from Newtonian principles. The deceleration, assuming a constant rate along the straight line segment of length s from the impact point to the resting point, is given by

$$a = \frac{v_k^2 \cos^2\phi}{2\,s}. \tag{2.16}$$

Impact velocities and angles as well as decelerations do not appear to depend on whether the accidents are takeoff or landing related. The impact velocities are adequately modeled by a truncated Weibull distribution. Specifically, the off-runway impact velocity pdf f_{V_k} is given by

$$f_{V_k}(v) = \frac{c}{\alpha}\left[\frac{(v-\underline{v}_k)}{\alpha}\right]^{c-1} \exp\left(-\left[\frac{(v-\underline{v}_k)}{\alpha}\right]^c\right) \Big/ \left[1-\exp\left(-\left[\frac{\bar{v}_k-\underline{v}_k}{\alpha}\right]^c\right)\right],\ \underline{v}_k < v < \bar{v}_k\,, \tag{2.17}$$

where $\alpha = 161.7$, $c = 1.951$, and $(\underline{v}_k, \bar{v}_k) = (100., 500.)$. The mean of this distribution is about 243. See Figure 2.9. The cumulative distribution function associated with this pdf is used in the Standard's structural response calculations.

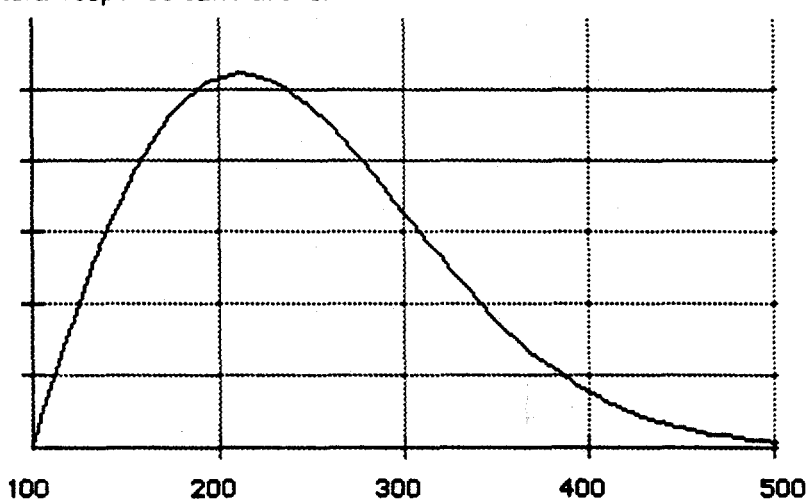

Figure 2.9 The truncated Weibull pdf of impact velocity for off-runway takeoff or landing crashes.

Impact angles depend on impact velocities as larger angles are associated with both smaller and larger velocities. Weibull log linear regression provides a satisfactory fit to allow evaluation of the conditional CDF $F_{\Phi \mid V_k}$ required in calculations. In fact, $\Phi \mid V_k$ is distributed as a truncated Weibull with pdf

$$g(\phi \mid v) = \frac{c}{\alpha(v)}\left(\frac{\phi}{\alpha(v)}\right)^{c-1} \exp\left(-\left[\frac{\phi}{\alpha(v)}\right]^c\right) \Big/ \left[\exp\left(-\left[\frac{\underline{\phi}}{\alpha(v)}\right]^c\right) - \exp\left(-\left[\frac{\bar{\phi}}{\alpha(v)}\right]^c\right)\right],\ \underline{\phi} < \phi < \bar{\phi}, \tag{2.18}$$

with $c = 1.08931$, $\alpha(v) = \exp(1.8580 - 0.022191\,v + 0.000036529\,v^2)$, and $(\underline{\phi}, \bar{\phi}) = \left(\frac{\pi}{360}, \frac{\pi}{2}\right)$, i.e., the range is from 1/2 to 90 degrees. The median impact angle as a function of impact velocity is shown in Figure 2.10. The mean cotangent of impact angle is used by the Standard in effective area calculations.

This quantity, obtainable in principle from the marginal distribution of impact angle, which is a function of (2.17) and (2.18), was computed in fact by Monte Carlo simulation based on two million realizations of $(V_k, \Phi|V_k)$. See Table 2.24.

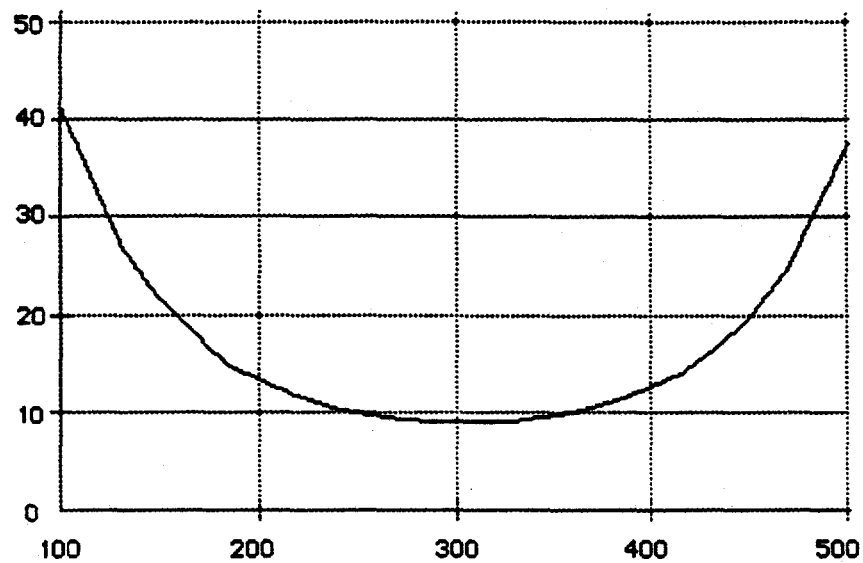

Figure 2.10 The median impact angle in degrees as a function of impact velocity for off-runway takeoff or landing crashes.

The calculated decelerations are adequately modeled by a truncated lognormal distribution. Specifically, the off-runway deceleration pdf f_A is given by

$$f_A(a) = \frac{\frac{1}{a\sqrt{2\pi}\,\sigma}\exp\left[-\frac{1}{2\sigma^2}(\ln a-\mu)^2\right]}{\Phi\left(\left[\ln\bar{a}-\mu\right]/\sigma\right)-\Phi\left(\left[\ln\underline{a}-\mu\right]/\sigma\right)}, \quad \underline{a} \le a \le \bar{a}, \tag{2.19}$$

where $\mu = 3.0390$, $\sigma = 0.6770$, $(\underline{a}, \bar{a}) = (1., 150.)$, and Φ is the standard normal CDF,

$$\Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}t^2\right)dt. \tag{2.20}$$

The mean deceleration is approximately 26. See Figure 2.11.

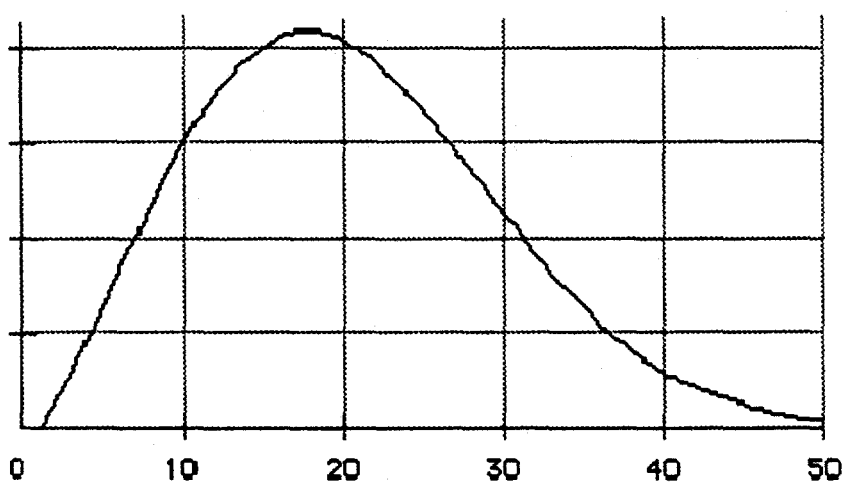

Figure 2.11 The truncated Weibull pdf of deceleration for off-runway takeoff or landing crashes.

The LLNL commercial model uses the deceleration distribution in conjunction with the ground impact velocity and angle distributions to characterize the sliding, or skidding, into a structure at a given velocity. Alternative models, such as the Standard's, which do not stochastically address the aircraft's velocity at the moment of skidding impact with the structure, make use of the skid distance distribution. The distance S that the aircraft slides, or skids, until it comes to rest is given by the Newtonian relation

$$S = \frac{V_k^2 \cos^2\Phi}{2A}. \tag{2.21}$$

The pdf of S can be derived in principle from the distributions obtained earlier for V_K, $\Phi|V_K$, and A. It is easier, however, to determine the distribution by Monte Carlo computer simulation. In Table 2.25 selected percentiles of the skid distance distribution are presented, based on Monte Carlo simulation with two million realizations of (V_K, $\Phi|V_K$, A). To construct effective areas in crash frequency screening the Standard employs the mean skid distance.

y/x	[-1,0]	[0,1]	[1,2]	[2,3]	[3,4]	[4,5]	[5,6]	[6,7]	[7,8]	[8,9]	[9,10]	[10,11]	[11,12]	[12,13]	[13,14]	[14,15]	[15,16]	[16,17]	[17,18]	[18,19]
[19,20]	3.680E-14	5.906E-11	4.769E-09	8.591E-08	5.690E-07	1.835E-06	3.478E-06	4.441E-06	4.232E-06	3.250E-06	2.133E-06	1.249E-06	6.745E-07	3.443E-07	1.691E-07	8.106E-08	3.828E-08	1.794E-08	8.368E-09	3.928E-09
[18,19]	7.962E-14	1.078E-10	7.624E-09	1.239E-07	7.580E-07	2.298E-06	4.152E-06	5.110E-06	4.735E-06	3.560E-06	2.298E-06	1.329E-06	7.112E-07	3.605E-07	1.762E-07	8.409E-08	3.959E-08	1.851E-08	8.640E-09	4.040E-09
[17,18]	1.767E-13	2.003E-10	1.235E-08	1.807E-07	1.018E-06	2.898E-06	4.983E-06	5.906E-06	5.317E-06	3.910E-06	2.483E-06	1.418E-06	7.515E-07	3.781E-07	1.838E-07	8.737E-08	4.101E-08	1.913E-08	8.913E-09	4.162E-09
[16,17]	4.003E-13	3.787E-10	2.031E-08	2.668E-07	1.380E-06	3.678E-06	6.015E-06	6.859E-06	5.994E-06	4.310E-06	2.690E-06	1.517E-06	7.959E-07	3.975E-07	1.921E-07	9.095E-08	4.255E-08	1.980E-08	9.209E-09	4.295E-09
[15,16]	9.294E-13	7.307E-10	3.394E-08	3.983E-07	1.891E-06	4.708E-06	7.309E-06	8.007E-06	6.787E-06	4.768E-06	2.924E-06	1.627E-06	8.451E-07	4.189E-07	2.013E-07	9.487E-08	4.424E-08	2.054E-08	9.533E-09	4.440E-09
[14,15]	2.217E-12	1.441E-09	5.772E-08	6.035E-07	2.618E-06	6.080E-06	8.944E-06	9.403E-06	7.723E-06	5.297E-06	3.190E-06	1.750E-06	8.999E-07	4.425E-07	2.114E-07	9.919E-08	4.610E-08	2.134E-08	9.890E-09	4.599E-09
[13,14]	5.450E-12	2.913E-09	1.001E-07	9.269E-07	3.671E-06	7.930E-06	1.103E-05	1.111E-05	8.836E-06	5.912E-06	3.494E-06	1.890E-06	9.613E-07	4.690E-07	2.226E-07	1.040E-07	4.816E-08	2.224E-08	1.028E-08	4.775E-09
[12,13]	1.385E-11	6.052E-09	1.775E-07	1.455E-06	5.218E-06	1.046E-05	1.373E-05	1.323E-05	1.017E-05	6.634E-06	3.845E-06	2.049E-06	1.031E-06	4.966E-07	2.352E-07	1.093E-07	5.046E-08	2.324E-08	1.072E-08	4.972E-09
[11,12]	3.658E-11	1.297E-08	3.227E-07	2.324E-06	7.536E-06	1.397E-05	1.727E-05	1.589E-05	1.179E-05	7.488E-06	4.253E-06	2.233E-06	1.110E-06	5.323E-07	2.495E-07	1.154E-07	5.304E-08	2.436E-08	1.122E-08	5.193E-09
[10,11]	1.008E-10	2.878E-08	6.034E-07	3.797E-06	1.108E-05	1.892E-05	2.196E-05	1.927E-05	1.378E-05	8.512E-06	4.734E-06	2.448E-06	1.201E-06	5.709E-07	2.657E-07	1.223E-07	5.599E-08	2.564E-08	1.178E-08	5.443E-09
[9,10]	2.919E-10	6.652E-08	1.168E-06	6.365E-06	1.662E-05	2.605E-05	2.832E-05	2.362E-05	1.626E-05	9.755E-06	5.306E-06	2.696E-06	1.308E-06	6.156E-07	2.845E-07	1.302E-07	5.938E-08	2.711E-08	1.243E-08	5.732E-09
[8,9]	8.953E-10	1.612E-07	2.340E-06	1.100E-05	2.556E-05	3.659E-05	3.710E-05	2.934E-05	1.940E-05	1.129E-05	6.000E-06	2.998E-06	1.434E-06	6.683E-07	3.065E-07	1.395E-07	6.334E-08	2.862E-08	1.318E-08	6.068E-09
[7,8]	2.942E-09	4.137E-07	4.916E-06	1.972E-05	4.044E-05	5.259E-05	4.954E-05	3.704E-05	2.347E-05	1.322E-05	6.656E-06	3.360E-06	1.586E-06	7.314E-07	3.328E-07	1.505E-07	6.805E-08	3.086E-08	1.408E-08	6.469E-09
[6,7]	1.051E-08	1.137E-06	1.092E-05	3.693E-05	6.631E-05	7.761E-05	6.774E-05	4.770E-05	2.888E-05	1.571E-05	7.939E-06	3.815E-06	1.774E-06	8.069E-07	3.650E-07	1.640E-07	7.379E-08	3.334E-08	1.517E-08	6.955E-09
[5,6]	4.170E-08	3.412E-06	2.602E-05	7.316E-05	1.137E-04	1.194E-04	9.546E-05	6.300E-05	3.631E-05	1.904E-05	9.352E-06	4.399E-06	2.014E-06	9.070E-07	4.055E-07	1.810E-07	8.101E-08	3.646E-08	1.654E-08	7.586E-09
[4,5]	1.699E-07	1.148E-05	6.798E-05	1.560E-04	2.068E-04	1.922E-04	1.400E-04	8.610E-05	4.703E-05	2.367E-05	1.126E-05	5.184E-06	2.332E-06	1.037E-06	4.588E-07	2.033E-07	9.047E-08	4.054E-08	1.833E-08	8.367E-09
[3,4]	1.048E-06	4.534E-05	2.019E-04	3.685E-04	4.088E-04	3.313E-04	2.175E-04	1.235E-04	6.356E-05	3.058E-05	1.408E-05	6.307E-06	2.782E-06	1.219E-06	5.335E-07	2.344E-07	1.037E-07	4.624E-08	2.083E-08	9.483E-09
[2,3]	7.771E-06	2.294E-04	7.316E-04	1.021E-03	9.193E-04	6.354E-04	3.696E-04	1.916E-04	9.200E-05	4.201E-05	1.860E-05	8.086E-06	3.488E-06	1.502E-06	6.494E-07	2.826E-07	1.241E-07	5.504E-08	2.469E-08	1.121E-08
[1,2]	1.010E-04	1.856E-03	3.851E-03	3.818E-03	2.643E-03	1.498E-03	7.484E-04	3.463E-04	1.526E-04	6.533E-05	2.754E-05	1.155E-05	4.845E-06	2.044E-06	8.698E-07	3.741E-07	1.628E-07	7.174E-08	3.202E-08	1.448E-08
[0,1]	2.634E-02	1.805E-01	1.520E-01	7.138E-02	2.634E-02	1.066E-02	3.948E-03	1.464E-03	5.475E-04	2.075E-04	7.992E-05	3.131E-05	1.249E-05	5.072E-06	2.098E-06	8.831E-07	3.782E-07	1.646E-07	7.283E-08	3.270E-08
[-1,0]	2.634E-02	1.805E-01	1.520E-01	7.138E-02	2.634E-02	1.066E-02	3.948E-03	1.464E-03	5.475E-04	2.075E-04	7.992E-05	3.131E-05	1.249E-05	5.072E-06	2.098E-06	8.831E-07	3.782E-07	1.646E-07	7.283E-08	3.270E-08
[-2,-1]	1.010E-04	1.856E-03	3.851E-03	3.818E-03	2.643E-03	1.498E-03	7.484E-04	3.463E-04	1.526E-04	6.533E-05	2.754E-05	1.155E-05	4.845E-06	2.044E-06	8.698E-07	3.741E-07	1.628E-07	7.174E-08	3.202E-08	1.448E-08
[-3,-2]	7.771E-06	2.294E-04	7.316E-04	1.021E-03	9.193E-04	6.354E-04	3.696E-04	1.916E-04	9.200E-05	4.201E-05	1.860E-05	8.086E-06	3.488E-06	1.502E-06	6.494E-07	2.826E-07	1.241E-07	5.504E-08	2.469E-08	1.121E-08
[-4,-3]	1.048E-06	4.534E-05	2.019E-04	3.685E-04	4.088E-04	3.313E-04	2.175E-04	1.235E-04	6.356E-05	3.058E-05	1.408E-05	6.307E-06	2.782E-06	1.219E-06	5.335E-07	2.344E-07	1.037E-07	4.624E-08	2.083E-08	9.483E-09
[-5,-4]	1.699E-07	1.148E-05	6.798E-05	1.560E-04	2.068E-04	1.922E-04	1.400E-04	8.610E-05	4.703E-05	2.367E-05	1.126E-05	5.184E-06	2.332E-06	1.037E-06	4.588E-07	2.033E-07	9.047E-08	4.054E-08	1.833E-08	8.367E-09
[-6,-5]	4.170E-08	3.412E-06	2.602E-05	7.316E-05	1.137E-04	1.194E-04	9.546E-05	6.300E-05	3.631E-05	1.904E-05	9.352E-06	4.399E-06	2.014E-06	9.070E-07	4.055E-07	1.810E-07	8.101E-08	3.646E-08	1.654E-08	7.586E-09
[-7, -6]	1.051E-08	1.137E-06	1.092E-05	3.693E-05	6.631E-05	7.761E-05	6.774E-05	4.770E-05	2.888E-05	1.571E-05	7.939E-06	3.815E-06	1.774E-06	8.069E-07	3.650E-07	1.640E-07	7.379E-08	3.334E-08	1.517E-08	6.955E-09
[-8,-7]	2.942E-09	4.137E-07	4.916E-06	1.972E-05	4.044E-05	5.259E-05	4.954E-05	3.704E-05	2.347E-05	1.322E-05	6.656E-06	3.360E-06	1.586E-06	7.314E-07	3.328E-07	1.505E-07	6.805E-08	3.086E-08	1.408E-08	6.469E-09
[-9,-8]	8.953E-10	1.612E-07	2.340E-06	1.100E-05	2.556E-05	3.659E-05	3.710E-05	2.934E-05	1.940E-05	1.129E-05	6.000E-06	2.998E-06	1.434E-06	6.683E-07	3.065E-07	1.395E-07	6.334E-08	2.862E-08	1.318E-08	6.068E-09
[-10,-9]	2.919E-10	6.652E-08	1.168E-06	6.365E-06	1.662E-05	2.605E-05	2.832E-05	2.362E-05	1.626E-05	9.755E-06	5.306E-06	2.696E-06	1.308E-06	6.156E-07	2.845E-07	1.302E-07	5.938E-08	2.711E-08	1.243E-08	5.732E-09
[-11,-10]	1.008E-10	2.878E-08	6.034E-07	3.797E-06	1.108E-05	1.892E-05	2.196E-05	1.927E-05	1.378E-05	8.512E-06	4.734E-06	2.448E-06	1.201E-06	5.709E-07	2.657E-07	1.223E-07	5.599E-08	2.564E-08	1.178E-08	5.443E-09
[-12,-11]	3.658E-11	1.297E-08	3.227E-07	2.324E-06	7.536E-06	1.397E-05	1.727E-05	1.589E-05	1.179E-05	7.488E-06	4.253E-06	2.233E-06	1.110E-06	5.323E-07	2.495E-07	1.154E-07	5.304E-08	2.436E-08	1.122E-08	5.193E-09
[-13,-12]	1.385E-11	6.052E-09	1.775E-07	1.455E-06	5.218E-06	1.046E-05	1.373E-05	1.323E-05	1.017E-05	6.634E-06	3.845E-06	2.049E-06	1.031E-06	4.966E-07	2.352E-07	1.093E-07	5.046E-08	2.324E-08	1.072E-08	4.972E-09
[-14,-13]	5.450E-12	2.913E-09	1.001E-07	9.269E-07	3.671E-06	7.930E-06	1.103E-05	1.111E-05	8.836E-06	5.912E-06	3.494E-06	1.890E-06	9.613E-07	4.690E-07	2.226E-07	1.040E-07	4.816E-08	2.224E-08	1.028E-08	4.775E-09
[-15,-14]	2.217E-12	1.441E-09	5.772E-08	6.035E-07	2.618E-06	6.080E-06	8.944E-06	9.403E-06	7.723E-06	5.297E-06	3.190E-06	1.750E-06	8.999E-07	4.425E-07	2.114E-07	9.919E-08	4.610E-08	2.134E-08	9.890E-09	4.599E-09
[-16,-15]	9.294E-13	7.307E-10	3.394E-08	3.983E-07	1.891E-06	4.708E-06	7.309E-06	8.007E-06	6.787E-06	4.768E-06	2.924E-06	1.627E-06	8.451E-07	4.189E-07	2.013E-07	9.487E-08	4.424E-08	2.054E-08	9.533E-09	4.440E-09
[-17,-16]	4.003E-13	3.787E-10	2.031E-08	2.668E-07	1.380E-06	3.678E-06	6.015E-06	6.859E-06	5.994E-06	4.310E-06	2.690E-06	1.517E-06	7.959E-07	3.975E-07	1.921E-07	9.095E-08	4.255E-08	1.980E-08	9.209E-09	4.295E-09
[-18,-17]	1.767E-13	2.003E-10	1.235E-08	1.807E-07	1.018E-06	2.898E-06	4.983E-06	5.906E-06	5.317E-06	3.910E-06	2.483E-06	1.418E-06	7.515E-07	3.781E-07	1.838E-07	8.737E-08	4.101E-08	1.913E-08	8.913E-09	4.162E-09
[-19,-18]	7.962E-14	1.078E-10	7.624E-09	1.239E-07	7.580E-07	2.298E-06	4.152E-06	5.110E-06	4.735E-06	3.560E-06	2.298E-06	1.329E-06	7.112E-07	3.605E-07	1.762E-07	8.409E-08	3.959E-08	1.851E-08	8.640E-09	4.040E-09
[-20,-19]	3.680E-14	5.906E-11	4.769E-09	8.591E-08	5.690E-07	1.835E-06	3.478E-06	4.441E-06	4.232E-06	3.250E-06	2.133E-06	1.249E-06	6.745E-07	3.443E-07	1.691E-07	8.106E-08	3.828E-08	1.794E-08	8.368E-09	3.928E-09

intended direction of travel is left to right
origin is center of runway
units are miles

Table 2.22
Conditional Probabilities of Impact Location, Given a Crash on Takeoff

y/x	[-19,-18]	[-18,-17]	[-17,-16]	[-16,-15]	[-15,-14]	[-14,-13]	[-13,-12]	[-12,-11]	[-11,-10]	[-10,-9]	[-9,-8]	[-8,-7]	[-7,-6]	[-6,-5]	[-5,-4]	[-4,-3]	[-3,-2]	[-2,-1]	[-1,0]	[0,1]
[19,20]	2.133E-07	2.832E-07	3.403E-07	3.591E-07	3.206E-07	2.306E-07	1.263E-07	4.873E-08	1.206E-08	1.712E-09	1.196E-10	3.440E-12	3.187E-14	6.970E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[18,19]	2.294E-07	3.099E-07	3.807E-07	4.132E-07	3.822E-07	2.878E-07	1.667E-07	6.909E-08	1.873E-08	2.972E-09	2.397E-10	8.226E-12	9.557E-14	2.795E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[17,18]	2.469E-07	3.396E-07	4.266E-07	4.763E-07	4.567E-07	3.600E-07	2.208E-07	9.838E-08	2.922E-08	5.196E-09	4.837E-10	1.969E-11	2.904E-13	1.134E-15	8.617E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[16,17]	2.662E-07	3.726E-07	4.788E-07	5.501E-07	5.470E-07	4.515E-07	2.935E-07	1.407E-07	4.584E-08	9.152E-09	9.653E-10	4.864E-11	8.948E-13	4.691E-15	4.989E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[15,16]	2.873E-07	4.095E-07	5.383E-07	6.368E-07	6.569E-07	5.681E-07	3.918E-07	2.023E-07	7.237E-08	1.625E-08	2.027E-09	1.204E-10	2.800E-12	1.978E-14	3.014E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[14,15]	3.108E-07	4.509E-07	6.065E-07	7.369E-07	7.912E-07	7.173E-07	5.252E-07	2.925E-07	1.150E-07	2.910E-08	4.216E-09	3.023E-10	8.911E-12	8.496E-14	1.921E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[13,14]	3.364E-07	4.973E-07	6.849E-07	8.595E-07	9.559E-07	9.092E-07	7.073E-07	4.253E-07	1.842E-07	5.260E-08	8.873E-09	7.702E-10	2.888E-11	3.735E-13	1.242E-15	5.313E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[12,13]	3.650E-07	5.497E-07	7.753E-07	1.003E-06	1.159E-06	1.157E-06	9.574E-07	6.223E-07	2.973E-07	9.604E-08	1.891E-08	1.994E-09	9.550E-11	1.683E-12	8.299E-15	8.353E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[11,12]	3.968E-07	6.091E-07	8.800E-07	1.174E-06	1.410E-06	1.480E-06	1.303E-06	9.170E-07	4.841E-07	1.773E-07	4.089E-08	5.256E-09	3.229E-10	7.794E-12	5.731E-14	9.238E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[10,11]	4.325E-07	6.768E-07	1.002E-06	1.379E-06	1.724E-06	1.902E-06	1.786E-06	1.362E-06	7.960E-07	3.315E-07	8.981E-08	1.413E-08	1.119E-09	3.722E-11	4.109E-13	1.104E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[9,10]	4.727E-07	7.543E-07	1.145E-06	1.627E-06	2.117E-06	2.459E-06	2.464E-06	2.040E-06	1.323E-06	6.283E-07	2.007E-07	3.883E-08	3.988E-09	1.840E-10	3.073E-12	1.400E-14	1.196E-17	0.000E+00	0.000E+00	0.000E+00
[8,9]	5.183E-07	8.439E-07	1.314E-06	1.928E-06	2.615E-06	3.201E-06	3.428E-06	3.088E-06	2.228E-06	1.210E-06	4.575E-07	1.094E-07	1.467E-08	9.459E-10	2.412E-11	1.882E-13	3.173E-16	0.000E+00	0.000E+00	0.000E+00
[7,8]	5.707E-07	9.483E-07	1.518E-06	2.299E-06	3.253E-06	4.200E-06	4.814E-06	4.727E-06	3.804E-06	2.371E-06	1.067E-06	3.174E-07	5.596E-08	5.091E-09	2.004E-10	2.710E-12	9.208E-15	4.600E-18	0.000E+00	0.000E+00
[6,7]	6.315E-07	1.072E-06	1.759E-06	2.760E-06	4.078E-06	5.563E-06	6.838E-06	7.338E-06	6.606E-06	4.745E-06	2.554E-06	9.521E-07	2.228E-07	2.692E-08	1.781E-09	4.240E-11	2.958E-13	4.034E-16	0.000E+00	0.000E+00
[5,6]	7.032E-07	1.219E-06	2.057E-06	3.343E-06	5.164E-06	7.456E-06	9.849E-06	1.158E-05	1.171E-05	9.742E-06	6.312E-06	2.973E-06	9.332E-07	1.753E-07	1.716E-08	7.334E-10	1.073E-11	3.756E-14	1.721E-17	0.000E+00
[4,5]	7.898E-07	1.400E-06	2.430E-06	4.095E-06	6.624E-06	1.014E-05	1.444E-05	1.867E-05	2.129E-05	2.064E-05	1.623E-05	9.753E-06	4.164E-06	1.151E-06	1.831E-07	1.440E-08	4.552E-10	4.230E-12	7.147E-15	3.316E-19
[3,4]	8.982E-07	1.630E-06	2.914E-06	5.098E-06	8.654E-06	1.409E-05	2.168E-05	3.096E-05	4.006E-05	4.558E-05	4.390E-05	3.412E-05	2.015E-05	8.382E-06	2.230E-06	3.345E-07	2.379E-08	6.140E-10	3.783E-12	9.752E-16
[2,3]	1.042E-06	1.938E-06	3.574E-06	6.508E-06	1.162E-05	2.019E-05	3.374E-05	5.352E-05	7.918E-05	1.068E-04	1.278E-04	1.307E-04	1.093E-04	7.058E-05	3.269E-05	9.647E-06	1.677E-06	1.269E-07	3.114E-09	4.351E-12
[1,2]	1.258E-06	2.402E-06	4.583E-06	8.712E-06	1.644E-05	3.063E-05	5.600E-05	9.960E-05	1.705E-04	2.771E-04	4.201E-04	5.815E-04	7.146E-04	7.525E-04	6.481E-04	4.272E-04	1.943E-04	5.052E-05	5.442E-08	4.564E-08
[0,1]	1.633E-06	3.613E-06	7.181E-06	1.438E-05	2.902E-05	5.891E-05	1.202E-04	2.460E-04	5.044E-04	1.033E-03	2.111E-03	4.269E-03	8.644E-03	1.722E-02	3.366E-02	6.334E-02	1.090E-01	1.479E-01	9.897E-02	6.928E-03
[-1,0]	1.633E-06	3.613E-06	7.181E-06	1.438E-05	2.902E-05	5.891E-05	1.202E-04	2.460E-04	5.044E-04	1.033E-03	2.111E-03	4.269E-03	8.644E-03	1.722E-02	3.366E-02	6.334E-02	1.090E-01	1.479E-01	9.897E-02	6.928E-03
[-2,-1]	1.258E-06	2.402E-06	4.583E-06	8.712E-06	1.644E-05	3.063E-05	5.600E-05	9.960E-05	1.705E-04	2.771E-04	4.201E-04	5.815E-04	7.146E-04	7.525E-04	6.481E-04	4.272E-04	1.943E-04	5.052E-05	5.442E-08	4.564E-08
[-3,-2]	1.042E-06	1.938E-06	3.574E-06	6.508E-06	1.162E-05	2.019E-05	3.374E-05	5.352E-05	7.918E-05	1.068E-04	1.278E-04	1.307E-04	1.093E-04	7.058E-05	3.269E-05	9.647E-06	1.677E-06	1.269E-07	3.114E-09	4.351E-12
[-4,-3]	8.982E-07	1.630E-06	2.914E-06	5.098E-06	8.654E-06	1.409E-05	2.168E-05	3.096E-05	4.006E-05	4.558E-05	4.390E-05	3.412E-05	2.015E-05	8.382E-06	2.230E-06	3.345E-07	2.379E-08	6.140E-10	3.783E-12	9.752E-16
[-5,-4]	7.898E-07	1.400E-06	2.430E-06	4.095E-06	6.624E-06	1.014E-05	1.444E-05	1.867E-05	2.129E-05	2.064E-05	1.623E-05	9.753E-06	4.164E-06	1.151E-06	1.831E-07	1.440E-08	4.552E-10	4.230E-12	7.147E-15	3.316E-19
[-6,-5]	7.032E-07	1.219E-06	2.057E-06	3.343E-06	5.164E-06	7.456E-06	9.849E-06	1.158E-05	1.171E-05	9.742E-06	6.312E-06	2.973E-06	9.332E-07	1.753E-07	1.716E-08	7.334E-10	1.073E-11	3.756E-14	1.721E-17	0.000E+00
[-7,-6]	6.315E-07	1.072E-06	1.759E-06	2.760E-06	4.078E-06	5.563E-06	6.838E-06	7.338E-06	6.606E-06	4.745E-06	2.554E-06	9.521E-07	2.228E-07	2.692E-08	1.781E-09	4.240E-11	2.958E-13	4.034E-16	0.000E+00	0.000E+00
[-8,-7]	5.707E-07	9.483E-07	1.518E-06	2.299E-06	3.253E-06	4.200E-06	4.814E-06	4.727E-06	3.804E-06	2.371E-06	1.067E-06	3.174E-07	5.596E-08	5.091E-09	2.004E-10	2.710E-12	9.208E-15	4.600E-18	0.000E+00	0.000E+00
[-9,-8]	5.183E-07	8.439E-07	1.314E-06	1.928E-06	2.615E-06	3.201E-06	3.428E-06	3.088E-06	2.228E-06	1.210E-06	4.575E-07	1.094E-07	1.467E-08	9.459E-10	2.412E-11	1.882E-13	3.173E-16	0.000E+00	0.000E+00	0.000E+00
[-10,-9]	4.727E-07	7.543E-07	1.145E-06	1.627E-06	2.117E-06	2.459E-06	2.464E-06	2.040E-06	1.323E-06	6.283E-07	2.007E-07	3.883E-08	3.988E-09	1.840E-10	3.073E-12	1.400E-14	1.196E-17	0.000E+00	0.000E+00	0.000E+00
[-11,-10]	4.325E-07	6.768E-07	1.002E-06	1.379E-06	1.724E-06	1.902E-06	1.786E-06	1.362E-06	7.960E-07	3.315E-07	8.981E-08	1.413E-08	1.119E-09	3.722E-11	4.109E-13	1.104E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-12,-11]	3.968E-07	6.091E-07	8.800E-07	1.174E-06	1.410E-06	1.480E-06	1.303E-06	9.170E-07	4.841E-07	1.773E-07	4.089E-08	5.256E-09	3.229E-10	7.794E-12	5.731E-14	9.238E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-13,-12]	3.650E-07	5.497E-07	7.753E-07	1.003E-06	1.159E-06	1.157E-06	9.574E-07	6.223E-07	2.973E-07	9.604E-08	1.891E-08	1.994E-09	9.550E-11	1.683E-12	8.299E-15	8.353E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-14,-13]	3.364E-07	4.973E-07	6.849E-07	8.595E-07	9.559E-07	9.092E-07	7.073E-07	4.253E-07	1.842E-07	5.260E-08	8.873E-09	7.702E-10	2.888E-11	3.735E-13	1.242E-15	5.313E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-15,-14]	3.108E-07	4.509E-07	6.065E-07	7.369E-07	7.912E-07	7.173E-07	5.252E-07	2.925E-07	1.150E-07	2.910E-08	4.216E-09	3.023E-10	8.911E-12	8.496E-14	1.921E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-16,-15]	2.873E-07	4.095E-07	5.383E-07	6.368E-07	6.569E-07	5.681E-07	3.918E-07	2.023E-07	7.237E-08	1.625E-08	2.027E-09	1.204E-10	2.800E-12	1.978E-14	3.014E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-17,-16]	2.662E-07	3.726E-07	4.788E-07	5.501E-07	5.470E-07	4.515E-07	2.935E-07	1.407E-07	4.584E-08	9.152E-09	9.653E-10	4.864E-11	8.948E-13	4.691E-15	4.989E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-18,-17]	2.469E-07	3.396E-07	4.266E-07	4.763E-07	4.567E-07	3.600E-07	2.208E-07	9.838E-08	2.922E-08	5.196E-09	4.837E-10	1.969E-11	2.904E-13	1.134E-15	8.617E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-19,-18]	2.294E-07	3.099E-07	3.807E-07	4.132E-07	3.822E-07	2.878E-07	1.667E-07	6.909E-08	1.873E-08	2.972E-09	2.397E-10	8.226E-12	9.557E-14	2.795E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
[-20,-19]	2.133E-07	2.832E-07	3.403E-07	3.591E-07	3.206E-07	2.306E-07	1.263E-07	4.873E-08	1.206E-08	1.712E-09	1.196E-10	3.440E-12	3.187E-14	6.970E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

intended direction of travel is left to right
origin is center of runway
units are miles

Table 2.23
Conditional Probabilities of Impact Location, Given a Crash on Landing

percentile	angle
5	1.5
10	2.5
15	3.6
20	4.6
25	5.8
30	7.0
35	8.2
40	9.6
45	11.0
50	12.6
55	14.4
60	16.4
65	18.6
70	21.2
75	24.3
80	28.1
85	33.0
90	40.0
95	52.0

mean: 17.64
mean cotangent: 9.554

angle	CDF
5	0.2160
10	0.4150
15	0.5660
20	0.6780
25	0.7610
30	0.8220
35	0.8670
40	0.9000
45	0.9245
50	0.9436
55	0.9580
60	0.9690
65	0.9778
70	0.9846
75	0.9899
80	0.9941
85	0.9974
90	1.0000

Table 2.24
Impact Angle Distribution Properties

percentile	skid distance
5	160
10	260
15	350
20	440
25	530
30	620
35	710
40	820
45	930
50	1050
55	1190
60	1340
65	1520
70	1730
75	1990
80	2320
85	2760
90	3430
95	4700
mean:	1570

Table 2.25
Selected Skid Distance Percentiles (ft)

2.5 COMMERCIAL AVIATION AIRCRAFT CHARACTERISTICS

This section was prepared to provide to the analyst those characteristics of aircraft that could be important to determine the effect of the aircraft on the facility. Such aircraft characteristics which could be crucial in determine whether a facility could withstand an impact from an aircraft could be the weight of the aircraft, the amount of fuel aboard the aircraft, the speed of the aircraft, the dimensions of the aircraft, and potential missiles generated by the aircraft as its structure failed. Many of these parameters would vary greatly during the course of the flight, but the values of the characteristics given in this section could be considered the upper bound of these parameters. To determine the characteristics of an aircraft at the moment of impact in a particular accident, the analyst should refer to the specific accident report.

Tables 2.26 and 2.27 taken from References 2.33 and 2.34 presents the following information on commercial aviation aircraft characteristics:

1. Aircraft type,
2. Powerplant(s), number and type,
3. Nominal power rating of each powerplant,
4. Operating empty weight expressed in pounds, and kilograms,
5. Maximum allowed (or certificated) takeoff weight expressed in pounds, and kilograms,
6. Maximum allowed (or certificated) landing weight expressed in pounds, and kilograms,
7. Maximum zero-fuel weight expressed in pounds, and kilograms,
8. Maximum fuel-capacity expressed in imperial gallons, and liters,
9. Overall wing span expressed in feet and inches, and in meters,
10. Overall length expressed in feet and inches, and in meters,
11. Overall height expressed in feet and inches, and in meters,
12. Wing area expressed in $ft.^2$ and $meters^2$,
13. Takeoff runway length according to Federal Air Regulations (FAR) requirements, expressed in feet,
14. Landing runway length according to Federal Air Regulations (FAR) requirements, expressed in feet,
15. Stall speed with gear flaps deployed, expressed in miles/hour.

Powerplant(s) were included as potential missile generators. Weights were given for mass during various points of the flight. Fuel capacity was included in order to provide the maximum fuel available for a fire following the crash. Aircraft dimensions will be needed when the facility effective area is determined. The takeoff runway length and landing runway length were provided so that an analyst could screen certain aircraft from certain airports due to their inability to operate from the airport's runway(s). Stall speed was provided so that an estimate of the impact speed could be made as a large percentage of commercial aircraft crashes occur during the landing approach flight phase, and most commercial aircraft fly the approach phase at about 1.3 times the stall speed.

Table 2.26 presents the characteristics of Air Carrier aircraft that generally conduct flights under 14 CFR 121 regulations. The aircraft types are arranged in descending order of maximum takeoff weight with jet-powered aircraft listed first, followed by turboprop aircraft and pistonprop aircraft.

Table 2.27 presents the characteristics of Scheduled Air Taxi aircraft that generally conduct flights under 14 CFR 135 regulations. Again, the aircraft types are arranged in descending order of maximum takeoff weight. It should be noted that many general aviation aircraft types are also used for Air Taxi flights, particularly nonscheduled flights, but also for scheduled flights. These types have not been included due to lack of time but could be added in the future.

Finally, additional research is needed to characterize the missiles (projectiles) generated during the course of an aircraft's crash. Obvious examples of such missiles are the aircraft's engines, the auxiliary power units (APUs), and the landing gear. Much of the information on these aircraft components is not readily available and may have to be obtained directly from the aircraft or engine manufacturer or from the company that produces the component.

Table 2.26
Characteristics of Air Carrier (14 CFR 121) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilogram	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilogram	Maximum Landing Weight Pounds	Maximum Landing Weight Kilogram	Maximum Zero-Fuel Weight Pounds	Maximum Zero-Fuel Weight Kilogram
AIR CARRIER (14 CFR 121) JETS											
Boeing 747-400	4	RR. RB.211-524G HBTF	58,000 lbs. st.	401,800	182,255	870,000	394,625	N.A.	N.A.	N.A.	N.A.
Boeing 747-400	4	GE. CF6-80C2B4 HBTF	57,900 lbs. st.	399,100	181,030	870,000	394,625	N.A.	N.A.	N.A.	N.A.
Boeing 747-400	4	P&W. PW4056 HBTF	56,750 lbs. st.	399,000	180,985	870,000	394,625	N.A.	N.A.	N.A.	N.A.
Boeing 747-300	4	GE. CF6-50C2 HBTF	59,000 lbs. st.	384,480	174,400	833,000	377,840	630,000	285,765	565,000	256,280
Boeing 747-300	4	P&W. JT9D-7R4G2 HBTF	54,750 lbs. st.	384,480	174,400	833,000	377,840	630,000	285,765	565,000	256,280
Boeing 747-300	4	RR. RB.211-524D4 HBTF	53,110 lbs. st.	384,480	174,400	833,000	377,840	630,000	285,765	565,000	256,280
Boeing 747-300	4	GE. CF6-50E2 HBTF	52,500 lbs. st.	384,480	174,400	833,000	377,840	630,000	285,765	565,000	256,280
Boeing 747-200	4	P&W. JT9D-7R4G2 HBTF	54,750 lbs. st.	375,170	170,180	833,000	377,840	630,000	285,765	526,500	238,815
Boeing 747-200	4	RR. RB.211-524D4 HBTF	53,110 lbs. st.	375,170	170,180	833,000	377,840	630,000	285,765	526,500	238,815
Boeing 747-200	4	GE. CF6-50E2 HBTF	52,500 lbs. st.	375,170	170,180	833,000	377,840	630,000	285,765	526,500	238,815
McDonnell Douglas MD-11	3	GE. CF6-80C2	60,200 lbs. st.	277,000	125,646	602,500	273,300	430,000	195,047	400,000	181,439
McDonnell Douglas MD-11	3	P&W. PW4358	58,000 lbs. st.	277,000	125,646	602,500	273,300	430,000	195,047	400,000	181,439
McDonnell Douglas DC-10-30	3	GE. CF6-50C2B HBTF	54,000 lbs. st.	267,197	121,198	580,000	263,085	403,000	182,766	368,000	166,922
McDonnell Douglas DC-10-30	3	GE. CF6-50C1 HBTF	52,500 lbs. st.	267,197	121,198	580,000	263,085	403,000	182,766	368,000	166,922
McDonnell Douglas DC-10-30	3	GE. CF6-50A HBTF	49,000 lbs. st.	267,197	121,198	580,000	263,085	403,000	182,766	368,000	166,922
Airbus A.340-300	4	CFMI. CFM56-5S3 HBTF	30,600 lbs. st.	245,000	111,130	542,300	246,000	N.A.	N.A.	N.A.	N.A.
Airbus A.340-200	4	CFMI. CFM56-5S3 HBTF	30,600 lbs. st.	245,000	111,130	542,300	246,000	N.A.	N.A.	N.A.	N.A.
Lockheed L.1011-500	3	RR. RB211-524B4	50,000 lbs. st.	245,000	111,312	510,000	231,330	368,000	166,920	338,000	153,315
Airbus A.330	2	GE. CF6-80C2 HBTF	64,000 lbs. st.	245,000	111,130	450,000	204,000	N.A.	N.A.	N.A.	N.A.
Airbus A.330	2	P&W. PW4000 HBTF	60,000 lbs. st.	245,000	111,130	450,000	204,000	N.A.	N.A.	N.A.	N.A.
Aerospatiale BAC Concorde	4	RR. Olympus 593 Mk 610 TJ	38,050 lbs. st.	173,500	78,700	408,000	185,065	245,000	111,130	203,000	92,080
Airbus A.300-600	2	GE. CF6-80C2 HBTF	56,000 lbs. st.	197,767	89,715	375,880	170,500	N.A.	N.A.	286,600	130,000
Douglas DC-8-73	4	CFM. CFM56-2-C5 HBTF	24,000 lbs. st.	166,500	75,500	355,000	161,025	258,000	117,000	231,000	104,780
Boeing 767-300	2	P&W. JT9D-7R4E HBTF	50,000 lbs. st.	188,800	85,638	352,200	159,755	300,000	136,078	278,000	126,098
Boeing 767-300	2	GE. CF6-80A2 HBTF	50,000 lbs. st.	188,800	85,638	352,200	159,755	300,000	136,078	278,000	126,098
Airbus A.310-300	2	P&W. JT9D-7R4E1 HBTF	50,000 lbs. st.	169,842	77,040	337,305	153,000	271,170	123,000	249,120	113,000
Boeing 707-320C	4	P&W. JT3D-7 TF	19,000 lbs. st.	146,400	66,406	333,600	151,315	247,000	112,037	230,000	104,330
Boeing 767-200	2	P&W. JT9D-7R4D HBTF	48,000 lbs. st.	176,200	79,923	315,000	142,881	272,000	123,377	250,000	113,398
Boeing 767-200	2	GE. CF6-80A HBTF	48,000 lbs. st.	176,200	79,923	315,000	142,881	272,000	123,377	250,000	113,398
Boeing 757-200	2	RR. RB211-535E4 HBTF	40,100 lbs. st.	126,250	57,267	240,000	108,846	198,000	89,813	184,000	83,462
Boeing 757-200	2	P&W. PW2037 HBTF	38,200 lbs. st.	126,250	57,267	240,000	108,846	198,000	89,813	184,000	83,462
Boeing 727-200	3	P&W. JT8D-17R TF	16,000 lbs. st.	101,773	46,164	209,500	95,027	161,000	73,028	144,000	65,315
Airbuse A.321	2	CFMI. CFM56-5B1 HBTF	31,000 lbs. st.	104,746	47,512	182,984	83,000	N.A.	N.A.	N.A.	N.A.
McDonnell Douglas MD-90-55	2	IAE. V2528-D5 TF	28,000 lbs. st.	94,455	42,844	172,500	78,245	N.A.	N.A.	N.A.	N.A.
Boeing 737-800	2	CFMI. CFM56-7B4 HBTF	24,000 lbs. st.	N.A.	N.A.	168,500	76,430	N.A.	N.A.	N.A.	N.A.
Airbus A.320-200	2	CFMI. CFM56-5 HBTF	25,000 lbs. st.	85,604	38,830	158,730	72,000	138,890	63,000	130,072	59,000
McDonnell Douglas MD-90-30	2	IAE. V2525-D5 TF	25,000 lbs. st.	82,200	40,007	156,000	70,760	N.A.	N.A.	N.A.	N.A.
Boeing 737-700	2	CFMI. CFM56-7B4 HBTF	24,000 lbs. st.	N.A.	N.A.	149,000	67,585	N.A.	N.A.	N.A.	N.A.
Airbus A.320-100	2	CFMI. CFM56-5 HBTF	25,000 lbs. st.	84,171	38,180	145,503	66,000	134,480	61,000	125,662	57,000
McDonnell Douglas MD-81	2	P&W. JT8D TF	18,500 lbs. st.	78,420	35,570	140,000	63,503	128,000	58,060	118,000	53,524
Boeing 737-400	2	CFMI. CFM56-3B-2 HBTF	22,000 lbs. st.	73,710	33,435	138,500	62,820	N.A.	N.A.	N.A.	N.A.
Boeing 737-300	2	CFMI. CFM56-3B2 HBTF	22,000 lbs. st.	69,580	31,561	135,000	61,235	114,000	51,710	106,500	48,308
Boeing 737-200	2	P&W. JT8D-17R TF	16,400 lbs. st.	60,210	27,310	128,100	58,106	107,000	48,534	99,000	44,906
Douglas DC-9-30	2	P&W. JT8D-17 TF	16,000 lbs. st.	57,190	25,940	121,000	54,885	110,000	49,895	98,500	44,678
SUD-EST SE.210 Caravelle 10B3	2	P&W. JT8D-7 TF	14,000 lbs. st.	66,259	30,055	119,048	54,000	109,127	49,500	87,081	39,500
BAC 1-11-500	2	RR. Spek Mk512DW TF	12,550 lbs. st.	54,582	24,758	104,500	47,400	87,000	39,462	81,000	36,741
British Aerospace BAe.146-200	4	Avco Lycoming ALF 502R-5 HBTF	6,970 lbs. st.	50,500	22,861	93,000	42,184	81,000	36,741	73,500	33,339
Fokker 100	2	RR. Tay Mk620-15 TF	13,320 lbs. st.	51,260	23,250	91,500	41,500	84,500	38,330	76,500	34,700
Fokker F.28 Fellowship	2	RR. RB.183-2 Spey Mk555-15P T	9,900 lbs. st.	38,900	17,645	73,000	33,113	69,500	31,525	62,000	28,123

N.A. = Information not available when table prepared.

HBTF = High Bypass Turbofan
TF = Turbofan
TJ = Turbojet
TP = Turboprop
RP = Radial Piston
IP = In-Line Piston

Table 2.26 (continued)
Characteristics of Air Carrier (14 CFR 121) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
Boeing 747-400	N.A.	N.A.	211' 0"	64.31 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,650.0	524.9	N.A.	N.A.	N.A.
Boeing 747-400	N.A.	N.A.	211' 0"	64.31 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,650.0	524.9	N.A.	N.A.	N.A.
Boeing 747-400	N.A.	N.A.	211' 0"	64.31 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,650.0	524.9	N.A.	N.A.	N.A.
Boeing 747-300	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,450	6,920	N.A.
Boeing 747-300	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,450	6,920	N.A.
Boeing 747-300	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,450	6,920	N.A.
Boeing 747-300	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,450	6,920	N.A.
Boeing 747-200	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,400	6,950	N.A.
Boeing 747-200	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,400	6,950	N.A.
Boeing 747-200	46,385	210,867	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	5,500.0	511.0	10,400	6,950	N.A.
McDonnell Douglas MD-11	32,185	146,300	169' 6"	51.70 m.	198' 7"	60.50 m.	57' 9"	17.60 m.	3,674.0	341.3	10,100	6,470	N.A.
McDonnell Douglas MD-11	32,185	146,300	169' 6"	51.70 m.	198' 7"	60.50 m.	57' 9"	17.60 m.	3,674.0	341.3	10,100	6,470	N.A.
McDonnell Douglas DC-10-30	39,850	150,850	165' 4"	50.40 m.	182' 1"	55.50 m.	58' 1"	17.70 m.	3,958.0	367.7	9,289	5,970	N.A.
McDonnell Douglas DC-10-30	39,850	150,850	165' 4"	50.40 m.	182' 1"	55.50 m.	58' 1"	17.70 m.	3,958.0	367.7	9,289	5,970	N.A.
McDonnell Douglas DC-10-30	39,850	150,850	165' 4"	50.40 m.	182' 1"	55.50 m.	58' 1"	17.70 m.	3,958.0	367.7	9,289	5,970	N.A.
Airbus A.340-300	24,500	111,380	190' 0"	58.0 m.	208' 8"	63.6 m.	55' 1.5"	16.8 m.	3,500.0	325.2	N.A.	N.A.	N.A.
Airbus A.340-200	24,500	111,380	190' 0"	58.0 m.	194' 10"	59.38 m.	55' 1.5"	16.8 m.	3,500.0	325.2	N.A.	N.A.	N.A.
Lockheed L.1011-500	26,347	119,774	164' 4"	50.09 m.	164' 2.5"	50.05 m.	55' 4"	16.87 m.	3,541.0	329.0	9,200	6,770	N.A.
Airbus A.330	24,500	111,380	190' 0"	58.0 m.	205' 4.5"	62.6 m.	55' 1.5"	16.8 m.	3,500.0	325.2	N.A.	N.A.	N.A.
Airbus A.330	24,500	111,380	190' 0"	58.0 m.	205' 4.5"	62.6 m.	55' 1.5"	16.8 m.	3,500.0	325.2	N.A.	N.A.	N.A.
Aerospatiale BAC Concorde	26,350	119,786	83' 10"	25.56 m.	203' 9"	62.10 m.	37' 5"	11.40 m.	3,856.0	358.3	11,200	7,300	N.A.
Airbus A.300-600	13,836	62,900	147' 1"	44.84 m.	177' 5"	54.08 m.	54' 6.5 "	16.62 m.	2,798.6	260.0	7,600	5,025	N.A.
Douglas DC-8-73	20,213	91,890	148' 5"	45.20 m.	187' 5"	57.12 m.	43' 0"	13.11 m.	2,927.0	271.9	10,000	6,500	N.A.
Boeing 767-300	13,900	63,216	157' 1"	47.57 m.	180' 3"	54.94 m.	52' 0"	15.85 m.	3,050.0	283.3	7,900	5,600	N.A.
Boeing 767-300	13,900	63,216	157' 1"	47.57 m.	180' 3"	54.94 m.	52' 0"	15.85 m.	3,050.0	283.3	7,900	5,600	N.A.
Airbus A.310-300	15,016	68,260	144' 0"	43.90 m.	153' 1"	46.66 m.	51' 10"	15.81 m.	2,357.0	219.0	7,575	5,000	N.A.
Boeing 707-320C	19,863	90,299	145' 9"	44.42 m.	152' 11"	46.6 m.	42' 5"	12.93 m.	3,050.0	283.4	10,020	6,400	N.A.
Boeing 767-200	13,900	63,216	156' 1"	47.57 m.	159' 2"	48.51 m.	52' 0"	15.85 m.	3,050.0	283.3	5,650	4,750	N.A.
Boeing 767-200	13,900	63,216	156' 1"	47.57 m.	159' 2"	48.51 m.	52' 0"	15.85 m.	3,050.0	283.3	5,650	4,750	N.A.
Boeing 757-200	9,370	42,597	124' 10"	38.05 m.	155' 3"	47.32 m.	44' 6"	13.56 m.	1,994.0	185.3	7,760	4,600	N.A.
Boeing 757-200	9,370	42,597	124' 10"	38.05 m.	155' 3"	47.32 m.	44' 6"	13.56 m.	1,994.0	185.3	7,760	4,600	N.A.
Boeing 727-200	7,282	40,010	108' 0"	32.92 m.	153' 2"	46.69 m.	34' 0"	10.36 m.	1,700.0	157.9	9,950	4,900	N.A.
Airbuse A.321	N.A.	N.A.	111' 9.5"	34.09 m.	146' 0"	44.50 m.	38' 8.5"	11.80 m.	1,320.0	123.0	N.A.	N.A.	N.A.
McDonnell Douglas MD-90-55	N.A.	N.A.	107' 10"	32.87 m.	152' 7"	46.51 m.	30' 7"	9.33 m.	1,209.0	112.3	N.A.	N.A.	N.A.
Boeing 737-800	N.A.	N.A.	111' 2"	33.90 m.	128' 6"	39.20 m.	36' 6"	11.13 m.	1,344.0	125.0	N.A.	N.A.	N.A.
Airbus A.320-200	5,150	23,410	111' 9.5"	34.09 m.	123' 3"	37.58 m.	38' 8.5"	11.80 m.	1,320.0	123.0	5,630	4,750	N.A.
McDonnell Douglas MD-90-30	N.A.	N.A.	107' 10"	32.87 m.	152' 7"	46.51 m.	30' 7"	9.33 m.	1,209.0	112.3	N.A.	N.A.	N.A.
Boeing 737-700	N.A.	N.A.	111' 2"	33.90 m.	101' 8"	31.00 m.	36' 6"	11.13 m.	1,344.0	125.0	N.A.	N.A	N.A.
Airbus A.320-100	3,380	15,365	111' 3"	33.91 m.	123' 3"	37.58 m.	38' 7"	11.76 m.	1,317.5	122.4	5,630	4,750	N.A.
McDonnell Douglas MD-81	4,812	21,876	107' 10"	32.87 m.	147' 10"	45.06 m.	29' 8"	9.04 m.	1,270.0	118.0	7,250	4,860	N.A.
Boeing 737-400	N.A.	N.A.	94' 9"	28.88 m.	119' 7"	36.45 m.	36' 6"	11.13 m.	1,135.0	105.4	N.A.	N.A.	N.A.
Boeing 737-300	5,096	23,170	94' 9"	28.88 m.	109' 7"	33.40 m.	36' 6"	11.13 m.	1,135.0	105.4	6,360	4,580	N.A.
Boeing 737-200	4,971	22,598	93' 0"	28.35 m.	100' 2"	30.53 m.	37' 0"	11.28 m.	1,098.0	102.0	6,000	4,430	N.A.
Douglas DC-9-30	3,063	13,925	93' 5"	28.47 m.	119' 3.5"	36.37 m.	27' 6"	8.38 m.	1,000.7	93.0	5,530	4,290	N.A.
SUD-EST SE.210 Caravelle 10B3	4,180	19,000	112' 6"	34.30 m.	108' 3.5"	33.01 m.	28' 7"	8.72 m.	1,579.0	146.7	6,850	5,180	N.A.
BAC 1-11-500	3,785	17,206	93' 6"	28.50 m.	107' 0"	32.61 m.	24' 6"	7.47 m.	1,031.0	95.8	7,300	N.A.	N.A.
British Aerospace BAe.146-200	2,838	12,901	86' 5"	26.34 m.	93' 10"	28.60 m.	28' 3"	8.61 m.	832.0	77.3	4,950	3,790	N.A.
Fokker 100	2,868	13,040	92' 1.5"	28.08 m.	15' 10.3"	35.31 m.	27' 10.5"	8.50 m.	1,014.7	94.3	5,970	4,430	N.A.
Fokker F.28 Fellowship	2,869	13,040	82' 3"	25.07 m.	97' 1.8"	29.61 m.	27' 9.5"	8.47 m.	850.0	79.0	5,200	3,495	N.A.

N.A. = Information not available when table prepared.

Table 2.26 (continued)
Characteristics of Air Carrier (14 CFR 121) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram
AIR CARRIER (14 CFR 121) TURBOPROPS											
Lockheed L-100-30 Hercules	4	Allison 501D-22A TP	4,680 ehp	77,680	35,235	155,000	70,308	135,000	61,235	128,790	58,420
Lockheed L-188A Electra	4	Allison 501D-13 TP	3,750 shp	61,500	27,895	116,000	52,664	95,650	43,385	86,000	39,010
Vickers Viscount 800	4	RR. Dart Mk510 TP	1,740 ehp	41,000	18,600	64,500	29,260	58,500	26,535	54,000	24,494
Convair 580	2	Allison 501-D13H TP	3,750 shp	30,275	13,732	58,140	26,371	50,670	22,985	N.A.	N.A.
British Aerospace ATP	2	P&WC. PW124 TP	2,150 shp	29,970	13,594	49,500	22,453	48,000	21,773	44,300	20,094
Saab 2000	2	Allison AE2100A TP	4,125 shp	29,762	13,500	48,500	22,000	N.A.	N.A.	N.A.	N.A.
ATR.72-200	2	P&WC. PW124B TP	2,160 shp	27,558	12,500	47,400	21,500	N.A.	N.A.	N.A.	N.A.
Fokker F.50	2	P&WC. PW124 TP	2,150 shp	27,850	12,633	45,900	20,820	41,865	18,990	40,350	18,303
Fokker F.27 Friendship	2	RR. Dart Mk522 TP	2,280 ehp	22,696	10,295	45,000	20,410	41,000	18,600	39,500	17,917
DeHavilland Can. DHC-7-100	4	P&W. PT6A-50 TP	1,120 shp	27,690	12,560	44,000	19,958	44,000	19,958	39,000	17,690
ATR.42-200	2	P&WC. PW120 TP	1,800 shp	21,986	9,973	34,722	15,750	34,171	15,500	31,966	14,500
DeHavilland Can. DHC-8-100	2	P&W. PW120A TP	1,800 shp	21,590	9,793	34,500	15,649	33,900	14,923	31,000	14,062
CASA-Nurtanio CN.235	2	GE. CT7-7A TP	1,700 shp	20,723	9,400	31,746	14,400	31,305	14,200	29,982	13,600
Dornier 328	2	P&W. PW119B TP	1,850 shp	19,420	8,810	30,071	13,640	N.A.	N.A.	N.A.	N.A.
Saab Fairchild 340	2	GE. CT7-5A2 TP	1,735 shp	17,215	7,808	27,275	12,371	26,500	12,020	25,000	11,340
Shorts 360	2	P&W. PT6A-65AR TP	1,424 shp	16,950	7,689	26,000	11,793	25,700	11,657	N.A.	N.A.
AIR CARRIER (14 CFR 121) PISTONPROPS											
Douglas DC-7C	4	W. R3350-EA1 RP	3,400 hp	80,000	36,287	143,000	64,865	N.A.	N.A.	N.A.	N.A.
Douglas DC-7F	4	W. R3350-EA1 RP	3,400 hp	66,200	30,030	126,000	57,153	N.A.	N.A.	N.A.	N.A.
Douglas DC-6B	4	P&W R2800-CB17 RP	2,500 hp	62,000	28,123	107,000	48,534	88,200	40,000	83,200	37,740
Douglas DC-4	4	P&W R2000-2SD-BG RP	1450 shp	43,300	19,460	73,000	33,112	N.A.	N.A.	N.A.	N.A.
Convair 440	2	P&W R2800-CB17 RP	2,500 hp	33,314	15,110	49,700	22,544	47,650	21,614	47,000	21,320
Curtiss C-46 Commando	2	P&W R2800-34 RP	2,000 shp	33,000	14,970	48,000	21,772	46,800	21,228	45,168	20,488
Convair 340	2	P&W R2800-CB16 RP	2,400 hp	29,486	13,375	47,000	21,320	N.A.	N.A.	N.A.	N.A.
Convair 240	2	P&W R2800-CA18 RP	2,000 hp	27,600	12,520	41,790	18,956	N.A.	N.A.	N.A.	N.A.
Douglas DC-3	2	P&W R1830-92 RP	1,200 hp	17,720	8,030	26,000	12,700	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

HBTF = High Bypass Turbofan
TF = Turbofan
TJ = Turbojet
TP = Turboprop
RP = Radial Piston
IP = In-Line Piston

Table 2.26 (continued)
Characteristics of Air Carrier (14 CFR 121) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
Lockheed L-100-30 Hercules	9980 US	37,770	132' 7"	40.41 m.	112' 9"	34.37 m.	38' 3"	11.66 m.	1,745.0	162.1	6,200	4,850	N.A.
Lockheed L-188A Electra	4,596	20,895	99' 0"	30.18 m.	104' 6"	31.81 m.	32' 10"	10.0 m.	1,300.0	120.8	4,720	4,300	N.A.
Vickers Viscount 800	1,945	8,842	93' 8"	28.55 m.	85' 8"	26.11 m.	26' 9"	8.15 m.	963.0	89.4	5,310	4,950	N.A.
Convair 580	2,398	10,901	105' 4"	32.12 m.	81' 6"	24.84 m.	29' 2"	8.89 m.	920.0	85.5	4,700	4,160	N.A.
British Aerospace ATP	1,400	6,365	100' 6"	30.63 m.	85' 4"	21.01 m.	23' 5"	7.14 m.	843.0	78.3	N.A.	N.A.	N.A.
Saab 2000	N.A.	N.A.	81' 3"	24.76 m.	88' 8"	27.03 m.	25' 4"	7.73 m.	600.0	55.7	N.A.	N.A.	N.A.
ATR.72-200	N.A.	N.A.	88' 9"	27.05 m.	89' 2"	27.18 m.	25' 1"	7.65 m.	656.6	61.0	N.A.	N.A.	N.A.
Fokker F.50	1,130	5,136	95' 1.8"	29.00 m.	82' 10"	25.25 m.	28' 7"	8.60 m.	754.0	70.0	5,770	3,490	N.A.
Fokker F.27 Friendship	1,634	7,425	95' 2"	29.00 m.	77' 3.5"	23.56 m.	27' 11"	8.51 m.	753.5	70.0	3,240	3,290	N.A.
DeHavilland Can. DHC-7-100	1,232	5,602	93' 0"	28.35 m.	80' 6"	24.54 m.	26' 2"	7.98 m.	860.0	79.9	2,250	2,160	76
ATR.42-200	1,254	5,700	80' 7.5"	24.57 m.	74' 4.5"	22.67 m.	24' 11"	7.59 m.	586.6	54.5	3,575	3,150	N.A.
DeHavilland Can. DHC-8-100	1,244	5,656	85' 0"	25.91 m.	73' 0"	22.25 m.	24' 7"	7.49 m.	585.0	54.4	3,110	3,150	N.A.
CASA-Nurtanio CN.235	1,159	5,268	84' 8"	25.81 m.	70' 0.75"	21.35 m.	26' 10"	8.18 m.	645.8	60.0	2,165	1,920	N.A.
Dornier 328	N.A.	N.A.	68' 10"	20.98 m.	69' 8"	21.22 m.	23' 9"	7.24 m.	N.A.	N.A.	N.A.	N.A.	N.A.
Saab Fairchild 340	708	3,220	70' 4"	21.44 m.	64' 6"	19.72 m.	22' 6.5"	6.87 m.	450.0	41.8	4,000	4,000	N.A.
Shorts 360	480	2,182	74' 10"	22.81 m.	70' 10"	21.59 m.	23' 8"	7.21 m.	453.0	42.1	4,200	4,020	N.A.
Douglas DC-7C	N.A.	N.A.	127' 6"	38.80 m.	112' 3"	34.23 m.	31' 8"	9.65 m.	1,637.0	152.0	N.A.	N.A.	N.A.
Douglas DC-7F	N.A.	N.A.	117' 6"	35.81 m.	108' 11"	33.24 m.	29' 3"	8.92 m.	1,463.0	135.9	N.A.	N.A.	N.A.
Douglas DC-6B	4,580	20,820	117' 6"	35.81 m.	105' 7"	32.18 m.	29' 3"	8.92 m.	1,463.0	135.9	6,150	5,000	N.A.
Douglas DC-4	N.A.	N.A.	117' 6"	35.81 m.	93' 10"	28.60 m.	27' 6"	8.38 m.	1,460.0	135.6	N.A.	N.A.	N.A.
Convair 440	1,440	6,546	105' 4"	32.12 m.	81' 6"	24.84 m.	28' 2"	8.59 m.	920.0	85.5	N.A.	N.A.	N.A.
Curtiss C-46 Commando	1400 US	5,305	108' 0"	32.92 m.	76' 4"	23.27 m	21' 8"	6.60 m.	1,358.0	126.2	N.A.	N.A.	N.A.
Convair 340	N.A.	N.A.	105' 4"	32.12 m.	79' 2"	24.13 m.	28' 2"	8.59 m.	920.0	85.5	N.A.	N.A.	N.A.
Convair 240	N.A.	N.A.	91' 9"	27.97 m.	74' 8"	22.76 m.	26' 11"	8.20 m.	817.0	75.9	N.A.	N.A.	N.A.
Douglas DC-3	670	3,046	95' 0"	28.96 m.	64' 6"	19.66 m.	16' 11.5"	5.16 m.	987.0	91.7	N.A.	N.A.	N.A.

N.A. = *Information not available when table prepared.*

Table 2.27
Characteristics of Scheduled Air Taxi (14 CFR 135) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram
Embraer EMB-120 Brasilia	2	P&WC. PW118 TP	1,800 shp	15,163	6,878	25,353	11,500	24,802	11,250	23,148	10,500
British Aerospace Jetstream 41	2	Garrett TPE331-14 TP	1,650 shp	14,000	6,350	24,000	10,895	N.A.	N.A.	N.A.	N.A.
Aerospatiale Nord 262C	2	Turbomeca Bastan VIIA TP	1,130 shp	15,929	7,225	23,810	10,800	23,040	10,450	22,710	10,300
Shorts 330-200	2	P&WC. PT6A-45R TP	1,198 shp	14,727	6,680	22,900	10,387	22,600	10,251	N.A.	N.A.
British Aerospace Jetstream 31	2	Garrett TPE331-10UF TP	940 shp	9,570	4,341	15,212	6,900	14,550	6,600	13,889	6,300
Fairchild Swearingen Metro III	2	Garrett TPE-331-11U-611G TP	1,000 shp	8,737	3,963	14,500	6,577	14,000	6,350	12,500	5,670
Beechcraft 1900	2	P&WC. PT6A-65B TP	1,100 shp	8,700	3,946	16,600	7,530	16,100	7,303	14,000	6,350
Embraer EMB-110 Bandeirante	2	P&WC. PT6A-34 TP	750 shp	8,565	3,855	13,010	5,900	12,566	5,700	12,015	5,450
Dornier 228	2	Garrett TPE331-5-252D TP	715 shp	7,820	3,547	12,566	5,700	12,566	5,700	11,900	5,400
DeHavilland Can. DHC.6-300	2	P&W. PT6A-27 TP	620 shp	7,415	3,363	12,500	5,670	12,500	5,670	12,300	5,579
Beechcraft C99	2	P&WC. PT6A-36 TP	715 shp	6,494	2,946	11,300	5,126	11,300	5,126	N.A.	N.A.
GAF Nomad 24A Commuterliner	2	Detroit Allison 250-B17B TP	400 shp	5,197	N.A.	9,400	N.A.	N.A.	N.A.	N.A.	N.A.
GAF Nomad N22B Commuterliner	2	Allison 250-B17C TP	420 shp	5,436	2,446	8,500	3,855	8,500	3,855	8,250	3,742
Pilatus BN.2T Turbo Islander	2	Detroit Allison 250-B17C TP	400 shp	4,040	1,832	7,000	3,175	6,800	3,084	6,300	2,857

N.A. = Information not available when table prepared.

HBTF = High Bypass Turbofan
TF = Turbofan
TJ = Turbojet
TP = Turboprop
RP = Radial Piston
IP = In-Line Piston

Table 2.27 (continued)
Characteristics of Scheduled Air Taxi (14 CFR 135) Aircraft
[Reference 2.33 and 2.34]

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
Embraer EMB-120 Brasilia	734	3,340	64' 10.8"	19.78 m.	65' 7"	20.00 m.	20' 10"	6.35 m.	424.5	39.4	4,660	4,495	N.A.
British Aerospace Jetstream 41	N.A.	N.A.	60' 0"	18.29 m.	63' 2"	19.25 m.	18' 10"	5.74 m.	350.8	32.6	N.A.	N.A.	N.A.
Aerospatiale Nord 262C	565	2,570	74' 2"	22.60 m.	63' 3"	19.28 m.	20' 4"	6.21 m.	592.0	55.0	2,690	N.A.	N.A.
Shorts 330-200	560	2,546	74' 8"	22.76 m.	58' 0.5"	17.69 m.	16' 3"	4.95 m.	453.0	42.1	3,420	3,380	N.A.
British Aerospace Jetstream 31	378	1,718	52' 0"	15.85 m.	47' 1.5"	14.37 m.	17' 5.5"	5.32 m.	271.3	25.2	3,200	3,820	N.A.
Fairchild Swearingen Metro III	540	2,452	57' 10"	17.37 m.	59' 4.3"	18.09 m.	16' 8"	5.08 m.	309.0	28.7	3,250	2,805	99
Beechcraft 1900	358	1,627	54' 6"	16.61 m.	57' 10"	17.63 m.	14' 11"	4.54 m.	303.0	28.2	3,260	2,540	N.A.
Embraer EMB-110 Bandeirante	378	1,720	50' 3.5"	15.33 m.	49' 6.5"	15.10 m.	16' 1.8"	4.92 m.	313.2	29.1	4,000	4,400	N.A.
Dornier 228	525	2,386	55' 8"	16.97 m.	54' 3"	16.55 m.	15' 11.5"	4.86 m.	344.3	32.0	1,945	1,970	N.A.
DeHavilland Can. DHC.6-300	393	1,783	65' 0"	19.81 m.	51' 9"	15.77 m.	19' 6"	5.94 m.	420.0	39.0	1,500	1,940	66
Beechcraft C99	310	1,412	45' 10.5"	13.98 m.	44' 7"	13.58 m.	14' 4"	4.37 m.	279.7	26.0	N.A.	N.A.	N.A.
GAF Nomad 24A Commuterliner	389	1,770	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,706	1,380	65
GAF Nomad N22B Commuterliner	371	1,688	54' 2"	16.51 m.	41' 3"	12.57 m.	18' 2"	5.54 m.	324.0	30.1	1,180	1,340	62
Pilatus BN.2T Turbo Islander	108	492	53' 0"	16.15 m.	36' 3.8"	11.07 m.	13' 8.8"	4.18 m.	337.0	31.3	1,250	1,115	N.A.

N.A. = Information not available when table prepared.

2.6 COMMERCIAL AVIATION REFERENCES

[2.1] "Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 121 (14 CFR 121), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[2.2] "Air Taxi Operators and Commercial Operators", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 135 (14 CFR 135), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[2.3] Commercial Aviation Safety, Alexander T. Wells, TAB Books, Blue Ridge Summit, PA, 1991.

[2.4] "Air Traffic and General Operating and Flight Rules", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I, Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 91 (14 CFR 91), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[2.5] DOE Standard Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE-STD-3014-96, U.S. Department of Energy, Washington, DC, July 1996.

[2.6] Annual Reviews of Aircraft Accident Data, U.S. Air Carrier Operations, 1973, NTSB/ARC-74-2, U.S. National Transportation Safety Board, Bureau of Aviation Safety, Washington, DC, October 24, 1974.

[2.7] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1974, NTSB/ARC-76-1, U.S. National Transportation Safety Board, Bureau of Aviation Safety, Washington, DC, December 30, 1975.

[2.8] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1975, NTSB/ARC-77-1, U.S. National Transportation Safety Board, Bureau of Technology, Washington, DC, January 25, 1977.

[2.9] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1976, NTSB/ARC-78-1, U.S. National Transportation Safety Board, Bureau of Technology, Washington, DC, January 5, 1978.

[2.10] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1977, NTSB/ARC-78-2, U.S. National Transportation Safety Board, Bureau of Technology, Washington, DC, September 6, 1978.

[2.11] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1978, NTSB/ARC-80-1, U.S. National Transportation Safety Board, Bureau of Technology, Washington, DC, October 6, 1980.

[2.12] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, 1979, NTSB/ARC-81-1, U.S. National Transportation Safety Board, Bureau of Technology, Washington, DC, November 16, 1981.

[2.13] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1980, NTSB/ARC-83/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, January 14, 1983.

[2.14] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1981, NTSB/ARC-85/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, February 1, 1985.

[2.15] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1982, NTSB/ARC-86/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, (No Date).

[2.16] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1983, NTSB/ARC-87/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, February 13, 1987.

[2.17] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1984, NTSB/ARC-87/02, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, April 15, 1987.

[2.18] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1985, NTSB/ARC-87/03, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, November 27, 1987.

[2.19] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1986, NTSB/ARC-89/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, February 3, 1989.

[2.20] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1987, NTSB/ARC-90/01, U.S. National Transportation Safety Board, Washington, DC, November 29, 1990.

[2.21] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1988, NTSB/ARC-91/01, U.S. National Transportation Safety Board, Washington, DC, April 18, 1991.

[2.22] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1989, NTSB/ARC-93/01, U.S. National Transportation Safety Board, Washington, DC, May 7, 1993.

[2.23] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1990, NTSB/ARC-93/02, U.S. National Transportation Safety Board, Washington, DC, October 4, 1993.

[2.24] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1991, NTSB/ARC-94/01, U.S. National Transportation Safety Board, Washington, DC, April 15, 1994.

[2.25] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1992, NTSB/ARC-94-02, U.S. National Transportation Safety Board, Washington, DC, September 15, 1994.

[2.26] Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1993, NTSB/ARC-95/01, U.S. National Transportation Safety Board, Washington, DC, September 8, 1995.

[2.27] NTSB News Annual Press Release on U.S. Airline Accidents, SB 95-03, January 19, 1995.

[2.28] NTSB News Annual Press Release on U.S. Airline Accidents, SB 96-03, January 25, 1996.

[2.29] "Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air

Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 129 (14 CFR 129), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[2.30] Statistical Summary of Commercial Jet Aircraft Accidents Worldwide Operations 1959-1993, Boeing Commercial Airplane Group, Seattle, WA, March 1994.

[2.31] ACRAM Modeling Technical Support Document, LA-UR-96-2460/TSA-11-95-R12, C. Bolig, D. Sanzo, D. Stack, R. Mensing, and R. Glasser, Los Alamos National Laboratory, Los Alamos, NM, July, 1996.

[2.32] Probabilistic Model, Analysis and Computer Code for Take-off and Landing Related Aircraft Crashes into a Structure, UCRL-ID-122512, Ron Glaser,Lawrence Livermore National Laboratory, Livermore, CA, February 6, 1996.

[2.33] Modern Commercial Aircraft, William Green, Gordon Swanborough, and John Mowinski, Portland House, New York, NY, 1987.

[2.34] The International Directory of Civil Aircraft, 1995/1996, Gerard Frawley and Jim Thorn, Aerospace Publications Pty Ltd, Westron Creek, Australia, 1995.

APPENDIX 2. COMMERCIAL AVIATION

APPENDIX 2.1 NATIONAL TRANSPORTATION SAFETY BOARD (NTSB) 14 CFR 121 ACCIDENT DATABASE USED IN THE ACRAM DATA DEVELOPMENT TECHNICAL SUPPORT DOCUMENT

This appendix presents the database of aircrafts that suffered an accident while flying under 14 CFR 121 regulations during the years 1973 to 1994. This database was used in the development of the ACRAM Data Development Technical Support Document and was derived primarily from the National Transportation Safety Board accident database and various other NTSB publications. The following information, listed in order of columns from left to right, is presented for each accident in the database:

1. Accident Date (ACC. DATE)
2. Airline or Operator of Aircraft and Flight Number (OPERATOR Flt. No.)
3. Type of Flight (FLT. TYPE)
4. AIRCRAFT TYPE
5. Registration Number (REGN. NO.)
6. AIRCRAFT DAMAGE
7. Flight Phase that Accident Occurred (FLT. PHS.)
8. Airport Proximity (on/off)
9. ACCIDENT LOCATION
10. Degree of Injuries Associated with Accident (Injury Degree)
11. Crew FATALITIES
12. Passenger (Pass.) FATALITIES
13. Other FATALITIES
14. Total (Crew+Pass.+Other) FATALITIES
15. Number of Serious Injuries (Serious Injury)
16. Total Crew Aboard Aircraft (Crew Aboard AC)
17. Total Passengers Aboard Aircraft (Pass. Aboard AC)
18. NTSB Report Where Information Was Obtained (NTSB Report)
19. NTSB File Number
20. NTSB First Occurrence Classification

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Fit. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.20.73	American AL	SP	B.707-	N8436	Major	CC	off	Elk Grove Village, IL	Minor/N	0	0	0	0	0	8	64	ARC-74-2	1-0001	Eng. fail./malfunction, miscellaneous
2.26.73	Delta AL	SP	DC-8-61	N1302L	None	ID(s)	off	Las Vegas, NV	Serious	0	0	0	0	1	9	119	ARC-74-2	1-0002	Turbulence
3.03.73	Trans World AL	SP	B.727-231	N12307	Major	L	on	Wichita Midcontinent Airport, KS	Minor/N	0	0	0	0	0	7	60	ARC-74-2	1-0005	Overshoot, grd./water loop/swerve
3.05.73	American AL	Fy.	B.707-	N7577A	Major	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	Minor/N	0	0	0	0	0	3	0	ARC-74-2	1-0009	Grd./water loop/swerve, collision w/ grd./water, u
3.17.73	United AL	SP	B.727-22	N7002	None	E R	off	Harrisburg, PA	Serious	0	0	0	0	2	7	69	ARC-74-2	1-0007	Turbulence
3.17.73	Saturn AW	NSF	L.100-382G	N11ST	Major	L	on	Pensacola NAS, FL	Minor/N	0	0	0	0	0	3	0	ARC-74-2	1-0008	Gear collapse
4.01.73	Delta AL	SP	DC-9-32	N3324L	None	E R	off	ER New York, NY-Atlanta, GA	Serious	0	0	0	0	1	5	50	ARC-74-2	1-0004	Turbulence
4.09.73	Pan American AW	SF	B.707-	N473PA	Major	Taxi	on	Miami Intn'l Airport, FL (MIA)	Minor/N	0	0	0	0	0	3	0	ARC-74-2	1-0010	Gear collapse
4.26.73	Northwest AL	SP	B.747-151	N601US	None	E R	off	Tallahassee, FL	Serious	0	0	0	0	1	10	91	ARC-74-2	1-0006	Turbulence
6.12.73	Allegheny AL	SP	CV.580	N5637	Major	IC	off	Pittsburgh, PA	Minor/N	0	0	0	0	0	3	50	ARC-74-2	1-0014	Miscellaneous, gear collapse
6.20.73	Overseas National AW	NSP	DC-8-63	N863F	Minor	TO	on	Bangor Intn'l Airport, ME	Serious	0	0	0	0	3	10	251	AAR-74-01	1-0015	Airframe fail., fire/explosion
6.29.73	Western AL	SP	B.737-247	N4508W	None	E R	off	West Yellowstone, MT	Serious	0	0	0	0	1	5	34	ARC-74-2	1-0016	Turbulence
7.22.73	Pan American AW 816	SP	B.707-321B	N417PA	Destroyed	IC	off	Papette Faaa Airport, Tahiti	Fatal	10	68	0	78	1	10	69	ARC-74-2	1-0038	Collision w/ grd./water
7.23.73	Ozark AL 809	SP	FH.227B	N4215	Destroyed	RA	off	St. Louis Lambert Intn'l Airport, MO (STL)	Fatal	1	37	0	38	6	3	41	AAR-74-05	1-0041	Collision w/ grd./water, controlled
7.24.73	Frontier AL	SP	B.737-	N7370F	None	CC	off	St. Louis, MO	Serious	0	0	0	0	1	8	19	ARC-74-2	1-0013	Turbulence
7.31.73	Delta AL 723	SP	DC-9-31	N975NE	Destroyed	RA	on	Boston Logan Intn'l Airport, MA (BOS)	Fatal	6	83	0	89	0	6	83	AAR-74-03	1-0011	Collision w/ object
8.08.73	Braniff AW	SP	B.727-	N1726T	Major	E R	off	Washington, DC	Minor/N	0	0	0	0	0	6	75	ARC-74-2	1-0039	Fire/explosion, in-flt.
8.10.73	National AL	SP	DC-10-	N67NA	None	E R	off	New Orleans, LA	Serious	0	0	0	0	1	12	201	ARC-74-2	1-0034	Miscellaneous
8.15.73	Allegheny AL	SP	BAC 1-11	N136J	None	ID	off	Baltimore, MD	Serious	0	0	0	0	1	4	39	ARC-74-2	1-0040	Turbulence
8.16.73	Frontier AL	SP	B.737-	N7361F	None	E R	off	Missoula, MT	Serious	0	0	0	0	1	8	50	ARC-74-2	1-0022	Miscellaneous
8.20.73	Delta AL	SP	DC-8-51	N821E	None	E R	off	Belle Glade, FL	Serious	0	0	0	0	1	7	74	ARC-74-2	1-0021	Turbulence
8.22.73	Frontier AL	SP	B.737-	N7361F	None	E R	off	Rapid City, SD	Serious	0	0	0	0	1	8	40	ARC-74-2	1-0025	Miscellaneous
8.25.73	Eastern AL	SP	L.1011-	N381EA	None	E R	off	Grand Turk Island, Bahamas	Serious	0	0	0	0	1	12	167	ARC-74-2	1-0032	Turbulence
8.27.73	Trans World AL	SP	B.707-	N18703	None	E R	off	North Atlantic Ocean	Serious	0	0	0	0	1	9	75	ARC-74-2	1-0020	Turbulence
8.28.73	Trans World AL 742	SP	B.707-331B	N8705T	None	ID	off	Los Angeles, CA	Fatal	0	1	0	1	3	11	141	AAR-74-06	1-0042	Miscellaneous
9.04.73	American AL	SP	B.747-	N9676	None	E R	off	North Atlantic Ocean	Serious	0	0	0	0	1	16	330	ARC-74-2	1-0023	Turbulence
9.08.73	World AW 802	NSF	DC-8-63CF	N802WA	Destroyed	AA	off	King Cove, 24 kms. S of Cold Bay, AK	Fatal	3	3	0	6	0	3	3	AAR-74-06	1-0018	Collision w/ grd./water, controlled
9.27.73	Texas Intn'l AL 655	SP	CV.600	N94230	Destroyed	E R	off	Black Fork Mtn., Mena, AR	Fatal	3	8	0	11	0	3	8	AAR-74-04	1-0017	Collision w/ grd./water, controlled
10.08.73	Flying Tiger Line	SF	DC-8-	N794FT	None	Taxi	on	Tokyo Haneda Intn'l Airport, Japan	Fatal	0	0	1	1	0	3	0	ARC-74-2	1-0027	Collision w/ object
10.26.73	Piedmont AL	SP	B.737-222	N751N	Major	L	on	Greensboro/High Pt. Regional Airport, NC	Minor/N	0	0	0	0	0	4	92	AAR-74-07	1-0019	Overshoot, gear collapse
11.03.73	Pan American AW 160	SP	B.707-321CF	N458PA	Destroyed	RA	off	Boston, MA	Fatal	3	0	0	3	0	3	0	AAR-74-16	Z010	Collision w/ grd./water, uncontrolled
11.03.73	National AL 27	SP	DC-10-10	N60NA	Major	E R	off	Socorro, NM	Fatal	0	1	0	1	0	12	115	AAR-75-02	L031	Eng. fail./malfunction
11.27.73	Delta AL 516	SP	DC-9-32	N3323L	Major-W.O.	RA	on	Chattanooga Municipal Airport, TN (CHA)	Serious	0	0	0	0	3	5	74	AAR-74-13	Z011	Collision w/ RW/app. lights
11.27.73	Eastern AL 300	SP	DC-9-31	N8967E	Destroyed	L	on	Canton/Akron Regional Airport, OH (CAK)	Serious	0	0	0	0	16	5	21	AAR-74-12	Z012	Overshoot
12.09.73	Northwest AL	SP	B.727-251	N259US	Major	Taxi	on	Madison Truax Field, WI	Minor/N	0	0	0	0	0	6	38	ARC-74-2	1-0033	Collision w/ object
12.17.73	Eastern AL	SP	DC-9-	N8978E	Major	TO	on	Greensboro High Point Airport, NC	Minor/N	0	0	0	0	0	4	85	ARC-74-2	1-0035	Eng. fail./malfunction, collision w/ object
12.21.73	Delta AL	SP	DC-9-32	N3338L	None	E R	off	Lebanon, NH	Serious	0	0	0	0	1	5	89	ARC-74-2	1-0031	Turbulence
12.22.73	American AL	SP	B.727-	N2914	None	G	on	Detroit Wayne Co. Metro. Airport, MI (DTW)	Serious	0	0	0	0	1	10	84	ARC-74-2	1-0036	Miscellaneous
									Total:	26	201	1	228	49	250	2601			

38 Accidents

38 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1 01 74	American AL	SP	B.707-	N7521	Minor	Taxi	on	San Antonio Intn'l Airport, TX (SAT)	Minor/N	0	0	0	0	0	8	119	ARC-76-1	1-0011	Collision w/ aircraft, both on grd.
	?	?	?	?	?	?	on		?	0	0	0	0	?	?	2	ARC-76-1	1-0011	Collision w/ aircraft, both on grd.
1 04 74	United AL	SP	B.727-222	N7624U	Minor	TO	on	Tampa Intn'l Airport, FL (TPA)	Serious	0	0	0	0	1	7	111	ARC-76-1	1-0002	Airframe fail. on grd., eng. fail. or malfunction
1.13 74	Frontier AL	SP	CV.580	N73145	None	RA	off	Cheyenne, WY	Serious	0	0	0	0	1	3	44	ARC-76-1	1-0005	Turbulence
1.16 74	Trans World AL 701	SP	B.707-131B	N757TW	Major-W.O.	L	on	Los Angeles Intn'l Airport, CA (LAX)	Serious	0	0	0	0	2	7	58	AAR-74-10	1-0012	Hard landing, gear collapse
1 17 74	Trans World AL	SF	B.707-	N791TW	Major	L	on	Indianpolis Weir Cook Intn'l Airport, IN (IND)	Minor/N	0	0	0	0	0	3	0	ARC-76-1	1-0014	Collision w/ RW or app. lights, gear collapse
1 30 74	Pan American AW 806	SP	B.707-321B	N454PA	Destroyed	RA	off (a)	Pago Pago, American Samoa	Fatal	10	87	0	97	4	10	91	AAR-77-07	1-0001	Undershoot, collision w/ trees
2 02 74	Pan American AW	SP	B.747-121	N732PA	None	E R	off	Honolulu, HI	Fatal	0	1	0	1	0	19	280	ARC-76-1	1-0004	Miscellaneous
2 15 74	Delta AL	SP	DC-9-32	N1288L	None	E R	off	Alexandria, LA	Serious	0	0	0	0	1	5	64	ARC-76-1	1-0003	Turbulence
2 16 74	Trans World AL	SP	B.707-	N788TW	Minor	AA	off	Herndon, VA	Serious	0	0	0	0	1	7	45	ARC-76-1	1-0027	Fire/explosion, in-flt.
2 21 74	Delta AL	SP	DC-9-32	N1262L	None	ID	off	Pontiac, AL	Serious	0	0	0	0	1	5	39	ARC-76-1	1-0015	Turbulence
3 21 74	Eastern AL	SP	L.1011-	N321EA	None	ID	off	Ft. Lauderdale, FL	Serious	0	0	0	0	1	12	173	ARC-76-1	1-0017	Turbulence
3.27 74	World AW	NSP	DC-8-	N801WA	Minor	TO	on	Anchorage Intn'l Airport, AK (ANC)	Serious	0	0	0	0	1	14	219	ARC-76-1	1-0019	Airframe fail. on grd., miscellaneous
4 01 74	Trans World AL	SP	B.707-	N7567W	None	E R	off	Rosewood, OH	Serious	0	0	0	0	1	7	54	ARC-76-1	1-0009	Turbulence
4.01 74	Trans World AL	SP	B.727-31	N833TW	None	E R	off	Terre Haute, IN	Serious	0	0	0	0	1	6	45	ARC-76-1	1-0018	Turbulence
4 02 74	Texas Intn'l AL	SP	CV.240D	N94239	None	E R	off	Arlington, TX	Serious	0	0	0	0	1	3	11	ARC-76-1	1-0007	Turbulence
4.18 74	Pan American AW	SP	B.747-	N653PA	None	G	on	San Juan Intn'l Airport, Puerto Rico (SJU)	Serious	0	0	0	0	1	13	0	ARC-76-1	1-0042	Miscellaneous
4 22 74	Pan American AW 812	SP	B.707-321B	N446PA	Destroyed	AA	off	Denpasar, Bali Is., Indonesia	Fatal	11	96	0	107	0	11	96	ARC-76-1	1-0047	Collision w/ grd./water controlled
5 23 74	Saturn AW 14	NSF	L.100/382-10C	N14ST	Destroyed	E R	off	Springfield, IL	Fatal	3	1	0	4	0	3	1	AAR-75-05	1-0008	Airframe fail. in-flt.
7 03 74	Delta AL	SP	L.1011-385-1	N708DA	Minor	ID	off	Atlanta, GA	Serious	0	0	0	0	2	13	138	ARC-76-1	1-0023	Turbulence, hail damage to aircraft
7 08 74	National AL	SP	DC-10-10	N60NA	Major	CC	off	Tampa, FL	Minor/N	0	0	0	0	0	12	160	AAR-74-09	1-0013	Airframe fail. in-flt.
7 10 74	American AL	SP	B.727-	N6818	None	IC	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	2	8	45	ARC-76-1	1-0026	Miscellaneous
7.24 74	Allegheny AL	SP	BAC 1-11	N1122J	None	G	on	Cleveland Hopkins Intn'l Airport, OH (CLE)	Serious	0	0	0	0	1	4	67	ARC-76-1	1-0021	Miscellaneous
7 27 74	Delta AL	SP	DC-8-61	N1303L	None	ID	off	Ft. Myers, FL	Serious	0	0	0	0	1	8	168	ARC-76-1	1-0022	Turbulence
9 01 74	Eastern AL	SP	DC-9-	N8962E	None	E R	off	Meridian, MS	Serious	0	0	0	0	1	5	59	ARC-76-1	1-0010	Turbulence
9 08 74	Trans World AL 841	SP	B.707-331B	N8734	Destroyed	E R	off	50 mi. W of Cephalonia, Greece	Fatal	9	79	0	88	0	9	79	AAR-75-07	1-0024	Fire/explosion, in-flt., collision w/ grd./water
9.11 74	Eastern AL 212	SP	DC-9-31	N8984E	Destroyed	RA	off	Charlotte Douglas Intn'l Airport, NC (CLT)	Fatal	2	70	0	72	10	4	78	AAR-75-09	1-0020	Collision w/ grd./water controlled
9 20 74	Allegheny AL	SP	BAC 1-11	N1548	None	CC	off	Pittsburgh, PA	Serious	0	0	0	0	1	4	49	ARC-76-1	1-0028	Turbulence
9 21 74	United AL	SP	B.727-	N7061U	None	CC	off	New York, NY	Serious	0	0	0	0	1	6	36	ARC-76-1	1-0039	Turbulence
9 21 74	Northwest AL	SP	B.747-251B	N615US	None	E R	off	Northern Pacific Ocean	Serious	0	0	0	0	1	15	284	ARC-76-1	1-0025	Turbulence
11 06 74	Delta AL	SP	DC-8-51	N815E	None	CC	off	Detroit, MI	Serious	0	0	0	0	1	7	118	ARC-76-1	1-0034	Turbulence
11.17 74	National AL	SP	B.727-	N4611	None	E R	off	Grand Isle, LA	Serious	0	0	0	0	2	7	67	ARC-76-1	1-0040	Turbulence
11 21 74	Allegheny AL	SP	BAC 1-11	N1120J	None	G	on	Albany Co. Airport, NY (ALB)	Serious	0	0	0	0	1	4	46	ARC-76-1	1-0033	Miscellaneous
11 21 74	Northwest AL	SP	B.747-151	N604US	Minor	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	Minor/N	0	0	0	0	0	11	11	ARC-76-1	1-0037	Collision w/ aircraft, both on grd.
	Eastern AL	SP	DC-9-	N8975E	Major	Taxi	on		Minor/N	0	0	0	0	0	5	23	ARC-76-1	1-0037	Collision w/ aircraft, both on grd.
11 25 74	Pan American AW	SP	B.707-	N765PA	Minor	TO	on	Beirut Intn'l Airport, Lebanon	Serious	0	0	0	0	1	9	21	ARC-76-1	1-0046	Eng. fail/malfunction, miscellaneous
11 25 74	Delta AL	SP	B.727-232 Adv.	N473DA	Major	G	on	New York LaGuardia Airport, NY (LGA)	Minor/N	0	0	0	0	0	7	46	ARC-76-1	1-0038	Collision w/ aircraft, both on grd.
	?	?	?	?	?	?	on		?	0	0	0	0	?	?	?	ARC-76-1	1-0038	Collision w/ aircraft, both on grd.
11 26 74	Trans World AL	SP	B.747-131	N93104	Minor	G	on	Rome Fiumicino Airport, Italy	Serious	0	0	0	0	3	14	141	ARC-76-1	1-0041	Miscellaneous
12 01 74	Eastern AL	SP	B.727-	N8123N	None	ID	off	Gordonsville, VA	Serious	0	0	0	0	1	6	92	ARC-76-1	1-0036	Turbulence
12 01 74	Trans World AL 514	SP	B.727-231	N54328	Destroyed	AA	off	Berryville, VA	Fatal	7	85	0	92	0	7	85	AAR-75-16	1-0029	Collision w/ grd./water controlled
12 05 74	Braniff AW	SP	DC-8-	N1803	None	ID	off	Bogota, Colombia	Serious	0	0	0	0	2	7	112	AAR-75-13	1-0043	Turbulence
12 10 74	American AL	SP	B.707-	N7554A	None	ID	off	Phoenix, AZ	Serious	0	0	0	0	1	6	58	ARC-76-1	1-0045	Evasive maneuver
12 28 74	American AL	SP	B.707-	N8432	None	ID	off	Richmond, VA	Serious	0	0	0	0	1	7	28	ARC-76-1	1-0044	Uncontrolled altitude deviations
									Total:	42	419	0	461	50	328	3463			

41 Accidents

44 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.22.75	Fairbanks AS	NSF	C-46F	N1663M	Major	TO	on	Arctic Village, AK	None	0	0	0	0	0	2	0	ARC-77-1	1-0005	Eng. fail. or malfunction, grd.-water loop-swerve
2.04.75	Eastern AL	SP	B.727-25	N8102N	Major	G	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	2	0	ARC-77-1	1-0002	Fire or explosion on grd.
2.16.75	Pacific Alaska AL	NSF	DC-6BF	N77DG	Destroyed	IC	off	Fairbanks Intn'l Airport, AK	Fatal	3	0	0	3	0	3	0	ARC-77-1	1-0025	Eng. fail. or malfunction, collision w/ trees
3.13.75	Northwest Orient AL	SP	DC-10-40	N149US	None	IC	off	La Crosse, WI	Serious	0	0	0	0	1	11	116	ARC-77-1	1-0043	Turbulence, miscellaneous
3.21.75	Flying Tiger Lines	NSP	DC-8-63 CF	N798FT	None	E R	off	Las Vegas, NV	Serious	0	0	0	0	1	7	172	ARC-77-1	1-0004	Turbulence
3.27.75	Fairbanks AS	NSF	C-46A	N4860V	Major	RA	on	Deadhorse, AK	None	0	0	0	0	0	2	0	ARC-77-1	1-0008	Undershoot, gear collapse
3 31.75	Western AL 470	SP	B.737-247	N4527W	Destroyed	L	on	Casper Natrona Co. Intn'l Airport, WY (CYS)	Serious	0	0	0	0	1	6	93	AAR-75-15	1-0001	Overshoot, collision w/ ditch
4.26.75	Eastern AL	SP	L.1011-1	N315EA	None	ID	off	Philadelphia, PA	Serious	0	0	0	0	1	12	241	ARC-77-1	1-0010	Miscellaneous
4.30.75	Zantop Intn'l AL	NSF	L.188AF Electra	N263F	Destroyed	L	on	Deadhorse, AK	None	0	0	0	0	0	3	0	ARC-77-1	1-0018	Hard landing
5.17.75	Fairbanks AS	NSF	C-46F	N800FA	Major-W.O.	L	on	100 mi. SE of Barrow, AK	None	0	0	0	0	0	2	0	ARC-77-1	1-0017	Grd.-water loop-swerve, collision w/ snowbank
6.13.75	Air New England	SP	FH.227C	N378NE	Major	L	on	New Bedford Municipal Airport, MA	Minor	0	0	0	0	0	3	24	ARC-77-1	1-0014	Overshoot, collision w/ object
6.14.75	Trans World AL	SP	L.1011-1	N41016	None	G	on	Los Angeles Intn'l Airport, CA (LAX)	Serious	0	0	0	0	1	13	230	ARC-77-1	1-0019	Fire or explosion on grd.
6.20.75	Frontier AL	SP	CV.580	N73168	None	E R	off	Gunnison, CO	Serious	0	0	0	0	1	3	50	ARC-77-1	1-0011	Turbulence
6.24.75	Eastern AL 66	SP	B.727-225	N8845E	Destroyed	RA	on	New York Kennedy Intn'l Airport, NY (JFK)	Fatal	6	109	0	115	9	8	116	AAR-76-08	1-0006	Undershoot, collision w/ RW or app. lights
7.12.75	American AL	SP	B.747-	N670AA	None	ID	off	Atlantic Ocean	Serious	0	0	0	0	1	14	315	ARC-77-1	1-0033	Turbulence
7.12.75	Trans World AL	SP	B.707-	N6797TW	None	ID	off	Boulder, NV	Serious	0	0	0	0	1	7	87	ARC-77-1	1-0016	Turbulence
8.06.75	Pan American AW	SP	B.707-321B	N425PA	None	E R	off	25o 10' N, 68o 10' W	Serious	0	0	0	0	1	9	92	ARC-77-1	1-0030	Turbulence
8.07.75	Continental AL 426	SP	B.727-224	N88777	Destroyed	IC	off (a)	Denver Stapleton Intn'l Airport, CO (DEN)	Serious	0	0	0	0	15	7	127	AAR-76-14	1-0012	Collision w/ grd./water, uncontrolled
8.08.75	Delta AL	SP	DC-8-51	N801E	None	E R	off	Wilmington, DE	Serious	0	0	0	0	1	7	95	ARC-77-1	1-0015	Turbulence
8.08.75	Rich Intn'l AW	NSF	C-46F	N4873V	Destroyed	RA	off	Aguadilla, Puerto Rico	None	0	0	0	0	0	2	0	ARC-77-1	1-0039	Eng. fail. or malfunction, ditching
8.13.75	Trans World AL	SP	B.707-131B	N6726	None	E R	off	Bloomington, IN	Serious	0	0	0	0	1	8	120	ARC-77-1	1-0040	Turbulence
8.16.75	Delta AL	SP	B.727-232	N468DA	Major	Taxi	on	Portland Intn'l Airport, ME	None	0	0	0	0	0	7	83	ARC-77-1	1-0029	Fire or explosion on grd.
8.23.75	American AL	SP	B.727-223	N6814	Major	L	on	Buffalo Intn'l Airport, NY	None	0	0	0	0	0	8	109	ARC-77-1	1-0027	Gear collapse
8.25.75	American AL	SP	DC-10-10	N109AA	Major	TO	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	3	13	218	ARC-77-1	1-0032	Airframe fail. on grd., fire or explosion on grd.
8.30.75	Wien Air Alaska 99	SP	F.27B	N4904	Destroyed	RA (a	off (a)	Gambell Village, St. Lawrence Is., AK	Fatal	3	7	0	10	20	4	28	AAR-76-01	1-0013	Collision w/ grd./water, controlled
9.06.75	American AL	SP	B.747-123	N9655A	Major	RA (a	off (a)	San Juan, Puerto Rico	Minor	0	0	0	0	0	14	157	ARC-77-1	1-0026	Airframe fail. in-flt.
9.15.75	Pan American AW	SP	B.747-121	N735PA	None	E R	off	San Juan, Puerto Rico	Serious	0	0	0	0	1	18	151	ARC-77-1	1-0023	Turbulence
9 20.75	Airlift Intn'l	SF	DC-8-63CF	N6161A	Major	IC	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	3	1	AAR-76-11	1-0041	Collision w/ RW or app. lights
9.22.75	Delta AL	SP	DC-8-51	N808E	None	E R	off	Texico VORTAC, TX	Serious	0	0	0	0	1	7	104	ARC-77-1	1-0028	Turbulence
9 24.75	Zantop Intn'l AL	SF	DC-8B	N3549H	Major	L	on	Cleveland Hopkins Intn'l Airport, OH	None	0	0	0	0	0	3	0	ARC-77-1	1-0042	Gear collapse
10.16.75	United AL	SP	DC-10-10	N1815U	None	Taxi	on	Seattle/Tacoma Intn'l Airport, WA (SEA)	Serious	0	0	0	0	1	12	120	ARC-77-1	1-0037	Fire or explosion on grd.
11.03.75	Trans-Intn'l AL	NSP	DC-10-30CF	N101TV	None	E R	off	Calgary, Canada	Serious	0	0	0	0	2	13	159	ARC-77-1	1-0034	Turbulence
11.12.75	Overseas National 32	SP	DC-10-30CF	N1032F	Destroyed	TO	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	2	11	128	AAR-76-19	1-0021	Eng. fail. or malfunction, fire or explosion on grd.
11.12.75	Eastern	SP	B.727-225	N8838E	Major	RA	on (a)	Raleigh/Durham Airport, NC	Serious	0	0	0	0	1	8	131	AAR-83/08	1-0022	Undershoot, collision w/ grd./water, controlled
11.26.75	American AL 182	SP	DC-10-10	N124AA	Minor	ER (a	off	Carleton, MI	Serious	0	0	0	0	3	13	175	AAR-76-03	1-0024	Evasive maneuver
	Trans World AL 37	SP	L.1011-1	N11002	Minor (a)	ER (a	off			0	0	0	0	?	?	?			
12.22.75	Braniff AW	SP	DC-8-51	N812BN	Major	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	8	116	ARC-77-1	1-0038	Gear collapse
12.22.75	Trans World AL	SP	B.707-331B	N18701	Destroyed	RA	off (a)	Milan Malpensa Airport, Italy	Serious	0	0	0	0	3	9	113	ARC-77-1	1-0044	Collision w/ grd./water, controlled
12.22.75	Delta AL	SP	B.727-232	N454DA	None	ID	off	Atlanta, GA	Serious	0	0	0	0	1	8	?	ARC-77-1	1-0045	Turbulence
									Total:	12	116	0	128	73	291	3671			

38 Accidents

39 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	FATALITIES Pass.	FATALITIES Other	FATALITIES Total	Serious Injury	Aboard AC Crew	Aboard AC Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.02.76	Overseas National AL	NSP	DC-10-30CF	N1031F	Major-W.O.	L	on	Istanbul Yesilkoy Airport, Turkey	Serious	0	0	0	0	1	12	364	ARC-78-1	1-0024	Collision w/ grd./water, controlled
1.17.76	Western AL	SP	B.727-247	N2821W	Minor	G	on	Los Angeles Intn'l Airport, CA (LAX)	Serious	0	0	0	0	2	7	49	ARC-78-1	1-0002	Miscellaneous
2.16.76	United AL	SP	B.727-222	N7620U	None	ID	off	Boise, ID	Serious	0	0	0	0	1	7	76	ARC-78-1	1-0006	Turbulence
2.16.76	Continental AL	SP	B.727-224	N88708	Minor	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	Serious	0	0	0	0	1	7	113	ARC-78-1	1-0012	Eng. fail. or malfunction, fire or explosion on grd.
2.22.76	Delta AL	SP	B.727-232	N400DA	None	ID	off	Tampa, FL	Serious	0	0	0	0	1	7	76	ARC-78-1	1-0004	Turbulence
3.03.76	Delta AL	SP	B.727-232	N483DA	None	E R	off	40 mi. NNE of Springfield, MO	Serious	0	0	0	0	1	6	86	ARC-78-1	1-0007	Turbulence
3.12.76	Great Northern AL	NSF	L.188AF Electra	N401FA	Destroyed	L	on	Udrivik Lake, AK	None	0	0	0	0	0	3	0	ARC-78-1	1-0025	Overshoot, gear collapse
4.05.76	Alaska AL 60	SP	B.727-81	N124AS	Destroyed	L	on	Ketchikan Intn'l Airport, AK (KTN)	Fatal	0	1	0	1	32	7	50	AAR-76-20	1-0003	Overshoot, collision w/ ditch
4.24.76	Trans World AL	SP	B.707-331B	N8738	Major	Taxi	on	Paris De Gaulle Airport, France	None	0	0	0	0	0	8	71	ARC-78-1	1-0028	Gear collapse
4.27.76	American AL 625	SP	B.727-95	N1963	Destroyed	L	on	St. Thomas Airport, Virgin Is.	Fatal	2	35	0	37	23	7	81	AAR-77-01	1-0005	Overshoot, collision w/ object
5.06.76	American AL	SF	B.747-123	N9672	Major	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	3	2	ARC-78-1	1-0008	Overshoot, gear collapse
5.27.76	Continental AL	SP	DC-10-10	N68044	Major	Taxi	on	Honolulu Intn'l Airport, HI (HNL)	None	0	0	0	0	0	12	15	ARC-78-1	1-0010	Collision w/ object
5.27.76	Delta AL	SP	DC-8-51	N806E	None	CC	off	Atlanta, GA	Serious	0	0	0	0	1	7	99	ARC-78-1	1-0013	Turbulence
6.01.76	Trans World AL	SP	L.1011	N31013	Major (a)	ER(a)	off	Salinas, KS	None	0	0	0	0	0	?	?	ARC-78-1	1-0009	?
6.12.76	Western AL	SP	B.727-247	N2820W	None	ID	off	85 mi. W of Minneapolis, MN	Serious	0	0	0	0	1	7	33	ARC-78-1	1-0019	Turbulence
6.23.76	Allegheny AL 121	SP	DC-9-31	N994VJ	Major-W.O.	RA	off	Philadelphia Intn'l Airport, PA (PHL)	Serious	0	0	0	0	86	4	102	AAR-78-02	1-0011	Collision w/ grd./water, uncontrolled
8.02.76	Eastern AL	SP	B.727-25C	N8155G	Minor	E R	off	112 nmi. SE of Atlanta, GA	Serious	0	0	0	0	1	6	71	ARC-78-1	1-0021	Turbulence
8.04.76	National AL	SP	B.727-35	N4622	Major	L	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	7	0	ARC-78-1	1-0026	Airframe fail. in-flt., gear retracted
8.08.76	American AL	SP	B.727-223	N854AA	None	E R	off	Bethlehem, PA	Serious	0	0	0	0	1	7	121	ARC-78-1	1-0017	Turbulence
9.19.76	American AL	SP	B.747-123	N9665	None	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	1	11	231	ARC-78-1	1-0018	Miscellaneous
11.12.76	Allegheny AL	SP	DC-9-31	N979VJ	Major	Taxi	on	Greater Buffalo Intn'l Airport, NY (BUF)	None	0	0	0	0	0	4	55	ARC-78-1	1-0022	Gear collapse
11.16.76	Texas Intn'l AL 987	SP	DC-9-15	N9104	Destroyed	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	Serious	0	0	0	0	2	5	79	AAR-77-10	1-0020	Collision w/ ditch
11.17.76	Trans World AL	SP	DC-9-15	N1070T	None	E R	off	Appleton, OH	Serious	0	0	0	0	1	4	73	ARC-78-1	1-0027	Evasive maneuver
	?	?	?	N7842TW	None	E R	off		?	0	0	0	0	?	?	?			
12.21.76	Allegheny AL	SP	CV.580	N5811	None	G	on	Bradford Regional Airport, PA (BFD)	Serious	0	0	0	0	1	3	30	ARC-78-1	1-0023	Miscellaneous
24 Accidents			25 Aircraft Involved						Total:	2	36	0	38	157	151	1877			

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.16.77	Capitol Intn'l AW	NSP	DC-8-32/33	N904CL	Minor	TO	on	Baltimore/Wash. Intn'l Airport, MD (BWI)	Serious	0	0	0	0	7	8	93	ARC-78-2	1-0013	Eng. fail. or malfunction, miscellaneous
1.25.77	National AL	SP	B.727-35	N4620	Major	Taxi/L	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	6	38	ARC-78-2	1-0002	Collision w/ AC, both on grd.
	American AL	SP	B.707-323C	N7508A	Major	Taxi/	on		None	0	0	0	0	0	7	24			Collision w/ AC, both on grd.
2.10.77	Piedmont AL	SP	YS.11A-205	N247P	None	E R	off	Shenandoah, VA	Serious	0	0	0	0	1	4	23	ARC-78-2	1-0006	Turbulence
2.11.77	Braniff AW	SP	B.727-62C	N7268	None	ID	off	Waco, TX	Serious	0	0	0	0	1	6	46	ARC-78-2	1-0007	Turbulence
2.21.77	Delta AL	SP	DC-8-61	N1302L	Major	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	8	89	ARC-78-2	1-0003	Collision w/ parked AC
	Pan American AW	G	B.747SP	N533PA	?	G	on		?	0	0	0	0	?	?	?			Parked AC
3.04.77	American AL	SP	B.727-223	N6834	None	E R	off	Dayton, OH	Serious	0	0	0	0	1	6	65	ARC-78-2	1-0005	Turbulence
3.12.77	Eastern AL	SP	L.1011-1	N329EA	None	CC	off	Tallahassee, FL	Serious	0	0	0	0	1	13	111	ARC-78-2	1-0020	Turbulence
3.18.77	Allegheny AL	SP	CV.580	N5812	Major	Taxi	on	New York LaGuardia Airport, NY (LGA)	None	0	0	0	0	0	3	47	ARC-78-2	1-0004	Collision w/ parked AC
	Eastern AL	G	B.727-	?	?	G	on		?	0	0	0	0	?	?	?			Parked AC
3.27.77	Pan American AW 1736	NSP	B.747-121	N736PA	Destroyed	Taxi	on	Los Rodeos Airport, Tenerife, Canary Is.	Fatal	9	326	0	335	25	16	350	ARC-78-2	1-0026	Collision w/ AC, both on grd., fire/explosion
	K.L.M. 4806	NSP	B.747-206B	PH-BUP	Destroyed	TO	on		Fatal	14	234	0	248	0	14	234			on grd.
4.04.77	Southern AW 242	SP	DC-9-31	N1335U	Destroyed	E R	off	NW of New Hope, GA	Fatal	2	60	9	71	22	4	81	AAR-78-03	1-0010	Eng. fail. or malfunction, collision w/ grd. cntrl
5.16.77	New York AW	SP	S.61L	N619PA	Major	Grd	on	New York Pan Am Heliport, NY	Fatal	0	5	0	5	0	3	22	AAR-77-09	1-0025	Gear collapse, roll over
6.03.77	Continental AL 63	SP	B.727-224	N32725	Major	IC	off	Tucson Intn'l Airport, AZ (TUS)	None	0	0	0	0	0	7	84	AAR-78-09	1-0022	Collision w/ wires/poles
6.09.77	Pan American AW	SP	B.727-21	N329PA	None	E R	off	Berlin, Germany	Serious	0	0	0	0	1	6	62	ARC-78-2	1-0024	Turbulence
7.06.77	National AL	SP	DC-10-10	N66NA	None	ID	off	100 mi. E of Los Angeles, CA	Serious	0	0	0	0	1	10	66	ARC-78-2	1-0011	Uncontrolled altitude deviations
7.08.77	Fleming Intn'l AW	NSF	L.188AF Electra	N260F	Destroyed	IC	off (a)	St. Louis Intn'l Airport, MO (STL)	Fatal	3	0	0	3	0	3	0	ARC-78-2	1-0018	Prop. fail., collision w/ grd./water, uncontrolled
7.16.77	Rosenblum Aviation	NSF	DC-6A	N515TY	None	E R	off	Ft. Wayne, IN	Serious	0	0	0	0	1	4	3	ARC-78-2	1-0015	Turbulence
7.22.77	Pacific Southwest AL	SP	L.188C	N171PS	None	AA	off	Glendale, CA	Serious	0	0	0	0	2	5	97	ARC-78-2	1-0017	Evasive maneuver
	Private AC	Pvt.	Cessna 150	N19095	?	?	off		?	0	0	0	0	?	?	?			
8.05.77	Delta AL	SP	DC-8-51	N815E	None	ID	off	Miami, FL	Serious	0	0	0	0	1	7	56	ARC-78-2	1-0014	Turbulence
8.07.77	Braniff AL	SP	DC-8-51	N612BN	None	E R	off	Varadero, Cuba	Serious	0	0	0	0	10	9	116	ARC-78-2	1-0016	Turbulence
8.21.77	Allegheny AL	SP	DC-9-31	N956VJ	Major	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	4	92	ARC-78-2	1-0012	Collision w/ object
9.21.77	Eastern AL	SP	B.727-25	N8130N	None	E R	off	Daytona Beach, FL	Serious	0	0	0	0	1	6	96	ARC-78-2	1-0001	Turbulence
10.02.77	Capitol Intn'l AW	NSP	DC-8-61	N911CL	Major	TO	on	Shannon Airport, Ireland	Serious	0	0	0	0	17	10	249	ARC-78-2	1-0019	Miscellaneous
11.17.77	Northwest Orient AL	SF	B.747-251F	N616US	Major	L	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	3	0	ARC-78-2	1-0023	Grd./water loop/swerve, gear collapse
12.18.77	United AL 2860	SF	DC-8-54F	N8047U	Destroyed	AA	off	Kaysville, NE of Salt Lake City, UT	Fatal	3	0	0	3	0	3	0	AAR-78-06	1-0021	Collision w/ grd./water, controlled
									Total:	31	625	9	665	92	175	2178			

24 Accidents

29 Aircraft Involved

ACC. DATE	OPERATOR FR. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
3 01 78	Continental AL 603	SP	DC-10-10	N68045	Destroyed	TO	on	Los Angeles Intn'l Airport, CA (LAX)	Fatal	0	2	0	2	32	14	186	AAR-79-01	1-0001	Airframe fail. on grd., gear collapse
3 09 78	Eastern AL	SP	B.727-225	N8842E	None	G	on	Greensboro Piedmont Airport, NC (GSO)	Serious	0	0	0	0	1	7	32	ARC-80-1	1-0006	Miscellaneous
3 11 78	Trans Intn'l AL	NSF	L.188CF Electra	N859U	Major	E R	off	Ft. Myers, FL	None	0	0	0	0	0	3	5	ARC-80-1	1-0007	Fire or explosion in-flt.
3 28 78	Delta AL	SP	DC-8-61	N1306L	Minor	CC	off	Bimini, FL	Serious	0	0	0	0	1	7	122	ARC-80-1	1-0002	Turbulence
4 05 78	Texas Intn'l AL	SP	DC-9-14	N8961	None	E R	off	Wichita Falls, TX	Serious	0	0	0	0	1	4	26	ARC-80-1	1-0003	Turbulence
4 19 78	Eastern AL	SP	B.727-25	N8136N	None	E R	off	Melbourne, FL	Serious	0	0	0	0	5	6	103	ARC-80-1	1-0012	Turbulence
4 20 78	Evergreen Intn'l AL	NSF	CV.580	N5829	Major	L	on	Cleveland Hopkins Intn'l Airport, OH (CLE)	None	0	0	0	0	0	2	1	ARC-80-1	1-0023	Grd./water loop/swerve, gear collapse
5 08 78	National AL 193	SP	B.727-235	N4744	Major-W.O.	RA	off	Escambia Bay, Pensacola, FL	Fatal	0	3	0	3	11	6	52	AAR-78-13	1-0008	Collision w/ grd./water, controlled
5 21 78	American AL	SP	B.727-23	N1974	Minor	IC	on	Greater Cincinnati Intn'l Airport, KY (CVG)	Serious	0	0	0	0	3	6	98	ARC-80-1	1-0011	Eng. fail./malfunction, miscellaneous
5 30 78	Western AL	SP	B.737-247	N4518W	Minor	E R	off	Cheyenne, WY	Serious	0	0	0	0	1	6	92	ARC-80-1	1-0005	Turbulence
6 11 78	Delta AL	SP	L.1011-1	N720DA	None	Taxi	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	Fatal	0	0	1	1	0	12	174	ARC-80-1	1-0009	Miscellaneous
7 09 78	Allegheny AL 453	SP	BAC 1-11 203AE	N1550	Major-W.O.	L	on	Rochester Municipal Airport, NY (ROC)	Serious	0	0	0	0	1	4	73	AAR-79-02	1-0010	Overshot, collision w/ ditch
7 25 78	North Central AL 601	SP	CV.580	N4825C	Major-W.O.	IC	off	Kalamazoo Municipal Airport, MI (AZO)	Serious	0	0	0	0	3	3	40	AAR-79-04	1-0015	Eng. fail./malfunction, collision w/ grd., controlled
8 08 78	American AL	SP	DC-10-10	N102AA	None	G	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	1	13	244	ARC-80-1	1-0004	Miscellaneous
9 07 78	Delta AL	SP	B.727-232	N484DA	Minor	TO	on	Baton Rouge Ryan Airport, LA (BTR)	None	0	0	0	0	0	8	48	ARC-80-1	1-0014	Collision w/ AC, both on grd.
	Private AC	Pvt.	Beech V35B	N1835L	Major	Taxi	on		None	0	0	0	0	0	1	0			
9 20 78	American AL	SP	B.707-123B	N7573A	None	CC	off	St. Louis, MO	Serious	0	0	0	0	1	7	65	ARC-80-1	1-0016	Turbulence
9 25 78	Pacific SW AL 182	SP	B.727-214	N533PS	Destroyed	RA	off	San Diego Lindbergh Field, CA (SAN)	Fatal	7	128	13	148	0	7	128	AAR-79-05	1-0021	Collision w/ AC, both in-flt.
	Gibbs Flite Center	Pvt.	Cessna 172	N7711G	Destroyed	C	off		Fatal	2	0	0	2	0	2	0			
10 04 78	American AL	SP	B.727-23	N1979	Major	G	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	4	7	103	ARC-80-1	1-0022	Miscellaneous
11 18 78	Wright AL	SF	CV 600	N74853	Major	G	on	Wilmington Airport, OH	None	0	0	0	0	0	2	1	ARC-80-1	1-0019	Prop./jet/rotor blast
12 06 78	Eastern AL	SP	L.1011-1	N312EA	None	E R	off	Intn'l Waters, ER New York, NY-San Juan, PR	Serious	0	0	0	0	1	12	290	ARC-80-1	1-0020	Turbulence
12 21 78	United AL	SP	B.737-222	N9009U	None	E R	off	Norfolk, VA	Serious	0	0	0	0	1	5	93	ARC-80-1	1-0018	Turbulence
12 28 78	United AL 173	SP	DC-8-61	N8082U	Destroyed	AA	off	10 kms. N of Portland, OR	Fatal	2	8	0	10	23	8	181	AAR-79-07	1-0017	Eng. fail./malfunction, collision w/ trees
									Total:	11	141	14	166	90	152	2157			

22 Accidents

24 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR FR. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	FATALITIES Pass.	FATALITIES Other	FATALITIES Total	Serious Injury	Aboard AC Crew	Aboard AC Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.05.79	Great Northern AL	NSP	L.188PF Electra	N403GN	Destroyed	RA	off	Umiat, Inigok, North Slope, AK	Minor	0	0	0	0	0	6	9	ARC-81/01	1-0019	Undershoot, collision w/ object
2.12.79	Allegheny AL 561	SP	Mohawk 298	N29824	Destroyed	IC	off	Clarksburg Airport, WV (CKB)	Fatal	1	1	0	2	8	3	22	AAR-79-12	1-0011	Collision w/ grd./water, uncontrolled
2.15.79	Airlift Intn'l	SF	B.727-172C	N727AL	Major	L	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	3	0	ARC-81/01	1-0001	Hard landing, gear collapse
2.15.79	Delta AL	SP	B.727-232	N467DA	None	Taxi	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	9	106	AAR-79-11	1-0012	Collision w/ AC, both on grd.
	Flying Tiger	SF	B.747-132F	N804FT	None	L	on		None	0	0	0	0	0	3	3			Collision w/ AC, both on grd.
2.21.79	Aloha AL	SP	B.737-297	N73711	None	E R	off	Honolulu, HI	Serious	0	0	0	0	2	5	72	ARC-81/01	1-0007	Turbulence
2.24.79	Federal Express	SF	Falcon 20	N36FE	Major	L	on	Memphis Intn'l Airport, TN (MEM)	Minor	0	0	0	0	0	3	0	ARC-81/01	1-0003	Collision w/ AC, both on grd.
4.04.79	Trans World AL	SP	B.727-31	N840TW	Major	E R	off	Saginaw, MI	Minor	0	0	0	0	0	7	82	AAR-81-08	1-0022	Uncontrolled altitude deviations, airframe fail.
4.09.79	Texas Intn'l AL	SP	DC-9-31	N3504T	None	E R	off	Dallas, TX	Serious	0	0	0	0	1	5	113	ARC-81/01	1-0008	Miscellaneous
4.16.79	Seaboard World AL	SF	B.747-251F	N617US	Major	TO	on	Frankfurt Main Intn'l Airport, W. Germany	None	0	0	0	0	0	4	0	ARC-81/01	1-0005	Grd./water loop/swerve, gear collapse
4.18.79	New York AW	SP	S.61L	N618PA	Destroyed	CC	off	Newark Intn'l Airport, NJ (EWR)	Fatal	0	3	0	3	13	3	15	AAR-79-14	1-0013	Propirotor fail, roll over
4.19.79	American AL	SP	B.727-223	N6821	Major	L	on	Philadelphia Intn'l Airport, PA (PHL)	None	0	0	0	0	0	6	85	ARC-81/01	1-0032	Hard landing
4.21.79	North Central AL	SP	DC-9-32	N941N	Major	L	on	Mosinee Central Wisconsin Airport, WI (CWA	None	0	0	0	0	0	4	37	ARC-81/01	1-0020	Dragged wingtip, pod, or float
4.21.79	Pan American AW	SP	B.707-321B	N453PA	None	ID	off	Panama City, Panama	Serious	0	0	0	0	1	9	79	ARC-81/01	1-0030	Turbulence
5.25.79	American AL 191	SP	DC-10-10	N110AA	Destroyed	IC	off	Chicago O'Hare Intn'l Airport, IL (ORD)	Fatal	13	258	2	273	2	13	258	AAR-79-17	1-0026	Engine tearaway, stall
5.27.79	Braniff AW	SP	DC-8-51	N814BN	None	G	on	Bogota Eldorado Intn'l Airport, Colombia	Serious	0	0	0	0	4	9	129	ARC-81/01	1-0006	Fire or explosion on grd.
5.31.79	Zantop Intn'l AL	NSF	CV.640	N640R	Major	G	on	St. Louis Lambert Intn'l Airport, MO (STL)	None	0	0	0	0	0	1	0	ARC-81/01	1-0002	Fire or explosion on grd.
6.24.79	Delta AL	SP	L.1011-100	N724DA	None	G	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	Serious	0	0	0	0	1	12	87	ARC-81/01	1-0014	Fire or explosion on grd.
7.15.79	Delta AL	SP	L.1011-50	N707DA	None	Taxi	on	Ft. Lauderdale/Hollywod Airport, FL (FLL)	Serious	0	0	0	0	2	12	208	ARC-81/01	1-0015	Miscellaneous
7.26.79	Frontier AL	SP	CV.580	N120	None	E R	off	Joplin, MO	Serious	0	0	0	0	1	4	38	ARC-81/01	1-0010	Miscellaneous
8.07.79	Continental AL	SP	B.727-22	N40490	Major	L	on	El Paso Intn'l Airport, TX (ELP)	Minor	0	0	0	0	0	7	36	ARC-81/01	1-0021	Gear retracted
8.18.79	Wien Air Alaska	SF	B.737-210C	N4907	Major	L	on	Dillingham Airport, AK	None	0	0	0	0	0	2	2	ARC-81/01	1-0031	Gear collapse
9.12.79	Rich Intn'l AW	NSF	C-46D	N7766B	Major	?	off (a)	S. Caicos, British W. Indies	None	0	0	0	0	0	2	1	ARC-81/01	1-0023	Undetermined
9.18.79	American AL	SF	B.707-323C	N7566A	Major	AA	off	Palatine, IL	None	0	0	0	0	0	3	0	ARC-81/01	1-0029	Airframe fail. in-flt.
10.14.79	Braniff AW	SP	DC-8-62	N1809E	Major	L	on	Panama City Tocumen Airport, Panama	Minor	0	0	0	0	0	9	138	ARC-81/01	1-0025	Grd./water loop/swerve, gear collapse
10.31.79	Western AL 2605	SP	DC-10-10	N903WA	Destroyed	L	on	Mexico City Intn'l Airport, Mexico (MEX)	Fatal	11	61	1	73	13	13	76	ARC-81/01	1-0026	Collision w/ automobile
11.16.79	Nevada AL	NSP	M.404	N40436	Destroyed	IC	off	Grand Canyon Airport, Tusayan, AZ (GCN)	Serious	0	0	0	0	10	3	41	AAR-80-07	1-0009	Eng. fail/malfunction, collision w/ trees
11.18.79	Transamerica AL 3N18	NSF	L.188CF Electra	N859U	Destroyed	CC	off	Salt Lake City, UT	Fatal	3	0	0	3	0	3	0	AAR-80-11	1-0017	Miscellaneous, airframe fail. in-flt.
11.24.79	Charter AL	NSP	CV.440-86	N444JM	Major	CC	off	Freeport, Bahamas	Serious	0	0	0	0	1	3	43	ARC-81/01	1-0024	Fire or explosion in-flt. engine tearaway
12.27.79	Pan American AW	SF	B.747-121 SCD	N771PA	Major	L	on	London Heathrow Intn'l Airport, U.K.	None	0	0	0	0	0	3	0	ARC-81/01	1-0004	Engine tearaway, fire or explosion on grd
									Total:	28	323	3	354	59	169	1660			

29 Accidents

30 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.18.80	Zantop AT	NSF	L.188CF	N290F	Major	E R	off	Syracuse, NY	Minor	0	0	0	0	0	4	0	ARC-83/01	1-0006	Airframe fail.-in flt.
1.19.80	Air California	SP	B.737-293	N469AC	Major	Taxi	on	Las Vegas McCarran Intn'l Airport, NV (LAS)	Serious	0	0	0	0	2	5	20	ARC-83/01	1-0007	Landing gear collapsed
1.23.80	Flying Tiger Line	SF	DC-8-63AF	N783FT	Major	Taxi	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Minor	0	0	0	0	0	4	0	ARC-83/01	1-0005	Landing gear collapsed
3.17.80	Texas Intn'l	SP	DC-9-14	N9103	Major-W.O.	L	on	Baton Rouge Ryan Airport, LA (BTR)	Serious	0	0	0	0	1	4	46	ARC-83/01	1-0015	Overshoot, collision w/ ditches
4.04.80	Eastern AL	SP	DC-9-31	N8922E	None	E R	off	Southeast, PA	Serious	0	0	0	0	2	5	63	ARC-83/01	1-0003	Turbulence
4.21.80	Trans World AL	SP	B.707-331B	N780TW	None	ID	off	Fillmore, CA	Serious	0	0	0	0	1	8	115	ARC-83/01	1-0019	Turbulence
6.07.80	Hughes Airwest	SP	DC-9-31	N915RW	Minor	Taxi	on	Orange County John Wayne Airport, CA (SNA	None	0	0	0	0	0	5	17	ARC-83/01	1-0009	Collision w/ AC, both on grd.
	Private AC	Pvt.	Cessna 152	N67649	?	Taxi	on		?	0	0	0	0	?	1	0			Collision w/ AC, both on grd.
6.10.80	Zantop Intn'l	NSF	DC-6BF	N111AS	Major	L	on	Indianpolis Weir-Cook Intn'l Airport, IN (IND)	None	0	0	0	0	0	3	0	ARC-83/01	1-0008	Airframe fail.- on grd.
6.19.80	Airborne Express	SF	SE.210-VIR	N905MW	Destroyed	L	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	None	0	0	0	0	0	3	1	ARC-83/01	1-0011	Turbulence, hard landing
7.15.80	Delta AL	SP	DC-9-32	N3332L	None	ID	off	Tampa, FL	Serious	0	0	0	0	2	5	51	ARC-83/01	1-0004	Turbulence
8.23.80	Trans Intn'l	NSF	L.100/382G-7C	N18ST	Minor	ID	off	Otay, CA	Fatal	0	0	1	1	0	4	0	ARC-83/01	1-0001	Miscellaneous
9.03.80	Pan American AW	SP	B.727-21	N327PA	Major-W.O.	RA	off	San Jose Intn'l Airport, Costa Rica	Minor	0	0	0	0	0	6	67	ARC-83/01	1-0017	Undershoot, collision w/ grd./water, controlled
9.12.80	Delta AL	SP	L.1011-50	N710DA	None	E R	off	Nassau, Bahames	Serious	0	0	0	0	2	12	57	ARC-83/01	1-0010	Turbulence
9.16.80	Pan American AW	SP	DC-10-30	N83NA	Major	TO	on	London Heathrow Intn'l Airport, U.K.	Serious	0	0	0	0	1	17	217	ARC-83/01	1-0016	Airframe fail.- on grd., fire or explosion on grd
10.06.80	Air Florida	SP	B.737-222	N61AF	Major	L	on	Port Au Prince Airport, Haiti	None	0	0	0	0	0	6	73	ARC-83/01	1-0018	Grd./water loop/swerve, gear collapsed
10.17.80	American AL	SP	B.707-323C	N8406	None	CC	off	Kingston, Jamaica	Serious	0	0	0	0	1	7	93	ARC-83/01	1-0012	Turbulence
11.11.80	Braniff AL	SP	B.727-227	N462BN	None	L	on	Newark Intn'l Airport, NJ (EWR)	Serious	0	0	0	0	2	7	30	ARC-83/01	1-0013	Grd./water loop/swerve, miscellaneous
11.21.80	Continental AL 614	SP	B.727-92C	N18479	Destroyed	L	on	Yap Airport, Yap Is., W. Caroline Islands	Serious	0	0	0	0	3	6	87	AAR-81-07	1-0002	Undershoot, gear collapsed
12.29.80	United AL	NSP	DC-8-61	N8069U	Major	Taxi	on	Phoenix Sky Harbor Intn'l Airport, AZ (PHX)	Serious	0	0	0	0	2	9	236	ARC-83/01	1-0014	Landing gear collapsed
19 Accidents			20 Aircraft Involved						Total:	0	0	1	1	19	121	1155			

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR FR. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.16.81	Northern Air Cargo	SF	C-118A	N1036F	Major	E R	off	Gambell, AK	None	0	0	0	0	0	3	0	ARC-85/01	1-0003	Collision w/ grd./water-controlled
1.31.81	Eastern AL	SP	B.727-225	N8847E	Major	L	on	New York LaGuardia Airport, NY (LGA)	Minor	0	0	0	0	0	7	124	ARC-85/01	1-0011	Gear retracted
2.06.81	Eastern AL	SP	A.300B4-2C/103	N206EA	None	G	on	Miami Intn'l Airport, FL (MIA)	Fatal	0	0	1	1	0	9	40	ARC-85/01	1-0007	Miscellaneous
2.10.81	United AL	SP	B.737-222	N9019U	None	ID	off	Newport News, VA	Serious	0	0	0	0	1	6	36	ARC-85/01	1-0002	Turbulence
2.11.81	Northwest AL	SP	B.747-151	N610US	Major	Taxi	on	Fargo Hector Intn'l Airport, ND (FAR)	None	0	0	0	0	0	9	362	ARC-85/01	1-0020	Collision w/ object
2.12.81	Pan American AW	SP	B.727-51	N3606	None	G	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	1	8	81	ARC-85/01	1-0006	Miscellaneous
2.17.81	Air California 336	SP	B.737-293	N468AC	Destroyed	L	on	Orange Co. John Wayne Airport, CA (SNA)	Serious	0	0	0	0	4	5	95	AAR-81-12	1-0024	Wheels-up landing
4.03.81	United AL	SP	DC-10-10	N1809U	Minor	E R	off	Hannibal, MO	Serious	0	0	0	0	8	12	154	ARC-85/01	1-0016	Turbulence
4.18.81	Reeve Aleutian	SP	YS.11A-626	N173RV	Major	RA	on	Sand Point, AK	None	0	0	0	0	0	3	36	ARC-85/01	1-0001	Birdstrike, collision w/ RW or app. lights
5.18.81	Delta AL	SP	DC-9-32	N1295L	None	E R	off	New Orleans, LA	Serious	0	0	0	0	1	5	80	ARC-85/01	1-0022	Turbulence
5.20.81	Pan American AW	SP	DC-10-10	N66NA	None	Taxi	on	Miami Intn'l Airport, FL (MIA)	Fatal	0	0	1	1	0	10	77	ARC-85/01	1-0009	Miscellaneous
6.03.81	Trans World AL	SP	B.707-131B	N6728	None	G	on	St. Louis Lambert Intn'l Airport, MO (STL)	Serious	0	0	0	0	1	6	63	ARC-85/01	1-0004	Miscellaneous
6.05.81	United AL	SP	B.727-222	N7255U	None	E R	off	Columbus, OH	Serious	0	0	0	0	1	8	101	ARC-85/01	1-0010	Turbulence
6.30.81	USAir	SP	BAC 1-11 204AF	N1127J	None	ID	off	Pittsburgh, PA	Serious	0	0	0	0	1	4	66	ARC-85/01	1-0008	Turbulence
8.13.81	Ozark AL	SP	DC-9-32	N924L	Major	G	on	St. Louis Lambert Intn'l Airport, MO (STL)	Serious	0	0	0	0	1	5	54	ARC-85/01	1-0015	Miscellaneous
	Airport Terminal Service	?	SA.226TC	N3228A	Minor	G	on		?	0	0	0	0	0	?	?			Miscellaneous
8.17.81	Pan American AW	SP	B.727-235	N4742	Major	TO	on	Ft. Lauderdale Intn'l Airport, FL (FLL)	Minor	0	0	0	0	0	6	58	ARC-85/01	1-0023	Eng. fail./malfunction, collision w/ ditches
8.25.81	Air Illinois	SP	HS.748-2A/FAA	N748LL	Major	Taxi	on	Chicago Midway Airport, IL (MDW)	None	0	0	0	0	0	4	22	ARC-85/01	1-0014	Collision w/ object
9.03.81	Alaska Intn'l Air	NSF	L.100	N108AK	Major	Taxi	on	Yakutat, AK	None	0	0	0	0	0	4	0	ARC-85/01	1-0012	On grd. fire/explosion
9.07.81	American AL	SP	DC-10-10	N109AA	None	G	on	Salt Lake City Intn'l Airport, UT (SLC)	Fatal	0	1	0	1	0	13	263	ARC-85/01	1-0013	Miscellaneous
9.20.81	World AW 32	SP	DC-10-30CF	N112WA	None	E R	off	N. Atlantic Ocean	Fatal	1	0	0	1	0	14	332	AAR-82-01	1-0027	Miscellaneous
9.22.81	Air Florida 2196	SP	DC-10-30CF	N101TV	Major	TO	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	15	56	AAR-82-03	1-0025	Eng. fail./malfunction, miscellaneous
9.22.81	Eastern AL	SP	L.1011-385-1	N309EA	Major	CC	off	Colts Neck, NJ	None	0	0	0	0	0	11	190	AAR-82-05	1-0026	Eng. fail./malfunction, miscellaneous
10.12.81	Eastern AL	SP	B.727-25	N8142N	Major	Taxi	on	St. Louis Lambert Intn'l Airport, MO (STL)	None	0	0	0	0	0	6	42	ARC-85/01	1-0021	Collision w/ automobile
10.13.81	American AL	SP	B.727-223	N6816	None	G	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Serious	0	0	0	0	1	7	83	ARC-85/01	1-0017	Miscellaneous
10.23.81	USAir	SP	B.727-2B7	N771AL	None	ID	off	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Serious	0	0	0	0	1	6	105	ARC-85/01	1-0018	Turbulence
12.30.81	Caribbean Air	SF	C-46	N7560U	Major	L	on	San Juan Intn'l Airport, Puerto Rico (SJU)	None	0	0	0	0	0	3	0	ARC-85/01	1-0019	Grd./water loop/swerve, collision w/ ditches
									Total:	1	1	2	4	21	187	2511			

26 Accidents

27 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	FATALITIES Pass.	FATALITIES Other	FATALITIES Total	Serious Injury	Aboard AC Crew	Aboard AC Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.07.82	South Central Aviation	NSF	C-46	?	Major	?	on (a)	Laredo, TX	None	0	0	0	0	0	?	?	ARC-86/01		Explosion
1.13.82	Air Florida 90	SP	B.737-222	N62AF	Destroyed	IC	off	Washington National Airport, DC (DCA)	Fatal	4	70	4	78	6	5	74	AAR-82-08	3375	In-flt. collision w/ terrain
1.23.82	World AW 30H	SP	DC-10-30CF	N113WA	Destroyed	L	on	Boston Logan Intn'l Airport, MA (BOS)	Fatal	0	2	0	2	4	12	200	AAR-85/06	2853	Overrun
2.03.82	United AL 99	SP	DC-10-10	N1814U	Minor	TO	on	Philadelphia Intn'l Airport, PA (PHL)	Serious	0	0	0	0	1	11	144	ARC-86/01	1334	Overrun
2.16.82	Reeve Aleutian	SP	YS.11A	N169RV	Major	RA	off	King Salmon, AK	Minor	0	0	0	0	0	3	36	AAR-82-14	2513	Loss of power (part.)-nonmechanical
2.17.82	Pan American AW	SP	B.727-235	N4734	Major	TO	on	Miami Intn'l Airport, FL (MIA)	Serious	0	0	0	0	1	6	47	ARC-86/01	2639	Loss of power (part.)-mech. fail./malfunction
3.26.82	Woods Air Fuel	NSF	C-46A	?	Major	RA?	off (a)	Wulik River Strip, AK	None	0	0	0	0	0	?	?	ARC-86/01		Undershoot
4.18.82	Continental AL	SP	B.727-224	N32717	Major	L	on	Austin Mueller Municipal Airport, TX (AUS)	None	0	0	0	0	0	7	61	ARC-86/01	1680	Main gear collapsed
5.22.82	Republic AL	SP	DC-9-15RC	N9356	None	ID	off	Memphis, TN	Serious	0	0	0	0	1	5	52	ARC-86/01	0955	In-flt. encounter w/ weather
5.26.82	United AL	SP	DC-10-10	N1833U	Major	Taxi	on	San Francisco Intn'l Airport, CA (SFO)	Minor	0	0	0	0	0	11	127	ARC-86/01	2689	Nose gear collapsed
5.29.82	Providence AL	SF	CV.240	N153PA	Major	L	on	Detroit Metro. Wayne Co. Airport, MI (DTW)	None	0	0	0	0	0	2	1	ARC-86/01	1195	In-flt. encounter w/ weather
5.29.82	Northeastern Intn'l AW	SP	DC-8-52	N801EV	None	E R	off	Atlantic Ocean	Serious	0	0	0	0	1	9	102	ARC-86/01	2176	In-flt. encounter w/ weather
7.09.82	Pan American AW 759	SP	B.727-235	N4737	Destroyed	IC	off	New Orleans Intn'l Airport, LA (MSY)	Fatal	7	138	8	153	9	7	138	AAR-83/02	3148	In-flt. collision w/ object
7.16.82	United AL	SP	DC-10-10	N1815U	Minor	E R	off	Morton, WY	Serious	0	0	0	0	7	11	157	ARC-86/01	3395	In-flt. encounter w/ weather
11.02.82	Southwest AL	SP	B.737-214	N55SW	None	CC	off	Austin, TX	Serious	0	0	0	0	1	5	63	ARC-86/01	2466	Miscellaneous/other
11.04.82	Northern Air Cargo	NSF	Fc. C-82	N4752C	Major	RA	on	Nelson Lagoon, AK	Serious	0	0	0	0	2	2	0	ARC-86/01	3296	Undershoot
11.11.82	Arrow AW	NSF	B.707-338C	N707GB	None	E R	off	Miami, FL	Fatal	1	0	0	1	0	4	0	ARC-86/01	2689	Decompression
11.18.82	Continental AL	SP	DC-10-10CF	N68056	Major	G	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	18	120	ARC-86/01	3413	Nose gear collapsed
12.09.82	Frontier AL	SP	B.737-291	N7346F	Major	Taxi	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	5	52	ARC-86/01	2627	Miscellaneous/other
									Total:	12	210	12	234	33	121	1374			

19 Accidents

19 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.07.83	Western AL	SP	B.727-247	N292WA	None	CC	off	Yakima, WA	Serious	0	0	0	0	1	7	30	ARC-87/01	0120	In-flt. encounter w/ weather
1.09.83	Republic AL 927	SP	CV.580	N8444H	Major-Rblt.	L	on	Brainerd Crow Wing Co. Airport, MN (BRD)	Fatal	0	1	0	1	1	3	30	AAR-83/06	3351	On grd. collision w/ terrain
1.11.83	United AL 2885	SF	DC-8-54F	N8053U	Destroyed	IC	on	Detroit Wayne Co. Airport, MI (DTW)	Fatal	3	0	0	3	0	3	0	AAR-83/07	3192	Loss of control-in flt.
3.23.83	Frontier AL	SP	B.737-214	N7381F	Minor	L	on	Casper Airport, WY	Serious	0	0	0	0	1	5	91	ARC-87/01	3336	In-flt. collision w/ terrain
4.02.83	Global Intn'l AW	NSP	B.707-323C	N8415	None	ID	off	Baltimore, MD	Serious	0	0	0	0	1	7	184	ARC-87/01	1966	In-flt. encounter w/ weather
5.20.83	Continental AL 415	SP	B.727-22	N40483	Major	Taxi	on	St. Louis Lambert Intn'l Airport, MO (STL)	None	0	0	0	0	0	7	45	ARC-87/01	0804	On grd. collision w/ object
5.21.83	Woods Air Fuel	NSF	C-46F	N1822M	Major	L	on	King Salmon Airport, AK	None	0	0	0	0	0	2	0	ARC-87/01	1006	Loss of power (total)-mech. fail./malfunction
6.04.83	Continental AL	SP	DC-10-10	N68043	None	E R	off	Yuma, AZ	Serious	0	0	0	0	1	9	232	ARC-87/01	3372	Abrupt maneuver
6.08.83	Reeve Aleutian AW	SP	L.188C Electra	N1968R	Major-Rblt.	CC	off	Anchorage Intn'l Airport, AK (ANC)	None	0	0	0	0	0	5	10	ARC-87/01	3041	Airframe/component/system fail./malfunction
6.11.83	United AL	SP	B.727-222 Adv.	N7273U	Major	TO	on	Chicago O'Hare Intn'l Arpt., IL (ORD)	Serious	0	0	0	0	2	7	135	ARC-87/01	1622	Loss of power (total)-mech. fail./malfunction
6.21.83	Ozark AL	SP	DC-9-31	N960Z	Minor	G	on	Milwaukee Mitchell Field, WI (MWC)	Serious	0	0	0	0	1	5	5	ARC-87/01	3321	Airframe/component/system fail./malfunction
6.29.83	Pacific Air Express	SF	C-54G-10-DO	N300JT	Major-W.O.	RA	off	Kahului, Maui, HI	None	0	0	0	0	0	3	0	ARC-87/01	1330	Loss of power (total)-nonmechanical
8.04.83	Pan American AW	SP	B.747-121	N738PA	Major-W.O.	L	on	Karachi Intn'l Airport, Pakistan	None	0	0	0	0	0	16	227	DCA83RA001	7000	Not reported
10.11.83	Flying Tiger	SP	B.747-249F	N806FT	Major	TO	on	Frankfort Main Airport, W. Germany	None	0	0	0	0	0	3	3	DCA84RA002	7000	Not reported
10.11.83	Air Illinois 710	SP	HS.748-2A	N748LL	Destroyed	AA	off	5 kms. NE of Pinckneyville, IL	Fatal	3	7	0	10	0	3	7	AAR-85/03	3352	Airframe/component/system fail./malfunction
10.19.83	Combs AW	SF	CV.340/440	N199CF	Major	IC	on	Pierre Municipal Airport, SD	None	0	0	0	0	0	2	0	ARC-87/01	2998	In-flt. collision w/ terrain
11.06.83	Republic AL	SP	CV.580	N7517U	Minor	RA	off	Sioux Falls, SD	Serious	0	0	0	0	1	3	32	ARC-87/01	2382	In-flt. collision w/ object
11.11.83	Eastern AL	SP	B.727-225 Adv.	N812EA	Major	CC	on	Miami, FL	Serious	0	0	0	0	1	7	152	ARC-87/01	3323	Airframe/component/system fail./malfunction
12.19.83	Combs AW 709	SP	CV.340/440	N73162	Major	L	on	Rock Springs Sweetwater Co. Airport, WY	None	0	0	0	0	0	4	29	ARC-87/01	2969	Loss of control-on grd.
12.20.83	Ozark AL	SP	DC-9-31	N994Z	Major	L	on	Sioux Falls Joe Foss Field, SD (FSD)	Fatal	0	0	1	1	0	5	77	ARC-87/01	3315	On grd. collision w/ object
12.22.83	Hawaiian AL	SP	DHC.7-102	N929HA	None	RA	off	Honolulu, HI	Serious	0	0	0	0	1	4	23	ARC-87/01	2707	Abrupt maneuver
12.25.83	America West AL	SP	B.737-2C6	N133AW	None	G	on	Phoenix Sky Harbor Arpt., AZ (PHX)	Serious	0	0	0	0	1	5	99	ARC-87/01	2636	Prop. blast or jet exhaust/suction
12.28.83	Continental AL	SP	B.727-224	N79750	Major	RA	on	New York LaGuardia Airport, NY (LGA)	None	0	0	0	0	0	7	120	ARC-87/01	3297	In-flt. encounter w/ weather
12.29.83	Piedmont Aviation	SP	B.737-201	N811N	None	CC	off	Tampa, FL	Serious	0	0	0	0	1	5	41	ARC-87/01	2199	In-flt. encounter w/ weather
24 Accidents			24 Aircraft Involved						Total:	6	8	1	15	13	127	1572			

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.01.84	Blue Bell, Inc.	NSF	CL.44D4	N104BB	Major	L	on	Boston Logan Intn'l Airport, MA (BOS)	None	0	0	0	0	0	4	0	ARC-87/02	0504	Main gear collapsed
1.13.84	Pilgrim AL 35	SP	F.27-100	N184PM	Destroyed	IC	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	1	3	21	AAR-84/12	1567	Loss of power (total)-nonmechanical
2.17.84	Provincetown Boston	SP	DC-3	N34PB	Major	Taxi	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	3	2	ARC-87/02	0608	Main gear collapsed
3.04.84	Braniff AL	SP	B.727-227	N471BN	Minor	E R	off	Lampasas, TX	Serious	0	0	0	0	1	8	40	ARC-87/02	1007	In-flt. encounter w/ weather
4.23.84	Intn'l Air Leases	SP	DC-8-63	N940JW	Minor	ID	off	Miami, FL	Serious	0	0	0	0	1	12	180	ARC-87/02	0737	In-flt. encounter w/ weather
5.17.84	Republic AL	SP	B.727-2M7	N723RW	None	L	on	Greater Cincinnati Intn'l Airport, KY (CVG)	Serious	0	0	0	0	1	7	131		3325	Airframe/component/system fail./malfunction
5.30.84	Zantop Intn'l AL 931	SF	L.188AF Electra	N5523	Destroyed	E R	off	Chalkhill, PA	Fatal	3	1	0	4	0	3	1	AAR-85/04	1974	Loss of control-in flt.
5.31.84	United AL 663	SP	B.727-222	N7647U	Major	IC	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	7	96	AAR-85/05	2563	In-flt. encounter w/ weather
6.06.84	Northern Air Cargo	NSF	C-118A	N4206L	Major	RA	off	Deadhorse Kuparak Airport, AK	None	0	0	0	0	0	3	0	ARC-87/02	3011	In-flt. collision w/ object
6.13.84	USAir 183	SP	DC-9-31	N946VJ	Major	L	on	Detroit Wayne Co. Airport, MI (DTW)	Minor	0	0	0	0	0	5	51	AAR-85/01	1976	In-flt. encounter w/ weather
7.25.84	Eastern AL	SP	DC-9-31	N8976E	None	E R	off	Augusta, GA	Serious	0	0	0	0	1	4	96	ARC-87/02	1803	In-flt. encounter w/ weather
8.14.84	Florida AC Leasing (14 CFR 1	NSF	C-54	N74183	Major	Taxi	on	Ft. Lauderdale Airport, FL	None	0	0	0	0	0	2	0	ARC-87/02	1944	Nose gear collapsed
10.19.84	Delta AL 977	SP	DC-8-71	N825E	None	ID	off	Hamilton, AL	Serious	0	0	0	0	1	10	86	ARC-87/02	3196	In-flt. encounter w/ weather
11.16.84	United AL	SP	B.747-122	N4714U	Major	TO	on	Honolulu Intn'l Airport, HI (HNL)	Serious	0	0	0	0	2	18	395	ARC-87/02	3322	Airframe/component/system fail./malfunction
11.19.84	Arrow AW	SP	DC-8-	N1234	None	?	off(a)	Nassau, Bahamas	Serious	0	0	0	0	1	7	216	MIA85RA039	7000	Not reported
12.07.84	Republic AL	SP	DC-9-32	N942N	None	E R	off	Denver, CO	Serious	0	0	0	0	1	8	97	ARC-87/02	2958	In-flt. encounter w/ weather
12.16.84	Air Resorts 953/ Flight Trails	NSP	CV.440-62	N44828	Destroyed	E R	on	Jasper Walker Co. Airport, AL	Serious	0	0	0	0	2	4	35	ARC-87/02	2961	Loss of power
									Total:	3	1	0	4	12	99	1449			

17 Accidents

17 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.01.85	Eastern AL	SP	B.727-225 Adv.	N819EA	Destroyed	AA?	off	Mt. Illimani near La Paz, Bolivia	Fatal	8	21	0	29	0	8	21	DCA89RA007	7000	In-flt. collision w/ terrain
1.09.85	TPI International AW	NSF	L.188AF Electra	N357Q	Destroyed	RA	off	Kansas City Downtown Airport, MO (MKC)	Fatal	3	0	0	3	0	3	0	AAR-85/02/SUM	0311	Loss of control-in flt.
1.21.85	Galaxy AL 203	NSP	L.188A Electra	N5532	Destroyed	IC	off	Reno Cannon Intn'l Airport, NV (RNO)	Fatal	6	64	0	70	1	6	65	AAR-86/01	0212	Loss of control-in flt.
1.29.85	Galaxy AL	SF	L.188CF Electra	N854U	Major-W.O.	L	on	Dobbins AFB, Atlanta, GA	None	0	0	0	0	0	3	0	ARC-87/03	1151	Airframe/component/system fail./malfunction
2.05.85	Bo-S-Aire AL	SF	DC-3	N288A	Major	L	on	Charlotte Douglas Intn'l Airport, NC (CLT)	None	0	0	0	0	0	2	0	ARC-87/03	1265	Miscellaneous/other (prefl. fail. to deice)
2.05.85	Airborne Express	SF	DC-9-15	N926AX	Major-W.O.	IC	on	Philadelphia Intn'l Airport, PA (PHL)	Serious	0	0	0	0	2	2	0	ARC-87/03	2082	Loss of control-in flt.
4.23.85	American AL	SP	B.727-223	N856AA	None	E R	off	Little Rock, AR	Serious	0	0	0	0	1	7	65	ARC-87/03	2301	In-flt. encounter w/ weather
4.26.85	Southwest AL	SP	B.737-3H4	N300SW	Major	L	on	Amarillo Intn'l Airport, TX (AMA)	Minor	0	0	0	0	0	5	128	ARC-87/03	1847	Loss of control-on grd.
5.04.85	Perris Valley (14 CFR 125)	NSP	DC-3	N157U	Destroyed	TO	on	Perris, CA	None	0	0	0	0	0	2	31	ARC-87/03	2532	Airframe/component/system fail./malfunction
5.28.85	Eastern AL	SP	A.300B4-2C/103	N206EA	None	E R	off	530 nmi. N of San Juan, PR, Atlantic Ocean	Serious	0	0	0	0	2	9	85	ARC-87/03	1223	In-flt. encounter w/ weather
5.28.85	American AL	SP	DC-10-10	N106AA	Major	CC	off	Jamaica, NY	None	0	0	0	0	0	14	198	ARC-87/03	2949	Airframe/component/system fail./malfunction
5.31.85	Orion Air 115/General Av.	SF	G.159 Gulfstream I	N181TG	Destroyed	IC	on	Nashville Metropolitan Airport, TN (BNA)	Fatal	2	0	0	2	0	2	0	ARC-87/03	2693	Loss of power (total)-nonmechanical
6.16.85	Piedmont Aviation	SP	B.737-201	N814N	None	E R	off	Vero Beach, FL	Serious	0	0	0	0	1	5	45	ARC-87/03	1769	In-flt. encounter w/ weather
6.19.85	Providence AL	NSF	CV.240-27	N155PA	Destroyed	IC	off	West Trenton, NJ	Serious	0	0	0	0	2	2	0	ARC-87/03	2392	Loss of power (part.)-mech. fail./malfunction
6.23.85	American AL 803	SP	B.727-123	N1965	None	ID	off	South Haven, MI	Serious	0	0	0	0	2	6	63	ARC-87/03	2474	Near collision between aircraft
	Private AC	Pvt.	Cessna 421C	N1200L	None	E R			Minor/N	0	0	0	0	0	7	6			Near collision between aircraft
6.27.85	American AL	SP	DC-10-10	N129AA	Major	TO	on	San Juan Marin Intn'l Airport, PR (SJU)	Serious	0	0	0	0	3	13	257	AAR-86/01/SUM	2420	Airframe/component/system fail./malfunction
8.02.85	Delta AL 191	SP	L.1011-385-1	N726DA	Destroyed	RA	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Fatal	8	126	1	135	15	11	152	AAR-86/05	1572	In-flt. encounter w/ weather
9.06.85	Midwest Express 105	SP	DC-9-14	N100ME	Destroyed	IC	off	Milwaukee Mitchell Intn'l Airport, WI (MKE)	Fatal	4	27	0	31	0	4	27	AAR-87/01	1147	Loss of power (total)-mech. fail./malfunction
9.25.85	Markair	SP	B.737-2X6C	N674MA	Major	RA	on	Unalaska Airport, AK	Minor	0	0	0	0	0	4	17	ARC-87/03	2835	Undershoot
11.03.85	Piedmont Aviation	SP	B.737-201	N787N	None	E R	off	Charleston, WV	Serious	0	0	0	0	1	8	52	ARC-87/03	2364	In-flt. encounter w/ weather
11.07.85	American AL 334	SP	B.727-23	N1908	Major	AA	off	Bellevue, NE	None	0	0	0	0	0	7	64	ARC-87/03	1861	In-flt. collision w/ object
12.12.85	Arrow AW	NSP	DC-8-63PF	N950JW	Destroyed	IC	off	Gander Airport, Newfoundland, Canada	Fatal	8	248	0	256	0	8	248	DCA86RA010	7000	Loss of power (part.)-mech. fail./malfunction
									Total:	39	486	1	526	30	131	1504			

22 Accidents

23 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	FATALITIES Pass.	FATALITIES Other	FATALITIES Total	Serious Injury	Aboard AC Crew	Aboard AC Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.17.86	Eastern AL	SP	B.727-225 Adv.	N802EA	Major	L	on	Washington/Dulles Intn'l Airport, DC (IAD)	None	0	0	0	0	0	7	124	ARC-89/01	2748	Airframe/component/system fail./malfunction
1.19.86	Skybus	NSP	B.727-214	N545PS	None	CC	on	28 mi. NE of Las Vegas, NV	Serious	0	0	0	0	1	8	138	ARC-89/01	0016	Airframe/component/system fail./malfunction
2.15.86	Eastern AL	SP	L.1011-385-1	N309EA	None	G	on	New York Kennedy Intn'l Airport, ND (JFK)	Serious	0	0	0	0	1	11	242	ARC-89/01	1179	Unauthorized evacuation of passengers
2.20.86	Continental AL	SP	B.737-3T0	N17309	Major	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	6	105	ARC-89/01	1197	On grd. collision w/ terrain
2.21.86	USAir 499	SP	DC-9-31	N961VJ	Major-W.O.	L	on	Erie Intn'l Airport, PA (ERI)	Minor	0	0	0	0	0	5	18	ARC-89/01	1337	Overrun
3.03.86	United AL	SP	B.747-122	N4729U	None	E R	off	500 nmi. E of Honolulu, HI	Serious	0	0	0	0	2	15	325	ARC-89/01	2665	In-flt. encounter w/ weather
3.12.86	American AL 502	SP	B.727-223 Adv.	N877AA	None	CC	on	Memphis, TN	Serious	0	0	0	0	1	7	63	ARC-89/01	0698	Emergency evacuation of passengers
4.08.86	United AL	SP	B.737-222	N9054U	Major	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Minor	0	0	0	0	0	5	109	ARC-89/01	2698	Main gear collapsed
4.25.86	Aspen AW 416	SP	CV.580	N73104	None	ID	off	Denver, CO	Serious	0	0	0	0	1	3	26	ARC-89/01	2303	In-flt. encounter w/ weather
5.04.86	Southwest AL 558	SP	B.737-2H4 Adv.	N26SW	None	E R	off	Almosa, CO	Serious	0	0	0	0	2	6	46	ARC-89/01	1729	In-flt. encounter w/ weather
5.23.86	United AL	SP	B.747SP-21	N531PA	Major	L	on (a)	Sydney, Australia	None	0	0	0	0	0	7	95	DCA86WA000	7000	Airframe/component/system fail./malfunction
7.13.86	Eastern AL	SP	A.300B4-2C	N206EA	None	ID	off	West Palm Beach, FL	Serious	0	0	0	0	2	14	229	ARC-89/01	1365	In-flt. encounter w/ weather
7.21.86	Republic AL	SP	DC-9-31	N9332	Minor	E R	off	Montgomery, AL	Serious	0	0	0	0	1	6	35	ARC-89/01	1532	In-flt. encounter w/ weather
8.05.86	Continental AL	SP	B.727-224 Adv.	N32724	None	CC	off	Gulf of Mexico	Serious	0	0	0	0	1	7	96	ARC-89/01	1483	In-flt. encounter w/ weather
10.04.86	Southern AT LOGAIR 15	NSF	L.100-30/382G-23	N155T	Destroyed	IC	on	Kelly AFB, San Antonio, TX	Fatal	3	0	0	3	1	3	1	AAR-87/04	1691	Loss of control-in flt.
10.09.86	Zantop International	NSF	L.188PF Electra	N342HA	None	G	on	Boston Logan Intn'l Airport, MA (BOS)	Serious	0	0	0	0	1	3	0	ARC-89/01	2597	Prop./rotor contact
10.25.86	Piedmont AL 467	SP	B.737-222	N752N	Destroyed	L	on	Charlotte Douglas Intn'l Airport, NC (CLT)	Serious	0	0	0	0	3	5	114	AAR-87/06	1690	Overrun
11.06.86	Pan American AW	SP	B.727-235	N4743	Major	Taxi	on	Tampa Intn'l Airport, FL (TPA)	Serious	0	0	0	0	1	6	17	AAR-87/06	1693	On grd. collision w/ aircraft
	Private Aircraft	Pvt.	Piper PA.23-150	N2185P	Destroyed	L	on		Fatal	1	0	0	1	0	1	0			On grd. collision w/ aircraft
11.07.86	Continental AL	SP	DC-10-10	N68043	None	E R	off	Los Angeles, CA	Serious	0	0	0	0	1	14	109	ARC-89/01	2497	Airframe/component/system fail./malfunction
11.13.86	Delta AL 194	SP	L.1011-385-1	N714DA	Major	Taxi	on	Newark Intn'l Airport, NJ (EWR)	None	0	0	0	0	0	11	114	ARC-89/01	2331	Airframe/component/system fail./malfunction
12.15.86	United AL	SP	B.727-222	N7635U	Minor	ID	off	39 mi. E of Anchorage, AK	Serious	0	0	0	0	2	7	93	ARC-89/01	1598	In-flt. encounter w/ weather
12.22.86	USAir 95	SP	B.737-3B7	N369AU	Minor	E R	off	Dublin, VA	Serious	0	0	0	0	1	7	129	ARC-89/01	2563	In-flt. encounter w/ weather
12.30.86	Piedmont AL	SP	F.28-4000	N510	Minor	G	on	West Palm Beach Intn'l Airport, FL (PBI)	Serious	0	0	0	0	1	4	75	ARC-89/01	2015	Airframe/component/system fail./malfunction
									Total:	4	0	0	4	23	161	2307			

23 Accidents

24 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
2.11.87	United AL 108	SP	B.747-122	N4718U	None	E R	on	Detroit Wayne Co. Metro. Airport, MI (DTW)	Serious	0	0	0	0	3	14	227	ARC-90/01	1796	Miscellaneous/other
2.14.87	Ports of Call/Skyworld	NSP	B.707-323B	N712PC	None	E R	off	Durango, Mexico	Fatal	0	1	0	1	0	7	126	FTW87RA066	7000	Not reported
2.25.87	Continental AL 866	SP	B.727-224	N88704	None	IC	on	Los Angeles Intn'l Airport, CA (LAX)	None	0	0	0	0	0	7	84	ARC-90/01	0204	In-flt. collision w/ object
	Private AC	Pvt.	Cessna 310	N96834	?	Taxi	on			0	0	0	0	0	1	0			
2.27.87	Pacific SW AL	SP	BAe.146-200A	N356PS	Major	E R	off	Fresno Air Terminal, CA (FAT)	None	0	0	0	0	0	4	83	ARC-90/01	2661	Loss of power (total)-mech. fail./malfunction
3.10.87	USAir	SP	B.727-227	N780AL	Major	Taxi	on	Burlington Intn'l Airport, VT (BTV)	None	0	0	0	0	0	7	97	ARC-90/01	1394	On grd. collision w/ object
3.13.87	Western AL	SP	B.727-247	N2819W	Major	L	on	Calgary Airport, Canada	None	0	0	0	0	0	7	104	DCA87RA002	7000	Not reported
3.16.87	Southwest AL	SP	B.737-3H4	N314SW	None	E R	off	Midland, TX	Serious	0	0	0	0	1	6	53	ARC-90/01	0454	In-flt. encounter w/ weather
3.24.87	Metro Flt./Amer. Eagle	SP	CV.580	N73107	Major-Rbld.	TO	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	None	0	0	0	0	0	3	8	ARC-90/01	0374	On grd. encounter w/ weather
3.25.87	American AL	SP	DC-10-10	N126AA	None	IC	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	1	13	164	ARC-90/01	1484	Airframe/component/system fail./malfunction
3.29.87	Eastern AL 477	SP	A.300B4-203	N230EA	None	E R	off	Indianapolis, IN	Serious	0	0	0	0	1	9	236	ARC-90/01	2471	In-flt. encounter w/ weather
4.01.87	Piedmont AL	SP	B.727-295	N1643	None	IC	off	Miami, FL	Serious	0	0	0	0	1	7	89	ARC-90/01	0267	Miscellaneous/other
4.10.87	Mid Pacific	SP	YS.11A	N118MP	None	TO	on	Honolulu Intn'l Airport, HI (HNL)	Serious	0	0	0	0	1	4	39	ARC-90/01	0327	Airframe/component/system fail./malfunction
4.13.87	Buffalo AW 721	SF	B.707-351CF	N144SP	Destroyed	RA	off	Kansas City Intn'l Airport, MO (MCI)	Fatal	3	1	0	4	0	3	1	AAR-89/01/SUM	0330	In-flt. collision w/ terrain
4.30.87	Buffalo	SF	B.707-323C	N8704	Major	Taxi	on	Oklahoma City World Airport, OK (OKC)	Minor	0	0	0	0	0	3	0	ARC-90/01	1223	On grd. collision w/ object
5.03.87	Florida Leasing (14CFR125)	NSF	DC-6A	N43867	Major	Taxi	on	Ft. Lauderdale Airport, FL (FLL)	None	0	0	0	0	0	3	0	ARC-90/01	0369	Airframe/component/system fail./malfunction
6.22.87	America West	SP	B.737-277	N184AW	Major	Taxi	on	Los Angeles Intn'l Airport, CA (LAX)	None	0	0	0	0	0	5	76	ARC-90/01	2664	On grd. collision w/ object
	United AL	G	B.747SP-21	N141UA	Major	Taxi	on		None	0	0	0	0	0	2	0			
6.22.87	Southern Air	SP	L.382-30	N20ST	Major	L	on	Wright Patterson AFB, Dayton, OH	None	0	0	0	0	0	3	0	ARC-90/01	1892	Nose gear collapse
7.28.87	Ferreteria (14CFR125)	NSF	DC-3A	N30DT	Major	IC	on	Laredo Intn'l Airport, TX	None	0	0	0	0	0	2	0	ARC-90/01	0865	Loss of power
8.16.87	Northwest AL 255	SP	DC-9-82	N312RC	Destroyed	IC	on	Detroit Wayne Co. Airport, MI (DTW)	Fatal	6	148	2	156	2	6	149	AAR-88/05	0785	In-flt. collision w/ object
8.20.87	Rosenbalm/Emery 074	SF	DC-8-63AF	N951R	Major	L	on	Newburgh Stewart Intn'l Airport, NY (SWF)	None	0	0	0	0	0	4	0	ARC-90/01	0789	On grd. collision
	Airborne Express 124	SF	DC-9-31	N908AX	Major	Taxi	on		None	0	0	0	0	0	2	0		0789	On grd. collision
8.25.87	Delta AL	SP	L.1011-385-1	N720DA	Major	L	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	None	0	0	0	0	0	12	135	ARC-90/01	1776	Hard landing
9.15.87	Eastern AL	SP	B.727-225	N8857E	Major	L	on	Tulsa Intn'l Airport, OK (TUL)	None	0	0	0	0	0	7	55	ARC-90/01	1964	In-flt. encounter w/ weather
9.17.87	USAir 10	SP	B.727-264	N774AL	None	ID	off	Pittsburgh, PA	Serious	0	0	0	0	1	8	63	ARC-90/01	1847	In-flt. encounter w/ weather
9.18.87	USAir	SP	B.737-267	N318AU	None	ID	off	Philadelphia, PA	Serious	0	0	0	0	1	5	76	ARC-90/01	2225	In-flt. encounter w/ weather
9.28.87	Eastern AL	SP	L.1011-1	N317EA	Minor	E R	off	Atlantic Ocean, ER Bermuda-New York	Serious	0	0	0	0	1	10	129	ARC-90/01	2662	In-flt. encounter w/ weather
10.04.87	Piedmont AL	SP	B.767-201ER	N604P	Major	L	on	Los Angeles Intn'l Airport, CA (LAX)	None	0	0	0	0	0	9	139	ARC-90/01	2619	In-flt. collision w/ terrain
10.28.87	SMB Stage Line	NSF	CV.640	N3411	Destroyed	E R	on	Bartlesville Municipal Airport, OK (BVO)	Minor	0	0	0	0	2	2	0	ARC-90/01	2589	Loss of power (total)-nonmech.
11.10.87	Delta AL	SP	B.737-232	N315DL	None	ID	off	Raleigh, NC	Serious	0	0	0	0	1	5	61	ARC-90/01	2072	In-flt. encounter w/ weather
11.11.87	Pan American AW	SP	A.310-324	N813PA	Minor	E R	off	Atlantic Ocean	Serious	0	0	0	0	3	10	130	ARC-90/01	2273	In-flt. encounter w/ weather
11.15.87	Continental AL 1713	SP	DC-9-14	N626TX	Destroyed	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	Fatal	3	25	0	26	26	5	77	AAR-88/09	1288	In-flt. loss of control-initial climb
11.25.87	USAir 20	SP	B.737-3B7	N383AU	None	CC	on	Los Angeles Intn'l Airport, CA (LAX)	Serious	0	0	0	0	1	6	138	ARC-90/01	2622	Miscellaneous/other
12.05.87	USAir 224	SP	B.737-2B7	N319UA	Major	CC	off	Deptford, NJ	None	0	0	0	0	0	5	62	ARC-90/01	2402	Airframe/component/system fail./malfunction
12.07.87	Pacific SW AL 1771	SP	BAe.146-200A	N350PS	Destroyed	E R	off	Paso Robles, CA	Fatal	5	39	0	44	0	5	39	ARC-90/01	1750	Suicide/sabotage
12.15.87	Eastern AL 275	SP	B.727-225 Adv.	N8866E	Minor	TO	on	Kansas City Intn'l Airport, MO (MCI)	None	0	0	0	0	0	7	82	ARC-90/01	2447	On grd. collision w/ object
	Private AC	Pvt.	Aero Commander	N6509V	Major	Taxi	on		None	0	0	0	0	0	1	0			
12.26.87	American AL	SP	B.727-223	N705AA	Major	Taxi	on	San Juan Marin Intn'l Airport, PR (SJU)	None	0	0	0	0	0	6	106	ARC-90/01	2186	On grd. collision
	American AL	SP	B.727-223	N893AA	Minor	Taxi	on		None	0	0	0	0	0	6	82		2186	
12.27.87	Eastern AL 573	SP	DC-9-31	N8948E	Major-W.O.	L	on	Pensacola Regional Airport, FL (PNS)	Minor	0	0	0	0	0	4	103	AAR-89/02/SUM	1505	Hard landing
									Total:	17	214	2	233	48	235	3017			

36 Accidents

41 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.10.88	American AL	SP	DC-10-30	N142AA	None	G	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Serious	0	0	0	0	1	13	276	ARC-91/01	2290	Miscellaneous/other
1.13.88	Challenge Air Cargo	SF	B.707-330C	N707HE	Major	L	on (a)	Bogota, Colombia	None	0	0	0	0	0	3	0	MIA88WA085	7000	Not reported
1.19.88	American AL	SP	B.767-223	N306AA	None	ID	off	Chicago, IL	Serious	0	0	0	0	1	8	139	ARC-91/01	1999	Altitude deviation, uncontrolled
1.19.88	Trans World AW	SP	DC-9-82	N915TW	None	E R	off	Hickman, KY/Linden, TN	Serious	0	0	0	0	1	6	91	ARC-91/01	0566	In-flt. encounter w/ weather
1.25.88	Delta AL	SP	B.767-332	N117DL	None	ID	off	Block Island, RI	Serious	0	0	0	0	1	9	146	ARC-91/01	0372	In-flt. encounter w/ weather
1.27.88	American AL	SP	DC-9-82	N262AA	None	E R	off	Decatur, MI	Serious	0	0	0	0	1	6	76	ARC-91/01	0114	Miscellaneous/other
2.02.88	Aspen AW	SP	CV.580	N5808	Major-W.O.	L	on	Durango La Plata Airport, CO	Minor	0	0	0	0	0	3	38	ARC-91/01	0196	On grd. collision w/ object
3.29.88	Aerial Trans.	NSF	DC-6B	N928L	Minor	Taxi	on	Miami Intn'l Airport, FL (MIA)	None	0	0	0	0	0	3	0	ARC-91/01	0325	On grd. collision w/ object
	?	Fy.	SA.226TA	N30042	Major	G	on		None	0	0	0	0	0	2	0			
4.03.88	Continental AL	SP	B.727-224	N88703	None	G	on	Sarasota-Bradenton Airport, FL (SRQ)	Serious	0	0	0	0	1	8	136	ARC-91/01	0394	Miscellaneous/other
4.14.88	Piedmont AL 486	SP	F.28-4000	N110UR	Major	E R	off	Charleston Yeager Airport, WV (CRW)	Minor	0	0	0	0	0	6	56	ARC-91/01	2444	Loss of power (total)-mech. fail./malfunction
4.15.88	Horizon Air 2658	SP	DHC.8-102	N819PH	Destroyed	CC	on	Seattle/Tacoma Intn'l Airport, WA (SEA)	Serious	0	0	0	0	4	3	37	AAR-89/02	0401	Fire/explosion
4.16.88	Eastern AL 918	SP	B.757-225	N510EA	None	CC	off (a)	San Jose, Costa Rica	Serious	0	0	0	0	1	7	193	MIA88WA161	7000	Not reported
4.28.88	Aloha AL 243	SP	B.737-297	N73711	Major-W.O.	E R	off	ER Hilo, HI-Honolulu, HI, near Maui, HI	Fatal	0	1	0	1	7	5	90	AAR-89/03	0261	Airframe/component/system fail./malfunction
5.21.88	American AL 70	SP	DC-10-30	N136AA	Destroyed	TO	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Serious	0	0	0	0	2	14	240	SIR-90/01	0373	Airframe/component/system fail./malfunction
6.26.88	United AL	SP	B.737-222	N9040U	None	ID	off	Salisbury, MD	Serious	0	0	0	0	1	5	102	ARC-91/01	2202	In-flt. encounter w/ weather
7.11.88	Northwest AL	SP	B.727-251	N254US	Major	Taxi	on	Minneapolis/St. Paul Intn'l Airport, MN (MSP)	None	0	0	0	0	0	7	86	ARC-91/01	1860	On grd. collision w/ object
8.10.88	United AL	SP	B.737-222	N9060U	None	TO	on	Little Rock Adams Field, AR (LIT)	Serious	0	0	0	0	5	6	101	ARC-91/01	0560	Loss of power (part.)-mech. fail./malfunction
8.26.88	Delta AL	SP	B.767-332	N120DL	None	E R	off	Charleston, SC	Serious	0	0	0	0	1	12	53	ARC-91/01	2029	In-flt. encounter w/ weather
8.27.88	Trans World AW	SP	B.727-31	N852TW	Major-W.O.	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Minor	0	0	0	0	0	6	62	ARC-91/01	2384	Airframe/component/system fail./malfunction
8.31.88	Delta AL 1141	SP	B.727-232	N473DA	Destroyed	IC	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Fatal	2	12	0	14	26	7	103	AAR-89/04	0895	Loss of control-in flt.
9.09.88	Northwest AL	SP	B.727-2M7 Adv.	N729RW	Major	Taxi	on	Minneapolis/St. Paul Intn'l Airport, MN (MSP)	None	0	0	0	0	0	8	85	ARC-91/01	2297	On grd. collision w/ object
9.12.88	United AL	SP	DC-10-10	N1830U	Major	L	on	Denver Stapleton Intn'l Airport, CO (DEN)	Minor	0	0	0	0	0	10	197	ARC-91/01	0977	Airframe/component/system fail./malfunction
9.21.88	Pan Am Express	SP	DHC.7-102	N170RA	Major	E R	off	Albany, NY	Serious	0	0	0	0	1	3	12	ARC-91/01	2138	Loss of power (total)-mech. fail./malfunction
10.30.88	Northwest AL	SP	DC-9-31	N918RW	Major	Taxi	on	Memphis Intn'l Airport, TN (MEM)	None	0	0	0	0	0	4	38	ARC-91/01	2225	On grd. collision w/ object
11.03.88	Pan American AW	SP	B.747-123	N9674	None	E R	off	Bridgetown, Barbados	Serious	0	0	0	0	1	16	196	ARC-91/01	2432	Miscellaneous/other
11.14.88	Pan American AW 427	SP	A.300B4-203	N205PA	None	E R	off (a)	Panama City, Panama	Serious	0	0	0	0	1	7	227	MIA89WA071	7000	Not reported
12.16.88	Flying Tiger	SF	B.747-124	N822FT	Major	Taxi	on	Hong Kong Intn'l Airport, Hong Kong	None	0	0	0	0	0	7	15	DCA89WA019	7000	Not reported
12.21.88	Pan American AW 103	SP	B.747-121	N739PA	Destroyed	E R	off	Lockerbie, Scotland, U.K.	Fatal	16	243	11	270	2	16	243	DCA89RA014	7000	Explosion due to sabotage
12.23.88	United AL 820	SP	B.747SP-21	N146UA	None	E R	off	38.54o N, 173.24o W, Pacific Ocean	Serious	0	0	0	0	1	14	206	ARC-91/01	2363	In-flt. encounter w/ weather
									Total:	18	256	11	285	59	201	3226			

29 Accidents

30 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.20.89	Piedmont AL	SP	B.737-201 Adv.	N242US	Major	IC	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	6	27	ARC-93/01	0756	Airframe/component/system fail./malfunction
1.20.89	Aspen AW/United Express	SP	CV.580	N73160	Major-W.O.	E R	off	Buena Vista, CO	Minor	0	0	0	0	0	3	26	ARC-93/01	1755	Loss of eng. power (total)-nonmechanical
2.08.89	Independent Air 1851	NSP	B.707-331B	N7231T	Destroyed	AA	off	Mt. Pico Alto, Santa Maria, Azore Islands	Fatal	7	137	0	144	0	7	137	ARC-93/01		Not reported
2.09.89	Evergreen Intn'l AL	SF	DC-9-32F	N935F	None	CC	off	Salt Lake City, UT	Fatal	1	0	0	1	0	2	0	ARC-93/01	0944	Miscellaneous/other
2.19.89	Flying Tiger	SF	B.747-249F	N807FT	Destroyed	AA	off	Puchong, Kuala Lumpur, Malaysia	Fatal	4	0	0	4	0	4	0	ARC-93/01		In-flt. collision w/ terrain
2.24.89	United AL 811	SP	B.747-121	N4713U	Major	CC	off	Pacific Ocean near Honolulu, HI	Fatal	0	9	0	9	5	19	337	AAR-92/02	0083	Airframe/component/system fail./malfunction
3.15.89	Mid Pacific AL/Phoenix AL	NSF	YS.11A-300F	N128MP	Destroyed	RA	off	Lafayette Purdue University Airport, IN (LAF)	Fatal	2	0	0	2	0	2	0	ARC-93/01	0569	Loss of control-in flt.
3.17.89	Continental AL	SP	B.737-3T0	N12318	Major	G	on	Oakland Intn'l Airport, CA (OAK)	None	0	0	0	0	0	5	64	ARC-93/01	2036	Fire, starting engine(s)
3.18.89	Evergreen Intn'l AL	SF	DC-9-33RC	N931F	Destroyed	IC	off	Carswell AFB, Saginaw, TX	Fatal	2	0	0	2	0	2	0	AAR-90/02	0074	Airframe/component/system fail./malfunction
4.03.89	Piedmont AL	SP	B.767-201ER	N645US	None	G	on	Los Angeles Intn'l Airport, CA (LAX)	Serious	0	0	0	0	2	9	213	ARC-93/01	0357	Miscellaneous/other
5.10.89	Continental AL	SP	A.300B4-203	N972C	None	ID	off	San Diego, CA	Serious	0	0	0	0	1	10	84	ARC-93/01	0766	In-flt. encounter w/ weather
5.28.89	Continental AL	SP	DC-9-82	N806NY	Major	L	on	Denver Stapleton Intn'l Airport, CO (DEN)	Minor	0	0	0	0	0	6	39	ARC-93/01	2400	Main gear collapsed
6.16.89	Delta AL	SP	L.1011-385-1	N721DA	None	ID	off	Jacks Creek, TN	Serious	0	0	0	0	7	15	274	ARC-93/01	2007	In-flt. encounter w/ weather
6.26.89	Continental AL	SP	B.737-291	N7375F	None	G	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	Serious	0	0	0	0	1	5	100	ARC-93/01	1475	Prop. blast or jet exhaust/suction
7.12.89	American AL 699	SP	A.300B4-605R	N7062A	None	Taxi	on	San Juan Intn'l Airport, Puerto Rico (SJU)	Fatal	0	0	1	1	0	9	235	ARC-93/01	1075	On grd. collision w/ object
7.13.89	Rosenblam Aviation/Emery	NSF	DC-8-63F	N950R	Major	Taxi	on	Dayton Cox Intn'l Airport, OH (DAY)	None	0	0	0	0	0	3	0	ARC-93/01	0755	Airframe/component/system fail./malfunction
	?	G	B.727-	?	?	G	on		None	0	0	0	0	0	0	0			
7.19.89	United AL 232	SP	DC-10-10	N1819U	Destroyed	E R	on	Sioux City Gateway Airport, IA (SUX)	Fatal	1	110	0	111	47	11	285	AAR-90/06	0437	Airframe/component/system fail./malfunction
8.03.89	Zantop Intn'l	SF	CV.640	N5509K	Major	L	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	None	0	0	0	0	0	2	0	ARC-93/01	0977	Hard landing
8.19.89	USAir	SP	F.28-4000	N489US	None	E R	off	Vero Beach, FL	Serious	0	0	0	0	1	4	10	ARC-93/01	1160	In-flt. encounter w/ weather
9.12.89	American AL	SP	DC-9-82	N244AA	Major	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Minor	0	0	0	0	0	6	104	ARC-93/01	2154	Airframe/component/system fail./malfunction
9.20.89	USAir 5050	SP	B.737-401	N416US	Destroyed	TO	on	New York LaGuardia Airport, NY (LGA)	Fatal	0	2	0	2	3	6	57	AAR-90/03	0791	Loss of control-on grd.
9.30.89	Mesaba Aviation	SP	F.27	N280MA	Major	L	on	Bemidji Airport, MN	None	0	0	0	0	0	3	26	ARC-93/01	2379	In-flt. encounter w/ weather
10.07.89	USAir	NSP	DC-9-31	N958VJ	None	Taxi	on	Orlando Intn'l Airport, FL (MCO)	Fatal	0	0	1	1	0	5	102	ARC-93/01	1518	On grd. encounter w/ weather
10.14.89	Delta AL 1558	SP	B.727-232 Adv.	N530DA	Major-W.O.	G	on	Salt Lake City Intn'l Airport, UT (SLC)	Minor	0	0	0	0	0	7	12	ARC-93/01	1425	Fire/explosion
11.06.89	America West	SP	B.757-2S7	N902AW	None	Taxi	on	Phoenix Sky Harbor Intn'l Airport, AZ (PHX)	Serious	0	0	0	0	1	7	91	ARC-93/01	1839	Miscellaneous/other
12.21.89	American AL	SP	B.757-223	N611AM	Major	L	on	Orange Co. John Wayne Airport, CA (SNA)	None	0	0	0	0	0	7	104	ARC-93/01	2166	In-flt. collision w/ terrain/water
12.27.89	Eastern AL	SP	B.727-225B	N822EA	None	E R	off	Miami, FL	Fatal	0	1	0	1	0	7	47	ARC-93/01	1622	Miscellaneous/other
12.30.89	America West	SP	B.737-204	N198AW	Major-W.O.	AA	on	Tucson Intn'l Airport, AZ (TUS)	Minor	0	0	0	0	0	5	128	ARC-93/01	2381	In-flt. fire
									Total:	17	259	2	278	68	177	2502			

28 Accidents

29 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.02.90	American AL	SP	DC-10-10	N100AA	None	E R	on	Baltimore, MD	Serious	0	0	0	0	3	10	247	ARC-93/02	1685	Airframe/component/system fail./malfunction
1.16.90	United AL	SP	B.757-222	N505UA	Major	TO	on	New York LaGuardia Airport, NY (LGA)	None	0	0	0	0	0	7	189	ARC-93/02	0026	On grd. collision w/ terrain/water
1.16.90	Eastern AL 111	SP	B.727-225 Adv.	N8867E	Major	L	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	None	0	0	0	0	0	8	141	AAR-91/03	?	On grd. collision w/ object
	Eppa Air Service	Fy.	Bch. A100 King Air	N44UE	Major-W.O.	Taxi	on		Fatal	1	0	0	1	1	1	1			
1.20.90	American AL	SP	DC-10-10	N124AA	Minor	ID	off	San Juan, Puerto Rico	Serious	0	0	0	0	2	11	144	ARC-93/02	1125	In-flt. encounter w/ weather
1.31.90	Federal Express	SF	B.727-	N519FE	Minor	G	on	Indianapolis Weir-Cook Intn'l Airport, IN (IND)	Fatal	0	0	1	1	0	3	3	ARC-93/02	1009	On grd. collision w/ object
3.16.90	America West AL	SP	B.737-3G7	N306AW	Major	?	on	Orange Co. John Wayne Airport, CA (SNA)	None	0	0	0	0	0	?	110	LAX90LA122	1861	On grd. collision w/ terrain
3.31.90	Alaska AL	SP	B.727-227	N271AF	Minor	TO	on	Phoenix Sky Harbor Intn'l Airport, AZ (PHX)	Fatal	0	0	1	1	0	6	35	ARC-93/02	1058	On grd. collision w/ object
4.18.90	Federal Express	SF	DC-10-10CF	N68058	Major	L	on	Los Angeles Intn'l Airport, CA (LAX)	None	0	0	0	0	0	6	0	ARC-93/02	1432	On grd. collision w/ terrain/water
5.05.90	Aerial Transit/Traslados	SF	DC-6B/F	N94BL	Destroyed	IC	off	Guatemala City, Guatemala	Fatal	3	0	22	25	0	3	0	DCA90RA025	7000	Loss of eng. power
5.11.90	United AL	SP	B.737-291	N900UA	None	ID	off	Washington, DC	Serious	0	0	0	0	1	5	?	ARC-93/02	0198	In-flt. encounter w/ weather
6.02.90	Markair 3087	SP/F	B.737-2X6C Adv.	N670MA	Major-W.O.	RA	off	Unalakleet, AK	Serious	0	0	0	0	1	4	0	AAR-91/02	0274	In-flt. collision w/ terrain/water
6.16.90	USAir 1948	SP	F.28-1000	N458US	Major	G	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	4	52	ARC-93/02	1207	On grd. collision w/ object
	Alitalia 606	SP	B.747-243B Combi	I-DEMC	Minor	Taxi	on		None	0	0	0	0	0	?	77			
6.21.90	USAir	SP	B.727-293/281	N743US	None	ID	on	Charleston AFB/Intn'l Airport, SC (CHS)	Serious	0	0	0	0	2	7	113	ARC-93/02	1497	Airframe/component/system fail./malfunction
7.14.90	TPI Intn'l AW	NSF	L.188CF Electra	N4465F	Major-W.O.	CC	off	Aruba, Netherlands Antilles	None	0	0	0	0	0	3	0	MIA90LA153	2118	Airframe/component/system fail./malfunction
7.18.90	American AL	SP	B.727-223	N6834	None	ID	off	Ft. Myers, FL	Serious	0	0	0	0	1	6	144	ARC-93/02	0819	In-flt. encounter w/ weather
7.22.90	USAir 1949	SP	B.737-222	N210US	Major-W.O.	TO	on	Kinston Airport, NC	Minor	0	0	0	0	0	5	22	ATL90FA146	2324	Airframe/component/system fail./malfunction
7.27.90	World AW	NSP	DC-10-30CF	N108WA	None	Taxi	on	Johor Bharu Airport, Malaysia	Serious	0	0	0	0	1	?	?	DCA90WA049	7000	Prop. blast or jet exhaust/suction
8.03.90	United AL	SP	DC-10-10	N1804U	None	E R	off	Coeur D'Arlene, ID	Serious	0	0	0	0	1	?	283	ARC-93/02	1187	Miscellaneous/other
8.09.90	Southwest AL	SP	B.737-3H4	N327SW	None	E R	off	Corpus Christi, TX	Serious	0	0	0	0	1	5	71	ARC-93/02	1586	In-flt. encounter w/ weather
8.12.90	Pan American AW	SP	A.310-222	N803PA	None	TO	on	Paris DeGaulle Intn'l Airport, France	Serious	0	0	0	0	1	?	162	DCA90WA045	7000	Airframe/component/system fail./malfunction
9.28.90	Northwest AL 297	SP	B.727-200	N2278	Minor	Taxi	on	Detroit Wayne Co. Metro. Airport, MI (DTW)	Serious	0	0	0	0	4	?	120	CHI90FA278	1950	Fire
10.03.90	Eastern AL	SP	DC-9-31	N8923E	Minor	E R	off	West Palm Beach, FL	Fatal	0	1	0	1	2	?	97	MIA91LA005	2139	In-flt. encounter w/ weather
10.29.90	USAir	SP	DC-9-31	N972VJ	Minor	Taxi	on	Port Columbus Intn'l Airport, OH (CMH)	None	0	0	0	0	0	5	42	ARC-93/02	1740	On grd. collision w/ object
	Private AC	Pvt.	Cessna 310	?	?	Taxi	on		?	0	0	0	0	?	?	?			
12.03.90	Northwest AL 1482	SP	DC-9-14	N3313L	Destroyed	Taxi	on	Detroit Wayne Co. Metro. Airport, MI (DTW)	Fatal	1	7	0	8	10	4	40	AAR-91/05	1390	On grd. collision
	Northwest AL 299	SP	B.727-251 Adv.	N278US	Major	TO	on		None	0	0	0	0	0	8	146			On grd. collision
									Total:	5	8	24	37	31	113	2219			

24 Accidents

28 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Fli. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.25.91	American AL 323	SP	B.727-200	N815AA	None	G	on	Indianapolis Weir-Cook Intn'l Airport, IN (IND)	Serious	0	0	0	0	1	?	92	CHI91LA067	0020	Miscellaneous/other
2.01.91	USAir 1493	SP	B.737-3B7	N388US	Destroyed	L	on	Los Angeles Intn'l Airport, CA (LAX)	Fatal	2	20	0	22	13	6	83	AAR-91/06	0047	On grd. collision w/ object
	Skywest AL/Delta 5569	SP	SA.227AC Metro.III	N663AV	Destroyed	Taxi	on		Fatal	2	10	0	12	0	2	10			
2.17.91	Emery AL 590	SF	DC-9-15F RC	N565PC	Destroyed	IC	off	Cleveland Hopkins Intn'l Airport, OH (CLE)	Fatal	2	0	0	2	0	2	0	AAR-91/09	0153	Abrupt maneuver
3.02.91	Simmons AL	SP	S. SD.360-200	N365MQ	Major	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	3	19	ARC-94/01	1270	Hard landing
3.03.91	United AL 585	SP	B.737-291 Adv.	N999UA	Destroyed	RA	off	Colorado Springs, CO	Fatal	5	20	0	25	0	5	20	DCA91MA023	0154	In-flt. loss of control
3.12.91	Air Transport Intn'l 102	SF	DC-8-62H AF	N730PA	Destroyed	TO	on	New York Kennedy Intn'l Airport, NY (JFK)	Minor	0	0	0	0	0	5	0	ARC-94/01	1417	Overrun
3.23.91	United AL	SP	B.727-222 Adv.	N7449U	None	E R	off	Buffalo, NY	Serious	0	0	0	0	1	?	43	CHI91LA115	1363	Altitude deviation, uncontrolled
5.03.91	Ryan Intn'l/Emery	SF	B.727-22C	N425EX	Major-W.O.	TO	on	Hartford Bradley Intn'l Airport, CT (BDL)	None	0	0	0	0	0	3	0	NYC91FA125	1418	Airframe/component/system fail./malfunction
5.04.91	USAir	SP	B.767-2B7 ER	N651US	None	E R	off	Memphis, TN	Serious	0	0	0	0	1	?	115	ATL91LA091	1008	In-flt. encounter w/ weather
5.05.91	Delta AL	SP	DC-9-88	N938DL	Major	Taxi	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	Serious	0	0	0	0	1	7	98	ATL91FA090	0824	On grd. collision w/ object
5.11.91	American Eagle 4346/ Simmons AL	SP	SH. SD.360-	N715NC	Major	Taxi	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	3	18	CHI91FA152	1370	Airframe/component/system fail./malfunction
6.05.91	America West AL	SP	B.737-3G7	N304AW	None	E R	off	Elko, NV	Serious	0	0	0	0	1	?	139	SEA91LA126	1183	Miscellaneous/other
7.01.91	American AL	SP	A.300B4-605R	N41063	None	E R	off	Newark, NJ	Serious	0	0	0	0	2	?	216	NYC91LA164	1040	In-flt. encounter w/ weather
7.04.91	Delta AL	SP	B.757-232	N605DL	None	E R	off	Alma, GA	Serious	0	0	0	0	1	7	118	ATL91LA123	0853	In-flt. encounter w/ weather
7.08.91	Southern AT 711	NSF	B.707-323C	N8404	Major	TO	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	3	3	DEN91FA098	0807	Airframe/component/system fail./malfunction
7.17.91	Trans World Express/ Trans States AL	SP	ATR.42-300	N425TE	Major	RA	off	Greater Peoria Airport, IL (PIA)	None	0	0	0	0	0	?	19	CHI91MA220	1776	Loss of eng. power (total)-mech. fail./malf.
7.27.91	American AL 602	SP	DC-9-82	N491AA	Minor	Taxi	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	None	0	0	0	0	0	?	123	FTW91LA137A	0863	On grd. collision w/ object
	Metro AL 3711	SP	BAe.3100	N405AE	Major	G	on		None	0	0	0	0	0	?	?			On grd. collision w/ object
9.14.91	Simmons AL	SP	ATR.42-300	N243AT	None	E R	off	Muskegon Co. Airport, MI (MKG)	Serious	0	0	0	0	1	?	26	CHI91LA300	0790	Airframe/component/system fail./malfunction
9.23.91	American AL	SP	DC-9-82	N442AA	Major	Taxi	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Minor	0	0	0	0	0	?	80	CHI91LA301	1608	On grd. collision w/ object
9.26.91	Continental AL	SP	DC-9-82	N819NY	Minor	Taxi	on	Boston Logan Intn'l Airport, MA (BOS)	Serious	0	0	0	0	2	5	123	ARC-94/01	0907	Grd. fire
10.04.91	Aerolease	SF	DC-8-63F	N952R	Major	Taxi	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	None	0	0	0	0	0	3	0	FTW92LA005	1527	On grd. collision w/ object
10.05.91	Continental AL	SP	B.727-243	N17402	None	E R	off	Little Rock, AR	Serious	0	0	0	0	1	?	54	FTW92LA001	1745	In-flt. encounter w/ weather
10.12.91	Continental Express/ Brit AW	SP	ATR.42-312	N25811	None	G	on	Bridgeport, CT	Fatal	?	?	?	1	0	?	?	NYC92LA005	1612	Propeller/rotor contact
10.16.91	Continental AL	SP	B.737-291	N7385F	Major	Taxi	on	Newark Intn'l Airport, NJ (EWR)	Minor	0	0	0	0	0	?	57	NYC92FA009B	1419	On grd. collision
	American AL	SP	DC-9-82	N496AA	Major	Taxi	on		Serious	0	0	0	0	2	6	109	NYC92FA009A		On grd. collision
10.23.91	USAir	SP	B.737-4B7	N441US	None	L	on	Boston Logan Intn'l Airport, MA (BOS)	Serious	0	0	0	0	1	?	92	NYC92LA018	0959	Airframe/component/system fail./malfunction
11.30.91	Southwest AL	SP	B.737-2H4 Adv.	N73SW	Major	AA	off	7 mi. from Lubbock Airport, TX (LBB)	None	0	0	0	0	0	?	107	FTW92LA033	1884	In-flt. collision w/ object
									Total:	11	50	0	62	28	60	1764			

26 Accidents

29 Aircraft Involved

ACC. DATE	OPERATOR Fli. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.09.92	United AL	SP	B.747-100	N4279U	None	?	off	Narita, Japan	Serious	0	0	0	0	?	?	?	ARC/94/02	?	In-flt. encounter w/ weather
1.18.92	USAir 305	SP	DC-9-31	N964VJ	Major-W.O.	L	on	Elmira Corning Regional Airport, NY (ELM)	Serious	0	0	0	0	2	5	36	BFO92FA020	2059	On grd. collision w/ terrain/water
2.15.92	Burlington Air Express/ Air Transport Intn'l 805	SF	DC-8-63(F)	N794AL	Destroyed	RA	off	Toledo, OH	Fatal	3	1	0	4	0	4	0	AAR-92/05	1042	In-flt. loss of control
3.21.92	United AL	SP	B.757-222	N519UA	None	Taxi	on	Phoenix Sky Harbor Intn'l Airport, AZ (PHX)	Serious	0	0	0	0	1	6	147	LAX92LA147	0390	Miscellaneous/other
3.22.92	USAir 405	SP	F.28-4000	N485US	Destroyed	TO	on	New York LaGuardia Airport, NY (LGA)	Fatal	2	25	0	27	24	4	47	AAR-93/02	1045	In-flt. loss of control
3.27.92	American AL	SP	B.757-223	N615AM	None	Taxi	on	Hayden Yampa Valley Regional Airport, CO (	Serious	0	0	0	0	1	8	187	FTW92LA100	0341	On grd. collision w/ object
4.08.92	Trans World AL	SP	DC-9-32	N926L	Minor	Taxi	on	Dayton Cox Intn'l Airport, OH (DAY)	Fatal	0	0	1	1	0	4	24	NYC92LA076	0011	Airframe/component/system fail./malfunction
5.14.92	Southwest AL	SP	B.737-2H4 Adv.	N67SW	None	ID	off	Palacios, TX	Serious	0	0	0	0	1	5	109	FTW92LA142	2028	In-flt. encounter w/ weather
6.02.92	Delta AL	SP	L.1011-385-1	N718DA	None	CC?	off	Atlanta, GA	Serious	0	0	0	0	1	7	131	ATL92LA113		Airframe/component/system fail./malfunction
7.02.92	United AL	SP	B.727-222 Adv.	N7467U	None	ID	off	Janesville, WI	Serious	0	0	0	0	1	7	130	CHI92LA206	2256	In-flt. encounter w/ weather
7.30.92	Trans World AL 843	SP	L.1011-385-1	N11002	Destroyed	TO	on	New York Kennedy Intn'l Airport, NY (JFK)	Serious	0	0	0	0	1	12	280	AAR-93/04	2459	Airframe/component/system fail./malfunction
8.03.92	Southwest AL	SP	B.737-3H4	N357SW	None	ID	off	Springfield, MO	Serious	0	0	0	0	1	5	62	FTW92LA200	2600	In-flt. encounter w/ weather
8.06.92	United AL	SP	B.737-222	N9010U	None	Taxi	on	San Francisco Intn'l Airport, CA (SFO)	Serious	0	0	0	0	1	5	109	LAX92LA336	2999	Abrupt maneuver
8.26.92	Carnival AL	SP	B.737-201	N206AU	None	Taxi	on	Miami Intn'l Airport, FL (MIA)	Serious	0	0	0	0	1	5	90	MIA92LA167	2662	Airframe/component/system fail./malfunction
10.01.92	DHL AW	NSF	B.727-200	N726DH	Major	?	on (a)	Martinique, France	None	0	0	0	0	0	5	0	ARC-94/02	?	Miscellaneous/other
11.13.92	Delta AL	SP	B.757-232	N619DL	None	Taxi	on	Atlanta Hartsfield Intn'l Airport, GA (ATL)	Serious	0	0	0	0	1	7	180	ATL93LA024	0699	Miscellaneous/other
11.27.92	Delta AL	SP	B.727-232 Adv.	N401DA	None	Grd.	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	1	7	117	CHI93LA043	2635	Miscellaneous/other
12.08.92	USAir	SP	B.737-3B7	N516AU	None	Taxi	on	New York LaGuardia Airport, NY (LGA)	Fatal	0	0	1	1	0	5	54	NYC93LA040	0804	On grd. collision w/ object
12.09.92	Kalitta American Intn'l/ American Intn'l AW	NSF	DC-8-52F	N810CK	Major	E R	off	20 mi. W of Denver, CO	None	0	0	0	0	0	3	0	DEN93FA015	0653	In-flt. encounter w/ weather
									Total:	5	26	2	33	37	97	1703			

19 Accidents

19 Aircraft Involved

APPENDIX A2.1 NTSB 14 CFR 121 ACCIDENT DATABASE

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	FATALITIES Pass.	FATALITIES Other	FATALITIES Total	Serious Injury	Aboard AC Crew	Aboard AC Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
1.05.93	American AL	SP	B.767-323 ER	N360AA	Minor	E R	off	Sarasota, FL	Serious	0	0	0	0	3	10	214	MIA93LA045	0122	In-flt. encounter w/ weather
2.23.93	Delta AL	SP	B.757-232	N678DL	Major	CC	on	Ft. Lauderdale, FL	None	0	0	0	0	0	9	182	MIA93FA073	1118	Loss of eng. power (total), mech. fail/malfunction
3.05.93	Trans World Express	SP	DHC.7-102	N175RA	None	RA	off	Philadelphia, PA	Serious	0	0	0	0	1	3	9	BFO93LA048	0513	In-flt. encounter w/ weather
3.09.93	Continental AL	SP	B.727-200	N79754	None	E R	off	Gulf of Mexico	Serious	0	0	0	0	1	8	36	FTW93FA100	0279	Abrupt maneuver
3.23.93	Henson Aviation	SP	DHC.8-102	N928HA	None	AA	off	Jacksonville, FL	Serious	0	0	0	0	1	3	19	MIA93LA090	0498	In-flt. encounter w/ weather
4.04.93	Simmons AL	SP	ATR.42-300	N422MQ	Minor	G	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Fatal	0	0	1	1	0	5	43	CHI93FA129	2107	Airframe/component/system fail./malfunction
4.14.93	American AL 102	SP	DC-10-30	N139AA	Major-W.O.	L	on	Dallas/Ft. Worth Intn'l Airport, TX (DFW)	Serious	0	0	0	0	2	13	189	DCA93MA040	0388	Loss of control-on grd./water
4.26.93	Delta AL	SP	B.757-232	N646DL	None	ID	off	Miami, FL	Serious	0	0	0	0	1	7	55	MIA93LA110	0611	In-flt. encounter w/ weather
4.26.93	Continental AL	SP	DC-9-82	N14816	Major	RA	on	Denver Stapleton Intn'l Airport, CO (DEN)	Minor	0	0	0	0	0	6	84	DEN93FA047	0789	In-flt. encounter w/ weather
4.27.93	Continental AL	SP	DC-9-82	N72822	Major	L	on	Denver Stapleton Intn'l Airport, CO (DEN)	Minor	0	0	0	0	0	6	115	DEN93FA049	0798	Main gear collapsed
5.04.93	American Eagle AL/ Simmons AL	SP	ATR.42-300	N254AT	Major	L	on	Muskegon Co. Airport, MI	None	0	0	0	0	0	3	41	CHI93LA160	0415	On grd./water encounter w/ terrain/water
5.07.93	Air Wisconsin	SP	BAe.ATP	N852AW	None	G	on	Green Bay Austin Strabel Airport, WI	Serious	0	0	0	0	1	4	30	CHI93LA327	1669	Miscellaneous/other
6.04.93	American Eagle AL 4126/ Simmons AL	SP	ATR.72-212	N345AT	None	CC	off	Chicago, IL	Serious	0	0	0	0	1	4	64	CHI93LA192	0577	Uncontrolled altitude deviation
6.24.93	United AL	SP	B.757-222	N579UA	None	ID	off	Baraboo, WI	Serious	0	0	0	0	1	8	140	CHI93LA224	1642	Uncontrolled altitude deviation
7.16.93	United AL	SP	B.767-322 ER	N645UA	None	E R	off	Caribbean Sea	Serious	0	0	0	0	1	12	152	MIA93LA157	1316	In-flt. encounter w/ weather
7.25.93	American Eagle/Flagship AL	SP	ATR.42-320	N242AT	Major	Taxi	on	New York Kennedy Intn'l Airport, NY (JFK)	None	0	0	0	0	0	3	30	NYC93FA137B	6029	On grd./water collision w/ object
	Saudia	SP	B.747-368	HZ-AIS	Major?	Taxi	on		None	0	0	0	0	0	7	151			
8.02.93	United AL	SP	B.757-222	N508UA	Major	L	on	Denver Stapleton Intn'l Airport, CO (DEN)	None	0	0	0	0	0	7	157	DEN93LA098	0525	Hard landing
9.03.93	Delta AL	SP	MD-88	N913DL	None	L	on	Lexington Blue Grass Airport, KY (LEX)	Serious	0	0	0	0	1	6	100	BFO93LA155	1237	Miscellaneous/other
9.15.93	Delta AL	SP	B.757-232	N627DL	None	CC	off	Atlanta, GA	Serious	0	0	0	0	1	8	180	ATL93LA159	1551	In-flt. encounter w/ weather
10.22.93	United AL	SP	B.767-322	N649UA	None	E R	off	Atlantic Ocean	Serious	0	0	0	0	1	10	98	MIA94LA010	2116	In-flt. encounter w/ weather
11.15.93	Continental AL	SP	B.727-227	N16762	Major	L	on	Chicago O'Hare Intn'l Airport, IL (ORD)	None	0	0	0	0	0	7	79	CHI94FA039	2132	Wheels-up landing
									Total:	0	0	1	1	16	142	2179			

21 Accidents

22 Aircraft Involved

ACC. DATE	OPERATOR Flt. No.	FLT. TYPE	AIRCRAFT TYPE	REGN. NO.	AIRCRAFT DAMAGE	FLT. PHS.	Airport Proximity (on/off)	ACCIDENT LOCATION	Injury Degree	FATALITIES Crew	Pass.	Other	Total	Serious Injury	Aboard AC Crew	Pass.	NTSB Report	NTSB File No.	NTSB First Occurrence Classification
2 01 94	American Eagle 3641/ Simmons AL	SP	SF.340B	N349SB	Major	L	on	False River Air Park, LA	Minor	0	0	0	0	0	3	23	DCA94MA033	0928	Loss of eng. power (total)-nonmechanical
2 12 94	United AL	SP	B.747-422	N186UA	None	E R	off	Pacific Ocean	Serious	0	0	0	0	1	21	388	LAX94LA141	0220	In-flt. encounter w/ weather
3 02 94	Continental AL 795	SP	MD-82 (DC-9-82)	N18835	Major	TO	on	New York LaGuardia Airport, NY (LGA)	Minor	0	0	0	0	0	6	110	AAR-95/01	1438	Overrun
3.15.94	American Intn'l AW	NSF	DC-8-61	N817CK	Minor	CC	off	Greater Cincinnati Intn'l Airport, KY (CVG)	Serious	0	0	0	0	1	3	0	NYC94LA062	0110	Miscellaneous/other
4 07.94	Federal Express	SF	DC-10-30	N306FE	Minor	CC?	off	Memphis, TN	Serious	0	0	0	0	3	3	1	ATL94LA077	0501	In-flt. loss of control
6.29 94	American AL	SP	MD-11	N1752K	Minor	E R	off	Caribbean Sea	Serious	0	0	0	0	2	17	80	MIA94FA169	0294	Uncontrolled altitude deviation
6 29 94	Trans World AL	SP	B.767-200	N16006	None	ID	off	East Hampton, NY	Serious	0	0	0	0	1	9	158	NYC94LA111	0091	In-flt. encounter w/ weather
7 02 94	USAir 1016	SP	DC-9-31	N954VJ	Destroyed	IC?	off	Charlotte Douglas Intn'l Airport, NC (CLT)	Fatal	0	37	0	37	16	5	52	AAR-95/03		
7 05 94	Valujet AL	SP	DC-9-32	N901VJ	None	E R	off	Valdosta, GA	Serious	0	0	0	0	1	5	83	MIA94LA173	1280	In-flt. encounter w/ weather
7 07 94	Southwest AL	SP	B.737-2H4	N60SW	None	CC	off	South Bend, IN	Serious	0	0	0	0	1	5	100	FTW94LA229	1018	In-flt. encounter w/ weather
8 01 94	Atlantic Coast AL	SP	DHC.8-311	N433AW	Major	G	on	Washington Dulles Intn'l Airport, VA (IAD)	None	0	0	0	0	0	3	50	NYC94LA144	0605	On grd./water collision w/ object
8.19 94	America West AL	SP	B.757-200	N901AW	None	Taxi	on	Phoenix Sky Harbor Intn'l Airport, AZ (PHX)	Serious	0	0	0	0	1	7	160	LAX94LA333	1713	Miscellaneous/other
9 08.94	Skywest AL	SP	Canadair CL.600	N403SW	Major	Taxi	on	Burbank/Glendale Airport, CA (BUR)	None	0	0	0	0	0	3	33	LAX94LA357	1346	On grd./water collision w/ object
9.08.94	USAir 427	SP	B.737-3B7	N513AU	Destroyed	AA?	off	Aliquippa, 7 mi. NW of Pittsburgh, PA	Fatal	5	127	0	132	0	5	127			
9 19 94	USAir	SP	B.737-401	N433US	None	E R	off	Atlantic Ocean	Serious	0	0	0	0	1	6	126	MIA94LA214	0947	In-flt. encounter w/ weather
10 31 94	American Eagle 4184/ Simmons AL	SP	ATR.72-212	N401AM	Destroyed	ID?	off	Roselawn, IN	Fatal	4	64	0	68	0	4	64			
11.04 94	Federal Express	NSF	MD-11F	N611FE	Major	L	on	Anchorage Intn'l Airport, AK (ANC)	None	0	0	0	0	0	2	0	ANC05FA008	1931	Hard landing
11.06.94	Northwest AL	SP	B.757-231	N518US	None	Taxi	on	Minneapolis/St. Paul Intn'l Airport, MN (MSP)	Serious	0	0	0	0	1	7	116	CHI95LA031	2013	Prop. blast or jet exhuast/suction
11 22 94	Trans World AL 427	SP	MD-82	N954U	Major	TO	on	St. Louis Lambert Intn'l Airport, MO (STL)	None	0	0	0	0	0	5	132			
	Superior Aviation/Garrett Av.?	?	C.441 Conquest II	N441KM	Destroyed	Taxi	on		Fatal	2	0	0	2	0	2	0			
11 25.94	United Parcel Service	NSF	B.757-24APF	N413UP	Major	L	on	Tulsa Intn'l Airport, OK (TUL)	None	0	0	0	0	0	2	0	FTW95LA055	1763	Dragged wing/rotor/pod/float or tail/skid
11 30 94	Air Transport Intn'l	NSF	DC-8-71F	N826BX	Minor	G	on	Chicago O'Hare Intn'l Airport, IL (ORD)	Serious	0	0	0	0	1	7	0	CHI95LA049	1818	Tail gear collapsed
12 11 94	Markair	SP	B.737-3M8	N681MA	None	CC	off	Anchorage, AK	Serious	0	0	0	0	1	5	116	ANC95FA019	2001	Airframe/component/system fail /malfunction
									Total:	11	228	0	239	31	135	1919			

22 Accidents 23 Aircraft Involved

3. GENERAL AVIATION

3.1 INTRODUCTION

General aviation is the broad categorization of all aviation activities which do not fall under the categories of commercial aviation and military aviation. It includes diverse and dissimilar aviation activities such as personal flying, business flying, corporate/executive flights, aerial (spray) application, and instructional or training flights. As the first step in compiling the data necessary to determine the risk to facilities from general aviation aircraft crashes, the term general aviation must be more formally and precisely defined. This definition will determine which aircraft accidents and operations (flights, departures, landings, aircraft hours, aircraft miles, etc.) will be tabulated to determine the aircraft crash rate relevant to the risk analysis.

The Federal Aviation Administration (FAA) in their General Aviation Activity Survey [Refs. 3.1 to 3.8], defines general aviation as all aircraft in the U.S. civil air fleet except those operated under 14 CFR 121 [Ref. 3.9] and 14 CFR 127 [Ref. 3.10]. Thus, under the FAA definition, general aviation includes all aircraft of the U.S. civil air fleet operated under 14 CFR 91 [Ref. 3.11], 103 [Ref. 3.12], 105 [Ref. 3.13], 125 [Ref. 3.14], 133 [Ref. 3.15], 135 [Ref. 3.16], and 137 [Ref. 3.17]. Note that this definition excludes all foreign owned and foreign operated aircraft . Those foreign aircraft which operate as air carriers in U.S. airspace and foreign operators of U.S. registered aircraft engaged in common carriage operate under 14 CFR 129 [Ref. 3.18].

As defined by the National Transportation Safety Board (NTSB) in their compilation of accident data [Refs. 3.19 to 3.25], general aviation is considered as all accidents involving U.S. registered aircraft that were not conducting air carrier revenue operations under 14 CFR 121, 125, 127 or 135. So, under the NTSB definition, general aviation includes aircraft operated under 14 CFR 91, 103, 105, 133, and 137. Note that the difference between the FAA's definition and the NTSB's definition of general aviation is the inclusion or exclusion of aircraft operating under 14 CFR 125 and 135.

For the purpose of developing the ACRAM Standard [Ref. 3.19], general aviation will be as defined by the NTSB in their compilation of general aviation accident data, that is all accidents involving U.S. registered aircraft that were not conducting air carrier revenue operations under 14 CFR 121, 125, 127, or 135.

The reason for adopting the NTSB for general aviation is because of the method that the FAA uses to tabulate their estimate of the general aviation operations. In conversations with the FAA staff which prepares the General Aviation Activity Survey [Refs. 3.1 to 3.8] and reviewing the operational data in those documents, it was discovered that contrary to their definition given in their introductory section, no 14 CFR 125 operators, and those operators that were known to be scheduled 14 CFR 135 operators were not included in the survey. Nevertheless, despite a conscious effort to exclude these operators, some scheduled 14 CFR 135 operators (commuter air carriers) were included in the survey along with nonscheduled 14 CFR 135 operators (air taxis).

If the FAA definition was used for general aviation, it would be necessary to determine the accidents of those particular scheduled 14 CFR 135 operators along with all of the nonscheduled 14 CFR 135 operators which were included in the General Aviation Activity Survey [Refs. 3.1 to 3.8]. This would require the identification of those scheduled 14 CFR 135 operators and the nonscheduled 14 CFR 135 operators which were included in the General Aviation Activity Survey, and determining the accidents that occurred to the particular aircraft operated by these operators while performing scheduled 14 CFR 135 flights. These accidents would then have to be added to the accidents compiled by the NTSB for general aviation. Then an accident rate could be determined using the combined accidents of the NTSB for general aviation and the scheduled 14 CFR 135 operators included in the General Aviation Activity Survey, divided by the total number of operations (landings, aircraft hours, aircraft miles, etc.) as estimated by the General Aviation Activity Survey.

Instead, we have chosen to subtract the operations of the scheduled and nonscheduled14 CFR 135 operators included in the General Aviation Activity Survey from the total number of general aviation operations estimated. It is then possible to determine the general aviation accident rate by dividing the total general aviation accidents tabulated by the NTSB by general aviation operations (total-scheduled

135 and nonscheduled 135 operators) calculated from the General Aviation Activity Survey. This method was chosen because it was judged to be easier to accomplish.

The major category of general aviation has been divided further into seven subcategories. This was done because the general aviation covers a wide array of dissimilar aircraft types, accident and operational data was available for the subcategories, and by determining the general aviation accident rates by subcategory would enable certain subcategories of general aviation aircraft to be screened from further analysis due to facility structural considerations, i.e. the facility is built such that it could withstand the direct impact with smaller general aviation aircraft subcategories. For general aviation, seven subcategories are defined: 1) single-engine piston, fixed wing, 2) multiple-engine piston, fixed wing, 3) turboprop, fixed wing, 4) turbojet, fixed wing, 5) piston, rotary wing, 6) turbine, rotary wing, and 7) other. The seventh subcategory, other, developed only for the purpose of completing the accident and operations table such that it could be screened from further consideration. Aircraft included in the "other" subcategory include hanggliders, gliders, balloons, and any other aircraft which did not fit the previous six subcategories.

The development of general aviation data for the ACRAM Standard is discussed in the following sections: 3.2 General Aviation Crashes, 3.3 General Aviation Operations, 3.4 General Aviation Crash Rates, 3.5 General Aviation In-Flight Non-Airway Crash Rate, 3.6 General Aviation Crash Parameter Distributions, 3.7 General Aviation Aircraft Characteristics, and 3.8 References.

3.2 GENERAL AVIATION CRASHES

Tables 3.1 to 3.13 taken from the NTSB Annual Review of Aircraft Accident Data, U.S. General Aviation [Ref. 3.20 to 3.27] presents the following information by years for the years 1986 to 1993:

1. The number of fatal accidents by phase of operation for each year,
2. The number of injury accidents by phase of operation for each year,
3. The number of property damage accidents by phase of operation for each year, and
4. The total number of accidents by phase of operation for each year.

The tables listed below gives the general aviation subcategories for which the general aviation accidents by phase of flight operation table was created.

Table 3.1 Single-engine reciprocating (piston), fixed wing
Table 3.2 Multiple-engine reciprocating (piston), fixed wing
Table 3.3 Turboprop, fixed wing
Table 3.4 Turbojet, fixed wing
Table 3.5 Total, fixed wing (summation of Tables 3.1 to 3.4)
Table 3.6 Reciprocating (piston), rotary wing
Table 3.7 Turbine, rotary wing
Table 3.8 Total, rotary wing (summation of Tables 3.6 and 3.7)
Tab.e 3.9 Total powered aircraft (summation of Tables 3.1 to 3.4, 3.6 and 3.7)
Table 3.10 Gliders
Table 3.11 Balloons
Table 3.12 Other aircraft
Table 3.13 Total aircraft (summation of Tables 3.1 to 3.4, 3.6 to 3.7, 3.10 to 3.12)

The years 1986 to 1993 were chosen as the period of interest because it is the most current and complete. General aviation accident data compiled by the NTSB prior to 1985 were tabulated by on the bases of aircraft destruction, aircraft substantial damage, or minor or no aircraft damage. It would be possible to tabulate NTSB general aviation accident data prior to 1985 and to combine it with the current tables. However, the utility of that exercise would be limited due to limitations on the operations data compiled by the FAA prior to 1985. See Section 3.3 for further discussion on the general aviation operations data prior to 1985.

Because of the number of phases of operation used by the NTSB in their general aviation accident summary documents [Ref. 3.20 to 3.27], and because the ACRAM standard defines only three flight phases for its frequency analysis, it was judge necessary to combine the phases of operation into a smaller set of flight phases that could be more easily matched with the ACRAM flight phases. The phases of operation called standing, stand-preflight, standing-standing engine(s), standing-engine(s) operating, standing-engine(s) not operating, and standing-idling rotors were combined into the standing flight phase. The phases of operation called taxi, taxi-to takeoff, take-from landing, and taxi-aerial were combined into the taxi flight phase. The phases of operation called takeoff, takeoff-aborted, and takeoff-ground run were combined into the takeoff flight phase. The phase of operation called takeoff-initial climb was retained as the intial climb flight phase. The climb and climb-to-cruise phases of operation were combined into the climb (to cruise) flight phase. The phases of operation called cruise, cruise-normal, and cruise-holding (IFR) were combined into the cruise (enroute) flight phase. The Phases of operation called descent, descent-normal, descent-emergency, and descent-uncontrolled were combined into the descent (from cruise) flight phase. The flight phases called approach, approach-VFR pattern-downwind, approach-VFR pattern-base turn, approach-VFR pattern-base to final, approach-VFR pattern-final approach, approach-go around (VFR), approach-IAF to FAR/outer marker (IFR), approach-FAR/outer marker to threshold, approach-circling (IFR), and approach-missed approach (IFR) were combined in the landing approach flight phase. The phases of operation called landing-aborted, landing, landing-flare/touchdown, and landing/roll were combined in the landing flight phase. The phases of operation called maneuvering, manuevering-aerial application, manuevering-turn to reverse direction, manuevering-turn to landing area (emer.), and hover were combined into the manuevering flight phase. The other, unknown, and not reported phases of operation were combined into the other/?/NR flight phase. The manuevering and other/?/NR flight phases were created for the sole purpose of tabulating the accidents

to assure that the numbers in Tables 3.1 to 3.13 were consistent with Refs. 3.20 to 3.27. These flight phases were not included in determining the accident percentages by flight phase.

One additional feature of Table 3.13 is the inclusion of aircraft damage for each year. The NTSB did not tabulate accident data according to aircraft damage by flight phase after 1986 but did include totals on aircraft damage. These data are included at the bottom of Table 3.13. An noteworthy feature is that of the 18.418 general aviation accidents tabulated by the NTSB for 1986 to 1993, only 236 accidents or 1.28% of the total resulted in minor or no damage to the aircraft. From this, it was determined that for general aviation, different definitions for aircraft accidents and aircraft crashes were not necessary since virtually all general aviation accidents resulted in destruction or substantial damage to the aircraft. Therefore, for general aviation only, the terms aircraft accidents and aircraft crashes are used synonymously.

Table 3.14 summarizes the general aviation accidents by phase of flight operation and by aircraft subcategories as presented by Tables 3.1 to 3.13. Table 3.15 presents the same information as Table 3.14 (General aviation accidents by phase of flight operation and by aircraft subcategories) except that accidents during the standing, and taxi flight phases and accidents classified as either other, unknown, or not recorded flight phases have been excluded. This was done in order the develop the aircraft accident percentages occurring in the flights phases applicable to the ACRAM standard frequency analysis.

Table 3.1
General Aviation Accidents by Phase of Flight Operation
Single Engine-Reciprocating, Fixed Wing
References 3.20 to 3.27

Single-Engine Reciprocating, Fixed Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	1	0	0	2	2
Standing-preflight	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	2
Standing-starting engine(s)	0	5	16	21	1	2	17	20	0	3	15	18	0	0	13	13	0	1	7	8	0	2	4	6
Standing-engine(s) operating	1	0	4	5	2	2	7	11	1	1	6	8	1	4	9	14	0	1	6	7	2	1	8	11
Standing-engine(s) not operating	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	1	0	12	13	0	0	3	3	1	0	5	6	0	0	5	5	1	0	9	10	0	1	4	5
Taxi-to takeoff	0	0	18	18	0	0	24	24	0	1	22	23	0	0	20	20	0	0	22	22	0	0	14	14
Taxi-from landing	0	1	15	16	0	0	26	26	0	0	28	28	0	0	23	23	0	0	16	16	0	2	15	17
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Takeoff	6	5	19	30	1	6	15	22	5	5	20	30	3	3	19	25	5	7	21	33	5	4	22	31
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	4	6	100	110	1	7	99	107	1	2	70	73	2	1	67	70	3	3	68	74	1	5	79	85
Takeoff-initial climb	54	52	204	310	42	63	195	300	56	64	167	287	48	48	185	281	54	56	161	271	43	52	165	260
Climb	11	5	18	34	4	4	10	18	3	2	13	18	6	1	7	14	6	5	7	18	13	9	18	40
Climb-to cruise	18	5	22	45	12	6	27	45	21	4	23	48	9	2	13	24	11	5	9	25	8	4	21	33
Cruise	29	13	96	138	30	8	73	111	33	16	85	134	43	16	90	149	36	16	74	126	41	19	99	159
Cruise-normal	36	32	143	211	48	15	134	197	45	27	143	215	49	17	121	187	29	12	117	158	29	20	103	152
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1	0	0	0	0	0	0	1	1
Descent	9	0	9	18	3	0	3	6	8	1	7	16	8	1	5	14	4	1	8	13	3	5	6	14
Descent-normal	9	5	22	36	7	5	28	40	4	1	34	39	5	2	18	25	9	5	20	34	3	4	21	28
Descent-emergency	2	2	4	8	0	0	4	4	1	0	1	2	0	0	2	2	0	0	1	1	2	1	2	5
Descent-uncontrolled	3	1	1	5	2	0	2	4	0	1	0	1	1	0	2	3	2	0	2	4	2	0	2	4
Approach	9	5	17	31	5	6	21	32	9	5	19	33	11	7	29	47	8	2	13	23	10	1	18	29
Approach-VFR pattern-downwind	4	2	15	21	9	4	10	23	3	3	10	16	5	2	8	15	11	1	13	25	5	4	8	17
Approach-VFR pattern-base turn	4	0	5	9	1	2	3	6	2	2	5	9	3	1	4	8	4	1	9	14	3	1	3	7
Approach-VFR pattern-base to final	7	2	6	15	7	1	6	14	2	2	7	11	9	4	6	19	6	3	10	19	7	2	11	20
Approach-VFR pattern-final approach	9	28	77	114	9	15	80	104	7	20	69	96	13	15	71	99	17	8	80	105	15	8	58	81
Approach-go-around (VFR)	4	9	42	55	4	11	31	46	6	7	37	50	4	5	27	36	7	5	22	34	4	7	34	45
Approach-IAF to FAF/outer marker (IFR)	1	2	1	4	4	0	0	4	5	0	2	7	4	1	0	5	3	0	2	5	2	1	1	4
Approach-FAF/outer marker to threshold	14	3	6	23	6	3	4	13	2	3	3	8	3	0	2	5	5	1	4	10	3	2	2	7
Approach-circling (IFR)	1	0	1	2	1	0	0	1	0	1	1	2	0	0	0	0	0	0	0	0	0	1	0	1
Approach-missed approach (IFR)	1	0	3	4	3	0	0	3	3	0	2	5	1	0	0	1	3	0	0	3	1	1	0	2
Landing-aborted	0	0	0	0	0	0	0	0	3	4	18	25	0	0	0	0	0	0	0	0	0	0	0	0
Landing	3	7	38	48	3	3	30	36	0	1	36	37	2	2	33	37	1	2	18	21	1	3	11	15
Landing-flare/touchdown	3	9	188	200	1	9	195	205	2	5	153	160	3	8	146	157	2	5	141	148	0	2	146	148
Landing-roll	6	6	259	271	0	8	280	288	1	9	238	248	2	7	220	229	1	5	234	240	1	0	208	209
Maneuvering	87	28	53	168	110	20	49	179	99	21	55	175	65	23	57	145	86	12	42	140	85	27	54	166
Maneuvering-aerial application	6	8	41	55	9	10	42	61	5	14	39	58	16	7	37	60	9	5	42	56	8	9	41	58
Maneuvering-turn to reverse direction	10	2	17	29	2	8	8	18	8	2	9	19	7	2	0	9	11	4	9	24	8	2	9	19
Maneuvering-turn to landing area (emer.	0	0	2	2	1	0	0	1	0	0	7	7	0	0	1	1	2	0	0	2	1	0	1	2
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	3	0	2	5	3	1	20	24	0	0	1	1	3	6	53	62	4	5	51	60	9	3	40	52
Unknown	11	2	0	13	11	1	2	14	10	1	2	13	16	0	2	18	17	0	1	18	11	0	1	12
Not reported	1	0	1	2	4	0	2	6	2	0	4	6	1	0	0	1	3	0	5	8	4	0	6	10
Total:	368	245	1477	2090	346	221	1451	2018	348	229	1375	1952	343	185	1297	1825	360	172	1245	1777	331	204	1238	1773

Table 3.1 (Continued)
General Aviation Accidents by Phase of Flight Operation
Single Engine-Reciprocating, Fixed Wing
References 3.20 to 3.27

Single-Engine Reciprocating, Fixed Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	1	1	2	0	2	5	7			
Standing-preflight	0	1	0	1	0	0	0	0	2	3	1	6			
Standing-starting engine(s)	0	1	3	4	1	0	8	9	2	14	83	99			
Standing-engine(s) operating	2	0	1	3	3	3	2	8	12	12	43	67			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	1	1			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	180	1.22%
Taxi	0	0	4	4	0	0	6	6	3	1	48	52			
Taxi-to takeoff	0	2	15	17	0	1	17	18	0	4	152	156			
Taxi-from landing	0	1	13	14	0	1	14	15	0	5	150	155			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	1	1	Taxi	364	2.48%
Takeoff	4	2	11	17	4	2	13	19	33	34	140	207			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16			
Takeoff-ground run	0	4	67	71	2	0	70	72	14	28	620	662	Takeoff	885	6.02%
Takeoff-initial climb	46	46	153	245	40	44	147	231	383	425	1377	2185	Initial Climb	2185	14.86%
Climb	5	1	14	20	8	3	17	28	56	30	104	190			
Climb-to cruise	4	3	16	23	5	5	14	24	88	34	145	267	Climb	457	3.11%
Cruise	39	13	73	125	39	21	97	157	290	122	687	1099			
Cruise-normal	35	11	105	151	27	10	89	126	298	144	955	1397			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	4	4	Cruise	2500	17.00%
Descent	4	2	2	8	10	0	6	16	49	10	46	105			
Descent-normal	10	2	24	36	3	0	24	27	50	24	191	265			
Descent-emergency	1	0	2	3	1	1	3	5	7	4	19	30			
Descent-uncontrolled	1	2	2	5	0	1	2	3	11	5	13	29	Descent	429	2.92%
Approach	9	7	5	21	6	2	15	23	67	35	137	239			
Approach-VFR pattern-downwind	2	1	14	17	2	3	4	9	41	20	82	143			
Approach-VFR pattern-base turn	2	1	6	9	3	2	3	8	22	10	38	70			
Approach-VFR pattern-base to final	6	3	6	15	5	0	10	15	49	17	62	128			
Approach-VFR pattern-final approach	12	11	61	84	10	9	63	82	92	114	559	765			
Approach-go-around (VFR)	6	3	23	32	3	6	34	43	38	53	250	341			
Approach-IAF to FAF/outer marker (IFR)	3	0	1	4	1	0	1	2	23	4	8	35			
Approach-FAF/outer marker to threshold	7	1	4	12	4	2	4	10	44	15	29	88			
Approach-circling (IFR)	0	0	0	0	2	0	0	2	4	2	2	8			
Approach-missed approach (IFR)	2	0	1	3	0	2	0	2	14	3	6	23	Approach	1840	12.51%
Landing-aborted	0	0	0	0	0	0	0	0	3	4	18	25			
Landing	3	2	32	37	0	3	31	34	13	23	229	265			
Landing-flare/touchdown	2	7	139	148	2	3	123	128	15	48	1231	1294			
Landing-roll	3	4	209	216	1	5	209	215	15	44	1857	1916	Landing	3500	23.80%
Maneuvering	80	18	44	142	94	25	41	160	706	174	395	1275			
Maneuvering-aerial application	6	8	34	48	8	7	27	42	67	68	303	438			
Maneuvering-turn to reverse direction	9	5	9	23	3	3	7	13	58	28	68	154			
Maneuvering-turn to landing area (emer.	1	1	0	2	0	0	1	1	5	1	12	18			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	1885	12.82%
Other	10	5	39	54	2	3	42	47	34	23	248	305			
Unknown	13	0	6	19	12	2	1	15	101	6	15	122			
Not reported	4	0	7	11	4	2	5	11	23	2	30	55	Other/?/NR	482	3.28%
Total:	331	168	1145	1644	305	172	1151	1628	2732	1596	10379	14707		14707	100.00%

Table 3.2
General Aviation Accidents by Phase of Flight Operation
Multi-Engine Reciprocating, Fixed Wing
References 3.20 to 3.27

Multi-Engine Reciprocating, Fixed Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.
Standing	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Standing-starting engine(s)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Standing-engine(s) operating	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	2	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	3	3	0	0	7	7	0	0	1	1	0	0	2	2	0	0	3	3	0	0	2	2
Taxi-from landing	0	0	3	3	0	0	0	0	1	0	2	3	0	0	3	3	0	0	2	2	0	0	1	1
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	2	0	5	7	1	0	3	4	0	0	0	0	0	0	1	1	1	1	1	3	6	0	3	9
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	5	5	1	1	8	10	0	0	7	7	0	0	7	7	0	0	3	3	0	2	2	4
Takeoff-initial climb	13	2	11	26	5	3	14	22	8	0	7	15	10	2	9	21	4	2	10	16	5	4	14	23
Climb	1	1	1	3	0	0	2	2	2	1	1	4	1	1	0	2	1	0	1	2	1	1	1	3
Climb-to cruise	2	0	2	4	2	2	2	6	3	0	2	5	2	0	1	3	1	1	4	6	4	0	1	5
Cruise	4	2	6	12	3	0	5	8	8	0	3	11	4	0	4	8	2	0	2	4	8	3	5	16
Cruise-normal	7	3	14	24	10	3	11	24	14	0	7	21	10	0	12	22	4	1	9	14	4	2	6	12
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Descent	2	0	0	2	1	0	1	2	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0
Descent-normal	0	0	2	2	0	1	2	3	0	0	3	3	0	0	1	1	0	0	0	0	1	1	1	3
Descent-emergency	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-uncontrolled	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Approach	2	0	2	4	1	0	0	1	2	1	2	5	3	0	4	7	5	1	2	8	2	0	3	5
Approach-VFR pattern-downwind	0	0	1	1	0	0	1	1	0	1	2	3	1	0	0	1	1	1	3	5	0	0	3	3
Approach-VFR pattern-base turn	1	0	0	1	0	1	0	1	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
Approach-VFR pattern-base to final	2	0	1	3	1	0	1	2	2	0	0	2	0	0	0	0	0	0	1	1	1	0	1	2
Approach-VFR pattern-final approach	3	2	5	10	1	1	6	8	1	3	2	6	0	1	8	9	1	1	5	7	0	1	4	5
Approach-go-around (VFR)	0	0	3	3	1	0	1	2	1	0	2	3	0	0	1	1	0	3	3	6	3	1	2	6
Approach-IAF to FAF/outer marker (IFR)	1	1	0	2	0	0	0	0	2	1	0	3	2	0	0	2	1	0	0	1	2	0	0	2
Approach-FAF/outer marker to threshold	2	3	2	7	1	1	1	3	3	1	1	5	0	0	2	2	2	0	2	4	2	1	3	6
Approach-circling (IFR)	1	0	1	2	1	0	0	1	3	0	1	4	0	0	1	1	1	0	0	1	1	1	0	2
Approach-missed approach (IFR)	1	2	0	3	1	0	1	2	1	0	0	1	0	0	0	0	1	0	1	2	1	0	1	2
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	0	0	1	0	2	3	0	0	2	2	0	0	7	7	0	0	3	3	0	0	1	1
Landing-flare/touchdown	0	0	18	18	1	0	25	26	0	0	12	12	0	0	12	12	1	1	10	12	0	0	9	9
Landing-roll	1	0	27	28	0	1	26	27	0	0	19	19	0	0	15	15	0	1	19	20	0	0	20	20
Maneuvering	7	2	2	11	6	0	0	6	4	0	1	5	4	0	3	7	2	1	1	4	4	0	0	4
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0
Maneuvering-turn to reverse direction	0	0	1	1	2	0	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0	1	0	1
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	1	1	1	0	1	2	0	0	0	0	1	0	1	2	2	0	3	5	0	0	1	1
Unknown	2	0	1	3	1	0	1	2	1	0	0	1	1	0	0	1	1	0	1	2	0	0	0	0
Not reported	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	2	1	5	8	3	0	2	5
Total:	54	18	119	191	46	14	126	186	60	8	80	148	41	4	95	140	35	15	94	144	49	18	89	156

Table 3.2 (Continued)
General Aviation Accidents by Phase of Flight Operation
Multi-Engine Reciprocating, Fixed Wing
References 3.20 to 3.27

Multi-Engine Reciprocating, Fixed Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	0	2	2			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	1	1			
Standing-starting engine(s)	0	0	1	1	0	0	2	2	0	0	5	5			
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	3	3			
Standing-engine(s) not operating	0	0	0	0	0	0	1	1	0	0	2	2			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	13	1.03%
Taxi	1	0	1	2	0	0	0	0	1	0	4	5			
Taxi-to takeoff	0	0	0	0	0	0	2	2	0	0	20	20			
Taxi-from landing	0	0	1	1	0	0	0	0	1	0	12	13			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	38	3.00%
Takeoff	0	0	1	1	1	0	1	2	11	1	15	27			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	1	3	4	1	0	3	4	2	4	38	44	Takeoff	71	5.60%
Takeoff-initial climb	4	0	7	11	8	3	16	27	57	16	88	161	Initial Climb	161	12.70%
Climb	1	0	0	1	2	0	1	3	9	4	7	20			
Climb-to cruise	4	0	1	5	2	0	0	2	20	3	13	36	Climb	56	4.42%
Cruise	4	2	6	12	6	4	8	18	39	11	39	89			
Cruise-normal	12	5	7	24	3	0	5	8	64	14	71	149			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	1	1	Cruise	239	18.85%
Descent	1	0	1	2	0	0	0	0	6	0	2	8			
Descent-normal	2	0	4	6	1	0	0	1	4	2	13	19			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	1	1			
Descent-uncontrolled	0	0	0	0	0	0	0	0	3	0	0	3	Descent	31	2.44%
Approach	3	0	5	8	3	0	1	4	21	2	19	42			
Approach-VFR pattern-downwind	1	0	0	1	0	0	4	4	3	2	14	19			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	3	1	0	4			
Approach-VFR pattern-base to final	0	0	0	0	2	0	0	2	8	0	4	12			
Approach-VFR pattern-final approach	0	1	5	6	0	3	4	7	6	13	39	58			
Approach-go-around (VFR)	1	0	1	2	0	0	3	3	6	4	16	26			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	1	0	1	8	3	0	11			
Approach-FAF/outer marker to threshold	1	1	1	3	0	0	3	3	11	7	15	33			
Approach-circling (IFR)	1	1	1	3	1	0	0	1	9	2	4	15			
Approach-missed approach (IFR)	2	1	1	4	1	0	1	2	8	3	5	16	Approach	236	18.61%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	0	0	2	2	0	2	2	4	1	2	19	22			
Landing-flare/touchdown	0	0	14	14	1	0	12	13	3	1	112	116			
Landing-roll	0	0	7	7	1	0	25	26	2	2	158	162	Landing	300	23.66%
Maneuvering	8	0	2	10	6	0	0	6	41	3	9	53			
Maneuvering-aerial application	0	0	0	0	0	0	0	0	2	0	0	2			
Maneuvering-turn to reverse direction	1	0	0	1	1	1	0	2	6	2	1	9			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	64	5.05%
Other	0	0	3	3	0	0	1	1	4	0	11	15			
Unknown	1	0	1	2	2	1	0	3	9	1	4	14			
Not reported	1	0	4	5	4	1	5	10	12	2	16	30	Other/?/NR	59	4.65%
Total:	49	12	80	141	46	16	100	162	380	105	783	1268		1268	100.00%

Table 3.3
General Aviation Accidents by Phase of Flight Operation
Turboprop, Fixed Wing
References 3.20 to 3.27

Turboprop, Fixed Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Standing-engine(s) not operating	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1
Taxi-to takeoff	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	1	1	0	1	1	2	0	0	0	0	0	0	3	3	1	0	2	3	0	0	0	0
Takeoff-initial climb	1	0	2	3	0	1	0	1	2	0	1	3	3	1	0	4	1	2	2	5	1	1	0	2
Climb	0	0	0	0	1	0	0	1	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0
Climb-to cruise	0	0	2	2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cruise	1	0	2	3	0	0	0	0	0	0	0	0	1	1	1	3	0	0	3	3	1	0	1	2
Cruise-normal	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	2	1	0	3	4	1	1	1	3
Cruise-holding (IFR)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Descent-normal	1	1	1	3	1	0	0	1	1	0	1	2	0	0	0	0	0	0	1	1	0	0	1	1
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	1	1	2	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1
Approach-VFR pattern-downwind	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	1	1
Approach-VFR pattern-final approach	1	0	1	2	0	0	1	1	0	0	1	1	1	0	0	1	3	0	1	4	0	0	0	0
Approach-go-around (VFR)	0	0	1	1	1	0	0	1	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	1	0	0	1	1	0	0	1	1	0	0	1	2	0	0	2	1	1	0	2	1	0	0	1
Approach-FAF/outer marker to threshold	2	0	0	2	0	0	0	0	1	1	1	3	0	0	0	0	0	0	0	0	1	0	1	2
Approach-circling (IFR)	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	2	2	0	0	2	2	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0
Landing-flare/touchdown	0	0	1	1	0	0	3	3	0	0	1	1	0	0	1	1	0	0	2	2	0	0	4	4
Landing-roll	0	0	1	1	0	2	2	4	0	0	2	2	0	0	5	5	1	0	2	3	0	0	4	4
Maneuvering	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	2
Maneuvering-aerial application	2	0	1	3	0	1	3	4	1	0	3	4	1	0	2	3	1	1	0	2	3	0	5	8
Maneuvering-turn to reverse direction	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Unknown	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Not reported	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	2
Total:	12	2	21	35	9	7	15	31	9	1	13	23	14	3	16	33	13	4	21	38	12	2	22	36

Table 3.3 (Continued)
General Aviation Accidents by Phase of Flight Operation
Turboprop, Fixed Wing
References 3.20 to 3.27

Turboprop, Fixed Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	0	1	1			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	0	1	1	0	0	2	2	0	0	5	5			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	1	0	1			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	7	2.34%
Taxi	1	0	0	1	0	0	2	2	2	0	4	6			
Taxi-to takeoff	0	0	0	0	0	0	2	2	0	0	5	5			
Taxi-from landing	0	0	1	1	0	0	0	0	1	0	2	3			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	14	4.68%
Takeoff	0	0	1	1	0	1	0	1	1	1	2	4			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	3	3	0	0	1	1	1	1	11	13	Takeoff	17	5.69%
Takeoff-initial climb	5	1	2	8	0	0	3	3	13	6	10	29	Initial Climb	29	9.70%
Climb	2	0	0	2	0	0	0	0	5	0	0	5			
Climb-to cruise	2	0	1	3	2	0	0	2	5	0	3	8	Climb	13	4.35%
Cruise	1	0	2	3	1	0	3	4	5	1	12	18			
Cruise-normal	1	0	3	4	2	0	3	5	6	1	12	19			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	1	1	Cruise	38	12.71%
Descent	1	0	0	1	0	0	0	0	3	1	0	4			
Descent-normal	0	0	0	0	0	0	1	1	3	1	5	9			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-uncontrolled	0	1	0	1	0	0	0	0	0	1	0	1	Descent	14	4.68%
Approach	0	0	0	0	0	0	0	0	2	1	2	5			
Approach-VFR pattern-downwind	0	0	0	0	1	0	0	1	2	0	0	2			
Approach-VFR pattern-base turn	0	0	0	0	1	0	0	1	1	0	0	1			
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	1	1	1	3			
Approach-VFR pattern-final approach	1	0	2	3	0	0	1	1	6	0	7	13			
Approach-go-around (VFR)	0	0	1	1	0	0	0	0	2	0	4	6			
Approach-IAF to FAF/outer marker (IFR)	1	0	1	2	0	0	0	0	8	1	1	10			
Approach-FAF/outer marker to threshold	2	0	0	2	0	0	0	0	6	1	2	9			
Approach-circling (IFR)	0	0	0	0	0	0	1	1	1	0	1	2			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	1	0	0	1	Approach	52	17.39%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	0	0	0	0	0	0	0	0	0	0	6	6			
Landing-flare/touchdown	1	0	5	6	1	0	2	3	2	0	19	21			
Landing-roll	0	0	2	2	0	1	2	3	1	3	20	24	Landing	51	17.06%
Maneuvering	1	0	3	4	3	0	2	5	7	0	7	14			
Maneuvering-aerial application	0	2	2	4	3	0	4	7	11	4	20	35			
Maneuvering-turn to reverse direction	0	0	0	0	0	1	0	1	2	1	1	4			
Maneuvering-turn to landing area (emer.	0	0	1	1	0	0	0	0	0	0	1	1			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	54	18.06%
Other	0	0	0	0	1	0	0	1	1	0	1	2			
Unknown	0	0	0	0	0	0	0	0	1	0	1	2			
Not reported	1	0	0	1	1	0	0	1	5	0	1	6	Other/?/NR	10	3.34%
Total:	20	4	31	55	16	3	29	48	105	26	168	299		299	100.00%

Table 3.4
General Aviation Accidents by Phase of Flight Operation
Turbojet, Fixed Wing
References 3.20 to 3.27

Turbojet, Fixed Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0	0	1
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Takeoff-initial climb	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0
Climb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Climb-to cruise	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	1	0	0	1
Cruise	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruise-normal	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Descent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-normal	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Approach-VFR pattern-final approach	0	0	1	1	1	1	0	2	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	2	0	0	2	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-flare/touchdown	0	0	3	3	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0
Landing-roll	0	0	3	3	0	0	1	1	0	0	3	3	0	0	2	2	0	0	2	2	0	0	1	1
Maneuvering	0	0	0	0	2	0	0	2	1	0	0	1	0	0	0	0	3	0	0	3	1	0	1	2
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total:	3	1	10	14	6	1	3	10	4	0	3	7	2	0	7	9	10	1	7	18	7	1	2	10

Table 3.4 (Continued)
General Aviation Accidents by Phase of Flight Operation
Turbojet, Fixed Wing
References 3.20 to 3.27

Turbojet, Fixed Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	0	0.00%
Taxi	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	2	2			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	2	2.27%
Takeoff	1	0	0	1	0	0	1	1	4	0	1	5			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	1	0	1	0	0	0	0	1	1	2	4	Takeoff	9	10.23%
Takeoff-initial climb	0	0	0	0	0	0	1	1	3	0	1	4	Initial Climb	4	4.55%
Climb	0	0	0	0	0	0	0	0	1	0	0	1			
Climb-to cruise	0	0	0	0	0	0	0	0	3	1	1	5	Climb	6	6.82%
Cruise	0	0	0	0	0	0	0	0	0	0	1	1			
Cruise-normal	0	0	0	0	0	0	1	1	2	0	2	4			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	1	0	0	1	Cruise	6	6.82%
Descent	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-normal	0	0	0	0	0	0	0	0	0	1	0	1			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	Descent	1	1.14%
Approach	1	0	1	2	1	0	0	1	2	0	1	3			
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	2	0	1	3			
Approach-VFR pattern-final approach	0	0	0	0	0	0	0	0	1	1	3	5			
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	4	0	0	4			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	1	0	1	2	Approach	17	19.32%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	0	0	0	0	0	0	0	0	1	0	0	1			
Landing-flare/touchdown	0	0	0	0	0	0	0	0	0	0	5	5			
Landing-roll	0	0	4	4	0	0	2	2	0	0	18	18	Landing	24	27.27%
Maneuvering	1	0	0	1	2	0	0	2	10	0	1	11			
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	1	0	1			
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	12	13.64%
Other	0	0	0	0	0	0	0	0	0	0	2	2			
Unknown	0	0	0	0	0	0	0	0	1	0	0	1			
Not reported	0	0	2	2	0	0	1	1	1	0	3	4	Other/?/NR	7	7.95%
Total:	3	1	7	11	3	0	6	9	38	5	45	88		88	100.00%

Table 3.5
General Aviation Accidents by Phase of Flight Operation
Total, Fixed Wing Aircraft
References 3.20 to 3.27

Total, Fixed Wing Aircraft	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	0	0	1	1	0	0	0	0	0	0	3	3	0	0	1	1	0	1	0	1	0	0	2	2
Standing-preflight	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	3
Standing-starting engine(s)	0	5	17	22	1	2	17	20	0	3	15	18	0	0	13	13	0	1	7	8	0	2	5	7
Standing-engine(s) operating	1	0	5	6	2	2	9	13	1	1	6	8	1	4	9	14	0	1	6	7	2	1	10	13
Standing-engine(s) not operating	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	1	0	13	14	0	0	5	5	1	0	6	7	0	0	5	5	2	0	9	11	0	1	5	6
Taxi-to takeoff	0	0	21	21	0	0	32	32	0	1	24	25	0	0	22	22	0	0	26	26	0	0	16	16
Taxi-from landing	0	1	18	19	0	0	28	28	1	0	30	31	1	0	26	27	0	0	19	19	0	2	16	18
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Takeoff	8	5	24	37	2	6	18	26	5	5	20	30	4	3	21	28	8	8	22	38	12	4	25	41
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	4	6	107	117	2	9	109	120	1	2	77	80	2	1	77	80	5	3	73	81	1	7	81	89
Takeoff-initial climb	68	54	217	339	48	67	209	324	66	64	175	305	61	51	194	306	61	60	173	294	49	57	179	285
Climb	12	6	19	37	5	4	12	21	5	3	14	22	9	2	7	18	7	5	8	20	15	10	19	44
Climb-to cruise	21	5	26	52	14	8	29	51	25	4	25	54	11	2	14	27	13	7	14	34	13	4	22	39
Cruise	34	15	105	154	33	8	78	119	41	16	88	145	48	17	95	160	38	16	79	133	50	22	105	177
Cruise-normal	44	35	158	237	59	18	145	222	59	27	150	236	60	17	135	212	34	13	129	176	34	23	110	167
Cruise-holding (IFR)	0	0	1	1	0	0	0	0	1	0	3	4	0	0	1	1	0	0	0	0	0	0	1	1
Descent	12	0	9	21	4	1	4	9	9	1	7	17	9	1	5	15	5	1	8	14	3	5	6	14
Descent-normal	10	7	25	42	8	6	30	44	5	1	38	44	5	2	19	26	9	5	21	35	4	5	23	32
Descent-emergency	2	2	4	8	0	0	5	5	1	0	1	2	0	0	2	2	0	0	1	1	2	1	2	5
Descent-uncontrolled	3	1	1	5	4	0	2	6	0	1	0	1	1	0	2	3	2	0	2	4	3	0	2	5
Approach	11	6	20	37	6	6	22	34	11	6	21	38	15	7	33	55	13	3	15	31	13	1	21	35
Approach-VFR pattern-downwind	5	2	16	23	9	4	11	24	3	4	12	19	6	2	8	16	12	2	16	30	5	4	11	20
Approach-VFR pattern-base turn	5	0	5	10	1	3	3	7	3	2	5	10	3	1	4	8	5	1	9	15	3	1	3	7
Approach-VFR pattern-base to final	9	2	7	18	9	1	7	17	5	2	7	14	10	5	6	21	6	3	12	21	8	2	13	23
Approach-VFR pattern-final approach	13	30	84	127	11	17	87	115	8	23	72	103	14	16	79	109	21	9	88	118	15	9	62	86
Approach-go-around (VFR)	4	9	46	59	6	11	32	49	8	7	39	54	4	5	29	38	7	8	26	41	7	8	36	51
Approach-IAF to FAF/outer marker (IFR)	3	3	1	7	5	0	0	5	8	1	2	11	8	1	0	9	5	1	2	8	5	1	1	7
Approach-FAF/outer marker to threshold	18	6	8	32	7	4	5	16	7	5	5	17	4	0	4	8	9	1	6	16	6	3	6	15
Approach-circling (IFR)	2	0	2	4	3	0	0	3	3	1	2	6	0	0	1	1	1	0	0	1	1	2	0	3
Approach-missed approach (IFR)	2	2	4	8	4	0	1	5	5	0	2	7	1	0	0	1	4	0	1	5	3	1	1	5
Landing-aborted	0	0	0	0	0	0	0	0	3	4	18	25	0	0	0	0	0	0	0	0	0	0	0	0
Landing	4	7	40	51	4	3	34	41	0	1	39	40	2	2	40	44	1	2	22	25	1	3	12	16
Landing-flare/touchdown	3	9	210	222	2	9	223	234	2	5	166	173	3	8	161	172	3	6	153	162	0	2	159	161
Landing-roll	7	6	290	303	0	11	309	320	1	9	262	272	2	7	242	251	2	6	257	265	1	0	233	234
Maneuvering	95	30	55	180	119	20	49	188	104	21	56	181	69	23	61	153	91	13	43	147	91	27	56	174
Maneuvering-aerial application	8	8	42	58	9	11	45	65	6	14	42	62	18	7	39	64	11	6	42	59	11	10	46	67
Maneuvering-turn to reverse direction	10	2	19	31	5	8	8	21	10	2	9	21	7	2	0	9	11	4	9	24	9	3	9	21
Maneuvering-turn to landing area (emer.	0	0	2	2	1	0	0	1	0	0	7	7	0	0	1	1	2	0	0	2	1	0	1	2
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	3	0	3	6	4	1	21	26	0	0	1	1	4	6	56	66	6	5	55	66	9	3	41	53
Unknown	13	2	1	16	13	1	3	17	11	1	2	14	17	0	2	19	18	0	3	21	12	0	1	13
Not reported	1	0	1	2	7	0	2	9	2	0	4	6	1	0	0	1	6	1	10	17	9	0	9	18
Total:	437	266	1627	2330	407	243	1595	2245	421	238	1471	2130	400	192	1415	2007	418	192	1367	1977	399	225	1351	1975

Table 3.5 (Continued)
General Aviation Accidents by Phase of Flight Operation
Total, Fixed Wing Aircraft
References 3.20 to 3.27

Total, Fixed Wing Aircraft	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	1	1	2	0	2	8	10			
Standing-preflight	0	1	0	1	0	0	0	0	2	3	2	7			
Standing-starting engine(s)	0	1	4	5	1	0	10	11	2	14	88	104			
Standing-engine(s) operating	2	0	2	4	3	3	4	10	12	12	51	75			
Standing-engine(s) not operating	0	0	0	0	0	0	1	1	0	1	3	4			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	200	1.22%
Taxi	2	0	5	7	0	0	8	8	6	1	56	63			
Taxi-to takeoff	0	2	15	17	0	1	21	22	0	4	177	181			
Taxi-from landing	0	1	15	16	0	1	14	15	2	5	166	173			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	1	1	Taxi	418	2.55%
Takeoff	5	2	13	20	5	3	15	23	49	36	158	243			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16			
Takeoff-ground run	0	6	73	79	3	0	74	77	18	34	671	723	Takeoff	982	6.00%
Takeoff-initial climb	55	47	162	264	48	47	167	262	456	447	1476	2379	Initial Climb	2379	14.54%
Climb	8	1	14	23	10	3	18	31	71	34	111	216			
Climb-to cruise	10	3	18	31	9	5	14	28	116	38	162	316	Climb	532	3.25%
Cruise	44	15	81	140	46	25	108	179	334	134	739	1207			
Cruise-normal	48	16	115	179	32	10	98	140	370	159	1040	1569			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	1	0	6	7	Cruise	2783	17.01%
Descent	6	2	3	11	10	0	6	16	58	11	48	117			
Descent-normal	12	2	28	42	4	0	25	29	57	28	209	294			
Descent-emergency	1	0	2	3	1	1	3	5	7	4	20	31			
Descent-uncontrolled	1	3	2	6	0	1	2	3	14	6	13	33	Descent	475	2.90%
Approach	13	7	11	31	10	2	16	28	92	38	159	289			
Approach-VFR pattern-downwind	3	1	14	18	3	3	8	14	46	22	96	164			
Approach-VFR pattern-base turn	2	1	6	9	4	2	3	9	26	11	38	75			
Approach-VFR pattern-base to final	6	3	6	15	7	0	10	17	60	18	68	146			
Approach-VFR pattern-final approach	13	12	68	93	10	12	68	90	105	128	608	841			
Approach-go-around (VFR)	7	3	25	35	3	6	37	46	46	57	270	373			
Approach-IAF to FAF/outer marker (IFR)	4	0	2	6	1	1	1	3	39	8	9	56			
Approach-FAF/outer marker to threshold	10	2	5	17	4	2	7	13	65	23	46	134			
Approach-circling (IFR)	1	1	1	3	3	0	1	4	14	4	7	25			
Approach-missed approach (IFR)	4	1	2	7	1	2	1	4	24	6	12	42	Approach	2145	13.11%
Landing-aborted	0	0	0	0	0	0	0	0	3	4	18	25			
Landing	3	2	34	39	0	5	33	38	15	25	254	294			
Landing-flare/touchdown	3	7	158	168	4	3	137	144	20	49	1367	1436			
Landing-roll	3	4	222	229	2	6	238	246	18	49	2053	2120	Landing	3875	23.68%
Maneuvering	90	18	49	157	105	25	43	173	764	177	412	1353			
Maneuvering-aerial application	6	10	36	52	11	7	31	49	80	73	323	476			
Maneuvering-turn to reverse direction	10	5	9	24	4	5	7	16	66	31	70	167			
Maneuvering-turn to landing area (emer.	1	1	1	3	0	0	1	1	5	1	13	19			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	2015	12.32%
Other	10	5	42	57	3	3	43	49	39	23	262	324			
Unknown	14	0	7	21	14	3	1	18	112	7	20	139			
Not reported	6	0	13	19	9	3	11	23	41	4	50	95	Other/?/NR	558	3.41%
Total:	403	185	1263	1851	370	191	1286	1847	3255	1732	11375	16362		16362	100.00%

Table 3.6
General Aviation Accidents by Phase of Flight Operation
Reciprocating Engine, Rotary Wing
References 3.20 to 3.27

Reciprocating Engine, Rotary Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	2	2	0	0	1	1	0	0	1	1	1	3	0	4	0	1	0	1	0	0	0	0
Standing-engine(s) not operating	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	2	4	0	0	1	1
Taxi	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Taxi-from landing	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	1	1	0	0	2	2	0	0	5	5	0	1	3	4	0	0	1	1	0	0	1	1
Takeoff	1	1	0	2	0	2	2	4	1	1	7	9	0	0	5	5	0	1	7	8	2	2	4	8
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	0	0	0	1	3	4	0	0	0	0	0	1	1	2	0	0	0	0	1	0	0	1
Takeoff-initial climb	1	0	8	9	1	1	9	11	5	4	10	19	0	4	8	12	2	1	10	13	5	0	7	12
Climb	0	0	1	1	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	1	1
Climb-to cruise	0	0	0	0	0	0	0	0	1	1	1	3	0	0	1	1	0	0	0	0	0	1	1	2
Cruise	3	4	6	13	3	2	3	8	2	0	1	3	2	2	8	12	4	2	8	14	3	0	4	7
Cruise-normal	0	0	13	13	3	1	9	13	2	1	9	12	1	2	9	12	1	2	13	16	2	0	5	7
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent	1	1	1	3	0	0	2	2	0	0	1	1	0	0	1	1	0	0	2	2	0	0	2	2
Descent-normal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1
Descent-emergency	0	0	3	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Descent-uncontrolled	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	1	1	2	1	0	0	1
Approach	1	1	1	3	0	0	1	1	0	1	1	2	0	0	1	1	0	0	1	1	1	2	2	5
Approach-VFR pattern-downwind	1	1	0	2	0	0	0	0	1	0	1	2	0	0	1	1	0	0	1	1	0	0	1	1
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	1	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	2
Approach-VFR pattern-final approach	1	0	3	4	1	1	3	5	0	1	2	3	0	1	1	2	0	1	4	5	1	0	1	2
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	3	3	0	0	5	5	0	0	3	3	0	0	3	3	0	0	5	5	0	0	5	5
Landing-flare/touchdown	0	0	7	7	0	0	15	15	0	2	8	10	0	1	8	9	1	0	9	10	0	0	15	15
Landing-roll	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0
Maneuvering	7	1	6	14	2	0	5	7	1	1	3	5	7	3	5	15	5	0	10	15	2	2	11	15
Maneuvering-aerial application	2	3	13	18	0	3	10	13	1	0	14	15	2	3	4	9	1	2	10	13	0	1	14	15
Maneuvering-turn to reverse direction	0	2	0	2	1	0	2	3	0	0	5	5	1	1	3	5	0	1	1	2	0	0	4	4
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	2	12	14	1	1	10	12	0	0	12	12	0	1	17	18	1	1	11	13	0	2	12	14
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	1	0	0	1	2	0	0	2	0	0	0	0	0	0	0	0	1	1	0	2
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Total:	21	16	81	118	16	13	85	114	16	13	87	116	14	23	83	120	16	14	104	134	19	13	93	125

Table 3.6 (Continued)
General Aviation Accidents by Phase of Flight Operation
Reciprocating Engine, Rotary Wing
References 3.20 to 3.27

Reciprocating Engine, Rotary Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	1	0	0	1			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	1	0	1	0	0	0	0	1	5	4	10			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	1	0	1			
Standing-idling rotors	0	0	0	0	1	0	0	1	3	1	4	8	Standing	20	2.11%
Taxi	0	0	1	1	0	0	0	0	0	0	2	2			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	1	1			
Taxi-from landing	0	0	0	0	0	0	0	0	1	0	0	1			
Taxi-aerial	0	0	5	5	0	1	2	3	0	2	20	22	Taxi	26	2.74%
Takeoff	0	1	6	7	0	1	3	4	4	9	34	47			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	2	2	0	0	0	0	1	2	6	9	Takeoff	56	5.90%
Takeoff-initial climb	2	0	5	7	3	2	8	13	19	12	65	96	Initial Climb	96	10.12%
Climb	1	0	0	1	0	0	2	2	2	1	5	8			
Climb-to cruise	0	2	0	2	0	0	0	0	1	4	3	8	Climb	16	1.69%
Cruise	7	1	10	18	4	1	6	11	28	12	46	86			
Cruise-normal	5	1	5	11	3	0	4	7	17	7	67	91			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Cruise	177	18.65%
Descent	0	0	5	5	1	0	0	1	2	1	14	17			
Descent-normal	0	0	0	0	0	0	1	1	0	1	2	3			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	6	6			
Descent-uncontrolled	0	0	1	1	0	0	2	2	2	1	5	8	Descent	34	3.58%
Approach	0	0	1	1	1	1	2	4	3	5	10	18			
Approach-VFR pattern-downwind	1	0	1	2	1	0	0	1	4	1	5	10			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base to final	0	0	1	1	0	0	1	1	1	1	6	8			
Approach-VFR pattern-final approach	1	0	5	6	0	0	2	2	4	4	21	29			
Approach-go-around (VFR)	0	0	0	0	1	0	1	2	1	0	4	5			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	70	7.38%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	1	0	3	4	0	0	4	4	1	0	31	32			
Landing-flare/touchdown	0	0	15	15	1	1	10	12	2	4	87	93			
Landing-roll	0	0	1	1	0	0	0	0	0	0	3	3	Landing	128	13.49%
Maneuvering	3	2	8	13	1	1	5	7	28	10	53	91			
Maneuvering-aerial application	0	0	5	5	1	0	11	12	7	12	81	100			
Maneuvering-turn to reverse direction	0	0	3	3	0	0	2	2	2	4	20	26			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	1	1	5	7	1	0	8	9	4	8	87	99	Maneuvering	316	33.30%
Other	0	0	0	0	0	0	1	1	0	0	2	2			
Unknown	0	0	0	0	0	0	0	0	4	1	0	5			
Not reported	0	0	1	1	0	0	0	0	0	0	3	3	Other/?/NR	10	1.05%
Total:	22	9	89	120	19	8	75	102	143	109	697	949		949	100.00%

Table 3.7
General Aviation Accidents by Phase of Flight Operation
Turbine Engine, Rotary Wing
References 3.20 to 3.27

Turbine Engine, Rotary Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	1	1	0	0	0	0	0	1	0	1	0	0	2	2	0	1	0	1	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1
Takeoff	0	2	3	5	1	1	1	3	0	1	5	6	0	0	3	3	2	1	1	4	0	0	0	0
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-initial climb	0	4	7	11	1	2	2	5	0	1	2	3	2	4	0	6	2	0	2	4	3	1	1	5
Climb	0	0	0	0	1	0	0	1	0	0	1	1	0	0	2	2	0	0	0	0	0	0	1	1
Climb-to cruise	0	0	1	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
Cruise	4	0	4	8	2	1	3	6	1	2	2	5	5	2	4	11	2	1	8	11	2	1	7	10
Cruise-normal	3	2	7	12	2	0	4	6	2	3	5	10	0	1	2	3	0	0	3	3	1	0	1	2
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Descent	1	0	1	2	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0
Descent-normal	0	0	2	2	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	0	2	2	0	0	0	0	0	0	2	2	1	0	2	3	0	1	0	1	2	0	0	2
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-final approach	0	0	1	1	0	1	3	4	0	1	1	2	1	0	2	3	0	0	2	2	0	1	1	2
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	1	1	0	0	2	2	0	0	1	1	0	0	1	1	0	0	4	4	0	0	1	1
Landing-flare/touchdown	0	0	2	2	0	0	5	5	0	0	7	7	0	0	4	4	0	0	4	4	0	0	6	6
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering	5	1	3	9	1	2	6	9	1	0	1	2	3	1	5	9	0	1	8	9	1	1	1	3
Maneuvering-aerial application	0	0	1	1	0	0	1	1	0	0	2	2	1	0	4	5	1	1	1	3	0	0	2	2
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	4	1	8	13	1	1	9	11	0	7	6	13	1	3	6	10	2	3	4	9	1	0	2	3
Other	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Total:	18	10	45	73	9	8	40	57	5	16	43	64	16	11	39	66	9	11	42	62	10	5	26	41

Table 3.7 (Continued)
General Aviation Accidents by Phase of Flight Operation
Turbine Engine, Rotary Wing
References 3.20 to 3.27

Turbine Engine, Rotary Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	1	0	1			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	0	1	1	0	1	0	1	0	2	3	5			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-idling rotors	0	0	0	0	0	0	2	2	0	2	5	7	Standing	13	2.70%
Taxi	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-from landing	0	0	0	0	0	0	1	1	0	0	2	2			
Taxi-aerial	1	0	0	1	0	0	2	2	1	0	6	7	Taxi	9	1.87%
Takeoff	0	0	0	0	0	0	0	0	3	5	13	21			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	0	0	0	0	0	0	1	0	1	2	Takeoff	23	4.77%
Takeoff-initial climb	0	0	2	2	2	0	3	5	10	12	19	41	Initial Climb	41	8.51%
Climb	0	0	0	0	0	0	0	0	1	0	4	5			
Climb-to cruise	0	0	0	0	0	0	1	1	1	0	4	5	Climb	10	2.07%
Cruise	6	2	2	10	2	2	3	7	24	11	33	68			
Cruise-normal	4	1	3	8	0	1	3	4	12	8	28	48			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	1	1	Cruise	117	24.27%
Descent	0	0	1	1	0	0	0	0	1	0	5	6			
Descent-normal	0	0	0	0	0	0	0	0	0	0	4	4			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	1	1			
Descent-uncontrolled	0	0	0	0	1	0	0	1	1	0	0	1	Descent	12	2.49%
Approach	1	0	1	2	0	1	2	3	4	2	9	15			
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	1	1			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	1	0	0	1			
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-final approach	0	0	2	2	0	0	1	1	1	3	13	17			
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	34	7.05%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	1	1			
Landing	0	1	1	2	0	0	2	2	0	1	13	14			
Landing-flare/touchdown	0	0	5	5	0	0	1	1	0	0	34	34			
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	Landing	49	10.17%
Maneuvering	5	0	5	10	3	3	9	15	19	9	38	66			
Maneuvering-aerial application	0	1	0	1	0	1	1	2	2	3	12	17			
Maneuvering-turn to reverse direction	0	0	1	1	0	0	0	0	1	0	2	3			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	0	1	9	10	5	1	4	10	14	17	48	79	Maneuvering	165	34.23%
Other	1	0	0	1	0	0	0	0	1	1	2	4			
Unknown	0	0	0	0	1	0	0	1	1	0	0	1			
Not reported	1	0	1	2	0	0	1	1	1	0	3	4	Other/?/NR	9	1.87%
Total:	19	6	34	59	14	10	36	60	100	77	305	482		482	100.00%

Table 3.8
General Aviation Accidents by Phase of Flight Operation
Total, Rotary Wing
References 3.20 to 3.27

Total, Rotary Wing	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	2	2	0	0	2	2	0	0	2	2	1	3	0	4	0	1	0	1	0	1	0	1
Standing-engine(s) not operating	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	1	0	1	2	0	0	0	0	0	1	1	2	0	0	2	2	1	2	2	5	0	0	1	1
Taxi	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Taxi-from landing	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	2	2	0	0	2	2	0	0	5	5	0	1	3	4	0	0	3	3	0	0	2	2
Takeoff	1	3	3	7	1	3	3	7	1	2	12	15	0	0	8	8	2	2	8	12	2	2	4	8
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	1	0	0	1	0	1	4	5	0	0	0	0	0	1	1	2	0	0	0	0	1	0	0	1
Takeoff-initial climb	1	4	15	20	2	3	11	16	5	5	12	22	2	8	8	18	4	1	12	17	8	1	8	17
Climb	0	0	1	1	2	0	0	2	0	1	1	2	0	0	3	3	0	0	0	0	0	0	2	2
Climb-to cruise	0	0	1	1	0	0	1	1	1	1	1	3	1	0	1	2	0	0	1	1	0	1	1	2
Cruise	7	4	10	21	5	3	6	14	3	2	3	8	7	4	12	23	6	3	16	25	5	1	11	17
Cruise-normal	3	2	20	25	5	1	13	19	4	4	14	22	1	3	11	15	1	2	16	19	3	0	6	9
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Descent	2	1	2	5	0	0	2	2	0	0	4	4	0	0	1	1	0	0	2	2	0	0	2	2
Descent-normal	0	0	2	2	0	0	0	0	0	0	1	1	0	0	2	2	0	0	0	0	0	1	0	1
Descent-emergency	0	0	3	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1
Descent-uncontrolled	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	1	1	2	1	0	0	1
Approach	1	1	3	5	0	0	1	1	0	1	3	4	1	0	3	4	0	1	1	2	3	2	2	7
Approach-VFR pattern-downwind	1	1	0	2	0	0	0	0	1	0	1	2	0	0	1	1	0	0	2	2	0	0	1	1
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	1	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	2
Approach-VFR pattern-final approach	1	0	4	5	1	2	6	9	0	2	3	5	1	1	3	5	0	1	6	7	1	1	2	4
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	4	4	0	0	7	7	0	0	4	4	0	0	4	4	0	0	9	9	0	0	6	6
Landing-flare/touchdown	0	0	9	9	0	0	20	20	0	2	15	17	0	1	12	13	1	0	13	14	0	0	21	21
Landing-roll	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0
Maneuvering	12	2	9	23	3	2	11	16	2	1	4	7	10	4	10	24	5	1	18	24	3	3	12	18
Maneuvering-aerial application	2	3	14	19	0	3	11	14	1	0	16	17	3	3	8	14	2	3	11	16	0	1	16	17
Maneuvering-turn to reverse direction	0	2	0	2	1	0	2	3	0	0	6	6	2	1	3	6	0	1	1	2	0	0	4	4
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	4	3	20	27	2	2	19	23	0	7	18	25	1	4	23	28	3	4	15	22	1	2	14	17
Other	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1	1
Unknown	0	0	0	0	1	0	0	1	2	0	0	2	0	0	0	0	0	0	0	0	1	1	0	2
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1
Total:	39	26	126	191	25	21	125	171	21	29	130	180	30	34	122	186	25	25	146	196	29	18	119	166

Table 3.8 (Continued)
General Aviation Accidents by Phase of Flight Operation
Total, Rotary Wing
References 3.20 to 3.27

Total, Rotary Wing	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	1	1	0	2			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	1	1	2	0	1	0	1	1	7	7	15			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	1	0	1			
Standing-idling rotors	0	0	0	0	1	0	2	3	3	3	9	15	Standing	33	2.31%
Taxi	0	0	1	1	0	0	0	0	0	0	2	2			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	1	1			
Taxi-from landing	0	0	0	0	0	0	1	1	1	0	2	3			
Taxi-aerial	1	0	5	6	0	1	4	5	1	2	26	29	Taxi	35	2.45%
Takeoff	0	1	6	7	0	1	3	4	7	14	47	68			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	2	2	0	0	0	0	2	2	7	11	Takeoff	79	5.52%
Takeoff-initial climb	2	0	7	9	5	2	11	18	29	24	84	137	Initial Climb	137	9.57%
Climb	1	0	0	1	0	0	2	2	3	1	9	13			
Climb-to cruise	0	2	0	2	0	0	1	1	2	4	7	13	Climb	26	1.82%
Cruise	13	3	12	28	6	3	9	18	52	23	79	154			
Cruise-normal	9	2	8	19	3	1	7	11	29	15	95	139			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	1	1	Cruise	294	20.55%
Descent	0	0	6	6	1	0	0	1	3	1	19	23			
Descent-normal	0	0	0	0	0	0	1	1	0	1	6	7			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	7	7			
Descent-uncontrolled	0	0	1	1	1	0	2	3	3	1	5	9	Descent	46	3.21%
Approach	1	0	2	3	1	2	4	7	7	7	19	33			
Approach-VFR pattern-downwind	1	0	1	2	1	0	0	1	4	1	6	11			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	1	0	0	1			
Approach-VFR pattern-base to final	0	0	1	1	0	0	1	1	1	1	6	8			
Approach-VFR pattern-final approach	1	0	7	8	0	0	3	3	5	7	34	46			
Approach-go-around (VFR)	0	0	0	0	1	0	1	2	1	0	4	5			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	104	7.27%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	1	1			
Landing	1	1	4	6	0	0	6	6	1	1	44	46			
Landing-flare/touchdown	0	0	20	20	1	1	11	13	2	4	121	127			
Landing-roll	0	0	1	1	0	0	0	0	0	0	3	3	Landing	177	12.37%
Maneuvering	8	2	13	23	4	4	14	22	47	19	91	157			
Maneuvering-aerial application	0	1	5	6	1	1	12	14	9	15	93	117			
Maneuvering-turn to reverse direction	0	0	4	4	0	0	2	2	3	4	22	29			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	1	2	14	17	6	1	12	19	18	25	135	178	Maneuvering	481	33.61%
Other	1	0	0	1	0	0	1	1	1	1	4	6			
Unknown	0	0	0	0	1	0	0	1	5	1	0	6			
Not reported	1	0	2	3	0	0	1	1	1	0	6	7	Other/?/NR	19	1.33%
Total:	41	15	123	179	33	18	111	162	243	186	1002	1431		1431	100.00%

Table 3.9
General Aviation Accidents by Phase of Flight Operation
Total Powered Aircraft
References 3.20 to 3.27

Total Powered Aircraft	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.
Standing	1	0	1	2	0	0	0	0	0	0	3	3	0	0	1	1	0	2	0	2	0	0	2	2
Standing-preflight	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	3
Standing-starting engine(s)	0	5	17	22	1	2	17	20	0	3	15	18	0	0	13	13	0	1	7	8	0	2	5	7
Standing-engine(s) operating	1	0	7	8	2	2	11	15	1	1	8	10	2	7	9	18	0	2	6	8	2	2	10	14
Standing-engine(s) not operating	0	0	0	0	0	2	1	3	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Standing-idling rotors	1	0	1	2	0	0	0	0	0	1	1	2	0	0	2	2	1	2	2	5	0	0	1	1
Taxi	1	0	13	14	0	0	5	5	1	0	7	8	0	0	5	5	2	0	9	11	0	1	5	6
Taxi-to takeoff	0	0	21	21	0	0	32	32	0	1	24	25	0	0	22	22	0	0	27	27	0	0	16	16
Taxi-from landing	1	1	18	20	0	0	28	28	1	0	31	32	1	0	26	27	0	0	19	19	0	2	16	18
Taxi-aerial	0	0	2	2	0	0	2	2	0	0	5	5	0	1	3	4	0	0	4	4	0	0	2	2
Takeoff	9	8	27	44	3	9	21	33	6	7	32	45	4	3	29	36	10	10	30	50	14	6	29	49
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	5	6	107	118	2	10	113	125	1	2	77	80	2	2	78	82	5	3	73	81	2	7	81	90
Takeoff-initial climb	69	58	232	359	50	70	220	340	71	69	187	327	63	59	202	324	65	61	185	311	57	58	187	302
Climb	12	6	20	38	7	4	12	23	5	4	15	24	9	2	10	21	7	5	8	20	15	10	21	46
Climb-to cruise	21	5	27	53	14	8	30	52	26	5	26	57	12	2	15	29	13	7	15	35	13	5	23	41
Cruise	41	19	115	175	38	11	84	133	44	18	91	153	55	21	107	183	44	19	95	158	55	23	116	194
Cruise-normal	47	37	178	262	64	19	158	241	63	31	164	258	61	20	146	227	35	15	145	195	37	23	116	176
Cruise-holding (IFR)	0	0	1	1	0	0	0	0	1	0	3	4	0	0	2	2	0	0	0	0	0	0	1	1
Descent	14	1	11	26	4	1	6	11	9	1	11	21	9	1	6	16	5	1	10	16	3	5	8	16
Descent-normal	10	7	27	44	8	6	30	44	5	1	39	45	5	2	21	28	9	5	21	35	4	6	23	33
Descent-emergency	2	2	7	11	0	0	6	6	1	0	1	2	0	0	2	2	0	0	3	3	2	1	3	6
Descent-uncontrolled	3	1	1	5	5	0	3	8	0	1	0	1	1	0	2	3	2	1	3	6	4	0	2	6
Approach	12	7	23	42	6	6	23	35	11	7	24	42	16	7	36	59	13	4	16	33	16	3	23	42
Approach-VFR pattern-downwind	6	3	16	25	9	4	11	24	4	4	13	21	6	2	9	17	12	2	18	32	5	4	12	21
Approach-VFR pattern-base turn	5	0	5	10	1	3	3	7	4	2	5	11	3	1	4	8	5	1	9	15	3	1	3	7
Approach-VFR pattern-base to final	9	2	8	19	10	1	8	19	5	2	7	14	10	5	6	21	6	3	13	22	8	3	14	25
Approach-VFR pattern-final approach	14	30	88	132	12	19	93	124	8	25	75	108	15	17	82	114	21	10	94	125	16	10	64	90
Approach-go-around (VFR)	4	9	46	59	6	11	32	49	8	7	39	54	4	5	30	39	7	8	28	43	7	8	36	51
Approach-IAF to FAF/outer marker (IFR)	3	3	1	7	5	0	0	5	8	1	2	11	8	1	0	9	5	1	2	8	5	1	1	7
Approach-FAF/outer marker to threshold	18	6	8	32	7	4	5	16	7	5	5	17	4	0	4	8	9	1	6	16	6	3	6	15
Approach-circling (IFR)	2	0	2	4	3	0	0	3	3	1	2	6	0	0	1	1	1	0	0	1	1	2	0	3
Approach-missed approach (IFR)	2	2	4	8	4	0	1	5	5	0	2	7	1	0	0	1	4	0	1	5	3	1	1	5
Landing-aborted	0	0	0	0	0	0	0	0	3	4	19	26	0	0	0	0	0	0	0	0	0	0	0	0
Landing	4	7	44	55	4	3	41	48	0	1	43	44	2	2	44	48	1	2	31	34	1	3	18	22
Landing-flare/touchdown	3	9	219	231	2	9	243	254	2	7	181	190	3	9	173	185	4	6	166	176	0	2	180	182
Landing-roll	7	6	290	303	0	11	309	320	1	9	263	273	2	7	242	251	2	6	258	266	1	0	233	234
Maneuvering	107	32	64	203	122	22	60	204	106	22	60	188	79	27	71	177	96	14	61	171	94	30	68	192
Maneuvering-aerial application	10	11	56	77	9	14	56	79	7	14	58	79	21	10	47	78	13	9	53	75	11	11	62	84
Maneuvering-turn to reverse direction	10	4	19	33	6	8	10	24	10	2	15	27	9	3	3	15	11	5	10	26	9	3	13	25
Maneuvering-turn to landing area (emer.	0	0	2	2	1	0	0	1	0	0	7	7	0	0	1	1	2	0	0	2	1	0	1	2
Hover	4	3	20	27	2	2	19	23	0	7	18	25	1	4	23	28	3	4	15	22	1	2	14	17
Other	3	0	3	6	4	1	22	27	0	0	1	1	4	6	57	67	6	6	55	67	9	3	42	54
Unknown	13	2	1	16	14	1	3	18	13	1	2	16	17	0	2	19	18	0	3	21	13	1	1	15
Not reported	1	0	1	2	7	0	2	9	2	0	4	6	1	0	0	1	6	1	12	19	9	0	10	19
Total:	476	292	1753	2521	432	264	1720	2416	442	267	1601	2310	430	226	1537	2193	443	217	1513	2173	428	243	1470	2141

Table 3.9 (Continued)
General Aviation Accidents by Phase of Flight Operation
Total Powered Aircraft
References 3.20 to 3.27

Total Powered Aircraft	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pd. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	1	1	2	1	3	8	12			
Standing-preflight	0	1	0	1	0	0	0	0	2	3	2	7			
Standing-starting engine(s)	0	1	4	5	1	0	10	11	2	14	88	104			
Standing-engine(s) operating	2	1	3	6	3	4	4	11	13	19	58	90			
Standing-engine(s) not operating	0	0	0	0	0	0	1	1	0	2	3	5			
Standing-idling rotors	0	0	0	0	1	0	2	3	3	3	9	15	Standing	233	1.31%
Taxi	2	0	6	8	0	0	8	8	6	1	58	65			
Taxi-to takeoff	0	2	15	17	0	1	21	22	0	4	178	182			
Taxi-from landing	0	1	15	16	0	1	15	16	3	5	168	176			
Taxi-aerial	1	0	5	6	0	1	4	5	1	2	27	30	Taxi	453	2.55%
Takeoff	5	3	19	27	5	4	18	27	56	50	205	311			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16			
Takeoff-ground run	0	6	75	81	3	0	74	77	20	36	678	734	Takeoff	1061	5.96%
Takeoff-initial climb	57	47	169	273	53	49	178	280	485	471	1560	2516	Initial Climb	2516	14.14%
Climb	9	1	14	24	10	3	20	33	74	35	120	229			
Climb-to cruise	10	5	18	33	9	5	15	29	118	42	169	329	Climb	558	3.14%
Cruise	57	18	93	168	52	28	117	197	386	157	818	1361			
Cruise-normal	57	18	123	198	35	11	105	151	399	174	1135	1708			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	1	0	7	8	Cruise	3077	17.29%
Descent	6	2	9	17	11	0	6	17	61	12	67	140			
Descent-normal	12	2	28	42	4	0	26	30	57	29	215	301			
Descent-emergency	1	0	2	3	1	1	3	5	7	4	27	38			
Descent-uncontrolled	1	3	3	7	1	1	4	6	17	7	18	42	Descent	521	2.93%
Approach	14	7	13	34	11	4	20	35	99	45	178	322			
Approach-VFR pattern-downwind	4	1	15	20	4	3	8	15	50	23	102	175			
Approach-VFR pattern-base turn	2	1	6	9	4	2	3	9	27	11	38	76			
Approach-VFR pattern-base to final	6	3	7	16	7	0	11	18	61	19	74	154			
Approach-VFR pattern-final approach	14	12	75	101	10	12	71	93	110	135	642	887			
Approach-go-around (VFR)	7	3	25	35	4	6	38	48	47	57	274	378			
Approach-IAF to FAF/outer marker (IFR)	4	0	2	6	1	1	1	3	39	8	9	56			
Approach-FAF/outer marker to threshold	10	2	5	17	4	2	7	13	65	23	46	134			
Approach-circling (IFR)	1	1	1	3	3	0	1	4	14	4	7	25			
Approach-missed approach (IFR)	4	1	2	7	1	2	1	4	24	6	12	42	Approach	2249	12.64%
Landing-aborted	0	0	0	0	0	0	0	0	3	4	19	26			
Landing	4	3	38	45	0	5	39	44	16	26	298	340			
Landing-flare/touchdown	3	7	178	188	5	4	148	157	22	53	1488	1563			
Landing-roll	3	4	223	230	2	6	238	246	18	49	2056	2123	Landing	4052	22.77%
Maneuvering	98	20	62	180	109	29	57	195	811	196	503	1510			
Maneuvering-aerial application	6	11	41	58	12	8	43	63	89	88	416	593			
Maneuvering-turn to reverse direction	10	5	13	28	4	5	9	18	69	35	92	196			
Maneuvering-turn to landing area (emer.	1	1	1	3	0	0	1	1	5	1	13	19			
Hover	1	2	14	17	6	1	12	19	18	25	135	178	Maneuvering	2496	14.03%
Other	11	5	42	58	3	3	44	50	40	24	266	330			
Unknown	14	0	7	21	15	3	1	19	117	8	20	145			
Not reported	7	0	15	22	9	3	12	24	42	4	56	102	Other/?/NR	577	3.24%
Total:	444	200	1386	2030	403	209	1397	2009	3498	1918	12377	17793		17793	100.00%

Table 3.10
General Aviation Accidents by Phase of Flight Operation
Gliders
References 3.20 to 3.27

Gliders	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	1	1	0	0	0	0	0	0	1	1	0	0	2	2	0	0	3	3	0	1	1	2
Takeoff-initial climb	2	1	10	13	0	1	4	5	2	2	4	8	0	1	3	4	0	3	3	6	1	1	2	4
Climb	0	0	1	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Cruise-normal	0	1	3	4	0	0	2	2	2	0	1	3	0	0	2	2	0	0	0	0	0	0	0	0
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1
Descent-normal	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	2
Descent-emergency	0	0	2	2	0	1	1	2	0	0	1	1	0	0	1	1	0	0	1	1	0	1	1	2
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	1	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	3
Approach-VFR pattern-downwind	0	1	0	1	0	0	0	0	0	0	1	1	0	1	1	2	0	0	0	0	0	0	0	0
Approach-VFR pattern-base turn	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0
Approach-VFR pattern-base to final	0	2	0	2	0	0	2	2	1	0	0	1	0	2	0	2	0	0	1	1	1	1	1	3
Approach-VFR pattern-final approach	2	3	11	16	0	0	4	4	0	3	3	6	0	1	3	4	1	1	5	7	0	3	7	10
Approach-go-around (VFR)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	4	4	0	0	1	1	0	1	2	3	0	0	0	0	0	1	1	2	0	1	1	2
Landing-flare/touchdown	0	1	3	4	0	0	3	3	0	0	4	4	0	1	1	2	0	2	1	3	0	1	3	4
Landing-roll	1	1	0	2	0	0	3	3	0	0	1	1	0	0	1	1	0	0	4	4	0	0	1	1
Maneuvering	3	3	2	8	2	1	2	5	4	1	3	8	1	0	1	2	3	0	2	5	1	1	3	5
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to reverse direction	1	0	0	1	1	1	1	3	1	0	3	4	0	0	0	0	1	0	0	1	0	0	0	0
Maneuvering-turn to landing area (emer.	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Unknown	1	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	10	16	43	69	4	6	26	36	13	7	25	45	1	6	16	23	5	8	27	40	5	10	28	43

Table 3.10 (Continued)
General Aviation Accidents by Phase of Flight Operation
Gliders
References 3.20 to 3.27

Gliders	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	0	0.00%
Taxi	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	0	0.00%
Takeoff	0	0	1	1	0	0	1	1	0	0	5	5			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	5	5	0	1	0	1	0	2	13	15	Takeoff	20	6.10%
Takeoff-initial climb	2	2	3	7	0	2	3	5	7	13	32	52	Initial Climb	52	15.85%
Climb	0	0	0	0	0	0	0	0	0	1	2	3			
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	Climb	3	0.91%
Cruise	0	2	3	5	0	0	2	2	0	2	7	9			
Cruise-normal	1	0	1	2	0	0	1	1	3	1	10	14			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Cruise	23	7.01%
Descent	0	0	0	0	0	0	0	0	2	0	1	3			
Descent-normal	0	0	0	0	0	0	0	0	1	1	4	6			
Descent-emergency	0	0	0	0	0	0	0	0	0	2	7	9			
Descent-uncontrolled	0	0	1	1	0	0	0	0	0	0	1	1	Descent	19	5.79%
Approach	0	0	0	0	0	0	1	1	0	1	7	8			
Approach-VFR pattern-downwind	0	0	0	0	0	0	1	1	0	2	3	5			
Approach-VFR pattern-base turn	0	1	0	1	0	0	0	0	1	3	0	4			
Approach-VFR pattern-base to final	0	0	1	1	0	0	1	1	2	5	6	13			
Approach-VFR pattern-final approach	1	3	4	8	0	1	5	6	4	15	42	61			
Approach-go-around (VFR)	0	0	0	0	0	0	1	1	0	0	2	2			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	1	1			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	94	28.66%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	0	1	1	2	0	0	0	0	0	4	10	14			
Landing-flare/touchdown	0	0	2	2	0	0	1	1	0	5	18	23			
Landing-roll	0	0	2	2	0	0	3	3	1	1	15	17	Landing	54	16.46%
Maneuvering	4	0	3	7	0	0	2	2	18	6	18	42			
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	4	1	4	9			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	1	1	2	0	2	4	6			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	57	17.38%
Other	0	0	0	0	0	0	0	0	0	0	3	3			
Unknown	0	0	0	0	0	0	0	0	3	0	0	3			
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	Other/?/NR	6	1.83%
Total:	8	9	27	44	0	5	23	28	46	67	215	328		328	100.00%

Table 3.11
General Aviation Accidents by Phase of Flight Operation
Balloons
References 3.20 to 3.27

Balloons	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.
Standing	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-initial climb	0	1	0	1	0	1	0	1	0	2	0	2	0	0	1	1	1	1	0	2	0	1	0	1
Climb	0	0	0	0	0	2	2	4	0	0	0	0	2	0	0	2	1	0	0	1	0	0	0	0
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruise	0	1	2	3	0	0	0	0	0	0	2	2	0	0	1	1	1	8	1	10	0	0	1	1
Cruise-normal	1	2	1	4	0	2	1	3	0	1	0	1	0	1	0	1	0	0	2	2	0	0	1	1
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent	0	0	0	0	2	0	1	3	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Descent-normal	0	0	0	0	0	0	0	0	0	1	3	4	0	1	1	2	0	0	0	0	0	0	0	0
Descent-emergency	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-uncontrolled	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	0	0	0	1	1	0	2	0	0	0	0	1	0	0	1	0	0	0	0	0	2	1	3
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-final approach	0	0	1	1	0	1	0	1	0	1	0	1	0	2	1	3	0	0	1	1	0	0	0	0
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	4	2	6	0	1	1	2	0	5	4	9	0	4	1	5	0	1	1	2	0	2	0	2
Landing-flare/touchdown	0	6	2	8	0	6	1	7	0	5	1	6	0	3	0	3	0	6	0	6	1	4	2	7
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	1	1	0	1	0	1	0	0	0	0	0	0	2	2	1	0	0	1	1	0	0	1
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	1	14	9	24	3	17	9	29	0	15	10	25	3	12	7	22	4	17	5	26	2	9	5	16

Table 3.11 (Continued)
General Aviation Accidents by Phase of Flight Operation
Balloons
References 3.20 to 3.27

Balloons	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	1	1	0	0	2	2			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	1	0	1	0	0	0	0	0	1	0	1			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	3	1.68%
Taxi	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	0	0.00%
Takeoff	0	0	0	0	0	0	0	0	0	1	0	1			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	0	0	0	0	0	0	0	0	0	0	Takeoff	1	0.56%
Takeoff-initial climb	0	0	0	0	0	1	0	1	1	7	1	9	Initial Climb	9	5.03%
Climb	0	2	0	2	0	0	0	0	3	4	2	9			
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	Climb	9	5.03%
Cruise	0	1	1	2	1	1	0	2	2	11	8	21			
Cruise-normal	0	0	0	0	0	0	0	0	1	6	5	12			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Cruise	33	18.44%
Descent	0	0	0	0	0	0	0	0	2	1	1	4			
Descent-normal	0	0	0	0	0	0	0	0	0	2	4	6			
Descent-emergency	0	1	0	1	0	0	0	0	0	1	1	2			
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	1	1	Descent	13	7.26%
Approach	0	0	1	1	1	1	0	2	3	4	2	9			
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-final approach	0	0	0	0	0	0	0	0	0	4	3	7			
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	16	8.94%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	1	1	2	4	0	3	3	6	1	21	14	36			
Landing-flare/touchdown	0	4	0	4	0	6	2	8	1	40	8	49			
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	Landing	85	47.49%
Maneuvering	1	0	0	1	0	0	1	1	1	2	1	4			
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	0	0	0	0	0	0	0	0	0	0	0	0	Maneuvering	4	2.23%
Other	0	0	0	0	0	0	0	0	2	1	3	6			
Unknown	0	0	0	0	0	0	0	0	0	0	0	0			
Not reported	0	0	0	0	0	0	0	0	0	0	0	0	Other/?/NR	6	3.35%
Total:	2	10	4	16	2	12	7	21	17	106	56	179		179	100.00%

Table 3.12
General Aviation Accidents by Phase of Flight Operation
Other Aircraft
References 3.20 to 3.27

Other Aircraft	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.
Standing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-initial climb	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Climb	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	1
Cruise-normal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-normal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-VFR pattern-final approach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landing-flare/touchdown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering	0	0	0	0	1	1	0	2	0	1	1	2	1	0	0	1	0	0	0	0	0	0	0	0
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not reported	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Total:	0	0	0	0	1	4	0	5	0	1	2	3	2	0	2	4	0	0	1	1	1	2	0	3

Table 3.12 (Continued)
General Aviation Accidents by Phase of Flight Operation
Other Aircraft
References 3.20 to 3.27

Other Aircraft	1992				1993				TOTAL						
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-preflight	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-starting engine(s)	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-engine(s) not operating	0	0	0	0	0	0	0	0	0	0	0	0			
Standing-idling rotors	0	0	0	0	0	0	0	0	0	0	0	0	Standing	0	0.00%
Taxi	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-to takeoff	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-from landing	0	0	0	0	0	0	0	0	0	0	0	0			
Taxi-aerial	0	0	0	0	0	0	0	0	0	0	0	0	Taxi	0	0.00%
Takeoff	0	0	1	1	0	0	0	0	0	0	1	1			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Takeoff-ground run	0	0	0	0	0	1	0	1	0	1	0	1	Takeoff	2	9.09%
Takeoff-initial climb	0	0	1	1	0	0	1	1	0	3	2	5	Initial Climb	5	22.73%
Climb	0	0	0	0	0	0	0	0	1	0	0	1			
Climb-to cruise	0	0	0	0	0	0	0	0	0	0	0	0	Climb	1	4.55%
Cruise	0	0	0	0	0	1	0	1	1	1	2	4			
Cruise-normal	0	0	0	0	0	0	0	0	0	0	0	0			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Cruise	4	18.18%
Descent	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-normal	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-emergency	0	0	0	0	0	0	0	0	0	0	0	0			
Descent-uncontrolled	0	0	0	0	0	0	0	0	0	0	0	0	Descent	0	0.00%
Approach	0	0	0	0	0	0	0	0	0	1	0	1			
Approach-VFR pattern-downwind	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base turn	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-base to final	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-VFR pattern-final approach	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-go-around (VFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-IAF to FAF/outer marker (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-FAF/outer marker to threshold	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-circling (IFR)	0	0	0	0	0	0	0	0	0	0	0	0			
Approach-missed approach (IFR)	0	0	0	0	0	0	0	0	0	0	0	0	Approach	1	4.55%
Landing-aborted	0	0	0	0	0	0	0	0	0	0	0	0			
Landing	0	0	0	0	0	0	0	0	0	1	0	1			
Landing-flare/touchdown	0	0	0	0	0	0	0	0	0	0	1	1			
Landing-roll	0	0	0	0	0	0	0	0	0	0	0	0	Landing	2	9.09%
Maneuvering	0	0	0	0	0	0	0	0	2	2	1	5			
Maneuvering-aerial application	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to reverse direction	0	0	0	0	0	0	0	0	0	0	0	0			
Maneuvering-turn to landing area (emer.	0	0	0	0	0	0	0	0	0	0	0	0			
Hover	0	0	1	1	0	0	0	0	0	0	1	1	Maneuvering	6	27.27%
Other	0	0	0	0	0	0	0	0	0	0	0	0			
Unknown	0	0	0	0	0	0	0	0	0	0	0	0			
Not reported	0	0	0	0	0	0	0	0	0	0	1	1	Other/?/NR	1	4.55%
Total:	0	0	3	3	0	2	1	3	4	9	9	22		22	100.00%

Table 3.13
General Aviation Accidents by Phase of Flight Operation
Total Aircraft, References 3.20 to 3.27

Total Aircraft	1986				1987				1988				1989				1990				1991			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.
Standing	1	0	1	2	0	0	1	1	0	0	3	3	0	0	1	1	0	2	0	2	0	0	2	2
Standing-preflight	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	3
Standing-starting engine(s)	0	5	17	22	1	2	17	20	0	3	15	18	0	0	13	13	0	1	7	8	0	2	5	7
Standing-engine(s) operating	1	0	7	8	2	2	11	15	1	1	8	10	2	7	9	18	0	2	6	8	2	2	10	14
Standing-engine(s) not operating	0	0	0	0	0	2	1	3	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Standing-idling rotors	1	0	1	2	0	0	0	0	0	1	1	2	0	0	2	2	1	2	2	5	0	0	1	1
Taxi	1	0	13	14	0	0	5	5	1	0	7	8	0	0	5	5	2	0	9	11	0	1	5	6
Taxi-to takeoff	0	0	21	21	0	0	32	32	0	1	24	25	0	0	22	22	0	0	27	27	0	0	16	16
Taxi-from landing	1	1	18	20	0	0	28	28	1	0	31	32	1	0	26	27	0	0	19	19	0	2	16	18
Taxi-aerial	0	0	2	2	0	0	2	2	0	0	5	5	0	1	3	4	0	0	4	4	0	0	2	2
Takeoff	9	8	28	45	3	9	21	33	6	7	32	45	4	3	29	36	10	11	31	52	14	6	30	50
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16	0	0	0	0	0	0	0	0	0	0	0	0
Takeoff-ground run	5	6	108	119	2	10	113	125	1	2	78	81	2	2	80	84	5	3	76	84	2	8	82	92
Takeoff-initial climb	71	60	242	373	50	73	224	347	73	73	191	337	63	60	206	329	66	65	188	319	58	62	189	309
Climb	12	6	21	39	7	7	14	28	5	4	16	25	12	2	10	24	8	5	8	21	15	10	21	46
Climb-to cruise	21	5	27	53	14	8	30	52	26	5	26	57	12	2	15	29	13	7	15	35	13	5	23	41
Cruise	41	20	117	178	38	11	84	133	44	18	93	155	55	21	109	185	45	27	99	171	56	23	117	196
Cruise-normal	48	40	182	270	64	21	161	246	65	32	165	262	61	21	148	230	35	15	147	197	37	23	117	177
Cruise-holding (IFR)	0	0	1	1	0	0	0	0	1	0	3	4	0	0	2	2	0	0	0	0	0	0	1	1
Descent	14	1	11	26	6	1	8	15	10	1	11	22	9	2	6	17	5	1	10	16	4	5	8	17
Descent-normal	10	8	29	47	8	6	30	44	5	2	42	49	5	3	22	30	9	5	22	36	5	6	24	35
Descent-emergency	2	2	9	13	0	1	8	9	1	0	2	3	0	0	3	3	0	0	4	4	2	2	4	8
Descent-uncontrolled	3	1	1	5	5	0	4	9	0	1	0	1	1	0	2	3	2	1	3	6	4	0	2	6
Approach	12	8	24	44	7	8	24	39	11	7	24	42	17	7	36	60	13	4	17	34	16	5	27	48
Approach-VFR pattern-downwind	6	4	16	26	9	4	11	24	4	4	14	22	6	3	10	19	12	2	18	32	5	4	12	21
Approach-VFR pattern-base turn	5	1	5	11	1	3	3	7	5	2	5	12	3	1	4	8	5	2	9	16	3	1	3	7
Approach-VFR pattern-base to final	9	4	8	21	10	1	10	21	6	2	7	15	10	7	6	23	6	3	14	23	9	4	15	28
Approach-VFR pattern-final approach	16	33	100	149	12	20	97	129	8	29	78	115	15	20	86	121	22	11	100	133	16	13	71	100
Approach-go-around (VFR)	4	9	47	60	6	11	32	49	8	7	39	54	4	5	30	39	7	8	28	43	7	8	36	51
Approach-IAF to FAF/outer marker (IFR)	3	3	1	7	5	0	0	5	8	1	2	11	8	1	0	9	5	1	2	8	5	1	1	7
Approach-FAF/outer marker to threshold	18	6	8	32	7	4	5	16	7	5	5	17	4	0	4	8	9	1	6	16	6	3	6	15
Approach-circling (IFR)	2	0	3	5	3	0	0	3	3	1	2	6	0	0	1	1	1	0	0	1	1	2	0	3
Approach-missed approach (IFR)	2	2	4	8	4	0	1	5	5	0	2	7	1	0	0	1	4	0	1	5	3	1	1	5
Landing-aborted	0	0	0	0	0	0	0	0	3	4	19	26	0	0	0	0	0	0	0	0	0	0	0	0
Landing	4	11	50	65	4	5	43	52	0	7	49	56	2	6	45	53	1	4	33	38	1	6	19	26
Landing-flare/touchdown	3	16	224	243	2	15	247	264	2	12	186	200	3	13	175	191	4	14	167	185	1	7	185	193
Landing-roll	8	7	290	305	0	11	312	323	1	9	264	274	2	7	243	252	2	6	262	270	1	0	234	235
Maneuvering	110	35	66	211	125	26	62	213	110	24	64	198	81	27	72	180	99	14	63	176	95	31	71	197
Maneuvering-aerial application	10	11	56	77	9	14	56	79	7	14	58	79	21	10	47	78	13	9	53	75	11	11	62	84
Maneuvering-turn to reverse direction	11	4	19	34	7	9	11	27	11	2	18	31	9	3	3	15	12	5	10	27	9	3	13	25
Maneuvering-turn to landing area (emer.	0	0	2	2	1	1	0	2	0	0	7	7	0	0	2	2	2	0	1	3	1	0	2	3
Hover	4	3	20	27	2	2	19	23	0	7	18	25	1	4	23	28	3	4	15	22	1	2	14	17
Other	3	0	4	7	4	2	23	29	0	0	1	1	4	6	59	69	7	6	55	68	10	3	44	57
Unknown	14	2	1	17	15	1	3	19	14	1	2	17	17	0	2	19	18	0	3	21	13	1	1	15
Not reported	1	0	1	2	7	0	2	9	2	0	5	7	1	0	0	1	6	1	12	19	9	0	10	19
Total:	487	322	1805	2614	440	291	1755	2486	455	290	1638	2383	436	244	1562	2242	452	242	1546	2240	436	264	1503	2203
	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total
Aircraft Damage	748	1832	35	2615	689	1800	34	2523	683	1703	29	2415	616	1620	26	2262	613	1598	31	2242	592	1583	33	2208

Table 3.13 (Continued)
General Aviation Accidents by Phase of Flight Operation
Total Aircraft, References 3.20 to 3.27

Total Aircraft				**1992**				**1993**				**TOTAL**			
Phase of Operation	Fatal Acc.	Injury Acc.	Pr. Dm Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Fatal Acc.	Injury Acc.	Pr. Dm. Acc.	Total Acc.	Flight Phase	No.	Pct.
Standing	0	0	0	0	0	1	2	3	1	3	10	14			
Standing-preflight	0	1	0	1	0	0	0	0	2	3	2	7			
Standing-starting engine(s)	0	1	4	5	1	0	10	11	2	14	88	104			
Standing-engine(s) operating	2	2	3	7	3	4	4	11	13	20	58	91			
Standing-engine(s) not operating	0	0	0	0	0	0	1	1	0	2	3	5			
Standing-idling rotors	0	0	0	0	1	0	2	3	3	3	9	15	Standing	236	1.29%
Taxi	2	0	6	8	0	0	8	8	6	1	58	65			
Taxi-to takeoff	0	2	15	17	0	1	21	22	0	4	178	182			
Taxi-from landing	0	1	15	16	0	1	15	16	3	5	168	176			
Taxi-aerial	1	0	5	6	0	1	4	5	1	2	27	30	Taxi	453	2.47%
Takeoff	5	3	21	29	5	4	19	28	56	51	211	318			
Takeoff-aborted	0	0	0	0	0	0	0	0	0	1	15	16			
Takeoff-ground run	0	6	80	86	3	2	74	79	20	39	691	750	Takeoff	1084	5.92%
Takeoff-initial climb	59	49	173	281	53	52	182	287	493	494	1595	2582	Initial Climb	2582	14.09%
Climb	9	3	14	26	10	3	20	33	78	40	124	242			
Climb-to cruise	10	5	18	33	9	5	15	29	118	42	169	329	Climb	571	3.12%
Cruise	57	21	97	175	53	30	119	202	389	171	835	1395			
Cruise-normal	58	18	124	200	35	11	106	152	403	181	1150	1734			
Cruise-holding (IFR)	0	0	0	0	0	0	0	0	1	0	7	8	Cruise	3137	17.12%
Descent	6	2	9	17	11	0	6	17	65	13	69	147			
Descent-normal	12	2	28	42	4	0	26	30	58	32	223	313			
Descent-emergency	1	1	2	4	1	1	3	5	7	7	35	49			
Descent-uncontrolled	1	3	4	8	1	1	4	6	17	7	20	44	Descent	553	3.02%
Approach	14	7	14	35	12	5	21	38	102	51	187	340			
Approach-VFR pattern-downwind	4	1	15	20	4	3	9	16	50	25	105	180			
Approach-VFR pattern-base turn	2	2	6	10	4	2	3	9	28	14	38	80			
Approach-VFR pattern-base to final	6	3	8	17	7	0	12	19	63	24	80	167			
Approach-VFR pattern-final approach	15	15	79	109	10	13	76	99	114	154	687	955			
Approach-go-around (VFR)	7	3	25	35	4	6	39	49	47	57	276	380			
Approach-IAF to FAF/outer marker (IFR)	4	0	2	6	1	1	1	3	39	8	9	56			
Approach-FAF/outer marker to threshold	10	2	5	17	4	2	7	13	65	23	46	134			
Approach-circling (IFR)	1	1	1	3	3	0	1	4	14	4	8	26			
Approach-missed approach (IFR)	4	1	2	7	1	2	1	4	24	6	12	42	Approach	2360	12.88%
Landing-aborted	0	0	0	0	0	0	0	0	3	4	19	26			
Landing	5	5	41	51	0	8	42	50	17	52	322	391			
Landing-flare/touchdown	3	11	180	194	5	10	151	166	23	98	1515	1636			
Landing-roll	3	4	225	232	2	6	241	249	19	50	2071	2140	Landing	4193	22.89%
Maneuvering	103	20	65	188	109	29	60	198	832	206	523	1561			
Maneuvering-aerial application	6	11	41	58	12	8	43	63	89	88	416	593			
Maneuvering-turn to reverse direction	10	5	13	28	4	5	9	18	73	36	96	205			
Maneuvering-turn to landing area (emer.	1	1	1	3	0	1	2	3	5	3	17	25			
Hover	1	2	15	18	6	1	12	19	18	25	136	179	Maneuvering	2563	13.99%
Other	11	5	42	58	3	3	44	50	42	25	272	339			
Unknown	14	0	7	21	15	3	1	19	120	8	20	148			
Not reported	7	0	15	22	9	3	12	24	42	4	57	103	Other/?/NR	590	3.22%
Total:	454	219	1420	2093	405	228	1428	2061	3565	2100	12657	18322		18322	100.00%
	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total	Dest.	Sub. Dam.	Minor/ None	Total			
Aircraft Damage	571	1501	20	2092	557	1476	28	2061	5069	13113	236	18418			

Table 3.14
General Aviation Accidents, 1986-1993
by Flight Phases and by Aircraft Subcategories Summary
References 3.20 - 3.27

Aircraft Subcategories	Standing		Taxi		Takeoff		Initial Climb		Climb		Cruise		Descent		Approach		Landing		Manuevering		Other/?/NR		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Single Engine Reciprocating Fixed Wing	180	1.22%	364	2.48%	885	6.02%	2185	14.86%	457	3.11%	2500	17.00%	429	2.92%	1840	12.51%	3500	23.80%	1885	12.82%	482	3.28%	14707	100.00%
Multi Engine Reciprocating Fixed Wing	13	1.03%	38	3.00%	71	5.60%	161	12.70%	56	4.42%	239	18.85%	31	2.44%	236	18.61%	300	23.66%	64	5.05%	59	4.65%	1268	100.00%
Turboprop Fixed Wing	7	2.34%	14	4.68%	17	5.69%	29	9.70%	13	4.35%	38	12.71%	14	4.68%	52	17.39%	51	17.06%	54	18.06%	10	3.34%	299	100.00%
Turbojet Fixed Wing	0	0.00%	2	2.27%	9	10.23%	4	4.55%	6	6.82%	6	6.82%	1	1.14%	17	19.32%	24	27.27%	12	13.64%	7	7.95%	88	100.00%
Total Fixed Wing	200	1.22%	418	2.55%	982	6.00%	2379	14.54%	532	3.25%	2783	17.01%	475	2.90%	2145	13.11%	3875	23.68%	2015	12.32%	558	3.41%	16362	100.00%
Reciprocating Engine Rotary Wing	20	2.11%	26	2.74%	56	5.90%	96	10.12%	16	1.69%	177	18.65%	34	3.58%	70	7.38%	128	13.49%	316	33.30%	10	1.05%	949	100.00%
Turbine Engine Rotary Wing	13	2.70%	9	1.87%	23	4.77%	41	8.51%	10	2.07%	117	24.27%	12	2.49%	34	7.05%	49	10.17%	165	34.23%	9	1.87%	482	100.00%
Total Rotary Wing	33	2.31%	35	2.45%	79	5.52%	137	9.57%	26	1.82%	294	20.55%	46	3.21%	104	7.27%	177	12.37%	481	33.61%	19	1.33%	1431	100.00%
Total Powered Aircraft	233	1.31%	453	2.55%	1061	5.96%	2516	14.14%	558	3.14%	3077	17.29%	521	2.93%	2249	12.64%	4052	22.77%	2496	14.03%	577	3.24%	17793	100.00%
Gliders	0	0.00%	0	0.00%	20	6.10%	52	15.85%	3	0.91%	23	7.01%	19	5.79%	94	28.66%	54	16.46%	57	17.38%	6	1.83%	328	100.00%
Balloons	3	1.68%	0	0.00%	1	0.56%	9	5.03%	9	5.03%	33	18.44%	13	7.26%	16	8.94%	85	47.49%	4	2.23%	6	3.35%	179	100.00%
Other	0	0.00%	0	0.00%	2	9.09%	5	22.73%	1	4.55%	4	18.18%	0	0.00%	1	4.55%	2	9.09%	6	27.27%	1	4.55%	22	100.00%
Total Aircraft	236	1.29%	453	2.47%	1084	5.92%	2582	14.09%	571	3.12%	3137	17.12%	553	3.02%	2360	12.88%	4193	22.89%	2563	13.99%	590	3.22%	18322	100.00%

Table 3.15
General Aviation Accidents, 1986-1993 by Flight Phases and by Aircraft Subcategories Summary
Manuevering Accidents and Accidents During Standing, Taxi, and Other Flight Phases Deleted
References 3.20 - 3.27

Aircraft Subcategories	Takeoff No.	Takeoff Pct.	Initial Climb No.	Initial Climb Pct.	Climb No.	Climb Pct.	Cruise No.	Cruise Pct.	Descent No.	Descent Pct.	Approach No.	Approach Pct.	Landing No.	Landing Pct.	Total No.	Total Pct.
Single Engine Reciprocating Fixed Wing	885	7.50%	2185	18.52%	457	3.87%	2500	21.19%	429	3.64%	1840	15.60%	3500	29.67%	11796	100.00%
Multi Engine Reciprocating Fixed Wing	71	6.49%	161	14.72%	56	5.12%	239	21.85%	31	2.83%	236	21.57%	300	27.42%	1094	100.00%
Turboprop Fixed Wing	17	7.94%	29	13.55%	13	6.07%	38	17.76%	14	6.54%	52	24.30%	51	23.83%	214	100.00%
Turbojet Fixed Wing	9	13.43%	4	5.97%	6	8.96%	6	8.96%	1	1.49%	17	25.37%	24	35.82%	67	100.00%
Total Fixed Wing	982	7.46%	2379	18.06%	532	4.04%	2783	21.13%	475	3.61%	2145	16.29%	3875	29.42%	13171	100.00%
Reciprocating Engine Rotary Wing	56	9.71%	96	16.64%	16	2.77%	177	30.68%	34	5.89%	70	12.13%	128	22.18%	577	100.00%
Turbine Engine Rotary Wing	23	8.04%	41	14.34%	10	3.50%	117	40.91%	12	4.20%	34	11.89%	49	17.13%	286	100.00%
Total Rotary Wing	79	9.15%	137	15.87%	26	3.01%	294	34.07%	46	5.33%	104	12.05%	177	20.51%	863	100.00%
Total Powered Aircraft	1061	7.56%	2516	17.93%	558	3.98%	3077	21.93%	521	3.71%	2249	16.03%	4052	28.87%	14034	100.00%
Gliders	20	7.55%	52	19.62%	3	1.13%	23	8.68%	19	7.17%	94	35.47%	54	20.38%	265	100.00%
Balloons	1	0.60%	9	5.42%	9	5.42%	33	19.88%	13	7.83%	16	9.64%	85	51.20%	166	100.00%
Other	2	13.33%	5	33.33%	1	6.67%	4	26.67%	0	0.00%	1	6.67%	2	13.33%	15	100.00%
Total Aircraft	1084	7.49%	2582	17.83%	571	3.94%	3137	21.66%	553	3.82%	2360	16.30%	4193	28.96%	14480	100.00%

3.3 GENERAL AVIATION OPERATIONS

General aviation operations are tabulated by the FAA Office of Aviation Policy, Plans, and Management Analysis in their publication General Aviation Activity and Avionics Survey published annually by calendar year. According to the introduction of this survey, all facets of civil (nonmilitary) aviation are included in this survey except for flights conducted by air carriers under 14 CFR 121 [Ref. 3.9] and 14 CFR 127 [Ref. 3.10]. However, in comparing the operations data for commuter carrier with the data published by the NTSB for scheduled 135 air carriers and in conversations with the FAA staff which prepares the General Aviation Activity and Avionics Survey, it was discovered that no 14 CFR 125 operators and those operators that were known to be scheduled 14 CFR 135 operators were not included in the survey. Despite a conscious effort to exclude these operators, some scheduled 14 CFR 135 operators (commuter air carriers) were included in the survey along with all nonscheduled 14 CFR 135 operators (air taxis).

To determine the general aviation operations consistent with the NTSB definition for general aviation, it is necessary to subtract the scheduled 14 CFR 135 operations (commuter carriers) and the nonscheduled 14 CFR 135 operations (air taxis) from the total operations given by the General Aviation Activity and Avionics Survey. This can be accomplished very readily for hours flown and nautical miles flown since the General Aviation Activity and Avionics Survey lists these numbers separately under total, commuter and air taxi. Determining the number of flights (or landings) for strictly general aviation is another matter. The General Aviation Activity and Avionics Survey gives numbers only on the total number of landings. No breakdown by commuter or air taxi or any other primary use is provided. An estimate of the number of commuter and air taxi flights must be made in order to continue the development of the general aviation accident rate by flight phase.

The number of commuter and air taxi flights can be estimated by two methods. One is to base the estimated number of flights on the number of primary use hours flown divided by the average trip time for that particular subcategory of aircraft. The other method is to base the estimated number of flights on the number of primary use nautical miles flown divided by the average trip length for that particular subcategory of aircraft. Both methods were used and two estimates in the number of commuter and air taxi flights were calculated. The reason for the difference in two estimates is due to rounding in the various factors used to estimate the number of flights.

Tables 3.16 to 3.26 taken from the FAA General Aviation Activity and Avionics Survey [Ref. 3.1 to 3.8] presents the following information by years for the years 1986 to 1993:

1. Population (from Ref. Table 2.1),
2. Number active (from Ref. Table 2.1),
3. Total hours flown (from Ref. Table 2.1),
   - 3a. Commuter hours flown (scheduled 14 CFR 135) hours flown (from Ref. Table 3.2),
   - 3b. Air taxi hours flown (nonscheduled 14 CFR 135) hours flown (from Ref. Table 3.2),
   - 3c. Total day hours flown (from Ref. Table 4.1),
   - 3d. Total night hours flown (from Ref. Table 4.1),
   - 3e. Visual Meteorological Conditions (VMC) day hours flown (from Ref. Table 4.2),
   - 3f. Visual Meteorological Conditions (VMC) night hours flown (from Ref. Table 4.2),
   - 3g. Total Visual Meteorological Conditions (VMC) hours flown (from Ref. Table 4.2),
   - 3h. Instrument Meteorological Conditions (IMC) day hours flown (from Ref. Table 4.3),
   - 3i. Instrument Meteorological Conditions (IMC) night hours flown (from Ref. Table 4.3),
   - 3j. Total Instrument Meteorological Conditions (IMC) hours flown (from Ref. Table 4.3),
4. General aviation hours flown = 3. total hours-3a. commuter hours-3b. air taxi hours
5. Total landings (from Ref. Table 2.5)
   - 5a. Local landings (from Ref. Table 2.6),
   - 5b. Cross country landings (from Ref. Table 2.7),
6. Estimated flights (based on primary use hours/average trip time),
   - 6a. Commuter flights (determined from 3a. commuter hours flown/13. average trip time),
   - 6b. Air taxi flights (determined from 3b. air taxi hours flown/13. average trip time),
7. Estimated flights (based on primary use nautical miles/average trip length)
   - 7a. Commuter flights (determined from 9a. commuter nautical miles flown/12. average trip length),

7b. Air taxi flights (determined from 9b. air taxi nautical miles flown/12. average trip length),

8. General aviation flights,

8a. Based on hours/average trip time (determined from 5. total landings-6a. commuter flights-6b. air taxi flights),

8b. Based on nautical miles/average trip length (determined from 5. total landings -7a commuter flights-7b. air taxi flights),

9. Total nautical miles flown (from Ref. Table 3.3),

9a. Commuter nautical miles flown (from Ref. Table 3.3),

9b. Air taxi nautical miles flown (from Ref. Table 3.3),

10. General aviation nautical miles flown = 9. total nmiles-9a. commuter nmiles-9b. air taxi nmiles,

11. Average speed (nmiles/hour) (determined from 9. total nmiles flown/5. total landings),

12. Average trip length (nmiles/hour) (determined from 9. total nmiles flown/3. total hours flown),

13. Average trip time (hours/landing) (determined from 3. total hours flown/5. total landings),

14. Average commuter speed (nmiles/hour) (determined from 9a. commuter nautical miles flown/3a. commuter hours flown),

15. Average air taxi speed (nmiles/hour) (determined from 9b. air taxi nautical miles flown/3b. air taxi hours flown),

16. General aviation average speed (nmiles/hour) (determined from 10. general aviation nautical miles flown/4. general aviation hours flown).

The tables listed below gives the general aviation subcategories for which the general aviation operations table were created:

Table 3.16	Single-engine reciprocating (piston), fixed wing,
Table 3.17	Multiple-engine reciprocating (piston), fixed wing,
Table 3.18	Turboprop, fixed wing,
Table 3.19	Turbojet, fixed wing,
Table 3.20	Total fixed wing (summation of Tables 3.16 to 3.19),
Table 3.21	Reciprocating engine (piston), rotary wing,
Table 3.22	Turbine engine, rotary wing,
Table 3.23	Total rotary wing (summation of Tables 3.21 and 3.22),
Table 3.24	Total powered aircraft (summation of Tables 3.16 to 3.19, and 3.21 to 3.22),
Table 3.25	Other aircraft (includes gliders and balloons),
Table 3.26	Total aircraft (summation of Tables 3.16 to 3.19, 3.21 to 3.22, and 3.25),

For consistency with the accident data of Section 3.2, general aviation operations data were added and summarized for the 1986 to 1993 time period. General aviation operations data tabulated by the FAA prior to 1986 are not as complete as operations data tabulated from 1986 onwards. Important information such as the estimated number of total landings were not tabulated prior to 1985. Prior to 1983, the estimated number of general aviation nautical miles flown were not tabulated. General aviation operations data were found only as far back as 1977 and could be added to Tables 3.16 to 3.26 if it becomes necessary to extend these tables backwards in time further. However, the utility of this exercise would be limited because of the incompleteness of the data. Therefore the decision was made to consider only the 1986 to 1993 time period for general aviation operations.

Table 3.27 summarizes the general aviation operations by aircraft subcategories for 1986-1993 and is based on the information developed in Tables 3.16 through 3.26.

Table 3.16
General Aviation Operations
Single-Engine Reciprocating, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	208,605	209,295	202,913	208,082	207,384	206,371	192,420	193,135	
No. Active (2.1)	171,777	171,035	164,760	170,370	165,073	154,102	143,580	139,304	
Total Hours Flown (2.1)	21,938,642	22,140,926	21,946,454	22,306,870	23,696,582	20,528,898	18,074,428	17,074,194	
Commuter Hrs. (3.2)	294,599	288,040	67,106	86,055	242,447	118,973	113,563	0	
Air Taxi Hrs. (3.2)	708,644	590,922	709,953	707,069	368,340	541,826	464,447	377,368	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	20,935,399	21,261,964	21,169,395	21,513,746	23,085,795	19,868,099	17,496,418	16,696,826	
Total Day Hours Flown (4.1)	19,560,278	19,716,454	19,701,670	19,406,490	20,528,366	12,206,819	16,144,922	15,000,116	
Total Night Hours Flown (4.1)	1,960,101	2,051,813	2,131,828	2,763,525	2,973,917	1,452,960	1,929,506	3,010,695	
VMC Day Hours Flown (4.2)	18,312,246	18,672,258	18,545,108	18,280,300	19,322,588	11,732,973	15,441,143	14,230,163	
VMC Night Hours Flown (4.2)	1,625,145	1,708,727	1,806,772	2,384,284	2,596,552	1,347,864	1,779,197	1,764,789	
Total VMC Hours Flown (4.2)	19,937,391	20,380,985	20,351,880	20,664,584	21,919,140	13,080,837	17,220,340	15,994,952	
IMC Day Hours Flown (4.3)	1,251,111	1,042,742	1,153,862	1,122,622	1,203,108	478,833	703,779	769,955	
IMC Night Hours Flown (4.3)	337,111	342,849	323,200	382,574	373,057	105,446	150,309	1,292,238	
Total IMC Hours Flown (4.3)	1,588,222	1,385,591	1,477,062	1,505,196	1,576,165	584,279	854,088	2,062,193	
Total Landings (2.5)	32,427,255	33,664,442	34,362,721	34,070,471	37,914,218	33,935,464	29,052,448	24,068,971	
Local Landings (2.6)	23,114,102	24,342,136	25,171,113	24,634,231	28,745,999	24,976,273	21,168,229	17,163,561	
Cross Country Landings (2.7)	9,266,973	9,266,726	9,148,458	9,404,824	9,131,370	8,946,030	7,879,566	6,882,758	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	435,443	437,954	105,071	131,436	387,912	196,669	182,539	0	
Air Taxi Flights	1,047,439	898,475	1,111,611	1,079,944	589,339	895,670	746,542	531,964	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	453,757	463,783	115,820	134,112	428,032	199,813	252,610	0	
Air Taxi Flights	1,039,913	946,676	1,146,194	1,113,830	636,329	907,118	839,986	466,789	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	30,944,373	32,328,013	33,146,039	32,859,090	36,936,967	32,843,125	28,123,367	23,537,007	
Based on nmiles/avg. trip length	30,933,585	32,253,983	33,100,707	32,822,530	36,849,858	32,828,533	27,959,852	23,602,182	
Total Nautical Miles Flown (3.3)	2,152,352,000	2,164,970,000	2,158,429,000	2,284,631,000	2,297,273,000	2,413,032,000	1,784,714,000	1,659,552,000	
Commuter Nmiles (3.3)	30,118,000	29,826,000	7,275,000	8,993,000	25,935,000	14,208,000	15,518,000	0	
Air Taxi Nmiles (3.3)	69,024,000	60,881,000	71,996,000	74,689,000	38,556,000	64,502,000	51,601,000	32,185,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	2,053,210,000	2,074,263,000	2,079,158,000	2,200,949,000	2,232,782,000	2,334,322,000	1,717,595,000	1,627,367,000	
Average Speed (nmiles/hour)	98.11	97.78	98.35	102.42	96.95	117.54	98.74	97.20	
Average Trip Length (nmiles/landing)	66.37	64.31	62.81	67.06	60.59	71.11	61.43	68.95	
Average Trip Time (hour/landing)	0.68	0.66	0.64	0.65	0.63	0.60	0.62	0.71	
Average Commuter Speed (nmiles/hour	102.23	103.55	108.41	104.50	106.97	119.42	136.65	N.A.	
Average Air Taxi Speed (nmiles/hour)	97.40	103.03	101.41	105.63	104.68	119.05	111.10	85.29	
GA Average Speed (nmiles/hour)	98.07	97.56	98.22	102.30	96.72	117.49	98.17	97.47	

N.A. = Not Applicable

Table 3.16 (Continued)
General Aviation Operations
Single-Engine Reciprocating, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Fixed Wing	Pct. of Tot. Aircraft
Population (2.1)		203,526	84.59%	78.05%
No. Active (2.1)		160,000	83.70%	78.13%
Total Hours Flown (2.1)	167,706,994	20,963,374	73.29%	66.52%
Commuter Hrs. (3.2)	1,210,783	151,348		
Air Taxi Hrs. (3.2)	4,468,569	558,571		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	162,027,642	20,253,455	78.70%	72.56%
Total Day Hours Flown (4.1)	142,265,115	17,783,139	77.06%	70.52%
Total Night Hours Flown (4.1)	18,274,345	2,284,293	55.33%	51.82%
VMC Day Hours Flown (4.2)	134,536,779	16,817,097	81.01%	73.56%
VMC Night Hours Flown (4.2)	15,013,330	1,876,666	64.66%	59.12%
Total VMC Hours Flown (4.2)	149,550,109	18,693,764	79.01%	71.80%
IMC Day Hours Flown (4.3)	7,726,012	965,752	41.62%	41.46%
IMC Night Hours Flown (4.3)	3,306,784	413,348	33.55%	33.35%
Total IMC Hours Flown (4.3)	11,032,796	1,379,100	38.82%	38.64%
Total Landings (2.5)	259,495,990	32,436,999	81.22%	70.44%
Local Landings (2.6)	189,315,644	23,664,456	92.46%	81.06%
Cross Country Landings (2.7)	69,926,705	8,740,838	61.06%	54.93%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	1,877,025	234,628		
Air Taxi Flights	6,900,984	862,623		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	2,047,925	255,991		
Air Taxi Flights	7,096,834	887,104		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	250,717,981	31,339,748		
Based on nmiles/avg. trip length	250,351,231	31,293,904		
Total Nautical Miles Flown (3.3)	16,914,953,000	2,114,369,125	57.31%	54.50%
Commuter Nmiles (3.3)	131,873,000	16,484,125		
Air Taxi Nmiles (3.3)	463,434,000	57,929,250		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	16,319,646,000	2,039,955,750	63.63%	60.67%
Average Speed (nmiles/hour)	100.86	100.89		
Average Trip Length (nmiles/landing)	65.18	65.33		
Average Trip Time (hour/landing)	0.65	0.65		
Average Commuter Speed (nmiles/hour	108.92	111.68		
Average Air Taxi Speed (nmiles/hour)	103.71	103.45		
GA Average Speed (nmiles/hour)	100.72	100.75		

Table 3.17
General Aviation Operations
Multi-Engine Reciprocating, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	28,645	27,679	26,498	26,722	26,674	26,095	23,298	22,134	
No. Active (2.1)	23,869	23,419	22,797	23,445	22,700	21,246	18,536	16,565	
Total Hours Flown (2.1)	4,922,215	4,898,421	4,279,602	4,664,601	4,276,233	3,561,730	3,176,476	2,525,537	
Commuter Hrs. (3.2)	425,119	572,401	268,807	332,564	220,018	127,333	293,027	0	
Air Taxi Hrs. (3.2)	999,243	943,264	1,009,393	1,051,176	1,010,269	582,037	576,472	483,273	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	3,497,853	3,382,756	3,001,402	3,280,861	3,045,946	2,852,360	2,306,977	2,042,264	
Total Day Hours Flown (4.1)	3,802,384	3,688,649	3,440,545	3,452,765	3,087,215	1,504,413	2,550,141	1,472,874	
Total Night Hours Flown (4.1)	1,076,946	957,365	853,327	1,164,902	1,130,368	362,107	626,335	926,635	
VMC Day Hours Flown (4.2)	2,972,293	2,937,703	2,794,605	2,782,354	2,472,211	1,203,372	2,088,109	1,111,936	
VMC Night Hours Flown (4.2)	671,192	602,320	537,536	753,503	758,087	236,234	458,402	356,671	
Total VMC Hours Flown (4.2)	3,643,485	3,540,023	3,332,141	3,535,857	3,230,298	1,439,606	2,546,511	1,468,607	
IMC Day Hours Flown (4.3)	834,699	743,443	642,513	665,553	614,842	302,229	462,032	360,938	
IMC Night Hours Flown (4.3)	410,328	349,289	316,823	411,380	371,785	123,086	167,933	569,964	
Total IMC Hours Flown (4.3)	1,245,027	1,092,732	959,336	1,076,933	986,627	425,315	629,965	930,902	
Total Landings (2.5)	5,287,776	3,768,708	3,990,514	4,736,298	4,094,349	3,561,076	3,090,811	2,338,243	
Local Landings (2.6)	1,736,977	1,125,457	1,229,611	1,562,348	1,407,703	1,378,897	1,010,598	766,344	
Cross Country Landings (2.7)	3,558,962	2,633,282	2,755,256	3,177,093	2,669,158	2,174,064	2,066,577	1,565,341	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	456,692	440,389	250,649	337,676	210,660	127,310	285,124	0	
Air Taxi Flights	1,073,454	725,721	941,208	1,067,333	967,299	581,930	560,925	447,433	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	461,228	456,169	258,951	370,147	237,081	125,021	295,102	0	
Air Taxi Flights	1,137,267	735,136	959,459	1,129,482	1,016,818	611,083	613,296	370,802	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	3,757,630	2,602,598	2,798,657	3,331,289	2,916,391	2,851,836	2,244,761	1,890,810	
Based on nmiles/avg. trip length	3,689,282	2,577,403	2,772,104	3,236,670	2,840,450	2,824,972	2,182,413	1,967,441	
Total Nautical Miles Flown (3.3)	712,362,000	721,110,000	628,062,000	701,948,000	622,215,000	506,927,000	459,220,000	341,383,000	
Commuter Nmiles (3.3)	62,136,000	87,284,000	40,756,000	54,858,000	36,029,000	17,797,000	43,845,000	0	
Air Taxi Nmiles (3.3)	153,211,000	140,662,000	151,008,000	167,396,000	154,525,000	86,989,000	91,121,000	54,137,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	497,015,000	493,164,000	436,298,000	479,694,000	431,661,000	402,141,000	324,254,000	287,246,000	
Average Speed (nmiles/hour)	144.72	147.21	146.76	150.48	145.51	142.33	144.57	135.17	
Average Trip Length (nmiles/landing)	134.72	191.34	157.39	148.21	151.97	142.35	148.58	146.00	
Average Trip Time (hour/landing)	0.93	1.30	1.07	0.98	1.04	1.00	1.03	1.08	
Average Commuter Speed (nmiles/hour	146.16	152.49	151.62	164.95	163.75	139.77	149.63	N.A.	
Average Air Taxi Speed (nmiles/hour)	153.33	149.12	149.60	159.25	152.95	149.46	158.07	112.02	
GA Average Speed (nmiles/hour)	142.09	145.79	145.36	146.21	141.72	140.99	140.55	140.65	

N.A. = Not Applicable

Table 3.17 (Continued)
General Aviation Operations
Multi-Engine Reciprocating, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Fixed Wing	Pct. of Tot. Aircraft
Population (2.1)		25,968	10.79%	9.96%
No. Active (2.1)		21,572	11.28%	10.53%
Total Hours Flown (2.1)	32,304,815	4,038,102	14.12%	12.81%
Commuter Hrs. (3.2)	2,239,269	279,909		
Air Taxi Hrs. (3.2)	6,655,127	831,891		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	23,410,419	2,926,302	11.37%	10.48%
Total Day Hours Flown (4.1)	22,998,986	2,874,873	12.46%	11.40%
Total Night Hours Flown (4.1)	7,097,985	887,248	21.49%	20.13%
VMC Day Hours Flown (4.2)	18,362,583	2,295,323	11.06%	10.04%
VMC Night Hours Flown (4.2)	4,373,945	546,743	18.84%	17.23%
Total VMC Hours Flown (4.2)	22,736,528	2,842,066	12.01%	10.92%
IMC Day Hours Flown (4.3)	4,626,249	578,281	24.92%	24.83%
IMC Night Hours Flown (4.3)	2,720,588	340,074	27.60%	27.44%
Total IMC Hours Flown (4.3)	7,346,837	918,355	25.85%	25.73%
Total Landings (2.5)	30,867,775	3,858,472	9.66%	8.38%
Local Landings (2.6)	10,217,935	1,277,242	4.99%	4.38%
Cross Country Landings (2.7)	20,599,733	2,574,967	17.99%	16.18%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	2,108,499	263,562		
Air Taxi Flights	6,365,304	795,663		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	2,203,698	275,462		
Air Taxi Flights	6,573,342	821,668		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	22,393,971	2,799,246		
Based on nmiles/avg. trip length	22,090,735	2,761,342		
Total Nautical Miles Flown (3.3)	4,693,227,000	586,653,375	15.90%	15.12%
Commuter Nmiles (3.3)	342,705,000	42,838,125		
Air Taxi Nmiles (3.3)	999,049,000	124,881,125		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	3,351,473,000	418,934,125	13.07%	12.46%
Average Speed (nmiles/hour)	145.28	144.59		
Average Trip Length (nmiles/landing)	152.04	152.57		
Average Trip Time (hour/landing)	1.05	1.06		
Average Commuter Speed (nmiles/hour	153.04	152.62		
Average Air Taxi Speed (nmiles/hour)	150.12	147.97		
GA Average Speed (nmiles/hour)	143.16	142.92		

Table 3.18
General Aviation Operations
Turboprop, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	6,632	5,871	5,783	6,876	6,411	6,279	6,072	5,988	
No. Active (2.1)	5,964	5,274	5,259	6,324	5,652	4,920	4,704	4,450	
Total Hours Flown (2.1)	2,881,538	2,177,061	2,369,947	3,131,961	2,521,281	1,512,668	1,477,709	1,232,450	
Commuter Hrs. (3.2)	1,332,308	488,415	647,906	1,061,206	887,897	310,559	260,319	0	
Air Taxi Hrs. (3.2)	203,967	281,419	306,331	296,808	305,458	272,018	199,954	200,089	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	1,345,263	1,407,227	1,415,710	1,773,947	1,327,926	930,091	1,017,436	1,032,361	
Total Day Hours Flown (4.1)	2,094,417	1,603,608	1,741,087	2,104,888	1,776,603	727,139	1,169,086	386,437	
Total Night Hours Flown (4.1)	693,101	484,619	671,376	946,522	687,500	268,549	308,623	497,763	
VMC Day Hours Flown (4.2)	1,235,962	1,110,557	1,368,623	1,516,658	1,210,805	533,764	892,193	219,758	
VMC Night Hours Flown (4.2)	286,953	255,935	429,652	559,103	393,212	160,006	183,617	129,518	
Total VMC Hours Flown (4.2)	1,522,915	1,366,492	1,798,275	2,075,761	1,604,017	693,770	1,075,810	349,276	
IMC Day Hours Flown (4.3)	859,883	494,213	374,547	589,747	579,791	195,151	276,893	166,680	
IMC Night Hours Flown (4.3)	405,092	228,889	242,367	388,205	298,200	108,984	125,006	368,244	
Total IMC Hours Flown (4.3)	1,264,975	723,102	616,914	977,952	877,991	304,135	401,899	534,924	
Total Landings (2.5)	3,074,229	2,490,601	2,417,659	3,863,795	2,904,657	2,033,602	1,743,365	1,307,109	
Local Landings (2.6)	608,250	533,688	310,552	700,860	743,809	608,507	558,064	335,975	
Cross Country Landings (2.7)	2,507,347	1,965,041	2,100,909	3,155,838	2,175,570	1,408,911	1,207,006	976,700	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	1,421,401	558,756	660,950	1,309,174	1,022,907	417,510	307,118	0	
Air Taxi Flights	217,606	321,949	312,498	366,162	351,905	365,696	235,901	212,210	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	1,414,358	557,773	663,598	1,351,273	1,051,242	427,781	357,458	0	
Air Taxi Flights	228,354	328,684	337,870	380,423	358,429	393,197	272,485	147,905	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	1,435,222	1,609,896	1,444,211	2,188,459	1,529,845	1,250,397	1,200,346	1,094,899	
Based on nmiles/avg. trip length	1,431,517	1,604,144	1,416,192	2,132,099	1,494,987	1,212,624	1,113,423	1,159,204	
Total Nautical Miles Flown (3.3)	550,215,000	406,624,000	457,579,000	593,875,000	493,971,000	289,827,000	280,381,000	194,893,000	
Commuter Nmiles (3.3)	253,137,000	91,064,000	125,596,000	207,694,000	178,776,000	60,967,000	57,489,000	0	
Air Taxi Nmiles (3.3)	40,870,000	53,662,000	63,947,000	58,472,000	60,955,000	56,038,000	43,823,000	22,053,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	256,208,000	261,898,000	268,036,000	327,709,000	254,240,000	172,822,000	179,069,000	172,840,000	
Average Speed (nmiles/hour)	190.94	186.78	193.08	189.62	195.92	191.60	189.74	158.13	
Average Trip Length (nmiles/landing)	178.98	163.26	189.27	153.70	170.06	142.52	160.83	149.10	
Average Trip Time (hour/landing)	0.94	0.87	0.98	0.81	0.87	0.74	0.85	0.94	
Average Commuter Speed (nmiles/hour)	190.00	186.45	193.85	195.72	201.35	196.31	220.84	N.A.	
Average Air Taxi Speed (nmiles/hour)	200.38	190.68	208.75	197.00	199.55	206.01	219.17	110.22	
GA Average Speed (nmiles/hour)	190.45	186.11	189.33	184.73	191.46	185.81	176.00	167.42	

N.A. = Not Applicable

Table 3.18 (Continued)
General Aviation Operations
Turboprop, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Fixed Wing	Pct. of Tot. Aircraft
Population (2.1)		6,239	2.59%	2.39%
No. Active (2.1)		5,318	2.78%	2.60%
Total Hours Flown (2.1)	17,304,615	2,163,077	7.56%	6.86%
Commuter Hrs. (3.2)	4,988,610	623,576		
Air Taxi Hrs. (3.2)	2,066,044	258,256		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	10,249,961	1,281,245	4.98%	4.59%
Total Day Hours Flown (4.1)	11,603,265	1,450,408	6.28%	5.75%
Total Night Hours Flown (4.1)	4,558,053	569,757	13.80%	12.93%
VMC Day Hours Flown (4.2)	8,088,320	1,011,040	4.87%	4.42%
VMC Night Hours Flown (4.2)	2,397,996	299,750	10.33%	9.44%
Total VMC Hours Flown (4.2)	10,486,316	1,310,790	5.54%	5.03%
IMC Day Hours Flown (4.3)	3,536,905	442,113	19.05%	18.98%
IMC Night Hours Flown (4.3)	2,164,987	270,623	21.96%	21.83%
Total IMC Hours Flown (4.3)	5,701,892	712,737	20.06%	19.97%
Total Landings (2.5)	19,835,017	2,479,377	6.21%	5.38%
Local Landings (2.6)	4,399,705	549,963	2.15%	1.88%
Cross Country Landings (2.7)	15,497,322	1,937,165	13.53%	12.17%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	5,697,816	712,227		
Air Taxi Flights	2,383,927	297,991		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	5,823,483	727,935		
Air Taxi Flights	2,447,345	305,918		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	11,753,275	1,469,159		
Based on nmiles/avg. trip length	11,564,189	1,445,524		
Total Nautical Miles Flown (3.3)	3,267,365,000	408,420,625	11.07%	10.53%
Commuter Nmiles (3.3)	974,723,000	121,840,375		
Air Taxi Nmiles (3.3)	399,820,000	49,977,500		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	1,892,822,000	236,602,750	7.38%	7.04%
Average Speed (nmiles/hour)	188.81	186.98		
Average Trip Length (nmiles/landing)	164.73	163.46		
Average Trip Time (hour/landing)	0.87	0.88		
Average Commuter Speed (nmiles/hour	195.39	197.79		
Average Air Taxi Speed (nmiles/hour)	193.52	191.47		
GA Average Speed (nmiles/hour)	184.67	183.91		

Table 3.19
General Aviation Operations
Turbojet, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	4,961	4,789	4,555	4,736	4,891	5,041	4,866	5,062	
No. Active (2.1)	4,480	4,338	4,187	4,402	4,374	4,353	4,022	4,068	
Total Hours Flown (2.1)	1,654,308	1,527,760	1,677,752	1,654,096	1,511,560	1,236,283	1,072,292	1,178,873	
Commuter Hrs. (3.2)	381	4,625	2,805	8,593	0	4,282	9,511	0	
Air Taxi Hrs. (3.2)	198,634	171,266	194,228	216,227	147,365	185,657	74,787	107,491	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	1,455,293	1,351,869	1,480,719	1,429,276	1,364,195	1,046,344	987,994	1,071,382	
Total Day Hours Flown (4.1)	1,276,996	1,138,852	1,227,229	1,168,399	1,085,973	726,577	838,941	297,320	
Total Night Hours Flown (4.1)	368,424	365,923	399,843	476,069	441,692	205,652	233,351	607,918	
VMC Day Hours Flown (4.2)	782,825	708,106	814,273	831,548	752,716	499,085	576,120	119,150	
VMC Night Hours Flown (4.2)	185,746	181,436	190,991	279,966	246,844	97,029	131,061	120,158	
Total VMC Hours Flown (4.2)	968,571	889,542	1,005,264	1,111,514	999,560	596,114	707,181	239,308	
IMC Day Hours Flown (4.3)	488,584	431,007	411,888	338,644	334,679	228,608	262,821	178,169	
IMC Night Hours Flown (4.3)	181,363	184,718	207,292	197,360	195,253	108,714	102,290	487,759	
Total IMC Hours Flown (4.3)	669,947	615,725	619,180	536,004	529,932	337,322	365,111	665,928	
Total Landings (2.5)	1,284,427	1,234,563	1,298,001	1,455,010	1,256,966	971,172	929,511	884,744	
Local Landings (2.6)	151,676	116,368	71,502	190,286	76,793	84,485	56,986	72,330	
Cross Country Landings (2.7)	1,130,769	1,115,781	1,225,081	1,269,027	1,182,918	885,844	874,324	814,790	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	296	3,737	2,170	7,559	0	3,364	8,245	0	
Air Taxi Flights	154,222	138,398	150,265	190,202	122,544	145,844	64,829	80,672	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	305	3,883	1,964	7,422	0	3,602	9,223	0	
Air Taxi Flights	156,949	143,155	154,223	186,815	126,670	151,771	70,285	94,185	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	1,129,909	1,092,428	1,145,565	1,257,249	1,134,422	821,964	856,438	804,072	
Based on nmiles/avg. trip length	1,127,173	1,087,525	1,141,814	1,260,772	1,130,296	815,799	850,003	790,559	
Total Nautical Miles Flown (3.3)	673,709,000	618,648,000	678,235,000	692,000,000	605,880,000	485,634,000	421,382,000	463,383,000	
Commuter Nmiles (3.3)	160,000	1,946,000	1,026,000	3,530,000	0	1,801,000	4,181,000	0	
Air Taxi Nmiles (3.3)	82,323,000	71,736,000	80,585,000	88,849,000	61,057,000	75,893,000	31,863,000	49,329,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	591,226,000	544,966,000	596,624,000	599,621,000	544,823,000	407,940,000	385,338,000	414,054,000	
Average Speed (nmiles/hour)	407.25	404.94	404.25	418.36	400.83	392.82	392.97	393.07	
Average Trip Length (nmiles/landing)	524.52	501.11	522.52	475.60	482.02	500.05	453.34	523.75	
Average Trip Time (hour/landing)	1.29	1.24	1.29	1.14	1.20	1.27	1.15	1.33	
Average Commuter Speed (nmiles/hour)	419.95	420.76	365.78	410.80	0.00	420.60	439.60	N.A.	
Average Air Taxi Speed (nmiles/hour)	414.45	418.86	414.90	410.91	414.32	408.78	426.05	458.91	
GA Average Speed (nmiles/hour)	406.26	403.12	402.93	419.53	399.37	389.87	390.02	386.47	

N.A. = Not Applicable

Table 3.19 (Continued)
General Aviation Operations
Turbojet, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Fixed Wing	Pct. of Tot. Aircraft
Population (2.1)		4,863	2.02%	1.86%
No. Active (2.1)		4,278	2.24%	2.09%
Total Hours Flown (2.1)	11,512,924	1,439,116	5.03%	4.57%
Commuter Hrs. (3.2)	30,197	3,775		
Air Taxi Hrs. (3.2)	1,295,655	161,957		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	10,187,072	1,273,384	4.95%	4.56%
Total Day Hours Flown (4.1)	7,760,287	970,036	4.20%	3.85%
Total Night Hours Flown (4.1)	3,098,872	387,359	9.38%	8.79%
VMC Day Hours Flown (4.2)	5,083,823	635,478	3.06%	2.78%
VMC Night Hours Flown (4.2)	1,433,231	179,154	6.17%	5.64%
Total VMC Hours Flown (4.2)	6,517,054	814,632	3.44%	3.13%
IMC Day Hours Flown (4.3)	2,674,400	334,300	14.41%	14.35%
IMC Night Hours Flown (4.3)	1,664,749	208,094	16.89%	16.79%
Total IMC Hours Flown (4.3)	4,339,149	542,394	15.27%	15.20%
Total Landings (2.5)	9,314,394	1,164,299	2.92%	2.53%
Local Landings (2.6)	820,426	102,553	0.40%	0.35%
Cross Country Landings (2.7)	8,498,534	1,062,317	7.42%	6.68%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	25,370	3,171		
Air Taxi Flights	1,046,977	130,872		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	26,399	3,300		
Air Taxi Flights	1,084,053	135,507		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	8,242,047	1,030,256		
Based on nmiles/avg. trip length	8,203,943	1,025,493		
Total Nautical Miles Flown (3.3)	4,638,871,000	579,858,875	15.72%	14.95%
Commuter Nmiles (3.3)	12,644,000	1,580,500		
Air Taxi Nmiles (3.3)	541,635,000	67,704,375		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	4,084,592,000	510,574,000	15.93%	15.19%
Average Speed (nmiles/hour)	402.93	401.81		
Average Trip Length (nmiles/landing)	498.03	497.86		
Average Trip Time (hour/landing)	1.24	1.24		
Average Commuter Speed (nmiles/hour	418.72	353.92		
Average Air Taxi Speed (nmiles/hour)	418.04	420.90		
GA Average Speed (nmiles/hour)	400.96	399.70		

Table 3.20
General Aviation Operations
Total, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	248,843	247,634	239,749	246,416	245,360	243,786	226,656	226,319	
No. Active (2.1)	206,090	204,066	197,003	204,541	197,799	184,621	170,842	164,387	
Total Hours Flown (2.1)	31,396,703	30,744,168	30,273,755	31,757,528	32,005,656	26,839,579	23,800,905	22,011,054	
Commuter Hrs. (3.2)	2,052,407	1,353,481	986,624	1,488,418	1,350,362	561,147	676,420	0	
Air Taxi Hrs. (3.2)	2,110,488	1,986,871	2,219,905	2,271,280	1,831,432	1,581,538	1,315,660	1,168,221	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	27,233,808	27,403,816	27,067,226	27,997,830	28,823,862	24,696,894	21,808,825	20,842,833	
Total Day Hours Flown (4.1)	26,734,075	26,147,563	26,110,531	26,132,542	26,478,157	15,164,948	20,703,090	17,156,747	
Total Night Hours Flown (4.1)	4,098,572	3,859,720	4,056,374	5,351,018	5,233,477	2,289,268	3,097,815	5,043,011	
VMC Day Hours Flown (4.2)	23,303,326	23,428,624	23,522,609	23,410,860	23,758,320	13,969,194	18,997,565	15,681,007	
VMC Night Hours Flown (4.2)	2,769,036	2,748,418	2,964,951	3,976,856	3,994,695	1,841,133	2,552,277	2,371,136	
Total VMC Hours Flown (4.2)	26,072,362	26,177,042	26,487,560	27,387,716	27,753,015	15,810,327	21,549,842	18,052,143	
IMC Day Hours Flown (4.3)	3,434,277	2,711,405	2,582,810	2,716,566	2,732,420	1,204,821	1,705,525	1,475,742	
IMC Night Hours Flown (4.3)	1,333,894	1,105,745	1,089,682	1,379,519	1,238,295	446,230	545,538	2,718,205	
Total IMC Hours Flown (4.3)	4,768,171	3,817,150	3,672,492	4,096,085	3,970,715	1,651,051	2,251,063	4,193,947	
Total Landings (2.5)	42,073,687	41,158,314	42,068,895	44,125,574	46,170,190	40,501,314	34,816,135	28,599,067	
Local Landings (2.6)	25,611,005	26,117,649	26,782,778	27,087,725	30,974,304	27,048,162	22,793,877	18,338,210	
Cross Country Landings (2.7)	16,464,051	14,980,830	15,229,704	17,006,782	15,159,016	13,414,849	12,027,473	10,239,589	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	2,750,363	1,811,953	1,371,029	2,068,086	1,947,983	846,779	989,472	0	
Air Taxi Flights	2,828,195	2,659,895	3,084,816	3,155,835	2,641,957	2,386,564	1,924,557	1,517,875	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	3,555,855	2,211,047	1,873,250	2,840,953	2,765,383	1,038,700	1,430,528	0	
Air Taxi Flights	3,554,589	3,440,330	3,942,027	4,021,755	3,619,477	3,106,268	2,581,434	1,696,062	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	36,495,129	36,686,466	37,613,051	38,901,653	41,580,250	37,267,971	31,902,106	27,081,192	
Based on nmiles/avg. trip length	34,963,242	35,506,937	36,253,617	37,262,866	39,785,330	36,356,347	30,804,173	26,903,005	
Total Nautical Miles Flown (3.3)	4,088,638,000	3,911,352,000	3,922,305,000	4,272,454,000	4,019,339,000	3,695,420,000	2,945,697,000	2,659,211,000	
Commuter Nmiles (3.3)	345,551,000	210,120,000	174,653,000	275,075,000	240,740,000	94,773,000	121,033,000	0	
Air Taxi Nmiles (3.3)	345,428,000	326,941,000	367,536,000	389,406,000	315,093,000	283,422,000	218,408,000	157,704,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	3,397,659,000	3,374,291,000	3,380,116,000	3,607,973,000	3,463,506,000	3,317,225,000	2,606,256,000	2,501,507,000	
Average Speed (nmiles/hour)	130.23	127.22	129.56	134.53	125.58	137.69	123.76	120.81	
Average Trip Length (nmiles/landing)	97.18	95.03	93.24	96.82	87.05	91.24	84.61	92.98	
Average Trip Time (hour/landing)	0.75	0.75	0.72	0.72	0.69	0.66	0.68	0.77	
Average Commuter Speed (nmiles/hour	168.36	155.24	177.02	184.81	178.28	168.89	178.93	N.A.	
Average Air Taxi Speed (nmiles/hour)	163.67	164.55	165.56	171.45	172.05	179.21	166.01	135.00	
GA Average Speed (nmiles/hour)	124.76	123.13	124.88	128.87	120.16	134.32	119.50	120.02	

N.A. = Not Applicable

Table 3.20 (Continued)
General Aviation Operations
Total, Fixed Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Fixed Wing	Pct. of Tot. Aircraft
Population (2.1)		240,595	100.00%	92.27%
No. Active (2.1)		191,169	100.00%	93.35%
Total Hours Flown (2.1)	228,829,348	28,603,669	100.00%	90.76%
Commuter Hrs. (3.2)	8,468,859	1,058,607		
Air Taxi Hrs. (3.2)	14,485,395	1,810,674		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	205,875,094	25,734,387	100.00%	92.20%
Total Day Hours Flown (4.1)	184,627,653	23,078,457	100.00%	91.52%
Total Night Hours Flown (4.1)	33,029,255	4,128,657	100.00%	93.66%
VMC Day Hours Flown (4.2)	166,071,505	20,758,938	100.00%	90.80%
VMC Night Hours Flown (4.2)	23,218,502	2,902,313	100.00%	91.44%
Total VMC Hours Flown (4.2)	189,290,007	23,661,251	100.00%	90.87%
IMC Day Hours Flown (4.3)	18,563,566	2,320,446	100.00%	99.62%
IMC Night Hours Flown (4.3)	9,857,108	1,232,139	100.00%	99.41%
Total IMC Hours Flown (4.3)	28,420,674	3,552,584	100.00%	99.55%
Total Landings (2.5)	319,513,176	39,939,147	100.00%	86.74%
Local Landings (2.6)	204,753,710	25,594,214	100.00%	87.67%
Cross Country Landings (2.7)	114,522,294	14,315,287	100.00%	89.96%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	11,785,665	1,473,208		
Air Taxi Flights	20,199,694	2,524,962		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	15,715,716	1,964,465		
Air Taxi Flights	25,961,942	3,245,243		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	287,527,817	35,940,977		
Based on nmiles/avg. trip length	277,835,518	34,729,440		
Total Nautical Miles Flown (3.3)	29,514,416,000	3,689,302,000	100.00%	95.09%
Commuter Nmiles (3.3)	1,461,945,000	182,743,125		
Air Taxi Nmiles (3.3)	2,403,938,000	300,492,250		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	25,648,533,000	3,206,066,625	100.00%	95.35%
Average Speed (nmiles/hour)	128.98	128.67		
Average Trip Length (nmiles/landing)	92.37	92.27		
Average Trip Time (hour/landing)	0.72	0.72		
Average Commuter Speed (nmiles/hour	172.63	173.08		
Average Air Taxi Speed (nmiles/hour)	165.96	164.69		
GA Average Speed (nmiles/hour)	124.58	124.45		

Table 3.21
General Aviation Operations
Reciprocating Engine, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	5,566	5,555	5,334	5,784	5,802	5,848	5,209	5,729	
No. Active (2.1)	2,921	2,813	2,584	3,244	3,459	2,470	2,211	2,497	
Total Hours Flown (2.1)	804,458	651,687	575,955	748,773	774,774	583,688	416,375	425,485	
Commuter Hrs. (3.2)	1,275	0	1,185	0	190	0	0	0	
Air Taxi Hrs. (3.2)	14,300	5,311	5,392	20,172	0	2,502	27,426	917	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	788,883	646,376	569,378	728,601	774,584	581,186	388,949	424,568	
Total Day Hours Flown (4.1)	641,145	586,072	494,242	N/A	642,194	433,246	360,264	334,668	
Total Night Hours Flown (4.1)	167,818	80,280	85,191	N/A	133,148	68,658	56,111	37,490	
VMC Day Hours Flown (4.2)	641,148	586,037	492,899	N/A	642,194	433,031	360,200	333,319	
VMC Night Hours Flown (4.2)	167,178	80,280	84,747	N/A	133,148	68,658	56,079	34,528	
Total VMC Hours Flown (4.2)	808,326	666,317	577,646	N/A	775,342	501,689	416,279	367,847	
IMC Day Hours Flown (4.3)	0	34	1,321	N/A	N/A	215	64	0	
IMC Night Hours Flown (4.3)	643	0	450	N/A	N/A	0	32	203	
Total IMC Hours Flown (4.3)	643	34	1,771	N/A	N/A	215	96	203	
Total Landings (2.5)	1,575,722	1,732,469	1,345,262	2,540,599	2,441,240	2,015,878	1,410,131	1,283,025	
Local Landings (2.6)	1,428,205	1,365,577	1,102,592	N/A	2,076,490	1,861,442	1,263,327	1,167,289	
Cross Country Landings (2.7)	158,061	367,024	235,980	N/A	355,030	149,109	148,994	122,200	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	2,497	0	2,768	0	599	0	0	0	
Air Taxi Flights	28,010	14,119	12,594	68,444	0	8,641	92,883	2,765	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	2,781	0	2,567	0	743	0	0	0	
Air Taxi Flights	28,618	20,167	13,212	68,629	0	9,437	101,097	6,066	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	1,545,215	1,718,350	1,329,900	2,472,155	2,440,641	2,007,237	1,317,248	1,280,260	
Based on nmiles/avg. trip length	1,544,323	1,712,302	1,329,484	2,471,970	2,440,497	2,006,441	1,309,034	1,276,959	
Total Nautical Miles Flown (3.3)	48,729,000	37,197,000	31,973,000	42,720,000	42,737,000	33,325,000	24,033,000	24,535,000	
Commuter Nmiles (3.3)	86,000	0	61,000	0	13,000	0	0	0	
Air Taxi Nmiles (3.3)	885,000	433,000	314,000	1,154,000	0	156,000	1,723,000	116,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	47,758,000	36,764,000	31,598,000	41,566,000	42,724,000	33,169,000	22,310,000	24,419,000	
Average Speed (nmiles/hour)	60.57	57.08	55.51	57.05	55.16	57.09	57.72	57.66	
Average Trip Length (nmiles/landing)	30.92	21.47	23.77	16.81	17.51	16.53	17.04	19.12	
Average Trip Time (hour/landing)	0.51	0.38	0.43	0.29	0.32	0.29	0.30	0.33	
Average Commuter Speed (nmiles/hour)	67.45	N.A.	51.48	N.A.	68.42	N.A.	N.A.	N.A.	
Average Air Taxi Speed (nmiles/hour)	61.89	81.53	58.23	57.21	0.00	62.35	62.82	126.50	
GA Average Speed (nmiles/hour)	60.54	56.88	55.50	57.05	55.16	57.07	57.36	57.51	

N/A = Information not available
N.A. = Not Applicable

Table 3.21 (Continued)
General Aviation Operations
Reciprocating Engine, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Tot. Aircraft
Population (2.1)		5,603	2.15%
No. Active (2.1)		2,775	1.35%
Total Hours Flown (2.1)	4,981,195	622,649	1.98%
Commuter Hrs. (3.2)	2,650	331	
Air Taxi Hrs. (3.2)	76,020	9,503	
GA Hrs. = Total Hrs.			
-Commuter Hrs.- Air Taxi Hrs.	4,902,525	612,816	2.20%
Total Day Hours Flown (4.1)	3,491,831	498,833	1.98%
Total Night Hours Flown (4.1)	628,696	89,814	2.04%
VMC Day Hours Flown (4.2)	3,488,828	498,404	2.18%
VMC Night Hours Flown (4.2)	624,618	89,231	2.81%
Total VMC Hours Flown (4.2)	4,113,446	587,635	2.26%
IMC Day Hours Flown (4.3)	1,634	272	0.01%
IMC Night Hours Flown (4.3)	1,328	221	0.02%
Total IMC Hours Flown (4.3)	2,962	494	0.01%
Total Landings (2.5)	14,344,326	1,793,041	3.89%
Local Landings (2.6)	10,264,922	1,466,417	5.02%
Cross Country Landings (2.7)	1,536,398	219,485	1.38%
Estimated Flights (hours/avg. trip time)			
Commuter Flights	5,864	733	
Air Taxi Flights	227,456	28,432	
Estimated Flights (nmiles/avg. trip length)			
Commuter Flights	6,090	761	
Air Taxi Flights	247,225	30,903	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.			
Based on hrs./avg. trip time	14,111,006	1,763,876	
Based on nmiles/avg. trip length	14,091,011	1,761,376	
Total Nautical Miles Flown (3.3)	285,249,000	35,656,125	0.92%
Commuter Nmiles (3.3)	160,000	20,000	
Air Taxi Nmiles (3.3)	4,781,000	597,625	
GA Nmiles = Total Nmiles			
-Commuter Nmiles -Air Taxi Nmiles	280,308,000	35,038,500	1.04%
Average Speed (nmiles/hour)	57.27	57.23	
Average Trip Length (nmiles/landing)	19.89	20.40	
Average Trip Time (hour/landing)	0.35	0.36	
Average Commuter Speed (nmiles/hour	60.38	62.45	
Average Air Taxi Speed (nmiles/hour)	62.89	63.82	
GA Average Speed (nmiles/hour)	57.18	57.13	

Table 3.22
General Aviation Operations
Turbine Engine, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	4,899	4,479	4,434	4,685	4,620	4,626	4,390	4,090	
No. Active (2.1)	4,022	3,520	3,822	4,232	3,938	3,822	3,541	2,948	
Total Hours Flown (2.1)	1,820,936	1,631,439	2,130,764	2,079,847	1,617,292	2,171,911	1,866,326	1,467,670	
Commuter Hrs. (3.2)	131,669	5,198	130,227	14,378	93,508	3,224	16,135	0	
Air Taxi Hrs. (3.2)	788,841	804,820	616,419	978,686	593,753	657,035	664,835	281,595	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	900,426	821,421	1,384,118	1,086,783	930,031	1,511,652	1,185,356	1,186,075	
Total Day Hours Flown (4.1)	1,577,446	1,462,698	1,887,467	N/A	1,401,958	1,228,993	1,609,221	989,474	
Total Night Hours Flown (4.1)	209,023	169,794	257,096	N/A	211,881	220,469	257,105	210,530	
VMC Day Hours Flown (4.2)	1,563,634	1,451,160	1,874,178	N/A	1,392,627	1,226,337	1,601,491	985,496	
VMC Night Hours Flown (4.2)	194,745	166,437	247,131	N/A	198,648	219,805	255,424	203,188	
Total VMC Hours Flown (4.2)	1,758,379	1,617,597	2,121,309	N/A	1,591,275	1,446,142	1,856,915	1,188,684	
IMC Day Hours Flown (4.3)	13,832	11,436	13,481	N/A	9,297	2,670	7,730	3,978	
IMC Night Hours Flown (4.3)	14,244	3,372	9,882	N/A	13,128	666	1,681	7,342	
Total IMC Hours Flown (4.3)	28,076	14,808	23,363	N/A	22,425	3,336	9,411	11,320	
Total Landings (2.5)	3,450,604	3,182,811	4,003,396	4,715,450	3,763,986	4,725,551	2,783,251	2,639,668	
Local Landings (2.6)	2,271,982	1,306,672	2,497,360	N/A	1,860,388	3,594,838	521,775	1,583,167	
Cross Country Landings (2.7)	1,202,266	1,842,805	1,504,849	N/A	1,853,186	1,131,195	2,309,526	1,058,663	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	249,508	10,141	244,678	32,598	217,625	7,015	24,062	0	
Air Taxi Flights	1,494,823	1,570,141	1,158,162	2,218,887	1,381,864	1,429,549	991,468	506,461	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	161,787	7,020	137,443	19,108	132,544	4,031	14,460	0	
Air Taxi Flights	948,372	1,094,081	650,226	1,289,680	781,728	754,589	578,210	457,374	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	1,706,273	1,602,529	2,600,557	2,463,965	2,164,497	3,288,988	1,767,721	2,133,207	
Based on nmiles/avg. trip length	2,340,444	2,081,710	3,215,727	3,406,663	2,849,714	3,966,930	2,190,581	2,182,294	
Total Nautical Miles Flown (3.3)	127,051,000	113,348,000	168,940,000	150,292,000	126,513,000	179,343,000	148,975,000	130,981,000	
Commuter Nmiles (3.3)	5,957,000	250,000	5,800,000	609,000	4,455,000	153,000	774,000	0	
Air Taxi Nmiles (3.3)	34,919,000	38,963,000	27,439,000	41,105,000	26,275,000	28,638,000	30,949,000	22,695,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	86,175,000	74,135,000	135,701,000	108,578,000	95,783,000	150,552,000	117,252,000	108,286,000	
Average Speed (nmiles/hour)	69.77	69.48	79.29	72.26	78.23	82.57	79.82	89.24	
Average Trip Length (nmiles/landing)	36.82	35.61	42.20	31.87	33.61	37.95	53.53	49.62	
Average Trip Time (hour/landing)	0.53	0.51	0.53	0.44	0.43	0.46	0.67	0.56	
Average Commuter Speed (nmiles/hour)	45.24	48.10	44.54	42.36	47.64	47.46	47.97	N.A.	
Average Air Taxi Speed (nmiles/hour)	44.27	48.41	44.51	42.00	44.25	43.59	46.55	80.59	
GA Average Speed (nmiles/hour)	95.70	90.25	98.04	99.91	102.99	99.59	98.92	91.30	

N/A = Information not available
N.A. = Not Applicable

Table 3.22 (Continued)
General Aviation Operations
Turbine Engine, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Tot. Aircraft
Population (2.1)		4,528	1.74%
No. Active (2.1)		3,731	1.82%
Total Hours Flown (2.1)	14,786,185	1,848,273	5.86%
Commuter Hrs. (3.2)	394,339	49,292	
Air Taxi Hrs. (3.2)	5,385,984	673,248	
GA Hrs. = Total Hrs.			
-Commuter Hrs.- Air Taxi Hrs.	9,005,862	1,125,733	4.03%
Total Day Hours Flown (4.1)	10,157,257	1,451,037	5.75%
Total Night Hours Flown (4.1)	1,535,898	219,414	4.98%
VMC Day Hours Flown (4.2)	10,094,923	1,442,132	6.31%
VMC Night Hours Flown (4.2)	1,485,378	212,197	6.69%
Total VMC Hours Flown (4.2)	11,580,301	1,654,329	6.35%
IMC Day Hours Flown (4.3)	62,424	8,918	0.38%
IMC Night Hours Flown (4.3)	50,315	7,188	0.58%
Total IMC Hours Flown (4.3)	112,739	16,106	0.45%
Total Landings (2.5)	29,264,717	3,658,090	7.94%
Local Landings (2.6)	13,636,182	1,948,026	6.67%
Cross Country Landings (2.7)	10,902,490	1,557,499	9.79%
Estimated Flights (hours/avg. trip time)			
Commuter Flights	785,626	98,203	
Air Taxi Flights	10,751,355	1,343,919	
Estimated Flights (nmiles/avg. trip length)			
Commuter Flights	476,394	59,549	
Air Taxi Flights	6,554,260	819,282	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.			
Based on hrs./avg. trip time	17,727,736	2,215,967	
Based on nmiles/avg. trip length	22,234,063	2,779,258	
Total Nautical Miles Flown (3.3)	1,145,443,000	143,180,375	3.69%
Commuter Nmiles (3.3)	17,998,000	2,249,750	
Air Taxi Nmiles (3.3)	250,983,000	31,372,875	
GA Nmiles = Total Nmiles			
-Commuter Nmiles -Air Taxi Nmiles	876,462,000	109,557,750	3.26%
Average Speed (nmiles/hour)	77.47	77.58	
Average Trip Length (nmiles/landing)	39.14	40.15	
Average Trip Time (hour/landing)	0.51	0.52	
Average Commuter Speed (nmiles/hour	45.64	46.19	
Average Air Taxi Speed (nmiles/hour)	46.60	49.27	
GA Average Speed (nmiles/hour)	97.32	97.09	

Table 3.23
General Aviation Operations
Total, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	10,465	10,034	9,768	10,469	10,422	10,474	9,599	9,819	
No. Active (2.1)	6,943	6,333	6,406	7,476	7,397	6,292	5,752	5,445	
Total Hours Flown (2.1)	2,625,394	2,283,126	2,706,719	2,828,620	2,392,066	2,755,599	2,282,701	1,893,155	
Commuter Hrs. (3.2)	132,944	5,198	131,412	14,378	93,698	3,224	16,135	0	
Air Taxi Hrs. (3.2)	803,141	810,131	621,811	998,858	593,753	659,537	692,261	282,512	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	1,689,309	1,467,797	1,953,496	1,815,384	1,704,615	2,092,838	1,574,305	1,610,643	
Total Day Hours Flown (4.1)	2,218,591	2,048,770	2,381,709	N/A	2,044,152	1,662,239	1,969,485	1,324,142	
Total Night Hours Flown (4.1)	376,841	250,074	342,287	N/A	345,029	289,127	313,216	248,020	
VMC Day Hours Flown (4.2)	2,204,782	2,037,197	2,367,077	N/A	2,034,821	1,659,368	1,961,691	1,318,815	
VMC Night Hours Flown (4.2)	361,923	246,717	331,878	N/A	331,796	288,463	311,503	237,716	
Total VMC Hours Flown (4.2)	2,566,705	2,283,914	2,698,955	N/A	2,366,617	1,947,831	2,273,194	1,556,531	
IMC Day Hours Flown (4.3)	13,832	11,470	14,802	N/A	9,297	2,885	7,794	3,978	
IMC Night Hours Flown (4.3)	14,887	3,372	10,332	N/A	13,128	666	1,713	7,545	
Total IMC Hours Flown (4.3)	28,719	14,842	25,134	N/A	22,425	3,551	9,507	11,523	
Total Landings (2.5)	5,026,326	4,915,280	5,348,658	7,256,049	6,205,226	6,741,429	4,193,382	3,922,693	
Local Landings (2.6)	3,700,187	2,672,249	3,599,952	N/A	3,936,878	5,456,280	1,785,102	2,750,456	
Cross Country Landings (2.7)	1,360,327	2,209,829	1,740,829	N/A	2,208,216	1,280,304	2,458,520	1,180,863	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	254,522	11,191	259,679	36,883	243,061	7,887	29,640	0	
Air Taxi Flights	1,537,616	1,744,109	1,228,740	2,562,296	1,540,247	1,613,523	1,271,702	585,376	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	172,796	8,162	156,030	22,895	163,811	4,850	18,760	0	
Air Taxi Flights	1,023,794	1,286,276	738,834	1,588,675	963,322	912,750	791,907	575,378	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	3,234,188	3,159,980	3,860,239	4,656,870	4,421,919	5,120,019	2,892,040	3,337,317	
Based on nmiles/avg. trip length	3,829,736	3,620,842	4,453,794	5,644,479	5,078,093	5,823,829	3,382,715	3,347,315	
Total Nautical Miles Flown (3.3)	175,780,000	150,545,000	200,913,000	193,012,000	169,250,000	212,668,000	173,008,000	155,516,000	
Commuter Nmiles (3.3)	6,043,000	250,000	5,861,000	609,000	4,468,000	153,000	774,000	0	
Air Taxi Nmiles (3.3)	35,804,000	39,396,000	27,753,000	42,259,000	26,275,000	28,794,000	32,672,000	22,811,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	133,933,000	110,899,000	167,299,000	150,144,000	138,507,000	183,721,000	139,562,000	132,705,000	
Average Speed (nmiles/hour)	66.95	65.94	74.23	68.24	70.75	77.18	75.79	82.15	
Average Trip Length (nmiles/landing)	34.97	30.63	37.56	26.60	27.28	31.55	41.26	39.65	
Average Trip Time (hour/landing)	0.52	0.46	0.51	0.39	0.39	0.41	0.54	0.48	
Average Commuter Speed (nmiles/hour	45.46	48.10	44.60	42.36	47.69	47.46	47.97	N.A.	
Average Air Taxi Speed (nmiles/hour)	44.58	48.63	44.63	42.31	44.25	43.66	47.20	80.74	
GA Average Speed (nmiles/hour)	79.28	75.55	85.64	82.71	81.25	87.79	88.65	82.39	

N/A = Information not available
N.A. = Not Applicable

Table 3.23 (Continued)
General Aviation Operations
Total, Rotary Wing
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Tot. Aircraft
Population (2.1)		10,131	3.89%
No. Active (2.1)		6,506	3.18%
Total Hours Flown (2.1)	19,767,380	2,470,923	7.84%
Commuter Hrs. (3.2)	396,989	49,624	
Air Taxi Hrs. (3.2)	5,462,004	682,751	
GA Hrs. = Total Hrs.			
-Commuter Hrs.- Air Taxi Hrs.	13,908,387	1,738,548	6.23%
Total Day Hours Flown (4.1)	13,649,088	1,949,870	7.73%
Total Night Hours Flown (4.1)	2,164,594	309,228	7.01%
VMC Day Hours Flown (4.2)	13,583,751	1,940,536	8.49%
VMC Night Hours Flown (4.2)	2,109,996	301,428	9.50%
Total VMC Hours Flown (4.2)	15,693,747	2,241,964	8.61%
IMC Day Hours Flown (4.3)	64,058	9,151	0.39%
IMC Night Hours Flown (4.3)	51,643	7,378	0.60%
Total IMC Hours Flown (4.3)	115,701	16,529	0.46%
Total Landings (2.5)	43,609,043	5,451,130	11.84%
Local Landings (2.6)	23,901,104	3,414,443	11.70%
Cross Country Landings (2.7)	12,438,888	1,776,984	11.17%
Estimated Flights (hours/avg. trip time)			
Commuter Flights	842,863	105,358	
Air Taxi Flights	12,083,609	1,510,451	
Estimated Flights (nmiles/avg. trip length)			
Commuter Flights	547,304	68,413	
Air Taxi Flights	7,880,936	985,117	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.			
Based on hrs./avg. trip time	30,682,571	3,835,321	
Based on nmiles/avg. trip length	35,180,802	4,397,600	
Total Nautical Miles Flown (3.3)	1,430,692,000	178,836,500	4.61%
Commuter Nmiles (3.3)	18,158,000	2,269,750	
Air Taxi Nmiles (3.3)	255,764,000	31,970,500	
GA Nmiles = Total Nmiles			
-Commuter Nmiles -Air Taxi Nmiles	1,156,770,000	144,596,250	4.30%
Average Speed (nmiles/hour)	72.38	72.65	
Average Trip Length (nmiles/landing)	32.81	33.69	
Average Trip Time (hour/landing)	0.45	0.46	
Average Commuter Speed (nmiles/hour	45.74	46.23	
Average Air Taxi Speed (nmiles/hour)	46.83	49.50	
GA Average Speed (nmiles/hour)	83.17	82.91	

Table 3.24
General Aviation Operations
Total Powered Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	259,308	257,668	249,517	256,885	255,782	254,260	236,255	236,138	
No. Active (2.1)	213,033	210,399	203,409	212,017	205,196	190,913	176,594	169,832	
Total Hours Flown (2.1)	34,022,097	33,027,294	32,980,474	34,586,148	34,397,722	29,595,178	26,083,606	23,904,209	
Commuter Hrs. (3.2)	2,185,351	1,358,679	1,118,036	1,502,796	1,444,060	564,371	692,555	0	
Air Taxi Hrs. (3.2)	2,913,629	2,797,002	2,841,716	3,270,138	2,425,185	2,241,075	2,007,921	1,450,733	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	28,923,117	28,871,613	29,020,722	29,813,214	30,528,477	26,789,732	23,383,130	22,453,476	
Total Day Hours Flown (4.1)	28,952,666	28,196,333	28,492,240	26,132,542	28,522,309	16,827,187	22,672,575	18,480,889	
Total Night Hours Flown (4.1)	4,475,413	4,109,794	4,398,661	5,351,018	5,578,506	2,578,395	3,411,031	5,291,031	
VMC Day Hours Flown (4.2)	25,508,108	25,465,821	25,889,686	23,410,860	25,793,141	15,628,562	20,959,256	16,999,822	
VMC Night Hours Flown (4.2)	3,130,959	2,995,135	3,296,829	3,976,856	4,326,491	2,129,596	2,863,780	2,608,852	
Total VMC Hours Flown (4.2)	28,639,067	28,460,956	29,186,515	27,387,716	30,119,632	17,758,158	23,823,036	19,608,674	
IMC Day Hours Flown (4.3)	3,448,109	2,722,875	2,597,612	2,716,566	2,741,717	1,207,706	1,713,319	1,479,720	
IMC Night Hours Flown (4.3)	1,348,781	1,109,117	1,100,014	1,379,519	1,251,423	446,896	547,251	2,725,750	
Total IMC Hours Flown (4.3)	4,796,890	3,831,992	3,697,626	4,096,085	3,993,140	1,654,602	2,260,570	4,205,470	
Total Landings (2.5)	47,100,013	46,073,594	47,417,553	51,381,623	52,375,416	47,242,743	39,009,517	32,521,760	
Local Landings (2.6)	29,311,192	28,789,898	30,382,730	27,087,725	34,911,182	32,504,442	24,578,979	21,088,666	
Cross Country Landings (2.7)	17,824,378	17,190,659	16,970,533	17,006,782	17,367,232	14,695,153	14,485,993	11,420,452	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	3,025,388	1,895,379	1,607,452	2,232,573	2,198,786	900,905	1,035,755	0	
Air Taxi Flights	4,033,613	3,901,862	4,085,667	4,858,159	3,692,689	3,577,425	3,002,960	1,973,727	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	3,883,316	2,386,201	2,075,935	3,172,142	3,066,157	1,147,509	1,523,591	0	
Air Taxi Flights	4,210,664	4,155,315	4,545,876	4,966,928	4,268,571	3,774,209	3,140,569	2,085,696	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	40,041,012	40,276,354	41,724,434	44,290,891	46,483,941	42,764,413	34,970,801	30,548,033	
Based on nmiles/avg. trip length	39,006,033	39,532,078	40,795,742	43,242,553	45,040,688	42,321,026	34,345,356	30,436,064	
Total Nautical Miles Flown (3.3)	4,264,418,000	4,061,897,000	4,123,218,000	4,465,466,000	4,188,589,000	3,908,088,000	3,118,705,000	2,814,727,000	
Commuter Nmiles (3.3)	351,594,000	210,370,000	180,514,000	275,684,000	245,208,000	94,926,000	121,807,000	0	
Air Taxi Nmiles (3.3)	381,232,000	366,337,000	395,289,000	431,665,000	341,368,000	312,216,000	251,080,000	180,515,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	3,531,592,000	3,485,190,000	3,547,415,000	3,758,117,000	3,602,013,000	3,500,946,000	2,745,818,000	2,634,212,000	
Average Speed (nmiles/hour)	125.34	122.99	125.02	129.11	121.77	132.05	119.57	117.75	
Average Trip Length (nmiles/landing)	90.54	88.16	86.96	86.91	79.97	82.72	79.95	86.55	
Average Trip Time (hour/landing)	0.72	0.72	0.70	0.67	0.66	0.63	0.67	0.74	
Average Commuter Speed (nmiles/hour)	160.89	154.83	161.46	183.45	169.80	168.20	175.88	N.A.	
Average Air Taxi Speed (nmiles/hour)	130.84	130.97	139.10	132.00	140.76	139.32	125.04	124.43	
GA Average Speed (nmiles/hour)	122.10	120.71	122.24	126.06	117.99	130.68	117.43	117.32	

N.A. = Not Applicable

Table 3.24 (Continued)
General Aviation Operations
Total Powered Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average		Pct. of Tot. Aircraft
Population (2.1)		250,727		96.16%
No. Active (2.1)		197,674		96.52%
Total Hours Flown (2.1)	248,596,728	31,074,591		98.60%
Commuter Hrs. (3.2)	8,865,848	1,108,231		
Air Taxi Hrs. (3.2)	19,947,399	2,493,425		
GA Hrs. = Total Hrs.				
-Commuter Hrs.- Air Taxi Hrs.	219,783,481	27,472,935		98.43%
Total Day Hours Flown (4.1)	198,276,741	24,784,593		98.29%
Total Night Hours Flown (4.1)	35,193,849	4,399,231		99.80%
VMC Day Hours Flown (4.2)	179,655,256	22,456,907		98.22%
VMC Night Hours Flown (4.2)	25,328,498	3,166,062		99.75%
Total VMC Hours Flown (4.2)	204,983,754	25,622,969		98.41%
IMC Day Hours Flown (4.3)	18,627,624	2,328,453		99.96%
IMC Night Hours Flown (4.3)	9,908,751	1,238,594		99.93%
Total IMC Hours Flown (4.3)	28,536,375	3,567,047		99.95%
Total Landings (2.5)	363,122,219	45,390,277		98.57%
Local Landings (2.6)	228,654,814	28,581,852		97.90%
Cross Country Landings (2.7)	126,961,182	15,870,148		99.73%
Estimated Flights (hours/avg. trip time)				
Commuter Flights	12,896,239	1,612,030		
Air Taxi Flights	29,126,101	3,640,763		
Estimated Flights (nmiles/avg. trip length)				
Commuter Flights	17,254,850	2,156,856		
Air Taxi Flights	31,147,829	3,893,479		
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.				
Based on hrs./avg. trip time	321,099,880	40,137,485		
Based on nmiles/avg. trip length	314,719,540	39,339,942		
Total Nautical Miles Flown (3.3)	30,945,108,000	3,868,138,500		99.70%
Commuter Nmiles (3.3)	1,480,103,000	185,012,875		
Air Taxi Nmiles (3.3)	2,659,702,000	332,462,750		
GA Nmiles = Total Nmiles				
-Commuter Nmiles -Air Taxi Nmiles	26,805,303,000	3,350,662,875		99.65%
Average Speed (nmiles/hour)	124.48	124.20		
Average Trip Length (nmiles/landing)	85.22	85.22		
Average Trip Time (hour/landing)	0.68	0.69		
Average Commuter Speed (nmiles/hour	166.94	167.79		
Average Air Taxi Speed (nmiles/hour)	133.34	132.81		
GA Average Speed (nmiles/hour)	121.96	121.82		

Table 3.25
General Aviation Operations
Other Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	9,309	9,732	9,917	10,306	10,562	10,781	9,739	9,832	
No. Active (2.1)	7,010	6,783	6,857	7,721	7,032	7,563	7,836	6,168	
Total Hours Flown (2.1)	394,256	415,888	612,998	428,680	368,804	459,360	409,872	435,672	
Commuter Hrs. (3.2)	0	0	81	4,798	360	5,200	34	0	
Air Taxi Hrs. (3.2)	0	0	0	0	10,722	0	881	0	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	394,256	415,888	612,917	423,882	357,722	454,160	408,957	435,672	
Total Day Hours Flown (4.1)	395,345	414,083	597,619	427,567	362,950	366,903	396,242	496,716	
Total Night Hours Flown (4.1)	1,796	111	22,107	3,071	2,269	3,330	13,630	24,909	
VMC Day Hours Flown (4.2)	395,122	413,999	595,815	425,972	362,651	366,741	395,788	294,458	
VMC Night Hours Flown (4.2)	1,775	91	22,107	3,060	1,886	3,324	13,531	18,662	
Total VMC Hours Flown (4.2)	396,897	414,090	617,922	429,032	364,537	370,065	409,319	313,120	
IMC Day Hours Flown (4.3)	224	84	1,739	1,692	298	110	454	2,593	
IMC Night Hours Flown (4.3)	21	20	0	10	383	6	99	6,246	
Total IMC Hours Flown (4.3)	245	104	1,739	1,702	681	116	553	8,839	
Total Landings (2.5)	454,067	804,545	771,432	649,385	576,048	735,927	597,753	664,820	
Local Landings (2.6)	408,917	745,048	721,463	615,754	552,123	702,785	544,831	606,182	
Cross Country Landings (2.7)	45,174	60,487	39,980	33,908	23,425	33,255	49,736	58,629	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	0	0	102	7,268	562	8,331	50	0	
Air Taxi Flights	0	0	0	0	16,747	0	1,285	0	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	0	0	0	0	0	0	0	0	
Air Taxi Flights	0	0	0	0	0	0	0	0	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	454,067	804,545	771,330	642,117	558,739	727,596	596,419	664,820	
Based on nmiles/avg. trip length	454,067	804,545	771,432	649,385	576,048	735,927	597,753	664,820	
Total Nautical Miles Flown (3.3)	12,613,000	9,504,000	15,856,000	12,267,000	7,914,000	10,013,000	13,444,000	11,522,000	
Commuter Nmiles (3.3)	0	0	0	0	0	0	0	0	
Air Taxi Nmiles (3.3)	0	0	0	0	0	0	0	0	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	12,613,000	9,504,000	15,856,000	12,267,000	7,914,000	10,013,000	13,444,000	11,522,000	
Average Speed (nmiles/hour)	31.99	22.85	25.87	28.62	21.46	21.80	32.80	26.45	
Average Trip Length (nmiles/landing)	27.78	11.81	20.55	18.89	13.74	13.61	22.49	17.33	
Average Trip Time (hour/landing)	0.87	0.52	0.79	0.66	0.64	0.62	0.69	0.66	
Average Commuter Speed (nmiles/hour	N.A.	N.A.	0.00	0.00	0.00	0.00	0.00	N.A.	
Average Air Taxi Speed (nmiles/hour)	N.A.	N.A.	N.A.	N.A.	0.00	N.A.	0.00	N.A.	
GA Average Speed (nmiles/hour)	31.99	22.85	25.87	28.94	22.12	22.05	32.87	26.45	

N.A. = Not Applicable

Table 3.25 (Continued)
General Aviation Operations
Other Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Tot. Aircraft
Population (2.1)		10,022	3.84%
No. Active (2.1)		7,121	3.48%
Total Hours Flown (2.1)	3,525,530	440,691	1.40%
Commuter Hrs. (3.2)	10,473	1,309	
Air Taxi Hrs. (3.2)	11,603	1,450	
GA Hrs. = Total Hrs.			
-Commuter Hrs.- Air Taxi Hrs.	3,503,454	437,932	1.57%
Total Day Hours Flown (4.1)	3,457,425	432,178	1.71%
Total Night Hours Flown (4.1)	71,223	8,903	0.20%
VMC Day Hours Flown (4.2)	3,250,546	406,318	1.78%
VMC Night Hours Flown (4.2)	64,436	8,055	0.25%
Total VMC Hours Flown (4.2)	3,314,982	414,373	1.59%
IMC Day Hours Flown (4.3)	7,194	899	0.04%
IMC Night Hours Flown (4.3)	6,785	848	0.07%
Total IMC Hours Flown (4.3)	13,979	1,747	0.05%
Total Landings (2.5)	5,253,977	656,747	1.43%
Local Landings (2.6)	4,897,103	612,138	2.10%
Cross Country Landings (2.7)	344,594	43,074	0.27%
Estimated Flights (hours/avg. trip time)			
Commuter Flights	16,313	2,039	
Air Taxi Flights	18,032	2,254	
Estimated Flights (nmiles/avg. trip length)			
Commuter Flights	0	0	
Air Taxi Flights	0	0	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.			
Based on hrs./avg. trip time	5,219,632	652,454	
Based on nmiles/avg. trip length	5,253,977	656,747	
Total Nautical Miles Flown (3.3)	93,133,000	11,641,625	0.30%
Commuter Nmiles (3.3)	0	0	
Air Taxi Nmiles (3.3)	0	0	
GA Nmiles = Total Nmiles			
-Commuter Nmiles -Air Taxi Nmiles	93,133,000	11,641,625	0.35%
Average Speed (nmiles/hour)	26.42	26.48	
Average Trip Length (nmiles/landing)	17.73	18.28	
Average Trip Time (hour/landing)	0.67	0.68	
Average Commuter Speed (nmiles/hour	0.00	0.00	
Average Air Taxi Speed (nmiles/hour)	0.00	0.00	
GA Average Speed (nmiles/hour)	26.58	26.64	

Table 3.26
General Aviation Operations
Total Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	1986	1987	1988	1989	1990	1991	1992	1993	1994
Population (2.1)	268,617	267,400	259,434	267,191	266,344	265,041	245,994	245,970	
No. Active (2.1)	220,043	217,182	210,266	219,738	212,228	198,476	184,430	176,000	
Total Hours Flown (2.1)	34,416,353	33,443,182	33,593,472	35,014,828	34,766,526	30,054,538	26,493,478	24,339,881	
Commuter Hrs. (3.2)	2,185,351	1,358,679	1,118,117	1,507,594	1,444,420	569,571	692,589	0	
Air Taxi Hrs. (3.2)	2,913,629	2,797,002	2,841,716	3,270,138	2,435,907	2,241,075	2,008,802	1,450,733	
GA Hrs. = Total Hrs.									
-Commuter Hrs.- Air Taxi Hrs.	29,317,373	29,287,501	29,633,639	30,237,096	30,886,199	27,243,892	23,792,087	22,889,148	
Total Day Hours Flown (4.1)	29,348,011	28,610,416	29,089,859	26,560,109	28,885,259	17,194,090	23,068,817	18,977,605	
Total Night Hours Flown (4.1)	4,477,209	4,109,905	4,420,768	5,354,089	5,580,775	2,581,725	3,424,661	5,315,940	
VMC Day Hours Flown (4.2)	25,903,230	25,879,820	26,485,501	23,836,832	26,155,792	15,995,303	21,355,044	17,294,280	
VMC Night Hours Flown (4.2)	3,132,734	2,995,226	3,318,936	3,979,916	4,328,377	2,132,920	2,877,311	2,627,514	
Total VMC Hours Flown (4.2)	29,035,964	28,875,046	29,804,437	27,816,748	30,484,169	18,128,223	24,232,355	19,921,794	
IMC Day Hours Flown (4.3)	3,448,333	2,722,959	2,599,351	2,718,258	2,742,015	1,207,816	1,713,773	1,482,313	
IMC Night Hours Flown (4.3)	1,348,802	1,109,137	1,100,014	1,379,529	1,251,806	446,902	547,350	2,731,996	
Total IMC Hours Flown (4.3)	4,797,135	3,832,096	3,699,365	4,097,787	3,993,821	1,654,718	2,261,123	4,214,309	
Total Landings (2.5)	47,554,080	46,878,139	48,188,985	52,031,008	52,951,464	47,978,670	39,607,270	33,186,580	
Local Landings (2.6)	29,720,109	29,534,946	31,104,193	27,703,479	35,463,305	33,207,227	25,123,810	21,694,848	
Cross Country Landings (2.7)	17,869,552	17,251,146	17,010,513	17,040,690	17,390,657	14,728,408	14,535,729	11,479,081	
Estimated Flights (hours/avg. trip time)									
Commuter Flights	3,019,563	1,904,494	1,603,911	2,240,240	2,199,937	909,256	1,035,408	0	
Air Taxi Flights	4,025,846	3,920,627	4,076,370	4,859,329	3,710,030	3,577,623	3,003,123	1,978,024	
Estimated Flights (nmiles/avg. trip length)									
Commuter Flights	3,909,191	2,422,202	2,101,626	3,203,433	3,094,034	1,162,406	1,540,298	0	
Air Taxi Flights	4,238,720	4,218,007	4,602,135	5,015,923	4,307,381	3,823,206	3,175,006	2,119,656	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.									
Based on hrs./avg. trip time	40,508,670	41,053,018	42,508,705	44,931,438	47,041,498	43,491,792	35,568,739	31,208,556	
Based on nmiles/avg. trip length	39,406,169	40,237,931	41,485,224	43,811,652	45,550,050	42,993,058	34,891,966	31,066,924	
Total Nautical Miles Flown (3.3)	4,277,031,000	4,071,401,000	4,139,074,000	4,477,733,000	4,196,503,000	3,918,101,000	3,132,149,000	2,826,249,000	
Commuter Nmiles (3.3)	351,594,000	210,370,000	180,514,000	275,684,000	245,208,000	94,926,000	121,807,000	0	
Air Taxi Nmiles (3.3)	381,232,000	366,337,000	395,289,000	431,665,000	341,368,000	312,216,000	251,080,000	180,515,000	
GA Nmiles = Total Nmiles									
-Commuter Nmiles -Air Taxi Nmiles	3,544,205,000	3,494,694,000	3,563,271,000	3,770,384,000	3,609,927,000	3,510,959,000	2,759,262,000	2,645,734,000	
Average Speed (nmiles/hour)	124.27	121.74	123.21	127.88	120.71	130.37	118.22	116.12	
Average Trip Length (nmiles/landing)	89.94	86.85	85.89	86.06	79.25	81.66	79.08	85.16	
Average Trip Time (hour/landing)	0.72	0.71	0.70	0.67	0.66	0.63	0.67	0.73	
Average Commuter Speed (nmiles/hour)	160.89	154.83	161.44	182.86	169.76	166.66	175.87	N.A.	
Average Air Taxi Speed (nmiles/hour)	130.84	130.97	139.10	132.00	140.14	139.32	124.99	124.43	
GA Average Speed (nmiles/hour)	120.89	119.32	120.24	124.69	116.88	128.87	115.97	115.59	

N.A. = Not Applicable

Table 3.26 (Continued)
General Aviation Operations
Total Aircraft
References 3.1 to 3.8

Parameter (Ref. Table No.)	Total	Average	Pct. of Tot. Aircraft
Population (2.1)		260,749	100.00%
No. Active (2.1)		204,795	100.00%
Total Hours Flown (2.1)	252,122,258	31,515,282	100.00%
Commuter Hrs. (3.2)	8,876,321	1,109,540	
Air Taxi Hrs. (3.2)	19,959,002	2,494,875	
GA Hrs. = Total Hrs.			
-Commuter Hrs.- Air Taxi Hrs.	223,286,935	27,910,867	100.00%
Total Day Hours Flown (4.1)	201,734,166	25,216,771	100.00%
Total Night Hours Flown (4.1)	35,265,072	4,408,134	100.00%
VMC Day Hours Flown (4.2)	182,905,802	22,863,225	100.00%
VMC Night Hours Flown (4.2)	25,392,934	3,174,117	100.00%
Total VMC Hours Flown (4.2)	208,298,736	26,037,342	100.00%
IMC Day Hours Flown (4.3)	18,634,818	2,329,352	100.00%
IMC Night Hours Flown (4.3)	9,915,536	1,239,442	100.00%
Total IMC Hours Flown (4.3)	28,550,354	3,568,794	100.00%
Total Landings (2.5)	368,376,196	46,047,025	100.00%
Local Landings (2.6)	233,551,917	29,193,990	100.00%
Cross Country Landings (2.7)	127,305,776	15,913,222	100.00%
Estimated Flights (hours/avg. trip time)			
Commuter Flights	12,912,809	1,614,101	
Air Taxi Flights	29,150,971	3,643,871	
Estimated Flights (nmiles/avg. trip length)			
Commuter Flights	17,433,189	2,179,149	
Air Taxi Flights	31,500,034	3,937,504	
GA Flights = Total Landings-Commuter Flts.-Air Taxi Flts.			
Based on hrs./avg. trip time	326,312,416	40,789,052	
Based on nmiles/avg. trip length	319,442,973	39,930,372	
Total Nautical Miles Flown (3.3)	31,038,241,000	3,879,780,125	100.00%
Commuter Nmiles (3.3)	1,480,103,000	185,012,875	
Air Taxi Nmiles (3.3)	2,659,702,000	332,462,750	
GA Nmiles = Total Nmiles			
-Commuter Nmiles -Air Taxi Nmiles	26,898,436,000	3,362,304,500	100.00%
Average Speed (nmiles/hour)	123.11	122.81	
Average Trip Length (nmiles/landing)	84.26	84.24	
Average Trip Time (hour/landing)	0.68	0.69	
Average Commuter Speed (nmiles/hour	166.75	167.48	
Average Air Taxi Speed (nmiles/hour)	133.26	132.72	
GA Average Speed (nmiles/hour)	120.47	120.31	

Table 3.27
General Aviation Operations Summary, 1986-1993
References 3.1 to 3.8

Aircraft Subcategories	Average No. Active	Total Hrs. Flown	Total GA Hrs. Flown	Total Nmi. Flown (000)	Total GA Nmi. Flown 000	Total Landings (flts.)	Est. GA Flights (based hrs./ avg. trip time)	Est. GA Flights (based nmi./ avg. trip dis.)	Average GA Flights	Average Speed (nmi./hr.)	GA Average Speed (nmi./hr.)	Average Trip Length (nmi./flt.)	Average Trip Time (hrs./flt.)
Single-Engine Reciprocating, Fixed Wing	160,000	167,708,994	162,027,642	16,914,953	16,319,646	259,495,990	250,717,981	250,351,231	250,534,606	100.86	100.72	65.18	0.65
Multi-Engine Reciprocating, Fixed Wing	21,572	32,304,815	23,410,419	4,693,227	3,351,473	30,867,775	22,393,971	22,090,735	22,242,353	145.28	143.16	152.04	1.05
Turboprop Fixed Wing	5,318	17,304,615	10,249,961	3,267,365	1,892,822	19,835,017	11,753,275	11,564,189	11,658,732	188.81	184.67	164.73	0.87
Turbojet Fixed Wing	4,278	11,512,924	10,187,072	4,638,871	4,084,592	9,314,394	8,242,047	8,203,943	8,222,995	402.93	400.96	498.03	1.24
Total Fixed Wing	191,168	228,829,348	205,875,094	29,514,416	25,648,533	319,513,176	293,107,274	292,210,098	292,658,686	128.98	124.58	92.37	0.72
Reciprocating Engine, Rotary Wing	2,775	4,981,195	4,902,525	285,249	280,308	14,344,326	14,111,006	14,091,011	14,101,009	57.27	57.18	19.89	0.35
Turbine Engine Rotary Wing	3,731	14,786,185	9,005,862	1,145,443	876,462	29,264,717	17,727,736	22,234,063	19,980,900	77.47	97.32	39.14	0.51
Total Rotary Wing	6,506	19,767,380	13,908,387	1,430,692	1,156,770	43,609,043	31,838,742	36,325,074	34,081,908	72.38	83.17	32.81	0.45
Total Powered Aircraft	197,674	248,596,728	219,783,481	30,945,108	26,805,303	363,122,219	324,946,016	328,535,172	326,740,594	124.48	121.96	85.22	0.68
Other Aircraft	7,121	3,525,530	3,503,454	93,133	93,133	5,253,977	5,219,632	5,253,977	5,236,805	26.42	26.58	17.73	0.67
Total Aircraft	204,795	252,122,258	223,286,935	31,038,241	26,898,436	368,376,196	330,165,648	333,789,149	331,977,399	123.11	120.47	84.26	0.68

3.4 GENERAL AVIATION CRASH RATES

Table 3.28 presents the general aviation accident (or crash) rates by aircraft subcategories. All accident data are taken from Table 3.15 of Section 3.2. All operations data are taken from Table 3.27 of Section 3.3.

Tables 3.29 to 3.37 presents the following information by flight phases for each subcategory of general aviation:

1. Number of accidents,
2. Percent of total subcategory accidents,
3. Average percent of subcategory flight time,
4. Average flight time per flight phase,
5. Assumed subcategory average flight phase speed in miles/hour,
6. Assumed subcategory average flight phase speed in nmiles (knots)/hour,
7. Calculated subcategory average flight phase distance flown in miles,
8. Calculated subcategory average flight phase distance in nmiles (knots),
9. Calculated crash rate by flight phase, expressed in
   - 9a. Crashes/landing,
   - 9b. Crashes/aircraft hour flown,
   - 9c. Crashes/mile flown,
   - 9d. Crashes/nmile (knot) flown,
10. Combined ACRAM flight phase crash rate, express in
    - 10a. Crashes/landing,
    - 10b. Crashes/aircraft hour flown,
    - 10c. Crashes/mile flown,
    - 10d. Crashes/nmile (knot) flown,

The tables listed below gives the general aviation subcategories for which the general aviation crash rate by flight phase table were created:

Table 3.29	Single-engine reciprocating (piston), fixed wing,
Table 3.30	Multiple-engine reciprocating (piston), fixed wing,
Table 3.31	Turboprop, fixed wing,
Table 3.32	Turbojet, fixed wing,
Table 3.33	Total fixed wing (summation of Tables 3.29 to 3.32)
Table 3.34	Reciprocating (piston) engine, rotary wing,
Table 3.35	Turbine engine, rotary wing
Table 3.36	Total rotary wing (summation of Tables 3.34 and 3.35)
Table 3.37	Total powered aircraft (summation of Tables 3.29 to 3.32, 3.34 and 3.35)

The number of accidents for each flight phase by general aviation subcategory were taken from Table 3.15 of Section 3.2. The hours average flight duration, nmiles average flight distance, and the number of landings were taken from Table 3.27 of Section 3.3. The number of estimated flights were taken to be equal to the estimated number of general aviation landings for that subcategory and is the average of the two methods used to estimate this number. The first method is to base the estimated number of flights on the number of primary use hours flown divided by the average trip time for that particular subcategory of general aviation. The other method is to base the estimated number of flights on the number of primary use nautical miles flown divided by the average trip length for that particular subcategory of general aviation. Flight times for each flight phase were assigned based on conversations with licensed pilots and instructors and engineering judgment and experience. A more formalized process for assigning flight times to the flight phases would be to solicit opinions from qualified pilots and instructors and to adjust the flight times for the flight phases appropriately. A process similar to the NRC expert opinion solicitation process could be followed if a more formalized, accepted procedure was desired. This was not done because of the time and resource constraints. Average flight phase velocities for the subcategory were then adjusted until the average flight distance was approximately equal to the average flight distance of Table 3.27. Again, as with commercial aviation, the seven flight phases used in Tables 3.29 to 3.37 were

combined to the three defined ACRAM flight phases, takeoff, landing, and in-flight or enroute. Again, as with commercial aviation, takeoff is defined as encompassing the actual takeoff roll, and the initial climb flight phase. Landing is defined as including the landing approach, and the actual landing roll. The enroute or in-flight phase is defined as including the climb to cruise, cruise or enroute, and the descent from cruise flight phases.

In the ACRAM Standard's [Ref. 3.19] estimation of the frequency of an impact with a facility, the near airport contribution is based on the assumption that the facility is located far enough from any runway that only impacts caused by off runway crashes need be considered, i.e., the contribution from on runway accidents (considered to be runway overruns and runway runoffs) is negligible. The fixed wing crash rates of Tables 3.29 to 3.33 include both off runway and on runway accidents, and thus they must be adjusted for use in the ACRAM Standard. Rotary wing aircraft are not considered to be capable of runway overruns and runway runoffs as their takeoff and landing runs are considered to be small (tens of feet versus hundreds or even thousands of feet for fixed wing aircraft). Analysis of the General Aviation NTSB database by SAIC has determined that approximately 89% of the general aviation takeoff crashes are off runway accidents, and 94% of the general aviation landing crashes are off runway accidents. Therefore, the appropriate crash rates that should be used in the ACRAM Standard are obtained by multiplying the relevant values of Tables 3.29 to 3.33 by 0.89 for takeoffs and 0.94 for landings. These adjusted crash rates are given in Table 3.38.

Table 3.28
General Aviation Accident Rates by Aircraft Subcategories
Based on FAA General Aviation Activity Survey, Calendar Years 1986-1993 [Ref. 3.1 - 3.8]
and NTSB Annual Review of Aircraft Accident Data, U.S. General Aviation, Calendar Years 1986-1993 [Ref. 3.20 - 3.27]

Aircraft Subcategories	Total GA Accidents	GA Hrs. Flown	GA Nmi. Flown	GA Miles Flown	Avg. GA Landings (flts.)	Acc./ Hrs.	Acc./ Nmi.	Acc./ Mile	Acc./ Landing
Single-Engine Reciprocating, Fixed Wing	14,707	162,027,642	16,319,646,000	18,780,273,265	250,534,606	9.08E-05	9.01E-07	7.83E-07	5.87E-05
Multi-Engine Reciprocating, Fixed Wing	1,268	23,410,419	3,351,473,000	3,856,798,045	22,242,353	5.42E-05	3.78E-07	3.29E-07	5.70E-05
Turboprop, Fixed Wing	299	10,249,961	1,892,822,000	2,178,216,023	11,658,732	2.92E-05	1.58E-07	1.37E-07	2.56E-05
Turbojet, Fixed Wing	88	10,187,072	4,084,592,000	4,700,454,528	8,222,995	8.64E-06	2.15E-08	1.87E-08	1.07E-05
Total, Fixed Wing	16,362	205,875,094	25,648,533,000	29,515,741,860	292,658,686	7.95E-05	6.38E-07	5.54E-07	5.59E-05
Reciprocating Engine, Rotary Wing	949	4,902,525	280,308,000	322,571,999	14,101,009	1.94E-04	3.39E-06	2.94E-06	6.73E-05
Turbine Engine, Rotary Wing	482	9,005,862	876,462,000	1,008,612,311	19,980,900	5.35E-05	5.50E-07	4.78E-07	2.41E-05
Total, Rotary Wing	1,431	13,908,387	1,156,770,000	1,331,184,310	34,081,909	1.03E-04	1.24E-06	1.07E-06	4.20E-05
Total Powered Aircraft	17,793	219,783,481	26,805,303,000	30,846,926,170	326,740,595	8.10E-05	6.64E-07	5.77E-07	5.45E-05
Other Aircraft	529	3,503,454	93,133,000	107,175,314	5,236,805	1.51E-04	5.68E-06	4.94E-06	1.01E-04
Total Aircraft	18,322	223,286,935	26,898,436,000	30,954,101,485	331,977,400	8.21E-05	6.81E-07	5.92E-07	5.52E-05

Table 3.29
General Aviation Single-Engine Reciprocating, Fixed Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	885	7.50%	1.28%	0.008	69.05	60.00	0.58	0.50	3.532E-06	4.239E-04	6.139E-06	7.065E-06	1.225E-05	7.352E-04	9.127E-06	1.050E-05
Initial Climb	2,185	18.52%	1.28%	0.008	92.06	80.00	0.77	0.67	8.721E-06	1.047E-03	1.137E-05	1.308E-05				
Climb to Cruise	457	3.87%	20.51%	0.133	120.83	105.00	16.11	14.00	1.824E-06	1.368E-05	1.132E-07	1.303E-07				
Cruise/ Enroute	2,500	21.19%	29.49%	0.192	126.59	110.00	24.26	21.08	9.979E-06	5.206E-05	4.113E-07	4.733E-07	1.352E-05	2.749E-05	2.233E-07	2.570E-07
Descent from Cruise	429	3.64%	25.64%	0.167	120.83	105.00	20.14	17.50	1.712E-06	1.027E-05	8.503E-08	9.785E-08				
Landing Approach	1,840	15.60%	20.51%	0.133	97.82	85.00	13.04	11.33	7.344E-06	5.508E-05	5.631E-07	6.480E-07				
Landing	3,500	29.67%	1.28%	0.008	57.54	50.00	0.48	0.42	1.397E-05	1.676E-03	2.914E-05	3.353E-05	2.131E-05	1.505E-04	1.576E-06	1.814E-06
TOTAL:	11,796	100.00%	100.00%	0.650			75.38	65.50	4.708E-05	7.244E-05	6.246E-07	7.188E-07	4.708E-05	7.244E-05	6.246E-07	7.188E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.65 Hours Average Flight Duration
65.2 Nmiles Average Flight Distance
250,534,606 Landings

Table 3.30
General Aviation Multi-Engine Reciprocating, Fixed Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	71	6.49%	0.79%	0.008	86.31	75.00	0.72	0.63	3.192E-06	3.831E-04	4.438E-06	5.107E-06	1.043E-05	6.258E-04	6.043E-06	6.954E-06
Initial Climb	161	14.72%	0.79%	0.008	120.83	105.00	1.01	0.88	7.238E-06	8.686E-04	7.189E-06	8.273E-06				
Climb to Cruise	56	5.12%	11.11%	0.117	149.60	130.00	17.45	15.17	2.518E-06	2.158E-05	1.443E-07	1.660E-07				
Cruise/ Enroute	239	21.85%	59.52%	0.625	178.37	155.00	111.48	96.88	1.075E-05	1.719E-05	9.639E-08	1.109E-07	1.466E-05	1.614E-05	9.238E-08	1.063E-07
Descent from Cruise	31	2.83%	15.87%	0.167	178.37	155.00	29.73	25.83	1.394E-06	8.362E-06	4.688E-08	5.395E-08				
Landing Approach	236	21.57%	11.11%	0.117	120.83	105.00	14.10	12.25	1.061E-05	9.095E-05	7.527E-07	8.662E-07				
Landing	300	27.42%	0.79%	0.008	74.80	65.00	0.62	0.54	1.349E-05	1.619E-03	2.164E-05	2.490E-05	2.410E-05	1.928E-04	1.637E-06	1.884E-06
TOTAL:	1,094	100.00%	100.00%	1.050			175.11	152.17	4.919E-05	4.684E-05	2.809E-07	3.232E-07	4.919E-05	4.684E-05	2.809E-07	3.232E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

1.05 Hours Average Flight Duration
152.04 Nmiles Average Flight Distance
22,242,353 Landings

Table 3.31
General Aviation Turboprop, Fixed Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	17	7.94%	0.96%	0.008	100.00	85.00	0.83	0.71	1.458E-06	1.750E-04	1.750E-06	2.059E-06	3.946E-06	2.367E-04	1.774E-06	2.059E-06
Initial Climb	29	13.55%	0.96%	0.008	166.86	145.00	1.39	1.21	2.487E-06	2.985E-04	1.789E-06	2.059E-06				
Climb to Cruise	13	6.07%	21.07%	0.183	224.40	195.00	41.14	35.75	1.115E-06	6.082E-06	2.710E-08	3.119E-08				
Cruise/ Enroute	38	17.76%	26.25%	0.228	241.66	210.00	55.18	47.95	3.259E-06	1.427E-05	5.907E-08	6.797E-08	5.575E-06	8.426E-06	3.557E-08	4.093E-08
Descent from Cruise	14	6.54%	28.74%	0.250	241.66	210.00	60.42	52.50	1.201E-06	4.803E-06	1.988E-08	2.287E-08				
Landing Approach	52	24.30%	21.07%	0.183	161.11	140.00	29.54	25.67	4.460E-06	2.433E-05	1.510E-07	1.738E-07				
Landing	51	23.83%	0.96%	0.008	100.00	75.00	0.83	0.63	4.374E-06	5.249E-04	5.249E-06	6.999E-06	8.835E-06	4.609E-05	2.909E-07	3.360E-07
TOTAL:	214	100.00%	100.00%	0.870			189.33	164.41	1.836E-05	2.110E-05	9.695E-08	1.116E-07	1.836E-05	2.110E-05	9.695E-08	1.116E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.87 Hours Average Flight Duration
164.73 Nmiles Average Flight Distance
11,658,732 Landings

Table 3.32
General Aviation Turbojet, Fixed Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	9	13.43%	0.67%	0.008	103.57	90.00	0.86	0.75	1.094E-06	1.313E-04	1.268E-06	1.459E-06	1.581E-06	6.324E-05	2.997E-07	3.449E-07
Initial Climb	4	5.97%	1.34%	0.017	264.68	230.00	4.41	3.83	4.864E-07	2.919E-05	1.103E-07	1.269E-07				
Climb to Cruise	6	8.96%	18.82%	0.233	483.33	420.00	112.78	98.00	7.297E-07	3.127E-06	6.470E-09	7.446E-09				
Cruise/ Enroute	6	8.96%	50.27%	0.623	512.10	445.00	319.21	277.38	7.297E-07	1.171E-06	2.286E-09	2.631E-09	1.581E-06	1.545E-06	3.067E-09	3.530E-09
Descent from Cruise	1	1.49%	13.44%	0.167	500.59	435.00	83.43	72.50	1.216E-07	7.297E-07	1.458E-09	1.677E-09				
Landing Approach	17	25.37%	14.78%	0.183	276.19	240.00	50.63	44.00	2.067E-06	1.128E-05	4.083E-08	4.699E-08				
Landing	24	35.82%	0.67%	0.008	103.57	90.00	0.86	0.75	2.919E-06	3.502E-04	3.382E-06	3.892E-06	4.986E-06	2.601E-05	9.682E-08	1.114E-07
TOTAL:	67	100.00%	100.00%	1.240			572.19	497.22	8.148E-06	6.571E-06	1.424E-08	1.639E-08	8.148E-06	6.571E-06	1.424E-08	1.639E-08

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

1.24 Hours Average Flight Duration
498.03 Nmiles Average Flight Distance
8,222,995 Landings

Table 3.33
General Aviation Total Fixed Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	982	7.46%	1.16%	0.008	80.55	70.00	0.67	0.58	3.355E-06	4.027E-04	4.999E-06	5.752E-06	1.148E-05	6.891E-04	7.044E-06	8.107E-06
Initial Climb	2,379	18.06%	1.16%	0.008	115.08	100.00	0.96	0.83	8.129E-06	9.755E-04	8.477E-06	9.755E-06				
Climb to Cruise	532	4.04%	20.83%	0.150	143.85	125.00	21.58	18.75	1.818E-06	1.212E-05	8.425E-08	9.695E-08				
Cruise/ Enroute	2,783	21.13%	34.03%	0.245	166.86	145.00	40.88	35.53	9.509E-06	3.881E-05	2.326E-07	2.677E-07	1.295E-05	2.376E-05	1.510E-07	1.738E-07
Descent from Cruise	475	3.61%	20.83%	0.150	155.35	135.00	23.30	20.25	1.623E-06	1.082E-05	6.965E-08	8.015E-08				
Landing Approach	2,145	16.29%	20.83%	0.150	120.83	105.00	18.12	15.75	7.329E-06	4.886E-05	4.044E-07	4.654E-07				
Landing	3,875	29.42%	1.16%	0.008	74.80	65.00	0.62	0.54	1.324E-05	1.589E-03	2.124E-05	2.444E-05	2.057E-05	1.299E-04	1.097E-06	1.263E-06
TOTAL:	13,171	100.00%	100.00%	0.720			106.14	92.23	4.500E-05	6.251E-05	4.240E-07	4.879E-07	4.500E-05	6.251E-05	4.240E-07	4.879E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.72 Hours Average Flight Duration
92.37 Nmiles Average Flight Distance
292,658,686 Landings

Table 3.34
General Aviation Reciprocating Engine, Rotary Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	56	9.71%	2.38%	0.008	57.54	50.00	0.48	0.42	3.971E-06	4.766E-04	8.282E-06	9.531E-06	1.078E-05	6.468E-04	1.071E-05	1.232E-05
Initial Climb	96	16.64%	2.38%	0.008	63.29	55.00	0.53	0.46	6.808E-06	8.170E-04	1.291E-05	1.485E-05				
Climb to Cruise	16	2.77%	23.81%	0.083	65.59	57.00	5.47	4.75	1.135E-06	1.362E-05	2.076E-07	2.389E-07				
Cruise/ Enroute	177	30.68%	11.90%	0.042	69.05	60.00	2.88	2.50	1.255E-05	3.013E-04	4.363E-06	5.021E-06	1.610E-05	7.727E-05	1.142E-06	1.314E-06
Descent from Cruise	34	5.89%	23.81%	0.083	69.05	60.00	5.75	5.00	2.411E-06	2.893E-05	4.191E-07	4.822E-07				
Landing Approach	70	12.13%	33.33%	0.117	63.29	55.00	7.38	6.42	4.964E-06	4.255E-05	6.723E-07	7.736E-07				
Landing	128	22.18%	2.38%	0.008	46.03	40.00	0.38	0.33	9.077E-06	1.089E-03	2.366E-05	2.723E-05	1.404E-05	1.123E-04	1.808E-06	2.080E-06
TOTAL:	577	100.00%	100.00%	0.350			22.87	19.88	4.092E-05	1.169E-04	1.789E-06	2.059E-06	4.092E-05	1.169E-04	1.789E-06	2.059E-06

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.35 Hours Average Flight Duration
19.89 Nmiles Average Flight Distance
14,101,009 Landings

Table 3.35
General Aviation Turbine Engine, Rotary Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	23	8.04%	1.63%	0.008	63.29	55.00	0.53	0.46	1.151E-06	1.381E-04	2.182E-06	2.511E-06	3.203E-06	1.922E-04	2.904E-06	3.342E-06
Initial Climb	41	14.34%	1.63%	0.008	69.05	60.00	0.58	0.50	2.052E-06	2.462E-04	3.566E-06	4.104E-06				
Climb to Cruise	10	3.50%	22.88%	0.117	92.06	80.00	10.74	9.33	5.005E-07	4.290E-06	4.660E-08	5.362E-08				
Cruise/ Enroute	117	40.91%	33.01%	0.168	103.57	90.00	17.43	15.15	5.856E-06	3.479E-05	3.359E-07	3.865E-07	6.957E-06	1.732E-05	1.788E-07	2.057E-07
Descent from Cruise	12	4.20%	22.88%	0.117	92.06	80.00	10.74	9.33	6.006E-07	5.148E-06	5.592E-08	6.435E-08				
Landing Approach	34	11.89%	16.34%	0.083	63.29	55.00	5.27	4.58	1.702E-06	2.042E-05	3.226E-07	3.713E-07				
Landing	49	17.13%	1.63%	0.008	46.03	40.00	0.38	0.33	2.452E-06	2.943E-04	6.393E-06	7.357E-06	4.154E-06	4.532E-05	7.342E-07	8.449E-07
TOTAL:	286	100.00%	100.00%	0.510			45.68	39.69	1.431E-05	2.807E-05	3.134E-07	3.606E-07	1.431E-05	2.807E-05	3.134E-07	3.606E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.51 Hours Average Flight Duration
39.14 Nmiles Average Flight Distance
19,980,900 Landings

Table 3.36
General Aviation Total Rotary Wing Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	79	9.15%	1.85%	0.008	60.99	53.00	0.51	0.44	2.318E-06	2.782E-04	4.561E-06	5.248E-06	6.338E-06	3.803E-04	6.008E-06	6.914E-06
Initial Climb	137	15.87%	1.85%	0.008	65.59	57.00	0.55	0.48	4.020E-06	4.824E-04	7.354E-06	8.463E-06				
Climb to Cruise	26	3.01%	22.22%	0.100	84.01	73.00	8.40	7.30	7.629E-07	7.629E-06	9.081E-08	1.045E-07				
Cruise/ Enroute	294	34.07%	27.78%	0.125	100.12	87.00	12.51	10.88	8.626E-06	6.901E-05	6.893E-07	7.932E-07	1.074E-05	3.143E-05	3.543E-07	4.077E-07
Descent from Cruise	46	5.33%	25.93%	0.117	80.55	70.00	9.40	8.17	1.350E-06	1.157E-05	1.436E-07	1.653E-07				
Landing Approach	104	12.05%	18.52%	0.083	63.29	55.00	5.27	4.58	3.051E-06	3.662E-05	5.785E-07	6.658E-07				
Landing	177	20.51%	1.85%	0.008	46.03	40.00	0.38	0.33	5.193E-06	6.232E-04	1.354E-05	1.558E-05	8.245E-06	8.994E-05	1.457E-06	1.677E-06
TOTAL:	863	100.00%	100.00%	0.450			37.03	32.18	2.532E-05	5.627E-05	6.839E-07	7.870E-07	2.532E-05	5.627E-05	6.839E-07	7.870E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.45 Hours Average Flight Duration
32.81 Nmiles Average Flight Distance
34,081,908 Landings

Table 3.37
General Aviation Total Powered Aircraft Crash Rates by Flight Phase

Flight Phases	No. of Accs.	Accs. Pct.	Average Pct. Flt. Time	Average Flt. Time (hours)	Assumed Average Velocity Miles	Assumed Average Velocity Knots	Calculated Average Distance Miles	Calculated Average Distance Knots	Crash Rate by Flight Phases Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot	Combined ACRAM Flight Phases Crash Rates Crashes /Landing	Crashes /AC Hour	Crashes /Mile	Crashes /Knot
Takeoff	1,061	7.56%	1.23%	0.008	69.05	60.00	0.58	0.50	3.247E-06	3.897E-04	5.644E-06	6.494E-06	1.095E-05	4.379E-04	4.963E-06	5.712E-06
Initial Climb	2,516	17.93%	2.45%	0.017	97.82	85.00	1.63	1.42	7.700E-06	4.620E-04	4.723E-06	5.436E-06				
Climb to Cruise	558	3.98%	19.61%	0.133	143.85	125.00	19.18	16.67	1.708E-06	1.281E-05	8.904E-08	1.025E-07				
Cruise/ Enroute	3,077	21.93%	32.60%	0.222	166.86	145.00	36.99	32.14	9.417E-06	4.248E-05	2.546E-07	2.930E-07	1.272E-05	2.438E-05	1.550E-07	1.784E-07
Descent from Cruise	521	3.71%	24.51%	0.167	155.35	135.00	25.89	22.50	1.595E-06	9.567E-06	6.158E-08	7.087E-08				
Landing Approach	2,249	16.03%	17.16%	0.117	109.32	95.00	12.75	11.08	6.883E-06	5.900E-05	5.397E-07	6.210E-07				
Landing	4,052	28.87%	2.45%	0.017	63.29	55.00	1.05	0.92	1.240E-05	7.441E-04	1.176E-05	1.353E-05	1.928E-05	1.446E-04	1.396E-06	1.607E-06
TOTAL:	14,034	100.00%	100.00%	0.680			98.07	85.23	4.295E-05	6.316E-05	4.379E-07	5.040E-07	4.295E-05	6.316E-05	4.379E-07	5.040E-07

Bases for Crash Rates by Flight Phase, 1986-1993 Totals:

0.68 Hours Average Flight Duration
85.22 Nmiles Average Flight Distance
326,740,594 Landings

Table 3.38

General Aviation Fixed Wing Crash Rates by Aircraft Subcategories and Flight Phase, Adjusted for Off Runway Crashes
Based on FAA General Aviation Activity Survey, Calendar Years 1986-1993 [Ref. 3.1 - 3.8], NTSB Annual Review of Aircraft Accident Data, U.S. General Aviation, Calendar Years 1986-1993 [Ref. 3.20 - 3.27], and SAIC Review of the NTSB General Aviation Database

Aircraft Subcategories	Off Runway Crash Rate /Takeoffs	Off Runway Crash Rate /Landings
Single-Engine Reciprocating, Fixed Wing	1.09E-05	2.00E-05
Multi-Engine Reciprocating, Fixed Wing	9.28E-06	2.27E-05
Turboprop, Fixed Wing	3.51E-06	8.30E-06
Turbojet, Fixed Wing	1.41E-06	4.69E-06
Total, Fixed Wing	1.02E-05	1.93E-05

3.5 GENERAL AVIATION IN FLIGHT NONAIRWAY CRASH PARAMETERS

Previous efforts to estimate nonairport related aircraft crash frequencies are based on the assumption that aircraft fly within fixed air corridors; such an assumption is not realistic for GA aircraft. Based on the product-kernel method for estimating multidimensional probability density functions, the Standard uses a data driven approach for estimating the GA nonairport crash frequency at a given DOE site. This approach is data driven since it directly uses the coordinates (latitudes and longitudes) of previous GA nonairport crsahes to make its estimates; no assumptions have been made about 1) an aircraft's position (either its coordinates or altitude) prior to a mishap that results in a crash, or 2) an aircraft's trajectory (flight path) from the point where a mishap occurs until ground impact (which would require an assessment of the aircraft's flight characteristics, such as glide ratio and the pilot's ability to maneuver the aircraft following the mishap).

Table A3.1 provides a listing of the 1250 crash locations as longitudes and latitudes with their NTSB number.

3.6 GENERAL AVIATION CRASH PARAMETER DISTRIBUTIONS

3.6.1 GENERAL AVIATION CRASH LOCATION

A stepwise process was used to compile data which could be used to evaluate the probability of a damaging general aviation crash for facility sites in the vicinity of airports. The National Transportation Safety Board electronic database for the period between 1983 and 1989 was reviewed. In order to segregate the crashes that provided a potential hazard to either a nuclear or chemical facility, only those accidents were included that were general aviation, that involved substantial damage or destruction of the aircraft, that were off the airstrip/off the airport by at least one mile, and that were helicopters or airplanes (aircraft such as ultralights, gliders, dirigibles, balloons, etc., were excluded). The narratives for crashes with suspect information were reviewed and some were added and others were deleted. 680 applicable crashes were chosen for evaluation.

The crash locations records obtained from the database allowed for an empirical evaluation of the crash location density f(x,y) for the general aviation category and phase operations. Due to the limited number of records in several GA subcategories, the database for crash location is insufficient for an effective statistical analysis of all subcategories and phases. Specifically, the fixed wing turbojet subcategory has seven observations and the combined rotating wing subcategories have four. Also, the subcategory fixed wing turboprop and takeoff phase has only four observations. It has been decided to combine all the subcategory crash location data for the takeoff phase, and likewise for the landing phase, to determine two GA category crash location density functions, one for takeoffs and one for landings.

The crash location f(x,y), based on a nonparametric bivariate estimation technique [Refs. 3.28 and 3.34] and the crash location data from the GA category, is given in Equation 3.1. Techniques based on parametric models are not as well suited to this location data.

$$f(x,y) = \frac{1}{n} w_{off} \sum_{i=1}^{n} \left\{ \left[\Phi\left(\frac{x_u - x_i}{h_x}\right) - \Phi\left(\frac{x_l - x_i}{h_x}\right) \right] \left[\Phi\left(\frac{y_u - y_i}{h_y}\right) - \Phi\left(\frac{y_l - y_i}{h_y}\right) \right] \right\} + w_{on} \left[\Phi\left(\frac{x_u}{\sigma}\right) - \Phi\left(\frac{x_l}{\sigma}\right) \right] \left[\Phi\left(\frac{y_u}{\sigma}\right) - \Phi\left(\frac{y_l}{\sigma}\right) \right]. \quad (3.1)$$

Φ represents the standard normal cumulative distribution function. The quantities h_x, h_y, and σ are "bandwidths" for the estimator. They control the smoothness and diffuseness of the density f. Also, $x_u = x + 0.5$, $x_l = x - 0.5$, $y_u = y + 0.5$, and $y_l = y - 0.5$, where the units are miles, and w_{off} and w_{on} are the relative frequencies of crash locations in the database off and on the airport, respectively. Values for the quantities (n, h_x, h_y, σ, w_{off}, w_{on}) are included as Table 3.39.

TABLE 3.39 Constants Required to Formulate Location Estimate Using Equation 3.1

PHASE	n	h_x	h_y	σ	w_{off}	w_{on}
GA Landing	574	0.95	0.41	0.46	0.4915	0.5085
GA Takeoff	106	0.69	0.45	0.46	0.4546	0.5454

The tables listed below give the GA crash locations and probabilities:

Table 3.40 General Aviation Takeoff Crash Locations
Table 3.41 General Aviation Landing Crash Locations
Table 3.42 General Aviation Takeoff Crash Location Probabilities
Table 3.43 General Aviation Landing Crash Location Probabilities.

	x coordinate	y coordinate
1	-1.000	0.000
2	-1.000	0.000
3	-0.857	-0.515
4	-0.342	-0.940
5	0.000	-1.000
6	0.000	1.000
7	0.174	-0.985
8	0.174	-0.985
9	0.174	0.985
10	0.174	0.985
11	0.342	-0.940
12	0.342	0.940
13	0.500	-0.866
14	0.500	0.866
15	0.695	-0.719
16	0.707	0.707
17	0.707	0.707
18	0.766	-0.643
19	0.766	0.643
20	0.819	0.574
21	0.866	-0.500
22	0.866	-0.500
23	0.866	0.500
24	0.866	0.500
25	0.940	-0.342
26	0.940	-0.342
27	0.940	0.342
28	0.940	0.342
29	0.940	0.342
30	0.940	0.342
31	0.966	0.259
32	0.966	0.259
33	0.985	-0.174
34	0.985	-0.174
35	0.985	0.174

	x coordinate	y coordinate
36	0.985	0.174
37	0.993	0.122
38	0.996	-0.087
39	0.996	-0.087
40	0.996	0.087
41	0.999	0.035
42	0.999	0.035
43	1.000	-0.017
44	1.000	0.000
45	1.000	0.000
46	1.000	0.000
47	1.000	0.000
48	1.000	0.000
49	1.000	0.000
50	1.000	0.000
51	1.000	0.000
52	1.000	0.000
53	1.000	0.000
54	1.000	0.000
55	1.000	0.000
56	1.000	0.000
57	1.000	0.000
58	1.000	0.000
59	1.000	0.000
60	1.000	0.000
61	1.000	0.000
62	1.000	0.000
63	1.000	0.000
64	1.000	0.000
65	1.000	0.000
66	1.000	0.000
67	1.000	0.000
68	1.000	0.000
69	1.000	0.000
70	1.000	0.000

	x coordinate	y coordinate
71	1.000	0.000
72	1.000	0.000
73	1.000	0.000
74	1.000	0.000
75	1.000	0.000
76	1.000	0.000
77	1.000	0.000
78	1.286	1.532
79	1.414	1.414
80	1.500	2.598
81	1.638	-1.147
82	1.813	0.845
83	1.879	0.684
84	1.913	-0.585
85	1.970	-0.347
86	1.970	0.347
87	2.000	0.000
88	2.000	0.000
89	2.000	0.000
90	2.000	0.000
91	2.000	0.000
92	2.000	0.000
93	2.571	-3.064
94	2.819	1.026
95	2.954	-0.521
96	3.000	0.000
97	3.000	0.000
98	3.000	0.000
99	4.698	1.710
100	4.698	1.710
101	5.000	0.000
102	5.000	0.000
103	5.000	0.000
104	5.000	0.000
105	5.438	-2.536
106	6.000	0.000

Table 3.40

General Aviation Takeoff Crash Locations

	x coordinate	y coordinate
1	-13.000	0.000
2	-12.951	1.133
3	-11.998	-0.209
4	-11.984	-0.628
5	-11.954	1.046
6	-11.818	-2.084
7	-11.818	2.084
8	-10.833	1.910
9	-10.000	0.000
10	-9.986	0.523
11	-9.962	-0.872
12	-9.848	-1.736
13	-9.848	1.736
14	-9.000	0.000
15	-8.000	0.000
16	-7.995	0.279
17	-7.878	1.389
18	-7.000	0.000
19	-6.983	0.488
20	-6.928	-4.000
21	-6.914	-1.095
22	-6.894	1.216
23	-6.578	-2.394
24	-6.000	0.000
25	-6.000	0.000
26	-6.000	0.000
27	-6.000	0.000
28	-6.000	0.000
29	-6.000	0.000
30	-6.000	0.000
31	-5.985	0.419
32	-5.909	1.042
33	-5.909	1.042
34	-5.638	2.052
35	-5.438	2.536
36	-5.000	0.000
37	-5.000	0.000
38	-5.000	0.000
39	-5.000	0.000
40	-5.000	0.000
41	-5.000	0.000
42	-5.000	0.000
43	-5.000	0.000
44	-5.000	0.000
45	-5.000	0.000
46	-4.981	0.436
47	-4.973	-0.523
48	-4.924	0.868
49	-4.698	-1.710
50	-4.532	-2.113

	x coordinate	y coordinate
51	-4.243	-4.243
52	-3.995	0.209
53	-3.985	-0.349
54	-3.939	0.695
55	-3.830	-3.214
56	-3.830	3.214
57	-3.830	-3.214
58	-3.825	-1.169
59	-3.214	-3.830
60	-3.000	0.000
61	-3.000	0.000
62	-3.000	0.000
63	-3.000	0.000
64	-3.000	0.000
65	-3.000	0.000
66	-3.000	0.000
67	-3.000	0.000
68	-3.000	0.000
69	-3.000	0.000
70	-3.000	0.000
71	-3.000	0.000
72	-3.000	0.052
73	-2.989	0.261
74	-2.954	-0.521
75	-2.954	-0.521
76	-2.954	0.521
77	-2.723	-4.193
78	-2.677	2.973
79	-2.516	1.634
80	-2.500	4.330
81	-2.298	-1.928
82	-2.298	1.928
83	-2.298	1.928
84	-2.298	1.928
85	-2.298	1.928
86	-2.121	-2.121
87	-2.000	0.000
88	-2.000	0.000
89	-2.000	0.000
90	-2.000	0.000
91	-2.000	0.000
92	-2.000	0.000
93	-2.000	0.000
94	-2.000	0.000
95	-2.000	0.000
96	-2.000	0.000
97	-2.000	0.000
98	-2.000	0.000
99	-2.000	0.000
100	-2.000	0.000

	x coordinate	y coordinate
101	-2.000	0.000
102	-2.000	0.000
103	-2.000	0.000
104	-2.000	0.000
105	-2.000	0.000
106	-2.000	0.000
107	-2.000	0.000
108	-2.000	0.000
109	-2.000	0.000
110	-2.000	3.464
111	-1.999	0.070
112	-1.995	-0.140
113	-1.992	-0.174
114	-1.992	-0.174
115	-1.992	0.174
116	-1.981	0.278
117	-1.975	0.313
118	-1.970	-0.347
119	-1.970	-0.347
120	-1.970	0.347
121	-1.970	0.347
122	-1.970	0.347
123	-1.970	0.347
124	-1.970	0.347
125	-1.970	0.347
126	-1.932	0.518
127	-1.928	-2.298
128	-1.902	-0.618
129	-1.879	0.684
130	-1.879	-0.684
131	-1.879	-0.684
132	-1.813	0.845
133	-1.732	-1.000
134	-1.732	1.000
135	-1.732	-1.000
136	-1.721	2.457
137	-1.634	-2.516
138	-1.532	-1.286
139	-1.532	-1.286
140	-1.500	-2.598
141	-1.500	2.598
142	-1.414	1.414
143	-1.414	1.414
144	-1.368	3.759
145	-1.362	2.673
146	-1.286	-1.532
147	-1.286	-1.532
148	-1.286	1.532
149	-1.286	1.532
150	-1.231	1.576

	x coordinate	y coordinate
151	-1.000	0.000
152	-1.000	0.000
153	-1.000	0.000
154	-1.000	0.000
155	-1.000	0.000
156	-1.000	0.000
157	-1.000	0.000
158	-1.000	0.000
159	-1.000	0.000
160	-1.000	0.000
161	-1.000	0.000
162	-1.000	0.000
163	-1.000	0.000
164	-1.000	0.000
165	-1.000	0.000
166	-1.000	0.000
167	-1.000	0.000
168	-1.000	0.000
169	-1.000	0.000
170	-1.000	0.000
171	-1.000	0.000
172	-1.000	0.000
173	-1.000	0.000
174	-1.000	0.000
175	-1.000	0.000
176	-1.000	0.000
177	-1.000	0.000
178	-1.000	0.000
179	-1.000	0.000
180	-1.000	0.000
181	-1.000	0.000
182	-1.000	0.000
183	-1.000	0.000
184	-1.000	0.000
185	-1.000	0.000
186	-1.000	0.000
187	-1.000	0.000
188	-1.000	0.000
189	-1.000	0.000
190	-1.000	0.000
191	-1.000	0.000
192	-1.000	0.000
193	-1.000	0.000
194	-1.000	0.000
195	-1.000	0.000
196	-1.000	0.000
197	-1.000	0.000
198	-1.000	0.000
199	-1.000	0.000
200	-1.000	0.000

	x coordinate	y coordinate
201	-1.000	0.000
202	-1.000	0.000
203	-1.000	0.000
204	-1.000	0.000
205	-1.000	0.000
206	-1.000	0.000
207	-1.000	0.000
208	-1.000	0.000
209	-1.000	0.000
210	-1.000	0.000
211	-1.000	0.000
212	-1.000	0.000
213	-1.000	0.000
214	-1.000	0.000
215	-1.000	0.000
216	-1.000	0.000
217	-1.000	0.000
218	-1.000	0.000
219	-1.000	0.000
220	-1.000	0.000
221	-1.000	0.000
222	-1.000	0.000
223	-1.000	0.000
224	-1.000	0.000
225	-1.000	0.000
226	-1.000	0.000
227	-1.000	0.000
228	-1.000	0.000
229	-1.000	0.000
230	-1.000	0.000
231	-1.000	0.000
232	-1.000	0.000
233	-1.000	0.000
234	-1.000	0.000
235	-1.000	0.000
236	-1.000	0.000
237	-1.000	0.000
238	-1.000	0.000
239	-1.000	0.000
240	-1.000	0.000
241	-1.000	0.000
242	-1.000	0.000
243	-1.000	0.000
244	-1.000	0.000
245	-1.000	0.000
246	-1.000	1.732
247	-0.999	0.035
248	-0.999	0.035
249	-0.999	-0.052
250	-0.996	-0.087

Table 3.41
General Aviation Landing Crash Locations

	x coordinate	y coordinate
251	-0.996	-0.087
252	-0.996	0.087
253	-0.985	-0.174
254	-0.985	-0.174
255	-0.985	-0.174
256	-0.985	-0.174
257	-0.985	-0.174
258	-0.985	0.174
259	-0.985	0.174
260	-0.985	0.174
261	-0.985	0.174
262	-0.985	0.174
263	-0.985	0.174
264	-0.985	0.174
265	-0.985	0.174
266	-0.985	0.174
267	-0.985	0.174
268	-0.982	0.191
269	-0.966	0.259
270	-0.966	0.259
271	-0.966	0.259
272	-0.966	0.259
273	-0.940	-0.342
274	-0.940	0.342
275	-0.940	0.342
276	-0.940	0.342
277	-0.940	0.342
278	-0.940	-0.342
279	-0.940	-0.342
280	-0.940	-0.342
281	-0.940	0.342
282	-0.940	0.342
283	-0.940	0.342
284	-0.940	0.342
285	-0.906	-0.423
286	-0.875	-0.485
287	-0.868	4.924
288	-0.866	-0.500
289	-0.866	0.500
290	-0.866	-0.500
291	-0.866	0.500
292	-0.866	0.500
293	-0.866	0.500
294	-0.819	-0.574
295	-0.819	-0.574
296	-0.788	0.616
297	-0.766	-0.643
298	-0.766	0.643
299	-0.766	-0.643
300	-0.766	-0.643

	x coordinate	y coordinate
301	-0.766	-0.643
302	-0.766	-0.643
303	-0.707	-0.707
304	-0.695	0.719
305	-0.695	3.939
306	-0.643	-0.766
307	-0.643	-0.766
308	-0.643	-0.766
309	-0.643	0.766
310	-0.643	-0.766
311	-0.643	0.766
312	-0.574	0.819
313	-0.515	-0.857
314	-0.515	-0.857
315	-0.500	0.866
316	-0.500	0.866
317	-0.500	0.866
318	-0.500	0.866
319	-0.342	-0.940
320	-0.342	-0.940
321	-0.342	-0.940
322	-0.309	0.951
323	-0.259	0.966
324	-0.174	-0.985
325	-0.174	-0.985
326	-0.174	0.985
327	-0.174	0.985
328	-0.174	0.985
329	-0.174	0.985
330	-0.156	0.988
331	-0.087	-0.996
332	-0.087	-0.996
333	-0.070	0.998
334	-0.017	-1.000
335	0.000	-5.000
336	0.000	5.000
337	0.000	-1.000
338	0.000	-1.000
339	0.000	-1.000
340	0.000	-1.000
341	0.000	-1.000
342	0.000	-1.000
343	0.000	-1.000
344	0.000	-1.000
345	0.000	1.000
346	0.000	1.000
347	0.000	1.000
348	0.000	1.000
349	0.000	1.000
350	0.000	1.000

	x coordinate	y coordinate
351	0.000	-2.000
352	0.000	-3.000
353	0.000	-3.000
354	0.000	3.000
355	0.000	-5.000
356	0.174	-0.985
357	0.174	-0.985
358	0.174	0.985
359	0.174	0.985
360	0.174	-0.985
361	0.174	-0.985
362	0.174	-0.985
363	0.174	0.985
364	0.174	0.985
365	0.174	0.985
366	0.174	0.985
367	0.309	0.951
368	0.342	-0.940
369	0.342	-0.940
370	0.342	0.940
371	0.342	0.940
372	0.342	0.940
373	0.342	0.940
374	0.342	0.940
375	0.438	-0.899
376	0.485	-0.875
377	0.500	-0.866
378	0.500	-0.866
379	0.500	-0.866
380	0.500	-0.866
381	0.500	0.866
382	0.500	0.866
383	0.500	0.866
384	0.500	0.866
385	0.643	0.766
386	0.643	0.766
387	0.643	0.766
388	0.684	-1.879
389	0.707	0.707
390	0.766	-0.643
391	0.766	0.643
392	0.766	-0.643
393	0.766	0.643
394	0.766	0.643
395	0.766	0.643
396	0.766	0.643
397	0.766	0.643
398	0.766	0.643
399	0.766	0.643
400	0.819	-0.574

	x coordinate	y coordinate
401	0.819	0.574
402	0.857	-0.515
403	0.866	-0.500
404	0.866	-0.500
405	0.866	-0.500
406	0.866	-0.500
407	0.866	-0.500
408	0.866	-0.500
409	0.866	0.500
410	0.866	0.500
411	0.866	0.500
412	0.866	0.500
413	0.866	0.500
414	0.866	0.500
415	0.866	0.500
416	0.868	4.924
417	0.906	-0.423
418	0.940	-0.342
419	0.940	-0.342
420	0.940	-0.342
421	0.940	-0.342
422	0.940	-0.342
423	0.940	-0.342
424	0.940	0.342
425	0.940	0.342
426	0.940	0.342
427	0.940	0.342
428	0.985	-0.174
429	0.985	-0.174
430	0.985	-0.174
431	0.985	-0.174
432	0.985	-0.174
433	0.985	-0.174
434	0.985	-0.174
435	0.985	-0.174
436	0.985	0.174
437	0.985	0.174
438	0.985	0.174
439	0.985	0.174
440	0.985	0.174
441	0.985	0.174
442	0.985	0.174
443	0.985	0.174
444	0.985	0.174
445	0.985	0.174
446	0.996	-0.087
447	0.996	-0.087
448	0.999	0.035
449	0.999	0.035
450	1.000	-1.732

	x coordinate	y coordinate
451	1.000	0.000
452	1.000	0.000
453	1.000	0.000
454	1.000	0.000
455	1.000	0.000
456	1.000	0.000
457	1.000	0.000
458	1.000	0.000
459	1.000	0.000
460	1.000	0.000
461	1.000	0.000
462	1.000	0.000
463	1.000	0.000
464	1.000	0.000
465	1.000	0.000
466	1.000	0.000
467	1.000	0.000
468	1.000	0.000
469	1.000	0.000
470	1.000	0.000
471	1.000	0.000
472	1.000	0.000
473	1.000	0.000
474	1.000	0.000
475	1.000	0.000
476	1.000	0.000
477	1.000	0.000
478	1.000	0.000
479	1.000	0.000
480	1.000	0.000
481	1.000	0.000
482	1.000	0.000
483	1.000	0.000
484	1.000	0.000
485	1.000	0.000
486	1.000	0.000
487	1.000	0.000
488	1.000	0.000
489	1.000	0.000
490	1.000	0.000
491	1.000	0.000
492	1.000	0.000
493	1.000	0.000
494	1.000	0.000
495	1.000	0.000
496	1.000	0.000
497	1.000	0.000
498	1.000	0.000
499	1.000	0.000
500	1.000	0.000

Table 3.41 (continued)
General Aviation Landing Crash Locations

	x coordinate	y coordinate
501	1.000	0.000
502	1.000	0.000
503	1.000	0.000
504	1.000	0.000
505	1.000	0.000
506	1.000	0.000
507	1.000	0.000
508	1.000	0.000
509	1.000	0.000
510	1.000	0.000
511	1.000	0.000
512	1.000	0.000
513	1.000	0.000
514	1.000	0.000
515	1.000	0.000
516	1.000	0.000
517	1.000	1.732
518	1.000	1.732
519	1.286	-1.532
520	1.286	1.532
521	1.368	3.759
522	1.782	0.908
523	1.879	0.684
524	1.928	-2.298
525	1.932	-0.518
526	1.970	-0.347
527	1.970	-0.347
528	1.970	-0.347
529	1.970	0.347
530	2.000	0.000
531	2.000	0.000
532	2.000	0.000
533	2.000	0.000
534	2.000	0.000
535	2.000	0.000
536	2.000	0.000
537	2.500	4.330
538	2.598	-1.500
539	2.598	-1.500
540	2.819	1.026
541	2.898	0.776
542	2.954	-0.521
543	2.954	-0.521
544	2.954	0.521
545	2.954	0.521
546	3.000	0.000
547	3.000	0.000
548	3.000	0.000
549	3.000	0.000
550	3.064	2.571

	x coordinate	y coordinate
551	3.830	-3.214
552	3.830	3.214
553	3.857	-4.596
554	3.939	-0.695
555	4.000	0.000
556	4.000	0.000
557	4.000	0.000
558	4.330	-2.500
559	4.330	2.500
560	4.455	2.270
561	4.596	3.857
562	4.830	1.294
563	4.924	-0.868
564	4.924	-0.868
565	4.924	-0.868
566	4.981	0.436
567	5.000	0.000
568	5.000	0.000
569	5.000	0.000
570	5.000	0.000
571	5.000	0.000
572	5.000	0.000
573	5.000	0.000
574	5.000	0.000

Table 3.41 (continued)
General Aviation Landing Crash Locations

Y \ X	(-4,-3)	(-3,-2)	(-2,-1)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	(5,6)	(6,7)	(7,8)
(3,4)				1.2E-05	1.7E-04	4.2E-04	1.7E-04	1.4E-05				
(2,3)			1.1E-05	1.5E-04	1.1E-03	2.2E-03	8.9E-04	4.0E-04	1.1E-03	6.5E-04	6.3E-05	
(1,2)		1.6E-05	5.2E-04	6.4E-03	1.3E-02	9.8E-03	4.0E-03	1.9E-03	3.2E-03	1.9E-03	2.1E-04	
(0,1)		3.4E-04	5.1E-03	1.5E-01	2.0E-01	6.9E-02	2.2E-02	5.8E-03	4.5E-03	4.5E-03	1.5E-03	4.6E-04
(-1,0)	1.1E-05	4.8E-04	6.4E-03	1.5E-01	2.0E-01	6.3E-02	2.1E-02	6.1E-03	4.3E-03	4.4E-03	1.5E-03	1.6E-04
(-2,-1)		5.9E-05	1.0E-03	7.2E-03	1.1E-02	5.7E-03	2.0E-03	5.1E-04	2.7E-04	3.8E-04	1.4E-04	1.0E-05
(-3,-2)			1.7E-05	1.0E-04	1.7E-04	4.5E-04	1.0E-03	5.1E-04	2.7E-04	3.8E-04	1.4E-04	1.0E-05
(-4,-3)					2.6E-05	4.4E-04	1.2E-03	5.7E-04	2.0E-04	3.4E-04	1.2E-04	
(-5,-4)						1.5E-05	4.2E-05	2.0E-05				

Table 3.42
Crash Location Probability f(x,y) for
General Aviation Takeoffs

Y \ X	(-16,-15)	(-15,-14)	(-14,-13)	(-13,-12)	(-12,-11)	(-11,-10)	(-10,-9)	(-9,-8)	(-8,-7)	(-7,-6)	(-6,-5)	(-5,-4)	(-4,-3)	(-3,-2)	(-2,-1)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	5,6)	(6,7)	(7,8)
(5,6)													1.5E-05	6.3E-05	1.9E-04	3.5E-04	3.5E-04	1.9E-04	6.2E-05	1.5E-05				
(4,5)												4.3E-05	1.9E-04	4.3E-04	6.1E-04	6.8E-04	6.0E-04	4.9E-04	3.8E-04	2.4E-04	1.7E-04	8.7E-05	2.0E-05	
(3,4)										3.3E-05	1.1E-04	2.7E-04	5.2E-04	8.3E-04	9.7E-04	7.6E-04	5.0E-04	3.9E-04	3.7E-04	4.8E-04	4.8E-04	2.3E-04	4.4E-05	
(2,3)			5.6E-05	2.0E-04	3.3E-04	2.9E-04	1.6E-04	7.1E-05	9.9E-05	3.1E-04	5.0E-04	4.5E-04	7.5E-04	1.5E-03	1.7E-03	1.1E-03	6.0E-04	4.0E-04	4.5E-04	7.1E-04	7.1E-04	3.3E-04	6.0E-05	
(1,2)		7.2E-05	2.8E-04	5.2E-04	6.1E-04	5.6E-04	4.5E-04	4.5E-04	6.5E-04	8.8E-04	8.7E-04	6.6E-04	1.1E-03	3.0E-03	5.8E-03	1.2E-02	1.1E-02	4.4E-03	1.5E-03	7.0E-04	5.3E-04	3.3E-04	8.9E-05	
(0,1)	1.2E-05	1.0E-04	3.5E-04	5.3E-04	5.0E-04	5.8E-04	7.4E-04	9.5E-04	1.6E-03	2.9E-03	4.0E-03	4.3E-03	7.2E-03	1.8E-02	3.9E-02	1.6E-01	1.6E-01	2.9E-02	1.1E-02	3.9E-03	2.6E-03	1.7E-03	5.6E-04	6.8E-05
(-1,0)		7.3E-05	3.1E-04	6.0E-04	6.3E-04	6.0E-04	6.5E-04	6.7E-04	1.1E-03	2.2E-03	3.3E-03	3.8E-03	6.8E-03	1.7E-02	3.7E-02	1.6E-01	1.6E-01	2.8E-02	1.0E-02	4.0E-03	3.0E-03	2.1E-03	6.5E-04	7.7E-05
(-2,-1)			5.8E-05	1.9E-04	3.0E-04	3.9E-04	3.7E-04	2.1E-04	2.5E-04	3.5E-04	5.1E-04	7.4E-04	1.0E-03	2.3E-03	4.9E-03	1.1E-02	1.0E-02	3.8E-03	1.6E-03	8.2E-04	6.0E-04	4.0E-04	1.2E-04	1.4E-05
(-3,-2)			4.6E-05	1.6E-04	2.1E-04	1.5E-04	1.0E-04	7.8E-05	1.9E-04	3.2E-04	3.9E-04	5.3E-04	6.8E-04	1.1E-03	1.4E-03	1.2E-03	9.4E-04	6.8E-04	4.7E-04	4.2E-04	3.7E-04	1.6E-04	2.7E-05	
(-4,-3)								5.2E-05	1.6E-04	2.0E-04	2.5E-04	6.0E-04	8.3E-04	5.8E-04	3.6E-04	3.9E-04	3.3E-04	1.4E-04	1.4E-04	2.8E-04	2.4E-04	8.1E-05		
(-5,-4)								4.8E-05	1.5E-04	1.7E-04	1.8E-04	3.5E-04	4.8E-04	3.8E-04	2.5E-04	3.3E-04	3.1E-04	1.2E-04	1.2E-04	2.6E-04	2.2E-04	6.8E-05		
(-6,-5)												1.3E-05	1.6E-05	2.5E-05	1.1E-04	3.0E-04	3.0E-04	3.5E-05	1.1E-04	5.3E-05	4.5E-05	1.4E-05		

Table 3.43
Crash Location Probability f(x,y) for
General Aviation Landings

3.6.2 IMPACT VELOCITY DISTRIBUTION

An important input to the detailed calculation of aircraft crash likelihood is the distribution of aircraft velocity at the time of impact. The NTSB database records airspeeds at impact using 11 ordinal categories; this information was regrouped into five segments to ensure adequate cell counts for further statistical analysis, as shown in Table 3.44.

Table 3.44
DISTRIBUTION OF IMPACT VELOCITIES

Impact Velocity (knots)	*Percentage*
0-30	6.3
30-60	29.7
60-90	38.4
90-120	14.2
> 120	11.4

An investigation was conducted to see if impact velocities were correlated to the angle of impact or to aircraft weight; results of an analysis of variance (ANOVA) indicated no significant interactions at the 0.05 significance level.

3.6.3 IMPACT ANGLE DISTRIBUTION

An important input to the detailed calculation of aircraft crash likelihood is the distribution of aircraft impact angle. In this study, the term *impact angle* is defined as the aircraft's flight path angle as measured with respect to horizontal (e.g., 0 degrees implies level flight while 90 degrees implies that the aircraft is traveling straight down); impact angle is not related to an aircraft's orientation, as measured by its roll, pitch, and yaw angles. The NTSB database records impact angles using nine ordinal categories; this information was regrouped into five segments to ensure adequate cell counts for further statistical analysis, as shown in Table 3.45.

Table 3.45
DISTRIBUTION OF IMPACT ANGLES

Impact Angle (degrees)	*Percentage*
0-10	42.6
10-20	19.0
20-30	11.2
30-60	14.9
> 60	12.3

As noted in Section 3.6.2, results of an analysis of variance (ANOVA) indicated no significant interactions among impact velocity, impact angle, and aircraft weight at the 0.05 significance level.

3.6.4 SKID DISTANCE DISTRIBUTION

In order to support the screening analysis, an empirical distribution of skid distances was developed from the NTSB database (Figure 3.1) by combining the data across all aircraft subcategories, impact velocities, and impact angles. It should be noted that about 32.1% of all aircraft crashes do not result in a measurable skid distance. Approximately 90% of all skids are less than 135 feet, and this value is suggested for use in the screening analysis.

In order to support the detailed analysis, multiple regression analysis was used to correlate skid distances to aircraft weight, impact velocity, and impact angle since these parameters dictate an aircraft's momentum at the time of impact. Regression analysis is well-suited since skid distance and aircraft weight are continuous quantities, and the influence of the ordinal impact velocity and impact angle groups can be readily accommodated using indicator variables. The basic form of the regression equation is:

$$\ln L = b * m \ln W = \sum_{i=1}^{5} S_i \alpha_i + \sum_{j=1}^{5} A_j \beta_j + \varepsilon \tag{3.2}$$

where: L = skid distance,
W = aircraft weight,
S_i = indicator variables for impact velocity,
A_j = indicator variables for impact angle,
b = intercept term,
m = slope coefficient related to weight,
α_i = differential intercept coefficients related to impact velocity,
β_i = differential intercept coefficients related to impact angle,
ε = normal random variable with mean = 0 and variance = σ^2,

It should be noted that the indicators variables are set as ordered quintuples when using the regression equation. For example, if the impact velocity range is 30-60 knots and the impact angle range is 0-10 degrees, then $\{S_1 = 0, S_2 = 1, S_3 = 0, S_4 = 0, S_5 = 0\}$ and $\{A_1 = 1, A_2 = 0, A_3 = 0, A_4 = 0, A_5 = 0\}$.

Results of the multiple regression are shown in Table 3.46. As expected, the signs and magnitudes of the regression parameters coincide with common sense: skid distance increases as the aircraft weight and impact velocity increase, and decreases as the impact angle increases. A plot of the residuals (Figure 3.2) shows a linear trend (distorted at the tails), tending to confirm the normality of the error term.

The results of the regression analysis can be used to predict the skid distance distribution given aircraft weight, impact velocity, and impact angle. For example, consider the situation in which the aircraft weight is 1500 pounds, the impact velocity range is 60-90 knots, and the impact angle range is 20-30 degrees. Then,

$$\begin{aligned} \ln L &= 0.184 + 0.349 \ln 1500 + (-0.485 * 0 - 0.310 * 0 + 0.000989 * 1 + 0.206 * 0 + 0.626 * 0) \\ &\quad + (0.471 * 0 + 0.116 * 0 - 0.236 * 1 - 0.405 * 0 - 0.559 * 0) \\ &= 2.50 \end{aligned} \tag{3.3}$$

Recalling that ln L is normally distributed, then L is log-normally distributed, i.e.,

$$\Pr\{L \le x\} = \Phi\left[\frac{\ln x - 2.50}{1.32}\right] \tag{3.4}$$

where:

$$\Phi[y] = \text{ standard normal distribution function} \tag{3.5}$$

Thus, the 90th percentile of the skid distance for this example (i.e., the value of x such that $\Pr\{L \le x\} = 0.90\}$) is given by:

$$\begin{aligned} x_{0.9} &= \exp\ [2.50 + 1.2816 \cdot 1.32] \\ &= 66.1 \text{ feet} \end{aligned} \tag{3.6}$$

Table 3.46
MULTIPLE REGRESSION ANALYSIS FOR SKID DISTANCE

Parameter	*Value*
b (intercept term)	0.184
m (aircraft weight-related slope)	0.349
differential intercept coefficients for impact velocity	
0-30 knots: α_1	-0.485
30-60 knots: α_2	-0.310
60-90 knots: α_3	0.000989
90-120 knots: α_4	0.206
> 120 knots: α_5	0.626
differential intercept coefficients for impact angle	
0-10 degrees: β_1	0.471
10-20 degrees: β_2	0.116
20-30 degrees: β_3	-0.236
30-60 degrees: β_4	-0.405
> 60 degrees: β_5	-0.559
coefficient of multiple regression (R)	0.44
sigma	1.32

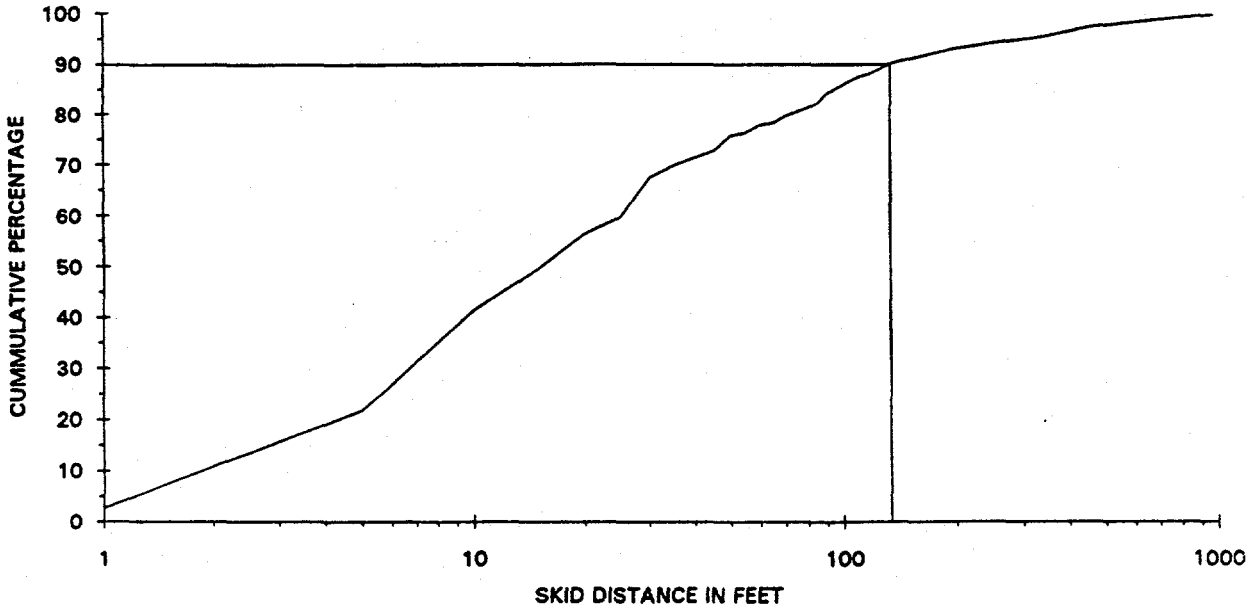

Figure 3.1
General Aviation Empirical Skid Distance Distribution

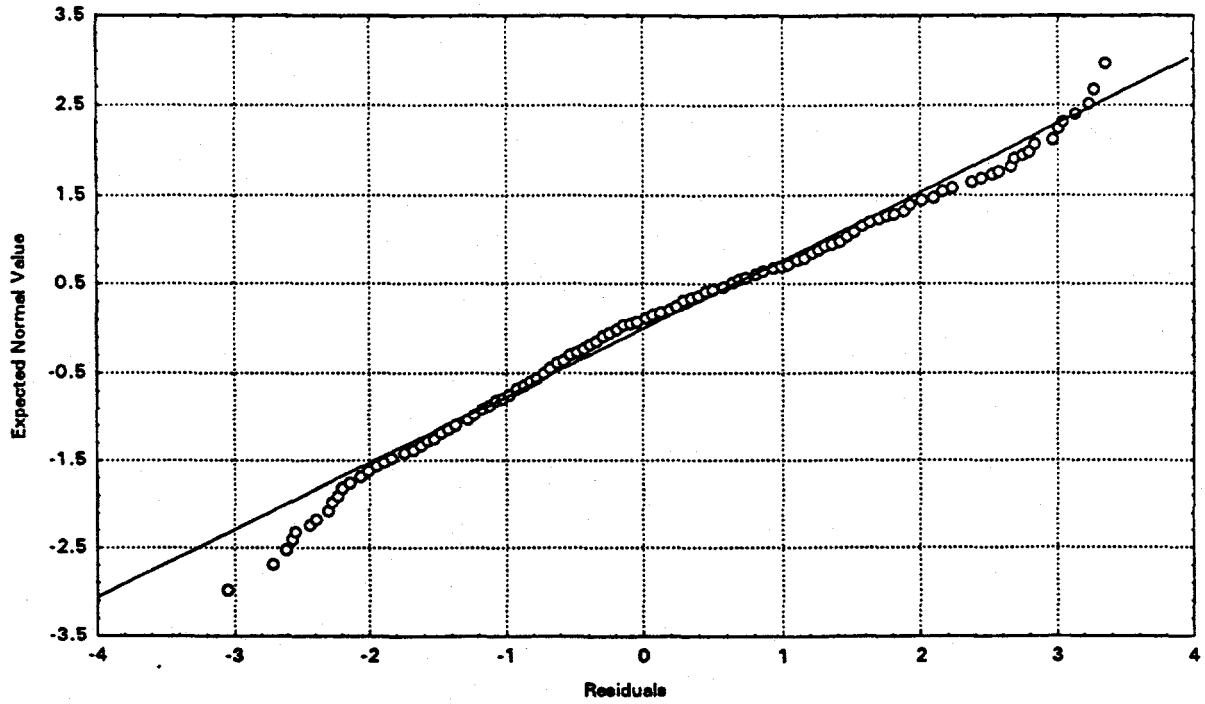

Figure 3.2
Normal Probability Plots of Residuals

3.7 GENERAL AVIATION AIRCRAFT CHARACTERISTICS

This section was prepared to provide to the analyst those characteristics of aircraft that could be important to determine the effect of the aircraft on the facility. Such aircraft characteristics which could be crucial in determine whether a facility could withstand an impact from an aircraft could be the weight of the aircraft, the amount of fuel aboard the aircraft, the speed of the aircraft, the dimensions of the aircraft, and potential missiles generated by the aircraft as its structure failed. Many of these parameters would vary greatly during the course of the flight, but the values of the characteristics given in this section could be considered the upper bound of these parameters. To determine the characteristics of an aircraft at the moment of impact in a particular accident, the analyst should refer to the specific accident report.

Tables 3.47 to 3.52 taken from References 3.29 to 3.35 presents the following information on general aviation aircraft characteristics:

1. Aircraft type,
2. Powerplant(s), number and type,
3. Nominal power rating of each powerplant,
4. Operating empty weight expressed in pounds, and kilograms,
5. Maximum allowed (or certificated) takeoff weight expressed in pounds, and kilograms,
6. Maximum allowed (or certificated) landing weight expressed in pounds, and kilograms,
7. Maximum zero-fuel weight expressed in pounds, and kilograms,
8. Maximum fuel-capacity expressed in imperial gallons, and liters,
9. Overall wing span expressed in feet and inches, and in meters,
10. Overall length expressed in feet and inches, and in meters,
11. Overall height expressed in feet and inches, and in meters,
12. Wing area expressed in $ft.^2$ and $meters^2$,
13. Takeoff runway length according to Federal Air Regulations (FAR) requirements, expressed in feet,
14. Landing runway length according to Federal Air Regulations (FAR) requirements, expressed in feet,
15. Stall speed with gear flaps deployed, expressed in miles/hour.

Powerplant(s) were included as potential missile generators. Weights were given for mass during various points of the flight. Fuel capacity was included in order to provide the maximum fuel available for a fire following the crash. Aircraft dimensions will be needed when the facility effective area is determined. The takeoff runway length and landing runway length were provided so that an analyst could screen certain aircraft from certain airports due to their inability to operate from the airport's runway(s). Stall speed was provided so that an estimate of the impact speed could be made as a large percentage of general aviation aircraft crashes occur during the landing approach flight phase, and most general aviation aircraft fly the approach phase at about 1.3 times the stall speed.

The tables listed below gives the general aviation subcategories for which the general aviation aircraft characteristics table were created:

Table 3.47	Single-engine reciprocating (piston), fixed wing,
Table 3.48	Single-engine agricultural, fixed wing,
Table 3.49	Multi-engine reciprocating (piston), fixed wing,
Table 3.50	Turboprop, fixed wing,
Table 3.51	Turbojet, fixed wing,
Table 3.52	Rotary wing,

Aircraft are listed in descending order of maximum takeoff weight within each subcategory.

A separate table for single-engine agricultural, fixed wing aircraft was created because the size, weight, engine power, and flight profiles of these aircraft differed so greatly from the standard single-engine piston, fixed wing aircraft population. We have not attempted to characterize the agricultural aircraft population in terms of number of active aircraft, distribution of active aircraft, number of opertions, etc.

This could be an area in which additional research would be justified, particularly if a facility has a large number of agricultural aircraft operations in the nearby vicinity.

Finally, additional research is needed to characterize the missiles (projectiles) generated during the course of an aircraft's crash. Obvious examples of such missiles are the aircraft's engines, the auxiliary power units (APUs), and the landing gear. Much of the information on these aircraft components is not readily available and may have to be obtained directly from the aircraft or engine manufacturer or from the company that produces the component.

Table 3.47
Characteristics of Single-Engine Reciprocating, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms
SINGLE-ENGINE RECIPROCATING (PISTON), FIXED WING											
Cessna Pressurized Centurion	1	Continental TSIO-520-P PP	310 hp	2,340	1,061	4,016	1,822	N.A.	N.A.	N.A.	N.A.
Cessna Turbo Centurion	1	Continental TSIO-520-R PP	310 hp	2,221	1,007	4,016	1,822	N.A.	N.A.	N.A.	N.A.
Cessna Turbo Stationair 8	1	Continental TSIO-520-M PP	310 hp	2,183	990	3,816	1,731	N.A.	N.A.	N.A.	N.A.
Cessna Stationair 8	1	Continental IO-520-F PP	300 hp	2,105	955	3,812	1,729	N.A.	N.A.	N.A.	N.A.
Cessna Centurion	1	Continental IO-520-L PP	300 hp	2,133	968	3,812	1,729	N.A.	N.A.	N.A.	N.A.
Beechcraft Bonanza A36TC	1	Continental TSIO-520-UB PP	300 hp	2,269	1,029	3,650	1,656	N.A.	N.A.	N.A.	N.A.
Cessna Turbo Stationair 6	1	Continental TSIO-520-M PP	310 hp	2,003	909	3,616	1,640	N.A.	N.A.	N.A.	N.A.
Piper Saratoga	1	Lycoming IO-540-K1G5D PP	300 hp	1,920	871	3,615	1,640	N.A.	N.A.	N.A.	N.A.
Cessna Stationair 6	1	Continental IO-520-F PP	300 hp	1,927	874	3,612	1,638	N.A.	N.A.	N.A.	N.A.
Piper Turbo Saratoga SP	1	Lycoming TIO-540-S1AD PP	300 hp	2,073	940	3,600	1,633	N.A.	N.A.	N.A.	N.A.
Piper Turbo Saratoga	1	Lycoming IO-540-K1G5D PP	300 hp	1,986	901	3,600	1,633	N.A.	N.A.	N.A.	N.A.
Beechcraft Bonanza A36	1	Continental IO-520-BB PP	285 hp	2,191	994	3,600	1,633	N.A.	N.A.	N.A.	N.A.
Beechcraft Bonanza F33A	1	Continental IO-520-BB PP	285 hp	2,132	967	3,400	1,542	N.A.	N.A.	N.A.	N.A.
Beechcraft Bonanza V35B	1	Continental IO-520-BB PP	285 hp	2,117	960	3,400	1,542	N.A.	N.A.	N.A.	N.A.
Cessna 185 Skywagon	1	Continental IO-520-D PP	300 hp	1,688	766	3,362	1,525	N.A.	N.A.	N.A.	N.A.
Cessna Turbo Skylane RG	1	Lycoming O-540-L3C5D PP	235 hp	1,791	812	3,112	1,412	N.A.	N.A.	N.A.	N.A.
Cessna Skylane RG	1	Lycoming O-540-L3C5D PP	235 hp	1,750	794	3,112	1,412	N.A.	N.A.	N.A.	N.A.
Cessna Turbo Skylane RG II	1	Lycoming O-540-L3C5D PP	235 hp	1,781	808	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Piper Turbo Saratoga	1	Lycoming TIO-540-SIAD PP	300 hp	1,617	733	3,000	1,361	N.A.	N.A.	N.A.	N.A.
Piper Dakota	1	Lycoming O-540-J3A5D PP	235 hp	1,634	741	3,000	1,361	N.A.	N.A.	N.A.	N.A.
Cessna 182R Skylane II	1	Continental O-470-U PP	230 hp	1,733	786	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Piper Turbo Arrow IV	1	Continental TSIO-360-F PP	200 hp	1,690	767	2,900	1,315	N.A.	N.A.	N.A.	N.A.
Piper Turbo Dakota	1	Continental TSIO-360-FB PP	200 hp	1,579	716	2,900	1,315	N.A.	N.A.	N.A.	N.A.
Mooney Turbo 231	1	Continental TSIO-360-GB PP	210 hp	1,800	816	2,900	1,315	N.A.	N.A.	N.A.	N.A.
Maule M-5-180C	1	Lycoming O-360-C1F PP	180 hp	1,300	590	2,900	1,315	N.A.	N.A.	N.A.	N.A.
Cessna 180 Skywagon	1	Continental O-470-U PP	230 hp	1,643	745	2,810	1,275	N.A.	N.A.	N.A.	N.A.
Piper Arrow IV	1	Lycoming IO-360-C1C6 PP	200 hp	1,641	744	2,750	1,247	N.A.	N.A.	N.A.	N.A.
Beechcraft Sierra 200	1	Lycoming IO-360-A1B6 PP	200 hp	1,713	777	2,750	1,247	N.A.	N.A.	N.A.	N.A.
Mooney 201	1	Lycoming IO-360-A3B6 PP	200 hp	1,640	744	2,740	1,243	N.A.	N.A.	N.A.	N.A.
Lake Aircraft Lake Buccanneer	1	Lycoming PP	200 hp	1,555	705	2,690	1,220	N.A.	N.A.	N.A.	N.A.
Cutlass RG	1	Lycoming O-360-F1A6 PP	180 hp	1,558	707	2,658	1,206	N.A.	N.A.	N.A.	N.A.
Cessna Hawk XP	1	Continental IO-360-KB PP	195 hp	1,538	698	2,558	1,160	N.A.	N.A.	N.A.	N.A.
Piper Archer II	1	Lycoming O-360-A4M	180 hp	1,418	643	2,550	1,157	N.A.	N.A.	N.A.	N.A.
Maule M-6	1	N.A.	N.A.	1,450	658	2,500	1,134	N.A.	N.A.	N.A.	N.A.
Maule M5-235C	1	Lycoming O-540-J1A5D PP	235 hp	1,400	635	2,500	1,134	N.A.	N.A.	N.A.	N.A.
Maule M5-210TC	1	Lycoming TO-360-F1A6D PP	210 hp	1,400	635	2,500	1,134	N.A.	N.A.	N.A.	N.A.
Maule M5-210C	1	Continental IO-360-D PP	210 hp	1,350	612	2,500	1,134	N.A.	N.A.	N.A.	N.A.
Beechcraft Sundowner	1	Lycoming O-360-A4K PP	180 hp	1,502	681	2,450	1,111	N.A.	N.A.	N.A.	N.A.
Piper Warrior II	1	Lycoming O-320-D3G PP	160 hp	1,340	608	2,325	1,055	N.A.	N.A.	N.A.	N.A.
Cessna Skyhawk	1	Lycoming O-320-H2AD PP	160 hp	1,403	636	2,307	1,046	N.A.	N.A.	N.A.	N.A.
Varga 2180	1	Lycoming O-320A	N.A.	1,175	533	1,870	848	N.A.	N.A.	N.A.	N.A.
Varga Kachina 2150A	1	Lycoming O-320-A2C PP	150 hp	1,125	510	1,817	824	N.A.	N.A.	N.A.	N.A.
Piper PA-18-150 Super Cub	1	Lycoming O-320 PP	150 hp	946	429	1,750	794	N.A.	N.A.	N.A.	N.A.
Beechcraft 77 Skipper	1	Lycoming O-235-L2C PP	115 hp	1,103	500	1,675	760	N.A.	N.A.	N.A.	N.A.
Piper PA-38-112 Tomahawk	1	Lycoming O-235-L2C PP	112 hp	1,128	512	1,670	757	N.A.	N.A.	N.A.	N.A.
Cessna 150 Commuter II	1	Continental O-200-A PP	100 hp	1,085	492	1,600	726	N.A.	N.A.	N.A.	N.A.
Cessna 150	1	Continental O-200-A PP	100 hp	985	447	1,500	680	N.A.	N.A.	N.A.	N.A.
Taylorcraft F-21	1	Lycoming O-235-L2C PP	118 hp	990	449	1,500	680	N.A.	N.A.	N.A.	N.A.
Piper J-3C-65 Cub	1	Continental A-65-1 PP	65 hp	640	290	1,100	499	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

PP = Pistonprop

hp = horsepower
bhp = brake horsepower

Table 3.47 (Continued)
Characteristics of Single-Engine Reciprocating, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
SINGLE-ENGINE RECIPROCATING (PISTON), FIXED WING													
Cessna Pressurized Centurion	89	405	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,160	1,500	66
Cessna Turbo Centurion	89	405	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,160	1,500	66
Cessna Turbo Stationair 6	73	332	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,860	1,500	66
Cessna Stationair 6	73	332	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,970	1,500	66
Cessna Centurion	89	405	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,030	1,500	64
Beechcraft Bonanza A36TC	74	336	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,012	1,449	65
Cessna Turbo Stationair 6	88	400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,640	1,395	62
Piper Saratoga	107	486	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,573	1,530	69
Cessna Stationair 6	88	400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,780	1,395	62
Piper Turbo Saratoga SP	107	486	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,420	1,640	69
Piper Turbo Saratoga	107	486	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,573	1,612	68
Beechcraft Bonanza A36	74	336	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,040	1,450	60
Beechcraft Bonanza F33A	74	336	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,769	1,324	58
Beechcraft Bonanza V35B	74	336	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,769	1,324	58
Cessna 185 Skywagon	84	382	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,430	1,400	56
Cessna Turbo Skylane RG	88	400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,570	1,320	57
Cessna Skylane RG	88	400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,570	1,320	57
Cessna Turbo Skylane RG II	92	418	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	56
Piper Turbo Saratoga	107	486	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,420	1,700	69
Piper Dakota	77	350	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,216	1,410	64
Cessna 182R Skylane II	88	400	35' 10"	10.92 m.	28' 0"	8.53 m.	9' 3"	2.82 m.	174.0	16.18	1,350	1,350	57
Piper Turbo Arrow IV	77	350	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,620	1,555	66
Piper Turbo Dakota	77	350	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,402	1,697	66
Mooney Turbo 231	72	327	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,060	2,280	65
Maule M-5-180C	63	286	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	600	600	38
Cessna 180 Skywagon	84	382	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,205	1,365	55
Piper Arrow IV	77	350	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,600	1,525	63
Beechcraft Sierra 200	57	259	32' 9"	9.98 m.	25' 9"	7.85 m.	8' 1"	2.46 m.	N.A.	N.A.	1,660	1,462	69
Mooney 201	64	291	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,517	1,610	61
Lake Aircraft Lake Buccanneer	54	245	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1100 (w)	600 (w)	45
Cutlass RG	62	282	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,775	1,340	57
Cessna Hawk XP	66	300	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,360	1,270	53
Piper Archer II	50	227	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,625	1,400	61
Maule M-6	69	314	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	26
Maule M5-235C	63	286	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	600	600	38
Maule M5-210TC	63	286	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	600	600	38
Maule M5-210C	63	286	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	600	600	38
Beechcraft Sundowner	57	259	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,955	1,484	58
Piper Warrior II	50	227	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,490	1,115	57
Cessna Skyhawk	50	227	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,390	1,250	50
Varga 2180	35	159	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,310	1,425	52
Varga Kachina 2150A	35	159	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	440	450	52
Piper PA-18-150 Super Cub	36	164	35' 3"	10.75 m.	22' 7"	6.88 m.	6' 9"	2.02 m.	178.5	16.58	500	885	42
Beechcraft 77 Skipper	29	132	30' 0"	9.14 m.	24' 0"	7.32 m.	7' 11"	2.41 m.	129.8	12.06	1,280	1,313	54
Piper PA-38-112 Tomahawk	32	145	34' 0"	10.36 m.	23' 1"	7.04 m.	9' 1"	2.77 m.	124.7	11.59	1,460	1,544	56
Cessna 150 Commuter II	37	168	33' 2"	10.11 m.	23' 11"	7.29 m.	8' 6"	2.59 m.	157.0	14.58	1,340	1,200	50
Cessna 150	37	168	33' 4"	10.17 m.	21' 6"	6.56 m.	6' 11"	2.11 m.	159.5	14.80	1,340	1,200	50
Taylorcraft F-21	24	109	36' 0"	10.98 m.	22' 3"	6.78 m.	6' 6"	1.98 m.	183.5	17.10	350	350	43
Piper J-3C-65 Cub	N.A.	N.A.	35' 3"	10.75 m.	22' 3"	6.78 m.	6' 8"	2.03 m.	178.5	16.60	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

w = water

Table 3.48
Characteristics of Single-Engine Agricultural, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram
SINGLE-ENGINE AGRICULTURAL, FIXED WING											
Ayres 400 Gal. Turbo Thrush	1	P&W. PT6A-34AG TP	750 hp	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Ayres 400 Gal. Turbo Thrush	1	P&W. PT6A-15AG TP	680 hp	3,600	1,633	8,200	3,719	N.A.	N.A.	N.A.	N.A.
NZ Aero. Ind. Cresco 600	1	Lycoming LTP 101/600A-1A TP	N.A.	2,560	1,161	7,000	3,175	N.A.	N.A.	N.A.	N.A.
Ayres 400 Gal. Turbo Thrush	1	P&W. PT6A-11AG TP	500 hp	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
PZL 600 Thrush	1	PZL-R3S PP?	600 hp	3,700	1,678	6,900	3,130	N.A.	N.A.	N.A.	N.A.
Ayres P&W 600 Thrush	1	P&W. R1340 PP	600 hp	3,700	1,678	6,900	3,130	N.A.	N.A.	N.A.	N.A.
Gulfstream Amer. Ag-Cat B/600	1	P&W. R1340 PP	600 hp	3,255	1,476	6,075	2,756	N.A.	N.A.	N.A.	N.A.
Gulfstream Amer. Ag-Cat B/450	1	P&W. R985 PP	450 hp	3,100	1,406	6,075	2,756	N.A.	N.A.	N.A.	N.A.
Ayres 1200 HP Bull Thrush	1	Wright R1820 PP	1200 hp	4,990	2,263	6,000	2,722	N.A.	N.A.	N.A.	N.A.
Ayres 500 Gal. Turbo Thrush	1	P&W. PT6A-34AG TP	N.A.	3,900	1,769	6,000	2,722	N.A.	N.A.	N.A.	N.A.
NZ Aero. Ind. Fletcher FU24-954	1	Lycoming 10-720 PP	400 hp	2,620	1,188	5,430	2,463	N.A.	N.A.	N.A.	N.A.
Eagle 300 Biplane	1	Lycoming IO-540-M1A5D PP	N.A.	2,322	1,053	5,400	2,449	N.A.	N.A.	N.A.	N.A.
Eagle 220 Biplane	1	Continental W-670-6N PP	N.A.	2,549	1,156	5,100	2,313	N.A.	N.A.	N.A.	N.A.
Weatherly 620 TP	1	P&W. PT6A-11AG TP	500 hp	2,500	1,134	5,000	2,268	N.A.	N.A.	N.A.	N.A.
Weatherly 620	1	P&W. R985 PP	450 hp	2,850	1,293	5,000	2,268	N.A.	N.A.	N.A.	N.A.
Cessna Ag Husky	1	Continental TSIO-520-T PP	310 hp	2,305	1,046	4,400	1,996	N.A.	N.A.	N.A.	N.A.
Cessna Ag Truck	1	Continental IO-520-D PP	300 hp	2,235	1,014	4,200	1,905	N.A.	N.A.	N.A.	N.A.
Piper Brave 375	1	Lycoming IO-720-DICD PP	375 hp	2,465	1,118	3,900	1,769	N.A.	N.A.	N.A.	N.A.
Piper Brave 300	1	Lycoming IO-540-K1G5 PP	300 hp	2,198	997	3,900	1,769	N.A.	N.A.	N.A.	N.A.
Piper Pawnee D-235	1	Lycoming O-540 PP	235 hp	1,599	725	2,900	1,315	N.A.	N.A.	N.A.	N.A.

N.A. = information not available when table prepared.

TP = Turboprop hp = horsepower

PP = Pistonprop

Table 3.48 (Continued)
Characteristics of Single-Engine Agricultural, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
SINGLE-ENGINE AGRICULTURAL, FIXED WING													
Ayres 400 Gal. Turbo Thrush	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Ayres 400 Gal. Turbo Thrush	106	482	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	815	500	57
NZ Aero. Ind. Cresco 600	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	52
Ayres 400 Gal. Turbo Thrush	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
PZL 600 Thrush	106	482	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	775	500	64
Ayres P&W 600 Thrush	106	482	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	775	500	64
Gulfstream Amer. Ag-Cat B/600	80	364	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	850	1,054	54
Gulfstream Amer. Ag-Cat B/450	80	364	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,090	933	53
Ayres 1200 HP Bull Thrush	190	864	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	550	550	57
Ayres 500 Gal. Turbo Thrush	100	455	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	600	500	57
NZ Aero. Ind. Fletcher FU24-954	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,220	1,280	56
Eagle 300 Biplane	69	314	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	51
Eagle 220 Biplane	69	314	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	51
Weatherly 620 TP	65	295	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	980	66
Weatherly 620	65	295	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	980	66
Cessna Ag Husky	54	245	41' 8"	12.70 m.	26' 6"	8.08 m.	8' 2"	2.49 m.	205.0	19.05	1,975	1,265	61
Cessna Ag Truck	54	245	41' 8"	12.70 m.	25' 11"	7.90 m.	8' 2"	2.49 m.	205.0	19.05	2,140	1,265	65
Piper Brave 375	86	391	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,208	1,850	76
Piper Brave 300	86	391	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,525	1,650	71
Piper Pawnee D-235	38	173	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,350	N.A.	70

N.A. = Information not available when table prepared.

Table 3.49
Characteristics of Multi-Engine Reciprocating, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram
MULTI-ENGINE RECIPROCATING (PISTON), FIXED WING											
Pilatus BN.2A Mk III-2 Trislander	3	Lycoming O-540-E4C5 PP	260 hp	5,600	2,540	10,000	4,536	N.A.	N.A.	N.A.	N.A.
Cessna Titan Courier	2	Continental GTSIO-520-M PP	375 hp	4,844	2,197	8,450	3,833	N.A.	N.A.	N.A.	N.A.
Cessna Titan Ambassador	2	Continental GTSIO-520-M PP	375 hp	4,816	2,185	8,450	3,833	N.A.	N.A.	N.A.	N.A.
Cessna Titan Freighter	2	Continental GTSIO-520-M PP	375 hp	4,685	2,125	8,450	3,833	N.A.	N.A.	N.A.	N.A.
Cessna 421 Golden Eagle	2	Continental TSIO-520-L PP	375 hp	4,623	2,097	7,500	3,402	N.A.	N.A.	N.A.	N.A.
Piper Chieftain	2	Lycoming TIO-540-J2BD PP	350 hp	4,221	1,915	7,000	3,175	N.A.	N.A.	N.A.	N.A.
Cessna 402C Businessliner	2	Continental TSIO-520-VB PP	325 hp	4,074	1,848	6,885	3,123	N.A.	N.A.	N.A.	N.A.
Cessna 402C Utiliner	2	Continental TSIO-520-VB PP	325 hp	4,126	1,872	6,850	3,107	6,850	3,107	6,515	2,955
Cessna 402	2	Continental TSIO-520-VB PP	325 hp	N.A.	N.A.	6,885	3,123	N.A.	N.A.	N.A.	N.A.
Cessna Chancellor	2	Continental TSIO-520-NB PP	310 hp	4,356	1,976	6,785	3,078	N.A.	N.A.	N.A.	N.A.
Beechcraft Duke B60	2	Lycoming TIO-541-E1C4 PP	380 hp	4,406	1,999	6,775	3,073	N.A.	N.A.	N.A.	N.A.
Pilatus BN.2B-26 Islander II	2	Lycoming O-540-E4C5 PP	260 hp	3,612	1,638	6,600	2,994	N.A.	N.A.	N.A.	N.A.
Pilatus BN.2A-21 (fg)	2	Lycoming IO-540-K1B5 PP	300 hp	3,762	1,706	6,600	2,994	N.A.	N.A.	N.A.	N.A.
Pilatus BN.2A-20 (fg)	2	Lycoming IO-540-K1B5 PP	300 hp	3,722	1,688	6,560	2,976	N.A.	N.A.	N.A.	N.A.
Piper Navajo C/R	2	Lycoming TIO-540-F2BD PP	325 hp	4,099	1,859	6,500	2,948	N.A.	N.A.	N.A.	N.A.
Piper Navajo	2	Lycoming TIO-540-A2C PP	310 hp	4,003	1,816	6,500	2,948	N.A.	N.A.	N.A.	N.A.
Beechcraft Baron 58P	2	Continental TSIO-520-WB PP	325 hp	4,020	1,823	6,200	2,812	N.A.	N.A.	N.A.	N.A.
Beechcraft Baron 58TC	2	Continental TSIO-520-WB PP	325 hp	3,793	1,720	6,200	2,812	N.A.	N.A.	N.A.	N.A.
Cessna 340	2	Continental TSIO-520-NB PP	310 hp	3,911	1,774	6,025	2,733	N.A.	N.A.	N.A.	N.A.
Piper Aerostar 601P	2	Lycoming IO-540-S1A5 PP	290 hp	4,056	1,840	6,000	2,722	N.A.	N.A.	N.A.	N.A.
Piper Aerostar 601B	2	Lycoming IO-540-S1A5 PP	290 hp	3,985	1,808	6,000	2,722	N.A.	N.A.	N.A.	N.A.
Beechcraft Baron 58	2	Continental IO-520-CB PP	285 hp	3,363	1,525	5,400	2,449	N.A.	N.A.	N.A.	N.A.
Beechcraft Baron E55	2	Continental IO-520-CB PP	285 hp	3,286	1,491	5,300	2,404	N.A.	N.A.	N.A.	N.A.
Cessna 303 Crusader	2	Continental TSIO-520-AE PP	250 hp	3,305	1,499	5,175	2,347	N.A.	N.A.	N.A.	N.A.
Beechcraft Baron B55	2	Continental IO-470-L PP	260 hp	3,233	1,466	5,100	2,313	N.A.	N.A.	N.A.	N.A.
Piper Seneca II	2	Continental TSIO-360-E	200 hp	2,841	1,289	4,570	2,073	N.A.	N.A.	N.A.	N.A.
Piper Turbo Seminole	2	Lycoming LO-360-E1A6D PP	180 hp	2,430	1,102	3,925	1,780	N.A.	N.A.	N.A.	N.A.
Beechcraft Duchess	2	Lycoming O-360-A1G6D PP	180 hp	2,460	1,116	3,900	1,769	N.A.	N.A.	N.A.	N.A.
Piper Seminole	2	Lycoming O-360-E1A6D PP	180 hp	2,354	1,068	3,800	1,724	N.A.	N.A.	N.A.	N.A.
Wing D-1 Derringer	2	Lycoming IO-320-B1C PP	160 hp	2,100	953	3,050	1,383	N.A.	N.A.	N.A.	N.A.

N.A. = information not available when table prepared.

PP = Pistonprop hp = horsepower

Table 3.49 (Continued)
Characteristics of Multi-Engine Reciprocating, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
MULTI-ENGINE RECIPROCATING (PISTON), FIXED WING													
Pilatus BN.2A Mk III-2 Trislander	196	891	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,919	1,430	58
Cessna Titan Courier	344	1,564	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,367	2,130	80
Cessna Titan Ambassador	344	1,564	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,367	2,130	80
Cessna Titan Freighter	344	1,564	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,367	2,130	80
Cessna 421 Golden Eagle	262	1,191	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,323	2,293	85
Piper Chieftain	192	873	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,450	1,880	N.A.
Cessna 402C Businessliner	206	936	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,195	2,485	78
Cessna 402C Utiliner	178	808	44' 1.5"	13.45 m.	36' 4.5"	11.09 m.	11' 5.5"	3.49 m.	225.8	21.0	2,195	2,485	78
Cessna 402	213	968	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,195	2,485	78
Cessna Chancellor	206	936	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,595	2,393	82
Beechcraft Duke B60	232	1,055	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,626	3,065	84
Pilatus BN.2B-26 Islander II	137	623	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,090	960	49
Pilatus BN.2A-21 (fg)	196	891	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,100	960	46
Pilatus BN.2A-20 (fg)	135	614	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,100	960	46
Piper Navajo C/R	192	873	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,080	1,818	80
Piper Navajo	192	873	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,095	1,818	80
Beechcraft Baron 58P	190	864	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,643	2,427	90
Beechcraft Baron 58TC	190	864	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,643	2,427	90
Cessna 340	207	941	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,175	1,850	81
Piper Aerostar 601P	174	791	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,490	2,030	87
Piper Aerostar 601B	174	791	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,490	2,030	87
Beechcraft Baron 58	194	882	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,101	2,498	85
Beechcraft Baron E55	166	755	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,050	2,202	84
Cessna 303 Crusader	155	705	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,100	1,535	72
Beechcraft Baron B55	136	618	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,154	2,148	84
Piper Seneca II	128	582	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,240	2,090	70
Piper Turbo Seminole	110	500	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,500	1,190	70
Beechcraft Duchess	100	455	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,119	1,181	69
Piper Seminole	110	500	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,400	1,190	68
Wing D-1 Derringer	87	396	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,240	N.A.	72

N.A. = Information not available when table prepared.

Table 3.50
Characteristics of Turboprop, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms
TURBOPROP, FIXED WING											
Grumman 159 Gulfstream I	2	RR. Dart 529-8X or 8E TP	1,990 shp	21,900	9,933	35,100	15,920	33,600	15,240	26,170	11,870
Beechcraft 350 Super King Air	2	P&WC. PT6A-60A TP	1,050 shp	9,030	4,096	15,000	6,804	N.A.	N.A.	N.A.	N.A.
Fairchild Swearingen Merlin IVC	2	Garrett TPE-331-110-601G TP	N.A.	9,100	4,128	14,200	6,441	N.A.	N.A.	N.A.	N.A.
Beechcraft 300 Super King Air	2	P&WC. PT6A-60A TP	1,050 shp	8,490	3,851	14,000	6,350	N.A.	N.A.	N.A.	N.A.
Fairchild Swearingen Merlin IIIC	2	Garrett TPE-331-IOU-503G TP	900 shp	8,150	3,697	12,500	5,670	N.A.	N.A.	N.A.	N.A.
Beechcraft 200 Super King Air	2	P&W. PT6A-41 TP	850 shp	7,543	3,421	12,500	5,670	N.A.	N.A.	N.A.	N.A.
Beechcraft B100 King Air	2	Garrett TPE-331-6-252B TP	715 shp	7,112	3,226	11,800	5,352	N.A.	N.A.	N.A.	N.A.
Mitsubishi MU.2 Marquise	2	Garrett TPE-331-10-501M TP	776 shp	7,650	3,470	11,575	5,250	N.A.	N.A.	N.A.	N.A.
Gulfstream Am. Commander 1000	2	Garrett TPE-331-10 TP	N.A.	N.A.	N.A.	11,250	5,103	N.A.	N.A.	N.A.	N.A.
Piper Cheyenne III	2	P&W. PT6A-41 TP	720 shp	6,240	2,830	11,000	4,990	N.A.	N.A.	N.A.	N.A.
Beechcraft F90 King Air	2	P&W. PT6A-135 TP	750 shp	6,640	3,012	10,950	4,967	N.A.	N.A.	N.A.	N.A.
Gulfstream Am. Commander 900	2	N.A.	N.A.	N.A.	N.A.	10,775	4,887	N.A.	N.A.	N.A.	N.A.
Mitsubishi MU.2 Solitaire	2	Garrett TPE-331-10-501M TP	727 shp	7,010	3,180	10,470	4,749	N.A.	N.A.	N.A.	N.A.
Gulfstream Am. Commander 960	2	Garrett TPE-331-10-Solk TP	717 shp	6,271	2,844	10,325	4,683	N.A.	N.A.	N.A.	N.A.
Gulfstream Am. Commander 840	2	Garrett TPE-331-5-524K TP	717 shp	6,120	2,776	10,325	4,683	N.A.	N.A.	N.A.	N.A.
Cessna 441 Conquest	2	Garrett TPE-331-8-401S TP	635 shp	5,706	2,588	9,850	4,468	N.A.	N.A.	N.A.	N.A.
Beechcraft E90 King Air	2	P&W. PT6A-21 TP	550 shp	5,778	2,621	9,650	4,377	N.A.	N.A.	N.A.	N.A.
Beechcraft C90 King Air	2	P&W. PT6A-21 TP	550 shp	5,765	2,615	9,650	4,377	9,168	4,159	N.A.	N.A.
Beechcraft 90 King Air	2	P&WC. PT6A-6 TP	500 shp	5,318	2,615	9,300	4,377	N.A.	N.A.	N.A.	N.A.
Piper PA-31T Cheyenne II	2	P&W. PT6A-28 TP	620 shp	4,983	2,097	9,000	4,082	9,000	4,082	7,600	3,447
Pilatus PC-12	1	P&WC. PT6A-67B TP	1,200 shp	5,260	2,386	8,818	4,000	N.A.	N.A.	N.A.	N.A.
Piper Cheyenne I	2	P&W. PT6A-11 TP	500 shp	4,904	2,224	8,700	3,946	N.A.	N.A.	N.A.	N.A.
Cessna 425 Corsair	2	P&W. PT6A-112 TP	450 shp	4,980	2,259	8,200	3,719	N.A.	N.A.	N.A.	N.A.
Cessna 208 Caravan I	1	P&W. PT6A-114 TP	600 shp	3,800	1,724	8,750	3,969	7,300	3,311	N.A.	N.A.
Lear Fan 2100	2	P&W. PT68-35F TP	N.A.	4,000	1,814	7,250	3,289	N.A.	N.A.	N.A.	N.A.
Pilatus PC-6/B2-H4 Turbo Porter	1	P&WC. PT6A-27 TP	550 shp	1,411	640	2,026	920	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

TP = Turboprop shp = shaft horsepower

Table 3.50 (Continued)
Characteristics of Turboprop, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
TURBOPROP, FIXED WING													
Grumman 159 Gulfstream I	1,290	5,865	78' 6"	23.92 m.	63' 9"	19.43 m.	22' 9"	6.94 m.	610.3	56.70	2,875	2,125	N.A.
Beechcraft 350 Super King Air	N.A.	N.A.	57' 11"	17.65 m.	46' 8"	14.22 m.	14' 4"	4.37 m.	310.0	28.80	N.A.	N.A.	N.A.
Fairchild Swearingen Merlin IVC	648	2,946	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,850	2,532	99
Beechcraft 300 Super King Air	N.A.	N.A.	54' 6"	16.61 m.	43' 10"	13.36 m.	14' 4"	4.37 m.	303.0	28.15	N.A.	N.A.	N.A.
Fairchild Swearingen Merlin IIIC	648	2,946	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3,650	3,150	102
Beechcraft 200 Super King Air	544	2,473	54' 6"	16.61 m.	43' 9"	13.34 m.	15' 0"	4.57 m.	303.0	28.15	2,579	2,074	86
Beechcraft B100 King Air	470	2,137	45' 11"	14.00 m.	39' 11"	12.17 m.	15' 5"	4.70 m.	279.7	25.98	2,694	2,679	96
Mitsubishi MU.2 Marquise	403	1,832	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,170	2,200	87
Gulfstream Am. Commander 1000	474	2,155	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Piper Cheyenne III	400	1,818	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,369	2,820	95
Beechcraft F90 King Air	470	2,137	45' 11"	14.00 m.	39' 10"	12.13 m.	15' 1"	4.60 m.	279.7	25.98	2,856	2,224	87
Gulfstream Am. Commander 900	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,937	2,696	N.A.
Mitsubishi MU.2 Solitaire	403	1,832	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,800	1,950	84
Gulfstream Am. Commander 980	430	1,955	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,830	2,150	86
Gulfstream Am. Commander 840	430	1,955	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,833	2,030	86
Cessna 441 Conquest	475	2,159	49' 4"	15.04 m.	39' 0"	11.89 m.	13' 1"	4.01 m.	253.6	23.56	2,465	1,875	87
Beechcraft E90 King Air	384	1,746	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,261	1,672	87
Beechcraft C90 King Air	320	1,454	50' 3"	15.32 m.	35' 6"	10.82 m.	14' 3"	4.34 m.	293.9	27.31	2,261	2,010	87
Beechcraft 90 King Air	N.A.	N.A.	45' 11"	13.98 m.	35' 6"	10.82 m.	14' 8"	4.47 m.	279.7	25.90	N.A.	N.A.	N.A.
Piper PA-31T Cheyenne	405	1,385	42' 8"	13.01 m.	34' 8"	10.57 m.	12' 9"	3.89 m.	229.0	21.30	2,650	2,100	N.A.
Pilatus PC-12	N.A.	N.A.	52' 9"	16.08 m.	47' 2"	14.38 m.	14' 0"	4.26 m.	277.8	25.81	N.A.	N.A.	N.A.
Piper Cheyenne I	308	1,400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,444	2,223	83
Cessna 425 Corsair	367	1,668	44' 1.5"	13.45 m.	35' 10"	10.93 m.	12' 7"	3.84 m.	225.0	20.90	N.A.	N.A.	N.A.
Cessna 208 Caravan I	335	1,268	52' 1"	15.88 m.	37' 7"	11.46 m.	14' 2"	4.32 m.	279.4	25.96	1,665	1,550	N.A.
Lear Fan 2100	250	1,137	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Pilatus PC-6/B2-H4 Turbo Porter	N.A.	N.A.	52' 1"	15.87 m.	36' 1"	11.00 m.	10' 6"	3.20 m.	324.5	30.15	3,525	3,270	50

N.A. = information not available when table prepared.

Table 3.51
Characteristics of Turbojet, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram	Pounds	Kilogram
TURBOJET, FIXED WING											
Gulfstream III	2	RR. Spey Mk511-8 TF	10,342 lbs.	32,500	14,742	69,700	31,615	N.A.	N.A.	N.A.	N.A.
Canadair 604 Challenger	2	GE. CF35-3B TF	8,729 lbs.	N.A.	N.A.	47,700	21,636	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 900B	3	Garrett TFE 731-5BR TF	4,750 lbs.	22,575	10,240	45,500	20,638	N.A.	N.A.	N.A.	N.A.
Canadair 601 Challenger	2	GE. CF34-3A TF	9,140 lbs.	25,500	11,567	45,100	20,457	N.A.	N.A.	N.A.	N.A.
Lockheed Jetstar II	4	Garrett TFE 731-3 TF	3,700 lbs.	24,178	10,967	43,750	19,845	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 50	3	Garrett TFE 731-3 TF	3,700 lbs.	20,170	9,149	40,780	18,497	N.A.	N.A.	N.A.	N.A.
Canadair 600 Challenger	2	Avco Lycoming ALF 502L TF	7,500 lbs.	22,675	10,285	40,125	18,200	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 2000	2	CFE CFE738-1-1B TF	5,725 lbs.	19,980	9,063	35,000	15,876	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 200	2	Garrett ATF 3-6A-4C TF	5,200 lbs.	18,290	8,296	32,000	14,515	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 20F	2	GE. CF700-2D-2 TF	4,500 lbs.	16,600	7,530	28,660	13,000	N.A.	N.A.	N.A.	N.A.
IAI 1125SP Astra	2	Garrett TFE-731-3C-200G TF	3,700 lbs.	13,225	5,999	24,650	11,181	N.A.	N.A.	N.A.	N.A.
IAI 1124A Westwind II	2	Garrett TFE-731-1-100G TF	3,700 lbs.	13,250	6,010	23,650	10,727	N.A.	N.A.	N.A.	N.A.
Learjet 60	2	P&WC PW305A TF	4,600 lbs.	13,750	6,237	23,100	10,478	N.A.	N.A.	N.A.	N.A.
Cessna 650 Citation VII	2	Garrett TFE 731-4R-2S TF	4,000 lbs.	11,686	5,301	22,450	10,183	N.A.	N.A.	N.A.	N.A.
Cessna 650 Citation III/VI	2	Garrett TFE 731-3B-100S TF	3,650 lbs. st	12,200	5,534	22,000	9,979	17,000	7,711	N.A.	N.A.
Learjet 55	2	Garrett TFE-731-3A-2B TF	3,700 lbs.	13,258	6,014	21,000	9,525	N.A.	N.A.	N.A.	N.A.
IAI 1123 Westwind I	2	GE. CJ-610-9 TJ	3,100 lbs.	11,750	5,330	20,700	9,389	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 100	2	Garrett TFE 731-2C TF	3,230 lbs.	11,145	5,055	19,300	8,754	N.A.	N.A.	N.A.	N.A.
Dassault Falcon 10	2	Garrett TFE 731-2C TF	3,230 lbs.	10,760	4,881	18,740	8,500	N.A.	N.A.	N.A.	N.A.
Learjet 36A	2	Garrett TFE-731-2B TF	3,500 lbs.	10,120	4,590	18,300	8,301	N.A.	N.A.	N.A.	N.A.
Learjet 35A	2	Garrett TFE-731-2B TF	3,500 lbs.	10,120	4,590	18,300	8,301	N.A.	N.A.	N.A.	N.A.
Cessna 560 Citation V	2	P&W. JT15D-5A TF	2,900 lbs. st	8,828	4,004	15,900	7,212	N.A.	N.A.	N.A.	N.A.
Cessna S550/551 Citation S/II, S/I	2	P&W. JT15D-4B TF	2,500 lbs. st	8,060	3,656	15,100	6,849	N.A.	N.A.	N.A.	N.A.
Learjet 29	2	GE. CJ610-8A TF	2,950 lbs.	8,224	3,730	15,000	6,804	N.A.	N.A.	N.A.	N.A.
Learjet 28	2	GE. CJ610-8A TF	2,950 lbs.	8,268	3,750	15,000	6,804	N.A.	N.A.	N.A.	N.A.
Learjet 25D	2	GE. CJ610-8A TF	2,950 lbs.	7,640	3,465	15,000	6,804	N.A.	N.A.	N.A.	N.A.
Cessna 550/551 Citation II	2	P&W. JT15D-4 TF	2,500 lbs. st	7,181	3,257	13,300	6,033	N.A.	N.A.	N.A.	N.A.
Learjet 24D	2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Mitsubishi Diamond I/Beechjet	2	P&W. JT15D-5 TF	2,900 lbs. st	8,050	3,651	15,780	7,158	N.A.	N.A.	N.A.	N.A.
Learjet 23	2	GE. CJ610-4 TJ	2,850 lbs.	6,550	2,971	12,500	5,670	N.A.	N.A.	N.A.	N.A.
Cessna 500/501 Citation I/SP	2	P&W. JT15D-1A1B TF	2,200 lbs. st	6,631	3,008	11,850	5,375	11,350	5,148	N.A.	N.A.
Cessna 500 Citation	2	P&W. JT15D-1 TF	2,200 lbs. st	5,408	2,453	10,850	4,921	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

TF = Turbofan

TJ = Turbojet

lbs. st. = pounds thrust static

Table 3.51 (Continued)
Characteristics of Turbojet, Fixed Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.) (FAR)	Landing Dist. (ft.) (FAR)	Stall Speed (gear/flaps down, mph)
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
GENERAL AVIATION TURBOJET, FIXED WING													
Gulfstream III	4,133	18,789	77' 10"	23.72 m.	83' 1"	25.32 m.	24' 5"	7.43 m.	934.6	86.83	5,850	3,400	139
Canadair 604 Challenger	N.A.	N.A.	61' 10"	18.85 m.	68' 5"	20.85 m.	20' 8"	6.30 m.	520.0	48.31	N.A.	N.A.	N.A.
Dassault Falcon 900B	N.A.	N.A.	63' 5"	19.33 m.	66' 4"	20.21 m.	24' 9"	7.55 m.	527.4	49.00	N.A.	N.A.	N.A.
Canadair 601 Challenger	N.A.	N.A.	61' 10"	18.85 m.	68' 5"	20.85 m.	20' 8"	6.30 m.	520.0	48.31	N.A.	N.A.	N.A.
Lockheed Jetstar II	N.A.	N.A.	54' 5"	16.60 m.	60' 5"	18.42 m.	20' 5"	6.23 m.	542.5	50.40	N.A.	N.A.	N.A.
Dassault Falcon 50	2,316	10,529	61' 11"	18.86 m.	61' 11"	18.52 m.	22' 11"	6.97 m.	504.1	46.83	4,900	3,800	87
Canadair 600 Challenger	N.A.	N.A.	61' 10"	18.85 m.	68' 5"	20.85 m.	20' 8"	6.30 m.	450.0	41.82	N.A.	N.A.	N.A.
Dassault Falcon 2000	N.A.	N.A.	63' 5"	19.34 m.	66' 4"	20.23 m.	23' 2"	7.06 m.	527.7	49.02	N.A.	N.A.	N.A.
Dassault Falcon 200	1,586	7,210	53' 7"	16.32 m.	56' 3"	17.15 m.	17' 6"	5.32 m.	441.3	41.00	5,700	2,610	N.A.
Dassault Falcon 20F	1,369	6,224	53' 7"	16.32 m.	56' 3"	17.15 m.	17' 6"	5.32 m.	441.3	41.00	4,600	1,975	96
IAI 1125SP Astra	N.A.	N.A.	52' 8"	16.05 m.	55' 7"	16.94 m.	18' 2"	5.53 m.	316.6	29.41	N.A.	N.A.	N.A.
IAI 1124A Westwind II	1,424	6,474	44' 5"	13.65 m.	52' 3"	15.93 m.	15' 10"	4.81 m.	306.3	28.64	5,250	2,450	114
Learjet 60	1,212	5,510	43' 9"	13.34 m.	58' 8"	17.88 m.	14' 8"	4.47 m.	264.5	24.57	5,130	2,950	113
Cessna 650 Citation VII	N.A.	N.A.	53' 6"	16.31 m.	55' 6"	16.90 m.	16' 10"	5.12 m.	312.0	29.00	N.A.	N.A.	N.A.
Cessna 650 Citation III/VI	991	4,505	53' 6"	16.31 m.	55' 6"	16.90 m.	16' 10"	5.12 m.	312.0	29.00	3,900	2,690	101
Learjet 55	1,015	4,614	43' 9"	13.34 m.	55' 1"	16.79 m.	14' 8"	4.47 m.	264.5	24.57	4,550	2,950	113
IAI 1123 Westwind I	1,300	5,910	44' 5"	13.65 m.	52' 3"	15.93 m.	15' 10"	4.81 m.	306.3	28.64	4,950	2,450	114
Dassault Falcon 100	882	4,010	42' 11"	13.08 m.	45' 6"	13.86 m.	15' 2"	4.61 m.	259.0	24.10	4,500	2,750	90
Dassault Falcon 10	882	4,010	42' 11"	13.08 m.	45' 6"	13.86 m.	15' 2"	4.61 m.	259.0	24.10	4,500	2,750	90
Learjet 36A	1,110	5,046	39' 6"	12.04 m.	48' 8"	14.83 m.	12' 3"	3.73 m.	253.3	23.53	4,784	2,884	110
Learjet 35A	931	4,232	39' 6"	12.04 m.	48' 8"	14.83 m.	12' 3"	3.73 m.	253.3	23.53	4,224	2,884	110
Cessna 560 Citation V	N.A.	N.A.	52' 3"	15.90 m.	48' 11"	14.90 m.	15' 0"	4.57 m.	342.6	31.83	N.A.	N.A.	N.A.
Cessna S550/551 Citation S/II, S/I	N.A.	N.A.	52' 3"	15.90 m.	47' 3"	14.39 m.	15' 0"	4.57 m.	342.6	31.83	N.A.	N.A.	N.A.
Learjet 29	802	3,646	43' 10"	13.35 m.	47' 7"	14.50 m.	12' 3"	3.73 m.	N.A.	N.A.	3,040	2,734	104
Learjet 28	699	3,178	35' 7"	10.85 m.	47' 7"	14.50 m.	N.A.	N.A.	N.A.	N.A.	3,040	2,734	104
Learjet 25D	910	4,137	35' 8"	10.84 m.	47' 7"	14.50 m.	12' 3"	3.73 m.	231.8	21.53	3,937	2,744	112
Cessna 550/551 Citation II	714	3,246	51' 8"	15.75 m.	43' 6"	13.26 m.	N.A.	N.A.	N.A.	N.A.	2,900	2,270	93
Learjet 24D	N.A.	N.A.	35' 7"	10.84 m.	43' 3"	12.5 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Mitsubishi Diamond I/Beechjet	732	3,328	43' 6"	13.26 m.	48' 5"	14.76 m.	13' 9.5"	4.2 m.	N.A.	N.A.	4,100	2,700	87
Learjet 23	N.A.	N.A.	35' 8"	10.84 m.	43' 3"	13.18 m.	12' 3"	3.73 m.	231.8	21.53	N.A.	N.A.	N.A.
Cessna 500/501 Citation I/SP	564	2,564	47' 1"	14.35 m.	43' 6"	13.26 m.	14' 3"	4.36 m.	278.5	25.90	2,930	2,270	94
Cessna 500 Citation	564	2,564	43' 9"	13.32 m.	43' 6"	13.26 m.	14' 3"	4.36 m.	260.0	24.15	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

Table 3.52
Characteristics of Rotary Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Landing Weight		Maximum Zero-Fuel Weight	
	No.	Type		Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms	Pounds	Kilograms
ROTARY WING											
Boeing Vertol 234LR Chinook	2	Lycoming AL 5512 TS	4,075 shp	25,900	11,748	51,000	23,133	N.A.	N.A.	N.A.	N.A.
Sikorsky S-61N Mk II	2	GE. CT58-140-2 TS	1,500 shp	12,510	5,674	22,000	9,979	N.A.	N.A.	N.A.	N.A.
Eurocopter AS332L Super Puma	2	Turbomeca Makila	1,755 shp	9,635	4,370	19,840	8,999	N.A.	N.A.	N.A.	N.A.
Boeing Vertol BV 107	2	GE. CT58-110-1 TS	1,250 shp	10,723	4,864	19,000	8,618	N.A.	N.A.	N.A.	N.A.
Bell 214ST	2	GE. CT 7-2A TS	1,625 shp	9,481	4,301	17,500	7,938	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA330J Puma	2	Turbomeca Turmo IVC	1,575 shp	8,305	3,767	16,535	7,500	N.A.	N.A.	N.A.	N.A.
Bell 214B Big Lifter	1	Lycoming T550-8D TS	2,930 shp	7,827	3,550	16,000	7,257	N.A.	N.A.	N.A.	N.A.
Sikorsky S-58T	1	P&WC PT6T-6 TS	1,875 shp	7,400	3,357	13,000	5,897	N.A.	N.A.	N.A.	N.A.
Bell 412	2	P&W. PT6T-3B TS	1,308 shp	6,070	2,753	11,500	5,216	N.A.	N.A.	N.A.	N.A.
Bell 212	2	P&W. PT6T-3 TS	1,290 shp	6,097	2,766	11,200	5,080	N.A.	N.A.	N.A.	N.A.
Bell 205A-1	1	Lycoming T531-13B TS	1,250 shp	5,323	2,414	10,500	4,763	N.A.	N.A.	N.A.	N.A.
Sikorsky S-76 Mk II	2	Allison 250C-30 TS	650 shp	5,600	2,540	10,300	4,672	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA365N2 Dauphin 2	2	Turbomeca Arriel 1C2	739 shp	4,940	2,241	9,370	4,250	N.A.	N.A.	N.A.	N.A.
Bell 222B	2	Lycoming LTS-101-650C TS	680 shp	4,577	2,076	8,250	3,742	N.A.	N.A.	N.A.	N.A.
Sikorsky S-62C	1	GE. CT58-110-1 TS	1,250 shp	4,860	2,204	7,900	3,583	N.A.	N.A.	N.A.	N.A.
Eurocopter/Kawasaki BK.117B-2	2	Lycoming LTS-101-750-B-1 TS	592 shp	3,807	1,727	7,385	3,350	N.A.	N.A.	N.A.	N.A.
Sikorsky S-55T	1	AiResearch TSE 331-3U-303 TS	650 shp	4,700	2,132	7,200	3,266	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA360C Dauphin	1	Turbomeca Astazou XVIIIA TS	1,050 shp	3,428	1,555	6,613	3,000	N.A.	N.A.	N.A.	N.A.
Agusta 109A Mk II	2	Allison 250C-20B TS	420 shp	3,126	1,418	5,732	2,600	N.A.	N.A.	N.A.	N.A.
Eurocopter AS355F Ecureuil 2	2	Allison 250C-20F TS	420 shp	2,877	1,305	5,732	2,600	N.A.	N.A.	N.A.	N.A.
Eurocopter BO.105 CBS	2	Allison 250C-20B TS	420 shp	2,868	1,301	5,511	2,500	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA315B Lama	1	Turbomeca Artouste IIIB	550 shp	2,250	1,021	5,070	2,300	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA319B Alouette III	1	Turbomeca Astazou XIVB	600 shp	2,513	1,140	4,960	2,250	N.A.	N.A.	N.A.	N.A.
Bell 206LT Twin Ranger	2	Allison 250C-20R TS	450 shp	2,748	1,246	4,550	2,064	N.A.	N.A.	N.A.	N.A.
Eurocopter AS350B2 Ecureuil	1	Turbomeca Arriel 1D1	732 shp	2,541	1,153	4,960	2,250	N.A.	N.A.	N.A.	N.A.
Aerospatiale SA342 Gazelle	1	Turbomeca Astazou XIV	858 shp	2,149	975	4,190	1,901	N.A.	N.A.	N.A.	N.A.
Bell 206L-1 Long Ranger II	1	Allison 250C-28B TS	500 shp	2,160	980	4,150	1,882	N.A.	N.A.	N.A.	N.A.
Bell 206B Jet Ranger III	1	Allison 250C-20J TS	420 shp	1,635	742	3,350	1,520	N.A.	N.A.	N.A.	N.A.
Hiller UH12E4T	1	Allison 250C-20B TS	301 hp	1,650	748	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Hiller UH12ET	1	Allison 250C-20B TS	301 hp	1,650	748	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Hiller UH12E4	1	Lycoming VO-540-C2A PS	305 hp	1,836	833	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Hiller UH12E	1	Lycoming VO-540-C2A PS	305 hp	1,759	798	3,100	1,406	N.A.	N.A.	N.A.	N.A.
Hughes 500D	1	Allison 250C-20B TS	420 shp	1,360	617	3,000	1,361	N.A.	N.A.	N.A.	N.A.
Bell 47G-3B-2A	1	Lycoming TVO-435-F1A	260 hp	1,893	859	2,950	1,338	N.A.	N.A.	N.A.	N.A.
Hiller UH FH1100	1	Allison 250C-11B TS	N.A.	1,395	633	2,750	1,247	N.A.	N.A.	N.A.	N.A.
Enstrom 280FX Shark	1	Lycoming HIO-360-F1AD PS	225 hp	1,585	719	2,600	1,179	N.A.	N.A.	N.A.	N.A.
Enstrom F-28F	1	Lycoming HIO-360-F1AD PS	225 hp	1,500	680	2,350	1,066	N.A.	N.A.	N.A.	N.A.
Enstrom 280C Shark	1	Lycoming HIO-360-EIAD PS	205 hp	1,500	680	2,350	1,066	N.A.	N.A.	N.A.	N.A.
Enstrom F-28A	1	Lycoming HIO-360-C1B PS	205 hp	1,450	658	2,150	975	N.A.	N.A.	N.A.	N.A.
Hughes 300C	1	Lycoming HIO-360-D1A PS	225 hp	1,046	474	2,050	930	N.A.	N.A.	N.A.	N.A.
Brantly-Hynes B2B	1	Lycoming IVO-360-A1A PS	180 hp	1,020	463	1,670	757	N.A.	N.A.	N.A.	N.A.
Robinson R-22	1	Lycoming O-320 PS	124 hp	796	361	1,300	590	N.A.	N.A.	N.A.	N.A.
Rotorway Exec	1	RW-145 PS	145 hp	780	354	1,263	573	N.A.	N.A.	N.A.	N.A.
Scorpion 133	1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

TS = Turboshaft shp = shaft horsepower
PS = Pistonshaft hp = horsepower

Table 3.52 (Continued)
Characteristics of Rotary Wing General Aviation Aircraft
References 3.29 to 3.35

Aircraft Type	Maximum Fuel Capacity		Rotor Diameter		Fuselage Length		Overall Height		Main Rotor Disc Area		Number Rotor(s)	Number Rotor Blades
	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2		
ROTARY WING												
Boeing Vertol 234LR Chinook	2,090	9,501	60' 0"	18.29 m.	52' 1"	15.87 m.	18' 8"	5.68 m.	5655.0	525.34	2	3
Sikorsky S-61N Mk II	N.A.	N.A.	62' 0"	18.90 m.	58' 11"	17.96 m.	17' 6"	5.32 m.	3019.0	280.47	1	5
Eurocopter AS332L Super Puma	408	1,855	49' 6"	15.08 m.	50' 11"	15.52 m.	16' 1"	4.92 m.	1922.5	178.60	1	4
Boeing Vertol BV 107	N.A.	N.A.	50' 0"	15.24 m.	44' 7"	13.59 m.	16' 9"	5.09 m.	3925.0	364.60	2	3
Bell 214ST	410	1,864	52' 0"	15.85 m.	50' 0"	15.24 m.	15' 11"	4.84 m.	2124.0	197.30	1	2
Aerospatiale SA330J Puma	N.A.	N.A.	49' 6"	15.08 m.	46' 2"	14.06 m.	16' 11"	5.14 m.	1905.0	177.00	1	4
Bell 214B Big Lifter	204	927	50' 0"	15.24 m.	N.A.	N.A.	N.A.	N.A.	1963.5	182.40	1	2
Sikorsky S-58T	N.A.	N.A.	56' 0"	17.07 m.	47' 3"	14.41 m.	14' 4"	4.36 m.	2460.0	228.50	1	4
Bell 412	215	977	46' 0"	14.02 m.	41' 9"	12.70 m.	15' 0"	4.57 m.	1662.0	154.40	1	4
Bell 212	215	977	48' 2"	14.69 m.	42' 5"	12.92 m.	14' 10"	4.53 m.	1809.6	168.10	1	2
Bell 205A-1	215	977	48' 0"	14.63 m.	41' 6"	12.65 m.	14' 7"	4.45 m.	1806.0	168.00	1	2
Sikorsky S-76 Mk II	280	1,273	44' 0"	13.41 m.	43' 4"	13.22 m.	14' 6"	4.41 m.	1520.5	141.30	1	4
Aerospatiale SA365N2 Dauphin 2	291	1,323	39' 2"	11.94 m.	37' 7"	10.96 m.	13' 1"	3.98 m.	1205.0	111.90	1	4
Bell 222B	184	836	42' 0"	12.80 m.	42' 2"	12.85 m.	11' 6"	3.51 m.	1385.4	128.70	1	2
Sikorsky S-62C	N.A.	N.A.	53' 0"	16.17 m.	44' 7"	13.60 m.	14' 2"	4.32 m.	2207.7	205.10	1	3
Eurocopter/Kawasaki BK.117B-2	1764 lbs.	N.A.	36' 1"	11.00 m.	32' 6"	9.91 m.	12' 8"	3.85 m.	1023.0	95.03	1	4
Sikorsky S-55T	N.A.	N.A.	53' 0"	16.16 m.	42' 3"	12.87 m.	13' 4"	4.06 m.	2207.7	205.10		
Aerospatiale SA360C Dauphin	169	768	37' 9"	11.50 m.	36' 0"	10.96 m.	11' 6"	3.50 m.	1118.0	103.87	1	4
Agusta 109A Mk II	146	664	36' 1"	11.00 m.	35' 2"	10.71 m.	10' 10"	3.30 m.	1022.9	95.03	1	4
Eurocopter AS355F Ecureuil 2	190	864	35' 1"	10.69 m.	35' 10"	10.91 m.	10' 4"	3.14 m.	966.1	89.75	1	3
Eurocopter BO.105 CBS	1720 lbs.	N.A.	32' 4"	9.84 m.	28' 11"	8.81 m.	9' 11"	3.02 m.	818.6	76.05	1	4
Aerospatiale SA315B Lama	152	691	36' 2"	11.02 m.	33' 8"	10.26 m.	10' 2"	3.09 m.	1026.7	95.38	1	2
Aerospatiale Alouette SA319B	152	691	36' 2"	11.02 m.	32' 11"	10.03 m.	9' 10"	3.00 m.	1026.7	95.38	1	3
Bell 206LT Twin Ranger	N.A.	N.A.	37' 0"	11.28 m.	32' 3"	9.81 m.	10' 4"	3.14 m.	1075.2	99.89	1	2
Eurocopter AS350B2 Ecureuil	140	636	35' 1"	10.69 m.	35' 10"	10.91 m.	10' 4"	3.14 m.	966.1	89.75	1	3
Aerospatiale SA342 Gazelle	N.A.	N.A.	34' 6"	10.5 m.	31' 3"	9.53 m.	10' 5"	3.18 m.	931.0	86.50	1	3
Bell 206L-1 Long Ranger II	98	446	37' 0"	11.28 m.	33' 3"	10.13 m.	10' 4"	3.14 m.	1075.2	99.89	1	2
Bell 206B Jet Ranger III	76	346	33' 4"	10.16 m.	31' 2"	9.50 m.	9' 7"	2.91 m.	872.7	81.07	1	2
Hiller UH12E4T	46	209	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hiller UH12ET	46	209	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hiller UH12E4	46	209	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hiller UH12E	46	209	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hughes 500D	64	291	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bell 47G-3B-2A	N.A.	N.A.	37' 2"	11.32 m.	31' 7"	9.63 m.	9' 4"	2.83 m.	1085.0	100.80	1	2
Hiller UH FH1100	136	618	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Enstrom 280FX Shark	42	191	32' 0"	9.75 m.	N.A.	N.A.	N.A.	N.A.	804.0	74.69	1	3
Enstrom F-28F	42	191	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Enstrom 280C Shark	40	182	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Enstrom F-28A	40	182	32' 0"	9.75 m.	N.A.	N.A.	N.A.	N.A.	804.0	74.69	1	3
Hughes 300C	30	136	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Brantly-Hynes B2B	31	141	23' 9"	7.24 m.	21' 9"	6.62 m.	6' 9"	2.06 m.	443.0	41.16	1	3
Robinson R-22	20	91	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Rotorway Exec	19	86	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Scorpion 133	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

3.8 GENERAL AVIATION REFERENCES

[3.1] General Aviation Activity and Avionics Survey, Annual Summary Report, 1986 Data. U.S. Department of Transportation, Federal Aviation Administration, Office of Management Systems, Washington, DC, December 1987.

[3.2] General Aviation Activity and Avionics Survey, Annual Summary Report, 1987 Data. U.S. Department of Transportation, Federal Aviation Administration, Office of Management Systems, Washington, DC, November 1988.

[3.3] General Aviation Activity and Avionics Survey, Calendar Year 1988. U.S. Department of Transportation, Federal Aviation Administration, Office of Management Systems, Washington, DC, (No Date).

[3.4] General Aviation Activity and Avionics Survey, Calendar Year 1989. U.S. Department of Transportation, Federal Aviation Administration, Office of Management Systems, Washington, DC, (No Date).

[3.5] General Aviation Activity and Avionics Survey, Calendar Year 1990. U.S. Department of Transportation, Federal Aviation Administration, Office of Management Systems, Washington, DC, (No Date).

[3.6] General Aviation Activity and Avionics Survey, Calendar Year 1991. U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, Washington, DC, (No Date).

[3.7] General Aviation Activity and Avionics Survey, Calendar Year 1992. U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, Washington, DC, (No Date).

[3.8] General Aviation Activity and Avionics Survey, Calendar Year 1993. U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, Washington, DC, (No Date).

[3.9] "Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 121 (14 CFR 121), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.10] "Certification and Operations of Scheduled Air Carriers with Helicopters", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter G-Air Carriers, Air Travel Clubs, and Operators for Compensation or Hire: Certification and Operations, Part 127 (14 CFR 127), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.11] "Air Traffic and General Operating and Flight Rules", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 91 (14 CFR 91), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.12] "Ultralight Vehicles", Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F, Air Traffic and General Operating Rules, Part 103 (14 CFR 103), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.13] "Parachute Jumping", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter F. Air Traffic and General Operating Rules. Part 105 (14 CFR 105), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.14] "Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload of 6,000 Pounds or More", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter G-Air Carriers. Air Travel Clubs. and Operators for Compensation or Hire: Certification and Operations. Part 125 (14 CFR 125), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.15] "Rotorcraft External-Load Operations", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter G-Air Carriers. Air Travel Clubs. and Operators for Compensation or Hire: Certification and Operations. Part 133 (14 CFR 133), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.16] "Air Taxi Operators and Commercial Operators", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter G-Air Carriers. Air Travel Clubs. and Operators for Compensation or Hire: Certification and Operations. Part 135 (14 CFR 135), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.17] "Agricultural Aircraft Operations", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter G-Air Carriers. Air Travel Clubs. and Operators for Compensation or Hire: Certification and Operations. Part 137 (14 CFR 137), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.18] ""Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage", Title 14 Aeronautics and Space. Code of Federal Regulations. Chapter I-Federal Aviation Administration. Department of Transportation. Subchapter G-Air Carriers. Air Travel Clubs. and Operators for Compensation or Hire: Certification and Operations. Part 129 (14 CFR 129), U.S. National Archives and Record Administration, Washington, DC, January 1, 1994.

[3.19] DOE Standard Accident Analysis for Aircraft Crash into Hazardous Facilities. DOE-STD-3014-96, U.S. Department of Energy, Washington, DC, July 1996.

[3.20] Annual Review of Aircraft Accident Data. U.S. General Aviation Calendar Year 1986. NTSB/ARG-88/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, October 25, 1988.

[3.21] Annual Review of Aircraft Accident Data. U.S. General Aviation Calendar Year 1987. NTSB/ARG-89/01, U.S. National Transportation Safety Board, Bureau of Safety Programs, Washington, DC, December 12, 1989.

[3.22] Annual Review of Aircraft Accident Data. U.S. General Aviation Calendar Year 1988. NTSB/ARG-91/01, U.S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, March 27, 1991.

[3.23] Annual Review of Aircraft Accident Data. U.S. General Aviation Calendar Year 1989. NTSB/ARG-93/01, U.S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, (No Date).

[3.24] Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1990, NTSB/ARG-93/02, U. S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, December 17, 1993.

[3.25] Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1991, NTSB/ARG-94/01, U.S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, April 4, 1994.

[3.26] Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1992, NTSB/ARG-94/02, U.S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, June 15, 1994.

[3.27] Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1993, NTSB/ARG-95/01, U.S. National Transportation Safety Board, Office of Research & Engineering, Washington, DC, May 12, 1995.

[3.28] ACRAM Modeling Technical Support Document, LA-UR-96-2460/TSA-11-95-R12, C. Bolig, D. Sanzo, D. Stack, R. Mensing, and R. Glasser, Los Alamos National Laboratory, Los Alamos, NM, July 1996.

[3.29] Modern Commercial Aircraft, William Green, Gordon Swanborough, and John Mowinski, Portland House, New York, NY, 1987.

[3.30] The Aviator's Source Book, Barbara B. Buchholz, editor, St. Martin's Press, New York, NY, 1982.

[3.31] A Field Guide to Airplanes of North America, 2nd Edition, M.R. Montgomery, Gerald Foster, Houghton Mifflin Co., New York, NY, 1984.

[3.32] Wings of Cessna, Model 120 to the Citation III, Edward H. Phillips, Flying Books, Eagan, MN, 1986.

[3.33] Beechcraft, Staggerwing to Starship, Edward H. Phillips, Flying Books, Eagan, MN, 1987.

[3.34] Multivariate Density Estimation, Theory, Practice, and Visualization, David W. Scott, John Wiley & Sons, Inc., New York, NY, 1992.

[3.35] The International Directory of Civil Aircraft, 1995/96, Gerard Frawley and Jim Thorn, Aerospace Publications Pty Ltd, Weston Creek, Australia, 1995.

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
1	ATL83AA184	28.6333	80.9167
2	ATL83AA235	31.0333	87.5167
3	ATL83AA305	36.2000	80.7833
4	ATL83FA128	36.6667	87.3333
5	ATL83FA140	35.7667	84.9667
6	ATL83FA144	35.8333	87.4333
7	ATL83FA155	34.8333	85.0833
8	ATL83FA198	32.3167	85.8833
9	ATL83FA262	31.1833	90.4667
10	ATL83FA263	33.5000	85.1500
11	ATL83FIG06	38.9000	79.2167
12	ATL84FA028	35.9833	86.7333
13	ATL84FA033	31.2667	81.4667
14	ATL84FA054	35.6667	88.3000
15	ATL84FA058	35.4667	83.1333
16	ATL84FA075	34.7167	82.8333
17	ATL84FA090	34.0000	78.9333
18	ATL84FA092	37.9000	76.4833
19	ATL84FA111	31.3333	87.4333
20	ATL84FA116	38.7667	77.5333
21	ATL84FA129	34.1000	84.4333
22	ATL84FA133	33.8333	84.3000
23	ATL84FA158	37.0333	82.3000
24	ATL84FA168	33.8333	84.8333
25	ATL84FA169	37.5000	87.2167
26	ATL84FA184	33.5833	87.8000
27	ATL84FA187	35.2333	80.9500
28	ATL84FA190	34.0833	84.6667
29	ATL84FA193	34.5500	86.6000
30	ATL84FA203	34.1167	84.2000
31	ATL84FA216	32.3000	82.5667
32	ATL84FA225	33.5000	90.2500
33	ATL84FA241	30.4167	88.7500
34	ATL84FA248	34.0167	84.6167
35	ATL84FA268	33.9000	80.6500
36	ATL84FA292	32.8167	85.2500
37	ATL84FA298	33.9333	82.3833
38	ATL84FLT10	35.7667	84.3500
39	ATL84MA063	35.3833	87.3000
40	ATL84MA101	38.0167	78.5500
41	ATL84MA208	34.3000	84.3833
42	ATL85FA011	36.6500	80.7000
43	ATL85FA020	32.2333	90.9333
44	ATL85FA039	36.0833	84.4500
45	ATL85FA041	33.4500	85.8167
46	ATL85FA043	34.4167	83.6667
47	ATL85FA050	35.9667	78.3667
48	ATL85FA070	39.8667	80.7333
49	ATL85FA143	32.4833	88.8000
50	ATL85FA146	34.5167	90.4167
51	ATL85FA147	35.0167	80.6167
52	ATL85FA165	37.0000	83.0000
53	ATL85FA191	34.5833	83.7667
54	ATL85FA198	31.2167	85.4833
55	ATL85FA221	33.9667	84.6500
56	ATL85FA237	38.7333	84.6667
57	ATL85FA242	34.1500	82.3500
58	ATL85FA252	32.6333	84.9833
59	ATL85FA256	35.2167	82.5667
60	ATL85FA261	35.7000	81.2167
61	ATL85FA266	34.2167	81.0833
62	ATL85FA272	33.1667	81.6000
63	ATL85FA283	38.3667	82.5500
64	ATL85FA285	34.6833	85.2833
65	ATL85FMG03	36.0667	78.8000
66	ATL85MA275	34.3667	86.7667
67	ATL86FA001	35.9333	79.1000
68	ATL86FA002	38.4667	82.0333
69	ATL86FA010	34.1333	87.6667
70	ATL86FA034	33.9833	83.9667
71	ATL86FA055	33.5667	86.0500
72	ATL86FA058	33.8333	86.1667
73	ATL86FA062	34.7833	83.9500
74	ATL86FA063	33.8167	85.8000
75	ATL86FA064	36.5667	77.1833
76	ATL86FA066	35.7833	80.3000
77	ATL86FA074	40.0500	77.4667
78	ATL86FA079	36.1500	81.1167
79	ATL86FA081	36.1833	82.8167
80	ATL86FA097	35.1167	90.1333
81	ATL86FA102	33.1667	84.7167
82	ATL86FA120	36.4667	76.9167
83	ATL86FA129	30.7833	87.7000
84	ATL86FA132	33.9333	83.3167
85	ATL86FA156	33.4333	87.3667
86	ATL86FA208	35.8667	78.7667
87	ATL86FA220	34.6000	83.2833
88	ATL86FA222	36.7833	80.8167
89	ATL86FA239	37.7833	80.3333
90	ATL86FA242	34.4500	83.1167
91	ATL86FA259	31.5333	82.0167
92	ATL86FA264	36.5667	80.8167
93	ATL86FA265	32.2500	88.2500
94	ATL86FA266	35.7333	78.9167
95	ATL86FEI06	41.0333	81.4667
96	ATL86FEI10	41.2500	81.9167
97	ATL86FEK02	40.3667	82.5000
98	ATL86FKG01	32.5000	83.7500
99	ATL86FKG07	32.5000	81.7500
100	ATL86FKG08	34.3000	84.4167
101	ATL86FLQ02	37.1667	82.6333
102	ATL86FLQ05	38.1667	85.7333
103	ATL86LA189	41.6167	81.3667
104	ATL86MA011	33.0000	83.7667
105	ATL86MA080	35.0500	84.3000
106	ATL86MA087	31.4167	86.4500
107	ATL86MA114A	42.2167	71.4167
108	ATL86MA114B	42.2167	71.4167
109	ATL87DEG03	39.3333	82.4333
110	ATL87DEG04	39.1833	83.5333
111	ATL87DEI01	41.0000	81.7667
112	ATL87DEI06	41.3000	81.7500
113	ATL87DMG02	36.4667	77.6667
114	ATL87FA001A	35.4500	77.9667
115	ATL87FA001B	35.4500	77.9667
116	ATL87FA004	32.1667	81.3667
117	ATL87FA010	36.7833	87.4333
118	ATL87FA016	32.8333	83.5667
119	ATL87FA030	34.9667	78.3500
120	ATL87FA045	35.4333	82.5333
121	ATL87FA052	31.6000	85.2333
122	ATL87FA071	34.1667	84.0167
123	ATL87FA074	35.9500	85.0833
124	ATL87FA122	32.7500	84.4167
125	ATL87FA123	34.2667	77.9000
126	ATL87FA136	35.0500	89.6833
127	ATL87FA142	39.4667	84.7167
128	ATL87FA147	35.0000	82.0000
129	ATL87FA160	36.3833	87.0167
130	ATL87FA173	26.2833	80.6333
131	ATL87FA174	35.4500	82.5167
132	ATL87FA194	33.8167	78.7167
133	ATL87FA230	31.4167	82.1000
134	ATL87FA243	41.4667	81.0833
135	ATL87FA257	32.0833	80.4333
136	ATL87FA262	32.4500	87.9500
137	ATL87FA268	35.7500	75.5000
138	ATL87FKG01	34.0000	84.5833
139	ATL87MA035	36.4000	85.0000
140	ATL87MA057	35.0167	77.4000
141	ATL88DLT01	36.1667	87.1333

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
142	ATL88DMG03	35.0000	80.0000
143	ATL88FA007	35.0167	90.0000
144	ATL88FA010	34.8833	82.3333
145	ATL88FA025	39.6333	84.5833
146	ATL88FA040	36.9833	86.9500
147	ATL88FA044	39.3333	83.0833
148	ATL88FA046	36.0000	84.3167
149	ATL88FA059	32.2333	80.7167
150	ATL88FA060	31.0000	83.0000
151	ATL88FA066	35.1833	80.5333
152	ATL88FA067	35.7667	84.9667
153	ATL88FA081	35.8000	82.4333
154	ATL88FA082	33.3667	81.9667
155	ATL88FA085	35.9667	87.8667
156	ATL88FA088	41.1167	80.6167
157	ATL88FA104	36.7000	85.3333
158	ATL88FA109	35.0000	83.0000
159	ATL88FA123	35.8500	83.5167
160	ATL88FA136	36.6167	83.6167
161	ATL88FA137	34.9500	78.9167
162	ATL88FA155	35.8500	84.0667
163	ATL88FA191	35.0000	84.0000
164	ATL88FA200	32.2667	87.9500
165	ATL88FA211	34.1333	81.9667
166	ATL88FA220	33.0333	85.1667
167	ATL88FA230	34.7333	80.3500
168	ATL88FA233	35.0000	79.0000
169	ATL88FA254	36.1667	84.4000
170	ATL88FA256	33.4167	87.2167
171	ATL88MA089	39.8333	83.8333
172	ATL88MA184	40.8833	74.2000
173	ATL89DMG01	35.4000	80.1500
174	ATL89FA004	36.4000	84.1333
175	ATL89FA006	32.9167	85.9500
176	ATL89FA015	36.4333	84.0667
177	ATL89FA019	33.8000	84.6333
178	ATL89FA035	36.1667	83.1667
179	ATL89FA047	36.0000	82.0000
180	ATL89MA023	36.0000	86.0000
181	ATL89MA070	39.5500	83.9167
182	BFO84FA001	38.4667	75.1833
183	BFO85FA004	39.0000	79.0000
184	BFO85FA006	39.1667	77.5667
185	BFO85FA009	38.7167	77.5167
186	BFO85FA023	39.3833	77.4333
187	BFO85FA048	38.6833	77.3167
188	BFO85FA049	38.0333	77.3667

	NTSB number	Crash Latitude	Crash Longitude
189	BFO85FA051	38.9667	76.9167
190	BFO85FA061	38.4500	76.7333
191	BFO85FA062	39.6333	79.0500
192	BFO85FA068	38.5167	77.9667
193	BFO85FA070	38.0333	78.8667
194	BFO85FA077	38.7333	76.9167
195	BFO86FA011	39.4667	77.0167
196	BFO86FA027	38.9667	76.9167
197	BFO86FA036	38.9333	76.7667
198	BFO86FA037	38.9500	76.5667
199	BFO86FA042	39.3167	76.3833
200	BFO86FA047	39.4167	77.1167
201	BFO86FIA02	38.5833	78.4000
202	BFO86FID01	38.1500	78.1667
203	BFO86FID03	38.0833	78.9500
204	BFO87FA022	39.5500	77.5833
205	BFO87FA037	39.7167	75.8000
206	BFO87FA046	36.8167	82.0667
207	BFO87FA057	38.8667	77.0333
208	BFO88DIA01	36.6333	80.0167
209	BFO88DID04	36.9833	77.0000
210	BFO88FA007	38.7167	77.7000
211	BFO88FA008	37.3333	79.0000
212	BFO88FA009	36.8000	78.1500
213	BFO88FA011	39.6500	77.2500
214	BFO88FA024	38.9000	80.0667
215	BFO88FA025	38.9333	76.7667
216	BFO88FA026	38.5000	77.3167
217	BFO88FA068	38.9833	76.3500
218	BFO88FID03	36.7833	76.4500
219	CHI83FA076	41.8000	88.0667
220	CHI83FA090	45.8167	92.3667
221	CHI83FA135	40.5500	89.2500
222	CHI83FA161	39.8333	88.3333
223	CHI83FA213	40.4333	88.9667
224	CHI83FA334	41.0833	88.7000
225	CHI83FA336	41.4667	87.0167
226	CHI83FA346	41.9500	88.4833
227	CHI83FA350	44.0500	88.7167
228	CHI83FA366	40.4167	80.8333
229	CHI83FA402	43.9500	86.0000
230	CHI83FA407	45.2500	93.3333
231	CHI83FA437	45.6833	92.9500
232	CHI84FA028	40.8333	85.1667
233	CHI84FA037	42.1333	86.1167
234	CHI84FA054	40.2333	84.2000
235	CHI84FA063	40.3000	84.7500

	NTSB number	Crash Latitude	Crash Longitude
236	CHI84FA121	42.1167	87.8833
237	CHI84FA250A	48.2000	96.6667
238	CHI84FA289	42.4833	86.0833
239	CHI84FA313	48.3333	96.5833
240	CHI84FA343	45.2500	83.4333
241	CHI84FA352	41.6333	82.8167
242	CHI84FA402	42.1167	87.9000
243	CHI84MA249	39.1000	84.4167
244	CHI85FA020	45.5000	91.4167
245	CHI85FA036	43.8000	88.8333
246	CHI85FA053	41.0000	87.0000
247	CHI85FA070	42.6667	83.5000
248	CHI85FA104	38.7833	83.0167
249	CHI85FA156	43.6833	85.6500
250	CHI85FA158	41.2167	81.3000
251	CHI85FA211	38.4667	89.6667
252	CHI85FA213	39.7500	86.1167
253	CHI85FA292	38.7167	88.1833
254	CHI85FA301	41.4167	87.3833
255	CHI85FA316	40.2000	83.2333
256	CHI85FA351	42.4500	83.6833
257	CHI85FA370	41.6000	88.0833
258	CHI85FEC01	41.3500	83.4167
259	CHI85FEI02	41.1000	81.2000
260	CHI85FEK01	41.0000	84.0000
261	CHI85FEK02	40.8000	84.7000
262	CHI85FEP02	42.0000	89.0000
263	CHI85FEP04	42.9667	88.8000
264	CHI85FER01	44.8333	93.0833
265	CHI85FER02	45.7500	93.8333
266	CHI85FEV03	40.0500	89.6500
267	CHI86FA007	44.2833	85.4167
268	CHI86FA031	40.9833	85.2000
269	CHI86FA046	41.9500	84.2000
270	CHI86FA068	41.9167	88.3000
271	CHI86FA077	38.6833	87.1167
272	CHI86FA098	41.7667	88.2667
273	CHI86FA100A	41.9000	88.2333
274	CHI86FA102	44.6333	86.2167
275	CHI86FA120	41.8667	84.4833
276	CHI86FA137	30.0000	83.0000
277	CHI86FA141	41.6333	85.0833
278	CHI86FA146	47.9333	97.0000
279	CHI86FA170	42.1333	86.4333
280	CHI86FA171	45.2167	88.0667
281	CHI86FA174	43.5500	87.9667
282	CHI86FA183	41.6833	88.1167

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
283	CHI86FA194	43.9833	88.5500
284	CHI86FA198	43.1667	84.6667
285	CHI86FA233	41.7833	87.7333
286	CHI86FEE05	41.7500	88.2000
287	CHI86FEM10	42.2500	85.0667
288	CHI86FEM12	44.5333	84.7000
289	CHI86FEM14	41.8000	85.5833
290	CHI86FEP02	44.3500	89.8333
291	CHI86FER03	44.6167	93.2167
292	CHI86FER06	46.5000	94.4833
293	CHI86FET01	41.6333	86.5833
294	CHI86FEX02	38.0500	87.6167
295	CHI86FEX07	38.7667	87.5333
296	CHI86FEX09	40.6333	85.6167
297	CHI86FEX10	40.5000	86.0833
298	CHI86MA071	43.3333	93.2500
299	CHI87DCA01	38.5667	90.1500
300	CHI87DEC01	42.5500	83.1833
301	CHI87DEC04	42.6500	83.4167
302	CHI87DEE03	41.7167	88.2667
303	CHI87DEE08	41.4000	87.8500
304	CHI87DEE09	41.0500	87.8000
305	CHI87DEE10	41.6167	88.2667
306	CHI87DEM01	43.0333	86.2000
307	CHI87DEM05	42.1500	85.8333
308	CHI87DEP06	44.0500	89.0833
309	CHI87DEP10	43.9667	90.4833
310	CHI87DER05	46.3000	95.5000
311	CHI87DER09	45.5000	93.2000
312	CHI87DET07	41.7000	86.6667
313	CHI87DEX04	39.8333	85.1667
314	CHI87DEX07	39.9000	85.9167
315	CHI87FA010	41.7167	87.7500
316	CHI87FA012	48.5667	93.4000
317	CHI87FA040	40.6667	89.6833
318	CHI87FA058	41.4167	83.1667
319	CHI87FA069	41.7833	87.7500
320	CHI87FA085	39.9500	91.2000
321	CHI87FA104	41.4833	87.8500
322	CHI87FA129	42.2500	85.5333
323	CHI87FA140	43.1167	89.5333
324	CHI87FA149	43.9667	90.4833
325	CHI88DCA01	38.5667	90.1667
326	CHI88DEE06	41.0000	87.9000
327	CHI88DEM07	42.2667	85.2333
328	CHI88DEP02	43.4167	88.2833
329	CHI88DEP11	44.3333	89.3667

	NTSB number	Crash Latitude	Crash Longitude
330	CHI88DER02	48.0000	95.3333
331	CHI88DER04	45.1667	96.0833
332	CHI88DER07	48.5333	93.1500
333	CHI88DET01	41.1333	85.1500
334	CHI88DEX01	38.0000	86.0000
335	CHI88DEX02	39.5333	86.8333
336	CHI88DEX07	39.1333	86.6333
337	CHI88DEX08	30.3333	85.2333
338	CHI88FA008	44.7000	94.3500
339	CHI88FA075	42.4667	83.0667
340	CHI88FA079	39.6167	89.3000
341	DCA83AA017	43.5000	114.3000
342	DCA83AA025	39.1667	77.1667
343	DCA87MA020B	39.1000	94.2667
344	DCA87MA024	36.2667	121.9333
345	DCA88MA032	35.8833	78.7833
346	DEN83FA049	45.6667	96.9833
347	DEN83FA053	38.1000	112.9333
348	DEN83FA056	39.1667	106.4167
349	DEN83FA062	38.6667	109.7500
350	DEN83FA070	39.5333	103.6167
351	DEN83FA087	40.7833	111.8833
352	DEN83FA108	43.2167	110.9833
353	DEN83FA123	41.5167	105.2167
354	DEN83FA131	37.6000	109.0667
355	DEN83FA150	44.3500	105.5167
356	DEN83FA203	38.4500	112.4500
357	DEN83FA214	37.8333	107.6333
358	DEN83FA221	40.7833	111.9667
359	DEN83FA222	41.3000	106.8000
360	DEN83FTC02	41.1000	102.1500
361	DEN83FTG01	46.9667	96.9667
362	DEN83FTI03	46.7667	112.7500
363	DEN84FA039	43.6000	110.7333
364	DEN84FA049	37.7667	108.8833
365	DEN84FA086	47.5833	104.3500
366	DEN84FA137	33.7000	100.8500
367	DEN84FA144	33.3500	105.6667
368	DEN84FA155	45.4333	105.4167
369	DEN84FA188	39.3667	104.6667
370	DEN84FA199	39.9000	105.1167
371	DEN84FA202	35.2000	106.6667
372	DEN84FA211	40.0167	104.9000
373	DEN84FA219	40.9667	103.1167
374	DEN84FA223	36.8000	105.4833
375	DEN84FA242	41.5000	113.1833
376	DEN84FA274	48.3000	114.2500

	NTSB number	Crash Latitude	Crash Longitude
377	DEN84FA275	41.6000	109.0667
378	DEN84FA278	34.7833	106.6167
379	DEN84FA295	47.4500	111.3667
380	DEN84FA298	37.0833	110.9000
381	DEN84MA247	40.1167	104.8167
382	DEN84MA266	41.5000	110.0167
383	DEN85FA002	45.4500	98.4167
384	DEN85FA008	35.1833	105.8167
385	DEN85FA010	39.5667	104.8333
386	DEN85FA015	41.0000	104.0000
387	DEN85FA017	41.1500	104.8000
388	DEN85FA027	40.0000	112.0000
389	DEN85FA028	38.5667	112.4333
390	DEN85FA034	36.1000	104.7333
391	DEN85FA035	40.2000	111.7167
392	DEN85FA037	39.0000	101.0167
393	DEN85FA043	34.9833	106.8500
394	DEN85FA048	45.8333	108.5500
395	DEN85FA055	35.1500	106.1667
396	DEN85FA062	40.8000	111.9667
397	DEN85FA069	37.0333	108.1333
398	DEN85FA084	48.4833	109.3667
399	DEN85FA096	41.7833	111.8500
400	DEN85FA097	32.1833	107.2833
401	DEN85FA103	48.9500	104.2667
402	DEN85FA167	39.3333	105.9833
403	DEN85FA180	43.8833	103.4167
404	DEN85FA189	44.0833	103.2500
405	DEN85FA202	46.1000	110.4333
406	DEN85FA203	40.3500	104.6000
407	DEN85FA214	39.7667	104.8667
408	DEN85FA222	37.5167	112.9667
409	DEN85FA229	39.1167	104.4667
410	DEN85FA233	41.2667	112.0667
411	DEN85FA240	40.5333	105.1833
412	DEN85FA241	40.7500	107.3167
413	DEN85FA246	34.9333	104.6333
414	DEN85FQA04	35.0000	108.0000
415	DEN85FTI01	45.7333	111.0000
416	DEN85LTG02	48.3500	101.9667
417	DEN85LTG06	48.2167	101.3500
418	DEN86FA002	43.8333	99.3333
419	DEN86FA006	32.1667	103.1500
420	DEN86FA009	39.7333	107.3167
421	DEN86FA023	35.1833	106.6500
422	DEN86FA028	38.7500	102.3167
423	DEN86FA054	39.0167	110.2000

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
424	DEN86FA056	40.7833	111.9667
425	DEN86FA060	40.7833	111.9667
426	DEN86FA071	48.2000	114.6000
427	DEN86FA075	46.7667	100.7500
428	DEN86FA076	35.0333	106.6000
429	DEN86FA092	46.0500	113.3167
430	DEN86FA142	46.4167	101.8333
431	DEN86FA146	41.1500	104.7667
432	DEN86FA147	38.8167	106.1167
433	DEN86FA150	33.9667	97.0167
434	DEN86FA160	38.0667	102.6833
435	DEN86FA163	43.8000	110.1333
436	DEN86FA165	35.8000	104.8333
437	DEN86FA170	33.4167	108.1333
438	DEN86FA175	44.3833	106.7167
439	DEN86FA181	46.3833	111.0500
440	DEN86FA207	36.4500	105.6667
441	DEN86FA211	48.4500	111.3833
442	DEN86FA213	41.8167	107.2500
443	DEN86FA232	38.9500	111.7000
444	DEN86FA252	39.8667	104.5167
445	DEN86FTE02	39.1833	104.7667
446	DEN86FTG02	47.0833	97.4500
447	DEN86FTK01	44.5000	98.1000
448	DEN86FTM02	41.1833	112.0000
449	DEN86MA129	38.5500	110.2000
450	DEN87DTI01	44.4167	108.4167
451	DEN87DTK01	45.5000	98.3333
452	DEN87DTM01	40.3667	112.0333
453	DEN87FA008	44.2500	107.0500
454	DEN87FA011	35.3667	108.5833
455	DEN87FA014	45.5000	111.2500
456	DEN87FA018	45.7833	108.5000
457	DEN87FA024	44.3167	103.5333
458	DEN87FA037	47.2000	108.9000
459	DEN87FA046	35.1833	105.4500
460	DEN87FA048	37.6333	102.2833
461	DEN87FA050	44.2167	110.4000
462	DEN87FA061	38.4333	108.4833
463	DEN87FA064	32.4833	104.7167
464	DEN87FA081	41.1333	111.7500
465	DEN87FA090	48.3500	101.8500
466	DEN87FA110	40.4833	107.5167
467	DEN87FA111	40.0333	105.2167
468	DEN87FA130	44.5167	109.0167
469	DEN87FA134	41.2167	111.9667
470	DEN87FA147	47.7167	112.7333

	NTSB number	Crash Latitude	Crash Longitude
471	DEN87FA159	33.7000	108.8500
472	DEN87FA177	39.5667	104.8333
473	DEN87FA178	40.7167	107.2833
474	DEN87FA186	39.6167	106.1667
475	DEN87FA188	38.3667	105.7500
476	DEN87FA203	48.3000	114.2500
477	DEN87FA216	45.7000	111.0500
478	DEN87FA219	40.4500	107.1000
479	DEN87FA220	39.5667	104.8500
480	DEN87FA224	48.1333	99.1500
481	DEN87FA226	34.7500	107.8000
482	DEN87FA230	37.7000	113.0000
483	DEN87LA170	39.3000	107.1500
484	DEN88DQA01	33.1333	104.5833
485	DEN88DTE02	40.0833	104.4667
486	DEN88DTK01	45.3333	98.1000
487	DEN88DTM01	40.5333	111.9667
488	DEN88DTM03	40.0000	113.0000
489	DEN88FA001	46.2833	105.2500
490	DEN88FA014	39.3000	105.4333
491	DEN88FA021	37.4000	107.7500
492	DEN88FA023	37.3833	113.0833
493	DEN88FA030	40.8000	113.0333
494	DEN88FA050	39.3000	104.1667
495	DEN88FA071	45.1667	109.7833
496	DEN88FA096	38.3333	112.9667
497	DEN88FA098	37.4333	113.1667
498	DEN88FA100	44.0333	103.0500
499	DEN88FA110	40.5167	111.5500
500	DEN88FA112	35.0000	106.0000
501	DEN88FA119	32.8500	103.7500
502	DEN88FA128	42.1833	110.6333
503	DEN88FA138	36.6333	105.1833
504	DEN88FA141	33.6000	105.3667
505	DEN88FA186	43.4167	97.8333
506	DEN88FA202	43.0000	110.0000
507	DEN88FA212	38.0000	112.0000
508	DEN88GA068	35.2833	106.0500
509	DEN88GA185	40.0167	105.7333
510	DEN89FA017	38.5000	106.3167
511	DEN89FA019	39.1167	105.3333
512	DEN89FA020	41.0000	111.0000
513	DEN89FA034	40.0000	112.0000
514	DEN89FA038	39.2833	105.8667
515	DEN89FA041	44.0000	106.0000
516	DEN89FA101	40.0000	111.0000
517	FTW83FA117	32.3333	102.5333

	NTSB number	Crash Latitude	Crash Longitude
518	FTW83FA142	27.8833	98.0333
519	FTW83FA144	34.9333	92.8667
520	FTW83FA149	34.0000	96.6500
521	FTW83FA226	29.6667	98.2000
522	FTW83FA245	36.1000	95.7833
523	FTW83FA252	30.0333	90.0333
524	FTW83FA254	33.2500	99.7667
525	FTW83FA259	29.9167	90.2500
526	FTW83FA276	29.9000	96.9000
527	FTW83FA299	35.2500	97.4833
528	FTW83FA387	35.3500	104.1667
529	FTW83FA415	30.0667	95.1667
530	FTW83FA416	34.7000	99.3333
531	FTW83FA430	29.5167	92.9833
532	FTW83FA441	31.1500	93.3333
533	FTW84FA023	34.4833	92.1000
534	FTW84FA032	31.9167	107.1000
535	FTW84FA060	36.7333	92.5500
536	FTW84FA083	27.4333	98.6833
537	FTW84FA104	35.4833	107.4500
538	FTW84FA107	29.0000	91.0000
539	FTW84FA125	30.6000	96.4167
540	FTW84FA171	35.9000	96.1167
541	FTW84FA180	30.1333	94.1000
542	FTW84FA206	30.0333	95.7500
543	FTW84FA214	33.1833	96.6000
544	FTW84FA218	29.2667	98.4500
545	FTW84FA220	29.3833	95.0333
546	FTW84FA224	31.6667	98.1000
547	FTW84FA242	35.1667	96.5333
548	FTW84FA244	29.3000	98.3333
549	FTW84FA272	34.9833	99.1667
550	FTW84FA297	31.0833	97.6833
551	FTW84FA300	30.6667	97.6667
552	FTW84FA331	29.9000	101.0833
553	FTW84FA354	29.5000	90.0833
554	FTW84FA404	32.8833	97.0667
555	FTW84FA408	35.3833	95.1333
556	FTW84LA416	30.3000	91.3667
557	FTW85FA006	32.1667	91.9167
558	FTW85FA010	35.3833	95.6333
559	FTW85FA014	29.6000	97.9833
560	FTW85FA019	32.9667	96.8333
561	FTW85FA032	29.2333	96.0167
562	FTW85FA034	35.5000	98.0333
563	FTW85FA040	32.3000	92.2333
564	FTW85FA050	31.5333	106.1500

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
565	FTW85FA055	32.3833	96.7833
566	FTW85FA065	25.7500	97.4167
567	FTW85FA088	29.5333	98.4667
568	FTW85FA090	29.2667	97.2000
569	FTW85FA130	29.3333	98.4667
570	FTW85FA159	35.9500	95.9667
571	FTW85FA171	31.4500	97.0167
572	FTW85FA181	32.6667	93.0500
573	FTW85FA188	29.8667	90.8333
574	FTW85FA204	35.5000	98.0000
575	FTW85FA224	30.3667	104.0167
576	FTW85FA245	33.4167	96.8667
577	FTW85FA247	31.3333	92.4333
578	FTW85FA257	32.7667	98.0500
579	FTW85FA259	29.7667	100.3500
580	FTW85FA265	32.6667	96.7833
581	FTW85FA287	32.9000	97.4333
582	FTW85FA300	29.6000	90.6833
583	FTW85FA306	33.5500	102.3667
584	FTW85FA310	29.9167	90.8833
585	FTW85FA335	34.8000	96.6667
586	FTW85FA346	35.2500	100.6667
587	FTW85FQG03	33.7167	102.6500
588	FTW85FRA01	29.6667	95.0000
589	FTW85FRD02	30.2000	94.8667
590	FTW85FRD03	30.0000	92.8333
591	FTW85MA297	35.4333	98.0000
592	FTW86FA008	31.4167	103.4833
593	FTW86FA019	30.5167	101.0667
594	FTW86FA023	32.4667	92.8000
595	FTW86FA025	30.5833	96.3500
596	FTW86FA026	35.3500	96.9500
597	FTW86FA027A	33.5333	96.2333
598	FTW86FA027B	33.5333	96.2333
599	FTW86FA033	28.4667	96.4833
600	FTW86FA035	33.5167	97.0500
601	FTW86FA046	35.2667	95.2833
602	FTW86FA050	32.6000	96.5167
603	FTW86FA054	36.3167	95.1667
604	FTW86FA059	33.7167	97.6333
605	FTW86FA063	33.0000	96.8000
606	FTW86FA086B	36.7833	97.3000
607	FTW86FA092	35.5833	98.1833
608	FTW86FA098	36.3333	95.9500
609	FTW86FA127	29.2167	95.0333
610	FTW86FA133	32.9500	96.8333
611	FTW86FA142	34.4333	94.5167

	NTSB number	Crash Latitude	Crash Longitude
612	FTW86FA154	47.9500	109.7167
613	FTW86FA171	29.5833	95.2667
614	FTW86FPA07	31.4167	97.7833
615	FTW86FPA13	32.6667	96.3833
616	FTW86FPA18	33.5167	96.6500
617	FTW86FPA22	32.5333	96.9000
618	FTW86FPA27	31.3333	96.8500
619	FTW86FPJ05	36.2500	95.7667
620	FTW86FQG02	31.6000	102.8500
621	FTW86FQG04	33.5833	101.8833
622	FTW86FRD25	32.8167	91.8167
623	FTW86FRG02	30.3833	97.5667
624	FTW86FRG19	30.6667	97.6667
625	FTW86MA001A	32.6833	96.6333
626	FTW86MA010	45.1333	108.6000
627	FTW86MA058	33.4167	94.2167
628	FTW87DPJ03	36.3667	97.9167
629	FTW87DPJ08	34.7333	99.9333
630	FTW87DPJ09	34.6667	98.0833
631	FTW87DRD03	31.3333	93.1667
632	FTW87DRG01	31.8500	99.4000
633	FTW87DRG04	26.2500	97.8333
634	FTW87FA029	33.9000	101.8500
635	FTW87FA031	35.5167	97.6833
636	FTW87FA043	31.0000	95.0000
637	FTW87FA047	32.2167	97.3167
638	FTW87FA064	31.0833	94.6833
639	FTW87FA088	32.3333	96.8500
640	FTW87FA096	32.4667	95.5333
641	FTW87FA123	35.8500	95.5167
642	FTW87FA168	36.0333	95.9833
643	FTW87FA177	32.0000	96.0000
644	FTW87FA183	40.4333	86.1500
645	FTW87FA206A	29.5000	96.2500
646	FTW87FA206B	29.5000	96.2500
647	FTW87FA209	30.1000	95.9167
648	FTW87FA210	32.9167	98.4333
649	FTW87FA223	32.5333	93.9667
650	FTW87MA133	36.1167	99.8667
651	FTW88DPJ02	36.1167	95.6167
652	FTW88DPJ03	35.2500	97.4667
653	FTW88DPJ07	36.0000	95.0000
654	FTW88DPJ08	34.7000	94.4833
655	FTW88DQG02	34.0833	101.5167
656	FTW88DRA04	29.0000	95.0000
657	FTW88DRA11	30.0000	95.0000
658	FTW88DRD08	32.7167	92.7667

	NTSB number	Crash Latitude	Crash Longitude
659	FTW88DRD12	32.4833	91.8667
660	FTW88DRD14	30.1833	92.3167
661	FTW88DRD18	30.2333	92.2500
662	FTW88DRD20	30.0000	89.0000
663	FTW88DRG04	26.2167	97.6500
664	FTW88DRG06	29.0000	98.0000
665	FTW88FA011	30.9333	95.6667
666	FTW88FA023	28.0833	97.0333
667	FTW88FA024	30.7167	96.3167
668	FTW88FA032	26.0000	97.0000
669	FTW88FA035	32.6833	96.8667
670	FTW88FA046	36.4333	99.5333
671	FTW88FA051	30.3167	95.4000
672	FTW88FA057	34.8167	96.6667
673	FTW88FA063	30.2167	93.2667
674	FTW88FA069	32.0833	101.5500
675	FTW88FA074B	32.1667	94.8333
676	FTW88FA084	33.6167	93.4833
677	FTW88FA103	33.8000	95.5333
678	FTW88FA104	34.8333	95.1000
679	FTW88FA110	31.3667	100.4667
680	FTW88FA119	36.2667	97.4167
681	FTW88FA162	33.9000	97.1667
682	FTW89DPJ01	34.8500	95.8333
683	FTW89FA006	32.5833	94.7500
684	FTW89FA028	30.0667	95.5500
685	LAX83FA090	33.9167	116.4667
686	LAX83FA091	35.6667	115.3000
687	LAX83FA141	38.5167	120.7333
688	LAX83FA240	33.5167	111.8167
689	LAX83FA314	37.8000	121.7833
690	LAX83FA377	36.0500	121.5000
691	LAX83FA395	37.1667	119.3000
692	LAX83FA424	33.1167	117.1333
693	LAX83FUM08	32.5667	116.9833
694	LAX83FVG10	38.8333	120.2667
695	LAX84AA054	33.8000	118.0833
696	LAX84FA002	40.7667	114.9167
697	LAX84FA012	38.8667	118.5333
698	LAX84FA055	38.3500	121.6667
699	LAX84FA065	37.6000	119.1333
700	LAX84FA071	33.3500	117.4667
701	LAX84FA087	32.7500	115.2667
702	LAX84FA107	35.1500	118.4000
703	LAX84FA113	34.1833	117.4667
704	LAX84FA116	35.3833	119.6000
705	LAX84FA129	32.5167	109.4833

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
706	LAX84FA138	37.6833	121.4333
707	LAX84FA142	34.2000	117.6667
708	LAX84FA152	36.3500	121.3667
709	LAX84FA193	34.2333	118.9667
710	LAX84FA221	34.9000	117.8000
711	LAX84FA227	38.1167	121.2000
712	LAX84FA253	40.9833	124.1167
713	LAX84FA258	34.5000	112.6667
714	LAX84FA280	38.8000	120.7833
715	LAX84FA300	33.8833	117.6000
716	LAX84FA319A	37.5167	122.5000
717	LAX84FA337	34.7667	116.4000
718	LAX84FA367	40.7833	122.9667
719	LAX84FA378A	37.9000	122.1667
720	LAX84FA390	33.0000	115.3333
721	LAX84FA396	35.8000	120.7000
722	LAX84FA429	33.0667	116.6000
723	LAX84FA439	34.9833	113.0500
724	LAX84FA460	35.3667	118.7500
725	LAX84FA467	33.9833	117.4167
726	LAX84FA473	37.0000	118.0667
727	LAX84FA481	34.3167	119.1000
728	LAX84FA498	34.4333	112.3833
729	LAX85FA036	33.9667	117.0333
730	LAX85FA048	35.7333	118.5500
731	LAX85FA068	36.2000	119.3333
732	LAX85FA071	34.9000	118.6500
733	LAX85FA084	33.5167	117.2000
734	LAX85FA086	37.7167	121.6667
735	LAX85FA088	34.1000	117.6833
736	LAX85FA093	34.0000	116.0000
737	LAX85FA100	36.8667	117.0500
738	LAX85FA102	34.5667	117.2000
739	LAX85FA123A	34.1167	117.8833
740	LAX85FA123B	34.1167	117.8833
741	LAX85FA137	33.0000	117.0000
742	LAX85FA159	33.2167	117.3500
743	LAX85FA163	37.6167	121.0000
744	LAX85FA192	33.8333	117.5833
745	LAX85FA213	34.4833	120.0667
746	LAX85FA228	33.6833	117.7333
747	LAX85FA232	37.2333	121.9667
748	LAX85FA241	36.3500	119.3000
749	LAX85FA251	37.6500	122.1167
750	LAX85FA253	34.5000	119.2167
751	LAX85FA259	34.0000	118.0000
752	LAX85FA280	33.9000	118.4167

	NTSB number	Crash Latitude	Crash Longitude
753	LAX85FA283	38.6833	120.9833
754	LAX85FA286	39.2167	120.1167
755	LAX85FA301	33.8333	117.5167
756	LAX85FA311	31.3500	111.1667
757	LAX85FA385	32.1333	111.1667
758	LAX85MA008	37.6167	122.3667
759	LAX86DVA04	37.8667	120.4167
760	LAX86DVA07	37.2833	120.5000
761	LAX86DVA09	35.7500	119.2333
762	LAX86DVA17	36.2500	119.4000
763	LAX86FA003	37.8667	122.2167
764	LAX86FA007	34.3000	110.9167
765	LAX86FA014	38.2167	122.4500
766	LAX86FA024	33.7000	118.1167
767	LAX86FA038	39.1833	120.6500
768	LAX86FA063	36.7000	118.3500
769	LAX86FA077	33.0500	113.3667
770	LAX86FA089	35.9833	112.1500
771	LAX86FA092	33.8000	116.1167
772	LAX86FA106	34.1000	110.9333
773	LAX86FA107	39.2500	123.7500
774	LAX86FA114	38.6833	122.6333
775	LAX86FA130	34.0500	117.6000
776	LAX86FA178	33.9500	116.9500
777	LAX86FA183	33.7667	116.2333
778	LAX86FA220	33.9667	117.6333
779	LAX86FA240	33.9333	117.9500
780	LAX86FA247	37.5000	118.6333
781	LAX86FA314	41.3333	122.9167
782	LAX86FA326	33.7667	118.2667
783	LAX86FA328	35.9167	112.1667
784	LAX86FUM02	32.9667	116.9000
785	LAX86FUM04	32.6333	116.9500
786	LAX86FVA10	37.2333	120.2500
787	LAX86FVA12	36.6167	120.2500
788	LAX86FVD07	37.8500	121.2667
789	LAX86MA311	37.8667	121.0167
790	LAX87DUG07	34.0833	117.1333
791	LAX87DUJ09	32.2333	109.1333
792	LAX87DUM01	33.1167	115.5167
793	LAX87DUM05	33.0500	117.0833
794	LAX87DVA02	36.7167	119.8833
795	LAX87DVA04	35.8500	119.1667
796	LAX87DVM04	36.9333	121.7833
797	LAX87FA017	34.4500	120.6167
798	LAX87FA084	34.2500	118.4167
799	LAX87FA087	35.5333	115.6333

	NTSB number	Crash Latitude	Crash Longitude
800	LAX87FA102	34.9333	119.4667
801	LAX87FA117	34.3500	118.5167
802	LAX87FA136	34.8833	118.9000
803	LAX87FA149	37.9167	120.3667
804	LAX87FA151	34.6500	112.4167
805	LAX87FA196	34.3500	118.4500
806	LAX87FA207	34.0000	118.4500
807	LAX87FA212	37.1667	121.9167
808	LAX87FA239	38.2667	119.2333
809	LAX87FA264	36.8667	120.4167
810	LAX87FA267	33.0000	118.0000
811	LAX87FA298	33.6000	117.9167
812	LAX87FA331	36.5833	121.8333
813	LAX87MA018	34.2167	118.1333
814	LAX87MA052	35.4333	119.0667
815	LAX88DUM03	33.0333	116.8333
816	LAX88DVA03	37.1667	121.0167
817	LAX88DVA04	37.2833	120.5167
818	LAX88DVD03	37.9333	121.7833
819	LAX88FA052	34.5667	111.9000
820	LAX88FA148	37.9333	122.1667
821	LAX88FA149	33.2667	111.8000
822	LAX88FA196	33.4167	112.0833
823	LAX88FA230	34.2500	115.9167
824	LAX88FA258	33.7167	118.2500
825	LAX88FA264	37.0000	112.0000
826	LAX88FA278	33.9500	117.7833
827	LAX89DVD03	39.8833	123.8667
828	LAX89FA032	33.8000	117.6833
829	MIA83FA065	30.4000	84.4000
830	MIA83FA073	28.6333	81.6667
831	MIA83FA082	28.4333	82.2500
832	MIA83FA113	29.5000	81.3333
833	MIA83FA140	26.0000	80.2333
834	MIA83FA152	27.8000	80.5000
835	MIA83FA175	26.5833	82.2333
836	MIA83FA178	27.6333	80.5333
837	MIA84FA003	26.9167	81.9833
838	MIA84FA032	26.2333	81.9333
839	MIA84FA036	28.0833	82.0833
840	MIA84FA038	29.9333	83.2500
841	MIA84FA081	29.1333	83.0500
842	MIA84FA082	26.0333	80.4167
843	MIA84FA090	27.7667	82.6000
844	MIA84FA092	27.3833	82.5500
845	MIA84FA101	30.3333	81.5167
846	MIA84FA149	29.9833	84.3833

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
847	MIA84FA161	28.7667	81.2333
848	MIA84FA170	27.6333	82.7500
849	MIA84FA190	30.7333	84.8333
850	MIA84FA200	29.9500	81.3333
851	MIA84FA206	27.4167	81.8667
852	MIA84FA225	30.4000	86.8167
853	MIA84FA234	27.6500	80.4167
854	MIA84FA240	26.0000	80.2333
855	MIA84FA265	30.3833	81.9000
856	MIA85FA009	26.9167	81.9833
857	MIA85FA037	27.5000	80.2333
858	MIA85FA038	27.8167	80.6667
859	MIA85FA041	28.3500	81.5500
860	MIA85FA065	26.0000	81.0000
861	MIA85FA067	26.9167	81.9833
862	MIA85FA098	29.3667	82.4500
863	MIA85FA101	26.0000	81.0000
864	MIA85FA105	30.4833	81.6833
865	MIA85FA106	29.3667	83.2833
866	MIA85FA128	28.8167	81.8167
867	MIA85FA146	30.0000	85.0000
868	MIA85FA150	28.0000	82.0000
869	MIA85FA227	29.1500	83.0667
870	MIA85FA234	26.4167	81.1667
871	MIA85FA239	29.2833	82.1167
872	MIA85FA248	28.9167	80.8667
873	MIA85FA251	27.6167	80.9500
874	MIA86FA012	30.4667	87.3500
875	MIA86FA028	28.7833	81.5500
876	MIA86FA033	26.5833	80.0833
877	MIA86FA034	27.3000	82.2667
878	MIA86FA044	30.4667	87.1833
879	MIA86FA055	30.4167	82.5833
880	MIA86FA059	29.0333	82.0167
881	MIA86FA085	28.2167	81.0500
882	MIA86FA091	29.0667	81.2833
883	MIA86FA093	28.2833	81.4333
884	MIA86FA097	27.9167	82.0333
885	MIA86FA101	27.9833	83.5000
886	MIA86FA110	29.9500	81.9333
887	MIA86FA113	27.4833	80.3667
888	MIA86FA119	29.0833	82.1667
889	MIA86FA126	28.8500	81.6000
890	MIA86FA135	27.7500	82.6167
891	MIA86FA146	25.9333	80.4167
892	MIA86FA184	26.5333	80.2000
893	MIA86FA202	33.3833	90.2167

	NTSB number	Crash Latitude	Crash Longitude
894	MIA86MA032	26.3667	80.1333
895	MIA86MA182	30.3167	81.7667
896	MIA87FA025	30.3000	84.2500
897	MIA87FA031	33.4500	88.5833
898	MIA87FA056	30.0500	81.8833
899	MIA87FA084	25.7500	80.7167
900	MIA87FA091	28.5333	81.3167
901	MIA87FA135	25.3833	80.6167
902	MIA87FA150	33.1667	90.8167
903	MIA87FA186	30.2167	85.6833
904	MIA87FA189	26.0000	80.2333
905	MIA87FA203	27.6333	80.5333
906	MIA87FA205	29.6500	81.6833
920	MIA88FA094	27.0667	82.4333
921	MIA88FA114	28.1667	81.3000
922	MIA88FA127	30.6000	81.4500
923	MIA88FA134	29.1833	81.0500
924	MIA88FA178	30.0000	85.0000
925	MIA88FA187	30.3333	81.5167
926	MIA88FA234	29.1833	81.0500
927	MIA88FA239	27.0000	81.0000
928	MIA88FA254	32.5167	90.8833
929	MIA88FA257	26.6833	80.1000
930	MIA89FA044	30.7500	87.3167
931	MIA89FA048	29.0000	82.0000
932	MIA89FA054	29.2000	83.1667
933	MKC83FA065	42.1000	92.6000
934	MKC83FA069	38.5667	98.1833
935	MKC83FA090	37.8000	97.2833
936	MKC83FA098	38.3667	92.9833
937	MKC83FA136	42.3833	98.0333
938	MKC83FA177	37.8500	97.5667
939	MKC84FA033	39.1500	94.6000
940	MKC84FA147	40.6500	99.0833
941	MKC84FA157	41.9833	97.4333
942	MKC84FA164	37.4167	100.9833
943	MKC84FA174	41.2833	99.5667
944	MKC84FA197	34.4333	92.0833
945	MKC84FA225	33.9833	93.8333
946	MKC84FA256	41.2167	92.4833
947	MKC84FA271	41.1000	92.4667
948	MKC84FA285	33.0667	91.5833
949	MKC85FA007	38.4000	100.2000
950	MKC85FA030	39.3000	100.9333
951	MKC85FA036	38.0500	92.5667
952	MKC85FA042	40.0000	96.0000
953	MKC85FA059	34.3167	93.3333

	NTSB number	Crash Latitude	Crash Longitude
954	MKC85FA078	34.8667	93.4167
955	MKC85FA080	33.0000	93.0000
956	MKC85FA084	38.4833	90.8667
957	MKC85FA087	34.5500	91.8833
958	MKC85FA088	34.7000	94.3667
959	MKC85FA105	34.0000	91.0000
960	MKC85FA111	38.8333	94.5500
961	MKC85FA124	41.4833	93.5000
962	MKC85FA180	38.0000	92.0000
963	MKC85FA199	38.0000	90.0000
964	MKC85FPG01	35.1333	90.2333
965	MKC85FPG02	35.0000	91.0000
966	MKC85FPG03	35.9000	93.8667
967	MKC86FA008	38.8167	97.7333
968	MKC86FA011	38.2167	91.1667
969	MKC86FA023	39.1833	94.1333
970	MKC86FA030	36.2000	94.2833
971	MKC86FA048	41.8333	90.3333
972	MKC86FA053	41.4500	96.5667
973	MKC86FA077	38.7333	90.5167
974	MKC86FA080	39.7167	91.4500
975	MKC86FA082	37.6833	96.0500
976	MKC86FA088	41.9833	97.4333
977	MKC86FA098	41.5667	103.8667
978	MKC86FA101	40.9667	98.3167
979	MKC86FA139	34.9667	94.3000
980	MKC86FA151	41.8500	93.6500
981	MKC86FA166	38.5667	95.0833
982	MKC86FA181	37.0000	101.9000
983	MKC86FA189	38.7167	90.9833
984	MKC86FA195	40.6333	98.1167
985	MKC86FCA01	37.2333	89.5667
986	MKC86FCJ03	40.7833	96.9667
987	MKC87DCQ01	37.2667	98.0333
988	MKC87DCQ02	37.2833	98.1333
989	MKC87DCQ03	38.1167	98.0333
990	MKC87DPG02	34.7667	91.6333
991	MKC87DPG03	33.7167	91.4500
992	MKC87FA002	37.8333	94.7000
993	MKC87FA012	36.2000	94.4833
994	MKC87FA015	37.0333	100.9500
995	MKC87FA017	33.4500	94.0000
996	MKC87FA020	37.0333	97.9167
997	MKC87FA022	37.2167	91.5000
998	MKC87FA027	39.3500	101.0500
999	MKC87FA030	39.0167	94.2333
1000	MKC87FA036	37.9500	91.0333

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
1001	MKC87FA051	40.7667	102.0500
1002	MKC87FA077	41.2500	95.7500
1003	MKC87FA078	37.1000	93.2833
1004	MKC87FA083	38.8000	94.6333
1005	MKC87FA087	42.0333	94.0500
1006	MKC87FA094	36.5667	90.5000
1007	MKC87FA103	39.2500	95.8833
1008	MKC87FA121	33.7167	93.6500
1009	MKC87FA131	40.4333	99.3333
1010	MKC87FA165	35.7333	91.6500
1011	MKC87FA169	39.3167	102.0500
1012	MKC88DCD01	41.7000	94.9167
1013	MKC88DCD02	41.5167	93.2167
1014	MKC88DCG01	36.0000	94.0000
1015	MKC88DCQ03	39.1500	97.8667
1016	MKC88DCQ04	37.0000	98.0000
1017	MKC88DPG01	34.7333	92.2333
1018	MKC88DPG02A	34.4000	91.4500
1019	MKC88FA007	39.0167	92.2833
1020	MKC88FA018	37.6667	97.0833
1021	MKC88FA021	34.7000	94.2333
1022	MKC88FA023	41.0833	96.2333
1023	MKC88FA026	30.3500	95.4167
1024	MKC88FA039	33.6167	92.7833
1025	MKC88FA042	37.8833	100.7167
1026	MKC88FA059	38.0833	91.9500
1027	MKC88FA070	37.0000	93.0000
1028	MKC88FA119	39.7500	100.7500
1029	MKC88FA147	39.0000	94.0000
1030	MKC88FA166	36.7000	93.5000
1031	MKC89FA014	38.9167	94.7500
1032	NYC83AA208	39.5167	74.5333
1033	NYC83FA060	40.6500	76.7333
1034	NYC83FA091	40.7500	74.5000
1035	NYC83FA105	40.7333	73.4167
1036	NYC83FA121	41.3000	72.3167
1037	NYC83FA125	42.2167	74.0667
1038	NYC83FA141	41.3500	73.5333
1039	NYC83FA144	43.7667	71.3833
1040	NYC83FA187	39.3667	75.0667
1041	NYC83FA192	42.2833	74.1000
1042	NYC83FA207	41.3333	75.7167
1043	NYC83FA253	42.0167	74.5167
1044	NYC83FA256	44.4667	72.8833
1045	NYC83FFJ02	43.2000	77.9833
1046	NYC84FA024	42.8500	78.7167
1047	NYC84FA032A	41.0833	74.5833

	NTSB number	Crash Latitude	Crash Longitude
1048	NYC84FA032B	41.0833	74.5833
1049	NYC84FA033	41.4500	79.8500
1050	NYC84FA039	40.0333	76.9833
1051	NYC84FA053	41.6167	73.6500
1052	NYC84FA074	41.3500	72.0333
1053	NYC84FA090	42.5833	70.9167
1054	NYC84FA107	43.3500	76.3833
1055	NYC84FA129	41.7667	72.5333
1056	NYC84FA137	42.3667	74.2500
1057	NYC84FA143	42.4667	71.3333
1058	NYC84FA148	39.8333	79.6833
1059	NYC84FA157	40.7000	75.3333
1060	NYC84FA158	40.8167	72.8500
1061	NYC84FA189	44.2500	70.4167
1062	NYC84FA218	39.0000	77.0000
1063	NYC84FA224	40.9333	74.3167
1064	NYC84FA247	44.1667	74.1667
1065	NYC84FA295	41.0667	73.2167
1066	NYC84FA306	43.0000	71.0000
1067	NYC84FA307	41.5000	72.7500
1068	NYC84FA310	42.7500	70.8000
1069	NYC84FA326	41.1167	76.7500
1070	NYC84FFA05	42.4500	75.0167
1071	NYC84FGM01	41.8833	78.8333
1072	NYC84FHM05	43.1667	77.8167
1073	NYC84FNC03	42.9500	70.8167
1074	NYC84MA270	40.0000	74.0000
1075	NYC85FA003	41.4667	74.5000
1076	NYC85FA014	41.6500	71.3500
1077	NYC85FA015	40.8667	79.8833
1078	NYC85FA029	39.0000	74.0000
1079	NYC85FA047	43.1167	77.6667
1080	NYC85FA059	39.3667	75.1833
1081	NYC85FA083	43.3000	73.0500
1082	NYC85FA098	40.7833	73.1000
1083	NYC85FA103	41.0000	77.0000
1084	NYC85FA201	40.5167	75.5500
1085	NYC85FA213	40.5667	73.9500
1086	NYC85FA219	43.1667	79.0333
1087	NYC85FA222	40.2833	77.1667
1088	NYC85FA240	40.3833	79.8667
1089	NYC85FA241	41.3333	74.5667
1090	NYC85FA245	39.8333	79.5667
1091	NYC85FFA01	44.2833	73.3667
1092	NYC85FFJ01	42.0833	76.1000
1093	NYC85FGM04	40.0000	78.7667
1094	NYC85FGM05	40.8000	80.1667

	NTSB number	Crash Latitude	Crash Longitude
1095	NYC85FGT02	34.8833	77.0667
1096	NYC85FHA03	41.7000	76.0500
1097	NYC85FHD02	40.5667	74.7333
1098	NYC85FNA02	42.4667	71.5167
1099	NYC86FA001	40.2000	74.6000
1100	NYC86FA002	42.5333	74.4167
1101	NYC86FA006	40.5167	79.1500
1102	NYC86FA030	44.6667	68.8000
1103	NYC86FA037	41.5000	72.8167
1104	NYC86FA068	42.4667	72.5667
1105	NYC86FA077	41.0000	74.7333
1106	NYC86FA112	41.9167	71.4833
1107	NYC86FA127	41.5500	73.8333
1108	NYC86FA135	39.8000	75.3500
1109	NYC86FA138	42.3000	73.9833
1110	NYC86FA176	39.8667	76.8333
1111	NYC86FA201	44.2833	72.8667
1112	NYC86FA214	40.0000	74.5000
1113	NYC86FA216	41.2333	71.1167
1114	NYC86FA218	39.3500	74.4500
1115	NYC86FA219	39.3667	76.6000
1116	NYC86FGM05	40.0333	79.0000
1117	NYC86FNC02	44.7667	68.7667
1118	NYC86FNC07	42.7833	71.5167
1119	NYC86FNC08	43.1667	71.3333
1120	NYC86MA148	42.1167	71.7167
1121	NYC87DHM02	41.9833	73.8333
1122	NYC87DNC05	45.3667	69.3833
1123	NYC87DNC12	42.0000	73.0000
1124	NYC87FA006	42.1667	72.6833
1125	NYC87FA021	42.2000	79.5000
1126	NYC87FA023	35.9167	84.6833
1127	NYC87FA045	40.2667	77.2500
1128	NYC87FA095	40.7833	78.0000
1129	NYC87FA119	40.7667	77.8667
1130	NYC87FA127	39.9167	76.8667
1131	NYC87MA024	40.7667	74.0000
1132	NYC88DGT01	40.6667	77.8333
1133	NYC88FA051	42.5000	76.3833
1134	SEA83FA037	45.5333	122.5667
1135	SEA83FA038	45.8333	121.5833
1136	SEA83FA045	47.9167	116.7500
1137	SEA83FA072	48.2333	122.4333
1138	SEA83FA087	48.0167	122.9500
1139	SEA83FA093	47.4833	122.2167
1140	SEA83FA118	45.2333	121.7333
1141	SEA83FA168	43.2667	123.1667

APPENDIX A3.1 GENERAL AVIATION IN FLIGHT CRASH LOCATIONS

	NTSB number	Crash Latitude	Crash Longitude
1142	SEA83FA178	48.0667	122.0167
1143	SEA83FA204	48.7167	122.8333
1144	SEA84FA058	45.5333	123.0500
1145	SEA84FA063	43.7167	116.6667
1146	SEA84FA068	45.6667	121.6667
1147	SEA84FA078	44.9500	117.8000
1148	SEA84FA088	43.0833	122.1167
1149	SEA84FA090	39.0167	119.7167
1150	SEA84FA101	48.6833	122.8167
1151	SEA84FA102	40.1667	118.4500
1152	SEA84FA111	45.5167	122.7500
1153	SEA84FA135	46.1833	123.9833
1154	SEA84FA158	35.9667	115.1167
1155	SEA84FA164	47.4833	122.7500
1156	SEA84FA173	46.4667	122.9167
1157	SEA84FA175	40.8167	115.7833
1158	SEA84FA178	35.9333	115.1500
1159	SEA84FA196	48.7167	116.2833
1160	SEA84FA215B	45.6333	121.2167
1161	SEA84FA217	44.7667	115.0833
1162	SEA84FA223	45.6333	122.0000
1163	SEA84FYK01	43.9167	123.0000
1164	SEA85FA001	39.3667	117.1167
1165	SEA85FA016	47.0500	123.7500
1166	SEA85FA035	39.0500	119.6667
1167	SEA85FA036	40.0000	117.0000
1168	SEA85FA043	47.3333	122.1000
1169	SEA85FA050	42.5333	122.9000
1170	SEA85FA051	39.0000	119.0000
1171	SEA85FA056	42.3833	122.8667
1172	SEA85FA065	39.7833	114.3667
1173	SEA85FA084	45.3667	123.3500
1174	SEA85FA100	42.8833	114.9167
1175	SEA85FA103	47.5333	122.3000
1176	SEA85FA113	43.1167	116.8833
1177	SEA85FA121	48.0500	122.9500
1178	SEA85FA122	47.0000	117.0000
1179	SEA85FA156	48.3000	122.5000
1180	SEA85FA162	43.9333	115.7500
1181	SEA85FA181	43.8667	114.7167
1182	SEA85FA203	43.3167	114.3167
1183	SEA85FA208	47.3667	120.2333
1184	SEA85FA211	44.0167	116.4833
1185	SEA85FA225	46.5167	114.6333
1186	SEA85LA054	42.4833	122.8167
1187	SEA85LA095	40.4833	115.5000
1188	SEA86FA004	42.2500	113.8667

	NTSB number	Crash Latitude	Crash Longitude
1189	SEA86FA034	46.3000	123.9333
1190	SEA86FA039	44.2000	123.4000
1191	SEA86FA046	38.9167	120.0000
1192	SEA86FA047	39.4833	119.7667
1193	SEA86FA052	47.3167	122.0500
1194	SEA86FA054	47.4833	122.2167
1195	SEA86FA066	44.7500	120.6000
1196	SEA86FA071	46.8667	122.9500
1197	SEA86FA073	44.9667	123.9167
1198	SEA86FA075	48.3833	122.5000
1199	SEA86FA092A	47.7333	122.2667
1200	SEA86FA092B	47.7333	122.2667
1201	SEA86FA096	47.4000	120.1000
1202	SEA86FA098	43.0000	112.2833
1203	SEA86FA121A	47.7833	118.3000
1204	SEA86FA121B	47.7833	118.3000
1205	SEA86FA126	44.2167	122.3167
1206	SEA86FA137	47.3333	120.5667
1207	SEA86FA144	47.8000	117.2833
1208	SEA86FA145	38.8333	116.6000
1209	SEA86FA155	45.2167	122.5833
1210	SEA86FA165	46.3000	119.3000
1211	SEA86FA215	42.6833	118.5667
1212	SEA86FA216	48.6000	123.1333
1213	SEA86FA225	37.0667	114.0833
1214	SEA86FA232	44.3167	118.8500
1215	SEA86FA233	47.4500	115.7000
1216	SEA86FA245	47.0667	122.0500
1217	SEA86LA122	44.3000	116.0667
1218	SEA87FA014	48.0000	122.9167
1219	SEA87FA031	48.7167	118.6500
1220	SEA87FA051	45.7333	122.7500
1221	SEA87FA098	36.2333	115.1500
1222	SEA87FA100A	47.1667	118.4167
1223	SEA87FA102	40.1500	117.4333
1224	SEA87FA141	39.2500	119.9833
1225	SEA87FA145	47.0000	115.0000
1226	SEA87FA149	42.0833	122.8000
1227	SEA87FA152	36.2000	115.5833
1228	SEA87FA178	47.9000	120.1000
1229	SEA87FA185	45.4667	123.9333
1230	SEA87FA190	43.5000	114.2667
1231	SEA87LA048	39.4167	118.7667
1232	SEA87LA142	42.0667	122.6000
1233	SEA87MA018	36.0667	115.0667
1234	SEA87MA035	36.5000	115.2500
1235	SEA87MA192	42.4833	114.4667

	NTSB number	Crash Latitude	Crash Longitude
1236	SEA88FA012	48.5500	117.2167
1237	SEA88FA021	48.0167	122.9167
1238	SEA88FA023	45.5333	122.9500
1239	SEA88FA024	44.6167	116.8167
1240	SEA88FA031	39.1167	123.0167
1241	SEA88FA034	44.9167	122.4833
1242	SEA88FA039	44.1333	112.0833
1243	SEA88FA069	42.6833	111.3167
1244	SEA88FA083	36.0000	115.0000
1245	SEA88FA095	47.0500	124.1333
1246	SEA88FA120	47.7500	121.1000
1247	SEA88FA122	45.3167	115.0333
1248	SEA88FA176	47.6167	120.3167
1249	SEA88LA094	39.8833	119.5167
1250	SEA89FA001	48.6500	122.5833

4. MILITARY AVIATION

4.1 INTRODUCTION

For the ACRAM Standard [Ref. 4.1], military aviation is defined as the broad categorization of aviation activities performed by military personnel in fulfillment of their official duties. Such activities include passenger and cargo transport, in-flight refueling, flight training, etc. Activities associated with military operations areas (MOA) and training ranges, such as air combat training, low level navigation, personnel and stores drops, are not included. However, cruise phase of flight between an originating airfield and the MOAs, as well as training associated with takeoff and landing at an airfield, including touch and go's; simulated emergency landings, e.g., no flap, flameout; and missed approach/go-arounds, are included.

To quantify the risk of a military aircraft crashing into a facility it is necessary to estimate the number of military flights in the vicinity of the facility, the frequency of military aircraft crashes and the probability that the aircraft crashes into the facility. The latter requires knowledge about the location of aircraft crashes, given an incident leading to a crash, as well as some crash kinematics, e.g., glide or impact angle, heading angle, and skid distance.

To estimate military aircraft crash frequencies, relevant crash and flight information was solicited from the U.S. Air Force, Army and Navy safety agencies. Useable information for fixed wing and rotary wing (helicopter) aircraft were received from the Air Force. The Army provided data on Army helicopters. Data received from the Navy was judged to be of limited value for this application, and is not included in the estimates presented here. Analysis of available crash data and the resulting estimates of military aircraft crash frequencies are presented in Section 4.2.

Crash kinematic and crash location data were derived by reviewing Air Force aircraft mishap reports from 1976 to 1993. A database of aircraft crash data was developed as part of the DNA supported W78/W87 Minuteman III Weapon System Safety Assessment (WSSA) [Ref. 4.2]. That formed the basis for developing crash kinematics and crash location probability distributions. Data analysis and distributions are summarized in Section 4.3.

Section 4.4 includes a summary of some of the appropriate characteristics of military aircraft which are necessary for the structural analyses.

4.2 MILITARY AVIATION CRASH FREQUENCIES

Development of estimates of aircraft crash frequencies is based on an analysis of aircraft crash and flight data supplied by Air Force and Army safety agencies [Ref. 4.3-4.6] and the database of Air Force mishaps developed for the DNA supported Minuteman III WSSA [Ref. 4.2].

For the ACRAM Standard, the flight phases of interest for military aviation are

Takeoffs at airfields in the vicinity of the facility of interest
Landings at airfields in the vicinity of the facility of interest
Overflights, during the cruise phase of flight, in the vicinity of the facility of interest

Analysis of the military crash data required the identification of the phase of flight in which the crash occurred as well as screening of crashes to delete those not applicable to crashes into structures, e.g., crashes involving taxiing and/or parked aircraft. This required a review of the individual accident reports/summaries to assign each accident to the proper phase and, occasionally, involved judgments in the applicability of an accident. Thus, there is some uncertainty in the estimates of crash frequencies in addition to inherent "statistical" variation due to the limited amount of historical data. Although recognized, this uncertainty is neither quantified nor included in the provided estimates of crash frequencies. Rather, the estimates provided are considered plausible point estimates of the appropriate frequencies.

Two analyses were considered in developing estimates for crash frequencies. One analysis is based on a review of the brief summaries of mishaps as provided by the Air Force/Army safety agencies. This approach is discussed and the resulting estimates of crash frequencies are presented in Section 4.2.2. The second analysis is based on the Air Force mishap database developed for the Minuteman III WSSA. This analysis and the resulting estimates are discussed in Section 4.2.3.

This Standard is expected to be applicable to facilities off an airfield and not in the immediate vicinity of a runway. Therefore, military takeoff and landing crashes were identified as "on runway" (i.e., crashes in which the initial impact occurred on the runway and the rolling/skidding aircraft departed the runway or remained on the runway) or "off runway" (i.e., the initial impact occurred off the runway). Although the off runway crashes include some that occurred on an airfield, the off runway crash frequency estimated from the historical data is considered a reasonable conservative estimate applicable for this Standard.

For military aviation the cruise phase of flight involved a number of different types of operations in addition to "normal" flight from one base to another. A significant part of the cruise portion of flight, particularly for military attack, fighter and trainer aircraft, involved maneuvers. Since this type of activity is not expected to affect facilities covered by this Standard, accidents occurring during maneuvers, air shows, and other special operations were not included in developing the estimated inflight crash frequencies. Deleting those accidents from consideration required that the mileage flown, which is the denominator of crash frequencies, be adjusted. Since the available military flight information is in flight hours, considerable judgment was involved in developing estimates of the number of miles flown during "normal" flight. Again, this needs to be recognized in using the provided estimates of crash frequencies.

Ideally, estimates of crash frequencies can be developed for each type of military aircraft. This was the goal in the second analysis (Section 4.2.3). Due to limited data and the reasonable expectation that actual frequencies are comparable for some subsets of aircraft, estimated crash frequencies are provided per aircraft type or group of types. The philosophy of this Standard is to use three subcategories of military aircraft:

Large aircraft: bomber and cargo aircraft such as the B-1, B-2, B-52, C-5, C-9, KC-10, C-21, C-130, KC-135 and C-141

Small aircraft: attack, fighter and trainer aircraft such as the A-7, A-10, A-37, F-4, F-5, F-15, F-16, F-106, F-111, F-117, T-33, T-37, T-38, T-39 and T-41

Helicopters: H-1, H-3, H-53 and H-60

Estimates of crash frequencies are provided for each subcategory as well as for all military aircraft. These combined estimates are based on a weighted average of the individual frequencies, weighted by the respective normalized number of takeoffs/landings and number of miles flown during "normal" flight. Application of the combined frequencies is appropriate only when (1) the distribution, among the different types of aircraft (e.g., T-38, F-16, B-52, ...), of the number of takeoffs/landings at the airfield of interest and (2) the distribution, among aircraft types, of the enroute overflights in the vicinity of the facility of interest are comparable to the distributions in the historical data. If operations at a given location are much different than the overall distribution in the historical data, alternative estimates of crash frequencies, based on the appropriate mix of aircraft at the location, should be considered.

4.2.1 ESTIMATES OF CRASH FREQUENCIES BASED ON AN ANALYSIS OF IMPACT ACCIDENTS

Air Force mishap data solicited from the Air Force Safety Agency [Ref. 4.3-4.5] provides one basis for estimating crash frequencies for military aviation. Air Force classification of mishaps is based on the economic costs of damage to the aircraft and personnel costs and are defined as follows:

Flight Mishap - A mishap involving an Air Force aircraft when intent for flight exists.

Class A - A mishap in which the resulting total cost of property damage, injury and illness is $1,000,000 or greater; or an Air Force aircraft is destroyed; or a fatality occurs.

Class B - A mishap in which the resulting total cost of property damage, injury and illness is $200,000 or more, but less than $1,000,000.

Class C - A mishap in which the resulting total cost of property damage is $10,000 or more, but less than $200,000 or injury or occupational illness resulted in a lost workday case involving days away from work.

Destroyed - Destroyed means uneconomical to repair, defined by the number of man-hours estimated as needed to repair the aircraft. Repair time varies depending on the type of aircraft.

Mishap Rates - Rates are computed on basis of the number of mishaps per 100,000 flying hours.

Flight Related - When there is a mishap with little or no damage to the aircraft, the incident does not affect the mishap rate.

One set of data provided by the AFSA is based on the lifetime mishap history, up to the early 1994 time frame, of a large number of Air Force aircraft. A total of 5171 Class A, 2450 Class B, and 3598 Destroyed mishaps are included in this data set. A summary of these mishaps, by aircraft type, is given in Table 4.1. Related flight information included in the table is the total flight hours for each type of aircraft. Also included in the table are estimates of mishap rates, given as rates per 100,000 flight hours.

The various aircraft types were grouped by the three subcategories of military aviation, small aircraft, large aircraft, and helicopter.The mishap data for the three subcategories are summarized in Tables 4.2 to 4.4. Again, estimates of mishap rates are per 100,000 flight hours. Since T-33 aircraft have been out of the Air Force inventory for some time, mishap rates for small aircraft are estimated excluding the T-33 data as well.

The mishaps recorded in Tables 4.1 to 4.4 include a large number of mishaps not applicable to crashes into off airfield facilities, e.g., nonimpact mishaps, on airfield crashes, etc. Therefore, the mishap rates provided in these tables may be over estimates of crash rates into off airfield structures. In addition, takeoff and landing incidents are likely to be significant contributors to crashes into structures; thus, it is appropriate to develop crash rates per takeoff and landing. To do this it is necessary to have a more detailed description of the mishap.

A second set of data provided by the AFSA included summary information for mishaps in the 1979-1993 time period. Useable information was derived from 1426 mishaps. To develop crash frequency estimates, the 1426 mishaps were classified either as impact or non-impact mishaps. Impact mishaps included accidents involving ground, runway, water, midair, terrain, vehicle, and building impact. Non-impact mishaps included incidents involving foreign objects, birds, etc., and parked aircraft fires and other such incidents. Non-impact mishaps are considered not applicable. There were 1093 impact mishaps. Those mishaps included all classes of damage to the crashing aircraft. The mishaps were partitioned by aircraft "size" (large, small and helicopter) and by flight phase (takeoff, landing and inflight). Takeoff and landing were further partitioned into "on runway" and "off runway" mishaps. In-flight mishaps were partitioned into "normal" and "special", i.e., low altitude and maneuvering operation mishaps. A graphical description of the classification of the mishaps is shown in Figure 4.1. For this analysis, takeoff includes takeoff roll, abort/discontinue, and initial climb portions of a flight; landing includes the pattern, final approach, flare

and rollout portions; normal in-flight includes climb to cruise, cruise between an originating airfield and an operations area, if applicable, and cruise descent portions; and special in-flight includes low level and maneuvering operations in restricted airspace.

The number of impacting mishaps for each subcategory of aircraft and flight phase, appropriate flight information and the resulting estimates of crash frequencies are summarized in Table 4.5.

Crash frequencies for takeoffs and landings are per takeoff/landing. Crash frequencies for "normal" inflight operation, are "per mile." The estimated mileage derived to estimate inflight rates is based on an analysis of the expected number of miles flown during "normal" flight. This analysis attempted to account for the time in the takeoff and landing phases of flight as well as the time in maneuvers and other special operations. This required a considerable amount of judgment by the analyst.

For some facilities, particularly hardened structures, a more appropriate estimate of a crash frequency may be one based on only considering impact mishaps in which the crashing aircraft was destroyed. Of the 1093 impact mishaps, a crashing aircraft was classified as "destroyed" in 819 mishaps. These impact destroyed mishaps were partitioned in the same way as impact mishaps as shown in Figure 4.1. A summary of this data and the resulting estimates of crash frequencies are given in Table 4.6.

Basic mishap data, flight information and partitioning of mishaps by aircraft subcategory and flight phase were developed by T. Lin at Sandia National Laboratory [Ref. 4.6]. Development of estimated miles flown during "normal" inflight operations is based on an analysis of aircraft operations by Logicon RDA [Ref. 4.7].

4.2.2 ESTIMATES OF CRASH FREQUENCIES BASED ON AN ANALYSIS OF THE MISHAP DATABASE DEVELOPED FOR THE MINUTEMAN III WSSA

Another source of mishap information is the mishap database developed for the DNA-supported Minuteman III WSSA [Ref. 4.2]. This database was developed from data extracted from individual mishap reports, also available from the AFSA. Its primary use was as a resource for crash location and crash kinematic information, but it is also useful as a basis for estimating crash frequencies. Development of crash frequency estimates using this database is based on identifying mishaps involving a "crash" which is defined as "An aircraft mishap associated with flight that prevents the aircraft from coming to a full stop landing on its gear." In addition, for this analysis, flight phases are defined as:

> Takeoff: The phase of flight from the application of takeoff power on the runway to the point where the aircraft altitude is not affected by its proximity from the departure runway.
>
> Landing: The phase of flight from the point where the aircraft altitude is affected by its proximity from the approach runway to its departure from the runway under a controlled taxi.
>
> In-flight: The phase of flight where the aircraft altitude is not affected by its proximity to the runway.

A summary of the crash data, estimated crash frequencies and applicable flight information for individual aircraft types and groups of aircraft types, as well as for the three subcategories of aircraft, is presented in Tables 4.7 and 4.8.

The basic crash data and flight information were developed by M. Fuentes at Sandia National Laboratories [Ref. 4.6]. The estimated miles used for estimating crash frequencies during the inflight phase of flight is based on analysis of military aircraft operations by Logicon RDA.

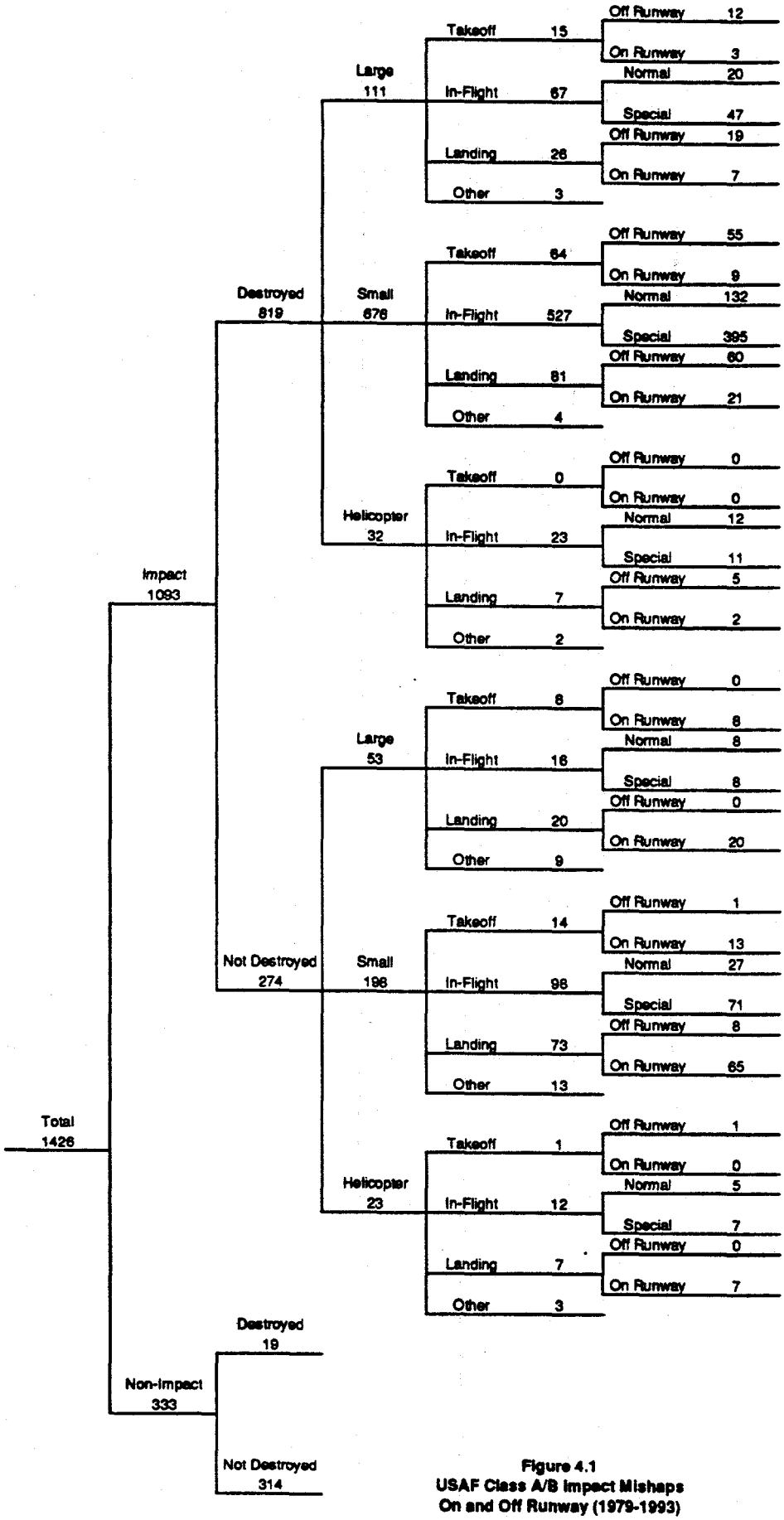

Figure 4.1
USAF Class A/B Impact Mishaps
On and Off Runway (1979-1993)

Table 4.1
Summary of U.S. Air Force Crash Mishap History
(Mishap Rates, per 100000 Flight Hours)

Aircraft Model	Class A Number	Class A Rate	Class B Number	Class B Rate	Destroyed Number	Destroyed Rate	Flight Hours
A-7	101	5.71	24	1.36	102	5.77	1,768,958
A-10	79	2.62	44	1.46	78	2.58	3,020,198
A-37	36	4.92	6	0.82	32	4.38	730,977
B-1	10	5.25	8	4.20	4	2.10	190,551
B-2	0	0.00	0	0.00	0	0.00	663
B-52	94	1.28	162	2.20	74	1.00	7,363,422
C-5	15	1.04	34	2.37	4	0.28	1,436,120
C-9	2	0.30	1	0.15	1	0.15	657,344
C-10	2	0.42	5	1.06	0	0.00	473,334
C-12	2	0.58	0	0.00	1	0.29	346,438
C-21	1	0.20	0	0.00	1	0.20	500,859
C-130	138	1.03	139	1.03	79	0.59	13,449,405
C-135	77	0.73	115	1.09	63	0.59	10,596,663
C-141	32	0.33	28	0.29	14	0.14	9,715,118
F-4/RF-4	593	5.75	387	3.76	516	5.01	10,304,926
F-4	468	5.80	308	3.82	411	5.09	8,066,975
F-5	39	8.82	16	3.62	40	9.05	442,176
RF-4C	125	5.59	79	3.53	105	4.69	2,237,767
F-15	83	2.74	127	4.19	80	2.64	3,031,730
F-16	201	5.06	24	0.60	191	4.81	3,971,946
F-106	151	9.35	61	3.78	118	7.31	1,614,846
F-111	113	6.23	94	5.18	94	5.18	1,814,333
F-117	1	2.01	2	4.03	1	2.01	49,640
T-33	2,351	13.67	589	3.43	1,189	6.92	17,193,534
T-37	131	1.15	31	0.27	129	1.13	11,439,050
T-38	183	1.57	90	0.77	180	1.54	11,664,996
T-39	29	1.10	21	0.80	12	0.45	2,641,197
T-41	7	1.16	5	0.83	3	0.50	602,788
H-1	48	3.35	14	0.98	34	2.37	1,434,316
H-3	31	4.29	20	2.77	21	2.91	722,328
H-53	24	6.69	15	4.18	18	5.01	359,002
H-60	4	3.74	1	0.93	3	2.80	107,083
Totals:	5,171	4.04	2,450	1.91	3,598	2.81	127,948,683

Table 4.2
Summary of Small (High-Performance) Aircraft Mishap History
(Mishap Rates, per 100000 Flight Hours)

Aircraft Model	Class A Number	Class A Rate	Class B Number	Class B Rate	Destroyed Number	Destroyed Rate	Flight Hours
A-7	101	5.71	24	1.36	102	5.77	1,768,958
A-10	79	2.62	44	1.46	78	2.58	3,020,198
A-37	36	4.92	6	0.82	32	4.38	730,977
F-4/RF-4	593	5.75	387	3.76	516	5.01	10,304,926
F-4	468	5.80	308	3.82	411	5.09	8,066,975
F-5	39	8.82	16	3.62	40	9.05	442,176
RF-4C	125	5.59	79	3.53	105	4.69	2,237,767
F-15	83	2.74	127	4.19	80	2.64	3,031,730
F-16	201	5.06	24	0.60	191	4.81	3,971,946
F-106	151	9.35	61	3.78	118	7.31	1,614,846
F-111	113	6.23	94	5.18	94	5.18	1,814,333
F-117	1	2.01	2	4.03	1	2.01	49,640
T-33	2,351	13.67	589	3.43	1,189	6.92	17,193,534
T-37	131	1.15	31	0.27	129	1.13	11,439,050
T-38	183	1.57	90	0.77	180	1.54	11,664,996
T-39	29	1.10	21	0.80	12	0.45	2,641,197
T-41	7	1.16	5	0.83	3	0.50	602,788
Totals:	4,691	5.82	1,908	2.37	3,281	4.07	80,596,037
Calculation of crash rate without T-33*							
Totals:	2,340	3.69	1,319	2.08	2,092	3.30	63,402,503

*T-33 excluded from crash rate calculation due to its withdrawal from active service.

Table 4.3
Summary of Large (Bomber and Cargo) Aircraft Mishap History
(Mishap Rates, per 100000 Flight Hours)

Aircraft Model	Class A Number	Class A Rate	Class B Number	Class B Rate	Destroyed Number	Destroyed Rate	Flight Hours
B-1	10	5.25	8	4.20	4	2.10	190,551
B-2	0	0.00	0	0.00	0	0.00	663
B-52	94	1.28	162	2.20	74	1.00	7,363,422
C-5	15	1.04	34	2.37	4	0.28	1,436,120
C-9	2	0.30	1	0.15	1	0.15	657,344
C-21	1	0.20	0	0.00	1	0.20	500,859
C-130	138	1.03	139	1.03	79	0.59	13,449,405
C-135	77	0.73	115	1.09	63	0.59	10,596,663
C-141	32	0.33	28	0.29	14	0.14	9,715,118
Totals:	369	0.84	487	1.11	240	0.55	43,910,145

Table 4.4
Summary of Helicopter Aircraft Mishap History
(Mishap Rates, per 100000 Flight Hours)

Aircraft Model	Class A Number	Class A Rate	Class B Number	Class B Rate	Destroyed Number	Destroyed Rate	Flight Hours
H-1	48	3.35	14	0.98	34	2.37	1,434,316
H-3	31	4.29	20	2.77	21	2.91	722,328
H-53	24	6.69	15	4.18	18	5.01	359,002
H-60	4	3.74	1	0.93	3	2.80	107,083
Totals:	107	4.08	50	1.91	76	2.90	2,622,729

Table 4.5
Mishaps and Estimates of Crash Frequencies Based on Impact Mishaps, Disregarding Damage Condition of the Crashing Aircraft

Aircraft Subcategory	Number Operations	TAKEOFF				LANDING				Flight Hours	NORMAL IN-FLIGHT			SPECIAL OPERATIONS		
		Number of Mishaps		Crash Rate/Takeoff		Number of Mishaps		Crash Rate/Landing			Estimated Miles	No. of Mishaps	Crashes/ Mile	Estimated Miles	No. of Mishaps	Crashes/ Mile
		On RW	Off RW	On RW	Off RW	On RW	Off RW	On RW	Off RW							
Large	15,337,472	11	12	7.17E-07	7.82E-07	27	19	1.76E-06	1.24E-06	19,435,867	4.50E+09	28	6.22E-09	4.50E+09	55	1.22E-08
Small	41,245,806	22	56	5.33E-07	1.36E-06	86	68	2.09E-06	1.65E-06	29,591,424	6.40E+09	159	2.48E-08	7.10E+09	466	6.56E-08
Helicopter	2,933,967	0	1	< 3.4E-7	3.41E-07	9	5	3.07E-06	1.70E-06	1,209,057	7.00E+07	17	2.43E-07	7.70E+07	18	2.34E-07
All Military	59,517,245	33	69	5.54E-07	1.16E-06	122	92	2.05E-06	1.55E-06	50,236,348	1.10E+10	204	1.86E-08	1.17E+10	539	4.62E-08

Table 4.6
Mishaps and Estimates of Crash Frequencies Based on Impact Mishaps in Which the Crashing Aircraft Was Destroyed

Aircraft Subcategory	Number Operations	TAKEOFF				LANDING				Flight Hours	NORMAL IN-FLIGHT			SPECIAL OPERATIONS		
		Number of Mishaps		Crash Rate/Takeoff		Number of Mishaps		Crash Rate/Landing			Estimated Miles	No. of Mishaps	Crashes/ Mile	Estimated Miles	No. of Mishaps	Crashes/ Mile
		On RW	Off RW	On RW	Off RW	On RW	Off RW	On RW	Off RW							
Large	15,337,472	3	12	1.96E-07	7.82E-07	7	19	4.56E-07	1.24E-06	19,435,867	4.50E+09	20	4.44E-09	4.50E+09	47	1.04E-08
Small	41,245,806	9	55	2.18E-07	1.33E-06	21	60	5.09E-07	1.45E-06	29,591,424	6.40E+09	132	2.06E-08	7.10E+09	395	5.56E-08
Helicopter	2,933,967	0	0	< 3.4E-7	<3.4E-7	2	5	6.82E-07	1.70E-06	1,209,057	7.00E+07	12	1.71E-07	7.70E+07	11	1.43E-07
All Military	59,517,245	12	67	2.02E-07	1.13E-06	30	84	5.04E-07	1.41E-06	50,236,348	1.10E+10	164	1.49E-08	1.17E+10	453	3.88E-08

Table 4.7
Crash Data and Estimates of Crash Frequencies Based on the Minuteman III Mishap Database

				Number of Landings	TAKEOFF				LANDING			
					Number of Crashes		Crash Rate/Takeoff		Number of Crashes		Crash Rate/Landing	
					On RW	Off RW	On RW	Off RW	On RW	Off RW	On RW	Off RW
Large	Bombers (Bs)		B1, B52, B57	1,072,000	3	2	2.80E-06	1.87E-06	2	6	1.87E-06	5.60E-06
	Cargo (Cs)		C130	6,341,000	1	2	1.58E-07	3.15E-07	8	8	1.26E-06	1.26E-06
			KC135	3,512,000	3	4	8.54E-07	1.14E-06	5	8	1.42E-06	2.28E-06
			Other Large Cs	4,932,000	0	2	< 2.0 E-7	4.06E-07	11	5	2.23E-06	1.01E-06
			Small Cs	1,628,000	0	0	< 6.1 E-7	< 6.1 E-7	2	1	1.23E-06	6.14E-07
			All Cargo	16,413,000	4	8	2.44E-07	4.87E-07	26	22	1.58E-06	1.34E-06
			All Large (Bs, Cs)	17,485,000	7	10	4.00E-07	5.72E-07	28	28	1.60E-06	1.60E-06
Small	Attack (As)	Single Engine	A7	940,000	2	9	2.13E-06	9.57E-06	12	5	1.28E-05	5.32E-06
			F16	2,818,000	2	16	7.10E-07	5.68E-06	24	34	8.52E-06	1.21E-05
			All Single-engine	3,758,000	4	25	1.06E-06	6.65E-06	36	39	9.58E-06	1.04E-05
		Multiple Engine	A10	1,738,000	0	2	< 5.8 E-7	1.15E-06	9	10	5.18E-06	5.75E-06
	Fighters (Fs)		F4	4,462,000	7	21	1.57E-06	4.71E-06	41	24	9.19E-06	5.38E-06
			F15	2,235,000	1	5	4.47E-07	2.24E-06	17	7	7.61E-06	3.13E-06
			F111, FB111	891,000	1	5	1.12E-06	5.61E-06	8	14	8.98E-06	1.57E-05
			All Multiple-engine	9,326,000	9	33	9.65E-07	3.54E-06	75	55	8.04E-06	5.90E-06
			Other As, Fs	1,677,000	5	12	2.98E-06	7.16E-06	23	26	1.37E-05	1.55E-05
			All As, Fs	14,761,000	18	70	1.22E-06	4.74E-06	134	120	9.08E-06	8.13E-06
	Trainers (Ts)		Subsonic: T37	14,147,000	1	4	7.07E-08	2.83E-07	2	6	1.41E-07	4.24E-07
			Supersonic: T38	15,118,000	6	9	3.97E-07	5.95E-07	17	20	1.12E-06	1.32E-06
			Other Ts	2,896,000	3	3	1.04E-06	1.04E-06	4	8	1.38E-06	2.76E-06
			All Ts	32,161,000	10	16	3.11E-07	4.97E-07	23	34	7.15E-07	1.06E-06
			All Small (As, Fs, Ts)	46,922,000	28	86	5.97E-07	1.83E-06	157	154	3.35E-06	3.28E-06
Helicopter				3,507,000	2	3	5.70E-07	8.55E-07	2	10	5.70E-07	2.85E-06
All Military Aircraft				67,914,000	37	99	5.45E-07	1.46E-06	187	192	2.75E-06	2.83E-06

Table 4.8

Crash Data and Estimates of Crash Frequencies Based on the Minuteman III Mishap Database

				Number of Sorties	Flight Hours	Normal Flight			Special Operations		
						Estimated Miles	No. of Crashes	Crash Rate/ Mile	Estimated Miles	No. of Crashes	Crash Rate/ Mile
Large	Bombers (Bs)		B1, B52, B57	343,000	2,177,000	5.00E+08	2	4.00E-09	5.00E+08	6	1.20E-08
	Cargo (Cs)		C130	2,669,000	6,343,000	1.50E+09	4	2.67E-09	1.50E+09	10	6.67E-09
			KC135	1,123,000	4,728,000	1.10E+09	1	9.09E-10	1.10E+09	0	<9.09E-10
			Other Large Cs	2,333,000	7,738,000	1.80E+09	2	1.11E-09	1.80E+09	1	5.56E-10
			Small Cs	821,000	1,535,000	3.50E+08	1	2.86E-09	3.50E+08	1	2.86E-09
			All Cargo	6,946,000	20,344,000	4.75E+09	8	1.68E-09	4.75E+09	12	2.53E-09
			All Large (Bs, Cs)	7,289,000	22,521,000	5.25E+09	10	1.90E-09	5.25E+09	18	3.43E-09
Small	Attack (As)	Single Engine	A7	925,000	1,387,000	2.40E+08	9	3.75E-08	2.60E+08	43	1.65E-07
			F16	2,675,000	3,730,000	8.30E+08	32	3.86E-08	9.30E+08	104	1.12E-07
			All Single-engine	3,600,000	5,117,000	1.07E+09	41	3.83E-08	1.19E+09	147	1.24E-07
	Fighters (Fs)	Multiple Engine	A10	1,740,000	2,962,000	5.10E+08	16	3.14E-08	5.60E+08	47	8.39E-08
			F4	3,882,000	5,162,000	1.20E+09	20	1.67E-08	1.30E+09	139	1.07E-07
			F15	2,082,000	2,864,000	6.40E+08	4	6.25E-09	7.10E+08	60	8.45E-08
			F111, FB111	658,000	1,648,000	3.70E+08	9	2.43E-08	4.10E+08	40	9.76E-08
			All Multiple-engine	8,362,000	12,636,000	2.72E+09	49	1.80E-08	2.98E+09	286	9.60E-08
			Other As, Fs	1,530,000	2,079,000	4.50E+08	12	2.67E-08	5.00E+09	73	1.46E-08
			All As, Fs	13,492,000	19,832,000	4.24E+09	102	2.41E-08	9.17E+09	506	5.52E-08
	Trainers (Ts)		Subsonic: T37	4,154,000	5,212,000	7.00E+08	4	5.71E-09	7.80E+08	11	1.41E-08
			Supersonic: T38	5,109,000	6,038,000	1.20E+09	11	9.17E-09	1.40E+09	27	1.93E-08
			Other Ts	1,347,000	2,254,000	3.90E+08	3	7.69E-09	4.30E+08	7	1.63E-08
			All Ts	10,610,000	13,504,000	2.29E+09	18	7.86E-09	2.61E+09	45	1.72E-08
			All Small (As, Fs, Ts)	24,102,000	33,336,000	6.53E+09	120	1.84E-08	1.18E+10	551	4.68E-08
Helicopter				1,028,000	1,449,000	8.30E+07	17	2.05E-07	9.30E+07	9	9.68E-08
All Military Aircraft				32,419,000	57,306,000	1.19E+10	147	1.24E-08	1.71E+10	578	3.38E-08

4.3 MILITARY AVIATION CRASH PARAMETER DISTRIBUTIONS

In addition to an assessment of crash frequencies and level of activity (i.e., numbers of flights), an analysis of the effects of a crashing aircraft on the safety of a facility requires a description of crash conditions, given a crash. Relevant crash parameters include crash locations as well as crash kinematics, e.g., crash velocity, impact angle, etc. Since crash locations and crash kinematics vary between crashes, these variables are considered stochastic (random) variables. Descriptions of the crash conditions are based on developing probability distributions for each of the crash parameters. The specific crash parameters considered relevant for this Standard are

1. crash location
2. impact angle of the crashing aircraft
3. air speed and horizontal velocity of the crashing aircraft
4. skid distance of the aircraft, given a crash.

The data used to develop probability distributions for the crash parameters was extracted from the crash information in the database developed for the Minuteman III WSSA [Ref. 4.2]. The data in the database was derived from Air Force mishap reports covering the 1976-1993 time period. Quantification of the crash parameters from the mishap descriptions in the reports often required considerable judgment. In addition, information about some crash parameters is very limited. Thus, there is considerable uncertainty associated with the probability distributions derived from the available data. Following the philosophy stated earlier, this uncertainty is not built into the distributions provided, rather the distributions provided are considered plausible estimates of reality.

A variety of statistical techniques were used to analyze the data and develop the probability distributions. Both parametric and non-parametric methods were used. The choice of the final distribution selected as the estimated distribution was primarily based on analyst judgment although some statistical tests of "goodness of fit" were applied. The 2-dimensional crash locations are correlated. Because of the scarcity of data, a non-parametric bivariate kernel estimation technique [Ref. 4.8] was used to develop the crash location density function. The same technique was used to develop the joint distributions of impact angle and crash velocity, and horizontal velocity and skid distance, which were also considered correlated. For the distribution of heading angle and the marginal distributions of impact angle, crash velocity and skid distance, a parametric fit to the data was attempted. Initially, a computer code, Best Fit [Ref. 4.9], was used to select an appropriate family of probability distributions. Then, either (1) the distributional parameter values provided by the program were used; or (2) if applicable, when truncated distributions are appropriate, maximum likelihood estimates of the distributional parameters, were developed.

Distributions were developed for the following classes of military aircraft types and flight phases:

Large aircraft, takeoff
Large aircraft, landing
Small aircraft, takeoff
Small aircraft, landing

Analysis of helicopter crash parameter data, derived from Air Force and Army mishap reports, is in progress.

Section 4.3.1 provides a summary of crash location analysis and probability distributions. The analysis and distributions for impact angle and the cotangent of the impact angle are discussed in Section 4.3.2. The air speed and horizontal velocity of the crashing aircraft is covered in Section 4.3.3. The marginal distribution of skid distance is the topic of Section 4.3.4.

4.3.1 CRASH LOCATION DISTRIBUTIONS

Before describing the probability distributions of crash locations, it is necessary to specify the coordinate convention used to quantify locations. For military aviation, crash locations are quantified in Cartesian coordinates consistent with the coordinate convention established for the Standard, specifically:

1. The origin of the coordinate system is at the center of the runway.
2. The x axis of the coordinate system coincides with the extended centerline of the runway such that the positive direction is the direction of flight during takeoff and landing.
3. The positive y axis coincides with a line defined by a 90 degree counterclockwise rotation of the positive x axis.

For military aviation, landings and operations at an airbase, e.g., touch and go's, involve flight patterns associated with each runway. At each airbase there is a well defined side of the runway for flight patterns. Since more traffic exists on the pattern side of the runway, crash locations tend to be biased to that side as well. For descriptive purposes in this document, the pattern side is assumed to be to the right of the direction of flight, i.e., in the negative y direction. As discussed in the Standard, in applying crash location distributions it is appropriate to identify where the facility of interest exists relative to the pattern side of the source runway. At non-military airfields, unless there is a well established pattern side, a conservative analysis would be based on assuming that the facility is on the pattern side.

Crash locations in the Minuteman III WSSA database, derived from mishaps reports about Air Force aircraft crashes between 1976 and 1994, were used to develop conditional, given a crash, distributions of crash location in terms of the joint distribution of the x,y coordinates of the crash location. A nonparametric kernel estimation technique (Ref. 4.8) was used to model the joint distributions. Because of differences in flight patterns and operations, separate crash location distributions were developed for:

- Large aircraft, landing
- Large aircraft, takeoff
- Small aircraft, landing
- Small aircraft, takeoff

Plots of the estimated joint distributions are shown in Figures 4.2 to 4.5.

For application in the crash frequency calculations, the crash location distributions are used to assess the probability, per unit area, of an aircraft crashing into a given location, given the aircraft crashes. Tables of these probabilities, per square mile, are given in Tables 4.9 to 4.12 for the four combinations of aircraft size and phase of flight. The entries in the tables were computed by integrating the appropriate joint probability distributions.

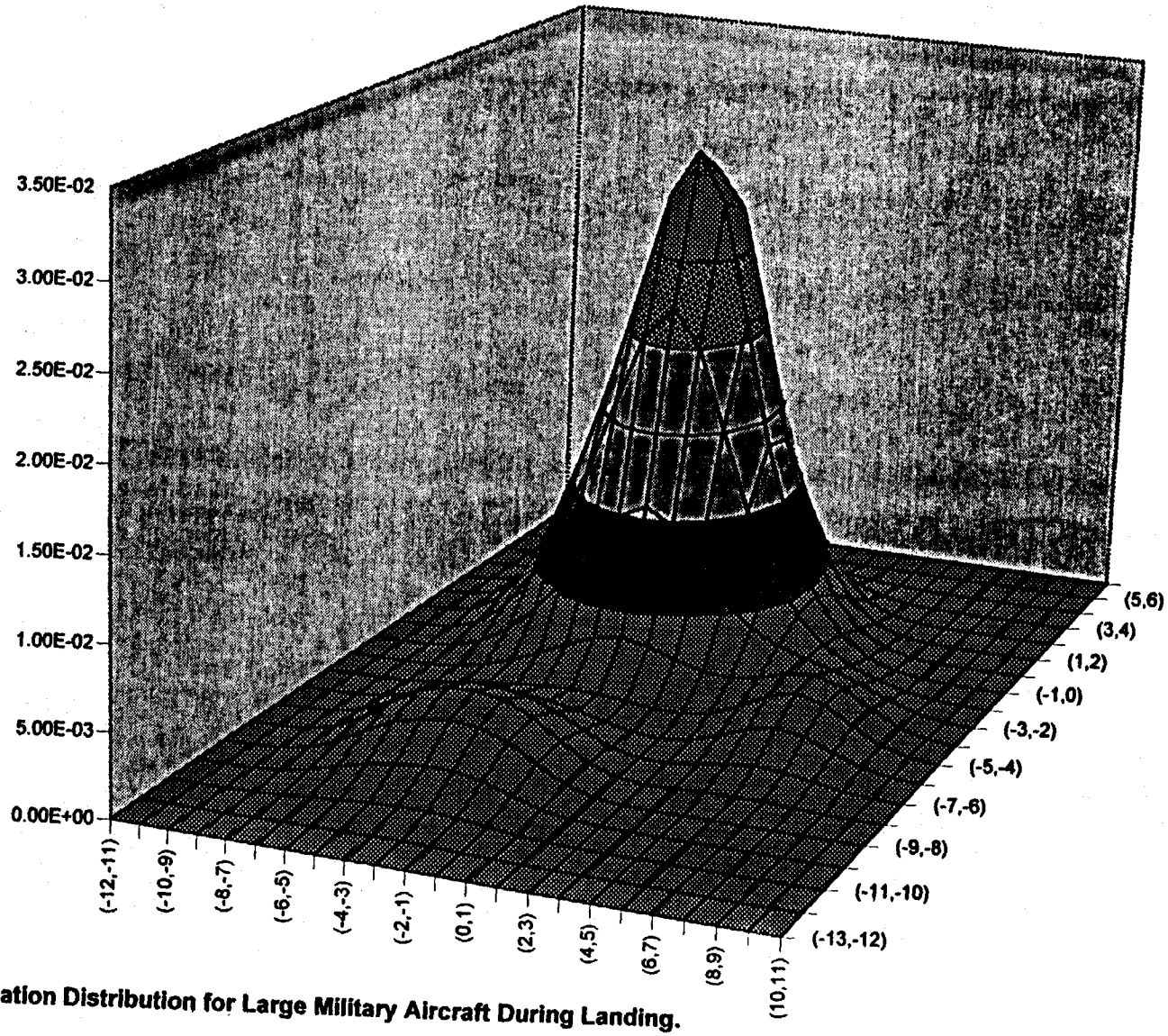

Figure 4.2 Crash Location Distribution for Large Military Aircraft During Landing.

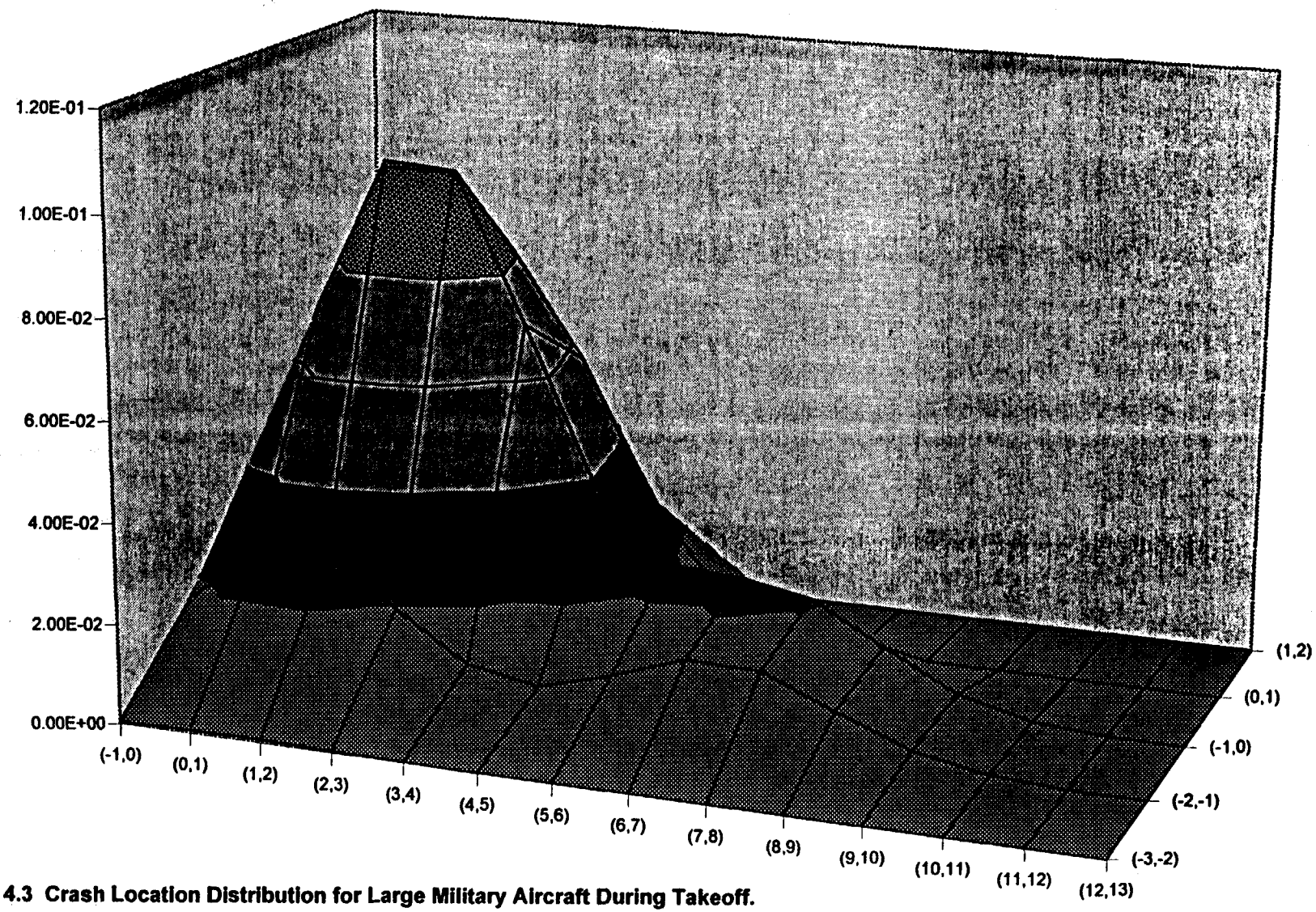

Figure 4.3 Crash Location Distribution for Large Military Aircraft During Takeoff.

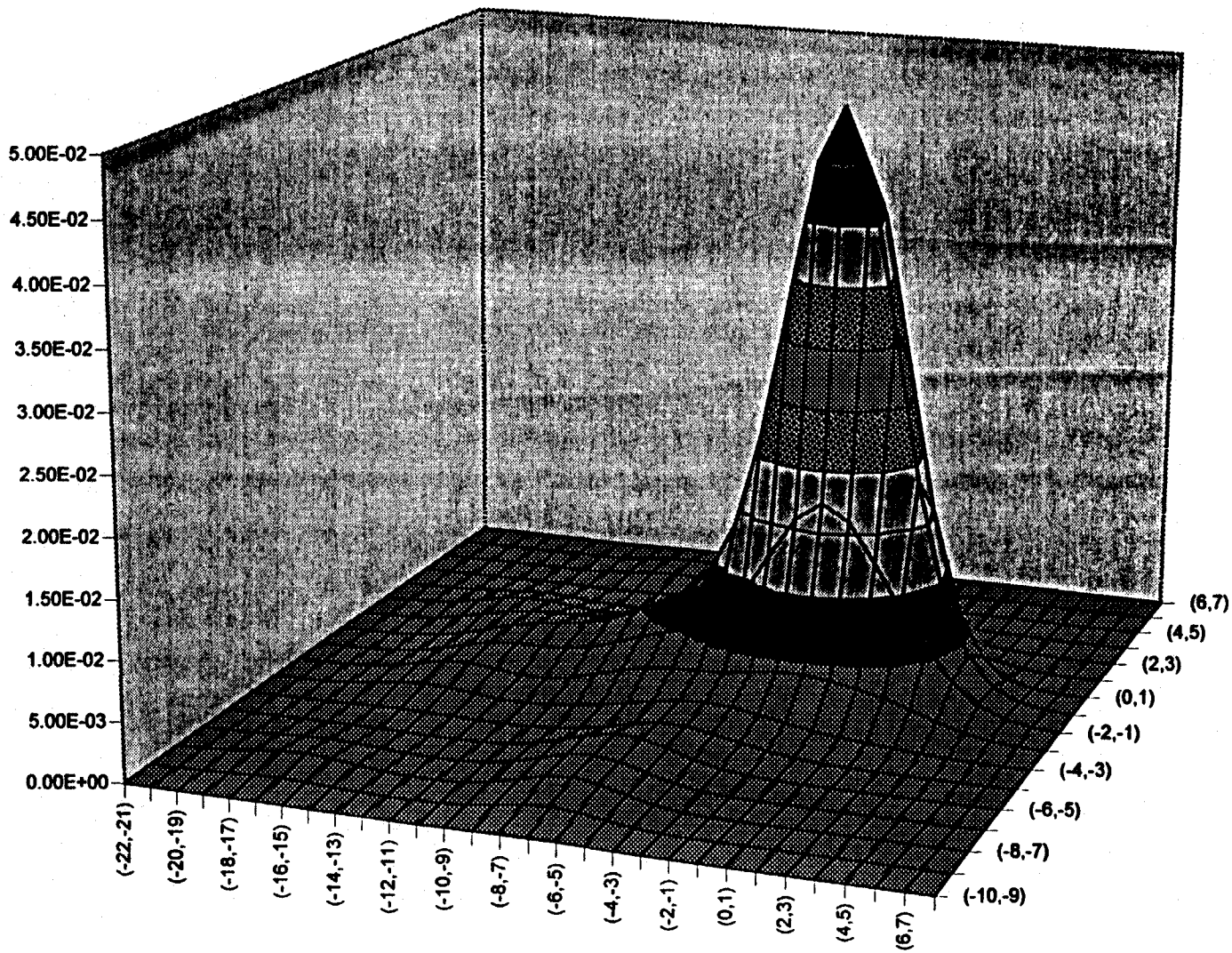

Figure 4.4 Crash Location Distribution for Small Military Aircraft During Landing.

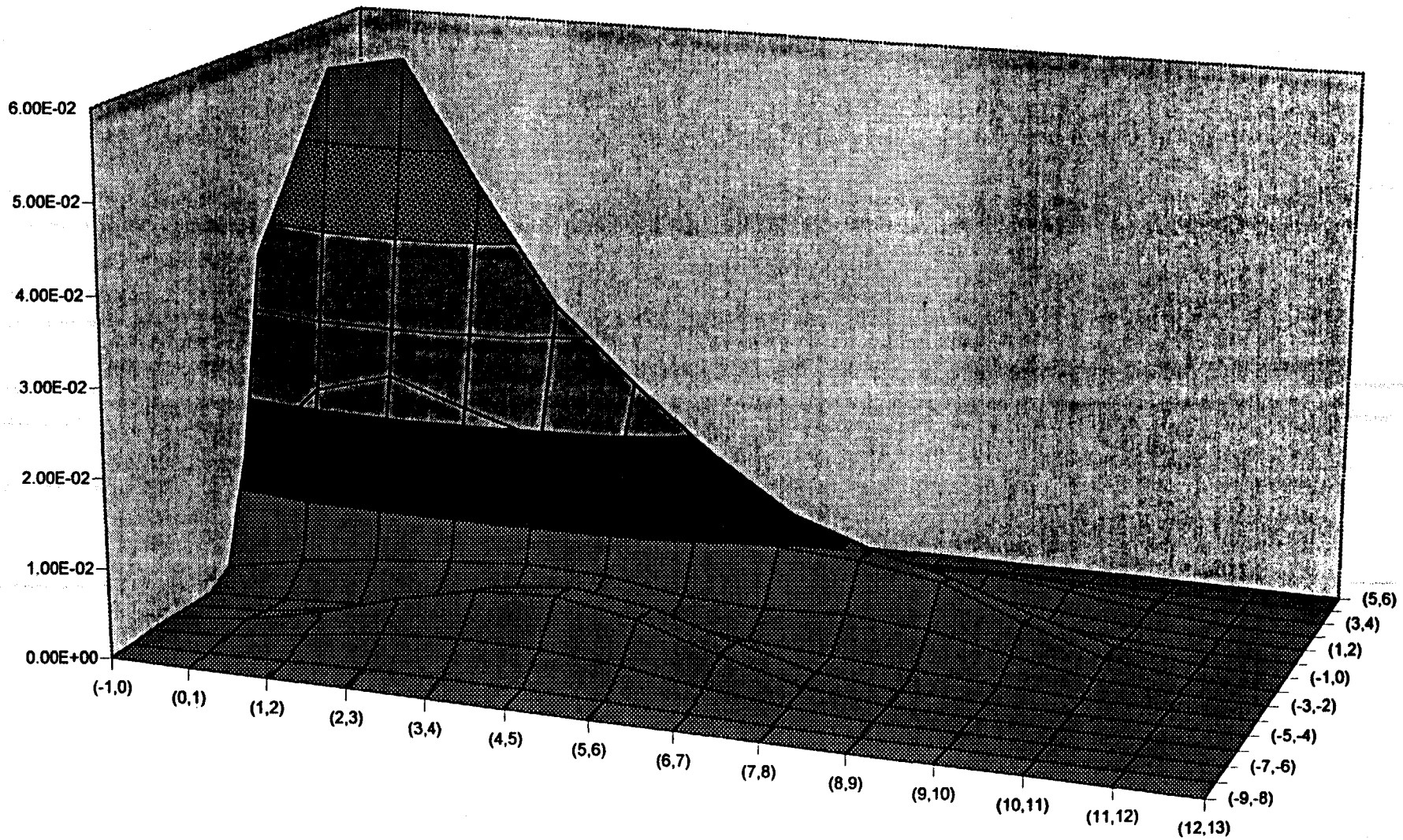

Figure 4.5 Crash Location Distribution for Small Military Aircraft During Takeoff.

Y (mi) \ X (mi)	(-12,-11)	(-11,-10)	(-10,-9)	(-9,-8)	(-8,-7)	(-7,-6)	(-6,-5)	(-5,-4)	(-4,-3)	(-3,-2)	(-2,-1)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	(5,6)	(6,7)	(7,8)	(8,9)	(9,10)	(10,11)
(-13,-12)	1.35E-08	9.88E-08	5.11E-07	1.87E-06	4.92E-06	9.51E-06	1.44E-05	1.88E-05	2.28E-05	2.45E-05	2.09E-05	1.33E-05	6.07E-06	1.97E-06	4.51E-07	7.33E-08	8.98E-09	1.49E-09	7.48E-10	4.35E-10	1.87E-10	5.69E-11	1.22E-11
(-12,-11)	9.82E-08	7.19E-07	3.72E-06	1.36E-05	3.57E-05	6.84E-05	1.02E-04	1.29E-04	1.51E-04	1.58E-04	1.34E-04	8.45E-05	3.85E-05	1.25E-05	2.87E-06	4.74E-07	7.28E-08	2.89E-08	2.16E-08	1.30E-08	5.62E-09	1.71E-09	3.67E-10
(-11,-10)	4.65E-07	3.40E-06	1.76E-05	6.44E-05	1.68E-04	3.20E-04	4.67E-04	5.75E-04	6.50E-04	6.64E-04	5.55E-04	3.49E-04	1.59E-04	5.15E-05	1.19E-05	2.13E-06	6.08E-07	4.96E-07	4.16E-07	2.53E-07	1.09E-07	3.32E-08	7.13E-09
(-10,-9)	1.43E-06	1.05E-05	5.41E-05	1.98E-04	5.16E-04	9.76E-04	1.40E-03	1.68E-03	1.83E-03	1.82E-03	1.50E-03	9.39E-04	4.27E-04	1.38E-04	3.28E-05	7.95E-06	5.51E-06	6.08E-06	5.23E-06	3.19E-06	1.38E-06	4.19E-07	8.98E-08
(-9,-8)	2.86E-06	2.10E-05	1.08E-04	3.96E-04	1.03E-03	1.94E-03	2.75E-03	3.20E-03	3.36E-03	3.25E-03	2.64E-03	1.64E-03	7.46E-04	2.44E-04	6.46E-05	3.21E-05	4.13E-05	4.95E-05	4.27E-05	2.61E-05	1.13E-05	3.42E-06	7.35E-07
(-8,-7)	3.73E-06	2.73E-05	1.41E-04	5.16E-04	1.34E-03	2.51E-03	3.51E-03	3.98E-03	4.05E-03	3.80E-03	3.04E-03	1.88E-03	8.52E-04	2.89E-04	1.13E-04	1.34E-04	2.15E-04	2.63E-04	2.27E-04	1.39E-04	5.98E-05	1.82E-05	3.90E-06
(-7,-6)	3.17E-06	2.32E-05	1.20E-04	4.38E-04	1.13E-03	2.12E-03	2.94E-03	3.25E-03	3.19E-03	2.90E-03	2.28E-03	1.41E-03	6.50E-04	2.63E-04	2.29E-04	4.40E-04	7.44E-04	9.08E-04	7.85E-04	4.79E-04	2.07E-04	6.28E-05	1.35E-05
(-6,-5)	1.76E-06	1.29E-05	6.66E-05	2.43E-04	6.31E-04	1.18E-03	1.63E-03	1.78E-03	1.72E-03	1.54E-03	1.22E-03	7.91E-04	4.32E-04	3.05E-04	4.91E-04	1.02E-03	1.69E-03	2.05E-03	1.77E-03	1.08E-03	4.64E-04	1.41E-04	3.03E-05
(-5,-4)	6.97E-07	5.13E-06	2.68E-05	9.95E-05	2.66E-04	5.23E-04	7.85E-04	9.76E-04	1.10E-03	1.17E-03	1.12E-03	9.53E-04	7.73E-04	7.38E-04	1.01E-03	1.70E-03	2.60E-03	3.05E-03	2.60E-03	1.58E-03	6.79E-04	2.07E-04	4.43E-05
(-4,-3)	5.81E-07	4.27E-06	2.29E-05	9.08E-05	2.71E-04	6.27E-04	1.17E-03	1.87E-03	2.65E-03	3.32E-03	3.57E-03	3.29E-03	2.72E-03	2.25E-03	2.12E-03	2.40E-03	2.90E-03	3.08E-03	2.53E-03	1.52E-03	6.49E-04	1.97E-04	4.22E-05
(-3,-2)	1.92E-06	1.36E-05	7.06E-05	2.73E-04	7.99E-04	1.82E-03	3.38E-03	5.42E-03	7.79E-03	9.93E-03	1.08E-02	9.77E-03	7.65E-03	5.61E-03	4.18E-03	3.31E-03	2.77E-03	2.31E-03	1.69E-03	9.87E-04	4.07E-04	1.23E-04	2.62E-05
(-2,-1)	5.61E-06	3.84E-05	1.92E-04	7.09E-04	1.97E-03	4.23E-03	7.42E-03	1.14E-02	1.61E-02	2.05E-02	2.24E-02	2.01E-02	1.52E-02	1.02E-02	6.64E-03	4.24E-03	2.60E-03	1.53E-03	8.62E-04	4.29E-04	1.70E-04	5.01E-05	1.06E-05
(-1,0)	1.11E-05	7.41E-05	3.58E-04	1.27E-03	3.35E-03	6.80E-03	1.12E-02	1.63E-02	2.23E-02	2.84E-02	3.13E-02	2.83E-02	2.11E-02	1.36E-02	7.96E-03	4.40E-03	2.22E-03	9.92E-04	3.99E-04	1.50E-04	5.04E-05	1.38E-05	2.84E-06
(0,1)	1.46E-05	9.57E-05	4.51E-04	1.54E-03	3.90E-03	7.49E-03	1.16E-02	1.58E-02	2.08E-02	2.65E-02	2.96E-02	2.74E-02	2.07E-02	1.31E-02	7.23E-03	3.55E-03	1.55E-03	5.78E-04	1.81E-04	4.90E-05	1.22E-05	2.74E-06	5.14E-07
(1,2)	1.28E-05	8.26E-05	3.81E-04	1.27E-03	3.09E-03	5.65E-03	8.18E-03	1.04E-02	1.31E-02	1.65E-02	1.89E-02	1.82E-02	1.43E-02	9.33E-03	5.04E-03	2.27E-03	8.62E-04	2.75E-04	7.24E-05	1.56E-05	2.83E-06	4.61E-07	6.90E-08
(2,3)	7.45E-06	4.73E-05	2.14E-04	6.98E-04	1.65E-03	2.89E-03	3.95E-03	4.67E-03	5.54E-03	6.92E-03	8.19E-03	8.35E-03	7.05E-03	4.84E-03	2.66E-03	1.15E-03	3.93E-04	1.07E-04	2.39E-05	4.32E-06	6.31E-07	7.64E-08	8.18E-09
(3,4)	2.85E-06	1.79E-05	8.01E-05	2.56E-04	5.91E-04	1.00E-03	1.30E-03	1.43E-03	1.56E-03	1.96E-03	2.43E-03	2.68E-03	2.46E-03	1.81E-03	1.03E-03	4.41E-04	1.43E-04	3.49E-05	6.63E-06	1.00E-06	1.22E-07	1.20E-08	9.67E-10
(4,5)	7.17E-07	4.47E-06	1.98E-05	6.24E-05	1.41E-04	2.33E-04	2.88E-04	2.96E-04	3.07E-04	3.78E-04	5.01E-04	6.05E-04	6.05E-04	4.73E-04	2.79E-04	1.21E-04	3.84E-05	8.89E-06	1.52E-06	1.98E-07	2.01E-08	1.63E-09	1.07E-10
(5,6)	1.18E-07	7.31E-07	3.21E-06	1.00E-05	2.24E-05	3.60E-05	4.31E-05	4.16E-05	4.04E-05	5.01E-05	7.22E-05	9.62E-05	1.04E-04	8.55E-05	5.20E-05	2.29E-05	7.23E-06	1.64E-06	2.68E-07	3.19E-08	2.83E-09	1.93E-10	1.04E-11
(6,7)	1.27E-08	7.83E-08	3.42E-07	1.06E-06	2.33E-06	3.70E-06	4.30E-06	3.95E-06	3.63E-06	4.61E-06	7.32E-06	1.07E-05	1.22E-05	1.05E-05	6.49E-06	2.89E-06	9.18E-07	2.07E-07	3.32E-08	3.81E-09	3.16E-10	1.92E-11	8.79E-13

Table 4.9 Per Square Mile Crash Location Probability, Given a Crash, for Large Military Aircraft During Landing

Y (mi) \ X (mi)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	(5,6)	(6,7)	(7,8)	(8,9)	(9,10)	(10,11)	(11,12)	(12,13)
(-3,-2)	4.23E-04	6.82E-04	6.76E-04	4.30E-04	1.83E-04	7.83E-05	8.69E-05	1.21E-04	1.17E-04	7.27E-05	2.88E-05	7.30E-06	1.18E-06	1.21E-07
(-2,-1)	1.64E-02	2.71E-02	2.81E-02	1.92E-02	9.82E-03	7.16E-03	1.13E-02	1.63E-02	1.58E-02	9.77E-03	3.87E-03	9.80E-04	1.58E-04	1.63E-05
(-1,0)	3.28E-02	7.07E-02	1.01E-01	1.00E-01	7.03E-02	3.86E-02	2.46E-02	2.35E-02	2.09E-02	1.28E-02	5.06E-03	1.28E-03	2.06E-04	2.12E-05
(0,1)	2.23E-02	4.97E-02	7.44E-02	7.77E-02	5.65E-02	2.83E-02	9.72E-03	2.45E-03	6.25E-04	2.25E-04	7.92E-05	1.97E-05	3.16E-06	3.25E-07
(1,2)	4.19E-04	9.61E-04	1.52E-03	1.70E-03	1.32E-03	6.94E-04	2.42E-04	5.50E-05	8.09E-06	7.70E-07	4.93E-08	2.65E-09	1.88E-10	1.55E-11

Table 4.10 Per Square Mile Crash Location Probability, Given a Crash, for Large Military Aircraft During Takeoff

Y (mi) \ X (mi)	(-22,-21)	(-21,-20)	(-20,-19)	(-19,-18)	(-18,-17)	(-17,-16)	(-16,-15)	(-15,-14)	(-14,-13)	(-13,-12)	(-12,-11)	(-11,-10)	(-10,-9)	(-9,-8)	(-8,-7)
(-10,-9)	7.71E-07	3.06E-06	8.86E-06	1.88E-05	2.91E-05	3.30E-05	2.73E-05	1.66E-05	7.45E-06	3.16E-06	4.70E-06	1.63E-05	4.62E-05	9.69E-05	1.49E-04
(-9,-8)	8.04E-06	3.19E-05	9.23E-05	1.96E-04	3.03E-04	3.44E-04	2.85E-04	1.73E-04	7.71E-05	2.92E-05	2.96E-05	9.42E-05	2.69E-04	5.70E-04	8.87E-04
(-8,-7)	1.89E-05	7.51E-05	2.18E-04	4.61E-04	7.15E-04	8.10E-04	6.71E-04	4.07E-04	1.82E-04	6.73E-05	5.89E-05	1.74E-04	4.84E-04	1.01E-03	1.56E-03
(-7,-6)	1.04E-05	4.12E-05	1.19E-04	2.53E-04	3.92E-04	4.44E-04	3.68E-04	2.23E-04	1.01E-04	4.62E-05	7.33E-05	2.30E-04	6.00E-04	1.19E-03	1.78E-03
(-6,-5)	1.33E-06	5.36E-06	1.58E-05	3.44E-05	5.54E-05	6.61E-05	5.88E-05	3.94E-05	2.16E-05	1.96E-05	5.84E-05	1.99E-04	5.35E-04	1.11E-03	1.79E-03
(-5,-4)	6.51E-07	3.70E-06	1.55E-05	4.76E-05	1.07E-04	1.77E-04	2.15E-04	1.92E-04	1.28E-04	7.16E-05	5.88E-05	1.12E-04	2.64E-04	5.72E-04	1.05E-03
(-4,-3)	2.30E-06	1.35E-05	5.78E-05	1.82E-04	4.22E-04	7.20E-04	9.07E-04	8.49E-04	6.06E-04	3.78E-04	3.25E-04	4.71E-04	7.50E-04	1.09E-03	1.48E-03
(-3,-2)	2.28E-06	1.39E-05	6.29E-05	2.11E-04	5.29E-04	9.90E-04	1.39E-03	1.50E-03	1.28E-03	9.96E-04	9.65E-04	1.31E-03	1.93E-03	2.57E-03	3.03E-03
(-2,-1)	8.80E-07	6.08E-06	3.16E-05	1.24E-04	3.68E-04	8.30E-04	1.43E-03	1.92E-03	2.11E-03	2.09E-03	2.18E-03	2.58E-03	3.29E-03	4.06E-03	4.68E-03
(-1,0)	9.77E-07	6.31E-06	3.12E-05	1.18E-04	3.48E-04	7.93E-04	1.42E-03	2.04E-03	2.47E-03	2.74E-03	3.08E-03	3.70E-03	4.63E-03	5.70E-03	6.86E-03
(0,1)	3.96E-06	2.20E-05	9.04E-05	2.78E-04	6.44E-04	1.14E-03	1.61E-03	1.89E-03	2.01E-03	2.09E-03	2.29E-03	2.76E-03	3.62E-03	4.79E-03	6.25E-03
(1,2)	6.63E-06	3.48E-05	1.34E-04	3.83E-04	8.05E-04	1.26E-03	1.51E-03	1.44E-03	1.21E-03	1.05E-03	1.10E-03	1.42E-03	2.04E-03	2.94E-03	4.00E-03
(2,3)	3.26E-06	1.67E-05	6.25E-05	1.72E-04	3.48E-04	5.18E-04	5.73E-04	4.84E-04	3.38E-04	2.48E-04	2.67E-04	4.03E-04	6.59E-04	1.03E-03	1.46E-03
(3,4)	4.03E-07	2.04E-06	7.59E-06	2.07E-05	4.15E-05	6.30E-05	7.79E-05	9.30E-05	1.24E-04	1.67E-04	1.93E-04	1.82E-04	1.57E-04	1.55E-04	1.89E-04
(4,5)	1.14E-08	5.90E-08	2.41E-07	8.94E-07	3.62E-06	1.56E-05	5.90E-05	1.73E-04	3.76E-04	6.00E-04	7.01E-04	6.00E-04	3.77E-04	1.75E-04	6.36E-05
(5,6)	1.69E-10	2.36E-09	3.04E-08	3.10E-07	2.35E-06	1.32E-05	5.38E-05	1.61E-04	3.52E-04	5.62E-04	6.58E-04	5.63E-04	3.52E-04	1.61E-04	5.39E-05
(6,7)	2.24E-11	4.40E-10	6.32E-09	6.63E-08	5.08E-07	2.85E-06	1.16E-05	3.48E-05	7.62E-05	1.22E-04	1.42E-04	1.22E-04	7.62E-05	3.49E-05	1.17E-05

Y (mi) \ X (mi)	(-7,-6)	(-6,-5)	(-5,-4)	(-4,-3)	(-3,-2)	(-2,-1)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	(5,6)	(6,7)	(7,8)
(-10,-9)	1.67E-04	1.38E-04	8.36E-05	3.71E-05	1.21E-05	2.88E-06	5.03E-07	6.44E-08	6.05E-09	4.16E-10	2.09E-11	7.70E-13	2.08E-14	4.09E-16	5.92E-18
(-9,-8)	1.01E-03	8.49E-04	5.22E-04	2.36E-04	7.82E-05	1.90E-05	3.39E-06	4.44E-07	4.25E-08	2.99E-09	1.54E-10	5.79E-12	1.60E-13	3.25E-15	4.97E-17
(-8,-7)	1.79E-03	1.52E-03	9.48E-04	4.37E-04	1.49E-04	3.73E-05	6.89E-06	9.39E-07	9.46E-08	7.11E-09	4.11E-10	1.98E-11	9.59E-13	5.98E-14	5.09E-15
(-7,-6)	2.03E-03	1.75E-03	1.15E-03	5.67E-04	2.12E-04	5.99E-05	1.31E-05	2.31E-06	3.58E-07	5.38E-08	8.04E-09	1.22E-09	1.98E-10	3.35E-11	5.10E-12
(-6,-5)	2.24E-03	2.17E-03	1.62E-03	9.47E-04	4.43E-04	1.76E-04	6.26E-05	2.06E-05	6.14E-06	1.68E-06	4.67E-07	1.37E-07	3.77E-08	8.59E-09	1.52E-09
(-5,-4)	1.58E-03	1.91E-03	1.86E-03	1.50E-03	1.04E-03	6.30E-04	3.34E-04	1.58E-04	7.25E-05	3.53E-05	1.71E-05	7.17E-06	2.38E-06	6.10E-07	1.19E-07
(-4,-3)	1.91E-03	2.25E-03	2.36E-03	2.21E-03	1.86E-03	1.43E-03	1.04E-03	7.70E-04	5.88E-04	4.21E-04	2.53E-04	1.20E-04	4.42E-05	1.24E-05	2.66E-06
(-3,-2)	3.23E-03	3.30E-03	3.43E-03	3.72E-03	4.01E-03	4.04E-03	3.77E-03	3.36E-03	2.84E-03	2.16E-03	1.37E-03	6.88E-04	2.68E-04	7.92E-05	1.76E-05
(-2,-1)	5.28E-03	6.43E-03	8.79E-03	1.23E-02	1.58E-02	1.73E-02	1.60E-02	1.26E-02	8.94E-03	5.76E-03	3.28E-03	1.56E-03	5.87E-04	1.69E-04	3.68E-05
(-1,0)	8.84E-03	1.32E-02	2.15E-02	3.33E-02	4.48E-02	4.96E-02	4.42E-02	3.16E-02	1.86E-02	9.31E-03	4.11E-03	1.59E-03	5.18E-04	1.35E-04	2.70E-05
(0,1)	8.51E-03	1.29E-02	2.06E-02	3.13E-02	4.16E-02	4.55E-02	3.98E-02	2.75E-02	1.51E-02	6.69E-03	2.46E-03	7.74E-04	2.07E-04	4.57E-05	8.06E-06
(1,2)	5.04E-03	6.10E-03	7.50E-03	9.43E-03	1.13E-02	1.19E-02	1.04E-02	7.37E-03	4.18E-03	1.91E-03	7.09E-04	2.13E-04	5.12E-05	9.78E-06	1.46E-06
(2,3)	1.80E-03	1.94E-03	1.96E-03	2.01E-03	2.08E-03	2.04E-03	1.79E-03	1.35E-03	8.35E-04	4.14E-04	1.61E-04	4.88E-05	1.14E-05	2.01E-06	2.70E-07
(3,4)	2.46E-04	3.23E-04	4.26E-04	5.31E-04	5.78E-04	5.32E-04	4.15E-04	2.76E-04	1.53E-04	6.85E-05	2.40E-05	6.47E-06	1.33E-06	2.10E-07	2.51E-08
(4,5)	2.60E-05	2.54E-05	3.98E-05	5.56E-05	6.10E-05	5.24E-05	3.63E-05	2.09E-05	1.01E-05	4.00E-06	1.27E-06	3.09E-07	5.72E-08	7.99E-09	8.40E-10
(5,6)	1.34E-05	2.87E-06	1.29E-06	1.44E-06	1.53E-06	1.25E-06	7.93E-07	4.03E-07	1.69E-07	5.96E-08	1.72E-08	3.91E-09	6.83E-10	8.96E-11	8.76E-12
(6,7)	2.85E-06	5.12E-07	7.18E-08	1.40E-08	8.66E-09	6.55E-09	3.92E-09	1.82E-09	6.75E-10	2.08E-10	5.34E-11	1.12E-11	1.85E-12	2.34E-13	2.22E-14

Table 4.11 Per Square Mile Crash Location Probability, Given a Crash, for Small Military Aircraft During Landing

Y (mi) \ X (mi)	(-1,0)	(0,1)	(1,2)	(2,3)	(3,4)	(4,5)	(5,6)	(6,7)	(7,8)	(8,9)	(9,10)	(10,11)	(11,12)	(12,13)
(-9,-8)	2.18E-06	9.79E-06	2.50E-05	3.85E-05	4.01E-05	3.45E-05	2.60E-05	1.41E-05	4.77E-06	9.38E-07	1.06E-07	6.75E-09	2.44E-10	5.00E-12
(-8,-7)	3.19E-05	1.44E-04	3.74E-04	5.90E-04	6.47E-04	5.92E-04	4.59E-04	2.52E-04	8.49E-05	1.67E-05	1.88E-06	1.21E-07	4.38E-09	8.99E-11
(-7,-6)	1.45E-04	6.68E-04	1.78E-03	2.97E-03	3.53E-03	3.47E-03	2.75E-03	1.51E-03	5.08E-04	1.00E-04	1.13E-05	7.33E-07	2.70E-08	5.81E-10
(-6,-5)	2.14E-04	1.03E-03	2.93E-03	5.45E-03	7.35E-03	7.84E-03	6.34E-03	3.46E-03	1.17E-03	2.32E-04	2.72E-05	1.98E-06	1.05E-07	5.13E-09
(-5,-4)	1.12E-04	5.77E-04	1.87E-03	4.10E-03	6.41E-03	7.42E-03	6.16E-03	3.41E-03	1.22E-03	2.98E-04	6.15E-05	1.18E-05	1.71E-06	1.56E-07
(-4,-3)	1.38E-04	3.98E-04	9.40E-04	1.91E-03	3.07E-03	3.60E-03	3.07E-03	2.12E-03	1.47E-03	9.64E-04	4.55E-04	1.32E-04	2.28E-05	2.29E-06
(-3,-2)	1.84E-03	3.51E-03	4.68E-03	5.44E-03	6.16E-03	5.90E-03	4.62E-03	4.20E-03	4.65E-03	4.00E-03	2.13E-03	6.75E-04	1.25E-04	1.36E-05
(-2,-1)	1.32E-02	2.23E-02	2.47E-02	2.19E-02	1.92E-02	1.66E-02	1.25E-02	9.78E-03	9.33E-03	7.85E-03	4.35E-03	1.45E-03	2.82E-04	3.20E-05
(-1,0)	3.61E-02	5.82E-02	5.99E-02	4.63E-02	3.34E-02	2.52E-02	1.81E-02	1.22E-02	9.11E-03	6.78E-03	3.66E-03	1.23E-03	2.42E-04	2.78E-05
(0,1)	3.51E-02	5.55E-02	5.51E-02	3.98E-02	2.57E-02	1.74E-02	1.14E-02	6.81E-03	4.11E-03	2.60E-03	1.33E-03	4.41E-04	8.76E-05	1.01E-05
(1,2)	1.23E-02	1.94E-02	1.86E-02	1.27E-02	7.61E-03	4.80E-03	3.05E-03	2.13E-03	2.04E-03	1.94E-03	1.24E-03	4.72E-04	1.03E-04	1.29E-05
(2,3)	1.68E-03	2.63E-03	2.44E-03	1.54E-03	8.46E-04	5.53E-04	6.29E-04	1.40E-03	2.72E-03	3.20E-03	2.18E-03	8.48E-04	1.88E-04	2.37E-05
(3,4)	9.18E-05	1.44E-04	1.29E-04	7.47E-05	3.83E-05	5.22E-05	2.24E-04	7.87E-04	1.64E-03	1.96E-03	1.33E-03	5.19E-04	1.15E-04	1.45E-05
(4,5)	1.86E-06	2.92E-06	2.58E-06	1.42E-06	1.12E-06	6.60E-06	4.10E-05	1.50E-04	3.14E-04	3.75E-04	2.56E-04	9.95E-05	2.21E-05	2.78E-06
(5,6)	1.25E-08	1.97E-08	1.73E-08	1.06E-08	3.59E-08	3.73E-07	2.39E-06	8.78E-06	1.84E-05	2.19E-05	1.50E-05	5.82E-06	1.29E-06	1.63E-07

Table 4.12 Per Square Mile Crash Location Probability, Given a Crash, for Small Military Aircraft During Takeoff

4.3.2 IMPACT ANGLE DISTRIBUTIONS

The impact angle associated with a crashing aircraft is one of the crash kinematics involved in the crash frequency calculations. It is used in the effective area calculations in the form of the cotangent of the impact angle. It, combined with the crash velocity, determines the horizontal velocity of the aircraft at impact which, in turn, affects the distance a crashing aircraft skids prior to coming to its final location after a crash and which is an important input into analyses of the response of a structure to the impact of a crashing aircraft or the impact of a significant component, e.g., an engine, of the crashing aircraft. For purposes of describing the crash kinematics associated with military aviation in this Standard, the impact angle is defined as the angle between the velocity vector of the crashing aircraft and the horizontal, often referred to as the flight path angle.

Development of the marginal distribution of the impact angle and the cotangent of the impact angle, the variable used in the effective area calculation, are based on data in the Minuteman III WSSA database. Given the data, the computer code Best Fit (Ref 4.9) was used to select candidate families of distributions to describe the distribution of impact angles of future crashes. Statistical goodness of fit tests and analyst judgment were combined to select an appropriate family. Given the selected distributional family, maximum likelihood methodology was used to estimate values of the distributional parameters. For the impact angle, truncated lognormal distributions were chosen for large aircraft and beta distributions were chosen for small aircraft. For the cotangent of the impact angle, Weibull distributions were selected for both large and small aircraft.

Tabulated values of the cumulative probability distributions for the impact angle and the cotangent of the impact angle, for the four combinations of aircraft size and phase of operation, are given in Tables 4.13 and 4.14 respectively.

Cumulative Probability	Impact Angle			
	Large Aircraft		*Small Aircraft*	
	Landing	Takeoff	Landing	Takeoff
5%	1.62	2.02	1.05	1.09
10%	2.46	2.98	1.07	1.52
15%	3.26	3.86	1.16	2.48
20%	4.07	4.74	1.37	4.08
25%	4.93	5.66	1.78	6.40
30%	5.84	6.63	2.49	9.53
35%	6.84	7.67	3.59	13.47
40%	7.95	8.81	5.20	18.23
45%	9.18	10.07	7.44	23.78
50%	10.57	11.48	10.44	30.02
55%	12.16	13.07	14.31	36.86
60%	14.01	14.91	19.17	44.14
65%	16.20	17.07	25.11	51.68
70%	18.84	19.66	32.19	59.26
75%	22.13	22.85	40.42	66.63
80%	26.37	26.93	49.75	73.51
85%	32.13	32.45	60.02	79.61
90%	40.63	40.56	70.87	84.61
95%	55.10	54.46	81.58	88.14
100%	90.00	90.00	90.00	90.00

Table 4.13 Estimated Cumulative Distributions for Impact Angle

Cumulative Probability	Cotangent of Impact Angle			
	Large Aircraft		*Small Aircraft*	
	Landing	Takeoff	Landing	Takeoff
5%	0.24	0.45	0.09	0.02
10%	0.58	0.89	0.27	0.07
15%	0.98	1.34	0.52	0.17
20%	1.43	1.82	0.84	0.30
25%	1.95	2.32	1.22	0.48
30%	2.52	2.84	1.69	0.71
35%	3.17	3.40	2.23	1.01
40%	3.89	4.00	2.88	1.38
45%	4.70	4.65	3.64	1.85
50%	5.62	5.35	4.54	2.43
55%	6.66	6.13	5.61	3.16
60%	7.87	6.98	6.89	4.07
65%	9.27	7.95	8.44	5.24
70%	10.93	9.06	10.36	6.76
75%	12.95	10.36	12.78	8.77
80%	15.51	11.94	15.97	11.56
85%	18.90	13.97	20.41	15.68
90%	23.87	16.80	27.26	22.44
95%	32.78	21.58	40.37	36.54
100%	∞	∞	∞	∞

Table 4.14 Estimated Cumulative Distributions for Cotangent of Impact Angle

4.3.3 CRASH VELOCITY DISTRIBUTIONS

Two other crash kinematic parameters are needed for the calculations associated with this Standard are the airspeed and horizontal velocity of the aircraft at the time of impact. Both of these parameters are necessary inputs into the structural response calculations. For purposes of describing the crash kinematics for military aviation in this Standard, the airspeed of the crashing aircraft is referred to as the crash velocity. The horizontal velocity is the crash velocity in the horizontal direction, i.e., the crash velocity adjusted by the cosine of the impact angle.

The Minuteman III WSSA database was the source of the data used in developing the distributions of the crash and horizontal velocities. The same analysis techniques as were used for the impact angle were used in selecting and estimating appropriate distributions for the velocities associated with future military aviation crashes. Lognormal distributions were selected for the crash velocity for both large and small aircraft. The logistic distribution seemed to be the best descriptor for the horizontal velocity.

Tabulated values of the cumulative probability distributions for the crash velocity and the horizontal velocity, for the four combinations of aircraft size and phase of operation, are given in Tables 4.15 and 4.16 respectively.

Impact Airspeed

Cumulative Probability	Large Aircraft		Small Aircraft	
	Landing	Takeoff	Landing	Takeoff
5%	70.70	83.75	96.00	89.05
10%	81.47	95.45	109.01	103.73
15%	89.64	104.26	118.78	114.97
20%	96.71	111.83	127.16	124.78
25%	103.23	118.77	134.82	133.85
30%	109.45	125.36	142.09	142.56
35%	115.55	131.80	149.18	151.13
40%	121.66	138.21	156.23	159.75
45%	127.87	144.71	163.37	168.55
50%	134.29	151.41	170.72	177.68
55%	141.03	158.42	178.39	187.31
60%	148.24	165.87	186.54	197.63
65%	156.07	173.94	195.36	208.90
70%	164.76	182.87	205.11	221.46
75%	174.70	193.02	216.17	235.87
80%	186.46	204.99	229.19	253.02
85%	201.18	219.89	245.37	274.60
90%	221.36	240.17	267.35	304.37
95%	255.06	273.73	303.60	354.55
100%	∞	∞	∞	∞

Table 4.15 Estimated Cumulative Distributions for Airspeed at Principal Impact

Horizontal Velocity

Cumulative Probability	Large Aircraft		Small Aircraft	
	Landing	Takeoff	Landing	Takeoff
5%	50.52	76.65	39.57	24.45
10%	71.96	90.73	64.55	49.21
15%	85.23	99.44	80.01	64.53
20%	95.23	106.00	91.66	76.07
25%	103.48	111.42	101.27	85.60
30%	110.69	116.16	109.67	93.93
35%	117.24	120.46	117.31	101.49
40%	123.37	124.48	124.45	108.57
45%	129.24	128.34	131.29	115.35
50%	135.00	132.12	138.00	122.00
55%	140.76	135.90	144.71	128.65
60%	146.63	139.76	151.55	135.43
65%	152.76	143.78	158.69	142.51
70%	159.31	148.08	166.33	150.07
75%	166.52	152.82	174.73	158.40
80%	174.77	158.24	184.34	167.93
85%	184.77	164.80	195.99	179.47
90%	198.04	173.52	211.45	194.79
95%	219.48	187.59	236.43	219.55
100%	∞	∞	∞	∞

Table 4.16 Estimated Cumulative Distributions for Horizontal Velocity at Principal Impact

4.3.4 SKID DISTANCE DISTRIBUTIONS

The final crash parameter applicable to the aircraft crash risk analysis methodology, as presented in this Standard, is the distance an aircraft travels after its initial principle impact, assuming that the initial principle impact point is the recorded crash location. This parameter is an important element of the effective area calculation. Use of the distance described above implies that impacts with 'insignificant' objects, such as telephone poles or trees, as the aircraft descends are not considered in establishing crash locations. It also implies that the distance traveled can include the flight distance if the aircraft becomes airborne after its initial principle impact. For purposes of describing the distributions of crash kinematic parameters for military aviation for this Standard, the distance traveled, as described above, is referred to as the skid distance. In most aircraft crashes there is considerable breakup of the aircraft after its initial impact. For purposes of assessing skid distance, judgment must be used regarding when a 'significant' part of the skidding aircraft still exists rather than it being just debris. This is a judgment made by the analysts who derived the information from the available mishap reports.

As with the other crash kinematic parameters, development of the marginal distributions for the skid distance was based on the data in the Minuteman III WSSA database. Since this Standard is applicable only to facilities not on an airfield, the data in the database was screened to delete mishaps for which part of the skid distance involved travel along a runway. This is appropriate since skidding along the paved runway is different than what is expected to be experienced by a crashing aircraft at a location away from the airfield. Based on a review of the military mishap data, it was observed that in almost all cases, if the impact angle is greater than 20 degrees, there was no skid. Rather, there was an initial crater and considerable breakup of the aircraft and a scattering of debris. Thus, the appropriate model for describing the distribution of skid distance is a mixture distribution in which a portion of the distribution is at zero, i.e., no skid, and the remainder of the distribution is defined on the positive axis. This is the model selected to describe the marginal distributions of skid distance for military aviation crashes. The proportion of the skid distance distribution at zero is 50%, 57%, 41%, and 62%, for large aircraft during landing and takeoff and for small aircraft during landing and takeoff, respectively. The distributions of skid distance, conditional on the distance being greater than zero, seemed to be best described by Pearson VI distributions for both large and small aircraft.

Tabulated values of the cumulative probability distributions for skid distance, for the four combinations of aircraft size and phase of operation, are given in Table 4.17.

Cumulative Probability	Skid Distance			
	Large Aircraft		*Small Aircraft*	
	Landing	Takeoff	Landing	Takeoff
40%	0	0	0	0
45%	0	0	131	0
50%	0	0	200	0
55%	185	0	262	0
60%	262	1326	326	0
65%	335	1498	396	125
70%	414	1568	477	242
75%	505	1717	574	330
80%	617	1817	698	431
85%	768	1925	868	560
90%	999	2056	1142	752
95%	1461	2245	1740	1134
100%	∞	∞	∞	∞

Table 4.17 Estimated Cumulative Distributions for Skid Distance

4.4 MILITARY AVIATION AIRCRAFT CHARACTERISTICS

This section was prepared to provide to the analyst those characteristics of aircraft that could be important to determine the effect of the aircraft on the facility. Such aircraft characteristics which could be crucial in determining whether a facility could withstand an impact from an aircraft could be the weight of the aircraft, the amount of fuel aboard the aircraft, the speed of the aircraft, the dimensions of the aircraft, and potential missiles generated by the aircraft as its structure failed. Many of these parameters would vary greatly during the course of the flight, but the values of the characteristics given in this section could be considered the upper bound of these parameters. To determine the characteristics of an aircraft at the moment of impact in a particular accident, the analyst should refer to the specific accident report.

Tables 4.18 to 4.20, taken from References 4.10 to 4.18, presents the following information on military aviation aircraft characteristics:

1. Military aircraft designation (commercial type, if applicable),
2. Powerplant(s), number and type,
3. Nominal power rating of each powerplant,
4. Operating empty weight expressed in pounds, and kilograms,
5. Maximum allowed takeoff weight expressed in pounds, and kilograms,
6. Maximum fuel-capacity expressed in imperial gallons, and liters,
7. Overall wing span expressed in feet and inches, and in meters,
8. Overall length expressed in feet and inches, and in meters,
9. Overall height expressed in feet and inches, and in meters,
10. Wing area expressed in $ft.^2$ and $meters^2$,
11. Nominal takeoff length, expressed in feet,
12. Takeoff runway length to clear 50 ft. obstacle, expressed in feet,
13. Landing runway length to clear 50 ft. obstacle, expressed in feet,

Powerplant(s) were included as potential missile generators. Weights were given for mass during various points of the flight. Fuel capacity was included in order to provide the maximum fuel available for a fire following the crash. Aircraft dimensions will be needed when the facility effective area is determined. The takeoff runway length and landing runway length were provided so that an analyst could screen certain aircraft from certain airports due to their inability to operate from the airport's runway(s).

Table 4.21, taken from References 4.10 to 4.18, presents the following information on military aviation helicopter characteristics:

1. Military aircraft designation (commercial type),
2. Powerplant(s), number and type,
3. Nominal power rating of each powerplant,
4. Operating empty weight expressed in pounds, and kilograms,
5. Maximum allowed takeoff weight expressed in pounds, and kilograms,
6. Maximum fuel-capacity expressed in imperial gallons, and liters,
7. Rotor diameter, expressed in feet and inches, and in meters,
8. Fuselage overall length expressed in feet and inches, and in meters,
9. Overall height expressed in feet and inches, and in meters,
10. Number of rotor(s),
11. Number of rotor blades per rotor,

Powerplant(s) were included as potential missile generators. Weights were given for mass during various points of the flight. Fuel capacity was included in order to provide the maximum fuel available for a fire following the crash. Aircraft dimensions will be needed when the facility effective area is determined. Helicopter rotor diameter should be considered equivalent to aircraft wingspan. The number of rotor(s) and number of blades per rotor were provided as potential missile generators.

The tables listed below gives the general aviation subcategories for which the military aviation aircraft characteristics table were created:

Table 4.18	Large military aircraft,
Table 4.19	Small high performance military aircraft,
Table 4.20	Small low performance military aircraft,
Table 4.21	Military helicopters.

Aircraft are listed in descending order of maximum takeoff weight within each subcategory. Aircraft are also listed in ascending order according to military aircraft designation, i.e., A for attack aircraft, B for bomber, C for cargo aircraft, E for electronic warfare aircraft, F for fighter aircraft, H for helicopter, O for observation aircraft, P for maritime patrol aircraft, R for reconnaissance aircraft, S for anti-submarine warfare aircraft, T for training aircraft, T for training aircraft and U for utility aircraft.

The criterion for the determination of large military aircraft from small military aircraft was arbitrarily set at 100,000 lbs. maximum takeoff weight. Also, because of the wide dissimilarity of flight performance, small military aircraft were further divided into high performance aircraft and low performance aircraft. All turbofan and turbojet aircraft were classified as the high performance aircraft. All small military aircraft which derived their propulsion power primarily through propellers were classified as low performance aircraft.

Finally, additional research is needed to characterize the missiles (projectiles) generated during the course of an aircraft's crash. Obvious examples of such missiles are the aircraft's engines, the auxiliary power units (APUs), and the landing gear. Much of the information on these aircraft components is not readily available and may have to be obtained directly from the aircraft or engine manufacturer or from the company that produces the component.

Table 4.18
Characteristics of Large Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilograms	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilograms	Maximum Fuel Capacity Imp. Gal	Maximum Fuel Capacity Liters	Overall Wing Span Ft. In.	Overall Wing Span Meters	Overall Length Ft. In.	Overall Length Meters	Overall Height Ft. In.	Overall Height Meters	Wing Area Ft.**2	Wing Area M**2	Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist (ft.) 50'
LARGE MILITARY AIRCRAFT																				
C-5B Galaxy	4	GE. TF39-GE-1C HBTFs	43,000 lbs. st.	374,000	169,644	837,000	379,657	51,150	232,533	222' 8.5"	67.88 m.	247' 10"	75.54 m.	65' 1.5"	19.85 m.	6200.0	576.00	8,300	9,800	N.A.
VC-25A (Boeing 747-200B)	4	GE. F103-GE-102 HBTFs	56,750 lbs. st.	N.A.	N.A.	803,700	364,552	50,359	228,937	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	N.A.	N.A.	N.A.	10,800	6,930
E-4B (Boeing 747)	4	GE. CF6-50E2 HBTFs	52,500 lbs. st.	N.A.	N.A.	800,000	362,874	50,359	228,937	195' 8"	59.64 m.	231' 4"	70.51 m.	63' 5"	19.33 m.	N.A.	N.A.	N.A.	10,800	6,930
C-5A Galaxy	4	GE. TF39-1 HBTFs	41,000 lbs. st.	337,937	153,266	769,000	348,813	N.A.	N.A.	222' 8.5"	67.88 m.	247' 10"	75.54 m.	65' 1.5"	19.85 m.	6200.0	576.00	N.A.	8,400	3,600
KC-10 Extender (DC-10-30CF)	3	GE. CF6-50C2 HBTFs	52,500 lbs. st.	N.A.	N.A.	590,000	267,620	117,829	535,663	165' 4.5"	50.41 m.	181' 7"	55.35 m.	58' 1"	17.70 m.	N.A.	N.A.	10,400	N.A.	5,350
C-17A	4	P&W. F117-PW-100 HBTFs	40,000 lbs. st.	N.A.	N.A.	580,000	263,084	N.A.	N.A.	171' 3"	52.20 m.	174' 0"	53.04 m.	55' 1"	16.79 m.	N.A.	N.A.	N.A.	N.A.	N.A.
B-52H Stratofortress	8	P&W. TF33-P-3 TFs	17,000 lbs. st.	N.A.	N.A.	488,000	221,353	47,400	215,485	185' 0"	56.39 m.	160' 11"	49.05 m.	40' 8"	12.40 m.	N.A.	N.A.	10,000	N.A.	N.A.
B-52G Stratofortress	8	P&W. J57-P-43WB TJs	13,750 lbs. st.	N.A.	N.A.	488,000	221,353	47,400	215,485	185' 0"	56.39 m.	160' 11"	49.05 m.	40' 8"	12.40 m.	N.A.	N.A.	10,000	N.A.	N.A.
B-1B Lancer	4	GE. F101-GE-102 TFs	30,780 lbs. st.	192,000	87,090	477,000	216,364	N.A.	N.A.	136' 8.5"	41.67 m.	147'	44.81 m.	34'	10.36 m.	N.A.	N.A.	N.A.	N.A.	N.A.
B-2A Spirit	4	GE. F118-GE-100 TFs	19,000 lbs. st.	110,000	49,895	400,000	181,437	25,000	113,653	172' 0"	52.43 m.	69' 0"	21.03 m.	17' 0"	5.18 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-141B Starlifter	4	P&W. JT3D-3 TFs	21,000 lbs. st.	148,120	67,186	344,900	156,444	N.A.	N.A.	159' 11"	48.74 m.	168' 3.5"	51.29 m.	39' 3"	11.96 m.	3228.0	299.90	N.A.	5,800	3,700
E-6A Mecury (Boeing 707-320)	4	GE/SNECMA. F108-CF-100 TFs	24,000 lbs. st.	172,795	78,378	342,000	155,129	N.A.	N.A.	148' 2"	45.17 m.	152' 11"	46.62 m.	42' 5"	12.93 m.	3050.0	283.40	N.A.	N.A.	N.A.
E-3B/C Sentry	4	P&W. TF33-PW-100/100A TFs	21,000 lbs. st.	N.A.	N.A.	335,000	151,953	23,915	108,720	145' 9"	44.42 m.	152' 11"	46.62 m.	41' 9"	12.73 m.	N.A.	N.A.	N.A.	N.A.	N.A.
KC-135R Stratotanker	4	CFMI. F108-CF-100 TFs	22,224 lbs. st.	119,231	54,082	322,000	146,057	23,855	108,447	130' 10"	39.88 m.	136' 3"	41.53 m.	38' 4"	11.68 m.	N.A.	N.A.	9,050	N.A.	N.A.
VC-137C Stratoliner (B.707-320)	4	P&W. JT3D-3 TFs	17,200 lbs. st.	N.A.	N.A.	322,000	146,057	23,855	108,447	145' 9"	44.42 m.	152' 11"	46.61 m.	42' 5"	12.93 m.	N.A.	N.A.	N.A.	N.A.	N.A.
VC-137B Stratoliner (B.707-120)	4	P&W. JT3D-3 TFs	17,200 lbs. st.	N.A.	N.A.	258,000	117,027	N.A.	N.A.	130' 10"	39.88 m.	144' 6"	44.04 m.	42' 0"	12.80 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-135B Stratolifter	4	P&W. TF33-P-5 TFs	N.A.	102,300	46,403	275,500	124,965	N.A.	N.A.	130' 10"	39.88 m.	134' 6"	41.00 m.	38' 4"	11.68 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-133B Cargomaster	4	P&W. T34-9PW TPs	7,500 eshp	120,263	54,550	275,000	124,738	N.A.	N.A.	179' 8"	54.76 m.	157' 6"	48.01 m.	48' 3"	14.71 m.	2673.0	248.33	N.A.	N.A.	N.A.
C-22B (Boeing 727)	3	TF	15,500 lbs. st.	N.A.	N.A.	203,000	92,079	10,570	48,052	108'	32.92 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9,450	4,690
C-124C Globemaster II	4	P&W. R-4360-63A RPs	3,800 hp	101,165	45,888	185,000	83,915	N.A.	N.A.	174' 1.5"	53.07 m.	130' 5"	39.75 m.	48' 3.5"	14.72 m.	2506.0	232.82	N.A.	N.A.	N.A.
KC-130R Hercules	4	Allison T56-A-15 TPs	4,591 shp	79,981	36,279	175,000	79,379	9,680	44,006	132' 7"	40.42 m.	97' 9"	29.79 m.	38' 3"	11.66 m.	1745.0	162.12	3,580	5,160	2,750
C-130H Hercules	4	Allison T56-A-15 TPs	4,910 ehp	72,892	33,063	175,000	79,379	9,680	44,006	132' 7"	40.42 m.	97' 9"	29.79 m.	38' 3"	11.66 m.	1745.0	162.12	3,580	5,160	2,750
SR-71	2	P&W. J58 TJs	32,500 lbs. AB	N.A.	N.A.	170,000	77,111	N.A.	N.A.	55' 7"	16.94 m.	107' 5"	32.74 m.	18' 6"	5.64 m.	N.A.	N.A.	N.A.	N.A.	N.A.
P-3C Orion	4	Allison T56-A-14 TPs	4,910 ehp	61,491	27,892	142,000	64,410	9,200	41,824	99' 8"	30.37 m.	116' 10"	35.61 m.	33' 8.5"	10.29 m.	1300.0	120.77	4,240	5,490	2,770
C-9A Nightingale (DC-9-30)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	N.A.	N.A.	122,000	55,338	5,038	22,903	93' 5"	28.47 m.	119' 4"	36.37 m.	27' 6"	8.38 m.	1000.7	92.97	6,850	8,020	4,720
T-43A (Boeing 737-200)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	N.A.	N.A.	115,500	52,390	6,295	28,618	93' 0"	28.35 m.	100' 0"	30.48 m.	37' 0"	11.28 m.	N.A.	N.A.	N.A.	N.A.	5,260
C-9B Skytrain II (DC-9-30)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	65,283	29,612	110,000	49,895	N.A.	N.A.	93' 5"	28.47 m.	119' 4"	36.37 m.	27' 6"	8.38 m.	1000.7	92.97	6,850	8,020	4,720

N.A. = Information not available when table prepared.

HBTF = High Bypass Turbofan
TF = Turbofan
TJ = Turbojet
TP = Turboprop
RP = Radial Pistonprop

lbs. st. = pounds thrust static
shp = shaft horsepower
hp = horsepower

Table 4.18 (Continued)
Characteristics of Large Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
BOMBERS																				
B-1B Lancer	4	GE. F101-GE-102 TFs	30,780 lbs. st.	192,000	87,090	477,000	216,364	N.A.	N.A.	136' 8.5"	41.67 m.	147'	44.81 m.	34'	10.36 m.	N.A.	N.A.	N.A.	N.A.	N.A.
B-2A Spirit	4	GE. F118-GE-100 TFs	19,000 lbs. st.	110,000	49,895	400,000	181,437	25,000	113,653	172' 0"	52.43 m.	69' 0"	21.03 m.	17' 0"	5.18 m.	N.A.	N.A.	N.A.	N.A.	N.A.
B-52H Stratofortress	8	P&W. TF33-P-3 TFs	17,000 lbs. st.	N.A.	N.A.	488,000	221,353	47,400	215,485	185' 0"	56.39 m.	160' 11"	49.05 m.	40' 8"	12.40 m.	N.A.	N.A.	10,000	N.A.	N.A.
B-52G Stratofortress	8	P&W. J57-P-43WB TJs	13,750 lbs. st.	N.A.	N.A.	488,000	221,353	47,400	215,485	185' 0"	56.39 m.	160' 11"	49.05 m.	40' 8"	12.40 m.	N.A.	N.A.	10,000	N.A.	N.A.
CARGO AIRCRAFT																				
C-5B Galaxy	4	GE. TF39-GE-1C HBTFs	43,000 lbs. st.	374,000	169,644	837,000	379,657	51,150	232,533	222' 8.5"	67.88 m.	247' 10"	75.54 m.	65' 1.5"	19.85 m.	6200.0	576.00	8,300	9,800	N.A.
C-5A Galaxy	4	GE. TF39-1 HBTFs	41,000 lbs. st.	337,937	153,286	769,000	348,813	N.A.	N.A.	222' 8.5"	67.88 m.	247' 10"	75.54 m.	65' 1.5"	19.85 m.	6200.0	576.00	N.A.	8,400	3,600
C-9B Skytrain II (DC-9-30)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	65,283	29,612	110,000	49,895	N.A.	N.A.	93' 5"	28.47 m.	119' 4"	36.37 m.	27' 6"	8.38 m.	1000.7	92.97	6,850	8,020	4,720
C-9A Nightingale (DC-9-30)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	N.A.	N.A.	122,000	55,338	5,038	22,903	93' 5"	28.47 m.	119' 4"	36.37 m.	27' 6"	8.38 m.	1000.7	92.97	6,850	8,020	4,720
KC-10 Extender (DC-10-30CF)	3	GE. CF6-50C2 HBTFs	52,500 lbs. st.	N.A.	N.A.	590,000	267,620	117,829	535,663	165' 4.5"	50.41 m.	181' 7"	55.35 m.	58' 1"	17.70 m.	N.A.	N.A.	10,400	N.A.	5,350
C-17A	4	P&W. F117-PW-100 HBTFs	40,000 lbs. st.	N.A.	N.A.	580,000	263,084	N.A.	N.A.	171' 3"	52.20 m.	174' 0"	53.04 m.	55' 1"	16.79 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-22B (Boeing 727)	3	TF	15,500 lbs. st.	N.A.	N.A.	203,000	92,079	10,570	48,052	108'	32.92 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9,450	4,690
VC-25A (Boeing 747-200B)	4	GE. F103-GE-102 HBTFs	56,750 lbs. st.	N.A.	N.A.	803,700	364,552	50,359	228,937	195' 8"	59.64 m.	231' 10"	70.66 m.	63' 5"	19.33 m.	N.A.	N.A.	N.A.	10,800	6,930
C-124C Globemaster II	4	P&W. R-4360-63A RPs	3,800 hp	101,165	45,888	185,000	83,915	N.A.	N.A.	174' 1.5"	53.07 m.	130' 5"	39.75 m.	48' 3.5"	14.72 m.	2506.0	232.82	N.A.	N.A.	N.A.
KC-130R Hercules	4	Allison T56-A-15 TPs	4,591 shp	79,981	36,279	175,000	79,379	9,680	44,006	132' 7"	40.42 m.	97' 9"	29.79 m.	36' 3"	11.66 m.	1745.0	162.12	3,580	5,160	2,750
C-130H Hercules	4	Allison T56-A-15 TPs	4,910 ehp	72,892	33,063	175,000	79,379	9,680	44,006	132' 7"	40.42 m.	97' 9"	29.79 m.	36' 3"	11.66 m.	1745.0	162.12	3,580	5,160	2,750
C-133B Cargomaster	4	P&W. T34-9PW TPs	7,500 eshp	120,263	54,550	275,000	124,738	N.A.	N.A.	179' 8"	54.76 m.	157' 6"	48.01 m.	48' 3"	14.71 m.	2673.0	248.33	N.A.	N.A.	N.A.
KC-135R Stratotanker	4	CFMI. F108-CF-100 TFs	22,224 lbs. st.	119,231	54,062	322,000	146,057	23,855	108,447	130' 10"	39.88 m.	136' 3"	41.53 m.	38' 4"	11.68 m.	N.A.	N.A.	9,050	N.A.	N.A.
C-135B Stratolifter	4	P&W. TF33-P-5 TFs	N.A.	102,300	46,403	275,500	124,965	N.A.	N.A.	130' 10"	39.88 m.	134' 6"	41.00 m.	38' 4"	11.68 m.	N.A.	N.A.	N.A.	N.A.	N.A.
VC-137C Stratoliner (B.707-320)	4	P&W. JT3D-3 TFs	17,200 lbs. st.	N.A.	N.A.	322,000	146,057	23,855	108,447	145' 9"	44.42 m.	152' 11"	46.61 m.	42' 5"	12.93 m.	N.A.	N.A.	N.A.	N.A.	N.A.
VC-137B Stratoliner (B.707-120)	4	P&W. JT3D-3 TFs	17,200 lbs. st.	N.A.	N.A.	258,000	117,027	N.A.	N.A.	130' 10"	39.88 m.	144' 6"	44.04 m.	42' 0"	12.80 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-141B Starlifter	4	P&W. JT3D-3 TFs	21,000 lbs. st.	148,120	67,186	344,900	156,444	N.A.	N.A.	159' 11"	48.74 m.	168' 3.5"	51.29 m.	39' 3"	11.96 m.	3228.0	299.90	N.A.	5,800	3,700
ELECTRONIC WARFARE AIRCRAFT																				
E-3B/C Sentry	4	P&W. TF33-PW-100/100A TFs	21,000 lbs. st.	N.A.	N.A.	335,000	151,953	23,915	108,720	145' 9"	44.42 m.	152' 11"	46.62 m.	41' 9"	12.73 m.	N.A.	N.A.	N.A.	N.A.	N.A.
E-4B (Boeing 747)	4	GE. CF6-50E2 HBTFs	52,500 lbs. st.	N.A.	N.A.	800,000	362,874	50,359	228,937	195' 8"	59.64 m.	231' 4"	70.51 m.	63' 5"	19.33 m.	N.A.	N.A.	N.A.	10,800	6,930
E-6A Mercury (Boeing 707-320)	4	GE/SNECMA. F108-CF-100 TFs	24,000 lbs. st.	172,795	78,378	342,000	155,129	N.A.	N.A.	148' 2"	45.17 m.	152' 11"	46.62 m.	42' 5"	12.93 m.	3050.0	283.40	N.A.	N.A.	N.A.
MARITIME PATROL AIRCRAFT																				
P-3C Orion	4	Allison T56-A-14 TPs	4,910 ehp	61,491	27,892	142,000	64,410	9,200	41,824	99' 8"	30.37 m.	116' 10"	35.61 m.	33' 8.5"	10.29 m.	1300.0	120.77	4,240	5,490	2,770
RECONNAISSANCE AIRCRAFT																				
SR-71	2	P&W. J58 TJs	32,500 lbs. AB	N.A.	N.A.	170,000	77,111	N.A.	N.A.	55' 7"	16.94 m.	107' 5"	32.74 m.	18' 6"	5.64 m.	N.A.	N.A.	N.A.	N.A.	N.A.
TRAINING AIRCRAFT																				
T-43A (Boeing 737-200)	2	P&W. JT8D-9 TFs	14,500 lbs. st.	N.A.	N.A.	115,500	52,390	6,295	28,618	93' 0"	28.35 m.	100' 0"	30.48 m.	37' 0"	11.28 m.	N.A.	N.A.	N.A.	N.A.	5,260

N.A. = Information not available when table prepared.

HBTF = High Bypass Turbofan
TF = Turbofan
TJ = Turbojet
TP = Turboprop
RP = Radial Pistonprop

lbs. st. = pounds thrust static
shp = shaft horsepower
hp = horsepower

Table 4.19
Characteristics of Small High Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilogram	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilogram	Maximum Fuel Capacity Imp. Gal	Maximum Fuel Capacity Liters	Overall Wing Span Ft. In.	Overall Wing Span Meters	Overall Length Ft. In.	Overall Length Meters	Overall Height Ft. In.	Overall Height Meters	Wing Area Ft.**2	Wing Area M**2	Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
SMALL HIGH PERFORMANCE MILITARY AIRCRAFT																				
F-111F	2	P&W. TF30-P-111 TFs	25,100 lbs. AB	47,481	21,537	100,000	45,359	N.A.	N.A.	63' 0"	19.20 m.	73' 6"	22.40 m.	17' 1.5"	5.22 m.	N.A.	N.A.	3,000	N.A.	3,000
EF-111A Raven	2	P&W. TF30-P-109 TFs	19,600 lbs. AB	55,275	25,072	88,948	40,346	N.A.	N.A.	63' 0"	19.20 m.	76' 0"	23.16 m.	20' 0"	6.10 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-15E Strike Eagle	2	P&W. F100-PW-220 or 229 TFs	23,450 lbs. st.	32,500	14,742	81,000	36,741	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F-14A Tomcat	2	P&W. TF30-P-414A TFs	20,900 lbs. AB	40,104	18,191	74,349	33,724	N.A.	N.A.	64' 1.5"	19.54 m.	62' 8"	19.1 m.	16' 0"	4.88 m.	565.0	52.49	2,500	N.A.	2,400
KA-3B Skywarrior	2	P&W. J57-P-10 TJs	37,329 lbs. WI	37,329	16,932	70,000	31,751	N.A.	N.A.	72' 6"	22.10 m.	76' 4"	23.27 m.	22' 9.5"	6.95 m.	812.0	75.44	N.A.	N.A.	N.A.
C-20A/B/D/H (Gulfstream III)	2	RR. F113-RR-100 TFs	11,400 lbs. st.	32,000	14,515	69,700	31,615	4,192	19,057	77' 10"	23.72 m.	83' 1"	25.32 m.	24' 4.5"	7.43 m.	934.6	86.83	5,100	N.A.	3,200
F-15C Eagle	2	P&W. F100-PW-100 or 220 TFs	23,450 lbs. st.	28,600	12,973	68,000	30,844	5,400	24,549	42' 10"	13.06 m.	63' 9"	19.43 m.	18' 5.5"	5.63 m.	N.A.	N.A.	N.A.	N.A.	3,500
RA-5C Vigilante	2	GE. J79-GE-10 TJs	17,860 lbs. AB	N.A.	N.A.	66,818	30,308	N.A.	N.A.	53' 0"	16.16 m.	75' 10"	23.11 m.	19' 5"	5.92 m.	769.0	71.44	N.A.	N.A.	N.A.
EA-6B Prowler	2	P&W. J52-P-408 TJs	11,200 lbs. st.	32,162	14,588	65,000	29,484	N.A.	N.A.	53' 0"	16.16 m.	59' 10"	18.24 m.	16' 3"	4.95 m.	528.9	49.10	N.A.	N.A.	N.A.
F-4E Phantom II	2	GE. J79-GE-17A TJs	17,900 lbs. AB	30,328	13,757	61,795	28,030	1,855	8,433	38' 7.5"	11.77 m.	63' 0"	19.20 m.	16' 5.5"	5.02 m.	N.A.	N.A.	4,390	5,880	3,780
A-6E Intruder	2	P&W. J52-P-8B TJs	9,300 lbs. st.	26,660	12,093	60,400	27,397	2,344	10,656	53' 0"	16.15 m.	54' 9"	16.69 m.	16' 2"	4.93 m.	528.9	49.10	3,890	4,560	2,540
F-22 Lightning II	2	P&W. F119-PW-100 TFs	35,000 lbs. st.	N.A.	N.A.	60,000	27,216	N.A.	N.A.	44' 6"	13.56 m.	62' 0.5"	18.91 m.	16' 6"	5.03 m.	N.A.	N.A.	N.A.	N.A.	N.A.
VC-11A (Gulfstream II)	2	RR. F113-RR-100 TFs	11,400 lbs. st.	N.A.	N.A.	59,500	26,989	N.A.	N.A.	68' 10"	21.00 m.	79' 11"	24.35 m.	24' 6"	7.47 m.	793.5	73.72	N.A.	N.A.	N.A.
F/A-18A Hornet	2	GE. F404-GE-402 TFs	17,700 lbs. st.	26,000	12,701	56,000	25,401	2,590	11,774	37' 6"	11.43 m.	56' 0"	17.07 m.	15' 3.5"	4.66 m.	400.0	37.16	1,400	N.A.	N.A.
B-57B Canberra	2	Wright J65-W-5 TJs	7,200 lbs. st.	26,793	13,060	56,965	25,839	N.A.	N.A.	64' 0"	19.51 m.	65' 6"	19.96 m.	15' 7"	4.75 m.	960.0	89.18	N.A.	N.A.	N.A.
F-105G Thunderchief	1	P&W. J75-19W TJ	24,500 lbs. AB	26,393	12,879	54,000	24,494	N.A.	N.A.	34' 11"	10.65 m.	69' 7.5"	21.21 m.	20' 2"	6.15 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-105D Thunderchief	1	P&W. J75-19W TJ	24,500 lbs. AB	27,500	12,474	52,546	23,834	N.A.	N.A.	34' 11"	10.65 m.	64' 3"	19.58 m.	19' 6"	5.99 m.	N.A.	N.A.	N.A.	N.A.	N.A.
S-3A Viking	2	GE. TF34-GE-400 TFs	9,275 lbs. st.	26,783	12,149	52,539	23,831	N.A.	N.A.	68' 8"	20.93 m.	53' 4"	16.26 m.	22' 9"	6.94 m.	598.0	55.56	N.A.	N.A.	N.A.
F-117A Stealth Fighter	2	GE. F404-GE-F1D2 TFs	10,800 lbs. st.	N.A.	N.A.	52,500	23,814	N.A.	N.A.	43' 4"	13.20 m.	65' 11"	20.09 m.	12' 5"	3.78 m.	N.A.	N.A.	N.A.	N.A.	N.A.
A-10A Thunderbolt II	2	GE. TF34-GE-100 TFs	9,065 lbs. st.	24,959	11,321	50,000	22,680	3,145	14,297	57' 6"	17.53 m.	53' 4"	16.26 m.	14' 8"	4.47 m.	N.A.	N.A.	4,500	N.A.	N.A.
F-101B Voodoo	2	P&W. J57-55 TJs	14,990 lbs. st.	26,000	12,701	46,673	21,171	N.A.	N.A.	39' 8"	12.09 m.	67' 5"	20.55 m.	N.A.	N.A.	368.0	34.22	N.A.	N.A.	N.A.
C-140 Jetstar	4	Garrett TFE731-3 TFs	3,700 lbs. st.	18,450	8,369	43,750	19,845	2,686	12,211	54' 5"	16.60 m.	60' 5"	18.42 m.	20' 5"	6.23 m.	542.5	50.40	N.A.	4,950	4,180
F-16C/N Fighting Falcon	1	GE. F110-GE-100 TFs	27,600 lbs. st.	17,278	7,837	42,300	19,187	1,500	6,819	32' 10"	10.0 m.	49' 3"	15.01 m.	16' 8.5"	5.09 m.	300.0	27.87	N.A.	N.A.	N.A.
A-7D/K Corsair II	1	Allison TF41-A-1 TF	14,500 lbs. st.	19,781	8,973	42,000	19,051	1,500	6,819	38' 9"	11.81 m.	46' 1.5"	14.06 m.	16' 1"	4.90 m.	N.A.	N.A.	6,000	N.A.	N.A.
TR-1/U-2R	1	GE. F101-GE-F29 TF	19,000 lbs. st.	N.A.	N.A.	40,000	18,144	1,175	5,342	103' 0"	31.39 m.	63' 0"	19.20 m.	16' 0"	4.88 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-100D Super Sabre	1	P&W. J57-P-21A TJ	17,000 lbs. st.	N.A.	N.A.	34,832	15,800	N.A.	N.A.	38' 9"	11.81 m.	49' 6"	15.09 m.	15' 0"	4.57 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-106A Delta Dart	1	P&W. J75-17 TJ	24,500 lbs. AB	24,420	11,077	34,510	15,653	N.A.	N.A.	38' 3"	11.67 m.	70' 9"	21.55 m.	20' 3"	6.15 m.	661.5	61.52	N.A.	N.A.	N.A.
F-8J Crusader	1	P&W. TF30-P420 TF	19,600 lbs. AB	N.A.	N.A.	34,000	15,422	N.A.	N.A.	35' 2"	10.72 m.	54' 6"	16.61 m.	15' 9"	4.8 m.	N.A.	N.A.	N.A.	N.A.	N.A.
HU-25 Guardian (Falcon 200)	2	Garrett ATF3-6-2C TFs	5,538 lbs. st.	19,000	8,618	33,510	15,200	1,585	7,206	53' 6"	16.30 m.	56' 3"	17.15 m.	17' 5"	5.32 m.	440.0	41.00	4,660	N.A.	3,710
F-102A Delta Dagger	1	P&W. J57-P-23 TJ	17,200 lbs. AB	19,350	8,777	31,276	14,187	N.A.	N.A.	38' 1.5"	11.62 m.	68' 4.5"	20.84 m.	21' 2.5"	6.46 m.	661.5	61.45	N.A.	N.A.	N.A.
AV-8B Harrier	1	RR. F402-RR-406 TF	21,700 lbs. st.	13,086	5,936	31,000	14,061	2,141	9,733	30' 4"	9.25 m.	46' 4"	14.12 m.	11' 6"	3.55 m.	230.0	21.37	1,330	N.A.	N.A.
F-104S Starfighter	1	GE. J79-GE-19 TJ	17,900 lbs. AB	N.A.	N.A.	31,000	14,061	1,286	5,848	21' 11"	6.68 m.	54' 9"	16.69 m.	13' 6"	4.11 m.	N.A.	N.A.	2,700	N.A.	2,500
F-5E Tiger II	2	GE. J85-GE-21B TJs	5,000 lbs. AB	9,723	4,410	24,722	11,214	1,133	5,151	26' 8"	8.13 m.	47' 5"	14.45 m.	13' 4"	4.06 m.	186.0	17.30	2,650	3,650	3,900
A-4M Skyhawk	1	P&W. J52-P-408 TJ	11,200 lbs. st.	10,465	4,747	24,500	11,113	N.A.	N.A.	27' 6"	8.38 m.	40' 4"	12.27 m.	15' 0"	4.57 m.	260.0	24.16	1,500	N.A.	N.A.
F-104C Starfighter	1	GE. J79-GE-7 TJ	15,800 lbs. AB	12,760	5,788	19,470	8,831	N.A.	N.A.	21' 9"	6.63 m.	54' 6"	16.66 m.	13' 5"	4.09 m.	196.1	18.22	N.A.	N.A.	N.A.
C-21A (Learjet 35)	2	Garrett TFE731-2 TFs	3,500 lbs. st.	N.A.	N.A.	18,300	8,301	1,104	5,019	39' 6"	12.04 m.	48' 8"	14.83 m.	12' 3"	3.73 m.	N.A.	N.A.	4,972	N.A.	3,075
CT-39E/G Sabreliner	2	P&W. J60-P-3A TJs	3,000 lbs. st.	N.A.	N.A.	17,760	8,056	903	4,105	44' 5"	13.53 m.	43' 9"	13.33 m.	16' 0"	4.88 m.	342.6	31.83	5,100	N.A.	N.A.
T-1A Jayhawk (Beechjet 400)	2	P&WC. JT15D-5B TFs	2,900 lbs. st.	5,200	2,359	16,100	7,303	N.A.	N.A.	43' 6"	13.25 m.	48' 5"	14.76 m.	13' 11"	4.24 m.	N.A.	N.A.	N.A.	N.A.	N.A.
T-33 Shooting Star	1	Allison J33-A-35 TJ	5,200 lbs. st.	N.A.	N.A.	14,442	6,551	N.A.	N.A.	38' 10.5"	11.85 m.	37' 9"	11.48 m.	11' 6"	3.55 m.	N.A.	N.A.	N.A.	2,560	3,480
A-37B Dragonfly	2	GE. J85-GE-17A TJs	2,850 lbs. st.	6,211	2,817	14,000	6,350	507	2,305	35' 10.5"	10.93 m.	28' 3"	8.61 m.	8' 10.5"	2.71 m.	N.A.	N.A.	1,740	2,596	4,150
T-47 (Cessna Citation II)	2	TF	2,500 lbs. st.	N.A.	N.A.	13,300	6,033	742	3,373	52'	15.85 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,270	2,365	N.A.
T-2C Buckeye	2	GE. J85-GE-4 TJs	2,950 lbs. st.	8,115	3,681	13,179	5,978	N.A.	N.A.	38' 2"	11.62 m.	38' 4"	11.67 m.	14' 10"	4.51 m.	255.0	23.69	N.A.	N.A.	N.A.
T-45A Goshawk	1	RR. F405-RR-401 TF	5,845 lbs. st.	9,399	4,263	12,758	5,787	761	3,460	30' 10"	9.39 m.	35' 9"	10.89 m.	13' 6"	4.12 m.	179.6	9.39	2,330	3,744	3,900
T-38A Talon	2	GE. J85-GE-5A TJs	3,850 lbs. AB	7,410	3,361	12,093	5,485	583	2,650	25' 3"	7.7 m.	46' 10"	14.13 m.	12' 10.5"	3.92 m.	170.0	15.80	2,500	3,700	4,500
T-37B Tweet	2	Cont. J69-T-25 TJs	1,025 lbs. st.	3,870	1,755	6,575	2,982	309	1,405	33' 9"	10.29 m.	29' 3"	8.92 m.	9' 2"	2.79 m.	N.A.	N.A.	2,050	2,750	3,400

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet

lbs. AB = pounds thrust with afterburning
lbs. st. = pounds thrust static
lbs. WI = pounds thrust with water injection

Table 4.19 (Continued)
Characteristics of Small High Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
ATTACK AIRCRAFT																				
KA-3B Skywarrior	2	P&W. J57-P-10 TJs	37,329 lbs. WI	37,329	16,932	70,000	31,751	N.A.	N.A.	72' 6"	22.10 m.	76' 4"	23.27 m.	22' 9.5"	6.95 m.	812.0	75.44	N.A.	N.A.	N.A.
A-4M Skyhawk	1	P&W. J52-P-408 TJ	11,200 lbs. st.	10,465	4,747	24,500	11,113	N.A.	N.A.	27' 6"	8.38 m.	40' 4"	12.27 m.	15' 0"	4.57 m.	260.0	24.16	1,500	N.A.	N.A.
RA-5C Vigilante	2	GE. J79-GE-10 TJs	17,860 lbs. AB	N.A.	N.A.	66,818	30,308	N.A.	N.A.	53' 0"	16.16 m.	75' 10"	23.11 m.	19' 5"	5.92 m.	769.0	71.44	N.A.	N.A.	N.A.
A-6E Intruder	2	P&W. J52-P-8B TJs	9,300 lbs. st.	26,660	12,093	60,400	27,397	2,344	10,656	53' 0"	16.15 m.	54' 9"	16.69 m.	16' 2"	4.93 m.	528.9	49.10	3,890	4,560	2,540
EA-6B Prowler	2	P&W. J52-P-408 TJs	11,200 lbs. st.	32,162	14,588	65,000	29,484	N.A.	N.A.	53' 0"	16.16 m.	59' 10"	18.24 m.	16' 3"	4.95 m.	528.9	49.10	N.A.	N.A.	N.A.
A-7D/K Corsair II	1	Allison TF41-A-1 TF	14,500 lbs. st.	19,781	8,973	42,000	19,051	1,500	6,819	38' 9"	11.81 m.	46' 1.5"	14.06 m.	16' 1"	4.90 m.	N.A.	N.A.	6,000	N.A.	N.A.
AV-8B Harrier	1	RR. F402-RR-406 TF	21,700 lbs. st.	13,086	5,936	31,000	14,061	2,141	9,733	30' 4"	9.25 m.	46' 4"	14.12 m.	11' 8"	3.56 m.	230.0	21.37	1,330	N.A.	N.A.
A-10A Thunderbolt II	2	GE. TF34-GE-100 TFs	9,065 lbs. st.	24,959	11,321	50,000	22,680	3,145	14,297	57' 6"	17.53 m.	53' 4"	16.26 m.	14' 8"	4.47 m.	N.A.	N.A.	4,500	N.A.	N.A.
A-37B Dragonfly	2	GE. J85-GE-17A TJs	2,850 lbs. st.	6,211	2,817	14,000	6,350	507	2,305	35' 10.5"	10.93 m.	28' 3"	8.61 m.	8' 10.5"	2.71 m.	N.A.	N.A.	1,740	2,596	4,150
BOMBER																				
B-57B Canberra	2	Wright J65-W-5 TJs	7,200 lbs. st.	26,793	13,060	56,965	25,839	N.A.	N.A.	64' 0"	19.51 m.	65' 6"	19.96 m.	15' 7"	4.75 m.	960.0	89.18	N.A.	N.A.	N.A.
CARGO AIRCRAFT																				
VC-11A (Gulfstream II)	2	RR. F113-RR-100 TFs	11,400 lbs. st.	N.A.	N.A.	59,500	26,989	N.A.	N.A.	68' 10"	21.00 m.	79' 11"	24.35 m.	24' 6"	7.47 m.	793.5	73.72	N.A.	N.A.	N.A.
C-20A/B/D/H (Gulfstream III)	2	RR. F113-RR-100 TFs	11,400 lbs. st.	32,000	14,515	69,700	31,615	4,192	19,057	77' 10"	23.72 m.	83' 1"	25.32 m.	24' 4.5"	7.43 m.	934.6	86.83	5,100	N.A.	3,200
C-21A (Learjet 35)	2	Garrett TFE731-2 TFs	3,500 lbs. st.	N.A.	N.A.	18,300	8,301	1,104	5,019	39' 6"	12.04 m.	48' 8"	14.83 m.	12' 3"	3.73 m.	N.A.	N.A.	4,972	N.A.	3,075
CT-39E/G Sabreliner	2	P&W. J60-P-3A TJs	3,000 lbs. st.	N.A.	N.A.	17,760	8,056	903	4,105	44' 5"	13.53 m.	43' 9"	13.33 m.	16' 0"	4.88 m.	342.6	31.83	5,100	N.A.	N.A.
C-140 Jetstar	4	Garrett TFE731-3 TFs	3,700 lbs. st.	18,450	8,369	43,750	19,845	2,686	12,211	54' 5"	16.60 m.	60' 5"	18.42 m.	20' 5"	6.23 m.	542.5	50.40	N.A.	4,950	4,180
FIGHTER AIRCRAFT																				
F-4E Phantom II	2	GE. J79-GE-17A TJs	17,900 lbs. AB	30,328	13,757	61,795	28,030	1,855	8,433	38' 7.5"	11.77 m.	63' 0"	19.20 m.	16' 5.5"	5.02 m.	N.A.	N.A.	4,390	5,880	3,780
F-5E Tiger II	2	GE. J85-GE-21B TJs	5,000 lbs. AB	9,723	4,410	24,722	11,214	1,133	5,151	26' 8"	8.13 m.	47' 5"	14.45 m.	13' 4"	4.06 m.	186.0	17.30	2,850	3,650	3,900
F-8J Crusader	1	P&W. TF30-P420 TF	19,600 lbs. AB	N.A.	N.A.	34,000	15,422	N.A.	N.A.	35' 2"	10.72 m.	54' 6"	16.61 m.	15' 9"	4.8 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-14A Tomcat	2	P&W. TF30-P-414A TFs	20,900 lbs. AB	40,104	18,191	74,349	33,724	N.A.	N.A.	64' 1.5"	19.54 m.	62' 8"	19.1 m.	16' 0"	4.88 m.	565.0	52.49	2,500	N.A.	2,400
F-15E Strike Eagle	2	P&W. F100-PW-220 or 229 TFs	23,450 lbs. st.	32,500	14,742	81,000	36,741	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F-15C Eagle	2	P&W. F100-PW-100 or 220 TFs	23,450 lbs. st.	28,600	12,973	68,000	30,844	5,400	24,549	42' 10"	13.06 m.	63' 9"	19.43 m.	18' 5.5"	5.63 m.	N.A.	N.A.	N.A.	N.A.	3,500
F-16C/N Fighting Falcon	1	GE. F110-GE-100 TFs	27,600 lbs. st.	17,278	7,837	42,300	19,187	1,500	6,819	32' 10"	10.0 m.	49' 3"	15.01 m.	16' 8.5"	5.09 m.	300.0	27.87	N.A.	N.A.	N.A.
F/A-18A Hornet	2	GE. F404-GE-402 TFs	17,700 lbs. st.	26,000	12,701	56,000	25,401	2,590	11,774	37' 6"	11.43 m.	56' 0"	17.07 m.	15' 3.5"	4.66 m.	400.0	37.16	1,400	N.A.	N.A.
F-22 Lightning II	2	P&W. F119-PW-100 TFs	35,000 lbs. st.	N.A.	N.A.	60,000	27,216	N.A.	N.A.	44' 6"	13.56 m.	62' 0.5"	18.91 m.	16' 6"	5.03 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-100D Super Sabre	1	P&W. J57-P-21A TJ	17,000 lbs. st.	N.A.	N.A.	34,832	15,800	N.A.	N.A.	38' 9"	11.81 m.	49' 6"	15.09 m.	15' 0"	4.57 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-101B Voodoo	2	P&W. J57-55 TJs	14,990 lbs. st.	26,000	12,701	46,673	21,171	N.A.	N.A.	39' 8"	12.09 m.	67' 5"	20.55 m.	N.A.	N.A.	368.0	34.22	N.A.	N.A.	N.A.
F-102A Delta Dagger	1	P&W. J57-P-23 TJ	17,200 lbs. AB	19,350	8,777	31,278	14,187	N.A.	N.A.	38' 1.5"	11.62 m.	68' 4.5"	20.84 m.	21' 2.5"	6.46 m.	661.5	61.45	N.A.	N.A.	N.A.
F-104S Starfighter	1	GE. J79-GE-19 TJ	17,900 lbs. AB	N.A.	N.A.	31,000	14,061	1,286	5,846	21' 11"	6.68 m.	54' 9"	16.69 m.	13' 6"	4.11 m.	N.A.	N.A.	2,700	N.A.	2,500
F-104C Starfighter	1	GE. J79-GE-7 TJ	15,800 lbs. AB	12,760	5,788	19,470	8,831	N.A.	N.A.	21' 9"	6.63 m.	54' 6"	16.66 m.	13' 5"	4.09 m.	196.1	18.22	N.A.	N.A.	N.A.
F-105G Thunderchief	1	P&W. J75-19W TJ	24,500 lbs. AB	28,393	12,879	54,000	24,494	N.A.	N.A.	34' 11"	10.65 m.	69' 7.5"	21.21 m.	20' 2"	6.15 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-105D Thunderchief	1	P&W. J75-19W TJ	24,500 lbs. AB	27,500	12,474	52,546	23,834	N.A.	N.A.	34' 11"	10.65 m.	64' 3"	19.58 m.	19' 8"	5.99 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-106A Delta Dart	1	P&W. J75-17 TJ	24,500 lbs. AB	24,420	11,077	34,510	15,653	N.A.	N.A.	38' 3"	11.67 m.	70' 9"	21.56 m.	20' 3"	6.15 m.	661.5	61.52	N.A.	N.A.	N.A.
F-111F	2	P&W. TF30-P-111 TFs	25,100 lbs. AB	47,481	21,537	100,000	45,359	N.A.	N.A.	63' 0"	19.20 m.	73' 6"	22.40 m.	17' 1.5"	5.22 m.	N.A.	N.A.	3,000	N.A.	3,000
EF-111A Raven	2	P&W. TF30-P-109 TFs	19,600 lbs. AB	55,275	25,072	88,948	40,346	N.A.	N.A.	63' 0"	19.20 m.	76' 0"	23.16 m.	20' 0"	6.10 m.	N.A.	N.A.	N.A.	N.A.	N.A.
F-117A Stealth Fighter	2	GE. F404-GE-F1D2 TFs	10,800 lbs. st.	N.A.	N.A.	52,500	23,814	N.A.	N.A.	43' 4"	13.20 m.	65' 11"	20.09 m.	12' 5"	3.78 m.	N.A.	N.A.	N.A.	N.A.	N.A.
RECONNAISSANCE AIRCRAFT																				
TR-1/U-2R	1	GE. F101-GE-F29 TF	19,000 lbs. st.	N.A.	N.A.	40,000	18,144	1,175	5,342	103' 0"	31.39 m.	63' 0"	19.20 m.	16' 0"	4.88 m.	N.A.	N.A.	N.A.	N.A.	N.A.
ANTI-SUBMARINE WARFARE AIRCRAFT																				
S-3A Viking	2	GE. TF34-GE-400 TFs	9,275 lbs. st.	26,783	12,149	52,539	23,831	N.A.	N.A.	68' 8"	20.93 m.	53' 4"	16.26 m.	22' 9"	6.94 m.	598.0	55.56	N.A.	N.A.	N.A.
TRAINING AIRCRAFT																				
T-1A Jayhawk (Beechjet 400)	2	P&WC. JT15D-5B TFs	2,900 lbs. st.	5,200	2,359	16,100	7,303	N.A.	N.A.	43' 6"	13.25 m.	48' 5"	14.76 m.	13' 11"	4.24 m.	N.A.	N.A.	N.A.	N.A.	N.A.
T-2C Buckeye	2	GE. J85-GE-4 TJs	2,950 lbs. st.	8,115	3,681	13,179	5,978	N.A.	N.A.	36' 2"	11.62 m.	36' 4"	11.67 m.	14' 10"	4.51 m.	255.0	23.69	N.A.	N.A.	N.A.

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet

lbs. AB = pounds thrust with afterburning
lbs. st. = pounds thrust static
lbs. WI = pounds thrust with water injection

Table 4.19 (Continued)
Characteristics of Small High Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
	No.	Type		Pounds	Kilograms	Pounds	Kilograms	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
TRAINING AIRCRAFT Continued																				
T-33 Shooting Star	1	Allison J33-A-35 TJ	5,200 lbs. st.	N.A.	N.A.	14,442	6,551	N.A.	N.A.	38' 10.5"	11.85 m.	37' 9"	11.48 m.	11' 8"	3.56 m.	N.A.	N.A.	N.A.	2,560	3,480
T-37B Tweet	2	Cont. J69-T-25 TJs	1,025 lbs. st.	3,870	1,755	6,575	2,982	309	1,405	33' 9"	10.29 m.	29' 3"	8.92 m.	9' 2"	2.79 m.	N.A.	N.A.	2,050	2,750	3,400
T-38A Talon	2	GE. J85-GE-5A TJs	3,850 lbs. AB	7,410	3,361	12,093	5,485	583	2,650	25' 3"	7.7 m.	46' 10"	14.13 m.	12' 10.5"	3.92 m.	170.0	15.80	2,500	3,700	4,500
T-45A Goshawk	1	RR. F405-RR-401 TF	5,845 lbs. st.	9,399	4,263	12,758	5,787	761	3,460	30' 10"	9.39 m.	35' 9"	10.89 m.	13' 6"	4.12 m.	179.8	9.39	2,330	3,744	3,900
T-47 (Cessna Citation II)	2	TF	2,500 lbs. st.	N.A.	N.A.	13,300	6,033	742	3,373	52'	15.85 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,270	2,385	N.A.
UTILITY AIRCRAFT																				
HU-25 Guardian (Falcon 200)	2	Garrett ATF3-6-2C TFs	5,538 lbs. st.	19,000	8,618	33,510	15,200	1,585	7,206	53' 6"	16.30 m.	56' 3"	17.15 m.	17' 5"	5.32 m.	440.0	41.00	4,660	N.A.	3,710

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet

lbs. AB = pounds thrust with afterburning
lbs. st. = pounds thrust static
lbs. WI = pounds thrust with water injection

Table 4.20
Characteristics of Small Low Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilograms	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilograms	Maximum Fuel Capacity Imp. Gal.	Maximum Fuel Capacity Liters	Overall Wing Span Ft. In.	Overall Wing Span Meters	Overall Length Ft. In.	Overall Length Meters	Overall Height Ft. In.	Overall Height Meters	Wing Area Ft.**2	Wing Area M**2	Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
SMALL LOW PERFORMANCE MILITARY AIRCRAFT																				
AC-119K Flying Boxcar	2/2	P&W.R3350-89B RPs/GE.J85-17	3,700 hp/2850	44,747	20,297	77,000	34,927	N.A.	N.A.	109' 3"	33.29 m.	86' 6"	26.36 m.	26' 6"	8.08 m.	1447.0	134.43	N.A.	N.A.	N.A.
C-131 Samaritan (Convair 580)	2	TP	4,508 hp	N.A.	N.A.	63,000	28,576	2,080	9,456	106'	32.31 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3,580	5,160	2,750
C-123K Provider	2/2	P&W.R2800-99W RPs/GE.J85-17	2,500 shp/2850	35,366	16,042	60,000	27,216	N.A.	N.A.	110' 0"	33.53 m.	76' 3"	23.92 m.	N.A.	N.A.	1223.0	113.60	N.A.	N.A.	N.A.
C-2A Greyhound	2	Allison T56-A-425 TPs	4,910 shp	36,346	16,486	57,500	26,082	N.A.	N.A.	80' 7"	24.58 m.	56' 8"	17.27 m.	15' 11"	4.85 m.	700.0	65.03	N.A.	N.A.	N.A.
C-27A Spartan (G.222)	2	GE. T64-GE-P4D TPs	3,400 shp	35,500	16,103	56,878	25,799	N.A.	N.A.	94' 2"	28.70 m.	74' 5.5"	22.69 m.	34' 6"	10.57 m.	N.A.	N.A.	N.A.	N.A.	N.A.
E-2C Hawkeye	2	Allison T56-A-422 TPs	4,591 shp	37,678	17,090	51,569	23,391	N.A.	N.A.	80' 7"	24.58 m.	57' 7"	17.56 m.	18' 4"	5.59 m.	700.0	65.03	1,850	2,800	1,440
C-8 Buffalo (DHC-5)	2	GE. CT64-820-4 TPs	3,130 shp	22,864	10,371	49,000	22,226	2,108	9,583	96' 0"	29.26 m.	79' 0"	24.08 m.	28' 6"	8.73 m.	N.A.	N.A.	2,300	2,750	2,010
VC-4/TC-4 Academe (Gulfstream	2	RR. Dart Mk529-8X TPs	2,210 shp	24,575	11,147	36,000	16,329	N.A.	N.A.	78' 4"	23.87 m.	67' 11"	20.69 m.	23' 4"	7.10 m.	610.3	185.99	N.A.	N.A.	N.A.
E-9A (DHC-8M)	2	P&WC. PW120A	1,800 shp	N.A.	N.A.	33,000	14,969	N.A.	N.A.	85' 0"	25.91 m.	73' 0"	22.25 m.	24' 7"	7.49 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-7B Caribou (DHC-4)	2	P&W. R2000-7M2 RPs	1,450 hp	18,260	8,283	31,300	14,197	829	3,769	95' 7.5"	29.15 m.	72' 7"	22.12 m.	31' 9"	9.68 m.	912.0	84.73	725	1,185	1,235
HU-16B Albatross	2	Wright R-1820-76B RPs	1,425 hp	22,833	10,357	30,353	13,768	N.A.	N.A.	96' 8"	29.46 m.	62' 10"	19.15 m.	25' 10"	7.87 m.	1035.0	96.15	N.A.	N.A.	N.A.
S-2E Tracker	2	Wright R-1820-82WA RPs	1,525 hp	18,750	8,505	26,867	12,187	N.A.	N.A.	72' 7"	22.12 m.	43' 6"	13.26 m.	16' 7.5"	5.06 m.	496.0	46.08	N.A.	N.A.	N.A.
C-23A Sherpa (Shorts 330)	2	P&WC. PT6A-45R TPs	1,198 shp	N.A.	N.A.	25,600	11,612	N.A.	N.A.	74' 8"	22.76 m.	58' 0.5"	17.69 m.	16' 3"	4.95 m.	N.A.	N.A.	802	N.A.	N.A.
OV-1D Mohawk	2	Lycoming T53-L15/L701 TPs	960 shp	12,054	5,468	18,450	8,369	N.A.	N.A.	47' 11"	14.60 m.	41' 0"	12.50 m.	12' 6"	3.86 m.	360.0	33.45	N.A.	N.A.	N.A.
C-26A (SA.26/27 Metroliner III)	2	Garrett TPE331-11U-612G TPs	1,100 shp	9,494	4,306	16,500	7,484	648	2,946	57' 0"	17.37 m.	59' 4"	18.08 m.	16' 8"	5.08 m.	N.A.	N.A.	4,640	N.A.	N.A.
C-12F Huron (Beech 200 Super K	2	P&WC. PT6A-42 TPs	850 shp	N.A.	N.A.	15,000	6,804	544	2,473	54' 6"	16.61 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
OV-10D Bronco	2	Garrett T76-G-420/421 TPs	1,040 shp	8,353	3,789	14,444	6,552	N.A.	N.A.	40' 0"	12.2 m.	42' 3"	12.9 m.	15' 1"	4.60 m.	291.0	27.03	N.A.	N.A.	N.A.
OV-10A Bronco	2	Garrett T76-G-416/417 TPs	715 shp	6,893	3,127	14,444	6,552	N.A.	N.A.	40' 0"	12.2 m.	41' 7"	12.67 m.	15' 2"	4.62 m.	N.A.	N.A.	N.A.	N.A.	N.A.
C-12C Huron (Beech A200 Super	2	P&WC. PT6A-41 TPs	850 shp	7,865	3,568	12,500	5,670	544	2,473	54' 10"	16.71 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
C-12A Huron (Beech A200 Super	2	P&WC. PT6A-38 TPs	750 shp	7,865	3,568	12,500	5,670	544	2,473	54' 10"	16.71 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
UV-18B (DHC-6-300 Twin Otter)	2	P&WC. PT6A-27 TPs	652 shp	7,415	3,363	12,500	5,670	382	1,737	65' 0"	19.81 m.	51' 9"	15.77 m.	19' 6"	5.94 m.	420.0	39.02	860	1,500	1,940
RU-21J Ute (Beech A200 Super K	2	P&WC. PT6A-41 TPs	850 shp	7,530	3,416	12,950	5,874	N.A.	N.A.	54' 6"	16.61 m.	43' 9"	13.33 m.	15'	4.57 m.	303.0	28.15	1,856	2,579	2,845
U-21F Ute (Beech 100 King Air)	2	P&WC. PT6A-28 TPs	680 shp	5,300	2,404	11,500	5,216	N.A.	N.A.	45' 10.5"	13.98 m.	35' 11"	10.95 m.	15' 4"	4.67 m.	280.0	26.01	1,856	2,579	2,845
RU-21B/C/E Ute (Beech 90 King A	2	P&WC. PT6A-29 TPs	620 shp	5,300	2,404	9,650	4,377	N.A.	N.A.	45' 10.5"	13.98 m.	35' 6"	10.82 m.	14' 2"	4.32 m.	280.0	26.01	1,856	2,579	2,845
U-21A/D/G/H Ute (Beech 90 King	2	P&WC. PT6A-20 TPs	550 shp	5,300	2,404	9,650	4,377	N.A.	N.A.	45' 10.5"	13.98 m.	35' 6"	10.82 m.	14' 2"	4.32 m.	280.0	26.01	1,856	2,579	2,845
T-44A (Beech 90 King Air)	2	P&WC. PT-6A-34B TPs	650 hp	6,326	2,869	9,650	4,377	N.A.	N.A.	50' 3"	15.32 m.	35' 6"	10.82 m.	14' 3"	4.33 m.	293.9	27.30	N.A.	N.A.	N.A.
T-28D Trojan	1	Wright R-1820-56S RP	1,300 hp	6,512	2,954	8,118	3,682	N.A.	N.A.	40' 7"	12.37 m.	32' 10"	10.00 m.	12' 8"	3.86 m.	271.2	25.19	N.A.	N.A.	N.A.
U-8D/F Seminole (Beech Twin Bo	2	Lycoming O-480-1/A1A6 PPs	340 hp	4,970	2,254	7,700	3,493	264	1,200	45' 3"	13.79 m.	31' 6"	9.60 m.	11' 6"	3.51 m.	277.0	25.73	N.A.	2,050	2,450
U-1 (DHC-3 Otter)	1	P&W. R-1340-59 RP	600 hp	4,431	2,010	8,000	3,629	213	968	58' 0"	17.68 m.	41' 10"	12.75 m.	12' 7"	3.84 m.	375.0	34.84	630	1,155	880
O-2 (Cessna 337 Skymaster)	2	Cont. IO-360C PPs	210 hp	2,848	1,292	5,400	2,449	N.A.	N.A.	38' 2"	11.63 m.	29' 9"	9.07 m.	N.A.	N.A.	202.5	18.80	N.A.	1,675	1,675
T-42 Cochise (Beech 55 Baron)	2	Cont. IO-470-L PPs	260 hp	3,197	1,450	5,100	2,313	166	755	37' 10"	11.53 m.	27' 0"	8.23 m.	9' 6"	2.90 m.	275.0	25.55	1,315	2,050	2,202
U-6A/B (DHC-2 Beaver)	1	P&W. R-985-AN-1/3/39/39A RP	450 hp	3,000	1,361	5,100	2,313	138	627	48' 0"	14.63 m.	30' 4"	9.25 m.	9' 0"	2.74 m.	250.0	23.23	560	1,015	1,000
U-3B (Cessna 310)	2	Cont. O-470-D	260 hp	3,082	1,389	5,100	2,313	207	941	37' 6"	11.43 m.	29' 7"	9.02 m.	9' 11"	3.02 m.	175.0	16.26	1,335	1,700	1,790
AU-23A Peacemaker	1	AiResearch TPE331-1-101 TP	576 eshp	2,612	1,185	4,850	2,200	170	773	49' 8"	15.13 m.	35' 9"	10.90 m.	10' 6"	3.20 m.	310.0	28.80	360	771	722
V-20A Chiricahua (Pilatus PC-6 T	1	P&WC. PT6A-27 TP	680 shp	2,685	1,218	4,850	2,200	N.A.	N.A.	49' 8"	15.13 m.	35' 9"	10.90 m.	10' 6"	3.20 m.	310.0	28.80	N.A.	N.A.	N.A.
U-3A (Cessna 310)	2	Cont. O-470-M	240 hp	2,900	1,315	4,700	2,132	207	941	36'	10.97 m.	27' 1"	8.25 m.	10' 5"	3.18 m.	175.0	16.26	1,335	1,700	1,790
T-34C Mentor	1	P&WC. PT6A-25 TP	400 shp	2,940	1,334	4,300	1,950	130	591	33' 4"	10.16 m.	28' 8.5"	8.75 m.	9' 7"	2.92 m.	179.6	16.69	1,155	1,920	1,795
U-10D Courier	1	Lycoming GO-480-G1D6 PP	295 hp	2,037	924	3,920	1,778	N.A.	N.A.	39' 0"	11.89 m.	30' 9"	9.37 m.	8' 10"	2.69 m.	231.0	21.46	N.A.	N.A.	N.A.
AU-24 Stallion	1	P&W. PT6 TP	280 hp	N.A.	N.A.	3,200	1,451	100	455	35'	10.67 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	800	N.A.	N.A.
T-3A Enhanced Flight Screener	1	Lycoming AEIO-540-D4A5 PP	260 hp	1,714	777	2,500	1,134	N.A.	N.A.	34' 9"	10.59 m.	24' 10"	7.57 m.	7' 9"	2.36 m.	N.A.	N.A.	N.A.	N.A.	N.A.
O-1F Bird Dog (Cessna 305)	1	Cont. O-470-15 PP	210 hp	1,614	732	2,400	1,089	N.A.	N.A.	36' 0"	10.97 m.	27' 10"	8.48 m.	7' 4"	2.24 m.	174.0	16.17	N.A.	N.A.	N.A.
T-41C Mescalero (Cessna 172)	1	Cont. O-360-D PP	210 hp	1,285	583	2,300	1,043	68	309	35' 10"	10.92 m.	26' 11"	8.20 m.	8' 9.5"	2.68 m.	N.A.	N.A.	1,400	2,160	1,345
T-41A Mescalero (Cessna 172)	1	Cont. O-300-C PP	145 hp	1,285	583	2,300	1,043	68	309	35' 10"	10.92 m.	26' 11"	8.20 m.	8' 9.5"	2.68 m.	N.A.	N.A.	1,400	2,160	1,345

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet
TP = Turboprop
PP = Pistonprop

shp = shaft horsepower
hp = horsepower

Table 4.20 (Continued)
Characteristics of Small Low Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Imp. Gal.	Liters	Ft. In.	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
CARGO AIRCRAFT																				
C-2A Greyhound	2	Allison T56-A-425 TPs	4,910 shp	36,346	16,486	57,500	26,082	N.A.	N.A.	80' 7"	24.58 m.	56' 8"	17.27 m.	15' 11"	4.85 m.	700.0	65.03	N.A.	N.A.	N.A.
VC-4/TC-4 Academe (Gulfstream	2	RR. Dart Mk529-8X TPs	2,210 shp	24,575	11,147	36,000	16,329	N.A.	N.A.	78' 4"	23.87 m.	67' 11"	20.69 m.	23' 4"	7.10 m.	610.3	185.99	N.A.	N.A.	N.A.
C-7B Caribou (DHC-4)	2	P&W. R2000-7M2 RPs	1,450 hp	18,260	8,283	31,300	14,197	829	3,769	95' 7.5"	29.15 m.	72' 7"	22.12 m.	31' 9"	9.68 m.	912.0	84.73	725	1,185	1,235
C-8 Buffalo (DHC-5)	2	GE. CT64-820-4 TPs	3,130 shp	22,864	10,371	49,000	22,226	2,108	9,583	96' 0"	29.26 m.	79' 0"	24.08 m.	28' 8"	8.73 m.	N.A.	N.A.	2,300	2,750	2,010
C-12F Huron (Beech 200 Super K	2	P&WC. PT6A-42 TPs	850 shp	N.A.	N.A.	15,000	6,804	544	2,473	54' 6"	16.61 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
C-12C Huron (Beech A200 Super	2	P&WC. PT6A-41 TPs	850 shp	7,865	3,568	12,500	5,670	544	2,473	54' 10"	16.71 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
C-12A Huron (Beech A200 Super	2	P&WC. PT6A-38 TPs	750 shp	7,865	3,568	12,500	5,670	544	2,473	54' 10"	16.71 m.	43' 9"	13.34 m.	14' 6"	4.42 m.	303.0	28.15	2,579	N.A.	N.A.
C-23A Sherpa (Shorts 330)	2	P&WC. PT6A-45R TPs	1,198 shp	N.A.	N.A.	25,600	11,612	N.A.	N.A.	74' 8"	22.76 m.	58' 0.5"	17.69 m.	16' 3"	4.95 m.	N.A.	N.A.	802	N.A.	N.A.
C-26A (SA.26/27 Metroliner III)	2	Garrett TPE331-11U-612G TPs	1,100 shp	9,494	4,306	16,500	7,484	648	2,946	57' 0"	17.37 m.	59' 4"	18.08 m.	16' 8"	5.08 m.	N.A.	N.A.	4,840	N.A.	N.A.
C-27A Spartan (G.222)	2	GE. T64-GE-P4D TPs	3,400 shp	35,500	16,103	56,878	25,799	N.A.	N.A.	94' 2"	28.70 m.	74' 5.5"	22.69 m.	34' 8"	10.57 m.	N.A.	N.A.	N.A.	N.A.	N.A.
AC-119K Flying Boxcar	2/2	P&W.R3350-89B RPs/GE.J85-17	3,700 hp/2850	44,747	20,297	77,000	34,927	N.A.	N.A.	109' 3"	33.29 m.	86' 6"	26.36 m.	26' 6"	8.08 m.	1447.0	134.43	N.A.	N.A.	N.A.
C-123K Provider	2/2	P&W.R2800-99W RPs/GE.J85-17	2,500 shp/2850	35,366	16,042	60,000	27,216	N.A.	N.A.	110' 0"	33.53 m.	78' 3"	23.92 m.	N.A.	N.A.	1223.0	113.60	N.A.	N.A.	N.A.
C-131 Samaritan (Convair 580)	2	TP	4,508 hp	N.A.	N.A.	63,000	28,576	2,080	9,456	106'	32.31 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3,580	5,160	2,750
ELECTRONIC WARFARE AIRCRAFT																				
E-2C Hawkeye	2	Allison T56-A-422 TPs	4,591 shp	37,678	17,090	51,569	23,391	N.A.	N.A.	80' 7"	24.58 m.	57' 7"	17.56 m.	18' 4"	5.59 m.	700.0	65.03	1,850	2,600	1,440
E-9A (DHC-8M)	2	P&WC. PW120A	1,800 shp	N.A.	N.A.	33,000	14,969	N.A.	N.A.	85' 0"	25.91 m.	73' 0"	22.25 m.	24' 7"	7.49 m.	N.A.	N.A.	N.A.	N.A.	N.A.
OBSERVATION AIRCRAFT																				
O-1F Bird Dog (Cessna 305)	1	Cont. O-470-15 PP	210 hp	1,614	732	2,400	1,089	N.A.	N.A.	36' 0"	10.97 m.	27' 10"	8.48 m.	7' 4"	2.24 m.	174.0	16.17	N.A.	N.A.	N.A.
OV-1D Mohawk	2	Lycoming T53-L15/L701 TPs	960 shp	12,054	5,468	18,450	8,369	N.A.	N.A.	47' 11"	14.60 m.	41' 0"	12.50 m.	12' 8"	3.86 m.	360.0	33.45	N.A.	N.A.	N.A.
O-2 (Cessna 337 Skymaster)	2	Cont. IO-360C PPs	210 hp	2,848	1,292	5,400	2,449	N.A.	N.A.	38' 2"	11.63 m.	29' 9"	9.07 m.	N.A.	N.A.	202.5	18.80	N.A.	1,675	1,675
OV-10D Bronco	2	Garrett T76-G-420/421 TPs	1,040 shp	8,353	3,789	14,444	6,552	N.A.	N.A.	40' 0"	12.2 m.	42' 3"	12.9 m.	15' 1"	4.60 m.	291.0	27.03	N.A.	N.A.	N.A.
OV-10A Bronco	2	Garrett T76-G-416/417 TPs	715 shp	6,893	3,127	14,444	6,552	N.A.	N.A.	40' 0"	12.2 m.	41' 7"	12.67 m.	15' 2"	4.62 m.	N.A.	N.A.	N.A.	N.A.	N.A.
ANTI-SUBMARINE WARFARE AIRCRAFT																				
S-2E Tracker	2	Wright R-1820-82WA RPs	1,525 hp	18,750	8,505	26,867	12,187	N.A.	N.A.	72' 7"	22.12 m.	43' 6"	13.26 m.	16' 7.5"	5.06 m.	496.0	46.08	N.A.	N.A.	N.A.
TRAINING AIRCRAFT																				
T-3A Enhanced Flight Screener	1	Lycoming AEIO-540-D4A5 PP	260 hp	1,714	777	2,500	1,134	N.A.	N.A.	34' 9"	10.59 m.	24' 10"	7.57 m.	7' 9"	2.36 m.	N.A.	N.A.	N.A.	N.A.	N.A.
T-28D Trojan	1	Wright R-1820-56S RP	1,300 hp	6,512	2,954	8,118	3,682	N.A.	N.A.	40' 7"	12.37 m.	32' 10"	10.00 m.	12' 8"	3.86 m.	271.2	25.19	N.A.	N.A.	N.A.
T-34C Mentor	1	P&WC. PT6A-25 TP	400 shp	2,940	1,334	4,300	1,950	130	591	33' 4"	10.16 m.	28' 8.5"	8.75 m.	9' 7"	2.92 m.	179.6	16.69	1,155	1,920	1,795
T-41C Mescalero (Cessna 172)	1	Cont. O-360-D PP	210 hp	1,285	583	2,300	1,043	68	309	35' 10"	10.92 m.	26' 11"	8.20 m.	8' 9.5"	2.68 m.	N.A.	N.A.	1,400	2,160	1,345
T-41A Mescalero (Cessna 172)	1	Cont. O-300-C PP	145 hp	1,285	583	2,300	1,043	68	309	35' 10"	10.92 m.	26' 11"	8.20 m.	8' 9.5"	2.68 m.	N.A.	N.A.	1,400	2,160	1,345
T-42 Cochise (Beech 55 Baron)	2	Cont. IO-470-L PPs	260 hp	3,197	1,450	5,100	2,313	166	755	37' 10"	11.53 m.	27' 0"	8.23 m.	9' 6"	2.90 m.	275.0	25.55	1,315	2,050	2,202
T-44A (Beech 90 King Air)	2	P&WC. PT-6A-34B TPs	650 hp	6,326	2,869	9,650	4,377	N.A.	N.A.	50' 3"	15.32 m.	35' 6"	10.82 m.	14' 3"	4.33 m.	293.9	27.30	N.A.	N.A.	N.A.
UTILITY AIRCRAFT																				
U-1 (DHC-3 Otter)	1	P&W. R-1340-59 RP	600 hp	4,431	2,010	8,000	3,629	213	968	58' 0"	17.68 m.	41' 10"	12.75 m.	12' 7"	3.84 m.	375.0	34.84	630	1,155	880
U-3B (Cessna 310)	2	Cont. O-470-D	260 hp	3,062	1,389	5,100	2,313	207	941	37' 6"	11.43 m.	29' 7"	9.02 m.	9' 11"	3.02 m.	175.0	16.26	1,335	1,700	1,790
U-3A (Cessna 310)	2	Cont. O-470-M	240 hp	2,900	1,315	4,700	2,132	207	941	36'	10.97 m.	27' 1"	8.25 m.	10' 5"	3.18 m.	175.0	16.26	1,335	1,700	1,790
U-6A/B (DHC-2 Beaver)	1	P&W. R-985-AN-1/3/39/39A RP	450 hp	3,000	1,361	5,100	2,313	138	627	48' 0"	14.63 m.	30' 4"	9.25 m.	9' 0"	2.74 m.	250.0	23.23	560	1,015	1,000
U-8D/F Seminole (Beech Twin Bo	2	Lycoming O-480-1/A1A6 PPs	340 hp	4,970	2,254	7,700	3,493	264	1,200	45' 3"	13.79 m.	31' 6"	9.60 m.	11' 6"	3.51 m.	277.0	25.73	N.A.	2,050	2,450
U-10D Courier	1	Lycoming GO-480-G1D6 PP	295 hp	2,037	924	3,920	1,778	N.A.	N.A.	39' 0"	11.89 m.	30' 9"	9.37 m.	8' 10"	2.69 m.	231.0	21.46	N.A.	N.A.	N.A.
HU-16B Albatross	2	Wright R-1820-76B RPs	1,425 hp	22,833	10,357	30,353	13,768	N.A.	N.A.	96' 8"	29.46 m.	62' 10"	19.15 m.	25' 10"	7.87 m.	1035.0	96.15	N.A.	N.A.	N.A.
UV-18B (DHC-6-300 Twin Otter)	2	P&WC. PT6A-27 TPs	652 ehp	7,415	3,363	12,500	5,670	382	1,737	65' 0"	19.81 m.	51' 9"	15.77 m.	19' 6"	5.94 m.	420.0	39.02	660	1,500	1,940
V-20A Chiricahua (Pilatus PC-6 T	1	P&WC. PT6A-27 TP	680 shp	2,685	1,218	4,850	2,200	N.A.	N.A.	49' 8"	15.13 m.	35' 9"	10.90 m.	10' 6"	3.20 m.	310.0	28.80	N.A.	N.A.	N.A.
RU-21J Ute (Beech A200 Super K	2	P&WC. PT6A-41 TPs	850 shp	7,530	3,416	12,950	5,874	N.A.	N.A.	54' 6"	16.61 m.	43' 9"	13.33 m.	15'	4.57 m.	303.0	28.15	1,856	2,579	2,845

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet
TP = Turboprop
PP = Pistonprop

shp = shaft horsepower
hp = horsepower

Table 4.20 (Continued)
Characteristics of Small Low Performance Military Aviation Aircraft
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s)		Nominal Power Rating (each)	Operating Empty Weight		Maximum Takeoff Weight		Maximum Fuel Capacity		Overall Wing Span		Overall Length		Overall Height		Wing Area		Takeoff Dist. (ft.)	Takeoff Dist. (ft.) 50'	Landing Dist. (ft.) 50'
	No.	Type		Pounds	Kilogram	Pounds	Kilogram	Imp. Gal.	Liters	Ft. In	Meters	Ft. In.	Meters	Ft. In.	Meters	Ft.**2	M**2			
UTILITY AIRCRAFT Continued																				
U-21F Ute (Beech 100 King Air)	2	P&WC. PT6A-28 TPs	680 shp	5,300	2,404	11,500	5,216	N.A.	N.A.	45' 10.5"	13.98 m.	35' 11"	10.95 m.	15' 4"	4.67 m.	280.0	26.01	1,856	2,579	2,845
RU-21B/C/E Ute (Beech 90 King A	2	P&WC. PT6A-29 TPs	620 shp	5,300	2,404	9,850	4,377	N.A.	N.A.	45' 10.5"	13.98 m.	35' 6"	10.82 m.	14' 2"	4.32 m.	280.0	26.01	1,856	2,579	2,845
U-21A/D/G/H Ute (Beech 90 King	2	P&WC. PT6A-20 TPs	550 shp	5,300	2,404	9,850	4,377	N.A.	N.A.	45' 10.5"	13.98 m.	35' 6"	10.82 m.	14' 2"	4.32 m.	280.0	26.01	1,856	2,579	2,845
AU-23A Peacemaker	1	AiResearch TPE331-1-101 TP	576 eshp	2,612	1,185	4,850	2,200	170	773	49' 8"	15.13 m.	35' 9"	10.90 m.	10' 6"	3.20 m.	310.0	28.80	360	771	722
AU-24 Stallion	1	P&W. PT6 TP	280 hp	N.A.	N.A.	3,200	1,451	100	455	35'	10.67 m.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	800	N.A.	N.A.

N.A. = Information not available when table prepared.

TF = Turbofan
TJ = Turbojet
TP = Turboprop
PP = Pistonprop

shp = shaft horsepower
hp = horsepower

Table 4.21
Characteristics of Military Helicopters
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilograms	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilograms	Maximum Fuel Capacity Imp. Gal	Maximum Fuel Capacity Liters	Rotor Diameter Ft. In.	Rotor Diameter Meters	Fuselage Overall Length Ft. In.	Fuselage Overall Length Meters	Overall Height Ft. In.	Overall Height Meters	Number Rotor(s)	Number Rotor Blades
MILITARY HELICOPTER																	
CH-53E Super Stallion	3	GE. T64-GE-416 TSs	4,380 shp	33,228	15,072	73,500	33,339	N.A.	N.A.	79' 0"	24.08 m.	73' 4"	22.33 m.	29' 5"	8.97 m.	1	7
MV-22 Osprey	2	Allison T406-AD-400 TSs	6,150 shp	N.A.	N.A.	59,000	26,762	N.A.	N.A.	36' 0"	10.98 m.	56' 10"	17.33 m.	17' 4"	5.28 m.	2	3
MH-53J Pave Low	2	GE. T64-GE-7A TSs	4,325 shp	N.A.	N.A.	50,000	22,680	1,300	5,910	72' 3"	22.02 m.	67' 2"	20.47 m.	24' 11"	7.59 m.	1	7
CH-54B Tarhe (S-64)	2	P&W. T73-700 TSs	4,800 shp	19,234	8,724	47,000	21,319	630	2,864	72' 0"	21.95 m.	N.A.	N.A.	18' 7"	5.67 m.	1	6
CH-47C/MH-47 Chinook	2	Lycoming T55-L-11A TSs	3,570 shp	20,616	9,351	46,000	20,865	1,042	4,737	60' 0"	18.29 m.	51' 0"	15.54 m.	18' 7"	5.67 m.	2	3
CH-53D Sea Stallion	2	GE. T64-GE-413 TSs	3,925 shp	23,628	10,717	42,000	19,051	N.A.	N.A.	72' 3"	22.04 m.	67' 2"	20.48 m.	24' 11"	7.59 m.	1	6
H-37A Mojave (S-56)	2	P&W. R-2800-50/54 RPSs	1,900 hp	20,831	9,449	31,000	14,061	N.A.	N.A.	72' 0"	21.95 m.	64' 3"	19.58 m.	22' 0"	6.71 m.	1	5
CH-46E Sea Knight	2	GE. T58-GE-16 TSs	1,870 shp	15,198	6,894	24,300	11,022	N.A.	N.A.	25' 6"	7.81 m.	46' 8"	13.92 m.	16' 8"	5.08 m.	2	3
MH/HH-60G Pave Hawk	2	GE. T700-GE-700/701C TSs	1,560 shp	10,624	4,819	22,500	10,206	820	3,728	53' 8"	16.36 m.	50' 1"	15.26 m.	16' 10"	5.13 m.	1	4
CH-3E/HH-3E Jolly Green Giant	2	GE. T58-GE-5 TSs	1,500 shp	13,255	6,012	22,050	10,002	1,209	5,496	62' 0"	18.9 m.	57' 3"	17.45 m.	18' 1"	5.51 m.	1	5
HH-3F Pelican	2	GE. T58-GE-5 TSs	1,500 shp	N.A.	N.A.	22,050	10,002	N.A.	N.A.	62' 0"	18.9 m.	57' 3"	17.45 m.	18' 1"	5.51 m.	1	5
SH-60B Seahawk	2	GE. T700-GE-401C TSs	1,900 shp	13,648	6,191	21,000	9,525	N.A.	N.A.	53' 8"	16.36 m.	50' 1"	15.26 m.	17' 2"	5.23 m.	1	4
AH-64 Apache	2	GE. T700-GE-700 TSs	1,800 shp	10,268	4,657	21,000	9,525	376	1,709	48' 0"	14.63 m.	49' 5"	15.06 m.	12' 7"	3.83 m.	1	4
SH-3H Sea King (S-61)	2	GE. T58-GE-10 TSs	1,400 shp	13,465	6,108	21,000	9,525	N.A.	N.A.	62' 0"	18.9 m.	54' 9"	16.69 m.	16' 10"	5.13 m.	1	5
VH-60N Seahawk	2	GE. T700-GE-700 TSs	1,560 shp	11,284	5,118	16,994	7,708	N.A.	N.A.	53' 8"	16.36 m.	50' 1"	15.26 m.	16' 10"	5.13 m.	1	4
H-21 Shawnee	1	Wright R-1820-103 RPS	1,425 hp	8,800	3,992	15,000	6,804	N.A.	N.A.	44' 0"	13.41 m.	52' 6"	16.0 m.	15' 5"	4.7 m.	2	3
AH-1W Sea Cobra	2	GE. T700-GE-401 TSs	1,690 shp	10,200	4,627	14,750	6,690	N.A.	N.A.	48' 0"	14.63 m.	45' 6"	13.87 m.	14' 2"	4.32 m.	1	2
AH-1T Cobra	2	P&WC. T400-WV-402	1,025 shp	8,608	3,905	14,000	6,350	N.A.	N.A.	48' 0"	14.63 m.	48' 2"	14.68 m.	13' 6"	4.12 m.	1	2
CH-34C Choctaw (S-58)	1	P&W. R-1820-84 RPS	1,525 hp	7,750	3,515	14,000	6,350	N.A.	N.A.	56' 0"	17.07 m.	46' 9"	14.25 m.	14' 3.5"	4.36 m.	1	4
SH-2F Seasprite	2	GE. T58-GE-8F TSs	1,350 shp	6,652	3,017	13,500	6,123	N.A.	N.A.	44' 0"	13.42 m.	38' 4"	11.69 m.	15' 6"	4.73 m.	1	4
UH-1N Iroquois	2	P&WC. T400-CP-400 TSs	1,290 shp	5,549	2,517	11,200	5,080	410	1,864	48' 2"	14.7 m.	42' 5"	12.93 m.	14' 5"	4.39 m.	1	2
AH-1S Cobra	1	Lycoming T53-703 TS	1,800 shp	6,479	2,939	10,000	4,536	N.A.	N.A.	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
AH-1J Cobra	2	P&WC. T400 TSs	900 shp	7,261	3,294	10,000	4,536	N.A.	N.A.	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
AH-1G Cobra	1	Lycoming T53-13 TS	1,400 shp	6,073	2,755	9,500	4,309	259	1,177	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
HH-1H Iroquois	1	Lycoming T53-L-13B TS	1,400 shp	N.A.	N.A.	9,500	4,309	330	1,500	48' 4"	14.73 m.	42' 0"	12.80 m.	13' 0"	3.96 m.	1	2
HH-65A Dolphin	2	Allison/Garrett LHTEC T800-800 T	1,200 shp	5,922	2,686	8,928	4,050	N.A.	N.A.	39' 2"	11.9 m.	37' 6"	11.43 m.	12' 9"	3.89 m.	1	4
HH-43F Huskie	1	Lycoming T53-L-11A TS	825 shp	4,469	2,027	8,800	3,992	N.A.	N.A.	47' 0"	14.33 m.	25' 2"	7.67 m.	15' 6.5"	4.74 m.	2	2
H-19D Chickasaw	1	Wright R-1300-3 RPS	700 hp	5,250	2,381	6,800	3,084	N.A.	N.A.	49' 0"	14.94 m.	42' 3"	12.88 m.	13' 4"	4.06 m.	1	3
H-25 Army Mule	1	Cont. R-975-42/48A RPS	550 hp	3,928	1,782	6,100	2,767	N.A.	N.A.	35' 0"	10.67 m.	31' 10"	9.7 m.	13' 2"	4.01 m.	2	3
H-5A (S-51)	1	P&W. R-985-4B RPS	450 hp	3,770	1,710	5,000	2,268	N.A.	N.A.	48' 0"	14.6 m.	40' 11"	12.47 m.	12' 11"	3.94 m.	1	3
AH-6/MH-6 Defender	1	Allison T250-C20B TS	420 shp	N.A.	N.A.	3,850	1,746	62	282	26' 4"	8.02 m.	23' 0"	7.0 m.	8' 1.5"	2.47 m.	1	3
OH-58/UH-58 Kiowa	1	Allison T63-720 (C20B) TS	650 shp	1,464	664	3,200	1,451	112	509	35' 4"	10.77 m.	N.A.	N.A.	9' 6.5"	2.91 m.	1	2
TH-57 Sea Ranger	1	Allison T63-A-700 TS	317 shp	1,464	664	3,000	1,361	N.A.	N.A.	35' 4"	10.78 m.	32' 7"	9.94 m.	9' 7"	2.91 m.	1	2
H-13 Sioux (Bell 47)	1	Lycoming TVO-435 PS	270 hp	1,819	825	2,950	1,338	N.A.	N.A.	37' 1.5"	11.32 m.	N.A.	N.A.	9' 3.5"	2.83 m.	1	2
OH-6B Cayuse	1	Allison T63-A-5A TS	317 shp	1,229	557	2,700	1,225	N.A.	N.A.	26' 4"	8.02 m.	23' 0"	7.0 m.	8' 1.5"	2.47 m.	1	3
H-23D Raven	1	Lycoming O-540-23B PS	250 hp	1,816	824	2,700	1,225	N.A.	N.A.	35' 0"	10.67 m.	27' 9.5"	8.46 m.	9' 9.5"	2.98 m.	1	2
TH-55A Osage	1	Lycoming HIO-360-B1A PS	180 hp	1,008	457	1,850	839	49	223	25' 3.5"	7.71 m.	N.A.	N.A.	8' 3"	2.50 m.	1	3

N.A. = Information not available when table prepared.

TS = Turboshaft
PS = Pistonshaft
RPS = Radial Pistonshaft

shp = shaft horsepower
hp = horsepower

Table 4.21 (Continued)
Characteristics of Military Helicopters
References 4.10 to 4.18

Military Aircraft Designation (Commercial Type)	Powerplant(s) No.	Powerplant(s) Type	Nominal Power Rating (each)	Operating Empty Weight Pounds	Operating Empty Weight Kilograms	Maximum Takeoff Weight Pounds	Maximum Takeoff Weight Kilograms	Maximum Fuel Capacity Imp. Gal.	Maximum Fuel Capacity Liters	Rotor Diameter Ft. In.	Rotor Diameter Meters	Fuselage Overall Length Ft. In.	Fuselage Overall Length Meters	Overall Height Ft. In.	Overall Height Meters	Number Rotor(s)	Number Rotor Blades
MILITARY HELICOPTER																	
AH-1W Sea Cobra	2	GE. T700-GE-401 TSs	1,690 shp	10,200	4,627	14,750	6,690	N.A.	N.A.	48' 0"	14.63 m.	45' 6"	13.87 m.	14' 2"	4.32 m.	1	2
AH-1T Cobra	2	P&WC. T400-WV-402	1,025 shp	8,606	3,905	14,000	6,350	N.A.	N.A.	48' 0"	14.63 m.	48' 2"	14.66 m.	13' 6"	4.12 m.	1	2
AH-1S Cobra	1	Lycoming T53-703 TS	1,800 shp	6,479	2,939	10,000	4,536	N.A.	N.A.	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
AH-1J Cobra	2	P&WC. T400 TSs	900 shp	7,261	3,294	10,000	4,536	N.A.	N.A.	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
AH-1G Cobra	1	Lycoming T53-13 TS	1,400 shp	6,073	2,755	9,500	4,309	259	1,177	44' 0"	13.41 m.	44' 7"	13.59 m.	13' 6"	4.12 m.	1	2
UH-1N Iroquois	2	P&WC. T400-CP-400 TSs	1,290 shp	5,549	2,517	11,200	5,080	410	1,864	48' 2"	14.7 m.	42' 5"	12.93 m.	14' 5"	4.39 m.	1	2
HH-1H Iroquois	1	Lycoming T53-L-13B TS	1,400 shp	N.A.	N.A.	9,500	4,309	330	1,500	48' 4"	14.73 m.	42' 0"	12.80 m.	13' 0"	3.96 m.	1	2
SH-2F Seasprite	2	GE. T58-GE-8F TSs	1,350 shp	6,652	3,017	13,500	6,123	N.A.	N.A.	44' 0"	13.42 m.	38' 4"	11.69 m.	15' 6"	4.73 m.	1	4
SH-3H Sea King (S-61)	2	GE. T58-GE-10 TSs	1,400 shp	13,465	6,108	21,000	9,525	N.A.	N.A.	62' 0"	18.9 m.	54' 9"	16.69 m.	16' 10"	5.13 m.	1	5
HH-3F Pelican	2	GE. T58-GE-5 TSs	1,500 shp	N.A.	N.A.	22,050	10,002	N.A.	N.A.	62' 0"	18.9 m.	57' 3"	17.45 m.	18' 1"	5.51 m.	1	5
CH-3E/HH-3E Jolly Green Giant	2	GE. T58-GE-5 TSs	1,500 shp	13,255	6,012	22,050	10,002	1,209	5,496	62' 0"	18.9 m.	57' 3"	17.45 m.	18' 1"	5.51 m.	1	5
H-5A (S-51)	1	P&W. R-985-4B RPS	450 hp	3,770	1,710	5,000	2,268	N.A.	N.A.	48' 0"	14.6 m.	40' 11"	12.47 m.	12' 11"	3.94 m.	1	3
AH-6/MH-6 Defender	1	Allison T250-C20B TS	420 shp	N.A.	N.A.	3,850	1,746	62	282	26' 4"	8.02 m.	23' 0"	7.0 m.	8' 1.5"	2.47 m.	1	3
OH-6B Cayuse	1	Allison T63-A-5A TS	317 shp	1,229	557	2,700	1,225	N.A.	N.A.	26' 4"	8.02 m.	23' 0"	7.0 m.	8' 1.5"	2.47 m.	1	3
H-13 Sioux (Bell 47)	1	Lycoming TVO-435 PS	270 hp	1,819	825	2,950	1,338	N.A.	N.A.	37' 1.5"	11.32 m.	N.A.	N.A.	9' 3.5"	2.83 m.	1	2
H-19D Chickasaw	1	Wright R-1300-3 RPS	700 hp	5,250	2,381	6,800	3,084	N.A.	N.A.	49' 0"	14.94 m.	42' 3"	12.88 m.	13' 4"	4.06 m.	1	3
H-21 Shawnee	1	Wright R-1820-103 RPS	1,425 hp	8,800	3,992	15,000	6,804	N.A.	N.A.	44' 0"	13.41 m.	52' 6"	16.0 m.	15' 5"	4.7 m.	2	3
H-23D Raven	1	Lycoming O-540-23B PS	250 hp	1,816	824	2,700	1,225	N.A.	N.A.	35' 0"	10.67 m.	27' 9.5"	8.46 m.	9' 9.5"	2.98 m.	1	2
H-25 Army Mule	1	Cont. R-975-42/46A RPS	550 hp	3,928	1,782	6,100	2,767	N.A.	N.A.	35' 0"	10.67 m.	31' 10"	9.7 m.	13' 2"	4.01 m.	2	3
CH-34C Choctaw (S-58)	1	P&W. R-1820-84 RPS	1,525 hp	7,750	3,515	14,000	6,350	N.A.	N.A.	56' 0"	17.07 m.	46' 9"	14.25 m.	14' 3.5"	4.36 m.	1	4
H-37A Mojave (S-56)	2	P&W. R-2800-50/54 RPSs	1,900 hp	20,831	9,449	31,000	14,061	N.A.	N.A.	72' 0"	21.95 m.	64' 3"	19.58 m.	22' 0"	6.71 m.	1	5
HH-43F Huskie	1	Lycoming T53-L-11A TS	825 shp	4,469	2,027	8,800	3,992	N.A.	N.A.	47' 0"	14.33 m.	25' 2"	7.67 m.	15' 6.5"	4.74 m.	2	2
CH-46E Sea Knight	2	GE. T58-GE-16 TSs	1,870 shp	15,196	6,894	24,300	11,022	N.A.	N.A.	25' 6"	7.81 m.	46' 8"	13.92 m.	16' 8"	5.08 m.	2	3
CH-47C/MH-47 Chinook	2	Lycoming T55-L-11A TSs	3,570 shp	20,616	9,351	46,000	20,865	1,042	4,737	60' 0"	18.29 m.	51' 0"	15.54 m.	18' 7"	5.67 m.	2	3
MH-53J Pave Low	2	GE. T64-GE-7A TSs	4,325 shp	N.A.	N.A.	50,000	22,680	1,300	5,910	72' 3"	22.02 m.	67' 2"	20.47 m.	24' 11"	7.59 m.	1	7
CH-53E Super Stallion	3	GE. T64-GE-416 TSs	4,380 shp	33,226	15,072	73,500	33,339	N.A.	N.A.	79' 0"	24.08 m.	73' 4"	22.33 m.	29' 5"	8.97 m.	1	7
CH-53D Sea Stallion	2	GE. T64-GE-413 TSs	3,925 shp	23,628	10,717	42,000	19,051	N.A.	N.A.	72' 3"	22.04 m.	67' 2"	20.46 m.	24' 11"	7.59 m.	1	6
CH-54B Tarhe (S-64)	2	P&W. T73-700 TSs	4,800 shp	19,234	8,724	47,000	21,319	630	2,864	72' 0"	21.95 m.	N.A.	N.A.	18' 7"	5.67 m.	1	6
TH-55A Osage	1	Lycoming HIO-360-B1A PS	180 hp	1,008	457	1,850	839	49	223	25' 3.5"	7.71 m.	N.A.	N.A.	8' 3"	2.50 m.	1	3
TH-57 Sea Ranger	1	Allison T63-A-700 TS	317 shp	1,464	664	3,000	1,361	N.A.	N.A.	35' 4"	10.76 m.	32' 7"	9.94 m.	9' 7"	2.91 m.	1	2
OH-58/UH-58 Kiowa	1	Allison T63-720 (C20B) TS	650 shp	1,464	664	3,200	1,451	112	509	35' 4"	10.77 m.	N.A.	N.A.	9' 6.5"	2.91 m.	1	2
VH-60N Seahawk	2	GE. T700-GE-700 TSs	1,560 shp	11,284	5,118	16,994	7,708	N.A.	N.A.	53' 8"	16.36 m.	50' 1"	15.26 m.	16' 10"	5.13 m.	1	4
MH/HH-60G Pave Hawk	2	GE. T700-GE-700/701C TSs	1,560 shp	10,624	4,819	22,500	10,206	820	3,728	53' 8"	16.36 m.	50' 1"	15.26 m.	16' 10"	5.13 m.	1	4
SH-60B Seahawk	2	GE. T700-GE-401C TSs	1,900 shp	13,648	6,191	21,000	9,525	N.A.	N.A.	53' 8"	16.36 m.	50' 1"	15.26 m.	17' 2"	5.23 m.	1	4
AH-64 Apache	2	GE. T700-GE-700 TSs	1,800 shp	10,268	4,657	21,000	9,525	376	1,709	48' 0"	14.63 m.	49' 5"	15.06 m.	12' 7"	3.83 m.	1	4
HH-65A Dolphin	2	Allison/Garrett LHTEC T800-800 T	1,200 shp	5,922	2,686	8,928	4,050	N.A.	N.A.	39' 2"	11.9 m.	37' 6"	11.43 m.	12' 9"	3.89 m.	1	4
MV-22 Osprey	2	Allison T406-AD-400 TSs	6,150 shp	N.A.	N.A.	59,000	26,762	N.A.	N.A.	36' 0"	10.98 m.	56' 10"	17.33 m.	17' 4"	5.28 m.	2	3

N.A. = Information not available when table prepared.

TS = Turboshaft
PS = Pistonshaft
RPS = Radial Pistonshaft

shp = shaft horsepower
hp = horsepower

4.5 MILITARY AVIATION REFERENCES

[4.1] DOE Standard Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE-STD-3014-96, U.S. Department of Energy, Washington, DC, July 1996.

[4.2] Defense Nuclear Agency, W78/W87 Minuteman III Weapon System Safety Assessment, Draft Report, Logicon RDA, Alexandria, VA., July, 1994.

[4.3] Class A/B Mishaps, 1979 to Date, Memo from J.J.Clark, Jr. Chief, Report Division, HQ AFSA/IMR, to Y.T.Lin, SNL, August 2, 1994.

[4.4] Bomber/Cargo/F/A/Trainer Class A/B Mishaps, 1979 to Date, Memo from J.J. Clark, Jr. Chief, Report Division, HQ AFSA/IMR, to Y.T. Lin, SNL, August 2, 1994.

[4.5] Flying Hours by FY/MDS, 1979 to Date, Memo from J.J. Clark, Jr. Chief, Report Division, HQ AFSA/IMR, to Y.T. Lin, SNL, August 2, 1994.

[4.6] Data Development and Analysis Task for Aircraft Crash Risk Analysis Methodology, Memo from Y.T. Lin, SNL/12333, MS-0491 to Kamiar Jamali, DOE/HQ/DP-31, March 18, 1995.

[4.7] Memo, First Order Estimate of Times and Airspeeds Associated with Cruise Phases for Fighter, Attack, Trainer and Bomber Aircraft, Logicon RDA, February, 10, 1995.

[4.8] Multivariate Density Estimation, Theory, Practice, and Visualization, David W. Scott, John Wiley & Sons, Inc., New York, NY, 1992.

[4.9] Best Fit, Distribution Fitting Software for Windows, Release 1.0, Palisade Corporation, Newfield, N.Y., June, 1993.

[4.10] Jane's All the World's Aircrafts, various editions.

[4.11] Federal Aviation Administration Air Traffic Control Manual, Appendix A, Aircraft Information, 7110.65H, Federal Aviation Administration

[4.12] USAF Almanac, Air Force Magazine, various issues.

[4.13] The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet, various editions, Norman Polmar, Naval Institute Press, Annapolis, MD.

[4.14] An Illustrated Guide to USAF, Bill Gunston, Arco Publishing, Inc., New York, NY, 1982.

[4.15] An Illustrated Guide to Military Helicopters, Bill Gunston, Arco Publishing, Inc., New York, NY, 1981.

[4.16] The Illustrated Encyclopedia of Modern Warplanes, Doug Richardson, Crescent Books, New York, NY, 1982.

[4.17] U.S. Army Aircraft Since 1947, Stephen Harding, Specialty Press, Stillwater, MN, 1990.

[4.18] Vietnam, the War in the Air, Rene' J. Francillon, Arch Cape Press, New York, NY, 1987.

5. AIRCRAFT OPERATIONS

5.1 INTRODUCTION

The determination of the number of aircraft operations near the facility under consideration in the aircraft crash frequency analysis is usually the foremost piece of information needed to perform this analysis. This determination of aircraft operations may be quite complicated depending on the particular location of the facility and the type and scale of aircraft operations that may take place nearby

The term Aircraft Operation, as defined by the Federal Aviation Administration (FAA), is the number of arrivals and departures from the airport at which an airport traffic control tower is located. For the ACRAM Standard [Ref. 5.1], the term Aircraft Operations will be used in a broader sense. Aircraft Operations will refer to the operation of any powered aircraft in any airspace. Aircraft Operations which occur in the Near Airport Environment will be referred to as Airport Operations. Aircraft Operations which occur in the Nonairport Environment, i.e. the Enroute/In-Flight and the TRACON Environments will simply be referred to as Aircraft Operations.

Before describing Aircraft Operations further, it may be useful at this point to describe how an aircraft is guided by the various air traffic facilities to ensure that aircraft are safely separated from each other and are guided safely to their destinations. As an aircraft takes off from an airport, they are initially given directions by the Airport Traffic Control Tower (ATCT). As the aircraft climbs, it is guided by the TRACON or Terminal Radar Control. As the aircraft climbs to its assigned cruising altitude, the Air Route Traffic Control Center or ARTCC guides the aircraft towards its destination. As the aircraft approaches its destination, it begins its descent. As it leaves 11,000 feet Mean Sea Level, and approximately 35 miles from its destination airport, the aircraft is handed over for guidance from the ARTCC to the TRACON. At about 5 to 20 miles, the aircraft is handed over for guidance from the TRACON to the Airport Traffic Control Tower. This narrative has described a typical flight by an Air Carrier or Air Taxi. Not all aircraft go through this process for every flight. Most General Aviation flights never enter the airspace controlled by an ARTCC because they fly below their airspace responsibility. Many Military Aviation flights remain under the control of military air traffic control facilities for most if not all of their flight. However, near busy airports, all forms of aviation, Commercial, General and Military do come under the guidance of a TRACON and/or the Airport Traffic Control Tower

This chapter is an attempt to provide some general guidance on the determination of aircraft operations near a facility. It should be noted that in many parts of the United States, unique situations may have developed in the air traffic flow patterns and thus, what is generally true in one part of the U.S., may not be applicable to other parts of the U.S.

Table 5-1 shows the results of a survey performed on 15 of the major Department of Energy (DOE) sites, airports near the site, and air traffic control facilities which provide guidance to air traffic near the site. Below each DOE site name in the first column of Table 5-1 is the name of the sectional map where the airport information was found. The second through fourth columns of Table 5-1 provides the name of the nearby airport(s), whether it has a control tower, and its longest runway in hundreds of feet. After each airport name is the three character designation for that airport. If an airport lacks the three character designation, it is considered a private airport. For larger airports, the class of airspace around that airport is given directly below its name, i.e. Class B, Class.C. Further discussion on airspaces around airports is provided in Section 5.2. The fifth column of Table 5-1 gives the air traffic control facility which provides terminal approach and departure control. Note that TRACONs, or Airport Traffic Control Towers could provide this service. This is discussed further in Section 5.4. Finally, the last column of Table 5-1 gives the air traffic control facility which provides Class A overflight control. This is always an ARTCC. More discussion on this service is given in Section 5.3. Table 5.1 is not intended to be an exhaustive or a conclusive list of Airports near DOE sites which should be considered in an aircraft crash frequency analysis. There may be Airports known locally which are not listed in Table 5.1. Some of the Airports listed in Table 5.1 may be too small or even closed to be considered further. All of these factors should be considered by the analyst in their aircraft crash frequency analysis of their facility.

This chapter discusses aircraft operations in the following Sections: 5.2) Near Airport Environment, 5.3) Enroute/In-Flight Environment, 5.4) TRACON Environment, and 5.5) References.

DEPT. OF ENERGY SITE	NEARBY AIRPORT(S)	Towered? (Yes/No)	Longest RW (100')	Terminal Approach and Departure Control	Class A Overflight Control
Hanford/Richland National Engineering Laboratory, Richland/Pasco, WA (Seattle Sectional)	Tri-Cities (PSC)	Yes	77	N.A.	Seattle ARTCC
	Richland (RLD)	No	40		
	Vista (S98)	No	35		
	Desert (Pvt.)	No	36		
	Mattawa (Pvt.)	No	26		
	Christensen Bros. (Pvt.)	No	25		
	McWhorter (Pvt.)	No	23		
	Basin City (Pvt.)	No	14		
Lawrence Livermore National Laboratory (LLNL), Livermore, CA (San Francisco Sectional)	Livermore Municipal (LVK)	Yes	52	Bay TRACON (O90)	Oakland ARTCC
	Meadowlark (Pvt.)	No	18		
Nevada Test Site (NTS), NV (Las Vegas Sectional)	Indian Springs (INS)	Yes	90	N.A.	Los Angeles ARTCC
	Desert Rock (Pvt.)	No	75		
	Jackass (U75)	No	62		
	Pahute Mesa (Pvt.)	No	58		
	Beatty (BTY)	No	56		
	Frans Star (2L1)	No	27		
Idaho National Engineering Laboratory (INEL), Idaho Falls, ID (Salt Lake City Sectional)	Idaho Falls Municipal (IDA)	Yes	90	N.A.	Salt Lake City ARTCC
	Arco/Butte Co. (AOC)	No	66		
	Howe (U97)	No	38		
	Midway (U37)	No	38		
	Mud Lake (1U2)	No	33		
	Big Southern Butte (U46)	No	26		
	QB One (Pvt.)	No	26		
Rocky Flats Plant, Boulder, CO (Denver Sectional)	Denver Int'l (DEN)	Yes	120	Denver TRACON (D84)	Denver ARTCC
	Class B Airspace				
	Jefferson Co. (BJC)	Yes	90		
	Boulder (1V5)	No	41		
Los Alamos National Laboratory (LANL), Los Alamos, NM (Albuquerque Sectional)	Los Alamos (Pvt.)	No	55	N.A.	Albuquerque ARTCC
Sandia National Laboratory (SNL), Albuquerque, NM (Albuquerque Sectional)	Albuquerque Intn'l (ABQ)	Yes	138	Albuquerque Intn'l (ABQ)	Albuquerque ARTCC
	Class C Airspace				
Pantex Plant, Amarillo, TX (Dallas/Ft. Worth Sectional)	Amarillo Intn'l (AMA)	Yes	135	Amarillo Intn'l (AMA)	Albuquerque ARTCC
	Class C Airspace				
	Tradewind (TDW)	No	51		
	Panhandle Carson (T45)	No	44		
	Eagles (Pvt.)	No	48		
	Finley Ranch (Pvt.)	No	30		
	True (Pvt.)	No	26		
	Stampts (Pvt.)	No	23		
	Finley Farm (Pvt.)	No	22		

Table 5-1
Survey of Major DOE Sites and Air Traffic Control Facilities

N.A. = not applicable

DEPT. OF ENERGY SITE	NEARBY AIRPORT(S)	Towered? (Yes/No)	Longest RW (100')	Terminal Approach and Departure Control	Class A Overflight Control
Argonne National Laboratory (ANL), Argonne, IL (Chicago Sectional)	Chicago O'Hare (ORD)	Yes	130	Chicago TRACON (C90)	Chicago ARTCC
	Class B Airspace				
	Chicago Midway (MDW)	Yes	65		
	Class C Airspace				
	Schaumburg (06C)	No	30		
	Brookeridge (Pvt.)	No	28		
Kansas City Plant Kansas City, MO (Kansas City Sectional)	Kansas City Intn'l (MCI)	Yes	108	Kansas City Intn'l (MCI)	Kansas City ARTCC
	Class B				
	Richards Gebaur (GVW)	Yes	95		
	Kansas City Downtown (R(	Yes	70		
	Heart (MO06)	No	50		
	Lee Summit (K84)	No	30		
	Independence Memorial (3	No	25		
Paducah Gaseous Diffusion Plant, Paducah, KY (St. Louis Sectional)	Barkley Regional (PAH)	Yes	65	N.A.	Memphis ARTCC
	Metropolis (M30)	No	30		
	Farrington (Pvt.)	No	29		
	Terry (Pvt.)	No	25		
Portsmouth Gaseous Diffusion Plant, Piketon, OH (Cincinnati Sectional)	Pike Co. (157)	No	42	N.A.	Indianapolis ARTCC
	Morkassel (Pvt.)	No	19		
	Hidden Quarry (Pvt.)	No	11		
	Glade STOL (Pvt.)	No	10		
Brookhaven National Laboratory (BNL), Upton, NY (New York Sectional)	Long Island Islip (ISP)	Yes	60	New York TRACON (N90)	New York ARTCC
	Class C Airspace				
	Navy Calverton (CTO)	Yes	100		
	Gabreski (FOK)	Yes	90		
	Brookhaven (HWV)	No	43		
	Lufker (4NY7)	No	23		
	Spadard (1N2)	No	22		
Savannah River Site, Aiken, SC (Atlanta Sectional)	Augusta Bush Field (AGS)	Yes	80	Augusta Bush Field (AGS)	Atlanta ARTCC
	Class C Airspace?				
	Barnwell Co. (BNL)	No	51		
	Wade (Pvt.)	No	45		
	Windy Acres (Pvt.)	No	23		
	Harman (Pvt.)	No	20		
Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (Atlanta Sectional)	Oliver Springs (Pvt.)	No	28	N.A.	Atlanta ARTCC
	Higdon (Pvt.)	No	15		

Table 5-1 (continued)
Survey of Major DOE Sites and Air Traffic Control Facilities

N.A. = not applicable

5.2 NEAR AIRPORT ENVIRONMENT

The Near Airport Environment is defined as that airspace area that extends from the center of the Airport outwards to a radius of approximately 5 miles to 35 miles depending on the presence or absence of a TRACON and other air traffic control considerations. This airspace near the Airport encompasses the local airport traffic pattern, the airport runway approach pattern(s), and the airport initial climb departure pattern(s). Generally, this is the airspace near an airport where aircraft are in the Runway Approach Flight Phase, the Landing Flight Phase, the Takeoff Flight Phase, and the Initial Climb Flight Phase. The airspace near an airport is classified as Class B Airspace, Class C Airspace, or Class D Airspace.

Formerly called Terminal Control Areas (TCAs), Class B Airspace is generally the airspace from the surface to 10,000 feet mean sea level (MSL) surrounding U.S. airports with more than 150,000 annual instrument flight rule (IFR) operations or 650,000 annual passenger enplanements. The configuration of each Class B Airspace is individually tailored and consists of a surface area, usually 5 nautical miles in radius from the primary airport, and two or more layers extending laterally from the core at typically 3 to 10 nautical mile increments to a radius of approximately 20 nautical miles, with each layer having a prescribed altitude floor. In many respects, Class B Airspace has been likened to upside down wedding cakes. Class B Airspace is designed to contain all published instrument procedures once an aircraft enters the airspace. Operations may be under either IFR or visual flight rules (VFR) with all aircraft subject to air traffic control clearances and instructions. Air traffic control provides aircraft separation and safety advisories.

Class C Airspace, formerly called Airport Radar Service Areas (ARSAs), is generally the airspace from the surface to approximately 4,000 feet MSL surrounding U.S. airports with more than 75,000 annual IFR operations at the primary airport, or 100,000 annual IFR operations at the primary and secondary airports in the terminal hub area, or 250,000 annual passenger enplanements at the primary airport. The configuration of each Class C Airport is individually tailored and consists of a surface area of 5 nautical miles radius from the primary airport, and another layer with a prescribed altitude floor, extending laterally from the core to a radius of 10 nautical miles. Operations may be under either IFR or VFR, with all aircraft subject to air traffic control clearances and instructions. Air traffic control provides aircraft separation between IFR/IFR and IFR/special VFR (SVFR) aircraft. VFR operations are given traffic advisories and, upon request, collision resolution instructions.

Class D Airspace, formerly called Airport Traffic Areas (ATAs) and Control Zones (Czs), is the airspace from the surface to 2,500 feet above ground level (AGL) within a 5 statue mile (4.3 nautical mile) radius of the center of the airport. Operations may be under either IFR or VFR, with all aircraft subject to air traffic control clearances and instructions. Air traffic control separation service is provided to IFR aircraft only, but all aircraft will be given traffic advisories and, upon request, conflict resolution instructions.

For the ACRAM Standard [Ref. 5.1] , the term Airport Operation will be used to describe Aircraft Operations that occur in the Near Airport Environment. An Aircraft Operation, as defined by the Federal Aviation Administration (FAA), is the number of arrivals and departures from the airport at which an Airport Traffic Control Tower is located. Operations which include aircraft that: 1) operate in the local traffic pattern or within sight of the airport, 2) are known to be departing for, arriving from flight in the local practice areas located within a 20-mile radius of the airport, or 3) execute simulated instrument approaches or low passes at the airport, are classified as local operations. All other operations are classified as itinerant operations.

Air traffic controllers at the Airport Traffic Control Towers classify the Aircraft Operations into the following four categories: 1) Air Carriers (AC), 2) Air Taxis (AT), 3) General Aviation (GA), and 4) Military Aviation (MA). Air carriers are defined as aircraft in general commercial service capable of carrying 70 or more passengers, regardless of the flight rules under which the flight is conducted, e.g. 14 CFR 121 or 14 CFR 91 rules. Foreign air carriers are also included under the category of air carriers as long as the aircraft type is capable of carrying 70 or more passengers. All other aircraft in general commercial service that carry less than 70 passengers are classified as Air Taxis. However, since many Air Taxis operate small single-engine aircraft, air traffic controllers often count these flights as General Aviation flights unless the flight is identified by a flight plan or a commercial livery is carried by the aircraft. Again, air traffic controllers classify Air Taxi flights by the aircraft type (carries less than 70 passengers), regardless of the

flight rules under which the flight is conducted, e.g. 14 CFR 135 or 14 CFR 91. (See Section 2 for further discussion on the regulations under which Air Carriers and Air Taxis flights are conducted). Military Aviation operations are classified as all Aircraft Operations operated by the Armed Forces of the United States. Finally, General Aviation operations are classified as all Aircraft Operations which were not included under the previous three categories.

Airports, may be classified as military or civilian. These airports may be further divided as to whether or not they have a control tower. A control tower is very important to the airport in that it not only provides control over the air traffic near the airport, it is also the location where counts are made on Airport Operations. Almost all civilian airports with a control tower are either staffed by F.A.A. personnel or under contract to the F.A.A. Most military airports with a control tower are staffed by military personnel. However, there are a few joint-use military airports where the control tower is staffed by F.A.A. personnel, e.g. Charleston AFB, SC. For the most current information on airport operations and flight patterns, the analyst should contact the Airport Traffic Control Tower directly. Airport operations and flight patterns do change due to population growth, new development, new businesses, airlines establishing or moving traffic hubs, and changes at other nearby airports. The analyst should obtain sufficient historical information on airport operations to assure the growth patterns are not undergoing radical changes. Most Airport Traffic Control Towers keep only limited historical data on Airport Operations. For historical data on airport operations at airports with F.A.A. control towers, the analyst should obtain the document "F.A.A. Air Traffic Activity" distributed by the F.A.A. Office of Aviation Policy, Plans and Management Analysis each fiscal year. In addition, future airport plans could radically alter current airport operations so the analyst should be aware of future airport developments. For projections of future airport operations, the analyst should obtain the document "Terminal Area Forecasts" again distributed by the F.A.A. Office of Aviation Policy, Plans and Management Analysis each fiscal year. For detailed information on future airport developments, the analyst should contact local airport planning offices.

5.3 ENROUTE/IN-FLIGHT ENVIRONMENT

The Enroute or In-Flight Environment is defined as the airspace outside of the Near Airport and TRACON Environments. The Near Airport Environment is described in Section 5.2. The TRACON Environment is described in Section 5.4. The Enroute/In-Flight Environment encompasses all airspace above 11,000 feet mean sea level (MSL) and most airspace above 10,000 feet MSL. Generally, this is the airspace where aircraft are in the Climb to Cruise Flight Phase, Enroute or Cruise Flight Phase, and the Descent from Cruise Flight Phase. Included within the Enroute/In-Flight Environment is Class A Airspace. All airspace over the Continental United States from 18,000 feet MSL to 60,000 feet MSL has been established as Class A Airspace (formerly called Positive Control Area or PCA) by 14 CFR 71.31 [Ref. 5.2]. For General Aviation, the Enroute/In-Flight Environment can include the airspace outside of the Near Airport and TRACON Environments and below 10,000 feet MSL.

In past aircraft crash frequency analyses, aircraft flights outside of the Near Airport Environment were considered as flying on established airways. Airways were established to assist aircraft in their navigation in the United States. A system of air routes were established based on radio navigation facilities called VORTACs (Very high frequency Omnidirectional Radio range and Tactical Navigation). When a VOR is colocated with a TACAN navigation aid (which is basically a military version of a VOR), it is referred to as a VORTAC. Airways are classified as Low Altitude Airways or Victor Airways, High Altitude Routes or Jet Routes, and Military Training Routes. Low Altitude (Victor) Airways are the designated air routes between VOR or VORTAC stations located below 18,000 feet MSL. Air routes established in Class A Airspace from 18,000 feet MSL to 45,000 feet MSL are called Jet Routes. Jet Routes are actually available to any aircraft capable of operating at 18,000 feet or above, not just jet traffic [Ref. 5.3]. Military Training Routes are the system of designated routes used by the armed forces of the United States.

During the late 1950s and early 1960s, several serious high altitude midair accidents in the United States spurred the development of an air traffic control system which would control all high altitude air traffic and ensure a minimum separation distance between aircraft. The facilities established to provide air traffic control service to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace, principally during the en route phase of flight are the Air Route Traffic Control Centers (ARTCCs). ARTCCs are the central authority for issuing IFR clearances, and provide nationwide monitoring of each IFR flight. Within the Continental United States, there are 20 ARTCCs, each responsible for handling en route traffic passing through a specific geographic area. Because of the size of the area covered by each ARTCC, each ARTCC's area is further divided into smaller blocks of airspace called Sectors. Each sector is monitored by one or more controllers who maintain lateral and/or vertical separation of aircraft within its airspace boundaries. Figure 5-1 presents the ARTCCs and their associated airspace boundaries within the Continental United States. [Refs. 5.3 to 5.6]. This situation has remained unchanged since 1976 when the Great Falls, Montana ARTCC was merged with the Salt Lake City, Utah ARTCC.

All civil aviation operations conducted in Class A Airspace must be conducted under IFR as established by 14 CFR 91.135 [Ref. 5.7]. Therefore, all air traffic in Class A Airspace including traffic in Jet Routes are under the direction and control of the ARTCCs. However, in discussions with the Federal Aviation Administration (FAA), the recent trend for routing of air traffic in Class A Airspace is toward increased point-to-point routing rather than the assignment along specific Jet Routes. Beginning in 1995, all flights above 41,000 feet MSL in Class A Airspace were allowed to be routed point-to-point, if so desired. At approximately two month intervals, the lower limit for point-to-point routing in Class A Airspace was decreased. It is currently at 31,000 feet MSL as of January 1996 and can be expected to be decreased even further in the near future. As a point of explanation, point-to-point routing is not equivalent to the concept of free flight. All separation margins between aircraft in Class A Airspace are maintained by the ARTCCs in point-to-point flights. What has been changed is that the point-to-point flights are not restricted to within a 4 mile air corridor on each side of the Jet Route centerline. This allows more direct flights between points (hence the name point-to-point). In contrast, the free flight concept, in its fullest application, would not be under the control of the ARTCCs and separation margins between aircraft in Class A Airspace would be maintained by onboard aircraft systems, perhaps an advanced version of the Traffic Collision Avoidance System (TCAS.

Data on the number of IFR aircraft handled by each ARTCC is available from the FAA Office of Aviation Policy, Plans, and Management Analysis document FAA Air Traffic Activity published annually by Fiscal Year. The FAA defines IFR Aircraft Handled by an ARTCC as including IFR Departures, and IFR Overs, where IFR Departures are defined as IFR Flights originating in the ARTCC's area, accepted by the ARTCC under Sole Enroute clearance procedures, and extended by the ARTCC. IFR Overs are defined as IFR Flights that originates outside the ARTCC area and passes through the area without landing. IFR Aircraft Handled are then the number of IFR Departures multiplied by two plus the number of IFR Overs. This definition assumes that the number of departures (acceptances, extensions, and originations of IFR flight plans) is equal to the number of landings (IFR flight plans closed).

Data on the number of IFR Aircraft Handled for the 20 Continental United States ARTCCs has been tabulated and summarized for the 1975 to 1994 time period in Table 5-2.

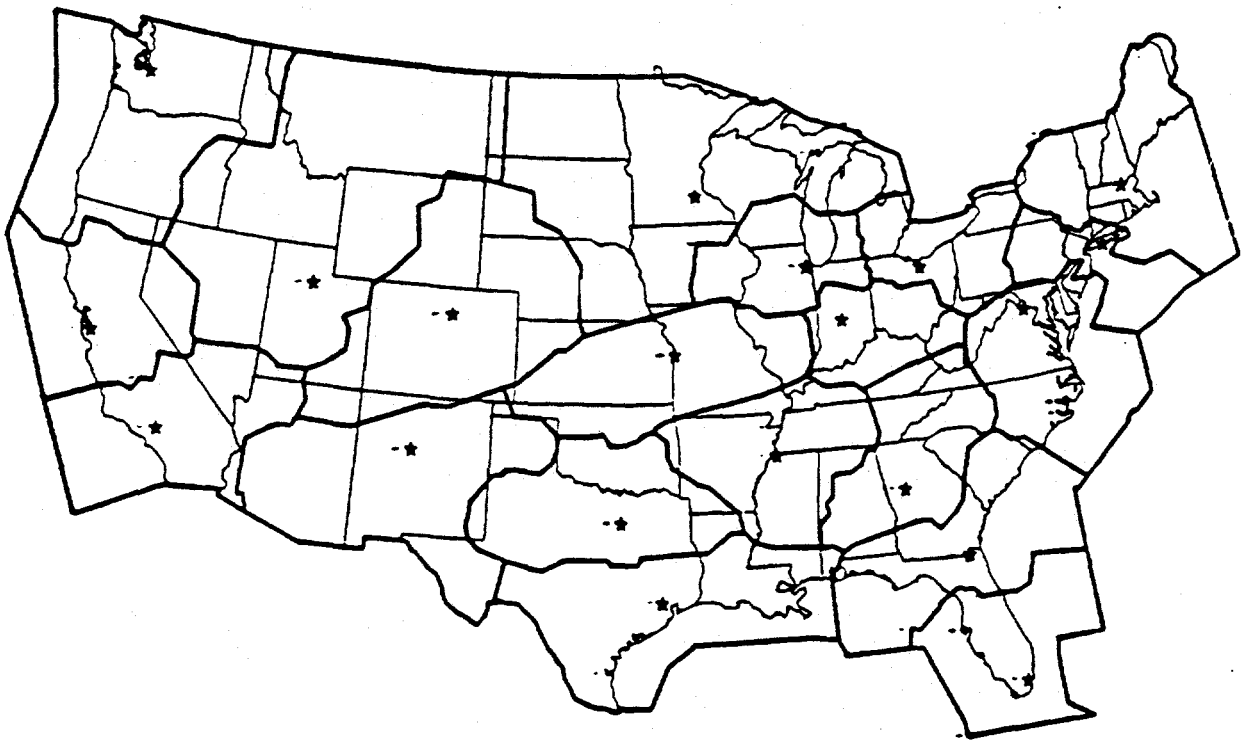

Figure 5-1
ARTCCs and Airspace Boundaries within the Continental United States

ARTCC	AIR CARRIER (FY1975-1994) Departures	Domestic Overs	Oceanic Overs	Aircraft Handled, N	AIR TAXI (FY1975-1994) Departures	Domestic Overs	Oceanic Overs	Aircraft Handled, N	Estimated Land Area (mi.^2)	Air Carrier N/Area (AC/yr/mi^2)	Air Taxi N/Area (AC/yr/mi^2)
Los Angeles, CA (ZLA)	7,858,048	992,277	0	16,708,373	1,963,445	14,166	0	3,941,056	123,983	6.738	1.589
Oakland, CA (ZOA)	5,127,604	1,025,936	2,081,913	13,363,057	1,594,727	48,972	7,450	3,245,876	100,478	6.650	1.615
Denver, CO (ZDV)	3,621,334	5,412,678	0	12,655,346	1,245,146	202,206	0	2,692,498	268,185	2.359	0.502
Washington, DC (ZDC)	6,940,796	6,976,105	0	20,857,697	1,283,358	130,894	0	2,697,610	N.A.	N.A.	N.A.
Jacksonville, FL (ZJX)	3,025,610	7,296,490	0	13,347,710	1,073,462	166,070	0	2,312,994	N.A.	N.A.	N.A.
Miami, FL (ZMA)	6,254,663	679,999	3,424,969	16,614,294	1,597,487	9,498	378,807	3,583,279	N.A.	N.A.	N.A.
Atlanta, GA (ZTL)	7,948,944	4,474,694	0	20,372,582	2,223,949	379,449	0	4,827,347	127,928	7.963	1.887
Chicago, IL (ZAU)	8,874,905	4,135,960	0	21,885,770	3,444,033	365,600	0	7,253,666	102,383	10.688	3.542
Indianapolis, IN (ZID)	3,846,741	7,421,296	0	15,114,778	2,085,483	465,121	0	4,636,087	87,881	8.600	2.638
Boston, MA (ZBW)	4,434,852	2,672,635	0	11,542,339	2,450,086	343,737	0	5,243,909	N.A.	N.A.	N.A.
Minneapolis, MN (ZMP)	3,872,395	4,570,104	0	12,314,894	2,329,855	71,358	0	4,731,068	N.A.	N.A.	N.A.
Kansas City, MO (ZKC)	4,384,267	4,948,665	0	13,717,199	1,840,425	232,046	0	3,912,896	185,644	3.694	1.054
Albuquerque, NM (ZAB)	3,720,105	3,971,870	0	11,412,080	504,107	89,366	0	1,097,580	236,753	2.410	0.232
New York, NY (ZNY)	7,751,607	3,529,945	1,920,001	20,953,160	1,931,493	528,253	42,848	4,434,087	31,839	32.905	6.963
Cleveland, OH (ZOB)	6,914,338	8,323,884	0	22,152,560	2,723,348	652,530	0	6,099,226	N.A.	N.A.	N.A.
Memphis, TN (ZME)	3,225,974	6,574,140	0	13,026,088	1,603,228	421,723	0	3,628,179	139,465	4.670	1.301
Ft. Worth, TX (ZFW)	6,294,549	2,848,087	0	15,437,185	2,075,630	133,722	0	4,284,982	N.A.	N.A.	N.A.
Houston, TX (ZHU)	5,263,331	1,033,000	399,205	11,958,867	1,259,310	44,151	11,697	2,574,468	N.A.	N.A.	N.A.
Salt Lake City, UT (ZLC)	2,012,757	4,513,820	0	8,539,334	1,316,200	222,321	0	2,854,721	415,008	1.029	0.344
Seattle, WA (ZSE)	3,625,362	424,851	0	7,675,575	2,517,467	7,017	0	5,041,951	186,624	2.056	1.351
Continental US Total	104,998,182	81,826,436	7,826,088	299,648,888	37,062,239	4,528,200	440,802	79,093,480	2,959,545	5.062	1.336

Table 5.2
Continental United States ARTCC Air Carrier and Air Taxi
Aircraft Handled for FY1975-1994, ARTCC Land Area and Traffic Density

N.A. = information not available at time of table preparation.

5.4 TRACON ENVIRONMENT

TRACON or Terminal Radar Control, refers to the air traffic control facility which is responsible for providing approach/departure aircraft separation, especially for IFR aircraft operations, for the airspace area from approximately 5 miles radius from the primary airport extending outwards to approximately 35 miles from the primary airport. The TRACON Environment is defined as that airspace outside of the Near Airport Environment (which is usually under the control of the Airport Traffic Control Tower) and inside and beneath the Enroute/In-Flight Environment Environment (which is below the minimum control altitude of the ARTCC).

The TRACON Environment may be important for those facilities which are located outside or beneath the Class B, or Class C Airspaces of Airports but are within the airspace controlled by the TRACON. An example of such a situation is the Lawrence Livermore National Laboratory (LLNL) which is located outside of the Class B Airspace of the San Francisco International Airport (SFO) and the Class C Airspaces of the Oakland International Airport (OAK) and the San Jose International Airport (SJC). The LLNL is located (barely) within the Class D Airspace of the Livermore Municipal Airport (LVK). Because of the peculiarities of the terrain in the San Francisco Bay area and the air traffic patterns which have developed, much of the air traffic entering the San Francisco Bay area from the Southeast, East, and Northeast is directed by the Bay TRACON (O90) to the V195 Airway located within 5 miles of LLNL. This air traffic is then directed to intersect the SUNOL intersection where Bay TRACON directs the air traffic to their respective airport. In the Enroute/In-Flight Environment, air traffic was assumed to be spread more or less uniformly across the airspace of the ARTCC. In the TRACON Environment, the control of the TRACON serves to concentrate the air traffic within TRACON airspace especially in Low Altitude Airways. If the facility is located outside the controlled airspace of nearby Airports, then the air traffic being directed by the local TRACON will not be counted by the Airport Operations of the local Airports. The number of aircraft handled by the local TRACON could be used as an estimate of air traffic handled by the TRACON near the facility of interest except for two important reasons. One is the that the number of aircraft handled by the TRACON refers to only the number of instrument operations handled by the TRACON and does not include visual flight rules (VFR) flights. The second reason is that the TRACON count includes the total number of instrument operations coming into the TRACON airspace from all directions. Directionality is not considered in the TRACON counts. So for the case of LLNL, the Bay TRACON undercounts due to the exclusion of VFR flights, then overcounts due to counting of flights coming into the San Francisco Bay area from the South, West and North.

Because of the difficulty of obtaining reasonable estimates of the air traffic handled by a TRACON near a facility, it is fortunate that in only a few situations is it necessary to perform the aircraft crash frequency analysis for the TRACON Environment. In most cases, if the facility is located near a large population center, the facility is located within the Class B, or Class C Airspace associated with the primary airport and thus the Airport Operations of the Airport Traffic Control Tower (ATCT) can be used. The aircraft crash frequency analysis would be done as for the Near Airport Environment Environment except that the radial distance that the airspace would be considered within the Near Airport Analysis could be extended beyond 5 miles depending upon the class of airspace designated for that Airport and other air traffic considerations. For those cases where the facility is located far from a large population center, there is usually no TRACON to provide terminal approach and departure service since TRACONs exist to provide air traffic guidance and separation because of air traffic congestion. No large population center implies that air traffic is minimal and therefore the need for a TRACON does not exist. It is only for those cases where a facility is located outside the Class B or Class C Airspaces of Airports and where a TRACON exists to provide terminal approach and departure control service, is it necessary to consider the aircraft crash frequency analysis in the TRACON Environment.

The terminal approach and departure control service is not always provided by a TRACON facility. Many of the major U.S. Airports have their terminal approach and departure control service provided by the Airport Traffic Control Tower. Of the 33 major U.S. Airports designated with Class B Airspaces, only the 19 have terminal approach and departure control service provided by a TRACON facility. Three of these airports have their terminal approach and departure control service provided by the same TRACON facility (the New York TRACON). These airports are:

Major U.S. Airports with Class B Airspace	TRACON Facility (FAA Designation)
Las Vegas NV	Las Vegas TRACON (N90)
Los Angeles, CA	Southern California TRACON (SCT)
San Diego, CA	San Diego TRACON (NKX)
San Francisco, CA	Bay TRACON (O90)
Denver, CO	Denver TRACON (D84)
Baltimore, MD	Baltimore TRACON (B95)
Chicago O'Hare, IL	Chicago TRACON (C90)
Boston, MA	Boston TRACON (A90)
Minneapolis/St. Paul, MN	Minneapolis TRACON (M98)
St. Louis, MO	St. Louis TRACON (T75)
Phoenix, AZ	Phoenix TRACON (P50)
Newark NJ	New York TRACON (N90)
New York Kennedy, NY	New York TRACON (N90)
New York LaGuardia, NY	New York TRACON (N90)
Detroit, MI	Detroit TRACON (D21)
Dallas/Ft. Worth, TX	Dallas/Ft. Worth TRACON (D10)
Houston, TX	Houston TRACON (I90)
Salt Lake City, UT	Salt Lake City TRACON (S56)
Seattle/Tacoma, WA	Seattle/Tacoma TRACON (S46)

Most U.S. Airports with Class C Airspaces have their terminal approach and departure control provided by the Airport Traffic Control Tower. There are several U.S. Airports designated with Class C Airspaces that have their terminal approach and departure control service provided by a TRACON facility. These Airports are:

U.S. Airports with Class C Airspace	TRACON Facility (FAA Designation)
Anchorage, AK	Anchorage TRACON (A11)
Ontario, CA	Ontario TRACON (O40)
Oakland, CA	Bay TRACON (O90)
San Jose, CA	Bay TRACON (O90)
Sacramento, CA	Sacramento TRACON (MCC)
Pensacola, FL	Pensacola TRACON (P31)
Chicago Midway, IL	Chicago TRACON (C90)
Hartford, CT	Yankee TRACON (Y90)
Omaha, NE	Omaha TRACON (R90)
Tucson, AZ	Tucson TRACON (U90)
Portland, OR	Portland TRACON (P80)

5.5 REFERENCES

[5.1] DOE Standard Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE-STD-3014-96, U.S. Department of Energy, Washington, DC, July 1996.

[5.2] "Designation of Class A, Class B, Class C, Class D, and Class E Airspace Areas; Airways; Routes; and Reporting Points," Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter E-Airspace, Part 71 (14 CFR 71), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.

[5.3] The Aviator's Guide to Modern Navigation, Donald J. Clausing, TAB Books, Inc., Blue Ridge Summit, PA, 1987.

[5.4] Instrument Rating Manual, Jeppesen Sanderson, Inc., Englewood, CO, 1990.

[5.5] Why Airplanes Crash, Clinton V. Oster, John S. Strong, and C. Kurt Zorn, Oxford University Press, New York, NY, 1992.

[5.6] The Pilot's Air Traffic Control Handbook, 2nd Edition, Paul E. Illman, TAB Books, Inc., Blue Ridge Summit, PA, 1993.

[5.7] "General Operating and Flight Rules," Title 14 Aeronautics and Space, Code of Federal Regulations, Chapter I-Federal Aviation Administration, Department of Transportation, Subchapter F-Air Traffic and General Operating Rules, Part 91 (14 CFR 91), U.S. National Archives and Record Administration, Washington, DC, January 1, 1995.