

NFPA 402M

Aircraft

Rescue and

Fire Fighting

Operations

1989 Edition



NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Licensing Provision

This document is copyrighted by the National Fire Protection Association (NFPA). The terms and conditions set forth below do not extend to the index to this document. If public authorities and others reference this document in laws, ordinances, regulations and administrative orders or similar instruments, it should be with the understanding that this document is informative in nature and does not contain mandatory requirements. Any deletions, additions, and changes desired by the adopting authority must be noted separately. Those using this method ("adoption by reference") are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use.

The term "adoption by reference" means the citing of the title and publishing information only.

(For further explanation, see the Policy Concerning the Adoption, Printing and Publication of NFPA Documents which is available upon request from the NFPA.)

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

**INSIDE,
THE PROFESSIONAL
RESEARCH,
REVIEW,
OPINION,
DISCUSSION
AND REVISION
YOU
ORDERED FROM
NFPA**



NATIONAL FIRE PROTECTION ASSOCIATION

Copyright © 1989 NFPA, All Rights Reserved

NFPA 402M

Manual for

Aircraft Rescue and Fire Fighting Operations

1989 Edition

This edition of NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting Operations*, was prepared by the Technical Committee on Aircraft Rescue and Fire Fighting, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 15-18, 1989 in Washington, DC. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989, and supersedes all previous editions.

The 1989 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 402M

The Standard Operating Procedures were first developed by the sponsoring NFPA committee in 1947 and were first adopted by the Association in 1951. They were amended in 1969 and 1973. In 1984, the Committee combined the text of NFPA 406M, *Manual on Aircraft Rescue and Fire Fighting Techniques for Fire Departments Using Structural Fire Apparatus and Equipment*, with the text of NFPA 402, *Recommended Practice for Aircraft Rescue and Fire Fighting Operational Procedures for Airport Fire Departments*, and reidentified the document as NFPA 402M. The entire texts of both NFPA 402 and NFPA 406M were revised to create NFPA 402M. The 1989 edition of NFPA 402M is a complete revision of the manual.

Committee on Aviation**Correlating Committee**

James J. Brenneman, *Chairman*
Sunnyvale, CA

L. M. Krasner, *Vice Chairman*
Factory Mutual Research Corp.

Gene E. Benzenberg, Alison Control Inc.
John R. Flynn, American Airlines
James F. O'Regan, Feecon Corp.

Bruce R. Pashley, Ogden Allied Aviation Services
John F. Rooney, Tucson, AZ
Donald J. Slater, Hartford Steam Boiler

Stanley J. Wolek, Port Authority of NY & NJ

**Technical Committee on
Aircraft Rescue and Fire Fighting**

John F. Rooney, *Chairman*
Tucson, AZ

James F. O'Regan, *Vice Chairman*
Feecon Corp.

Brian Gene Boucher, Canadian Air Line Pilots Assn.

James J. Brenneman, Sunnyvale, CA

B.T. Burley, Office of the Commissioner

William M. Carey, Underwriters Laboratories Inc.

Robert L. Darwin, Naval Sea Systems Command

Paul R. Funk, Lambert-St. Louis International
Rep. IAFC

George B. Geyer, FAA Technical Ctr.

B.V. Hewes, Airport Safety Services

Paul O. Huston, Amerex Corp.
Rep. FEMA

L. M. Krasner, Factory Mutual Research Corp.

C. T. Lindemann, Conifer, CO

Richard E. Livingston, International Airline Passengers Assoc.

D. A. MacPhail, British Airports Authority

R. J. Manley, Intl Federation of Airline Pilots

Stephen C. Nimmer, Oshkosh Truck Corp.

Davis R. Parsons, Los Angeles City Fire Dept., CA

Keith R. Pollard, National Foam System, Inc.

Philip P. Quinn, Jr., ICAOTAM

Paul R. Robinson, Marietta, GA
Rep. ALPA

Robert R. Rogers, Long Island MacArthur Airport

Bertrand F. Ruggles, FAA Dept. of Transportation

Jose L. Santamaria, Int'l Civil Aviation Organization

John M. Schuster, 3M Company

David F. Short, Simon-Gloster

John X. Stefanki, John X Stefanki Inc.

Joseph L. Walker, United States Air Force

William J. Wenzel, Walter Equipment USA Inc.

Alternates

David R. Maryon, Gloster Saro Ltd.

(Alternate to D. F. Short)

William E. Moore, US Federal Aviation Admin.

(Alternate to B. F. Ruggles)

James W. Morgan III, Sikorsky Aircraft

(Alternate to United Technologies Rep.)

Gary W. Schmiedel, Oshkosh Truck Corp.

(Alternate to S. C. Nimmer)

Ronald T. Strong, Atlanta Fire Bureau, Rep IAFC

(Alternate to P. R. Funk)

Miles R. Suchomel, Underwriters Laboratories Inc.

(Alternate to W. M. Carey)

Bruce A. Warner, ICI Americas Inc.

(Alternate to P. O. Huston)

William S. Weeks, Airline Pilots Assn.

(Alternate to P. R. Robinson)

Nonvoting

R. D. Halliday, Civil Aviation Authority
(Nonvoting)

John E. Lodge, Lodge Fire Protection Consultancy Ltd.
(Member Emeritus)

Gary Hammack, Nat'l Transportation Safety Board
(Alternate to NTSB Rep.)

Subcommittee on NFPA 402M

John F. Rooney, *Chairman*
Tucson, AZ

Brian G. Boucher, Canadian Airline Pilots Assoc.

Thomas J. Lett, U.S. Dept. of The Air Force

John E. Lodge, Lodge Fire Protection Consultancy

Robert J. Manley, International Federation of
Airline Pilots

Davis R. Parsons, Los Angeles City Fire Department, CA

Keith R. Pollard, National Foam Systems, Inc.

Bertrand F. Ruggles, Federal Aviation
Administration

Pam Walden, Port Authority of NY & NJ

Mark T. Conroy, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

Chapter 1 Administration	402M- 6
1-1 Scope	402M- 6
1-2 Purpose	402M- 6
1-3 General	402M- 6
1-4 Definitions	402M- 6
Chapter 2 Preplanning for Aircraft Emergencies	402M-10
2-1 General	402M-10
2-2 Emergency Response Preplanning	402M-10
2-3 Airport Fire Fighter Basic Knowledge	402M-12
2-4 Communications	402M-12
2-5 Mutual Aid Considerations	402M-12
Chapter 3 Flight Crew and RFF Personnel Responsibilities	402M-13
3-1 Areas of Responsibility	402M-13
3-2 Communications	402M-13
Chapter 4 Emergency Response	402M-14
4-1 General	402M-14
4-2 Low Visibility Operations	402M-15
Chapter 5 Factors Common to Airport Emergencies	402M-15
5-1 General	402M-15
5-2 Types of Emergency Alerts	402M-16
5-3 Vehicle Response to Aircraft Accidents	402M-16
5-4 Positioning of RFF Vehicles	402M-16
5-5 Hazards to RFF Personnel	402M-17
Chapter 6 Aircraft Construction and Materials	402M-18
6-1 Construction Materials	402M-18
6-2 Aircraft Fuel Tanks	402M-18
6-3 Aircraft Exits	402M-19
Chapter 7 Evacuation and Rescue	402M-19
7-1 Aircraft Evacuation	402M-19
7-2 Evacuation Slides	402M-20
7-3 Evacuation Assistance by RFF Personnel	402M-20
7-4 Aircraft Forcible Entry	402M-21
7-5 Extrication and Rescue	402M-21
Chapter 8 Fire Control and Extinguishment	402M-22
8-1 General	402M-22
8-2 Extinguishing Agents for Aircraft Fires	402M-22
8-3 Water and Agent Resupply and Conservation	402M-23
8-4 Major Aircraft Accidents	402M-23
8-5 Size-Up	402M-23
8-6 Aircraft Accident — Fire Involvement	402M-23
8-7 Extinguishment Techniques	402M-24
8-8 Turret Operations	402M-25
8-9 Aqueous Film-Forming Foam (AFFF) and Film-Forming Fluoroprotein (FFFP) for Turret Application	402M-25
8-10 Protein and Fluoroprotein Foam Turret Application	402M-25
8-11 Handline Foam Application	402M-25
8-12 Aircraft Accident — No Fire Involvement	402M-25
8-13 Exposure Protection	402M-25
Chapter 9 Interior Aircraft Fires	402M-26
9-1 General	402M-26
9-2 Aircraft Interior Fires Occurring in Flight	402M-26
9-3 Interior Fires in Unoccupied Aircraft	402M-27
9-4 Penetrating Nozzles	402M-27
9-5 Interior Aircraft Fire Overhaul	402M-28

Chapter 10 Miscellaneous Aircraft Incidents	402M-28
10-1 General	402M-28
10-2 Engine Fires	402M-28
10-3 Aircraft Fuel Servicing Incidents	402M-29
10-4 Hot Brakes and Wheel Fires	402M-29
10-5 Combustible Metal Fires	402M-30
10-6 Broken Flammable Liquid Lines	402M-30
10-7 Heater Fires	402M-30
10-8 Bomb Threats	402M-30
10-9 Incidents Where Aircraft Fire Warnings Occur	402M-30
10-10 Emergency Landings	402M-30
10-11 Aircraft Accidents in the Water	402M-30
Chapter 11 Post Aircraft Accident Procedures	402M-31
11-1 General	402M-31
11-2 Preservation of Evidence	402M-31
11-3 Fatalities	402M-32
11-4 Preservation of Mail, Baggage, and Cargo	402M-32
11-5 Flight Data and Cockpit Voice Recorders	402M-32
11-6 Defueling Accident Aircraft	402M-32
11-7 Aircraft Systems Hazards	402M-33
Chapter 12 Air Ambulance Aircraft and Nonambulatory Passengers	402M-33
12-1 Air Ambulance Aircraft	402M-33
12-2 Nonambulatory Passengers Permitted on Scheduled Airline Flights	402M-33
Chapter 13 Structural Fire Department Operations	402M-33
13-1 General	402M-33
13-2 Preplanning and Training	402M-33
13-3 Aircraft Accident Operations	402M-34
13-4 Basic Fire Control	402M-35
13-5 Accidents without Fire	402M-35
13-6 Accidents with Fire	402M-35
13-7 Fire Fighting with Water	402M-35
13-8 Fire Fighting Foam	402M-36
13-9 Vehicles	402M-36
13-10 Post Accident Procedures	402M-37
Chapter 14 Referenced Publications	402M-37
Appendix A Civil Aircraft Data for Rescue and Fire Fighting Personnel	402M-38
Appendix B Air Transport of Dangerous Goods (Hazardous Materials and Restricted Articles) and Nuclear Weapons	402M-55
Appendix C Specialized Vehicles and Equipment	402M-58
Appendix D Civil Aircraft Accident Investigation	402M-59
Appendix E Sample Mutual Aid Agreements	402M-61
Index	402M-62

NFPA 402M
Manual for
Aircraft Rescue and
Fire Fighting Operations
1989 Edition

NOTICE: Information on referenced publications can be found in Chapter 14.

Chapter 1 Administration

1-1 Scope.

1-1.1 This manual provides information relative to aircraft rescue and fire fighting operations and procedures for airport and structural fire departments. These procedures deal with aircraft not involved in military operations. They may, however, be generally applicable to military aircraft not operating in an armament mode. For specific guidance in these matters consult the commander or fire chief of the nearest military air installation.

1-1.2 Some airport fire departments have the total fire prevention and fire protection responsibility for the entire airport including structural fire fighting responsibilities in terminal buildings, aircraft hangars, airport hotels, cargo buildings, and other facilities. Procedures for these fire prevention and protection operations are not covered in this manual.

1-2 Purpose.

1-2.1 This manual has been prepared for the use and guidance of those charged with the responsibility of providing and maintaining aircraft rescue and fire fighting (RFF) services on airports.

1-2.2 The manual's content is also intended for the use of structural fire departments to assist them in developing methods to effectively handle aircraft incidents that may occur within their jurisdiction. It also provides for a basis of understanding relative to emergencies on airports which would enhance the structural fire departments' effectiveness when called to assist airport fire departments.

1-3 General.

1-3.1 Providing protection for the occupants of an aircraft takes precedence over all other operations. Fire control is frequently an essential condition to assure such survival. The objectives of the airport fire department should be to respond to any aircraft emergency in the minimum possible time and employ rescue and fire fighting techniques effectively. These objectives can be accomplished when properly trained personnel work together as a team and apply the operational procedures presented in this manual.

1-3.2 Governmental and organizational publications frequently referenced in this manual may be found in Chapter 14.

1-3.3 If a value for measurement as given in this manual is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

1-3.4 Metric units of measurement in this manual are in accordance with the modernized metric systems known as the International System of Units (SI). One unit (liter), outside of, but recognized by SI is commonly used in international fire protection.

1-4 Definitions.

Aircraft Accident. An occurrence during the operation of an aircraft in which any person involved suffers death or serious injury or in which the aircraft receives substantial damage.

Aircraft Accident Preplanning. This term is used to describe the process of forecasting all factors that could possibly exist involving an aircraft accident that could bear upon the existing emergency resources. A preplan should define the emergency organizational authority and the responsibilities of all those involved.

Aircraft Defueling. See Fuel Servicing.

Aircraft Familiarization. Refers to the knowledge of vital information that rescue and fire fighting personnel should learn and retain with regard to the specific types of aircraft that normally use the airport, and other aircraft that might use the airport due to weather conditions at scheduled destinations.

Aircraft Fire Fighting. The control or extinguishment of fire adjacent to or involving an aircraft following ground accidents/incidents. Aircraft fire fighting does not include the control or extinguishment of airborne fires in aircraft.

Aircraft Incident. An occurrence other than an accident associated with the operation of an aircraft, which affects or could affect continued safe operation if not corrected. An incident does not result in serious injury to persons or substantial damage to aircraft.

Aircraft Rescue. The fire fighting action taken to prevent, control, or extinguish fire involving or adjacent to an aircraft for the purpose of maintaining maximum fuselage integrity and an escape area for its occupants. Rescue and fire fighting personnel, to the extent possible, will assist in the evacuation of the aircraft using normal and emergency means of egress. Additionally, rescue and fire fighting personnel will, by whatever means necessary, and to the extent possible, enter the aircraft and provide all possible assistance in the evacuation of the occupants.

Airport (Aerodrome). An area on land or water that is used or intended to be used for the landing and takeoff of aircraft and includes buildings and facilities.

Airport Familiarization. Refers to the knowledge that rescue and fire fighting personnel must maintain relative

to locations, routes, and conditions that will enable them to respond quickly and efficiently to emergencies on the airport and those areas surrounding the airport.

Air Crew. Includes all on-duty airline employees aboard an aircraft.

Air Traffic Control (ATC). The airport radio control center for aircraft that is staffed by FAA personnel.

Aluminum. A lightweight metal used extensively in the construction of aircraft airframes and skin sections.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Auxiliary Power Unit (APU). A self-contained power source, either an external apparatus or one provided as a component of an aircraft, that is used to energize aircraft systems when power plants are not operating.

Backdraft. A phenomenon that occurs when a fire takes place in a confined area such as a sealed aircraft fuselage and burns undetected until most of the oxygen within is consumed. The heat continues to produce flammable gases, mostly in the form of carbon monoxide. These gases are heated above their ignition temperature and when a supply of oxygen is introduced, as when normal entry points are opened, the gases may ignite with explosive force.

Bogie. A tandem arrangement of aircraft landing gear wheels. The bogie can swivel up and down so that all wheels follow the ground as the attitude of the aircraft changes or the ground surface changes.

Cabin Crew. Those members of the flight crew whose responsibility includes the management of activities within the passenger cabin.

Cockpit Voice Recorder (CVR). A device which monitors flight crew communications through a pickup on the flight deck connected to a recorder which is usually mounted in the tail area of the aircraft and which is designed to withstand certain impact forces and a degree of fire.

COMBI. An aircraft designed to transport both passengers and cargo on the same level within the fuselage.

Command Post (CP). The location at the scene of an emergency where the Incident Commander is located and where command, coordination, control, and communications are centralized.

Composite Materials. Lightweight materials having great structural strength. They are made of fine fibers embedded in carbon/epoxy materials. The fibers are usually boron, fiberglass, aramid, or carbon in the form of graphite. Composite materials do not present unusual fire fighting problems, but products of their combustion should be considered a respiratory hazard to fire fighters.

Critical Rescue and Fire Fighting Access Area. The rectangular area surrounding any runway within which most aircraft accidents can be expected to occur on airports. Its width extends 500 ft (150 m) from each side of the runway centerline, and its length is 3300 ft (1000 m) beyond each runway end.

Dangerous Goods. This term is synonymous with the terms "Hazardous Materials" and "Restricted Articles." The term is used internationally in the transportation industry and includes: explosives and any other article defined as a combustible liquid, corrosive material, infectious substances, flammable compressed gases, oxidizing materials, poisonous articles, radioactive materials, and other restrictive articles.

Deck Gun (Deluge Set). See Turret.

Departure. An aircraft taking off from an airport.

Dry Chemical. An extinguishing agent essentially consisting of a chemical salt with fire-inhibiting properties.

Dry Powder. An extinguishing agent suitable for use on combustible metal fires.

Empennage. The tail assembly of an aircraft, which includes the horizontal and vertical stabilizers.

Evacuation Time. The elapsed time between an aircraft accident/incident and the removal of all surviving occupants.

Evacuee. An aircraft occupant who has exited the aircraft following an accident/incident.

Exposure. Any person or property that may be endangered by fire, smoke, gases, or runoff.

Extinguishing Agent Compatibility. Related to the requirement that the chemical composition of each agent be such that one will not adversely affect the performance of other agents that might be used on a common fire.

Extinguishing Agent, Complementary. Refers to an extinguishing agent that has the compatibility to perform fire suppressing functions in support of a primary extinguishing agent and where extinguishment may not be achievable using only the primary agent.

Extinguishing Agent, Primary. Agents that have the capability of suppressing and preventing the re-ignition of fires in liquid hydrocarbon fuels.

Extrication. The removal of trapped victims in an aircraft accident.

Federal Aviation Administration (FAA). An agency of the United States Federal Government charged with the primary responsibility of regulating safety in both military and civil aviation.

Fire Classifications.

- Class A.* Ordinary combustibles.
- Class B.* Flammable liquids.
- Class C.* Electrically charged components.
- Class D.* Combustible metals.

Fire Wall. A bulkhead designed to stop the lateral spread of fire in a fuselage or engine nacelle.

Flashback. The tendency of flammable liquid fires to re-ignite from any source of ignition after the fire has once been extinguished.

Flashover. All combustibles in a room or confined space have been heated to the point that they are giving off vapors that will support combustion, and all combustibles ignite simultaneously.

Flight Data Recorder (FDR). An instrument that monitors performance characteristics of an aircraft in flight. It is usually mounted in the tail area of an aircraft and is designed to withstand certain impact forces and a degree of fire. Its purpose is to provide investigators with flight performance data that may be relevant in determining the cause of an accident/incident.

Flight Deck Crew. Those members of the air crew whose responsibility includes the management of the aircraft's flight control and ground movements.

Foam Application Rate. The amount of foam solution in liters or gallons per minute expressed as a relationship with a unit of area, usually square meter or square foot.

Foam, Aqueous Film Forming Concentrate (AFFF). A concentrated aqueous solution of fluorinated surfactants and foam stabilizers which, when mixed with water and air in designated proportions, is capable of producing an aqueous fluorocarbon film on the surface of hydrocarbon fuels to prevent vaporization.

Foam Blanket. A covering of foam over the surface of flammable liquids to provide extinguishment and prevent ignition.

Foam Burnback Resistance. The ability of a foam blanket to retain aerated moisture and resist destruction by heat and flame.

Foam Drain Time. The foam drain time — commonly the 25 percent drainage time (or $\frac{1}{4}$ drainage time) — is the time required for 25 percent of the original foam solution (foam concentrate plus water) to drain out of the foam.

Foam, Film-Forming Fluoroprotein (FFFP) Foam Concentrate. A concentrate that uses fluorinated surfactants to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors. This type of foam also utilizes a protein base plus stabilizing additives and inhibitors to protect against freezing, corrosion, and bacterial decomposition, and it also resists fuel pickup.

Foam Fluoroprotein. A protein based foam concentrate to which fluorochemical surfactants have been added. This has the effect of giving the foam a measurable degree of compatibility with dry chemical extinguishing agents, and an increase in tolerance to contamination by fuel.

Foam, Protein. A foam concentrate which uses protein as the basic foaming agent, and is stabilized with metal salts to impart fire resistance to the foam blanket.

Forcible Entry. The act of making entry into an aircraft or other structure when normal entry points are not accessible.

Frangible Gate/Fence. Gates or fence sections designed to open, break away, or collapse when struck with the bumper of an RFF vehicle responding to an emergency.

Fuel Servicing. Fueling and defueling of aircraft fuel tanks, not including aircraft fuel transfer operations and design of aircraft fuel systems during aircraft maintenance or manufacturing operations.

Fuselage. The main body of an aircraft.

Grid Map. A map of an area overlaid with a grid system of rectangular coordinates that are used to identify ground locations where no other landmarks exist.

Halon. A liquefied gas extinguishing agent that extinguishes fire by chemically interrupting the combustion reaction between fuel and oxygen. Halon agents leave no residue.

Halon 1211. A Class ABC rated extinguishing agent that discharges as an 85 percent liquid which permits a long stream reach.

Halon 1301. An agent having ABC capability in total flooding systems and limited Class A capability when dispensed from portable extinguishers. The agent is discharged as a vapor.

Hazardous Materials. See Dangerous Goods.

Horizontal Stabilizer. That portion of an aircraft's structure that contains the elevators.

Hot Brakes. A condition in which the aircraft's brake and wheel components have become overheated, usually due to excessive braking during landing.

Ignition Temperature. The lowest temperature at which a fuel, when heated, will ignite in air and continue to burn.

Incident Commander (IC). The person in overall command at an emergency.

International Civil Aviation Organization (ICAO). An international body charged with matters dealing with the development, coordination, and preservation of international civil aviation.

Jet Blast. The thrust-producing exhaust from a jet engine.

Knockdown. A fire fighting term defining the reduction of flame and heat to a point where further extension of a fire has been abated and the overhaul stage can begin.

Magnesium. A silvery-white or grayish lightweight metal, two-thirds the weight of aluminum. Magnesium alloys are used in the construction of aircraft landing gears, wheels, engine mounts, and various engine parts.

Main Gear. Refers to the two or more larger landing gear structures of an aircraft, as opposed to wing, nose, or tail gear assemblies.

Master Stream. A fire fighting water stream of large gallonage and extended reach delivered from a master stream appliance such as a deck gun.

Mechanical Ventilation. A process of removing heat, smoke, and gases from a fire area by using exhaust fans, blowers, air conditioning systems, or smoke ejectors.

Mutual Aid. Reciprocal assistance by emergency services under a pre-arranged plan.

National Transportation and Safety Board (NTSB). A federal agency that is responsible for investigating and determining the probable cause of all aircraft accidents.

Nose Gear. That mechanical part of a landing gear system mounted under the nose of an aircraft. It may be designed either as a stationary component or one that retracts into the fuselage.

Overhaul. A fire fighting term involving the process of final extinguishment after the main body of a fire has been knocked down. All traces of fire must be extinguished at this time.

Penetrating Nozzle. An appliance designed to penetrate the skin of an aircraft and inject extinguishing agent.

Practical Critical Fire Area (PCA). This area is two-

thirds of the Theoretical Critical Fire Area (TCA). (*See also TCA.*)

Preservation of Evidence. After an aircraft accident/incident it is imperative that investigative evidence be preserved after life safety and rescue operations have been concluded.

Pressurized Aircraft. Sealed, modern type aircraft within which the internal atmospheric pressure can be regulated.

Protective Clothing. A general term used to describe fire fighters' clothing and that includes helmets, protective coats, protective trousers, boots, and gloves.

Rescue. Removal or assisting in the evacuation of occupants of an aircraft involved in an accident/incident or those persons exposed to such accident/incident.

Rescue Path. A fire free path from an aircraft accident site to a safe area. This path, normally selected by evacuees, must be maintained by fire fighters during the evacuation process.

Resources. Personnel, vehicles, and equipment required to overcome the problems incidental to an aircraft accident/incident.

Response Time. The total period of time measured from the time of an alarm until the first RFF vehicle arrives at the scene of an aircraft accident and is in position to apply agent to any fire.

Restricted Articles. See Dangerous Goods.

Runoff. Liquids which flow by gravity away from an aircraft accident and may include aviation fuel (ignited or not), water from fire fighting streams, liquid cargo, or a combination of these liquids.

Runway. A defined rectangular area on a land airport prepared for the landing and taking off of aircraft along its length. Runways are normally numbered relative to their magnetic direction.

Salvage. A fire fighting procedure for protecting property from further loss following an aircraft accident or fire.

Self-Contained Breathing Apparatus (SCBA). A respirator worn by the user that supplies a respirable atmosphere, that is either carried in or generated by the apparatus, and is independent of the ambient environment.

Size-Up. A mental process of evaluating the influencing factors at an emergency prior to committing resources to a course of action.

Skin. The outer covering of an aircraft fuselage, wings, and empennage.

Smoke Ejector. A mechanical device, similar to a large fan, which can be used to force heat, smoke, and gases from a post fire environment and draw in fresh air.

Tabletop Training. A workshop style of training involving a realistic emergency scenario and requiring problem-solving participation by personnel responsible for management and support at emergencies.

Theoretical Critical Fire Area (TCA). The theoretical critical fire area (TCA) is a rectangle, the longitudinal dimension of which is the overall length of the aircraft, and the width includes the fuselage and extends beyond it by a predetermined set distance that is dependent on the overall width. Therefore, the aircraft length multiplied by the calculated width equals the size of the TCA.

Threshold. The beginning of that portion of the runway usable for landing.

Titanium. A lightweight, strong alloy with a strong resistance to heat and fire. It is difficult to extinguish once ignited. Used mostly for engine parts and adjacent engine areas.

Triage. The sorting of casualties at an emergency according to the nature and severity of their injuries.

Triage Tag. A tag used in the classification of casualties according to the nature and severity of their injuries.

Turboprop Aircraft. An aircraft powered by one or more turbine engines each of which drives a propeller.

Turret. A vehicle-mounted master stream appliance.

Undercarriage. All components of an aircraft landing gear assembly.

Ventilation. The systematic removal of heated air, gases, and smoke from a fire area and replacing it with fresh air.

Vertical Stabilizer. That portion of the aircraft's empennage that contains the rudder.

Chapter 2 Preplanning for Aircraft Emergencies

2-1 General.

2-1.1 In addition to routine training programs, airport RFF services and all structural fire departments and community emergency services with jurisdictions adjacent to an airport or its traffic patterns are encouraged to frequently schedule and participate in multi-agency training sessions based on the material in this manual. The objective of these sessions should focus on achieving maximum unity, compatibility, and effectiveness at aircraft emergencies should they be on or off the airport. (See Section 2-5.)

2-1.2 All airport and community emergency services should participate in annual exercises involving a simulated aircraft accident. Frequent command-level training for those persons assigned to major roles in the airport/community emergency plan is also essential. Command training can be presented in the form of workshop or tabletop

exercises designed to develop effective emergency management techniques. Guidance for emergency plan exercises is provided in NFPA 424M, *Airport/Community Emergency Planning*.

2-1.3 Command authority at any accident site should be predetermined according to the jurisdictional responsibilities of the agencies involved and as designated in their airport/community mutual aid agreement.

2-2 Emergency Response Preplanning.

2-2.1 All RFF vehicles in use at the airport should be able to meet the provisions of NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, upon acceptance from the manufacturer and should be maintained in a manner to assure such levels of performance. Special training should be provided to enhance the skills of all vehicle operators as their performance is critical to successful vehicle utilization, particularly under unfavorable conditions.

2-2.2 Operators assigned to each RFF vehicle should make trial runs to all areas of the airport in all weather conditions during which flight operations take place. Particular emphasis should be placed on the ability to respond to the critical rescue and fire fighting access area since this is where most accidents occur. These runs will demonstrate each vehicle's operational capability and the time required to reach each site. Since many aircraft accidents occur in the overrun areas of the runways, it is important to provide suitable routes for use by the vehicles to enable them to reach these areas. Bridges spanning gullies, streams, ditches, cattle grids, or other ground surface appurtenances should be capable of supporting at least 120 percent of the weight of the heaviest emergency vehicle.

2-2.3 Where construction work of any kind is likely to affect the response capability or operational performance of the RFF service, prior notification of the work should be provided so that amendments can be made to operational procedures to overcome or minimize their effect. This is particularly important where work on airport water mains is likely to close down one or more fire hydrants.

2-2.4 In order to provide multi-vehicle access to the accident site, service roads should be so constructed that one vehicle cannot block ingress or egress for other emergency vehicles. This can be accomplished by providing roads of sufficient width or suitable passing and turnaround areas. (See 4-1.6 and 4-1.7.)

2-2.5 Frangible gates or fence sections should be located at strategic locations to allow rapid access by RFF vehicles to areas outside the airport boundary. Keys to gate locks should be carried on each authorized emergency vehicle, by airport security personnel and designated local emergency services.

2-2.6 Grid maps should be provided for each airport and its environs. They should be ruled with numbered and lettered grids (see Figure 2-2.6) to permit rapid identification of any response area. The area covered by a grid map should be a distance of 5 mi (8 km) from the center of the airport. This can vary depending upon the type of terrain or location of the airport in relation to other emergency facilities. Map nomenclature should be compatible with

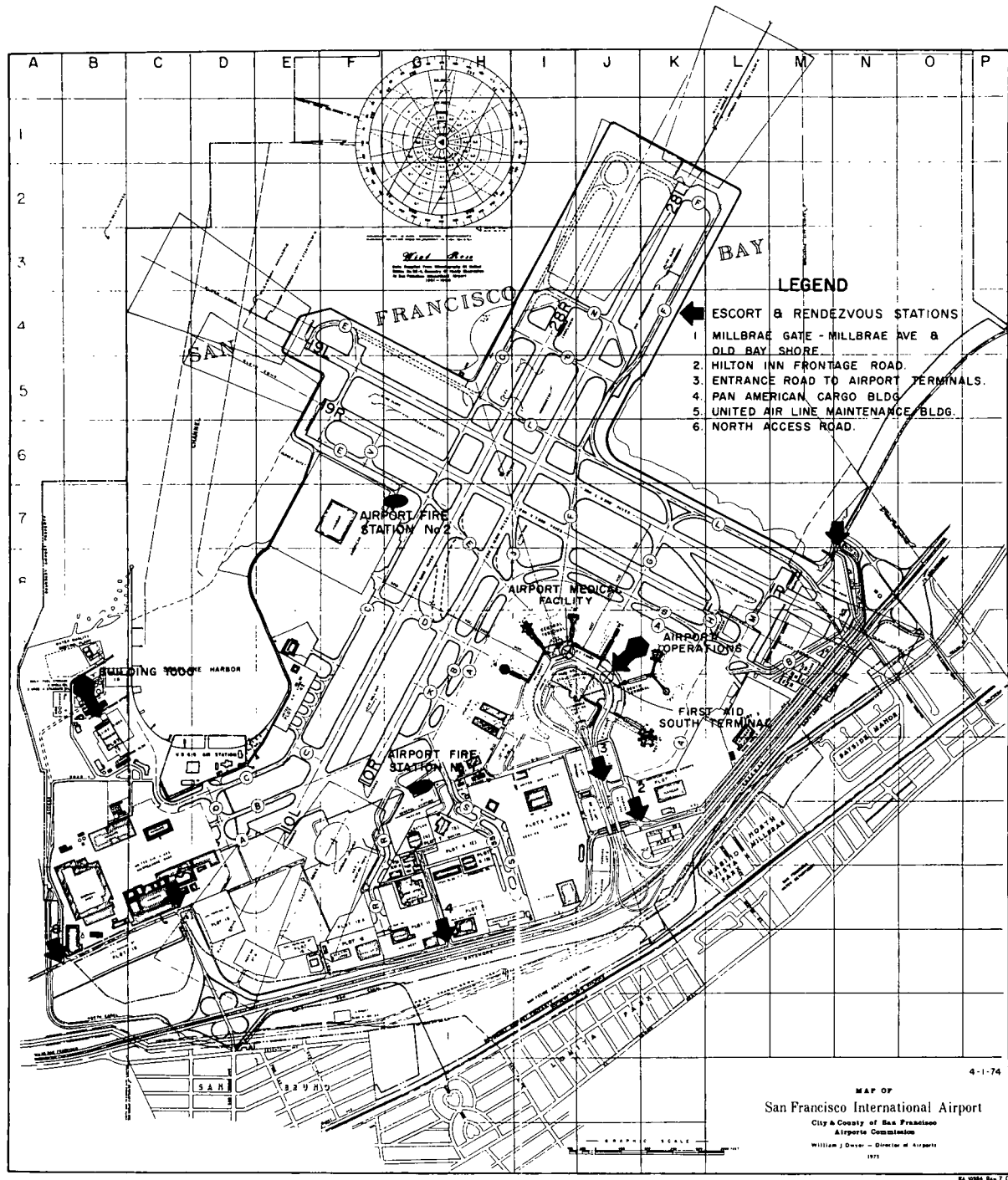


Figure 2-2.6 Typical airport grid map.

that used by off-airport public safety authorities. Two or more maps might be required where the area exceeds a 5-mi (8-km) radius. One map should display medical facilities, heliports, and other features according to the airport/community emergency plan. Where more than one grid map is used, grid identifications should differ by color and scale to assist in their identification. Prominent local features, access routes, staging areas, and compass headings should be shown to facilitate locating accident and

medical facility sites. Copies of grid maps should be prominently displayed at Air Traffic Control, the airport operations office, each airport and community fire station, all mutual aid services, and carried on all appropriate emergency vehicles.

2-2.7 A standby electrical system should be provided in airport fire stations so that in the event of failure of the primary system, sufficient power would be available for

the operation of electrically operated vehicle bay doors, station lighting, and communication systems.

2-2.8 A communication system from the airport to community or regional emergency services should be provided. The reliability of the system should be tested daily.

2-2.9 Any off-airport emergency services authorized to respond to an on-airport incident should preplan access to the various areas of the airport, particularly the designated staging areas. Personnel should also be trained in the special procedures to be followed once on the airport.

2-2.10 Sufficient RFF vehicles and equipment should be provided to meet the required level of protection as specified in NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports*, for the airport during flight operations. When this protection level is reduced for any reason (i.e., off-airport response, mechanical breakdown, lack of qualified personnel, etc.), all incoming and departing aircraft should be notified of the change in RFF capability.

2-2.11 It is important that preplanning includes response of additional pumping vehicles, ladder trucks, elevated platform vehicles, portable lighting equipment, hoisting and lifting equipment, medical supplies, and any other available specialized equipment or vehicle for which a requirement is anticipated. It is extremely important that the preplan also assures the immediate availability of the special vehicles and equipment, provision for qualified driver-operators, and especially the availability of approving authority on an around-the-clock basis.

2-3 Airport Fire Fighter Basic Knowledge.

2-3.1 To assure that airport fire fighters have a suitable degree of skill, basic training should be provided in accordance with NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*.

2-3.2 Comprehensive, continuous in-service training should be provided to maintain each fire fighter's proficiency. For further information on training subjects, see the references listed in Chapter 14. The following are specific basic training requirements for RFF personnel.

2-3.3 The complexity of modern aircraft and the variety of types in service make it difficult to train RFF personnel in all the important design features of each model. However, they should become as familiar as possible with each type of aircraft that normally uses the airport. Particular emphasis should be placed on the following (*see also Appendix A*):

- (a) Location and operation of normal and emergency exits, cargo doors, equipment, and galley access doors;
- (b) Seating configurations;
- (c) Type of fuel and location of fuel tanks;
- (d) Location of ejection seats and armament (military aircraft);
- (e) Locations of batteries, hydraulic, and oxygen systems;
- (f) Positions of break-in points on the aircraft;

(g) Location of rapidly activated standby generators or turbines; and

(h) Fire access panels.

2-3.4 Airports are large commercial complexes which contain many potential life and fire hazards. These hazards vary relative to aircraft operations, time of day, weather conditions, construction, or a combination of these factors. It is, therefore, vital that RFF personnel become extensively knowledgeable about the airport and any changes that occur which could adversely affect immediate response or the efficient performance of their rescue and fire fighting responsibilities. Minimum requirements of knowledge should include:

- (a) Water supply locations (hydrants);
- (b) Runway identifications and locations;
- (c) Taxiway identifications and locations;
- (d) Airport lighting systems;
- (e) Most effective response routes and alternatives;
- (f) Fuel handling and storage areas;
- (g) Key airport locations;
- (h) Airport service roads;
- (i) Gates and fences; and
- (j) Airport drainage systems.

2-4 Communications.

2-4.1 All airport emergency vehicles should be provided with multiple channel two-way radios operating on the airport's assigned ground control frequency and other airport emergency frequencies.

2-4.2 It is desirable that airport RFF vehicles are able to monitor or be in direct voice communications with an aircraft during an emergency situation. This procedure is especially important when airport control towers are not in operation.

2-4.3 At an aircraft accident site, power megaphones can be valuable tools to coordinate air crew/RFF activities, direct evacuating aircraft occupants to safe locations, etc.

2-4.4 Portable radios can be utilized at an accident site to communicate with the command post, airport emergency dispatcher, airport management, arriving back-up units, etc. Where personnel and vehicles from more than one agency will operate in mutual support, common radio frequencies should be available. If not, preplanned procedures should be established so that portable radios can be exchanged, the use of messengers employed, or methods of relaying messages through the command post utilized. When portable radios are exchanged, consideration should be given to avoiding channel saturation and the maintenance of communication discipline.

2-5 Mutual Aid Considerations.

2-5.1 As indicated previously, it is essential to have mutual fire fighting assistance agreements with community and regional, off-airport fire departments. Successful rescue operations and handling of aircraft accident fires both on or off the airport depends on preplanning the effective use

of mutual aid. (See also *Appendix E.*) The following considerations are significant:

(a) Special attention should be given to assuring compatibility in equipment designs (i.e., fire hose threads, communications equipment, etc.) and to fire control operational techniques.

(b) It is important to familiarize structural fire department personnel with the special problems relating to aircraft rescue and fire fighting including methods of access to aircraft operating areas and how to operate vehicles while on the airport.

2-5.2 Airport orientation visits should be arranged by fire departments bordering airports for consultations with the airport fire department, airlines, the military services, and others as appropriate. Their training in airport/aircraft familiarization should include those items listed in 2-3.3 and 2-3.4, diagrams in Appendix A, and grid maps of the airport and surrounding area.

2-5.3 Structural fire fighting vehicles normally carry small amounts of water as compared to the amounts usually carried on major airport RFF vehicles. However, they can be useful in relaying water from hydrants, reservoirs, or other sources to maintain RFF vehicle supplies.

2-5.4 Structural fire fighters can be utilized to provide assistance to airport RFF personnel by handling hose lines, operating tools and equipment, assisting in rescue operations, and protecting exposures.

Chapter 3 Flight Crew and RFF Personnel Responsibilities

3-1 Areas of Responsibility.

3-1.1 A proper understanding of RFF personnel and flight crew responsibilities at aircraft emergencies help to assure that all efforts are clearly directed toward a common goal.

3-1.2 The prime mission of all concerned is the safety of all persons aboard the aircraft and any others involved in the emergency. Duties and responsibilities can generally be defined as follows:

(a) Flight crews hold the primary responsibility for the aircraft and for the safety of its occupants. The final decision to evacuate an aircraft and the manner in which the evacuation is carried out is made by the flight crew provided they are able to function in the normal manner at the time.

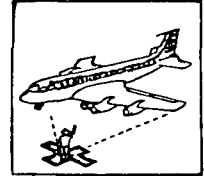
(b) It is the duty of responding RFF personnel to create conditions in which survival is possible and evacuation or rescue can be conducted. As visibility from within an aircraft is limited, any external features or situations likely to be of significance in the evacuation process should be communicated to the aircraft's crew. Should it become apparent that the crew's incapacity precludes the initiation of evacuation, the officer in charge of the RFF personnel should take the initiative.

3-2 Communications.

3-2.1 Effective communications between flight crews and RFF personnel are very important during emergencies. Contact should be established at the earliest possible time between persons in charge of each group. Exchange of pertinent information at this point can assist in developing better decisions and plans of action. Several methods of direct communication are generally available.

Location of Signalperson in Relation to Aircraft

The signalperson should take position relative to the aircraft as indicated in the drawing on the right, remaining in full view of the pilot at all times when using hand signals.



Taxi Straight Ahead

Day: Face left wing's leading edge (if necessary walk backward in direction aircraft has to move). Raise both hands before the body with elbows flexed and palms toward face and execute beckoning motions with both forearms.



Night: Same, using wand-type flashlight in both hands.

Left Turn

Day: Execute taxi ahead signal with left hand. At the same time hold right arm outstretched and stationary toward aircraft's left wing.



Night: Same, using wand-type flashlight in both hands.

Right Turn

Day: Execute taxi ahead signal with right hand. At the same time hold left arm outstretched and stationary toward aircraft's right wing.



Night: Same, using wand-type flashlight in both hands.

Stop Aircraft

Day: Cross both arms extended above head with palms toward aircraft.

Night: Same, using wand-type flashlight in both hands. Cross the wands.



Emergency Stop of Aircraft

Day: Cross arms above head, move from side to side.

Night: Same as above.



Stop Engines

Day: Move right hand across throat.

Night: Same, flashlight held in right hand.

Figure 3-2.3 Standard international ground to aircraft signals.

3-2.2 Where aircraft engines are operating, radio communications near the aircraft may be very difficult. Most aircraft are equipped with intercom systems and provided with plug-in jacks normally located under the forward portion of the aircraft near the nose gear. RFF personnel should be aware of this means of communication and carry the necessary headset and microphone to plug into these facilities. Even with the engines operating, direct communications with the flight crew can be established by use of this system as long as the power is on.

3-2.3 Where a more direct means of communication cannot be established, the officer in charge of the responding RFF personnel should go to the left side of the aircraft nose and establish direct eye contact and voice communications with the captain of the flight crew. If engine noise is a problem and a power megaphone is not available, it might be necessary to resort to hand signals to communicate. Figure 3-2.3 depicts standard international ground to aircraft hand signals that should be used by RFF personnel to communicate with the captain during emergencies.

3-2.4 If aircraft engines are operating, RFF personnel should use extreme caution when approaching an aircraft for communications purposes as described in 3-2.2 and 3-2.3. The aircraft should be approached only from the front and well ahead of the nose and, if possible, in full view of the captain. Vehicle and hand-held lights should be used in periods of darkness and poor visibility.

directly exposed to flame, burnthrough will occur within 60 seconds or less while the windows and insulation may withstand penetration for up to three minutes. Because of this serious life hazard to occupants, rapid fire control is critical. Therefore, whenever flight operations are in progress, RFF vehicles and personnel should be so located that optimum response and fire control can be achieved within this time frame.

4-1.2 At many airports portions of the critical rescue and fire fighting access areas might be outside the airport boundaries. There also can be obstructions created by natural features, highways, or railroad right-of-ways which would delay or preclude access by RFF vehicles. Consideration should be given in these instances to provide specialized vehicles where conventional vehicles can be restricted due to unusual terrain characteristics. Any delay in response time is critical, and mutual assistance agreements with off-airport agencies should be established to provide optimum response in problem areas. (See Figure 4-1.2.)

4-1.3 To obtain the desired response, preplanning should include a wide range of factors such as adequate alarm systems, fire station locations (or pre-positioning of resources), vehicle operator training, and airport familiarization.

4-1.4 To minimize response times, operational procedures should exist through which Air Traffic Control (ATC) would stop or divert all aircraft and nonessential traffic that would conflict with responding emergency vehicles.

4-1.5 All-weather access routes to the critical rescue and fire fighting access area suitable for RFF vehicles should be designated and should be maintained in usable condition while flight operations are in progress.

4-1.6 Airports updating their master plan for airport development should include items which would improve response times. Consideration should include fire station(s) and their location, two-way access roads in the approach

Chapter 4 Emergency Response

4-1 General.

4-1.1 The survivable atmosphere inside an aircraft fuselage involved in an exterior fuel fire is limited to approximately three minutes if the integrity of the airframe is maintained during the impact. This time is substantially reduced if the fuselage is fractured. When the aluminum skin is

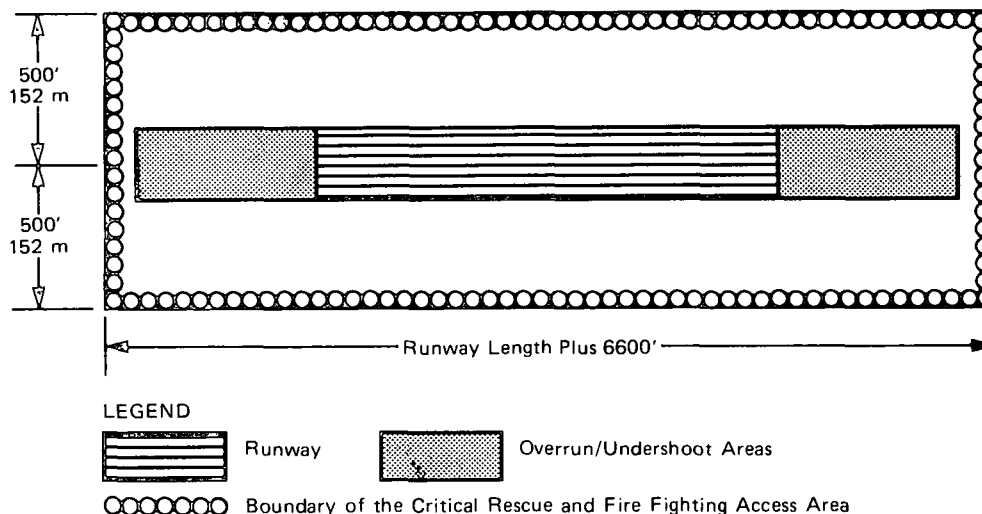


Figure 4-1.2 Critical rescue and fire fighting access area.

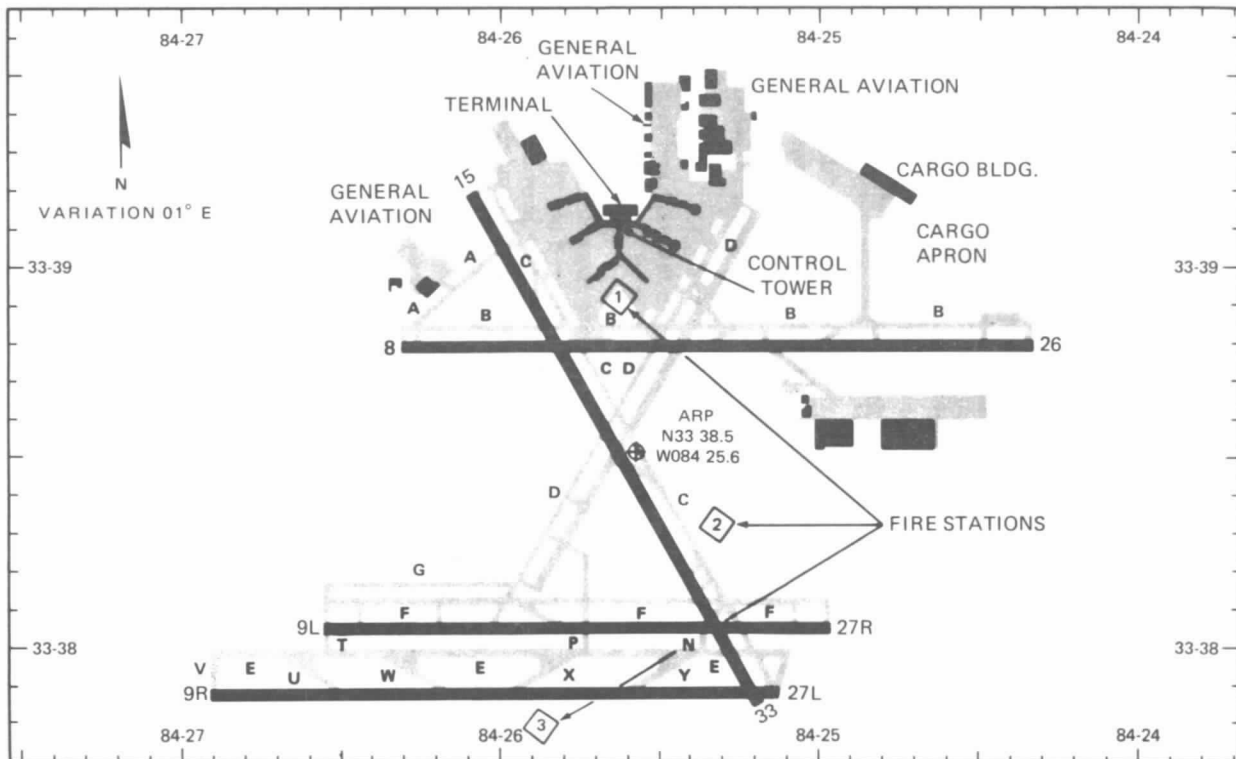


Figure 4-1.7 Example of airport fire station locations.

and overrun areas, and obstruction clearance in the critical rescue and fire fighting access area.

4-1.7 Response routes from the fire station(s) should be designed with the least number of turns required and with any turning angle being not more than 45 degrees. (See Figure 4-1.7.)

4-2 Low Visibility Operations.

4-2.1 New and improved techniques for instrument takeoff and landing permit flight operations to continue under adverse weather conditions. Low visibility operations criteria vary from one airport to another depending upon the type of instrument landing system available, the level of natural and manmade obstructions in the surrounding terrain, the type of runway lighting, and the capability of the onboard instrument systems of the aircraft using the airport. Such operational minimums can vary from 3 mi (5 km) visibility to 300 ft (100 m) for landings and with similar restrictions for takeoff. RFF personnel should ascertain operational restriction levels from the local Air Traffic Control (ATC) agency in order to establish response capability under minimum visibility conditions.

4-2.2 Although aircraft operational navigational weather minimums might not be in effect, fully staffed Alert 1 standby procedures should be initiated when flight operations are in progress and surface visibility and conditions are less than $\frac{1}{2}$ mi (800 m). (See also Section 8-2.)

4-2.3 Standbys during low visibility operations and adverse weather conditions should have at least one major

RFF vehicle located at a distance no closer than the taxiway hold line adjacent to the midpoint of the active runway unless the fire station(s) location(s) permit effective response times. (See Figure 4-1.7.) When on standby, vehicle operators should keep engines running and all emergency lights operating.

4-2.4 RFF personnel assigned to any standby should monitor all applicable radio frequencies.

4-2.5 Air Traffic Control (ATC) should be made aware of the exact location of the RFF vehicles assigned to standby duty. Where available, surface navigational aids, such as ground radar (ASDE), should be fully utilized through coordination between RFF personnel and the control tower.

Chapter 5 Factors Common to Airport Emergencies

5-1 General.

5-1.1 The primary hazard associated with aircraft accidents is that liquid fuels are likely to be released and ignited during the accident sequence. A secondary hazard is that fuels released but not ignited could subsequently be ignited prior to or during the egress of occupants. In addition, fires involving combustible materials such as interior furnishings, stored goods, and electrical system components can occur. Further complications could result if the aircraft comes to rest in such an attitude that forcible fuselage entry might be required.

5-1.2 During all aircraft emergencies, all persons not directly involved in the RFF phase of the incident, including the news media, should be required to stay well clear of the site until evacuation, occupant care, full fire control, and site safety security are completed. Responsibility for site security should be preassigned to the airport police and may be augmented by local police, guards, and volunteers as needed.

5-2 Types of Emergency Alerts.

5-2.1 The terms used to describe categories of emergency alerts are not standardized. The Federal Aviation Administration (FAA) terms, Alert I, Alert II, and Alert III, and the International Civil Aviation Organization (ICAO) terms, "Local Standby," "Full Emergency," and "Aircraft Accident" are equivalent.

5-2.2 Alert I — "Local Standby." When an aircraft has, or is suspected to have, an operational defect, the incident should be considered an Alert I. The defect should not normally cause serious difficulty for the aircraft to achieve a safe landing.

5-2.2.1 Under Alert I conditions, at least one RFF vehicle should be staffed and positioned to permit immediate use in the event of an accident. If the time and conditions permit, RFF personnel should be advised of the (1) aircraft type, (2) number of passengers and crew, (3) amount of fuel remaining, (4) nature of the emergency, (5) type, amount, and location of dangerous goods aboard, and (6) number and location of nonambulatory passengers on-board, if any. All other in-service RFF vehicles should remain available for immediate response.

5-2.2.2 An Alert I should also be initiated when an aeromedical evacuation aircraft with patients aboard is approaching or departing the airport. (*See Chapter 12.*)

5-2.2.3 Alert I procedures should be implemented whenever required response times cannot be achieved. Factors that can affect response times include construction work, field maintenance, adverse weather conditions, and low visibility. (*See Chapter 2 and Chapter 4.*)

5-2.2.4 Airports should have management policies for implementation of Alert I procedures during arrival and departure of certain categories of aircraft that do not normally use the airport.

5-2.3 Alert II — "Full Emergency." When an aircraft has, or is suspected to have, an operational defect that affects normal flight operations to the extent that there is danger of an accident, the incident should be considered to be an Alert II, "Full Emergency."

5-2.3.1 When an Alert II emergency is declared, RFF personnel should be provided with detailed information which allows preparation for likely contingencies. A full response should be made with the RFF vehicles staffed and in position with engines running and all emergency lights operating so that the fastest response to the accident/incident site can be accomplished.

5-2.3.2 It is important that appropriate radio frequencies be continuously monitored by RFF personnel. One

or more major RFF vehicles should be able to initiate fire suppression within the briefest period of time after the aircraft comes to rest. Standard standby positions for RFF vehicles should be established for a variety of anticipated circumstances.

5-2.3.3 RFF personnel should be informed of any changes in a distressed aircraft's emergency situation which could affect its touchdown point or ultimate behavior after touchdown.

5-2.4 Alert III — "Aircraft Accident." This alert denotes that an aircraft accident has occurred on, or in the vicinity of, the airport.

5-2.4.1 Regardless of the source of an Alert III alarm, full RFF response should be put into effect. When possible, all known pertinent information should be relayed via radio by Air Traffic Control (ATC) to responding units and include, as accurately as possible, the accident location using landmarks and grid map coordinates.

5-2.4.2 When an accurate accident location is not available, RFF personnel should anticipate the worst situation and stand by until signs of an accident are evident or better information is given. Mutual aid assistance should be initiated in accordance with the airport/community emergency plan. (*See also NFPA #24M, Airport/Community Emergency Planning, and ICAO ASM-7.*)

5-3 Vehicle Response to Aircraft Accidents.

5-3.1 RFF vehicles should approach any aircraft accident by the route that provides the quickest response time. This might not necessarily be the shortest distance to the scene. Traversing through unimproved areas can take longer than traveling a greater distance on paved surfaces such as taxiways, ramps, and roads. Total response time is vital. Preferred routes, especially those within the critical rescue and fire fighting access area, should be pre-selected. Practice response runs should be made under both ideal and inclement weather conditions.

5-3.2 In some cases, runways and taxiways are blocked by aircraft awaiting taxi clearance or takeoff. Vehicle operators should be aware of alternate routes that can be used so as not to delay response.

5-3.3 The load-bearing characteristics of the airport soil structure under various weather conditions should be known and vehicle operators should be trained to deal with off-road driving conditions.

5-3.4 When nearing the accident scene, vehicle operators should be alert to avoid all persons in the area, especially those who might be injured, unconscious, or wandering about in a dazed condition. In darkness, periods of low visibility, or when operating in areas of tall vegetation, extra caution and effective use of spotlights and floodlights are required. When feasible, the escort of vehicles by personnel on foot should be considered.

5-4 Positioning of RFF Vehicles.

5-4.1 Information from the flight crew relative to the nature of the emergency will assist the RFF personnel to

better determine the most advantageous positioning of the vehicles upon arrival at the scene of an aircraft emergency.

5-4.2 Piston-type engine aircraft provide more options for initial positioning of RFF vehicles than do turbojet aircraft which have swept-back wings and produce a jet blast hazard. RFF personnel should therefore consider an approach from the nose of jet aircraft. However, this should not become a standard procedure as wind conditions, terrain, type of aircraft, location of engines, cabin configurations, and other factors can dictate the optimum approach in a given circumstance.

5-4.3 Vehicle position should never obstruct aircraft evacuation or interfere with the deployment of evacuation slides. (See also Chapter 7.)

5-4.4 Propellers turning on turboprop or piston-type engine aircraft present a hazard to evacuees and RFF personnel. Turbojet engines present different problems. For example, the areas directly ahead of and for a considerable distance behind the engines should be avoided because of the intake and jet blast hazards. Turbojet engines will rotate for a considerable time after they have been shut down. (See Figure 5-5.6.)

5-4.5 When combination cargo/passenger (COMBI) aircraft have declared an emergency, RFF personnel should be informed of cabin configurations prior to the landing. Since some cargo areas extend over the wings, the over-wing exits could be unavailable for use as emergency exits.

5-4.6 The mission of the first-arriving RFF vehicle and crew is to assist in evacuation of occupants, prevent the outbreak or spread of fire and perform any rescue operations required. The vehicle should be positioned to protect the principal evacuation route being used by the occupants. When it is obvious that the occupants are evacuating safely without assistance and the fire or threat of fire is controlled, later-arriving vehicles and crews can be strategically positioned and tasks assigned. Caution must be exercised to avoid placing evacuees, RFF personnel, or vehicles in locations that could become hazardous in the event of a sudden extension of fire.

5-5 Hazards to RFF Personnel.

5-5.1 RFF personnel should always remain alert to the possibility of ignition of flammable vapors that are always present in the area of damaged aircraft. Elimination of ignition sources and the maintenance of an unbroken foam blanket is the best procedure in preventing ignition of these vapors.

5-5.2 All RFF personnel should be provided with and be required to wear proper and complete protective clothing and equipment. Minimum protective clothing and equipment should be either a fire fighter's helmet or proximity hood, protective coat and protective trousers, boots, gloves, and positive pressure self-contained breathing apparatus. Personnel should be fully trained in the use limitations and value of such protective clothing and equipment by utilizing them in frequent fire fighting drills.

5-5.3 Aircraft structures damaged by fire or impact forces are often very unstable and subject to collapse or roll over.

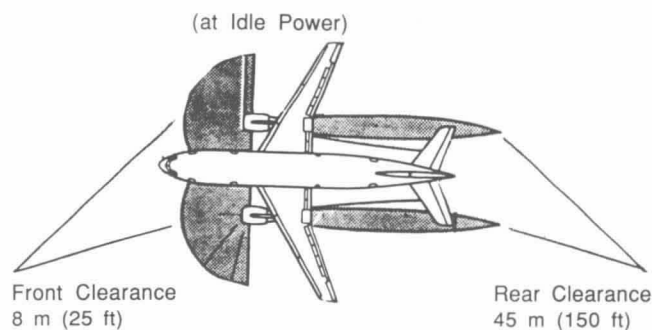
If these conditions are suspected to exist, precautions in the form of blocking or shoring should take place as soon as practicable to assure the safety of RFF personnel working in the area. Blocking and shoring nonessential to rescue and fire fighting operations should not be undertaken by RFF personnel.

5-5.4 If dangerous goods are believed to be involved in an emergency, procedures should be carried out as prescribed in the US Department of Transportation *Emergency Response Guidebook*. This also includes incidents involving agricultural spraying aircraft and the associated pesticides.

5-5.5 Any undercarriage fire creates a potential for aircraft collapse or the explosive disintegration of affected components.

5-5.6 RFF personnel should stay well clear of an operating jet engine to avoid intake and exhaust hazards. (See Figure 5-5.6.)

Danger Zones



Note: Crosswinds will have considerable effect on contours

Figure 5-5.6 Engine run danger areas.

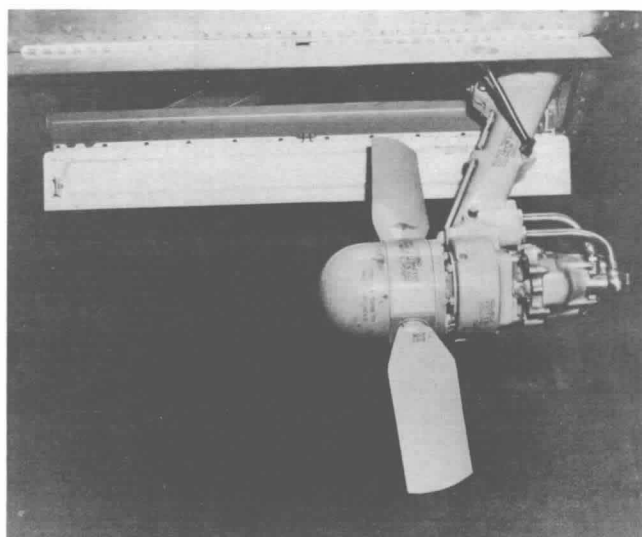


Figure 5-5.8 Ram Air Turbine. Shown is a deployed Ram Air Turbine on a Lockheed 1011 aircraft. It is located at the center underside of the fuselage slightly forward of a point directly in line with the main landing gears.

5-5.7 The propellers of piston-type engine aircraft should never be moved when at rest, as any movement could, under certain conditions, restart the engine.

5-5.8 Some modern jet aircraft are equipped with Ram Air Turbines (RAT) designed to provide backup electrical and hydraulic power in the event of in-flight failures of primary systems. These devices are often designed to deploy from flush fuselage or engine-mounted storages, and some can deploy with considerable force. RFF personnel should become aware of aircraft employing these systems and their locations. Serious injury could result should the RAT accidentally deploy and strike a person during emergency operations. (See Figure 5-5.8.)

Chapter 6 Aircraft Construction and Materials

6-1 Construction Materials.

6-1.1 RFF personnel should become familiar with aircraft construction materials. Most of these materials have a low resistance to flame exposure and their behavior under fire conditions should be understood. They have high resistance to cutting or other forcible entry methods that can sometimes be difficult and time consuming, and can virtually impede successful rescue and fire fighting operations.

6-1.2 Much of a modern aircraft structure is aluminum alloy. It is approximately one-half as heavy as steel and its appearance is light gray or has a silvery surface when polished. It is used as sheets for aircraft skin surfaces, as channels for framework, and as plates and castings for bulkheads and fittings. This metal will not contribute to a fire to any significant degree. However, it will melt under the conditions found in aircraft fires. For this reason it is essential to keep fuselage surfaces cool during rescue operations.

6-1.3 Magnesium alloys are used for landing gear, wheels, engine mounts, brackets, crankcase sections, cover plates, and other engine parts. The appearance of this metal is silvery-white or grayish, and it is about two-thirds the weight of aluminum. While it is not easily ignited, when it is ignited it burns violently and cannot be easily extinguished. It thus presents a serious reignition source. Sparks developed when the metal comes in contact with paved surfaces, as might occur in a wheels-up landing, have the capability of igniting flammable vapors.

6-1.3.1 Where special extinguishing agents are not available for magnesium fires, water in coarse heavy streams might provide a suitable alternative fire control method. At first, such streams will result in localized intensification of flame, and considerable sparking and showering of burning magnesium. Isolated burning pieces of magnesium should be removed from flammable vapor areas.

6-1.4 Steel is used in aircraft engine parts, around engine nacelles, engine fire walls, and tubing. The metal presents no fire hazard, nor does it contribute to a fire except that it can create friction sparks when in contact with runway surfaces during a wheels-up landing. The sparks have sufficient energy to ignite flammable vapors. In most forms

used in aircraft, steel can be cut with metal cutting saws, but because of the sparks produced, it is a potentially hazardous operation in the presence of flammable vapors. Stainless steel might be found on some fuselage surfaces of jet aircraft.

6-1.5 Titanium is used primarily in engine parts, nacelles, and for engine fire walls. It is a combustible metal but in the forms used in aircraft, it has a high degree of heat and fire resistance. Once ignited, titanium is difficult to extinguish. Water is ineffective. Turbine engine fires involving titanium cannot normally be extinguished by external fire fighting techniques within the time period necessary to complete rescue operations. Titanium metals are a friction spark hazard similar to steel and magnesium. Surfaces of titanium are very difficult to penetrate, even with power equipment.

6-1.6 To improve the payload/vehicle-weight ratio of aircraft without compromising structural strength, increasing use is being made of composite materials. They are made of small, fine fibers embedded in carbon/epoxy materials. The fibers are usually boron, fiberglass, aramid, or carbon in the form of graphite. Composite, fiber-plus-plastic materials have replaced metal in many aircraft components. These materials do not present any unusual fire extinguishment problems.

6-1.7 Many aircraft cabin materials in current and continuing use as well as newer fire resistive materials can produce high concentrations of toxic gases when heated even though no open flaming is visible. Therefore, it is imperative that positive pressure self-contained breathing apparatus be worn by all fire fighters engaged in rescue, fire fighting, and overhauling operations.

6-2 Aircraft Fuel Tanks.

6-2.1 In some aircraft, where the wing joins the fuselage, there is no substantial separation to provide a desired fire wall. As all aircraft have wing tanks, many without separate metal or synthetic bladders within the wing cavity, vapors are seriously exposed under fire conditions.

6-2.2 Some aircraft carry fuel in the center wing section which in effect places fuel storage within the fuselage. It is thus possible, under some conditions, for fuel or vapors from tanks damaged due to an aircraft accident to enter the fuselage.

6-2.3 Currently entering commercial service are wide-body aircraft with provision for additional fuel storage within both the horizontal and vertical stabilizers. Damage to these tanks in the event of an aircraft accident poses a number of problems including those where fuel or vapors might enter occupied sections of the aircraft and become ignited. These additional fuel storage locations can complicate the fire fighting operations and will require additional agent. (See also NFPA 403.)

6-2.4 Wing tanks on some aircraft are located directly above or to the side of landing gear mounts. These tanks have been ruptured during hard landings or other ground accidents.

6-3 Aircraft Exits.

6-3.1 Aircraft exits on transport category aircraft include doors, hatches, and windows of various sizes. These exits will vary with the age, size, and types of the aircraft. RFF personnel should remain familiar with the operation of the various exit facilities on the type of aircraft normally using the airport.

6-3.2 Doors on most older, unpressurized aircraft open outward and can be opened from outside and inside the aircraft.

6-3.3 The doors on modern pressurized aircraft are called "plug-type" doors. When these doors open they push in slightly, then pull out or retract upward into the ceiling. These doors are not operable as long as the cabin remains pressurized [as little as 0.015 psi (103 Pa)].

6-3.4 Pressurized aircraft are equipped with inflatable evacuation slides attached to emergency exit doors. When the system is armed, and the door is opened from the inside, the slide inflates and extends outward in less than 15 seconds with considerable force. RFF personnel therefore should remain out of those areas that are in line with emergency exit doors.

6-3.5 Doors should be approached and opened with caution as the slide might deploy either by design or malfunction.

6-3.6 When positioning ladders or mobile stairways prior to opening cabin doors from the outside, care should be taken since all aircraft doors do not open in the same direction.

6-3.7 Opening the doors of most modern type aircraft from the exterior can be accomplished more readily and safely using an aerial platform or a mobile stairway. If these units are not available, a ground ladder can be raised to a position adjacent to the door control mechanism, and if possible, on the side away from the direction the door is to be opened. Once the door is opened the ladder can then be moved into the door opening and secured at the top to prevent movement.

6-3.8 Overwing exits are part of the emergency evacuation system on several types of aircraft. They are also useful as entry points for rescue teams and for facilitating ventilation of the cabin. These exits have latch release devices both on the interior and exterior of the aircraft and are designed to open inward.

6-3.9 Some aircraft have doors that incorporate stairs on the side of the fuselage or in the tail section to facilitate passenger boarding and deplaning. Although in some circumstances they might be used as such, they are not considered emergency exits. RFF personnel should know which aircraft using the airport have these type doors and exercise proper caution when the need arises to open them.

Chapter 7 Evacuation and Rescue

7-1 Aircraft Evacuation.

7-1.1 Evacuation of occupants involved in aircraft accidents and assistance to those who cannot remove themselves should proceed with the greatest possible speed. While care is necessary in the movement of injured occupants so that their injuries are not aggravated, removal from the fire-threatened area is the primary objective.

7-1.2 Flight crews receive extensive training in aircraft emergency evacuation procedures. They are in the best position to make optimum decisions relative to evacuation procedures in most emergency situations. They also have immediate contact with those aboard the aircraft and therefore can direct the operations.

7-1.3 Prior to any planned emergency landing, flight crews normally will consider passenger relocation within the cabin. This procedure is used to expedite use of potential emergency exits. The practice of placing a crew member, or a person knowledgeable in evacuation procedures, at each exit to assist in the direction and movement of occupants is common practice where time and circumstances permit.

7-1.4 The tendency toward forward exiting is natural since most passengers boarded the aircraft at terminals through forward doors and will instinctively attempt to exit in the same manner. Other exit facilities are apt to be bypassed, especially if persons are under any mental strain or sense of panic. Overwing and other emergency exits requiring physical agility probably will be shunned by those doubting their ability to use them effectively. If visibility in the cabin is impaired due to darkness or dense smoke, orderly evacuation can be further complicated.

7-1.5 Limited evacuation options might be available to the flight crew due to circumstances aboard the aircraft. One or more emergency exits could be inoperable due to distortion caused by impact. Doors might be blocked by loose galley equipment. Aisles might be difficult to travel due to collapse of overhead panels and partitions, dislodged seats, and carry-on materials. Although normal evacuation procedures provide for the use of all available exits, flight crews are trained to remain flexible and are prepared to select the best means of exit as circumstances and conditions permit.

7-1.6 Many variations of aircraft accidents are possible and the flight crew can be faced with many decisions in the seconds before or after they occur. RFF personnel therefore cannot expect that standard procedures will be used in all instances and should remain flexible to provide whatever protection and support evacuees should require. In the event that the flight crew becomes incapacitated and evacuation does not immediately begin, RFF personnel should initiate evacuation procedures.

7-1.7 If fire conditions or fuel spills initially prohibit the use of certain emergency exits RFF personnel are usually in a better position to make this observation. The RFF officer in charge should not hesitate to communicate this information to the flight crew.

7-2 Evacuation Slides.

7-2.1 Evacuation slides are provided to expedite occupant egress from aircraft that have normal door sill heights above five feet. Because passengers are not trained in proper evacuation slide use, there is a degree of personal injury risk when they are used. RFF personnel should expect the occurrence of sprains, bruises, friction burns, and other minor injuries whenever evacuation slides are used. (See Figure 7-2.1.)



Figure 7-2.1 Photo shows proper entry and use of an evacuation slide.

7-2.2 If, during landing, the nose gear fails, the aircraft might come to rest in a tail-high attitude. The failure of one or more landing gears can result in a nose-high or listing attitude. In these instances, evacuation slides become somewhat ineffective because they do not deploy at the proper angle to the ground. A high percentage of injuries can be expected when evacuation slides are used under these circumstances. RFF personnel should be able to reduce the amount and severity of injuries and expedite evacuation by manipulating the slides and assisting evacuees. (See Figure 7-2.2.)



Figure 7-2.2 Assisting evacuees at the base of an evacuation slide.

7-2.3 Aircraft evacuation slides are susceptible to heat and fire exposure. They are combustible and when exposed to radiant heat they melt, then deflate, rendering them unusable. RFF personnel should protect evacuation slides from heat and flame to the best of their ability, but being extremely careful not to apply foam to the operational area of the slide. Foam on the slide makes it very slippery and increases the descent speed of evacuees, possibly causing severe injuries. (See Figure 7-2.3.)

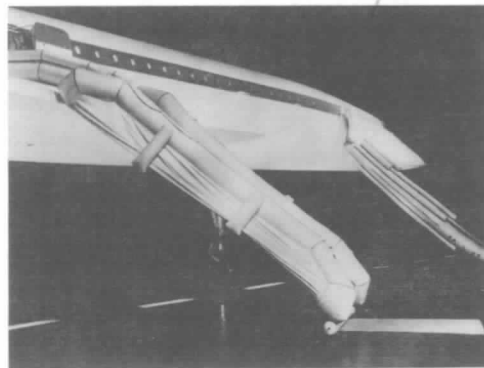


Figure 7-2.3 Photo shows two deployed evacuation slides. Evacuation slides are susceptible to heat and fire exposure.

7-2.4 If time and conditions permit, mobile stairways should be used as an alternative to deploying evacuation slides. This method of evacuation, when there is no immediate danger to aircraft occupants, would prevent many injuries. Response of available mobile stairways should be prearranged between RFF personnel, airlines, and/or airport maintenance facilities.

7-3 Evacuation Assistance by RFF Personnel.

7-3.1 The need to assist in aircraft occupant evacuation depends on a variety of factors. When occupants are self-evacuating, RFF personnel should support the operation and expedite it where possible. In other instances, actions would depend on the degree of occupant survivability, the fire situation, the condition of exits, and the status of evacuation facilities. In any event, rescue efforts should begin with fire prevention/control and by maintaining a safe path from egress points. Evacuees should be directed to an upwind location.

7-3.2 Fire prevention/control during evacuation should require strategic positioning of RFF vehicles and applying foam from turrets to establish a blanket covering the Practical Critical Fire Area (PCA). During this operation, emphasis should be placed on maintaining safe egress paths and eliminating the threat of fire extension into the fuselage. Foam handlines, which are more maneuverable than turret streams, should then be employed to protect evacuees and RFF personnel, extinguish spot fires, and maintain the integrity of the foam blanket. (See also Chapter 5.)

7-3.3 If time and conditions permit, RFF personnel should assist in the off-loading of evacuees at the base of the evacuation slides to minimize injuries. When high winds or unusual aircraft attitudes cause slides to invert or malposition, an attempt should be made to align them manually.

7-3.4 Ground ladders might be needed to assist occupants who have exited onto wing surfaces and those attempting to exit from openings where evacuation slides are unusable. It is important that assistance be given to evacuees using ladders to assure that they safely complete their exit and that any one ladder does not become overloaded.

7-4 Aircraft Forcible Entry.

7-4.1 Aircraft involved in accidents can come to rest in almost any attitude. Any abnormal landing force can jam emergency exits. In other instances the fuselage might be broken open by the impact forces and doors, windows, and hatches can become dislodged. It is difficult to anticipate the various possible accident conditions, and each incident presents unique problems that must be dealt with. RFF personnel should be thoroughly trained in forcible entry procedures as well as be provided with a wide variety of tools and equipment necessary to accomplish successful entry and extrication of trapped aircraft occupants.

7-4.2 In some instances, entry into an aircraft fuselage can only be gained by cutting through the aircraft skin. Knowledge of the aircraft is required to avoid contact with wires, cables, tubing, and heavy structural members. An area of the aircraft normally clear of these features is located in the upper fuselage area above the windows and any necessary cutting should be attempted in this area. Caution should be exercised to assure that cutting operations do not endanger trapped occupants.

7-4.3 Turbine powered aircraft have heavier skins and structures than the older piston aircraft. Due to this heavy construction, the only practical method of entry, other than using normal or emergency exits, is through the use of portable power tools. These tools take the form of electric, pneumatic, hydraulic, or gasoline powered cutting, spreading, or shifting equipment. Cutting areas on this type of aircraft are generally limited to spaces around doors and hatches. At best, this type of entry into a modern jet aircraft fuselage is very difficult and time consuming. These areas should be depicted on aircraft emergency diagrams. (See also Appendix A.)

7-4.4 Military combat-type aircraft present additional hazards due to armament, jettison equipment, and ejection seats. This type of aircraft should always be assumed as armed. Caution should be exercised to stay away from the front of this type of aircraft that can carry fixed guns and rockets. Unlaunched rockets, when exposed to fire,

are dangerous from both front and rear if they ignite. As with any ammunition, keep the rockets cool with foam or water. Further unclassified information should be obtained from the commanding officer of the nearest military installation.

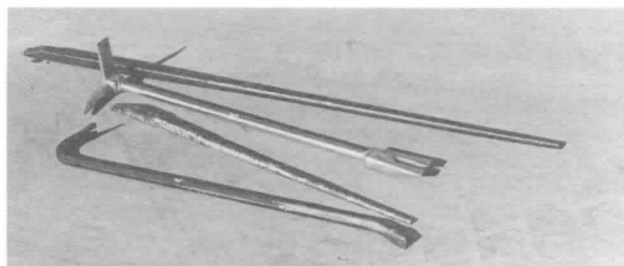


Figure 7-4(b) Prying tools. Claw and pry tools can be used for forcing doors and hatches that are jammed, to pull down panels and partitions, and to dislodge aircraft seats, etc.

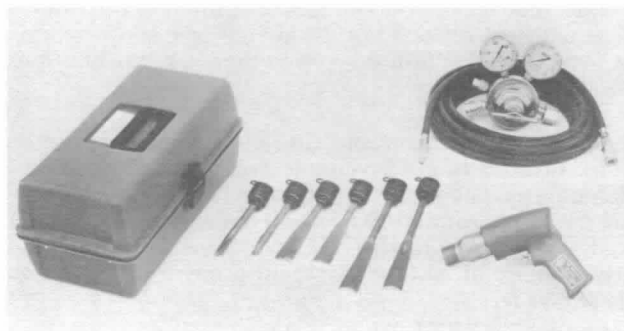


Figure 7-4(c) Air chisel. This tool can be used to cut aluminum and other light metals found on aircraft.

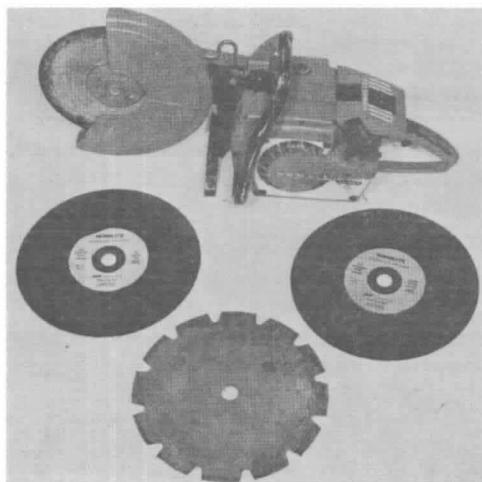


Figure 7-4(a) Rescue saws. Power saws can be used to cut through aircraft skin and structural materials. CAUTION SHOULD BE USED WHEN USING SPARK-PRODUCING POWER TOOLS WHERE FLAMMABLE VAPORS EXIST.

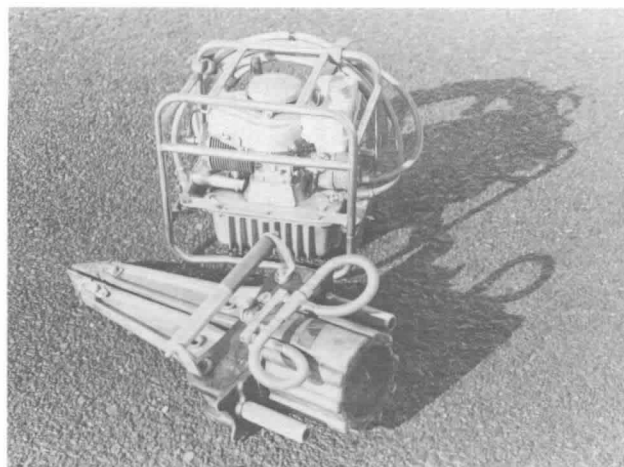


Figure 7-4(d) Hydraulic rescue tool. This portable tool is capable of applying extreme pressures to spread, cut, and lift. It can provide valuable forcible entry application in aircraft accident operations.

7-5 Extrication and Rescue.

7-5.1 Immediately following the self-evacuation phase of an aircraft accident a search of the fuselage interior and physical rescue of surviving occupants is crucial. Search and rescue teams should wear full protective clothing and

positive pressure self-contained breathing apparatus. They should also be equipped with charged hose lines for their protection and extinguishment of any fire that might have entered the fuselage. A THOROUGH SEARCH OF THE FUSELAGE INTERIOR AT THIS TIME IS EXTREMELY IMPORTANT. PERSONS, PARTICULARLY INFANTS, CAN BE EASILY OVERLOOKED OR HIDDEN BY DEBRIS.

7-5.2 Rescue operations should be carried out using normal aircraft openings whenever possible. Occasionally openings caused by airframe separations can be utilized when it is more convenient and safe to do so.

7-5.3 RFF personnel should have a general knowledge relative to the occupant capacity of the various types of aircraft which use the airport. Initial rescue plans should be based on the assumption that occupant load is at maximum.

7-5.4 The location of occupants in military aircraft can generally be determined by the aircraft type and sometimes by exterior design features such as canopies, gun positions, etc.

7-5.5 Even in survivable aircraft accidents, disruption of the fuselage can be severe, necessitating the improvisation of rescue efforts. RFF personnel should be skilled in the use of appropriate extrication tools and equipment as well as possessing the basic knowledge and skills to properly stabilize an injured occupant prior to removal from the wreckage.

7-5.6 RFF personnel rescue and extrication knowledge should include accepted post-aircraft accident procedures, particularly those matters dealing with fatalities and preservation of evidence as described in Chapter 11.

7-5.7 Aircraft accidents can occur during temperature extremes. These conditions can seriously aggravate the condition of persons trapped within an aircraft wreckage for an extended period. During this time it is extremely important to maintain the critical body temperature and vital functions of trapped victims.

7-5.7.1 Tarps, blankets, portable lights, fans, oxygen units, and portable temperature control units (heating and cooling) should be immediately available at an accident site. Temperature control units should be designed or located so as not to be an ignition hazard.

Chapter 8 Fire Control and Extinguishment

8-1 General.

8-1.1 The risk of fire at an aircraft accident is due to the close proximity of the systems that contain and distribute the fuel, and ignition sources such as heated components in engines and undercarriages, damaged electrical circuits, and friction caused by ground slide.

8-1.2 Any post-accident fire can seriously affect the ability of the aircraft occupants to safely evacuate and will reduce the time available to mount a successful fire fighting operation prior to rescue.

8-1.3 A fire can occur immediately upon impact, during a slide phase, when the aircraft comes to rest, after an interval, and in some instances, not at all. Once ignited, a fire can develop to lethal intensity very quickly and can enter the fuselage through opened exits and openings created by the impact.

8-1.4 Aircraft designers are continuously studying design factors and construction material changes which will increase "crashworthiness" and limit the development of fire situations that can impede evacuation. Additional modifications intended to increase the impact survivability of occupants are also being developed. Other changes include improved passenger restraints, reduced combustibility of cabin interiors, better marking of exit routes, upgraded emergency exits, and greater emphasis in the training of flight crews.

8-1.4.1 If these design improvement measures are as successful as anticipated, the prompt and effective intervention by trained RFF personnel becomes even more important than at present because a greater number of aircraft accident survivors needing assistance can be expected. RFF personnel should become intimately familiar with all aircraft types using the airport and pre-plan the optimum rescue and fire fighting effort that the fire department can produce with the resources it has at its disposal. Careful consideration of the recommendations in this manual can facilitate the development of practical operational plans.

8-2 Extinguishing Agents for Aircraft Fires.

8-2.1 Aqueous film forming foam (AFFF), film forming fluoroproteins (FFFP), protein foam, and fluoroprotein foam solutions are the primary extinguishing agents preferred for aircraft rescue and fire fighting.

8-2.2 Complementary extinguishing agents include dry chemicals and halons. They are generally best for use on three-dimensional flammable liquid fires or on fires in concealed spaces, such as those occurring behind wall panels, engine nacelles, or wheel wells.

8-2.3 Experience has shown that dry chemical tends to be more effective than halons when used in the open air to extinguish three-dimensional fires, while halons are the preferred agents for electrical fires and in concealed areas.

8-2.4 If dry chemical or halon is used, a fire area, once extinguished, may reflash if exposed to a source of ignition; therefore a follow-up application of foam is recommended when these agents are used.

8-2.5 AFFF and FFFP should not be mixed with protein-based concentrates. Before film forming foams are used in equipment that formerly contained protein-based foam concentrate, the foam tank and system must be thoroughly flushed with fresh water. The vehicle manufacturer should be consulted to assure that the agent system design is compatible with the agent to be used.

8-2.6 AFFF and FFFP are compatible with protein and fluoroprotein foams in the applied form and can be applied simultaneously on the same fire area.

8-2.7 AFFF and FFFP agents are compatible with dry chemicals. These agents can be applied simultaneously to improve flame knockdown and control fire spread.

8-2.8 Protein foams should be applied only with compatible dry chemicals. Fluoroprotein foams have demonstrated an improved compatibility with dry chemicals; however, the user should determine that it is adequate to meet operational requirements. If any problems arise, the agent manufacturer should be consulted.

8-2.9 If foam is being used and the fire is not completely extinguished before the supply is depleted, it might be necessary to complete extinguishment with water streams. When this occurs, avoid applying water or walking in any area that has been secured with foam, as it can break down the established vapor seal that the foam blanket provides.

8-2.10 If the fire has not been completely extinguished by foam, the secured area will "burn back" at a rate that is dependent on the stability of the foam being used. Also under certain circumstances, fire can "flash back" over a portion of an area covered by foam.

8-3 Water and Agent Resupply and Conservation. Auxiliary water tankers should be dispatched whenever there is any indication for possible need and especially when the aircraft accident site is known to be beyond water relay capability. Prearrangements should be made to assure that additional supplies of extinguishing agents are brought to the scene. Prudent utilization of agents under these circumstances is particularly important and application methods should be carefully selected to assure their most effective use.

8-4 Major Aircraft Accidents.

8-4.1 The primary objective to RFF personnel at the scene of any aircraft accident is the rescue of persons unable to self-evacuate the aircraft wreckage or any structure that is involved.

8-4.2 Occupant survival is generally limited to aircraft accidents that are of low impact in nature, where the fuselage is not severely broken up and a fuel fire has not developed. In more severe accidents, even those where fire does develop, RFF personnel should assume that there is always the possibility of survivors and take aggressive steps to control the fire, initiate evacuation, and rescue those unable to self-evacuate.

8-4.3 Rescue operations should begin as soon as conditions permit and often is a simultaneous function during the fire fighting phase that requires considerable coordination. The rescue team's mission includes assisting evacuees, accomplishing forcible entry if necessary, completing interior extinguishment, extricating trapped survivors, and removing the injured to safety.

8-4.4 One rescue team method consists of four RFF personnel equipped with full protective clothing and positive

pressure self-contained breathing apparatus (SCBA). Two of the persons are handline operators and precede the other two, who are equipped with appropriate hand-held tools needed for forcible entry, extrication, and making access to hidden fuselage fires behind panels, floors, and compartments.

8-4.4.1 A procedure preferred by some fire departments is to provide an additional handline operator, similarly attired and equipped with SCBA, operating behind the rescue team with a spray stream, as their protection throughout the entire operation.

8-5 Size-Up.

8-5.1 The process called size-up merely means the gathering of facts in preparation for making decisions. The facts pertaining to an aircraft accident, when mentally assembled, enable the responsible RFF officer to establish both initial tactics and overall strategy.

8-5.2 The size-up process is initiated by the first-responding RFF officer and is carried on throughout the duration of the incident in terms of depth and scope by later-arriving superior officers.

8-5.3 When an aircraft accident occurs, some size-up information in the form of established facts should be immediately known as the result of training, preplanning, knowledge of available resources, and interpretation of alarm information. Additional facts become known through observation during response and upon arrival at the scene.

8-5.4 Vital operational decisions based upon initial size-up information should be made without delay. Realistic objectives are critical and consideration should be given to the capabilities of resources that are immediately available.

8-5.5 Initial assignments of tasks based on the size-up are generally not fixed, and tend to be modified as the incident develops. The size-up process should continue throughout the duration of the incident and any changes in strategy or objective that develop should be communicated to key personnel involved in the operation.

8-6 Aircraft Accident — Fire Involvement.

8-6.1 In an aircraft accident, occupants are confined in an aluminum fuselage and are surrounded by very large amounts of fuel that, when ignited, can release heat at about five times the rate that develops in the typical structure fire. An aircraft fuselage has an extremely low resistance to fire and except for engine areas, cargo compartments, and galleys, fire walls and draft stops are nonexistent.

8-6.2 First and foremost, consideration should be given to aircraft occupant survival. Those who have survived the impact forces then face the exposure to fire. Initial fire fighting operations directed toward total extinguishment are acceptable only where size-up justifies this approach as presenting the best chance of successfully accomplishing rescue. A resource-conserving alternative would be selective control of fire in areas where occupants are successfully evacuating and maintaining these escape routes until it has

been determined that evacuation is complete. A decision as to the precise method of initial fire attack should be made by the RFF officer in charge immediately upon arrival at the scene. All members of the RFF team should realize that initial plans are always subject to change and should remain alert for orders that alter operations as conditions dictate.

8-6.3 If, upon the arrival at an aircraft accident site, operators of the first-arriving RFF vehicle or crewers attack a small fire, the first team will not be required to extinguish the entire fuel spill, including any fuel spills that are later discovered. The second arriving team will then determine if needed, a portion of the spill is fire and the officer in charge.

8-6.4 If a large fire is in progress upon arrival of the RFF personnel, foam should be applied using the vehicle turrets. Since initial foam supplies can be exhausted in two minutes, turret operators should understand that foam application by this method must be effective and that streams should be shut down on occasion to assess progress and conserve foam. Once a fire has been controlled and any fuel spill blanketed with foam, consideration should be given to employing foam handlines that are more maneuverable and therefore more effective for maintaining a foam blanket and extinguishing small fires.

8-6.5 If foam becomes contaminated by fuel splashing onto it, then at some time the foam will become flammable. The degree to which this is a problem depends on the type of foam and the amount of contamination. A solution, drains from the foam, the water drains at a faster rate than the fuel, resulting in a fuel-rich foam matrix that can ignite if exposed to a source of ignition. This problem is more evident in AFFF than in other foams because it has a much faster drainage rate and becomes flammable at a lower level of contamination.

8-6.6 Protein and fluoroprotein foaming agents should form a blanket over the surface of a flammable liquid fire in order to extinguish it. The foam should be applied using a dispersed pattern over the surface of the burning fuel to completely cover the spill area. It needs to be applied in such a manner that it does not break up any previously established blanket. If isolated openings in the foam blanket occur they should be filled in as soon as possible with new foam.

8-6.7 AFFF and FFFP agent solutions can be applied either with aspirating nozzles, turret nozzles used for protein and fluoroprotein foams, or conventional water spray nozzles. Either spray or straight streams can be used as the situation dictates. It is best to approach the fire area as closely as possible and apply the foam in a wide spray pattern initially, changing to a narrower pattern after the heat has been reduced. The stream should be applied in a gentle manner to avoid unnecessary plunging of the stream into the burning fuel. The foam should be applied to the near edge of the fire with a rapid side-to-side sweeping motion to distribute the foam rapidly and thinly over the burning fuel. Advance as the fire is controlled, always applying the foam to the nearest burning fuel surface. Advance only after a continuous, unbroken foam cover is established. The entire foam blanket integrity should be

maintained to compensate for voids created by movements of RFF personnel, evacuees, and equipment, as well as the normal breakdown of the foam.

8-7 Extinguishment Techniques.

8-7.1 Vehicle approach to a burning aircraft should be such that turret streams can be applied along the length of the fuselage with efforts concentrated on driving the fire outward while keeping the fuselage cool, protecting occupants as they evacuate, and assisting with the entry of rescue teams.

8-7.2 The location of survivors, if known, and the area of fire will determine where the first streams should be applied. If the fire has penetrated the fuselage, a direct interior attack with handlines should be initiated as soon as possible.

8-7.3 If there is a perceptible wind, and where it is compatible with the evacuation process, it is best to approach an aircraft fire from the windward side. Foam and water streams applied from the windward side provide better stream reach and greater ability to monitor extinguishing effectiveness as the heat and smoke will be moving in the opposite direction. When vehicle turrets are in operation on opposite sides of a fuselage, care should be taken so that the fire is not driven underneath from one side to the other.

8-7.4 When an aircraft comes to rest on sloping terrain or adjacent to a gulley or wash, circumstances permitting, the fire should be approached from high ground and drive the burning fuel away from the fuselage.

8-7.5 Aircraft accidents do not occur under the best conditions or permit the ideal arena for combating a fire. It will not always be possible to approach the fire from high ground or the windward side. What is important is an aggressive attack to isolate the fuselage from the fire and efficient fire ground coordination to achieve a successful evacuation of occupants and complete fire extinguishment.

8-7.6 The initial attack on an aircraft fuel fire should normally be by mass application of foam, or alternatively, by the combined use of foam and a complementary agent. A three-dimensional or flowing fire should be extinguished by using a dry chemical or halon agent followed by an application of foam. Even where foam alone is used, a suitable complementary agent should be available to deal with fire inaccessible to direct foam application.

8-7.7 If a fire threatens exposed aircraft structures, or other combustible, they should be protected by foam or water spray. Water streams or runoff should not be permitted to destroy any foam blanket in the critical fire area.

8-7.8 If a large fuel spill occurs without igniting, it is important to eliminate as many ignition sources as possible while the spill is being stabilized with a foam blanket. There can be enough residual heat present in jet engines to ignite fuel vapors 30 minutes after shutdown.

8-7.9 Extinguishing agents should be applied in a manner to avoid spot cooling of components that can cause stress failure and disintegration. If possible, streams should be employed so that even surface cooling can result. Dry

chemical or halon agents can extinguish fires involving hydraulic fluids or lubricants but they lack the cooling ability necessary to prevent reignition.

8-8 Turret Operations.

8-8.1 RFF vehicles should be positioned to make the most effective use of all extinguishing agent systems. The most efficient use can require movement of the vehicle during turret or even handline operations. It is vitally important not to waste available agent. **TURRETS SHOULD BE USED ONLY AS LONG AS THEY ARE BEING EFFECTIVE.** Frequently, after initial knockdown of the bulk of the heat and flame, use of handlines to maintain control of evacuation areas can be the key to a successful rescue operation.

8-8.2 When selecting vehicle positions for applying foam from a turret, remember that wind has a considerable influence upon the quality of the stream and the rate of fire and heat travel. Utilize the wind whenever possible to achieve more effective fire control.

8-8.3 Turret streams should never be directed so as to drive fuel or fire toward the fuselage. The main objective prior to total extinguishment of the fire is to maintain a fire-free escape route for occupants until complete evacuation is achieved.

8-8.4 Because limited water supplies are usually a factor, turret operators should concentrate their extinguishing efforts on the Practical Critical Fire Area and maintain this area fire-free after extinguishment.

8-8.5 The "pump and roll" concept, a method of applying agent from a turret while the vehicle is in motion, can be a very effective technique.

8-9 Aqueous Film-Forming Foam (AFFF) and Film-Forming Fluoroprotein (FFFP) for Turret Application.

8-9.1 The basic principle is to distribute a visible AFFF or FFFP blanket of sufficient thickness over the burning fuel to act as a blanket for vapor suppression. The original blanket should not be relied upon to be permanent and should be maintained as necessary until the fuel vapor hazard no longer exists.

8-9.2 Both aspirating and nonaspirating nozzles can be used for AFFF or FFFP application. A nonaspirated nozzle typically provides longer reach and therefore better personnel protection and quicker control and extinguishment. However, expansion rates and foam drainage times are generally less when AFFF or FFFP is applied with nonaspirating nozzles, and it should be understood that the foam blanket may be less stable and have a lower resistance to burnback than that formed using aspirating nozzles. Manufacturers should be consulted for guidance on nozzle performance. Extreme caution should be taken when using the straight stream method as this can cause an increase in the liquid pool surface or cause an opening in the foam blanket releasing flammable vapors.

8-10 Protein and Fluoroprotein Foam Turret Application.

8-10.1 Protein and fluoroprotein foams should be applied

to burning fuel so that they gently form a uniform and cohesive blanket with the least possible turbulence to the fuel surface.

8-10.2 Aspirating nozzles should be used for applying protein and fluoroprotein foams in either the straight stream or dispersed patterns to distribute the foam over a wide area. When using the straight stream method of application, the foam should be applied indirectly using deflection techniques and special care should be exercised to avoid disturbing the established foam blanket.

8-11 Handline Foam Application.

8-11.1 After the bulk of the fire has been knocked down by turrets, they should be shut down, perhaps repositioned, and held in a state of readiness to resume operation should the need occur. During this phase of rescue and fire fighting, handlines are generally more effective than turrets in controlling the fire, maintaining rescue paths for occupants, mopping up spot fires, maintaining the foam blanket, and conserving vital agent supply.

8-11.2 Whether or not there is an immediate need for them, charged handlines should be placed in strategic positions as soon as possible after RFF personnel arrive on the scene. This practice would assure their immediate availability for use when the need arises.

8-11.3 Foam application principles are the same for handlines as they are for turrets.

8-12 Aircraft Accident — No Fire Involvement. At an aircraft accident without fire, appropriate fire prevention measures should be initiated immediately.

(a) All spilled fuel should be covered with foam. Engines and other heated surfaces should be cooled with foam to prevent ignition. When foam is not available or in short supply, water spray can be used to cool heated surfaces but care should be taken so that the seal established by the foam blanket is not washed away or diluted by the streams.

(b) The washing of spilled fuel from around the aircraft requires caution. Raw fuel and flammable vapors should be directed away from sources of ignition.

(c) Every effort should be made to prevent sparks whenever there is the possibility of exposed fuel or fuel vapors in the area. Particular care should be taken to prevent sparks due to arcing before the aircraft electrical system can be de-energized.

8-13 Exposure Protection.

8-13.1 After rescue of occupants, protection of exposed property should be the next consideration at the scene of an aircraft accident, whether fire exists or not. In addition to airport structures and other aircraft, plans should include preventing contamination and fire spread into drains, sewers, waterways, and any below ground facilities. Authorities should be immediately notified of any exposure to fire or contamination involving property under their control.

8-13.2 Early and effective fire extinguishment assures the least amount of property loss and that includes exposed properties whether involved in fire or not. Where resources

are limited, conditions will dictate which exposures receive first priority for protection.

Chapter 9 Interior Aircraft Fires

9-1 General.

9-1.1 The recommendations contained in this chapter are provided for the guidance of RFF personnel encountering interior aircraft fires occurring in both parked, unoccupied aircraft and aircraft with passengers and crew aboard.

9-1.2 The occurrence of interior aircraft fires where passengers and crew are onboard presents a major problem for RFF personnel. An acute life safety hazard exists in these instances and the ability to enter the aircraft and extinguish the fire might have to be delayed until evacuation has been completed. Because forcible entry and rescue are discussed in detail elsewhere in this manual, they will not be covered here and instead emphasis will be on the procedures and techniques of attacking and extinguishing interior aircraft fires.

9-1.3 Aircraft passenger cabin fires normally involve ordinary combustibles such as upholstery, paneling, carpeting, refuse, electrical insulation, and carry-on materials. Generally a direct attack on the fire with water streams, using structural fire fighting techniques, is effective.

9-1.4 RFF personnel should understand the structural characteristics of an aircraft fuselage. The absence of fire stops at the floor, behind wall panels, and above ceiling areas permits fires to spread undetected and unchecked through combustible materials once fire has entered those areas. RFF personnel should always assume, until it is proven otherwise, that fire has moved away from its origin via these concealed spaces. Sections of flooring, wall panels, and ceilings should be removed where fire travel is suspected so that complete extinguishment can be accomplished.

9-1.5 Since the burning of aircraft interior materials creates a toxic atmosphere, RFF personnel should wear positive pressure self-contained breathing apparatus when working inside the fuselage both during the fire fighting stage and later, while overhauling. Additionally, the entire fuselage should be ventilated as quickly as possible by whatever means available. Smoke ejectors can expedite horizontal ventilation, which is usually the only choice of methods since aircraft have no designed vertical openings. [See Figure 9-5, 1(b).]

9-1.6 Interior aircraft fire situations can differ widely; therefore, explicit guidance regarding extinguishment techniques is not possible. Points of entry and methods of attack should be dependent upon an evaluation of conditions and assessment of resource capability by the RFF officer in charge.

9-1.7 An interior aircraft fire location and its intensity can to some degree be determined by observation through cabin windows, smoke concentrations, or aircraft skin that shows buckling or paint blisters.

9-1.8 In the event that an interior aircraft fire cannot be immediately extinguished, foam or water spray should be applied to wing and fuselage fuel tank areas that might be exposed to heat.

9-2 Aircraft Interior Fires Occurring in Flight.

9-2.1 A major hazard of commercial aviation is the in-flight fire that cannot be controlled by onboard portable extinguishers or fixed extinguishing systems.

9-2.2 Aircraft emergency landings or accidents can be the result of uncontrolled fires occurring in flight. The most frequent types of in-flight fires involve: (1) engines, (2) cabin areas, (3) restrooms, (4) heaters, (5) cargo areas, and (6) electrical compartments.

9-2.3 Portable fire extinguishers are required to be mounted at specific locations in the cabin of passenger aircraft, and flight crews receive periodic training in their use. The extinguishers are designed to handle incipient fires in accessible areas. However, fires can and do originate in locations not readily accessible from the cabin while the aircraft is in flight. If the area involved in fire is isolated and is not equipped with a fixed extinguishing system, a serious fire can develop and spread rapidly.

9-2.4 When an uncontrolled in-flight fire occurs, the aircraft must make an emergency landing at the nearest suitable airport and the occupants evacuated before being overcome by heat, smoke, and toxic gases. RFF personnel are usually notified of such emergencies well in advance of the landing and should be prepared to assist in the immediate evacuation and enter the aircraft and extinguish the fire.

9-2.5 When the aircraft is on the ground and whether or not the air conditioning system is operating, heat, smoke, and gases will build up, creating toxic atmosphere and setting the stage for a flashover.

9-2.6 After the aircraft has landed and the flight crew has initiated emergency evacuation, it should be assumed that some of the occupants might not have the ability to self-evacuate. RFF personnel should allow normal procedures to be carried out to their full potential without compromising the evacuation process; however, RFF personnel and vehicles should be placed in strategic positions to effect entry into fuselage to confirm complete evacuation and achieve fire control.

9-2.7 If there is no evidence of occupant evacuation, immediate steps should be taken to make entry for control of the fire and rescue of occupants. Entry will permit an influx of fresh air into a possibly overheated or unstable atmosphere which could rapidly accelerate the fire. Toxic gases will be present so ventilation and a thorough search for survivors should take place immediately and simultaneously with the fire fighting effort. In darkness or heavy smoke conditions these efforts will be much more difficult.

9-2.8 Extinguishing agents other than water that can be used on interior aircraft fires include foam, halons, and dry chemicals. However if onboard oxygen systems have been damaged, creating an oxygen-rich atmosphere, or if there is major interior fire involvement, water streams would be the best agent.

9-3 Interior Fires in Unoccupied Aircraft.

9-3.1 Fires occurring in unoccupied aircraft often result in delayed detection. An unattended aircraft with its doors closed can contain a smoldering fire which can burn unnoticed for an extended period of time. Under these conditions, a build-up of extremely hot fire gases can develop as the fire consumes all the available oxygen. Opening up an aircraft under such circumstances can be very hazardous because when oxygen is introduced into such an atmosphere the entire interior can become immediately ignited, possibly with explosive force.

9-3.2 When arriving at a closed, unoccupied aircraft that is suspected of having an interior fire, the internal atmosphere should be assessed before entry is attempted. If flame cannot be seen, and the windows are hot to the touch and obscured by heavy smoke, it can be expected that a hot, smoldering fire exists and entry of outside air at this time would ignite the entire interior.

9-3.3 If an interior fire in an unoccupied aircraft has not reached the smoldering stage, there is sufficient oxygen present and a free-burning fire can be maintained. Under these circumstances entry should be made and the fire extinguished with water in the conventional manner.

9-3.4 Extinguishment of a hot, smoldering, internal aircraft fire can be very difficult. Where this type of fire exists, one method is worth consideration. It can be referred to as an indirect attack which is made from small fuselage openings such as slightly opened exits or openings made in cabin windows. A coordinated multiple-point attack is more effective than a single point attack and is a necessity when applying the method to fires in wide-body or jumbo aircraft with large volume interiors. It must be remembered that this method is not suitable if there is any possibility of occupants being onboard the aircraft.

9-3.4.1 The extinguishment principle of this indirect method is based on the conversion of water spray into steam as it contacts the super heated atmosphere within an enclosure. The rapid expansion of water spray droplets into minute steam droplets increases the surface area of the water, permitting it to absorb more heat, thus making it more efficient as a cooling agent. Water in this form and under pressure has the ability to penetrate dense burning materials and enter areas behind panels and coverings. When properly applied the method lowers the temperature of the entire fire area to a point where combustion ceases.

9-3.4.2 Once an interior fire in an unoccupied aircraft reaches the smoldering stage and is confined, very little damage, if any, will occur during the few minutes it takes to set up for a coordinated indirect attack. Points of attack should be established, complete with means for safe footing for hose line operators, personnel assigned to create openings, and any backup positions. **ALL PERSONNEL NEAR THE AIRCRAFT SHOULD WEAR FULL PROTECTIVE CLOTHING AND SELF-CONTAINED BREATHING APPARATUS.** Hose lines with spray nozzles should be charged and before use the nozzles should be fully opened to expel all air from the hose. Nozzle pressure should be 100 psi (689 kPa) and the spray pattern preset at 30 degrees for best results.

At the given signal, all openings should be made simultaneously and flowing spray streams inserted at the lowest point possible. The streams should be aimed at the ceiling and moved in a wide circular motion, fore and aft of the fuselage. During this water spray application phase, a back flow of steam around openings will take place. The openings should be kept as small as possible in an attempt to retain the steam within the fuselage.

9-3.4.3 After a few minutes the escaping steam should subside, indicating a reduction in interior temperature and steam production. It also indicates that air intake at this point should not cause a sudden, violent ignition of the interior atmosphere. At this point, a second coordinated operation should take place. All hose lines should be shut down, but kept in readiness. Without permitting anyone to be positioned directly in front of any openings, all available doors and hatches should be opened and all RFF personnel should back away momentarily until the bulk of smoke, steam, and remaining heat have vented. Hose lines then should be advanced inside for final extinguishment, ventilation, and overhaul.

9-3.4.4 Should a smoldering, interior aircraft fire occur in compartments below the passenger and flight deck levels, the indirect attack method can also be applied, adapted to the particular circumstances involved. More difficulty can be experienced in achieving convenient openings in these compartments, however. Consideration should be given to attacking fires in these areas through openings in the cabin floor.

9-4 Penetrating Nozzles.

9-4.1 The use of penetrating nozzles is another way of combating aircraft cabin and compartment fires. Most penetrating nozzles are designed so that any agent currently used by RFF providers can be utilized.

9-4.2 To extinguish an aircraft cabin or compartment fire using penetrating nozzles, the total fire area requiring agent application needs to be considered. For example, to extinguish a large fire in the cabin of a wide-body aircraft, penetrating nozzles injecting agent simultaneously from dispersed, multiple injection points would be required to provide a sufficient amount of agent to effect extinguishment in a timely manner.

9-4.3 Currently there are a number of penetrating nozzles in use. Most are designed for structural fire fighting purposes and require the use of a sledge hammer to penetrate objects. This manner of application can be slow, awkward, and occasionally dangerous when applied to aircraft fire fighting and should be done with great care. RFF per-

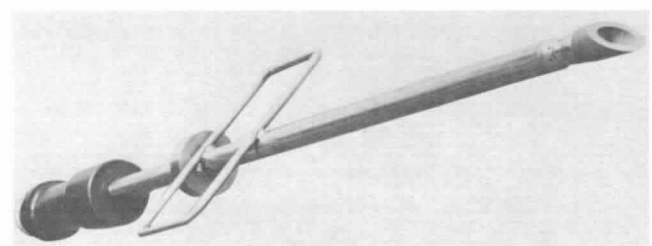


Figure 9-4.3 Aircraft skin penetrator nozzle.

sonnel when using this type of penetrating nozzle should make certain that they have proper footing and sufficient operating area. (See Figure 9-4.3.)

9-4.4 More recently a new type of penetrating nozzle concept has been introduced by the US Air Force. It is referred to as a skin penetrating agent applicator tool (SPAAT). This tool incorporates a pneumatic device that drills through aircraft skin and windows within 10 seconds and can immediately inject any of several agents into the fuselage. (See Figure 9-4.4.)



Figure 9-4.4 Skin penetrator agent applicator tool (SPAAT).

9-5 Interior Aircraft Fire Overhaul. During the overhaul phase of an interior aircraft fire, hose lines should remain charged and available to extinguish any deep-seated fire, hidden uncovered fire, or reignition. Carpeting, wall panels, partitions, and ceiling covering should be removed when necessary to assure that all fire is extinguished and that there is no threat of reignition. The use of portable

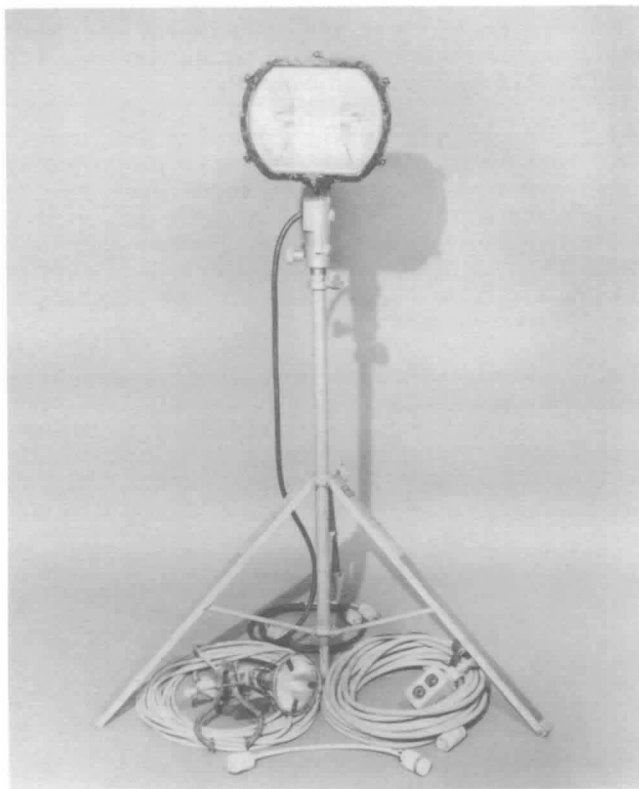


Figure 9-5.1(a) Portable lighting units.

lighting units and smoke ejectors will help to make the aircraft interior safer and more tenable for RFF personnel. [See Figures 9-5.1(a) and (b).] **ANY PERSON ENTERING THE AIRCRAFT DURING THE OVERHAUL PHASE SHOULD USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS.**

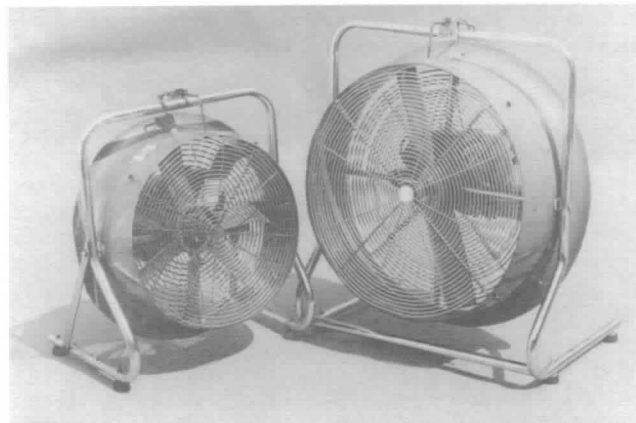


Figure 9-5.1(b) Smoke ejectors.

Chapter 10 Miscellaneous Aircraft Incidents

10-1 General.

10-1.1 Each year RFF personnel respond to numerous incidents on airports that are considered "minor." These seemingly routine activities do not make headlines but the absence of intervention could often result in catastrophic loss of life, serious injuries, and extensive property loss.

10-1.2 Guidance presented in this chapter is intended to inform RFF personnel of a variety of aircraft incident types and how to deal with them so that the hazards relative to aircraft operations on airports can be safely abated.

10-2 Engine Fires.

10-2.1 It is reasonable for RFF personnel responding to aircraft engine fires to expect that the following actions have probably been accomplished by the flight crew: (1) engine shut down, (2) engine fire extinguishing system (if any) activated, (3) electrical power to the affected engine(s) de-energized, and (4) fuel and hydraulic fluid supply to the affected engine(s) shut down.

These actions should be verified as conditions permit. It should be emphasized that turbine engines, following shutoff of power and fuel, can remain a potential hazard during "wind down" with high heat retention continuing for as long as 30 minutes. This heat constitutes a potential ignition source for flammable vapors. On propeller-driven or rotary-wing aircraft, contact with propellers, or entry into their path of rotation, should be avoided during all stages of the emergency.

10-2.2 When jet engines are started or shut down in certain wind conditions, hot starts or tail pipe fires can oc-

cur. These fires can usually be controlled by the flight crew. In some cases, however, fire department intervention might be necessary.

10-2.3 When reciprocating engine fires are confined within the nacelle, but cannot be controlled by the aircraft extinguishing system, dry chemical or a halon agent should be applied first as these agents are more effective than water or foam for fires inside an enclosure. Foam or water spray should be used to cool the outside of the nacelle.

10-2.4 Fires confined to the hot section of jet engines can be best controlled by keeping the engine rotating. Such action should be considered in the context of necessary aircraft evacuation and other safety considerations. Fires outside the combustion chambers, but confined within the nacelle, are best controlled with the engine's fixed extinguishing system. If the fire continues after the system has been exhausted, or if re-ignition occurs, a halon or dry chemical agent should be applied through maintenance openings. The aircraft operator should be advised of the type of extinguishing agent used in order that appropriate maintenance action can be taken later.

10-2.5 Foam or water should not be applied to either the intake or exhaust of a jet engine unless control cannot be secured or confined to the engine nacelle using halon or dry chemical. If foam or water is applied to either the intake or exhaust, RFF personnel should stand clear to avoid being struck by disintegrating engine parts.

10-2.6 Most jet engines are constructed with magnesium and titanium parts which, if ignited, are very difficult to extinguish. If these fires are contained within the nacelle they should be permitted to burn themselves out as long as:

(a) There are no external vapors present that cannot be eliminated, and

(b) Sufficient foam or water spray is available to maintain the integrity of the nacelle and surrounding exposed aircraft components.

10-2.7 When tail pipe fires occur in the elevated center engine of three-engine wide-body aircraft or a B-747 auxiliary power unit, special elevating equipment might be required to effectively discharge agent on the fire. (*See also Appendix C.*)

10-3 Aircraft Fuel Servicing Incidents.

10-3.1 A number of aircraft fires have occurred during fuel servicing. Ignition has been caused by static developed in flowing fuel, surface-generated static within an aircraft fuel tank, or refueling vehicle, defective fuel pumps, an external source of ignition, and other improper fueling procedures. Defueling and fuel transfer operations are also serious fire potentials. Standards relative to aircraft fueling procedures and proper equipment maintenance should be diligently enforced by the authority having jurisdiction on the airport.

10-3.2 Fuel spills exterior to the aircraft should be handled in the manner described in NFPA 407, *Standard for Aircraft Fuel Servicing*, when fire does not occur. If fire does occur, it should be handled similar to any other aircraft accident, with primary emphasis on life safety. The

practice of fueling occupied transport category aircraft necessitates that, in the event of a fuel spill fire, an immediate check of the interior for occupants is imperative.

10-3.3 Many transport category aircraft have ganged fuel tank vents near wing tips. Vented JET A type fuel (kerosene grades) vapors normally present very little hazard. If tanks are overfilled, the fuel will discharge through the vents, causing a fuel spill. There is a greater potential for a flammable vapor-air mixture being present in the immediate vicinity of wing tip vents when JET B is the fuel used. Regardless of which fuel is used, it is good practice not to position or operate vehicles within a 25-ft (8-m) radius of aircraft fuel system vent openings.

10-4 Hot Brakes and Wheel Fires.

10-4.1 The heating of aircraft tires causes overpressure and presents a potential explosion hazard. Good judgment should be exercised in determining the severity of the situation, and this information should be conveyed to the flight crew. The flight crew in turn can assist the rescue and fire fighting effort by performing necessary procedures (i.e., shut down engines, extend flaps, evacuation preparation, etc.)

10-4.2 In order to avoid endangering RFF personnel and aircraft occupants and cause unnecessary damage to the aircraft, it is important not to mistake hot brakes for brake fires. Hot brakes normally cool by themselves and do not require an extinguishing agent.

10-4.3 When a hot brake condition occurs on a propeller-driven aircraft it is usually beneficial to keep the propeller operating that is directly forward of the wheel with hot brakes until the brakes have cooled. Larger, modern aircraft have fusible plugs mounted in the wheels which fuse at approximately 300-400 °F (282-382 °C), allowing the tires to deflate before dangerous pressure can develop.

10-4.4 RFF personnel should remain clear of the sides of aircraft wheel assemblies that are involved in fire and approach only in a fore and aft direction. Since heat is transferred from the brake to the wheel, extinguishing agent should be applied to the brake area. The primary objective is to prevent the fire from spreading upward into the wheel wells, wings, and fuselage.

10-4.5 Foam, water spray, halons, and dry chemicals are effective agents for direct application on brake fires.

10-4.6 Dry chemical agents and Halon 1211 might extinguish fires involving hydraulic fluids and lubricants but re-ignition can occur since these agents lack sufficient cooling effect. Halon 1211 is particularly effective in extinguishing undercarriage fires; however, where magnesium wheel components are burning, halon agents should not be used.

10-4.7 Effectiveness of any gaseous extinguishing agent can be severely reduced if wind conditions are such that sufficient concentration cannot be maintained to extinguish the fire.

10-4.8 Solid streams of water should be used only as a last resort on wheel fires since the rapid cooling can cause

an explosive failure. However, fires involving magnesium wheels have been successfully extinguished by applying large amounts of water from a distance. This method rapidly reduces the heat to a point below the ignition temperature of the magnesium and the fire is extinguished. RFF personnel should exercise extreme caution when this method of extinguishment is used, as explosive failure of the wheel components is likely.

10-5 Combustible Metal Fires. Burning magnesium or titanium parts should be isolated if possible and extinguished by applying a Class D agent. Covering the burning metal with dry, uncontaminated sand can be effective when a Class D agent is not available.

10-6 Broken Flammable Liquid Lines. Broken fuel, hydraulic, alcohol, and lubricating oil lines should be plugged or crimped when possible to reduce the amount of spill potential.

10-7 Heater Fires. Heaters located in wings, fuselage, and tail sections of aircraft can be protected with a fixed fire extinguishing system. It can be assumed that in the event of an airborne heater compartment fire the system would have been activated. After the aircraft has landed, a thorough check of the heater compartment and surrounding area should be made to ensure that there has been no reignition or spread of fire.

10-8 Bomb Threats.

10-8.1 When a bomb threat involving an aircraft is declared an emergency, the aircraft should be evacuated without delay. Passengers should be directed to leave their carry-on materials and depart the aircraft as quickly as possible. The situation might dictate the use of the emergency evacuation slides or built-in stairs. Portable stairways positioned by RFF personnel should be the safest and most practical alternative.

10-8.2 Immediately after evacuation has been completed, the aircraft involved should be moved to a location at least 1000 ft (300 m) away from structures and other aircraft if not already so located.

10-8.3 Airport security (police) should have the primary responsibility in any bomb threat emergency for initiating protective measures, conducting and controlling any search activities, and declaring the termination of the emergency.

10-8.4 The role of the RFF personnel in bomb threat emergencies should be limited to: (1) assisting occupants evacuate the aircraft, (2) assume a standby status and remain in readiness after evacuation is complete and the aircraft has been moved to a safe location, and (3) in the event of a bomb detonation, assume command and control of any rescue operation or fire incident that results.

10-8.5 The airline, where involved, should have the responsibility for the safety and well-being of the passengers and should cooperate and assist the airport police in any needed search of baggage or aircraft.

10-9 Incidents Where Aircraft Fire Warnings Occur.

10-9.1 It is often difficult for the flight crew to accurately

appraise conditions following actuation of an aircraft fire warning indicator. Therefore, the aircraft should be brought to a stop after clearing the runway and before approaching the terminal. RFF personnel should inspect the affected area involved by checking for external evidence of smoke or heat. If no evidence exists, the aircraft should continue on to the terminal where a more thorough inspection can be made.

10-9.2 If there is evidence of fire, immediate access should be made and the fire extinguished. If this occurs the aircraft should be shut down and the decision made as to whether an evacuation of occupants should take place. Airline maintenance personnel and equipment should be requested to respond and assist RFF personnel in gaining access, operate ground power units, and assist with portable stairways if needed for evacuation.

10-10 Emergency Landings.

10-10.1 Often, landing gear stuck in the retracted position is the result of broken hydraulic lines or loss of electrical power. Spilled hydraulic fluid can ignite in the wheel wells due to the presence of electrical shorts, friction sparks due to a wheels-up landing, or other heat sources. Should ignition occur, the fire has a tendency to travel up into the fuselage and can rapidly become a major interior fire. RFF personnel should take immediate steps to assure the stabilization of this problem even though appearances from the exterior do not immediately indicate the presence of fire.

10-10.2 Hydraulic problems on landing aircraft can involve the brake systems, flaps, spoilers, etc. This has a tendency to lengthen the rollout after touchdown and can also affect the aircraft's directional control. As soon as the aircraft has touched down and passes each RFF vehicle that is standing by, that vehicle should immediately follow the aircraft and be ready to perform any necessary operation when it comes to a stop. It is extremely important that all other airport vehicles and personnel remain clear of the aircraft, thus permitting RFF vehicles and personnel to maneuver and position for effective rescue and fire fighting.

10-10.3 At emergencies involving landing gear malfunctions or tire problems, there is always a possibility of the aircraft veering off the runway after landing and hitting standby RFF vehicles. It is difficult to predict the touchdown point. Therefore, if there are two or more RFF vehicles available, one vehicle should standby on the opposite side of the runway, a suitable distance from the edge.

10-11 Aircraft Accidents in the Water.

10-11.1 Where airports are situated adjacent to large bodies of water, special provisions should be made for RFF operations in the water. Specialized equipment can include fire/rescue boats, air-cushion vehicles (ACV), helicopters, and coastal patrol boats. In those areas where this type of equipment is not operated by local emergency services, prearrangements should be made for private agencies to respond upon notification. (*Appendix C illustrates some typical water fire/rescue equipment currently in service.*)

10-11.2 Many transport category aircraft not engaged in intercontinental overwater flights are equipped only with

flotation-type seat cushions as emergency flotation devices. Survivability of passengers using this equipment is limited. Survivors are susceptible to hypothermia in water below 70 °F (52 °C), and ingestion of vapors from floating fuel. Rapid response is extremely important.

10-11.3 In water landing accidents, the possibility of fire is normally reduced because of the cooling of the heated surfaces by the water. In situations where fire occurs, chances of its control and extinguishment are minimal unless the accident occurs within close proximity to shore and extinguishing operations can take place at close range.

10-11.4 Where the distance offshore is within range, fire hose can sometimes be floated into position by scuba drivers or boats and used to supplement other means of fire attack.

10-11.5 The impact of an aircraft into water can rupture fuel tanks and lines. It is reasonable to assume that fuel is floating on the water surface. Watercraft having exhausts at or above the waterline can present an ignition hazard and should not enter the area. Advantage should be taken of wind and water currents when dealing with floating fuel. Every effort should be made to keep it from moving into areas where it would be hazardous to rescue operations. As soon as possible, pockets of fuel should either be broken up, moved away with large velocity nozzles, covered with foam, or disposed of by commercial reclaiming enterprises. The local water pollution control agency can be of assistance during this operation.

10-11.6 If fuel on the water has ignited, approach should be made from the direction where wind direction and velocity, water current, and site accessibility create an advantage. Fire can be moved away from an area by using a sweeping technique with hose streams. Foam and other extinguishing agents can be used where practical and necessary.

10-11.7 Scuba diving units should be dispatched to the scene of an aircraft accident in the water. Helicopters can be used to expedite the transportation of divers to the actual area of the accident. All divers who might be called for this type of service should be qualified in both scuba diving and underwater search and recovery techniques.

10-11.8 In all operations where divers are in the water, standard diver's flags should be flown and all watercraft restricted from the diving area.

10-11.9 Victims in the water are more apt to be found downwind or downstream. Where only the approximate location of the impact site is known upon arrival, divers should use standard underwater search patterns marking the locations of major parts of the aircraft with marker buoys. If sufficient divers are not available, dragging operations should be conducted from surface craft. In no instance should dragging and diving operations be conducted simultaneously.

10-11.10 Life sustaining air can remain in large, submerged, occupied sections of the aircraft. As soon as practicable, entry by divers should be made carefully at the deepest point possible.

10-11.11 Where occupied sections of the aircraft are found floating, great care should be exercised not to disturb their buoyancy and supplemental floating devices should be attached. Removal of any occupants should be accomplished as smoothly and quickly as possible. Any shift in weight or lapse in time can result in the section sinking. Rescuers should use caution so that they are not injured or trapped should the section capsize or sink.

10-11.12 A command post should be established on an adjacent shore to facilitate implementation of the airport/community emergency plan. (*See NFPA 424M, Airport/Community Emergency Planning.*)

Chapter 11 Post Aircraft Accident Procedures

11-1 General.

11-1.1 Many local statutes stipulate that it is the duty of the fire department to protect life and property from fire and to extinguish all destructive fires. They further state that no person has the right to interfere with or hinder the fire department in the performance of this responsibility. In aircraft accidents where the investigation of cause is very important, efforts consistent with the duty described above might involve moving parts and operating controls. When this must be done, RFF personnel should be prepared to subsequently advise responsible authorities of the action they took.

11-1.2 If it is necessary to move portions of a damaged aircraft, either in rescue operations or fire control, caution should be taken to avoid changes in the aircraft's stability. Undo strain on the airframe can liberate fuel from damaged tanks, cause collapse or rollover of the fuselage, or cause greater injuries to trapped occupants.

11-1.3 During the course of the emergency, RFF personnel should assure that the "no smoking" rule is rigidly enforced at the scene of an aircraft accident and that all nonessential sources of ignition be prohibited in the immediate vicinity.

11-1.4 RFF personnel should familiarize themselves with all regulations relating to movement of aircraft wreckage and disposition of accident fatalities. (*See also Appendix D.*)

11-2 Preservation of Evidence.

11-2.1 Following extrication of occupants from an aircraft, preservation of evidence at the site is of vital importance in determining the probable cause. RFF personnel should be aware of this requirement and it should be stressed in training exercises.

11-2.2 RFF personnel should take notice of the condition and position of the aircraft structure prior to beginning any significant cutting or shifting of any portions of the wreckage. If time permits, a photographic record of initial conditions should be made for later study.

11-2.3 Any aircraft accident area should be roped off and perimeter security established to prevent the entry of un-

authorized persons. Persons not actively engaged in operations should be denied entry into the area. Those persons inside the controlled area should be fully equipped with the necessary protective clothing and equipment to carry out their duties. (See also 5-1.2.)

11-3 Fatalities.

11-3.1 The location of all fatalities in and about the aircraft wreckage should be clearly identified by the use of a flag, stake, or other suitable marking and numbered to coincide with a number securely attached to the body, and photographed if possible. Triage/medical tags can be used for this purpose. (See also NFPA 424M, *Airport/Community Emergency Planning*.)

11-3.2 Removal of fatalities remaining in an aircraft wreckage after the fire has been extinguished should be done only by, or under the direction of, the responsible medical examiner (coroner). Premature body removal can interfere with identification and destroy pathological evidence. If body removal is absolutely necessary to prevent further incineration, the original location and the body should be photographed, identified with a number, and the fact reported to investigators.

11-4 Preservation of Mail, Baggage, and Cargo.

11-4.1 The original location of mail sacks, baggage, and cargo should be observed and this information passed on to investigators. These items should be protected from further damage. If necessary, remove to a safe location such as the command post.

11-4.2 Postal officials normally extend blanket authority to fire departments to remove mail from aircraft involved in an accident for the purpose of saving as much of it as possible. After the responding postal official has been properly identified, the RFF officer can transfer the custody of the mail.

11-4.3 If it is necessary to remove baggage from an aircraft involved in an accident, it should be placed in the custody of airline officials. Under certain circumstances, customs officials would be granted initial custody. Responsibility for final disposition of baggage belongs to the airline involved.

11-4.4 Cargo manifests should be reviewed for the presence of dangerous goods. If present, they should be examined for leaking containers. If leaks are found, contaminant and decontamination procedures should be initiated immediately by qualified personnel. If cargo is removed from the aircraft, it should be turned over to the responsible agency.

11-4.5 When personal property such as jewelry, purses, watches, etc. is found in the area of an aircraft accident, RFF personnel should not move it but record the location and notify their commanding officer, who should advise security personnel of the information. These items and their locations can be of great value to the medical examiner in making positive body identifications.

11-5 Flight Data and Cockpit Voice Recorders. Flight data and cockpit voice recorders are usually located in the

aft fuselage area of most commercial aircraft. RFF personnel should be able to recognize them so that they can be protected from loss or damage until accident investigators assume responsibility. Although no attempt should be made to remove these recorders from the aircraft, as they may be damaged by such efforts, if failure to remove them will result in their total loss, recovery should be made. (See Figure 11-5.)

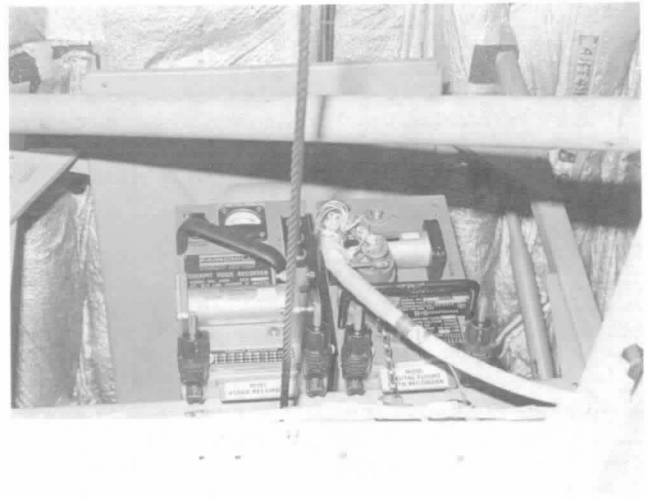


Figure 11-5 A flight data recorder (FDR) and a cockpit voice recorder (CVR) are shown mounted in an aircraft.

11-6 Defueling Accident Aircraft.

11-6.1 Defueling operations should be done under the direct supervision of a qualified aircraft fuel systems specialist. The defueling itself should be performed by qualified technicians using approved methods. (See NFPA 407, *Standard for Aircraft Fuel Servicing*, and NFPA 410, *Standard on Aircraft Maintenance*.) A standby fire watch should be provided by RFF personnel during the entire defueling operation.

11-6.2 To control fuel system leaks prior to completion of aircraft defueling, fuel cell sealant, clay, or other material can be used to make mini dams on smooth surfaces to direct the flow of fuel into containers. Crimping, pegs, and plugs should also be used where appropriate. It might also be possible to shovel trenches to direct the fuel to collecting spots where it can be protected from ignition sources.

11-6.3 During defueling operations, an ignition-free area with a radius of at least 50 ft (15 m) from the outer edge of the operating area should be maintained. Persons within the controlled area should be only those necessary for the work being done. Open flames, floodlights, ground power units, and radio transmitters should be prohibited in the operating area. RFF personnel should also be aware that their vehicles and equipment can be a source of ignition and take necessary precautions.

11-6.4 Concurrent operations such as jacking, shifting, and removing panels should not be conducted during defueling operations. Transfer of fuel during defueling operations can cause changes in weight distribution, balance, and stability of the aircraft. Cribbing, blocking, use of air

bags, and other stabilizing methods and equipment should be in place, ready for use if needed. Safe access for fueling vehicles, empty or full, should be provided.

11-6.5 Prior to moving, the interior of the aircraft wreckage should be well ventilated to remove all flammable vapors. After removal of the aircraft, ground surfaces should be thoroughly flushed of any flammable liquids or debris before permitting normal traffic to resume.

11-7 Aircraft Systems Hazards. RFF personnel should seek the advice of aircraft systems specialists concerning items that might present problems during overhaul and salvage operations. Advice can include information regarding liquid or pressurized systems that need to be bled off prior to any cutting, bending, or prying around components.

Chapter 12 Air Ambulance Aircraft and Nonambulatory Passengers

12-1 Air Ambulance Aircraft. If special protection is requested, the following procedures are recommended for the assistance to air ambulance aircraft (*see Section 5-2, Types of Emergency Alerts*):

(a) Prior to takeoff, one vehicle should follow the aircraft to the departure runway and stand by until the aircraft has left the airport ATC area.

(b) Prior to landing, the aircraft captain should report the number of litter or nonambulatory patients aboard and request that RFF personnel be alerted.

(c) One or more vehicles, as the situation warrants, should be strategically positioned for the landing. After the aircraft lands, at least one vehicle should follow the aircraft to its parking position and remain there during the transfer of the patient(s). The normal position for following an ambulance aircraft should be aft and off the wingtip of the off loading side.

(d) If the aircraft is to be refueled, or if it had experienced any difficulty prior to landing or parking, RFF personnel should stand by the exit with a charged hose line.

(e) If an emergency is declared prior to landing, all available RFF personnel and equipment should respond to standby positions. (*See Chapter 5.*)

12-2 Nonambulatory Passengers Permitted on Scheduled Airline Flights. Government regulations and airline policies permit the carriage of handicapped passengers on scheduled air carriers. A handicapped passenger is a person who might need the assistance of another person to expeditiously move to an exit in the event of an emergency. These people have a disability or condition that could lead to a significant delay during an emergency evacuation of an aircraft or could increase the risk of that person being injured during the evacuation. Handicapped passengers are categorized as:

(a) *Ambulatory.* A passenger who is able to board and deplane the aircraft unassisted and who is able to move about the aircraft unassisted. This includes the blind, deaf, mentally retarded, etc.

(b) *Nonambulatory.* A passenger who is not able to board and deplane an aircraft unassisted or who is not able to move about the aircraft unassisted. The individual airline's policy will dictate the requirement of having a qualified attendant accompany a disabled person on a flight.

Chapter 13 Structural Fire Department Operations

13-1 General.

13-1.1 A prerequisite for the application of information contained in this chapter is a thorough review of the preceding chapters. Discussed are recommended procedures using apparatus, equipment, and resources available to most structural fire departments. Emphasis is placed on rescue of aircraft occupants.

13-1.2 Fire control is often the means by which this can be accomplished. Aircraft fuel fires require extinguishing agents and techniques common to Class B fires. Structural fire fighters therefore should be trained to effectively combat this type of fire utilizing available equipment and extinguishing agents. IT IS IMPERATIVE THAT FIRE DEPARTMENTS LOCATED NEAR AIRPORTS OR AIRCRAFT FLIGHT PATHS BE THOROUGHLY FAMILIAR WITH THE RECOMMENDATIONS SET FORTH IN THIS MANUAL.

13-1.3 The recommendations presented in this chapter should not be interpreted as an alternative for adequate airport-based rescue and fire fighting services as outlined in NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports*.



Figure 13-1 On April 4, 1978, a DC-9 with 85 persons onboard crashed near the small town of New Hope, Georgia. Sixty-two occupants and nine persons on the ground were killed. Efforts by the volunteer fire department were credited with saving 23 aircraft occupants and preventing serious fire loss to several exposures.

13-2 Preplanning and Training.

13-2.1 Fire departments located near airports should make appropriate arrangements to participate in the airport/community emergency plan. The fire department's services should also be made available to the airport dur-

ing any special events such as air shows or during periods of unusually heavy aircraft traffic. Since no community is immune to an aircraft accident, all fire departments should implement preplanning and training for this type of incident.

13-2.2 At an aircraft accident, teamwork is so important that fire department officers should review preplanning as the one absolutely indispensable element in aircraft rescue and fire fighting.

13-2.3 The psychological factors involved in aircraft rescue and fire fighting can be successfully overcome only by realistic preplanning and training. Each fire department should conduct realistic simulated aircraft fire drills using the types of extinguishing agents and equipment they expect to have available. One important training objective should be to learn the capabilities and limitations of the department's preplanned procedures.

13-2.4 Training fires should involve aviation grades of fuel or flammable liquids having similar properties consistent with local environmental regulations. Aircraft fires should be simulated using discarded aircraft fuselages, automobile bodies, oil drums, or other metal shapes.

13-2.4.1 An aggressive attack using hose lines with spray nozzles, employing preplanned operating techniques, can develop the confidence necessary to successfully handle these types of incidents.

13-2.5 The volume of smoke, fire, and intense heat accompanying an aircraft fire can appear to be an overwhelming situation to untrained fire fighters. They might be reluctant to attack and control the fire with a limited water supply and conventional equipment for the amount of time required to complete rescue operations. Experience has proven that rescues can be accomplished even where large quantities of spilled aircraft fuel are burning.

13-2.6 Training coordination between military, civil airport, and structural fire departments is strongly recommended. Execution of mutual aid agreements between these agencies will help assure well-coordinated plans for rescue and fire fighting. In the United States and Canada, military air base commanders are urged to make their training facilities available to nearby fire departments, particularly where those departments are likely to be called upon to assist in rescue and fire fighting operations.

13-2.7 Structural fire department personnel should be thoroughly familiar with the most efficient response routes to the airport and the surrounding area. They should know all the airport's accesses and entrances to the operational areas and be provided with any necessary keys or gate codes. As a minimum, their training should include information relative to items (a) through (j) in 2-3.4 of this manual.

13-2.8 Aircraft familiarization is also an important part of aircraft rescue and fire fighting preplanning. Structural fire departments should contact the airport fire department to arrange qualified persons to take fire fighters through the various aircraft using the airport. When inspecting the aircraft, the following facts should be noted: location of fuel,

hydraulic oil, lubricating oils, and other storage locations and capacities; seating arrangements; and emergency exits and hatches and how they can be opened. Also important are the locations of batteries, oxygen storage, and various system shutoffs. (See also 2-3.3.)

13-2.9 Fire departments should avail themselves of informational charts of all aircraft types using the airport. Airlines and aircraft manufacturers can provide these charts that depict most information pertinent to rescue and fire fighting operations. (See also examples of charts in Appendix A.)

13-3 Aircraft Accident Operations.

13-3.1 When fire departments receive a report that an aircraft is experiencing an in-flight emergency or that it is down in the vicinity, they should immediately alert the fire forces that could be affected. Fire and police units should coordinate their efforts. Making use of a police helicopter, if available, could help coordinate operations and serve as a communication link between the fire units and the control tower.

13-3.2 Size-up begins with the fire department's first notification of an incident. Multiple calls from various sources in the vicinity of the airport should alert fire dispatchers of a possible major aircraft accident and warrant an immediate first alarm response. A multiple unit response would assure arrival at the scene of at least one unit despite the likelihood of blocked access due to debris and traffic. During the initial response, pre-plans should be activated and all pertinent information should be transmitted to the responding units.

13-3.3 The following factors are among those that are important to the size-up process:

(a) Occupant survival is generally limited to accidents where the fuselage is not severely broken up and a fire has not yet developed.

(b) Environmental and geographical factors have a major impact on response capability. An accident in a wooded area during a winter snowstorm presents different problems than a similar accident on a clear summer afternoon.

(c) Time of day is a factor. An aircraft accident that occurs in a shopping center parking lot has a different life hazard potential at 4:00 a.m. on Sunday than a similar event at 4:00 p.m. on Friday.

(d) The magnitude and nature of the aircraft accident needs to be considered. An aircraft accident in an open field can set off a major grass or brush fire, but an accident in a populated area can be more complex. If structures are involved, their occupancy, construction type, and stability need to be evaluated. In addition, an assessment of damage to public utilities and their possible effect on operations should be made. Because of the possibility that water supply from hydrants might not be available due to system damage, it is good practice to include water tanks in the first response.

(e) The nature of the aircraft operation at the time of the accident is of importance. If a crop dusting aircraft accident occurs, steps need to be taken to protect emergency personnel and limit the spread of pesticide contamination.

(f) Aircraft accidents that occur on takeoff usually involve large amounts of fuel. In addition to the fire problem that could evolve, steps need to be taken to prevent a fire, or fuel or fuel vapors from entering waterways, streets, and underground facilities.

13-4 Basic Fire Control.

13-4.1 Specific implementation of basic aircraft fire control methods should depend upon the fire fighting equipment and types of extinguishing agents available to individual fire departments.

13-4.2 Always assume that there are survivors of an aircraft accident until it is confirmed otherwise. In some instances, however, rescue of occupants cannot be accomplished because of the remoteness of the accident or the severity of the impact forces. In such instances fire fighters should make a thorough search for survivors, protect any exposures, attack and extinguish the fire, and preserve the scene until the proper authorities arrive to assume responsibility.

13-4.3 Fire fighters should be aware that aircraft structures differ from most other structures in ways that make fires more dangerous for the occupants and for themselves. Aircraft occupants are enclosed in a thin aluminum shell, and are surrounded by large amounts of fuel with tremendous heat potential. Large aircraft have hollow wall construction with the void filled with blanket-type insulation. Fire walls and draft stops are nonexistent except for engine, galley, and cargo bay areas. These deterrents to fire spread are not comparable to fire barriers found in building construction.

13-4.4 In all large aircraft and in many smaller models, plumbing, electrical, heating, and cooling services are provided. Consequently there are aircraft equivalents of pipe chases, electrical load centers, buss bars, etc. The aircraft electrical system should be treated with the same safety precautions as those used for a typical residence.

13-4.5 Most aircraft contain pressure hydraulic reservoirs and liquid or gaseous oxygen lines constructed mostly of aluminum. These, as well as brake lines, will rupture quickly under fire conditions. Fuel tanks are interconnected and fire can propagate through ventilation ducts or manifolds. Fire impingement on empty or near empty fuel spaces often results in a violent rupture of tanks and wings.

13-4.6 Aircraft also differ from other structures in the critical aspect of stability. Most structures are cubical in shape and will collapse in place. Aircraft are cylindrical, conical, and usually on wheels. Therefore, movement, such as tilting and rotation effects, should be considered. Guy lines, chocks, air bags, and cribbing should be required when working around damaged aircraft. Current modern aircraft can weigh 800,000 lb (363200 kg) or more and have a height greater than a five-story building.

13-5 Accidents without Fire.

13-5.1 When an aircraft accident occurs without fire, the following fire prevention procedures should be initiated. Hose lines should always be laid out and charged. Any spilled fuel should be covered with foam. Ignition sources

such as hot aircraft components or energized electrical circuits should be eliminated. When moving wreckage, care should be taken to avoid causing sparks.

13-5.2 When foam is not available, water spray can be used to cool hot aircraft components and to move fuel away from the fuselage. However, washing fuel away with water requires that special attention be given to exposures, low areas, and drains where fuel and vapors can flow. The fuel should be directed to an area of containment free from ignition sources where it can later be safely removed.

13-6 Accidents with Fire.

13-6.1 The location of survivors and the sources of heat or flame impingement against the aircraft will determine where hose streams should be applied first. Fire fighters should keep in mind that the heat input into the occupied portion will be reduced if the surfaces of the fuselage exposed to flame or heat can be kept wet. If the fire has penetrated the fuselage, a direct internal attack should be initiated. Care should be taken to see that water runoff does not cause the fire to spread.

13-6.2 Normally, hose streams should be directed along the fuselage and efforts concentrated on driving the flames outward, allowing occupants to escape and permitting entry by fire fighters for rescue operations. The fuselage and fuel tank areas should be kept cool. It might be necessary to create an escape path from an exit point by "sweeping" fire out of the area with spray streams. Once an escape path has been established it should be maintained for evacuating occupants and fire fighters performing rescue.

13-6.3 All available hose lines should attack the fire from the same general direction. If crews are operating on opposite sides of the fuselage, they should be cautious not to push the fire toward each other. Because prompt action is necessary to effect rescue, the first hose line in operation should be advanced immediately to keep the fuselage cool.

13-6.4 For aircraft rescue and fire fighting, there are too many variables to establish hard and fast rules regarding use of equipment. Spray streams are normally more effective than straight streams in applying water or foam and afford much more personal protection.

13-6.5 The number of hose lines and quantity of water will be determined by the availability of the water, equipment, and personnel. Immediately upon arrival, all deployed hose lines should be charged regardless of the fire situation. This cannot be overemphasized.

13-7 Fire Fighting with Water.

13-7.1 If an aircraft accident occurs in a remote area with limited water available on responding apparatus, a supplemental source of water should be established. The use of tank vehicles to shuttle water between the nearest water source and the accident site should be considered.

13-7.2 When using water to combat flammable liquid fires, spray nozzles, operating at approximately 100 psi (689 kPa), should be used. Spray patterns, on initial approach to the fire, should be set at a wide angle momen-

tarily to reduce the heat and flame, then reduced to 30 degrees to attack the fire. The best technique is to sweep the flame off the surface of the fuel by maintaining the lower portion of the spray pattern at the lowest level of the flame. This action also tends to cool the fuel surface and reduce vaporization. However, because there is no vapor seal provided, as when foam is used, chances for re-ignition remain and fire fighters should take the necessary precautions to prevent this occurrence. (See Section 13-5.) Additional hose lines, used exclusively for the protection of rescue and fire fighting personnel, are encouraged.

13-7.3 Runoff from water streams can cause the spread of fire to exposures. Straight streams should be used when the heat is too intense to approach initially with spray streams, or the objective is to wash the burning liquid away from the fuselage to an area where there is no exposure.

13-7.4 Trained fire fighters employing proper operating techniques can accomplish a successful rescue operation at an aircraft accident with a limited amount of water if all efforts concentrate on establishing a fire-free evacuation path. Efforts to save the aircraft hull or exposures may have to be delayed until additional resources arrive.

13-7.5 Addition of a wetting agent might increase the effectiveness of available water; however, certain wet water additives can destroy some foams. Compatibility of the agents should be checked prior to their use.

13-7.6 Approved portable dry chemical, foam, or halon extinguishers can be used to supplement the primary attack with hose streams. These agents are particularly effective on localized fires or in areas that cannot be readily reached by hose streams. In some instances, bulk supplies of dry chemical, foam, or halon are made available to fire departments on an emergency basis. This resource should be considered when preplanning for aircraft accidents.

13-7.7 The technique of using multiple spray nozzles with overlapping 30-degree patterns creates a continuous curtain of water spray. They should be advanced directly to the aircraft, parallel to the fuselage from either the nose or tail section, dependent on wind direction. This procedure will open an area for evacuation and rescue. If possible, hose lines should be advanced with the wind at the fire fighters' backs as greater reach is possible with the spray streams and less heat is experienced. Progress and stream effectiveness can be monitored more easily from upwind with the smoke moving away. If there is an adequate water supply, a large spray nozzle attached to a deck gun or a portable deluge set can be used to keep the fuselage and fuel tank areas cool.

13-7.8 Protection of exposed property should be considered whether fire exists or not. In addition to structures, exposure protection plans should include drains, sewers, waterways, power lines, and other properties where a flowing fire or unignited fuel could cause fire extension or contamination. Public utility authorities should be notified of any involvement affecting facilities under their control. Master streams from deluge sets, deck guns, or ladder pipes can be used to protect exposures if water supplies are adequate.



Figure 13-7 Photo shows a variety of typical spray nozzles currently used by structural fire departments. All have the feature of adjustable spray patterns and straight stream settings. Some also have variable flow settings. Most fire chiefs agree that a nozzle setting of 30 degrees provides the best pattern for fighting flammable liquid fires with either water, AFFF, or FFFP solutions.

13-8 Fire Fighting Foam.

13-8.1 Aqueous film forming foam (AFFF), film forming fluoroprotein foam (FFFP), or protein foam concentrates properly proportioned into fresh water are more effective than just water on flammable liquid fires.

13-8.2 Techniques for the application of foam vary with the type used. Protein and fluoroprotein foam solutions should be applied with an aspirating foam nozzle at a pressure of 100 psi (689 kPa). A constant flow from the nozzle should be maintained to assure an even pickup of the concentrate. The proper operating pressure should be maintained during the entire foam application for effective results. AFFF and FFFP can be applied using either an aspirating foam nozzle or a conventional spray nozzle operating at 100 psi (689 kPa).

13-8.3 A foam/water solution using protein, fluoroprotein, or AFFF can be made up in the water tank of a structural fire fighting apparatus for direct foam application through hose lines equipped with appropriate nozzles. After draining the appropriate amount of water from the tank, add the required amount of foam-liquid concentrate. Mix the solution by opening the "tank to pump" valve and place the pump in gear; open the "tank fill" valve slightly and circulate the solution through the pump and tank to assure a good mix. After use, any unused solution should be drained and the entire water system should be well flushed before refilling the water tank for regular use.

13-8.4 Some fire departments have purchased combined agent vehicles for special purposes, such as vehicle accidents and flammable liquid spills. Such combined agent vehicles are a valuable tool for the initial response to an aircraft accident.

13-9 Vehicles. Fire fighting apparatus designed and intended for use on paved surfaces should not be used for cross-country travel. Extended hose lines from a position on a hard road surface should be used rather than risking immobilization. Once a vehicle has become immobilized

it could not be moved if it became endangered by a developing fire situation. It can also block or delay other emergency vehicles responding to the site.

13-10 Post Accident Procedures. Fire department personnel should be familiar with the information contained in Chapter 11 and Appendix D of this manual.

Chapter 14 Referenced Publications

14-1 The following documents or portions thereof are referenced within this manual and should be considered part of the recommendations of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

14-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 403-1988, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports*

NFPA 407-1985, *Standard for Aircraft Fuel Servicing*

NFPA 410-1989, *Standard on Aircraft Maintenance*

NFPA 414-1984, *Standard for Aircraft Rescue and Fire Fighting Vehicles*

NFPA 422M-1989, *Manual for Aircraft Fire and Explosion Investigations*

NFPA 424M-1986, *Manual for Airport/Community Emergency Planning*

NFPA 1003-1987, *Standard for Airport Fire Fighter Professional Qualifications*.

14-1.2 Other Publications.

14-1.2.1 ICAO Publications. International standards and recommended practices are promulgated by the International Civil Aviation Organization, 1000 Sherbrooke Street West, Montreal, Quebec Canada H3A-2R2.

International Standards and Recommended Practices: Aerodromes (Annes 14), 8th Edition, March 1983

Airport Services Manual, Part 1: Rescue and Fire Fighting, Second Edition, 1984

Airport Services Manual, Part 7: Airport Emergency Planning, First Edition, 1980

Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods, First Edition, March 1987.

14-1.2.2 US Government Publications. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

14-1.2.2.1 FAR Part 139. Part 139 is sold on a subscription basis by the Superintendent of Documents. Subscribers will receive changes to this Part automatically.

14-1.2.2.2 Federal Aviation Administration Publications. Available from Department of Transportation, Distribution Unit, M-494.3, Washington, DC 20590.

Advisory Circulars. This listing is limited to those free advisory circulars relating to aircraft rescue and fire fighting

services. For a complete listing of FAA advisory circulars, write to the address above and request a copy of the latest "Advisory Circular Checklist and Status of Other FAA Publications." This checklist is also published periodically in the Federal Register.

150/5200-12A, *Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident* (4-8-85) (AAS-100). Furnishes general guidance for airport employees, airport management, and other personnel responsible for fire fighting and rescue operations, at the scene of an aircraft accident, on the proper presentation of evidence.

150/5200-15C, *Announcement of Availability — International Fire Service Training Association's Manual 206, Aircraft Fire Protection and Rescue Procedures* (Second Edition, 1978) (8-26-82) (AAS-100). Explains the nature of the manual and tells how it can be obtained.

150/5200-18A, *Airport Safety Self-Inspection* (12-18-85) (AAS-310). Suggests functional responsibility, procedures, a checklist, and schedule for an airport safety self-inspection.

150/5200-21A, *Announcing the Availability of U.S. Air Force Technical Order (T.O. 00-105E-9) Aircraft Emergency Rescue Information* (2-24-81) (AAS-100). Explains the nature of the Technical Order and tells how it can be obtained.

150/5210-2A, *Airport Emergency Medical Facilities and Services* (11-27-84) (AAS-300). Provides information and advice so that airports may take specific voluntary preplanning actions to assure at least minimum first aid and medical readiness appropriate to the size of the airport in terms of permanent and transient personnel.

150/5210-58, *Painting, Marking, and Lighting of Vehicles Used on an Airport* (7-11-86) (AAA-120). Provides guidance, specifications, and standards, in the interest of airport personnel safety and operational efficiency, for painting, marking, and lighting of vehicles operating in the airport air operations areas.

150/5210-6C, *Aircraft Fire and Rescue Facilities and Extinguishing Agents* (1-28-85) (AAS-100). Outlines scales of protection considered as the recommended level compared with the minimum level in Federal Aviation Regulation Part 139.49 and tells how these levels were established from test and experience data.

150/5210-78, *Aircraft Fire and Rescue Communications* (4-30-84) (AAS-120). Provides guidance and information for planning and implementing an airport communications system for airport fire and rescue service.

150/5210-13, *Water Rescue Plans, Facilities, and Equipment* (5-4-72) (AAS-300). Suggests planning procedures, facilities, and equipment to effectively perform rescue operations when an aircraft lands in a body of water, swamp, or tidal area where normal aircraft fire fighting and rescue service vehicles are unable to reach the accident scene.

150/5210-14, *Airport Fire and Rescue Personnel Protective Clothing* (3-12-86) (AAS-100). Developed to assist airport management in the development of local procurement specifications for an acceptable, cost-effective proximity suit for use in aircraft rescue and fire fighting operations.

+ 150/5210-15, *Airport Rescue and Fire Fighting Station Building Design* (7-30-87) (AAS-100). Provides standards and guidance for planning, designing, and constructing and airport rescue and fire fighting station.

150/5220-4A, *Water Supply Systems for Aircraft Fire and*

Rescue Protection (12-11-85) (AAS-120). Provides guidance for the water source selection and standards for a water distribution system designed to support aircraft rescue and fire fighting (ARF) service operations on airports.

150/5220-9, *Aircraft Arresting Systems for Joint Civil/Military Airports* (4-6-70) (AAS-300). Updates existing policy and describes and illustrates the various types of military aircraft emergency arresting systems that are now installed at various joint civil/military airports. It also informs users of criteria concerning installations of such systems at joint civil/military airports.

150/5220-10, *Guide Specification for Water/Foam Type Aircraft Fire and Rescue Trucks* (5-26-72) (Consolidated reprint incorporates changes 1 and 2) (AAS-100). Assists airport management in the development of local procurement specifications.

150/5220-14A, *Airport Fire and Rescue Vehicle Specification Guide* (2-25-85) (AAS-100). Assists airport management in the development of local procurement specifications.

150/5230-4, *Aircraft Fuel Storage, Handling, and Dispensing on Airports* (8-27-82) (AAS-300). Provides information on aviation fuel deliveries to airport storage and the handling, cleaning, and dispensing of fuel into aircraft.

150/5230-4, Chg. 1 (2-20-86).

+ + 150/5230-4, Chg. 2 (7-1-87).

150/5280-1, *Airport Operations Manual* (6-16-72) (AAS-310). Sets forth guidelines to assist airport operators in developing an Airport Operations Manual in compliance with the requirements of FAR Part 139.

150/5280-1, Chg. 1 (3-24-81).

150/5280-3, *Fire Fighting Exemptions Under the 1976 Amendment to the Federal Aviation Act* (2-4-77) (AAS-100). Outlines the type of information that may be used as justification in supporting petitions for exemption from a portion or all of the fire fighting and rescue requirements of Part 139.

+ + 150/5325-5C, *Aircraft Data* (6-29-87) (AAS-100). Presents a listing of principal aircraft weights and dimensions which affect airport facility design. It is to be used for guidance in airport development. Data presented are for common civil aircraft and those military aircraft which frequently utilize civil facilities.

150/5340-1E, *Marking of Paved Areas on Airports* (11-4-80) (AAS-200). Describes standards for marking paved runways, taxiways, closed and/or hazardous areas on airports.

150/5340-18B, *Standards for Airport Sign Systems* (8-21-84) (AAS-200). Contains the Federal Aviation Administration standards for use on airports.

150/5355-1A, *International Signs to Facilitate Passengers Using Airports* (11-3-71) (AAS-100). Informs airport authorities of the desirability to provide international signs and diagrammatic maps within terminal buildings and of the need of clearly marked road signs for airports.

150/5355-2, *Fallout Shelters in Terminal Buildings* (4-1-69) (AAS-100). Furnishes guidance for the planning and design of fallout shelters in airport terminal buildings.

150/5360-12, *Airport Signing and Graphics* (12-23-85) (AAS-110). Provides guidance on airport related signs and graphics.

150/5370-2C, *Operational Safety on Airports During Construction* (5-31-84) (AAS-300). Concerning operational safety on airports with special emphasis on safety during periods of construction activity, to assist airport operators in complying with Part 139.

150/5380-5A, *Debris Hazards at Civil Airports* (2-25-81) (AAS-100). Discusses problems of debris at airports, gives information on foreign objects, and tells how to eliminate such objects from operational areas.

14-1.2.2.3 Research and Special Programs Administration Materials Transportation Bureau. Request for single free copy for emergency service organizations may be addressed to: US Department of Transportation, Materials Transportation Bureau, Attention: DMT-11, Washington, DC 20590.

Guidebook for Hazardous Materials Incidents (1984 Emergency Response Guidebook), DOT P 5800.3.

14-1.2.2.4 United States Military Publications.

Air Force: Technical Manual 00-105E-9, *Aircraft Emergency (Fire Protection Information)*, available from HQ WR-ALC (MMEOTD), Robbins AFB, GA 31093.

Navy and Marine: NAVAIR 00-80R-14, *Aircraft Fire Fighting and Rescue Manual for US Naval and Marine Air Stations and Facilities*, available from Naval Air Technical Services Facility, 700 Robins Avenue, Philadelphia, PA 19111.

Army: *Technical Manual 5-315*, available from Superintendent of Public Documents, Public Documents Department, US Government Printing Office, Washington, DC 20402.

14-1.2.3 Miscellaneous.

ASTM E380-1986, *Standard for Metric Practice*, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

Advanced Techniques in Impact Protection and Emergency Egress from Air Transport Aircraft, R. G. Snyder Report, HEARD-AG 221, National Transportation Safety Board Accident Reports.

Appendix A Civil Aircraft Data for Rescue and Fire Fighting Personnel

This Appendix is not a part of the recommendations of this NFPA document, but is included for information purposes only.

A-1 Aircraft Familiarization.

A-1.1 This Appendix contains information and data on representative air carrier aircraft which are in common current usage. The purpose is to provide essential information needed to assess the true nature of the specialized problems involved in performing effective aircraft rescue and fire fighting services.

A-1.2 It is strongly emphasized that aircraft orientation inspections be conducted for aircraft rescue and fire fighting personnel on each of the aircraft in service at the airport to which they are assigned. Aircraft familiarization is essential as a basis for realistic training and effective operational techniques.

A-2 Aircraft Access Points — Fire Hazard Zones and Interior Fuselage Arrangements. The following charts depict typical aircraft exits, hazardous locations, interior

fuselage arrangements, and methods by which rescue and fire fighting personnel can make entry into an aircraft:

- Figure A-1 Normal aircraft exit points
- Figure A-2 Typical window exits
- Figure A-3 Preferred forcible entry locations
- Figure A-4 Fire hazard zones
- Figure A-5 Typical aircraft interior fuselage arrangement.

A-3 Crash Crew Charts. The following list of charts identifies specific information relative to various aircraft currently in use as commercial carriers:

- Figure A-6 Bell 206L helicopter
- Figure A-7 Boeing 707
- Figure A-8 Boeing 727
- Figure A-9 Boeing 737
- Figure A-10 Boeing 747
- Figure A-11 Boeing 747 SP

- Figure A-12 Boeing 757
- Figure A-13 Boeing 767 "Wide Body"
- Figure A-14 Canadair CL-44D4 (cargo/passenger)
- Figure A-15 CC115 Buffalo
- Figure A-16 CC117 Falcon
- Figure A-17 Concorde
- Figure A-18 DeHaviland Dash 7
- Figure A-19 DeHaviland Twin Otter
- Figure A-20 Douglas DC-3
- Figure A-21 Douglas DC-4
- Figure A-22 Douglas DC-8
- Figure A-23 Douglas DC-9
- Figure A-24 McDonnell Douglas MD-80
- Figure A-25 Douglas DC-10 "Wide Body"
- Figure A-26 Fairchild F-27
- Figure A-27 Lockheed L-1011 "Wide Body"
- Figure A-28 Short Dash 80
- Figure A-29 A-300 Air Bus "Wide Body"
- Figure A-30 Shorts SD 3.60.

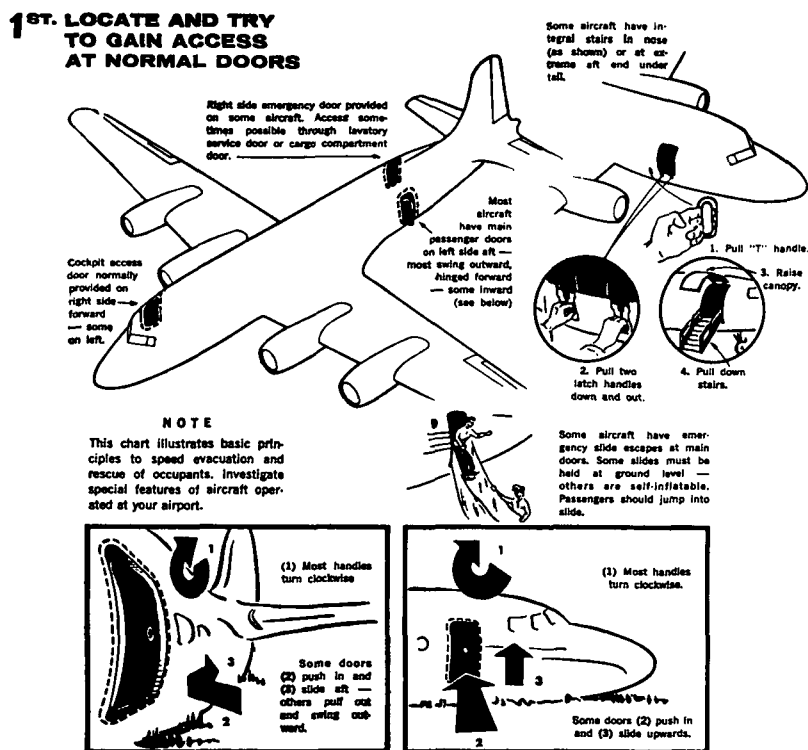


Figure A-1 Highlights of principal points of access to typical transport aircraft.

2ND. LOCATE AND TRY TO OPERATE WINDOW EXITS

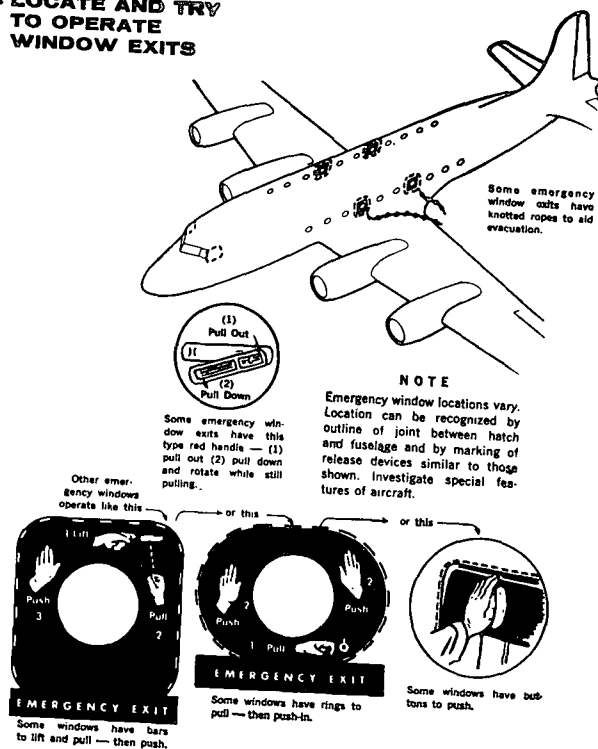
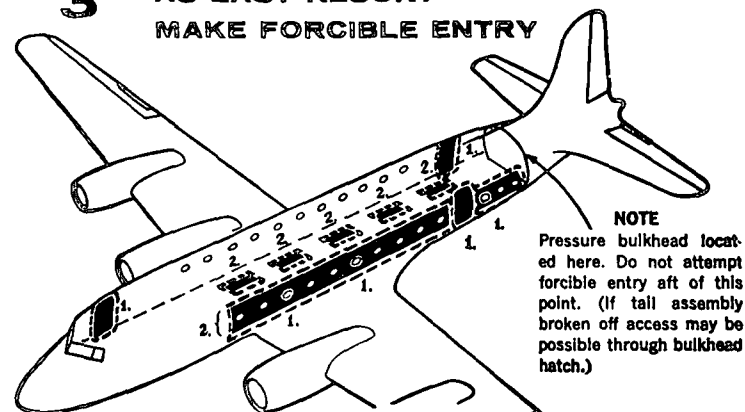


Figure A-2 Window exits on typical transport aircraft. Method of operation and routes of evacuation are shown.

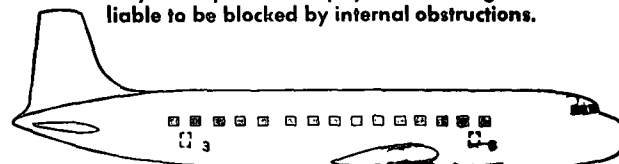
3RD AS LAST RESORT MAKE FORCIBLE ENTRY



PREFERRED FORCIBLE ENTRY LOCATIONS

NOTE
This chart illustrates basic principles to speed evacuation and rescue of occupants. Investigate special features of aircraft operated at your airport.

1. Force normal or emergency doors or windows if possible.
2. Saw or cut in at or between windows above seat arm level and below the hat rack or on either side of center line of top fuselage section (some aircraft marked in this area for "cut-in" as below). Remember when cutting-in, occupants may be exposed to injury from cutting tools. Other areas liable to be blocked by internal obstructions.



3. Saw or cut in at locations marked on some aircraft with red or yellow corner marks and/or words: "cut here".

Figure A-3 Preferred forcible entry locations for typical transport aircraft.

ALWAYS KNOW THE PRINCIPAL FIRE HAZARD ZONES IN CIVIL AIRCRAFT

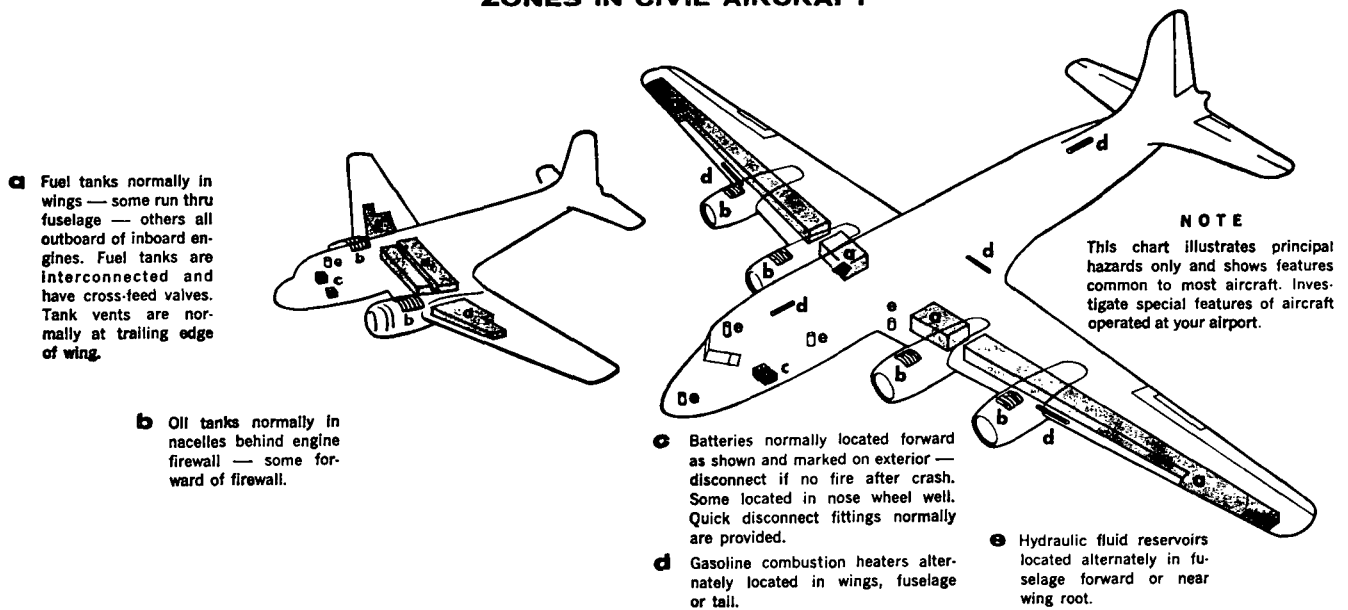


Figure A-4 Principal fire hazard zones on typical reciprocating engine-type transport aircraft.

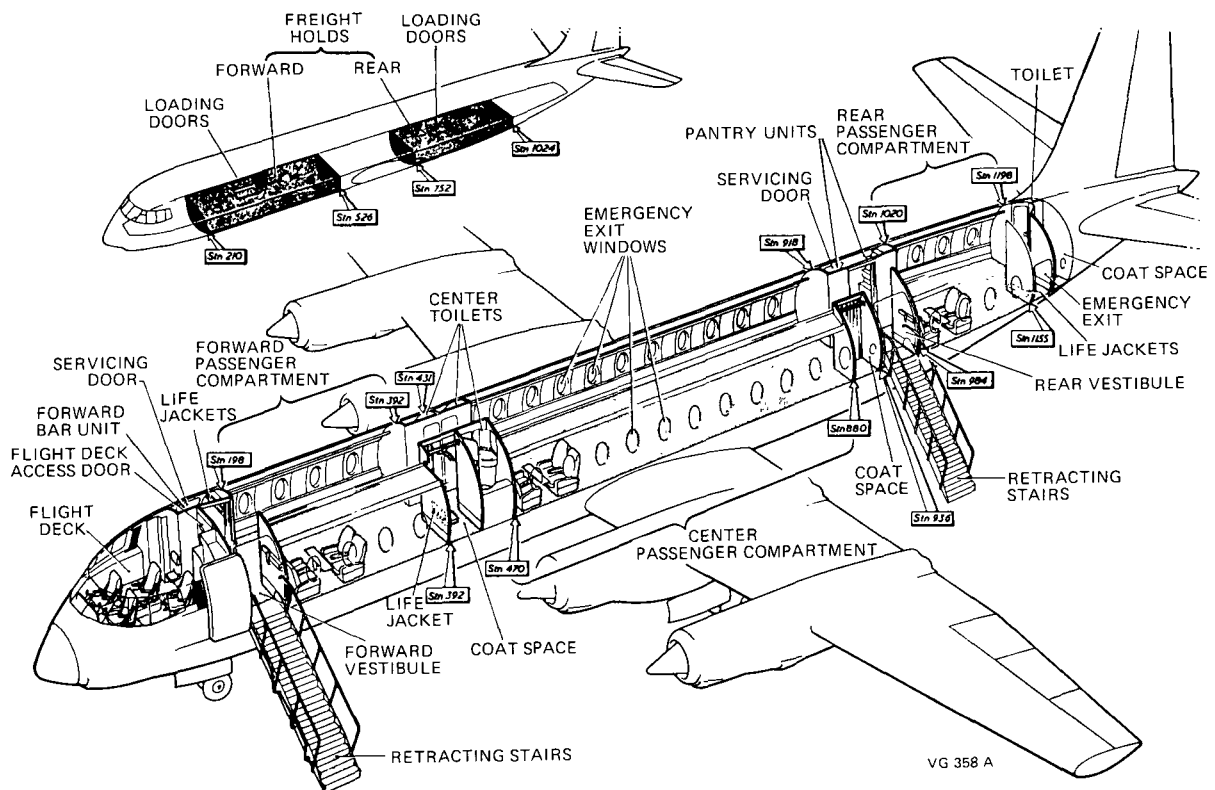


Figure A-5 Typical interior arrangement of transport aircraft.

- TO GAIN ENTRANCE TO CABIN, SLIDE OR BREAK EITHER CABIN DOOR WINDOW
- IF CABIN DOOR OR CARGO PASSENGER DOOR FAILS TO OPEN, BREAK WINDOWS OR WINDSHIELD

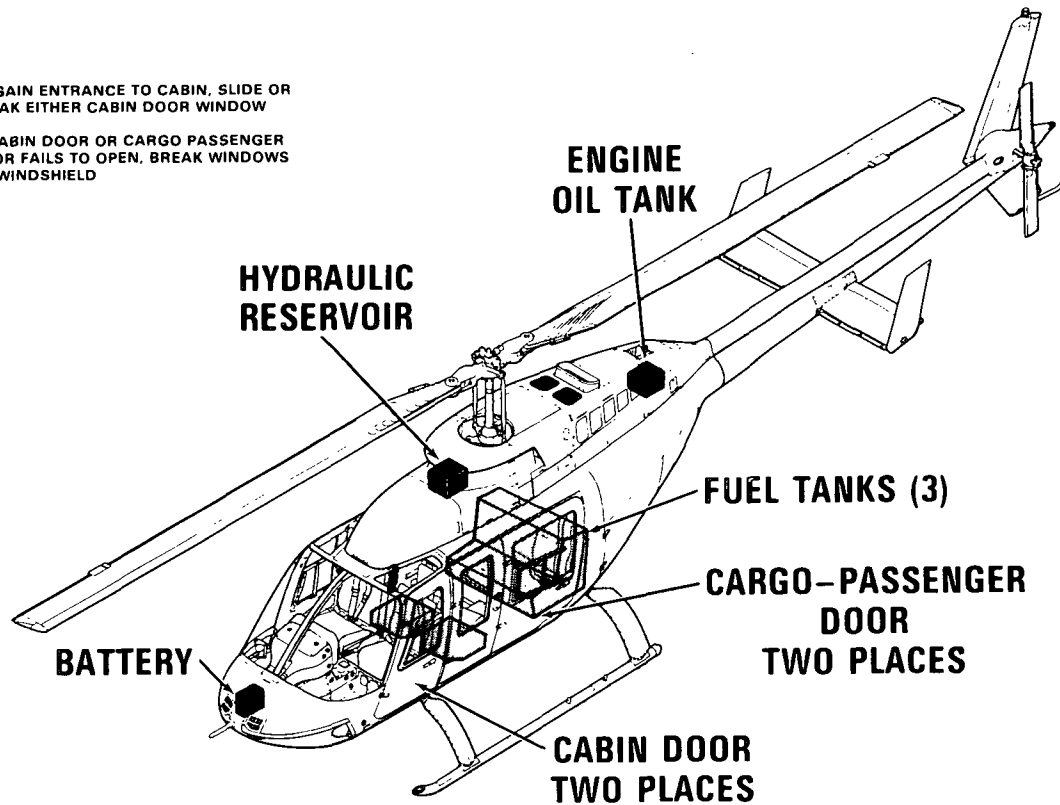
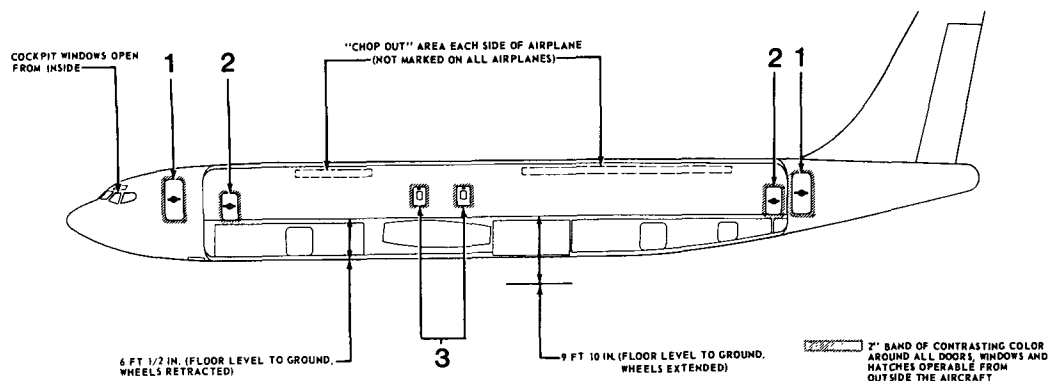
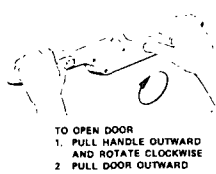


Figure A-6 Bell 206L helicopter.

EMERGENCY RESCUE ACCESS

BOEING 707-100 & 200
USAF C-137B

**1 ENTRY DOOR EXTERNAL HANDLE**

- TO OPEN DOOR
 1. PULL HANDLE OUTWARD
 AND ROTATE CLOCKWISE
 2. PULL DOOR OUTWARD

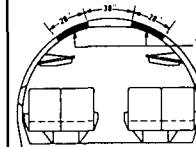
WARNING: PASSENGER AND SERVICE DOORS, CHUTE
 MAY AUTOMATICALLY DEPLOY WHEN
 DOORS ARE OPENED FROM OUTSIDE.

2 GALLEY DOOR EXTERNAL

- TO OPEN DOOR
 1. PULL HANDLE OUTWARD
 AND ROTATE COUNTER-
 CLOCKWISE
 2. PULL DOOR OUTWARD

3 EMERGENCY OVERWING EXIT HATCHES PUSH PANEL

- TO OPEN HATCH
 1. PUSH IN PANEL
 2. PUSH HATCH INWARD

AIRCRAFT CROSS SECTION**NOTE**

"CHOP OUT" AREAS RE-
 REQUIRE METAL CUTTING
 PORTABLE POWER EQUIP-
 MENT. BECAUSE OF TYPE
 OF STRUCTURE AND POS-
 SIBLE INJURY TO PERSON-
 NEL WITHIN, IT IS RECOM-
 MENDED THAT MAJOR
 EFFORT TO GAIN ACCESS
 BE DIRECTED TO HATCH-
 ES AND DOORS. URGEN-
 CY OF SITUATION WILL
 DICTATE NECESSITY FOR
 "CHOP OUT"

Figure A-7 Boeing 707.

EMERGENCY RESCUE ACCESS

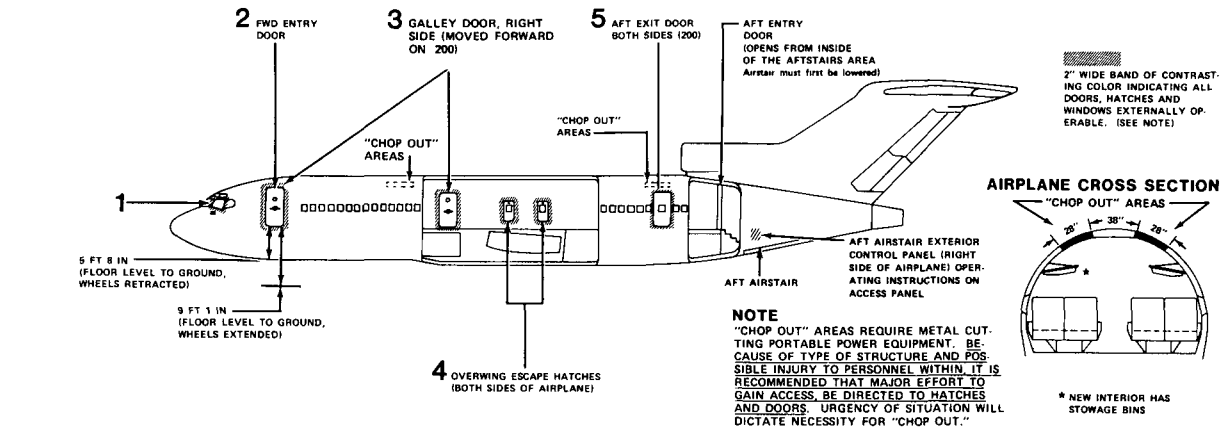
BOEING 727 100-200

Figure A-8 Boeing 727.

EMERGENCY RESCUE ACCESS

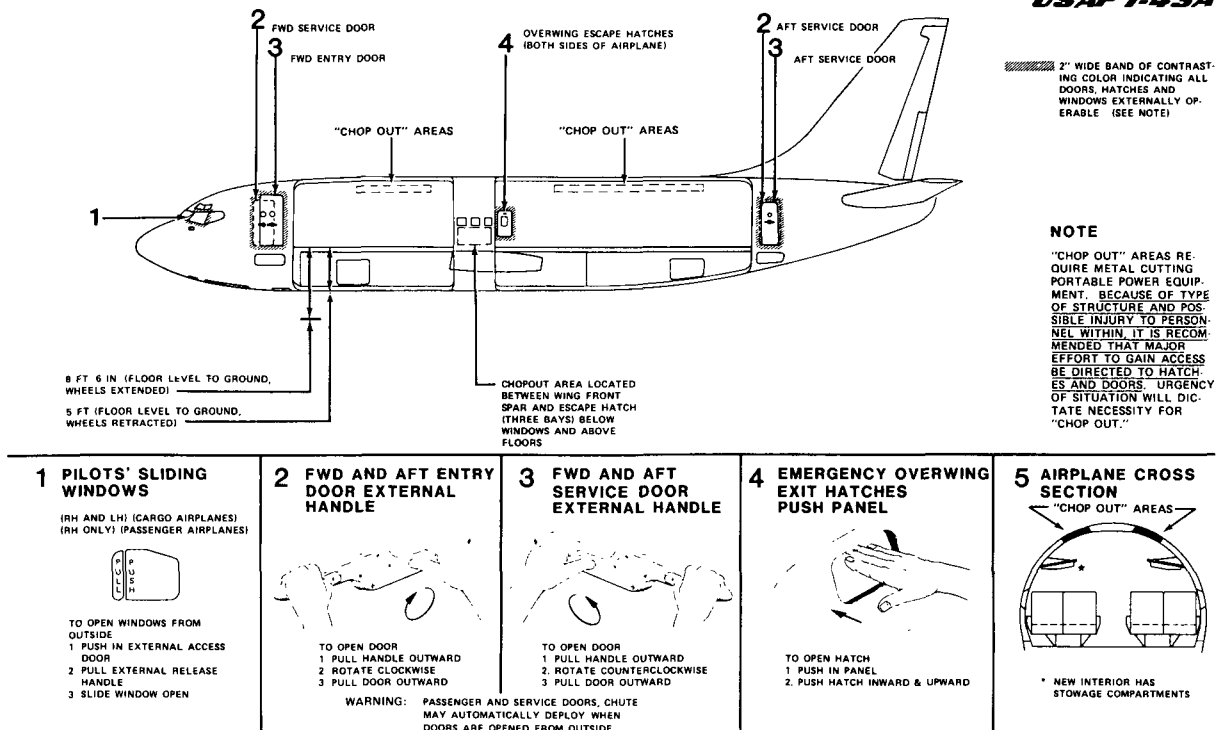
**BOEING 737 100-200-200C
USAF T-43A**

Figure A-9 Boeing 737.

EMERGENCY RESCUE ACCESS

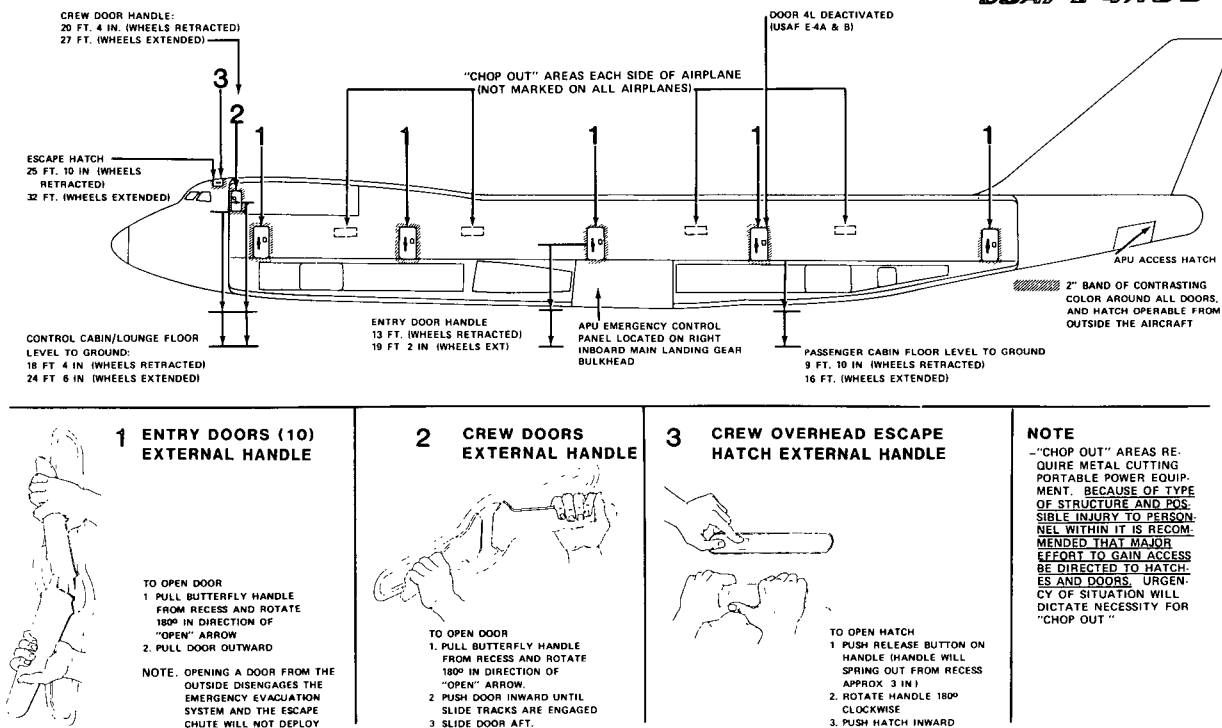
**BOEING 747-100 & 200
USAF E-4A & B**

Figure A-10 Boeing 747 flammable material locations.

EMERGENCY RESCUE ACCESS

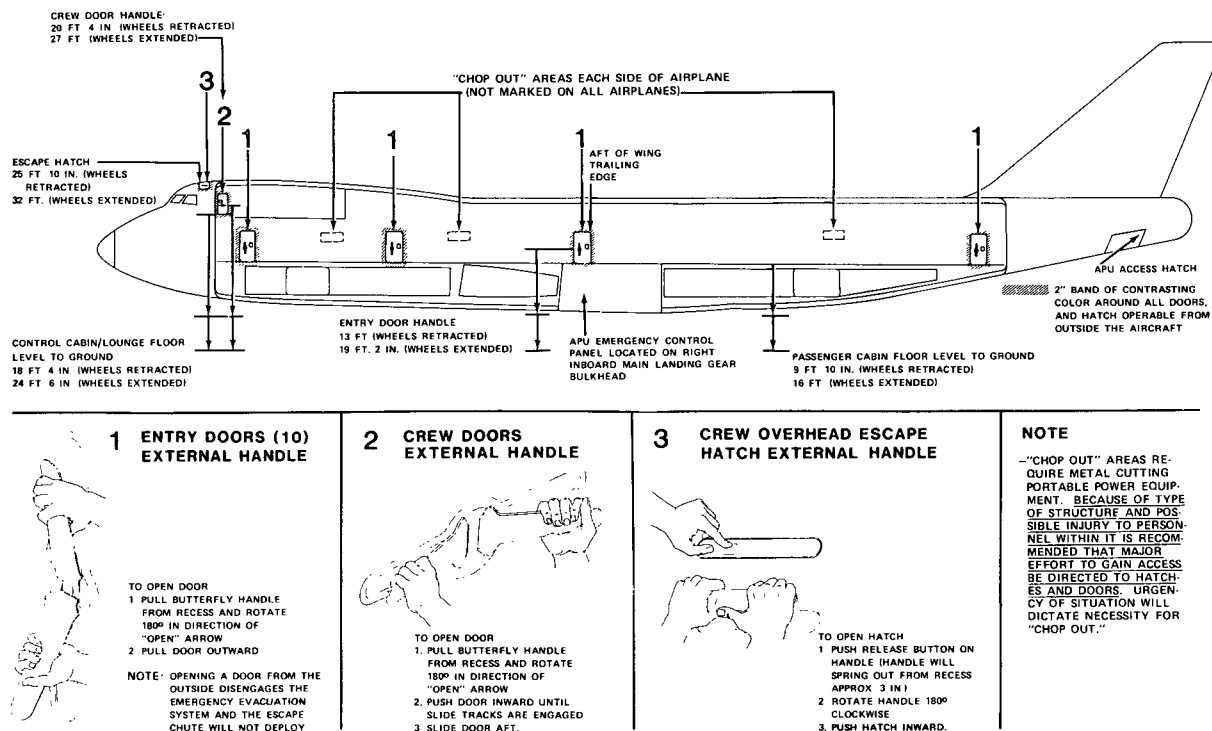
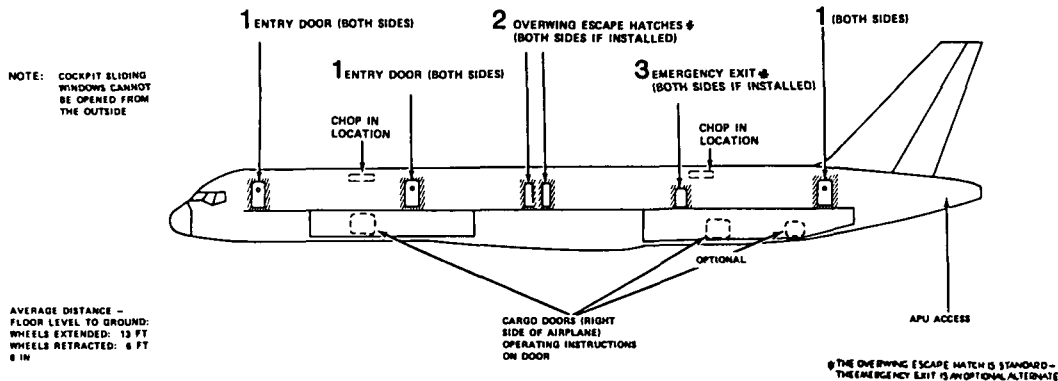
BOEING 747-SP

Figure A-11 Boeing 747 SP.

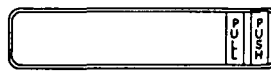
EMERGENCY RESCUE ACCESS

BOEING 757-200**1 ENTRY/SERVICE DOORS EXTERNAL HANDLE**

TO OPEN DOOR:
1. PUSH HANDLE RELEASE LATCH
2. PULL BUTTERFLY HANDLE FROM RECESS AND ROTATE 180° IN DIRECTION OF "OPEN" ARROW
3. PULL DOOR OUTWARD

2 OVERWING ESCAPE HATCHES (IF INSTALLED)

TO OPEN HATCH:
1. PUSH IN "PUSH" PANEL
2. PULL HANDLE UP AND OUTWARD
3. PUSH HATCH INWARD

3 NO. 3 EMERGENCY EXIT (IF INSTALLED)

WARNING: FOR EMERGENCY USE ONLY
DO NOT USE FOR OTHER THAN EMERGENCY USE. DO NOT PULL OUTWARD
DO NOT OPEN DOOR UNLESS RELEASED INTERNALLY

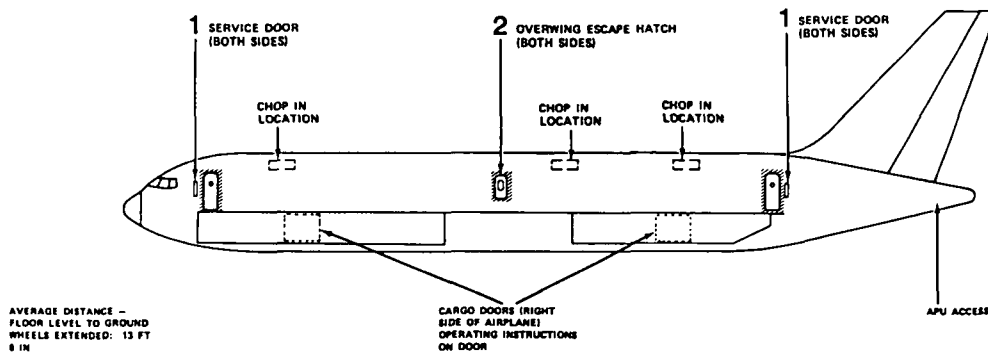
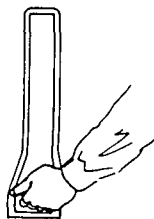
TO OPEN EXIT:
1. PUSH ON "PUSH" PANEL TO GAIN ACCESS TO HANDLE
2. PULL HANDLE FORWARD AND OUTWARD

NOTE:

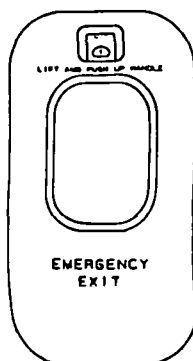
1. ESCAPE DISARMED AUTOMATICALLY WHEN DOOR OR HATCH IS OPENED FROM THE OUTSIDE, EXCEPT NO. 3 EMERGENCY EXIT.
2. COCKPIT SLIDING WINDOWS CANNOT BE OPENED FROM THE OUTSIDE.

Figure A-12 Boeing 757.

EMERGENCY RESCUE ACCESS

BOEING 767-200**1 ENTRY/SERVICE DOOR EXTERNAL HANDLE**

TO OPEN DOOR:
1. PUSH IN LOWER PART OF HANDLE
2. LIFT HANDLE TO UNLOCK DOOR
3. RAISE DOOR UPWARD

2 OVERWING ESCAPE HATCHES**NOTES**

1. ESCAPE DISARMED AUTOMATICALLY WHEN DOOR OR HATCH IS OPENED FROM THE OUTSIDE.
2. COCKPIT SLIDING WINDOWS CANNOT BE OPENED FROM THE OUTSIDE.

Figure A-13 Boeing 767 "Wide Body."

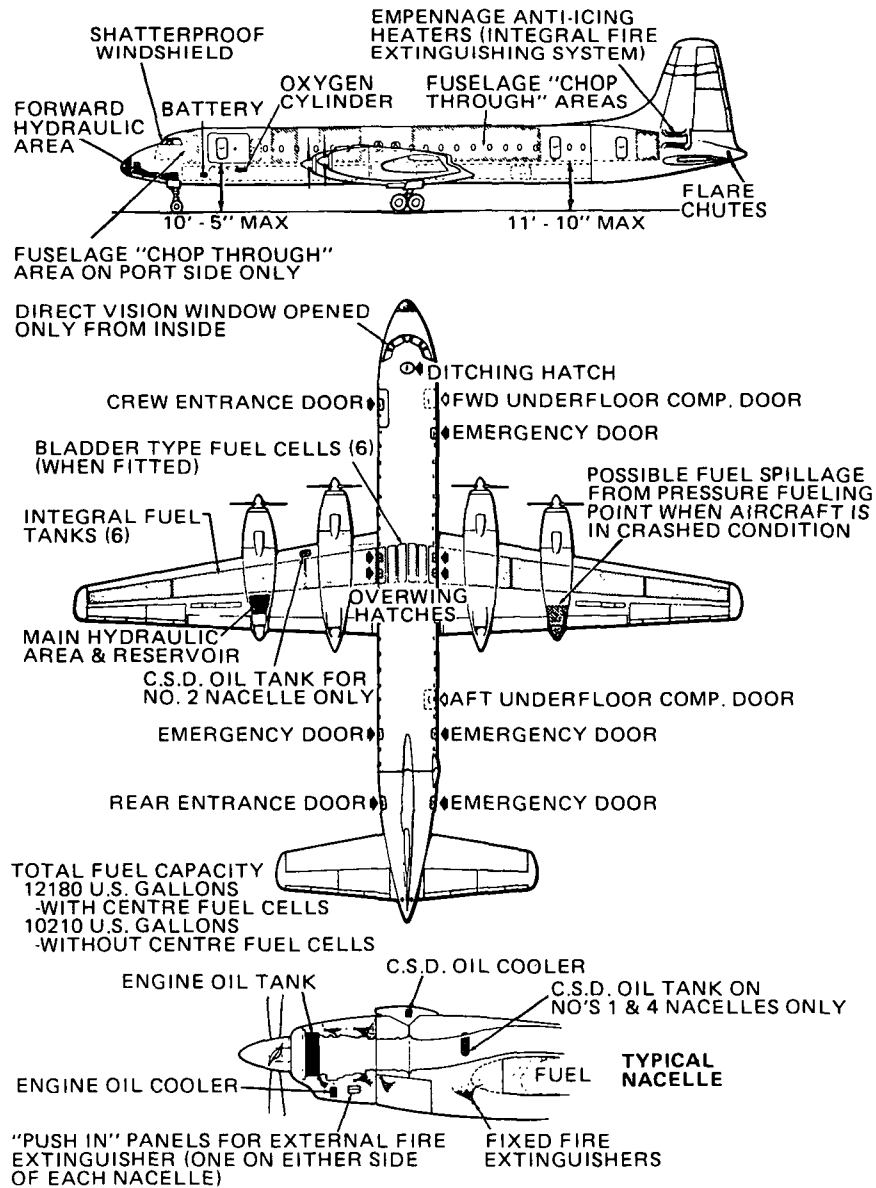
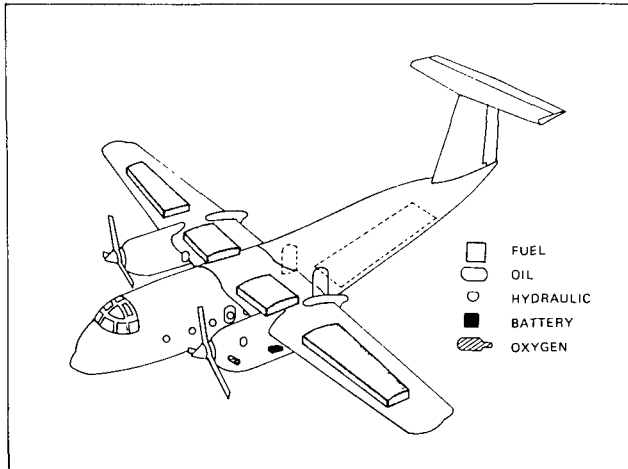


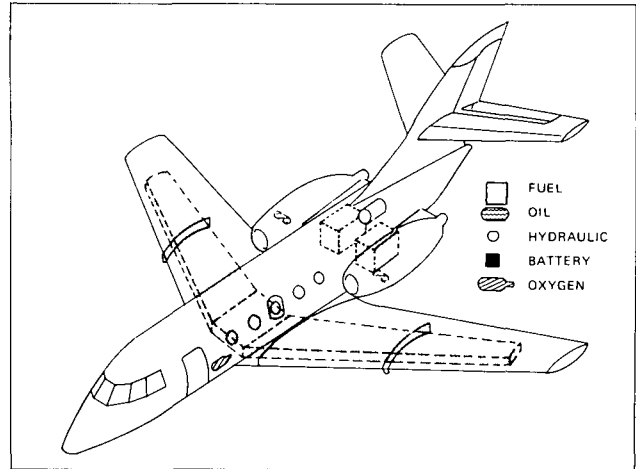
Figure A-14 Canadair CL-44D4 cargo/passenger aircraft.



GENERAL INFORMATION

Crew - 3 Passengers - 34 Span - 29.3 m (96 ft) Length - 24 m (79 ft)
 Height - 8.8 m (29 ft) Weight - 18,637 kg (41,000 lbs)
 Oil tanks (2) - 22.7 litres each (5 gals) Hydraulic Fluid (2) - 9 litres each (2 gals each)
 Fuel - Wing center tanks (2) - 2,423 litres each (533 gals)
 Wing outer tanks (2) - 1,527 litres each (336 gals)
 Maximum fuel capacity - 7,901 litres (1,738 gals)

Figure A-15 CC115 Buffalo.

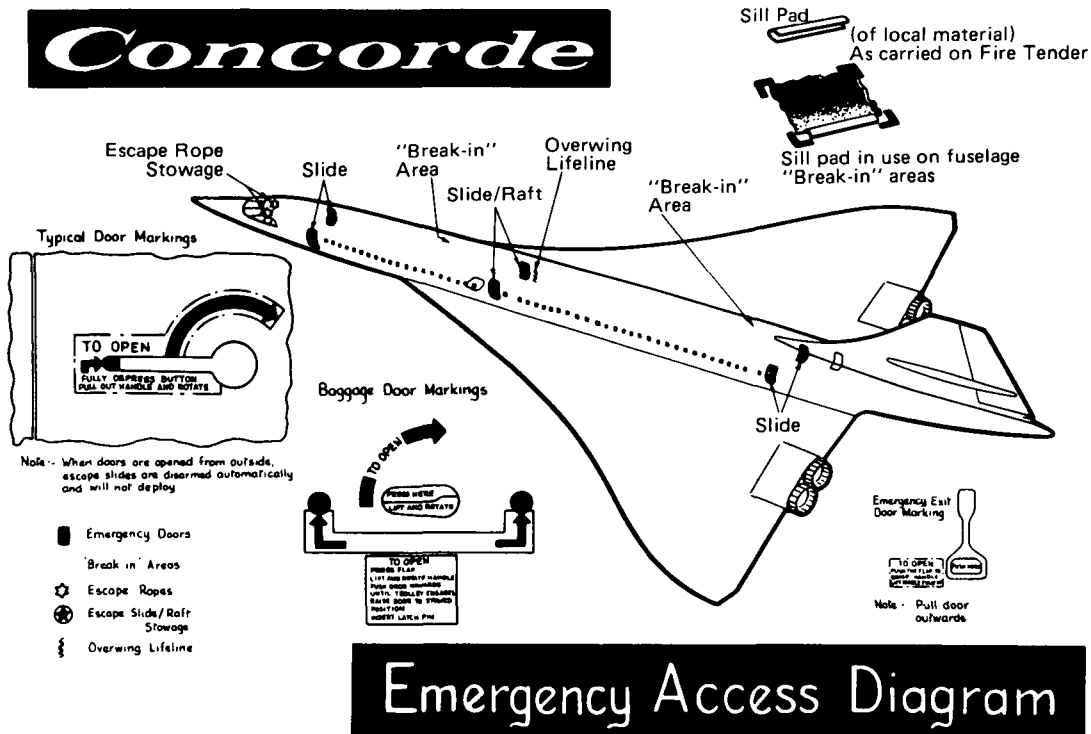


GENERAL INFORMATION

Crew - 2 Passengers - 10 Span - 16.1 m (53 ft) Length - 17 m (56 ft)
 Height - 5.2 m (17 ft) Fuel (Total) - 4,773 litres (1,050 gals)
 Oil - 4.5 litres (1 gal) Oxygen - 2.2 m³ (76 cu ft)

SPECIAL INFORMATION: Ensure engines are stopped before making over the wing approach to emergency exits.

Figure A-16 CC117 Falcon.



Courtesy of British Airways

Figure A-17 Concorde.

PASSENGER & CREW ESCAPE SYSTEMS

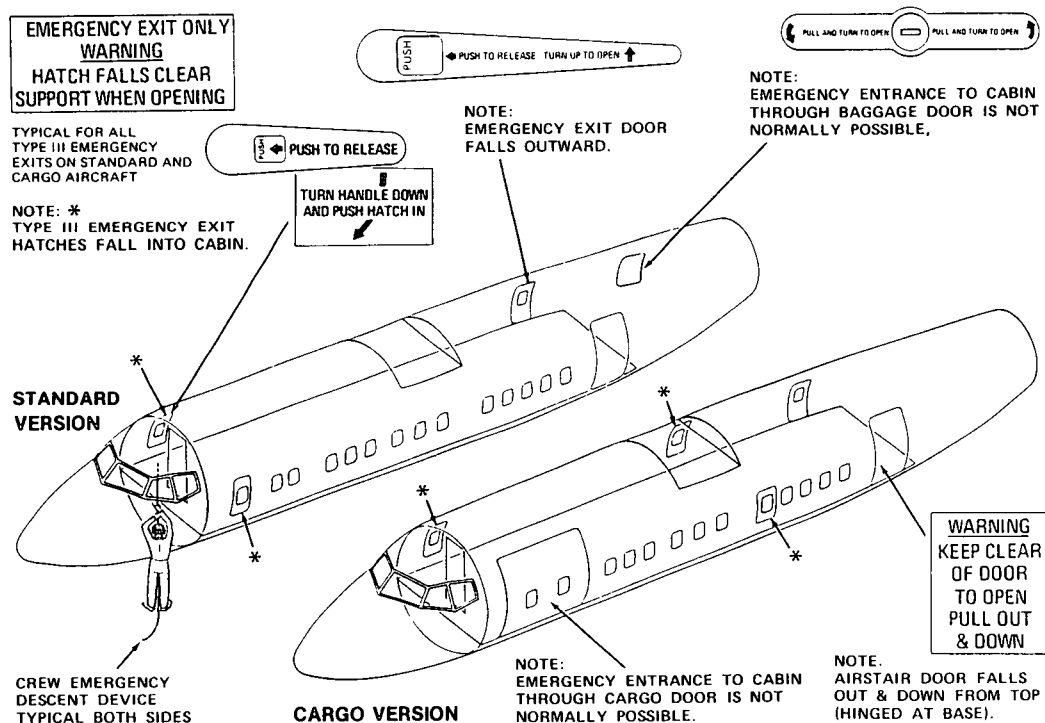


Figure A-18 DeHaviland Dash 7.

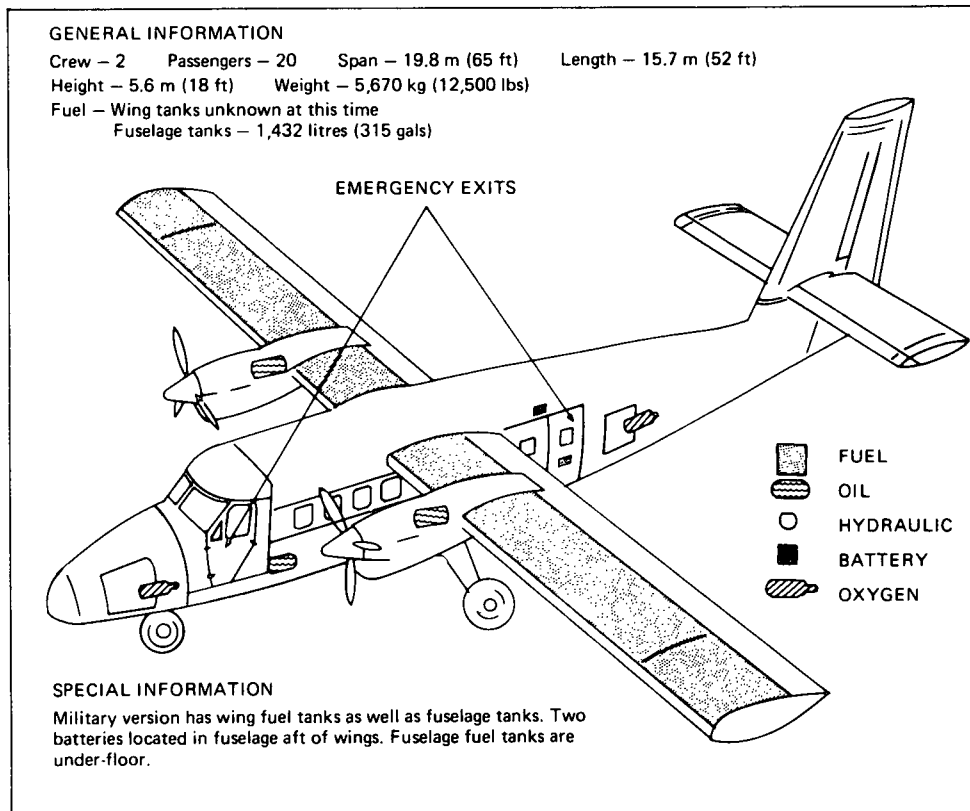


Figure A-19 DeHaviland Twin Otter.

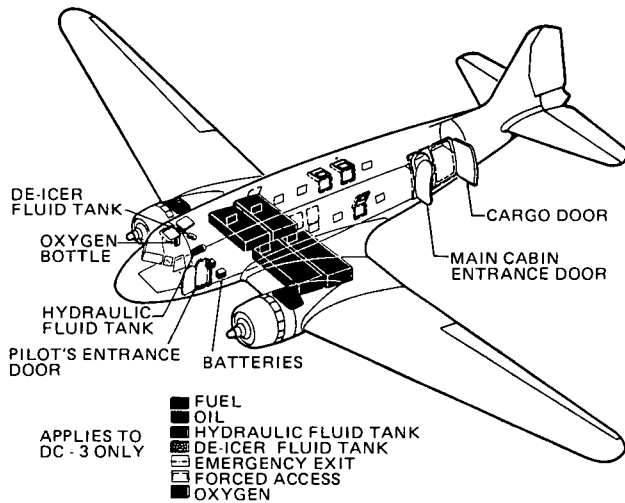


Figure A-20 Douglas DC-3.

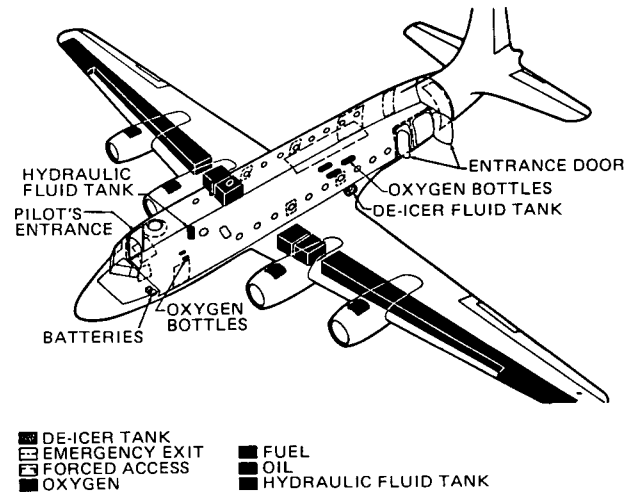


Figure A-21 Douglas DC-4.

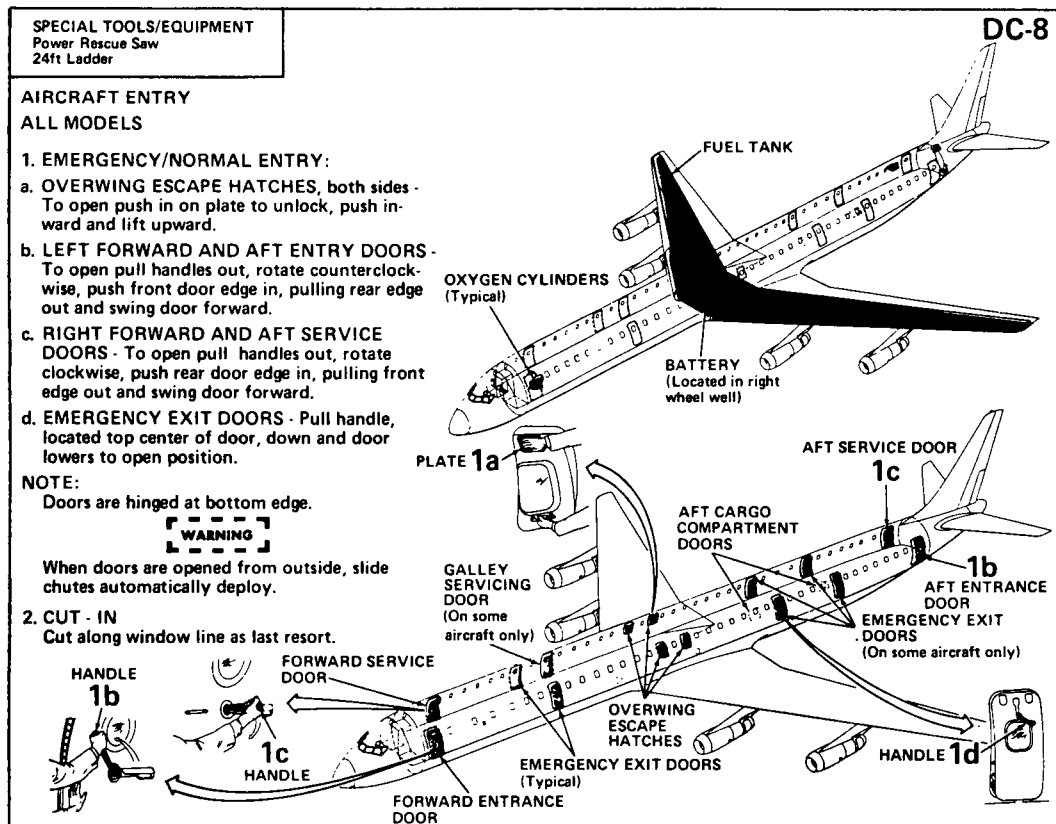


Figure A-22 Douglas DC-8.

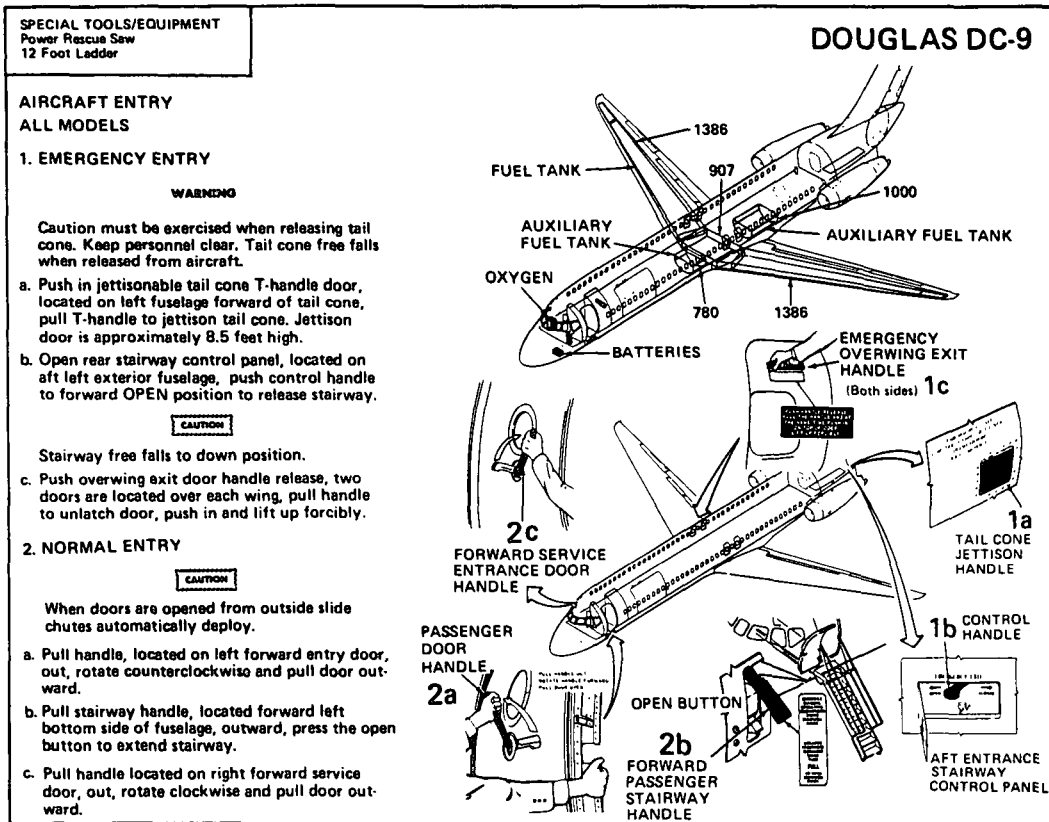


Figure A-23 Douglas DC-9.

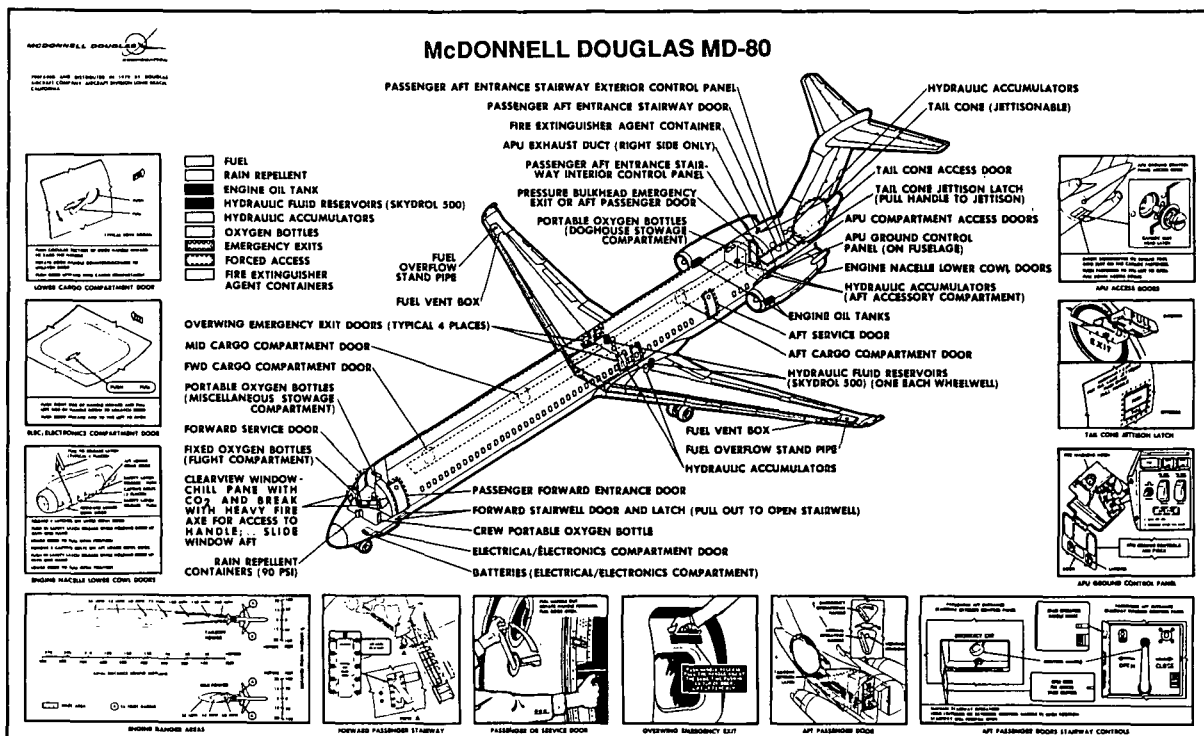


Figure A-24 McDonnell Douglas MD-80.

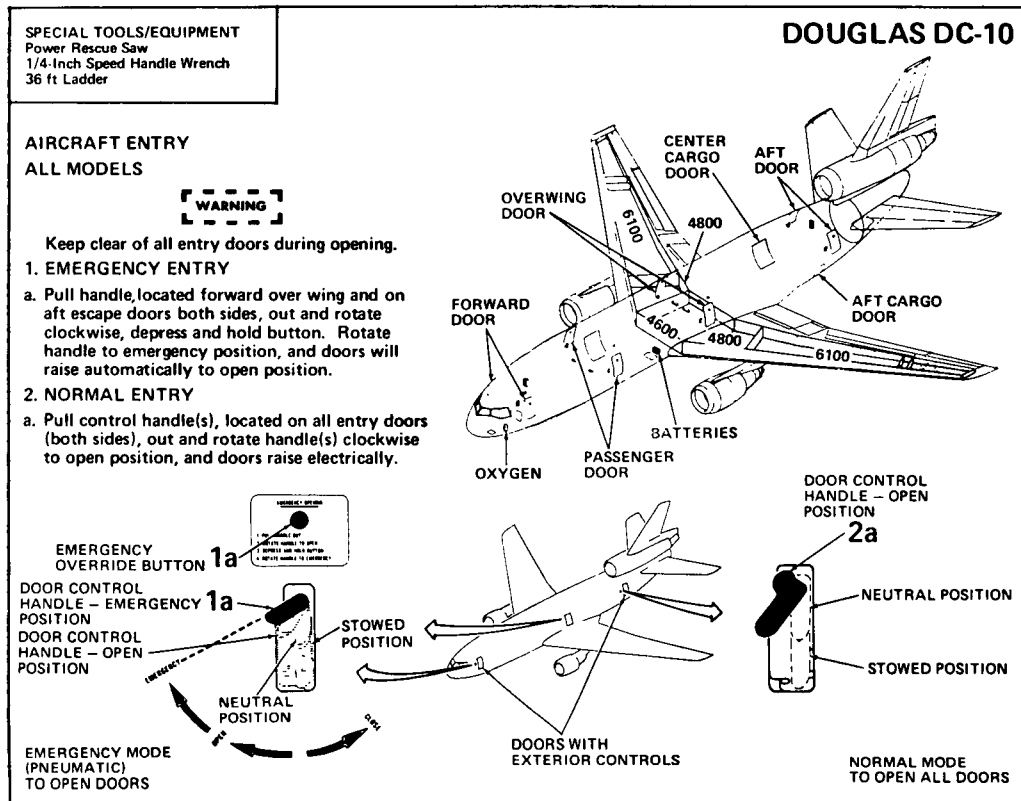


Figure A-25 Douglas DC-10 "Wide Body."

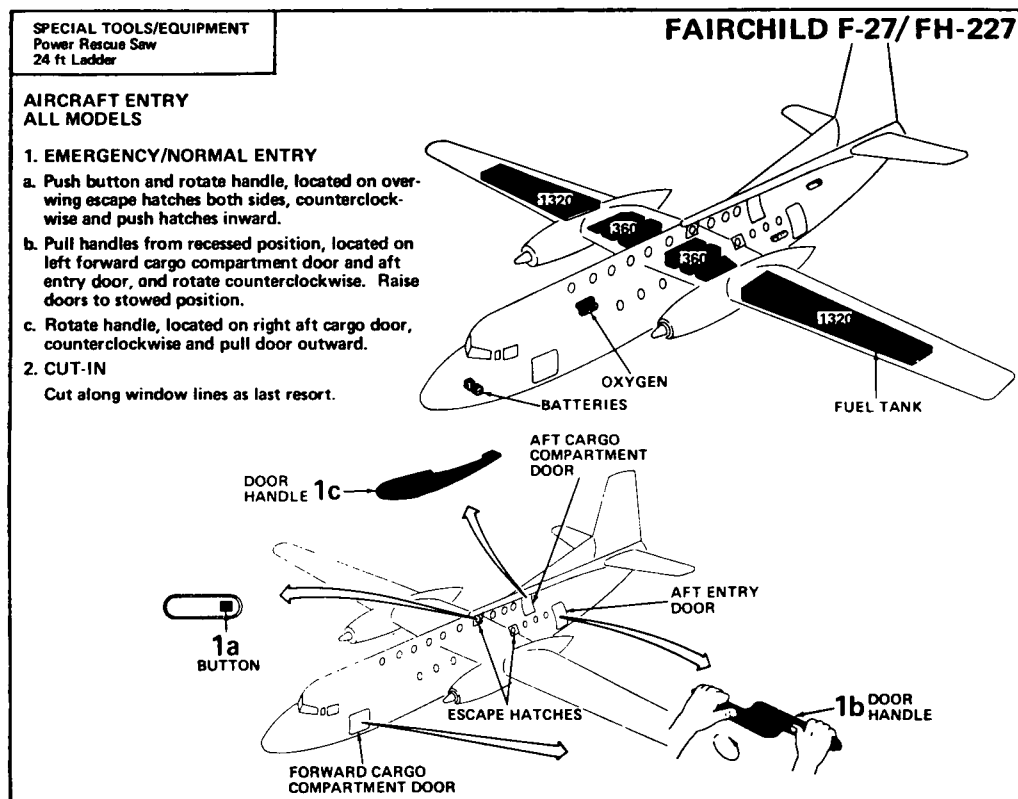


Figure A-26 Fairchild F-27.

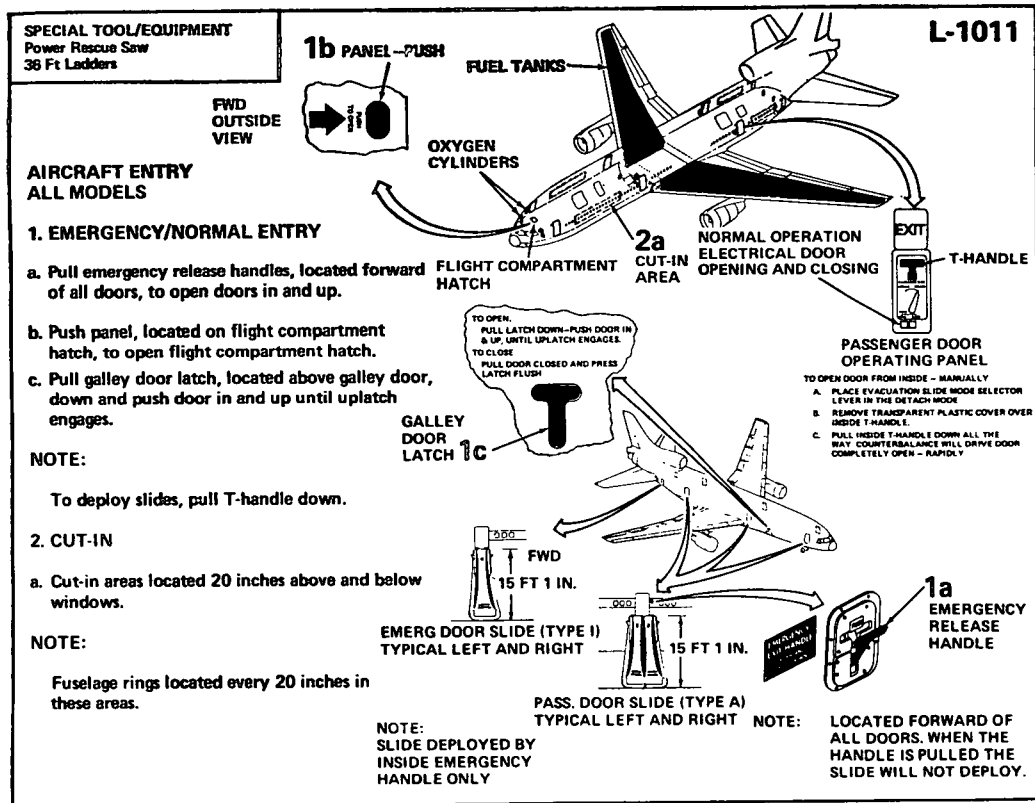


Figure A-27 Lockheed L-1011 "Wide Body."

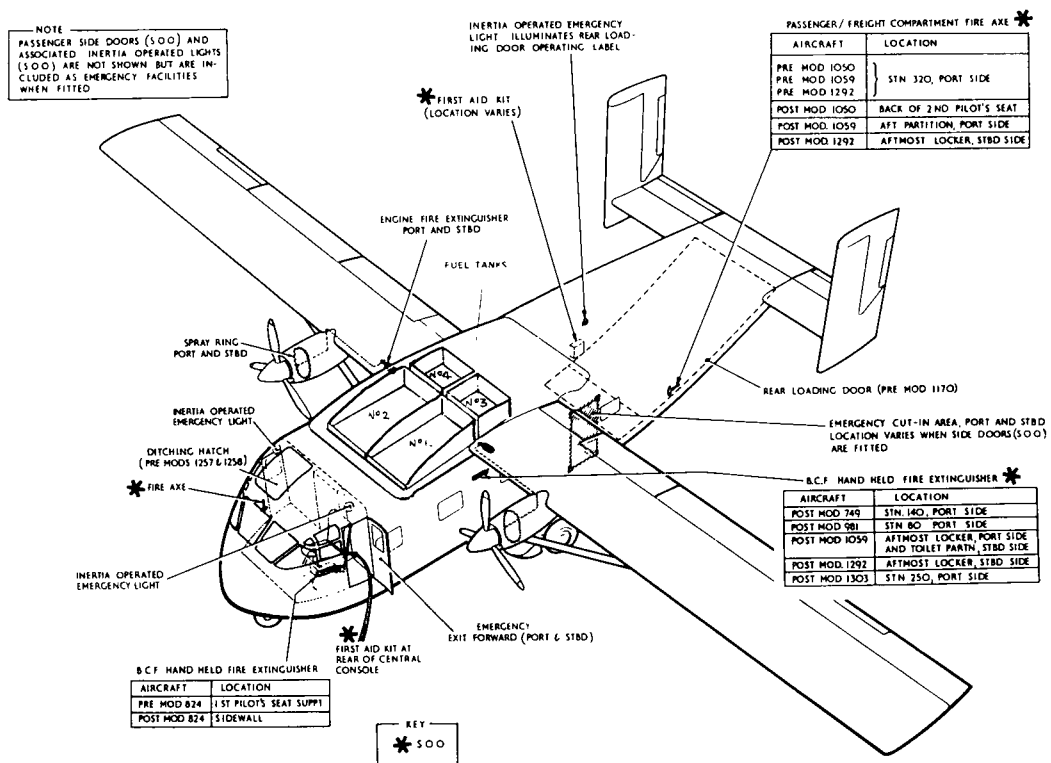


Figure A-28 Short Dash 80.

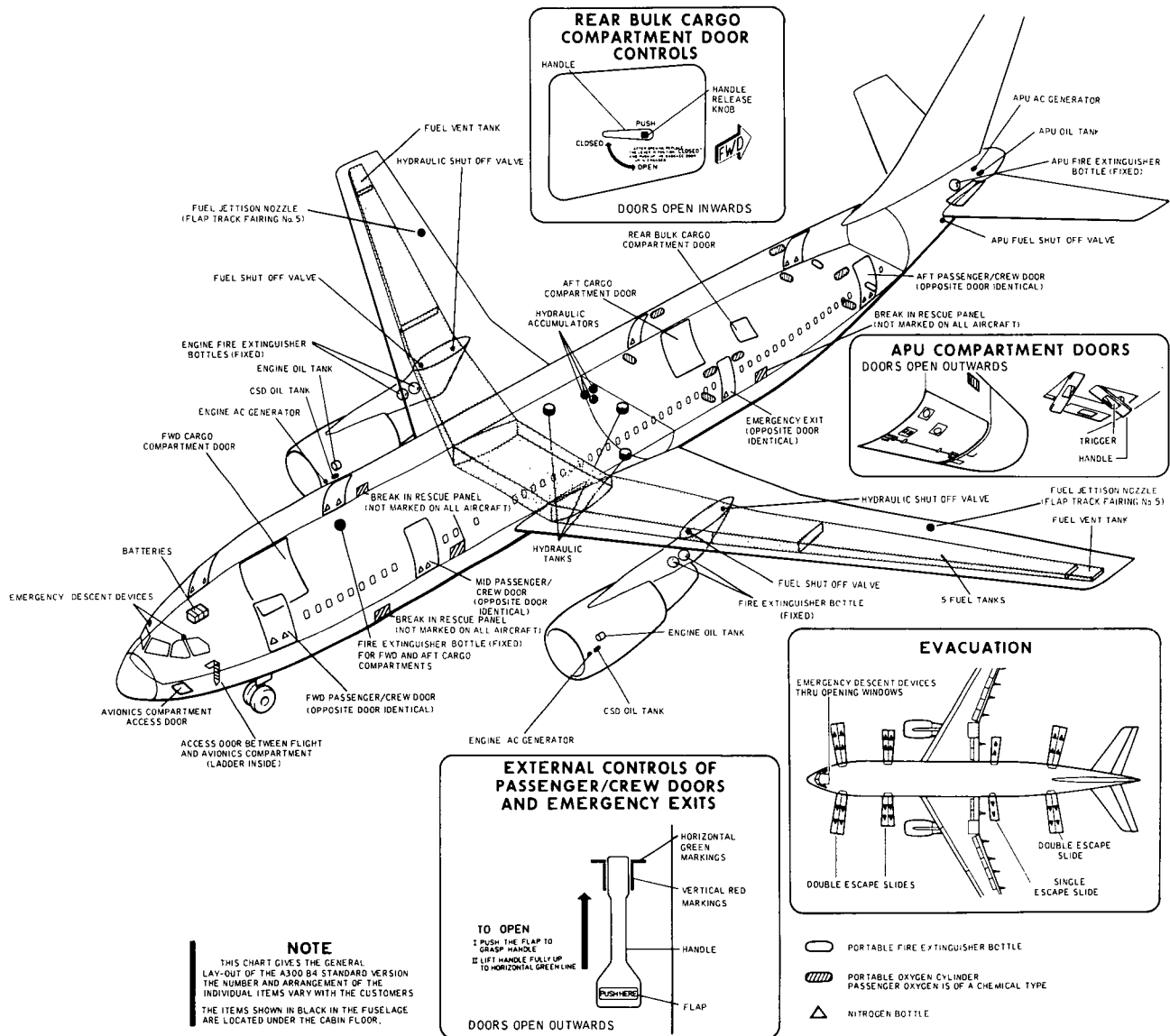


Figure A-29 A-300 Air Bus "Wide Body."

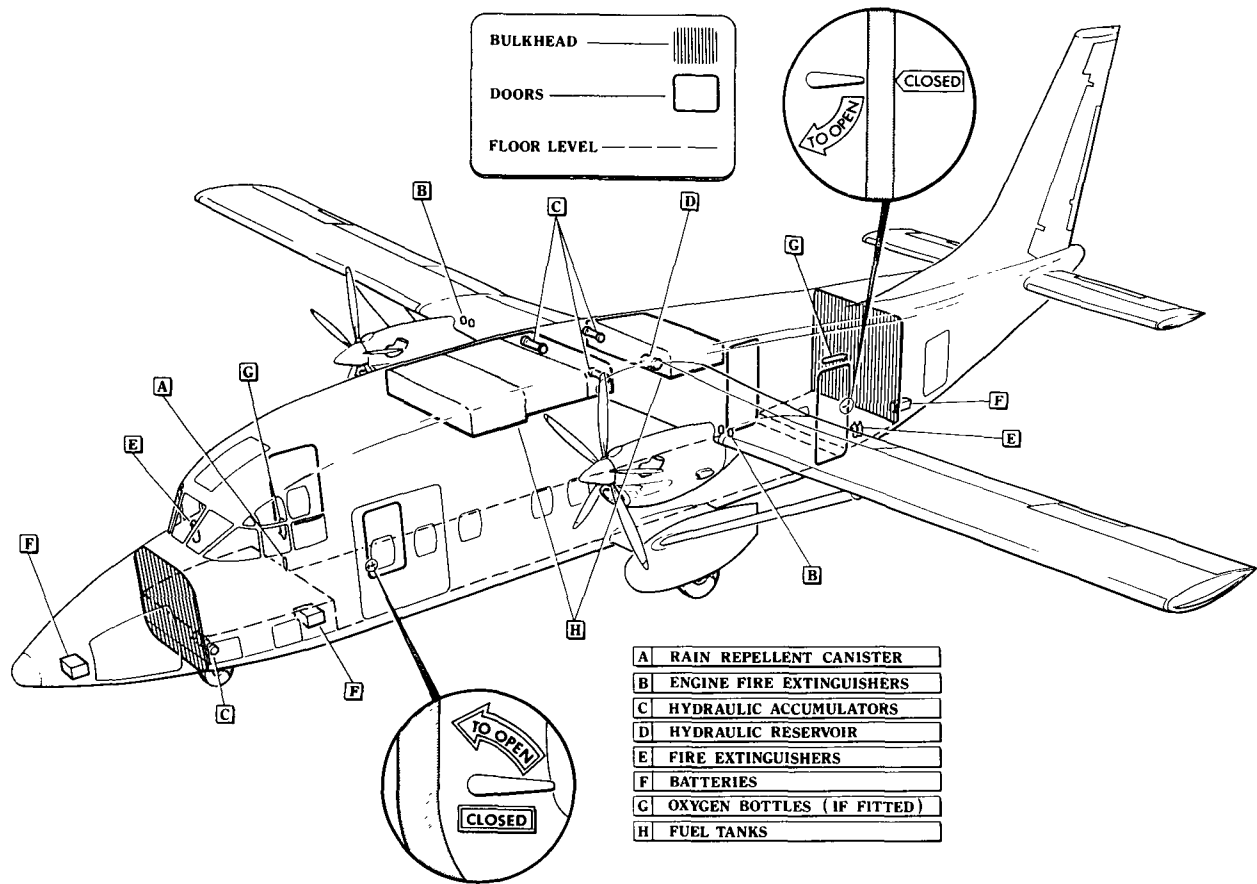


Figure A-30 Shorts SD 3.60.

Appendix B Air Transport of Dangerous Goods (Hazardous Materials and Restricted Articles) and Nuclear Weapons

This Appendix is not a part of the recommendations of this NFPA document, but is included for information purposes only.

B-1 Commercial Air Transport of Dangerous Goods. The carriage in commercial transport aircraft of dangerous goods is an accepted practice and is closely controlled by national and international regulations.

B-1.1 Definition of Dangerous Goods.

(a) Dangerous goods include explosives and any other article defined as a Combustible Liquid, Corrosive Material, Infectious Substance, Flammable Compressed Gas, Flammable Liquid, Flammable Solid, Magnetized Material, Nonflammable Compressed Gas, Oxidizing Material, Poisonous Article, Radioactive Material, and other restricted articles.

(b) Some unlikely items can come under the heading of Dangerous Goods; for example, wheel chairs may contain wet-cell batteries, breathing apparatus may have compressed air cylinders. It is well to be aware of hazards which may not be immediately apparent.

B-2 Radioactive Material.

Radioactive materials constitute a particular hazard. They emit certain rays which may be a health hazard and which cannot be detected except by instruments. Radioactive materials transported by air fall into three categories:

- Category I Material emits minimal radiation;
- Category II Emits more radiation and is assigned a transport index up to 1;
- Category III May have a transport index of 1.1, up to a maximum of 10.

B-3 Transport Index.

B-3.1 The transport index for a package of radioactive material is a simplified expression of the maximum amount of radiation emitted, in millirem per hour, measured one meter from the surface of the package; this number must appear on the notification and such notification received by the pilot-in-command. The sum of the transport indexes is the primary concern, along with the stowage of the packages, to ensure that no living beings are exposed to hazardous radiation.

NOTE 1: In the United States, dangerous goods are transported by air, under authority of the *Code of Federal Regulations*, Title 49, "Transportation," Part 175, published by the Office of the Federal Register National Archives and Records Service, General Services Administration, Washington, D.C. 20408.

NOTE 2: The International Air Transport Association has issued the *IATA Restricted Articles Regulations*, which is available from IATA Headquarters, Montreal, Canada. Also the International Civil Aviation Organization has developed technical instructions for the safe transportation of dangerous goods by air (document 9284-AN/905) available from ICAO, 1000 Sherbrooke Street West, Montreal, Quebec, Canada, H3A 2R2.

B-3.2 Dangerous goods are regularly being carried on commercial transport aircraft. This includes passenger air-

craft, passenger cargo aircraft (COMBI), and cargo aircraft. While the packaging requirements used to transport these materials are designed for proper containment, the possibility of breakage cannot be overlooked. This introduces the hazards of leaking flammable liquids and poisons, or radioactive contamination at an accident site. By knowing and recognizing dangerous goods labels, fire fighters can be alerted to these hazards.

B-4 Dangerous Goods Warning Labels.

B-4.1 The following dangerous goods warning labels are authorized by the US Department of Transportation based on the United Nations labeling system and are authorized for domestic and foreign shipments. Shippers must furnish and attach appropriate label(s) to each package of dangerous goods being offered for shipment by air. If the material in a package has more than one danger classification, one of which is Class A Poison, or radioactive materials, the package must be labeled for each danger. When two or more dangerous goods of different classes are packed within the same packaging or outer enclosure, the outside of the package must be labeled for each material involved. Radioactive materials requiring labeling must be labeled on two opposite sides of the package and indicate the transport index.

Dangerous Goods Class Numbers. Dangerous goods are classified by the UN, ICAO, IATA, and the US DOT as follows:

- Class 1 Explosives
- Class 2 Gases: compressed, liquefied, dissolved under pressure or deeply refrigerated
- Class 3 Flammable liquids
- Class 4 Flammable solids: substances susceptible to spontaneous combustion; substances which, on contact with water, emit flammable gases.
- Class 5 Oxidizing substances: organic peroxides
- Class 6 Poisonous (toxic) and infectious substances
- Class 7 Radioactive materials
- Class 8 Corrosives
- Class 9 Miscellaneous dangerous goods (including magnetized materials, articles liable to damage aircraft structures, and articles possessing other inherent characteristics which make them unsuitable for air carriage unless properly prepared for shipment).

The bottom half of the DOT diamond-shaped labels can be printed in the language of the country of origin.

B-4.2 The pilot in command of an aircraft must be provided with all relevant information regarding dangerous goods on board his aircraft and, in the event of an incident, this information should be obtained by airport emergency services either directly from the pilot or through the operations office.

B-4.3 The NFPA publication, *Fire Protection Guide on Hazardous Materials*, provides essential information for those confronted with emergencies such as fire, accidental spills, and aircraft accidents. With the urgency of prompt identification in mind, this guide has been arranged so that the user can get to the information with a minimum of delay.