

NFPA 402M

Aircraft

Rescue and

Fire Fighting

Operational

Procedures

1984



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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.

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Manual for Aircraft Rescue and Fire Fighting Operational Procedures

NFPA 402M-1984

1984 Edition of NFPA 402M

This edition of NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting Operational Procedures*, 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 21-24, 1984 in New Orleans, Louisiana. It was issued by the Standards Council on June 14, 1984, with an effective date of July 5, 1984, and supersedes all previous editions.

The 1984 edition of this standard has been approved by the American National Standards Institute as an American National Standard.

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.

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Manual for Aircraft Rescue and Fire Fighting Operational Procedures

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PART I — AIRPORT FIRE DEPARTMENTS

Chapter 1 Administration

1-1 Scope. Part I of this manual provides aircraft rescue and fire fighting operational procedures for airport fire departments to assure the efficient utilization of the available resources.

These procedures are designed for aircraft not involved in military operations. However, the procedures may be generally applicable to military aircraft in peacetime operations. Consult the commander or fire chief of the appropriate military organization for specific guidance.

1-2 Purpose. Part I of this manual is prepared for the use and guidance of those charged with providing and maintaining airport rescue and fire fighting services.

1-3 General.

1-3.1 Survival of aircraft occupants takes precedence over all other operations and fire control is frequently an essential condition to assure such survival. The objective of an airport fire department should be to respond to aircraft emergencies in the minimum possible time and to employ the rescue and fire fighting techniques with maximum skills. These objectives can be accomplished with properly trained personnel working together as a team while employing these operational procedures, as applicable.

1-3.2 Governmental and consensus standards frequently referenced in this manual may be found in Appendix A.

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.

1-4 Definitions.

Accident/Incident Preplanning. This term is used to describe the process of forecasting all factors that could possibly exist during an aircraft accident/incident and that could bear upon existing emergency resources. Preplanning should define the organizational authority and the responsibilities of all participants.

Aircraft Familiarization. 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

utilize the airport, and the aircraft types that may use the airport as a diversion airport due to weather conditions at scheduled destination.

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

Aircraft Rescue. The fire fighting action taken to prevent, control or extinguish fire involving, or adjacent to an aircraft, for the purpose of providing maximum fuselage integrity and escape area for its occupants. Rescue and fire fighting personnel, to the extent possible, will assist in evacuation of the aircraft using normal and/or 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 Access Road. Those roads which are provided and maintained on airport property for the purpose of providing emergency vehicles and other required airport vehicular traffic access to operational areas, taxiways, runways and remote areas of the airport.

Airport Familiarization. Refers to the knowledge 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.

Airport Fire Chief. The individual normally having operational control over the airport's aircraft rescue and fire fighting equipment and personnel, specifically made available for aircraft rescue and fire fighting activity at the airport, or a designated assistant. The chief has both the authority and responsibility for decisions affecting rescue and fire fighting activity and is normally in sole command of such operations at times of emergencies.

Airport Manager. The individual having managerial responsibility for the operation and safety of an airport. The manager may have administrative control over aircraft rescue and fire fighting services, but normally does not exercise authority over operational fire and rescue matters.

Airport Security. A policing agency, usually a division of airport administration, which is primarily responsible for law enforcement on airport property and the maintaining of security provisions required for airports under federal law.

Aqueous Film Forming Foam (AFFF) Concentrate. A concentrated aqueous solution of the fluorinated surfactant with a foam stabilizer normally diluted with fresh water in a 3 or 6 percent solution.

ARFF. Aircraft Rescue and Fire Fighting.

ATC. Air Traffic Control. The radio control center for aircraft at an airport staffed by FAA personnel.

Back Draft. This is a phenomenon that occurs when a fire takes place in an enclosed structure, such as an aircraft fuselage, and burns undetected until most of the oxygen within is consumed. The heat continues to distill flammable gases mostly in the form of carbon monoxide. When these gases are heated above their ignition temperature, and a supply of oxygen is introduced, as when normal entry points are opened, the gases may ignite with explosive force.

Cockpit Voice Recorder (CVR). The cockpit voice recorder monitors crew communication through a pickup on the flight deck to a recorder usually mounted in the tail area of the aircraft and designed to withstand certain impact forces and a degree of fire. The CVR recorder is a continuous 30-minute tape that requires the power to be removed by pulling the CVR circuit breaker in the flight deck to preserve communication recordings that may be vital to the accident investigation.

Command Post. The location at the scene of an emergency where command coordination and communication is centralized.

Critical Rescue and Fire Fighting Access Area. This is the rectangular area surrounding any given runway. Its width extends 150 m (500 ft) outward from each side of the runway centerline, and its length is 1,000 m (3,300 ft) beyond each threshold (*See Figure 2-1.1*).

Dangerous Goods. (*See Appendix C*).

Evacuation Time. The time between the accident/incident and the removal of all surviving occupants. A Federal Aviation Administration requirement prior to certification of civil air transport aircraft stipulates that the complete evacuation of all occupants using one-half of the required exits must be demonstrated in ninety (90) seconds or less. Accident records indicate that this time is usually exceeded under conditions of actual emergency.

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

Flight Data Recorder (FDR). The flight data recorder is an instrument that monitors performance characteristics of aircraft in flight. It is mounted in the tail area of the aircraft and 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.

Fuselage. The fuselage is the body of an aircraft containing the passenger cabin, flight deck and cargo compartments.

Mutual Aid. Mutual aid is synonymous with "mutual assistance," "outside aid," "memorandums of understanding," letters of agreement or other similar agreements, written or not, which constitute an agreed reciprocal assistance plan between emergency services.

(Sample Mutual Aid Agreements may be found in Appendix F.)

Rapid Intervention Vehicle (RIV). A complementary vehicle to the major fire fighting vehicles. The design and purpose of the RIV is to provide a means of bringing extinguishing agent to the aircraft crash scene significantly faster (up to 60 seconds) than can be achieved by major fire fighting vehicles.

The RIV brings to the crash scene the quantity and discharge capacity of extinguishing agent necessary to (1) extinguish an incipient fire, or (2) hold a fire from enlarging until larger crash vehicles arrive, and/or (3) maintain at least one fire-free, clear escape path for the rescue of passengers and crew.

At smaller airports where existing fire station locations and CFR vehicles provide acceptable rapid response, use of an RIV may not be necessary if it cannot provide a significant improvement in response time.

Response Time. The time elapsed between the initial notification of an accident/incident and the time of the first discharge of extinguishing agent at the incident site. (*See Part I, 2-1.1 and 2-1.3.*)

Size-Up. The process of evaluating an emergency situation, estimating the immediate objectives and determining how to most effectively achieve the established objective.

Triage. The process of assigning priorities to casualties for the purpose of providing treatment and transportation.

1-5 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (liter), outside of but recognized by SI, is commonly used in international fire protection.

For additional conversions and information, see ASTM E-380, *Standard for Metric Practice*.

Chapter 2 Response Time

2-1 General.

2-1.1 Airport-based fire fighting equipment should be available and located so that the demonstrated response time of the first responding fire fighting vehicle to reach any point on the operational runway is two minutes or less and any point remaining within the critical rescue and fire fighting access area is no more than a three-minute response time whenever flight operations are in progress (*see Figure 2-1.1*). At many airports, parts of the critical rescue and fire fighting access area may be outside the airport boundaries. The area may also contain obstructions such as highways, railroads, ravines or bodies of

ACCIDENT LOCATION CHART AIR CARRIER ACCIDENTS (1964-1980)

EXPLANATORY NOTE:

The runway depicted in the diagram is for reference purposes only. Each accident site is shown in relation to the ends/edges of the actual runway on the aerodrome involved.

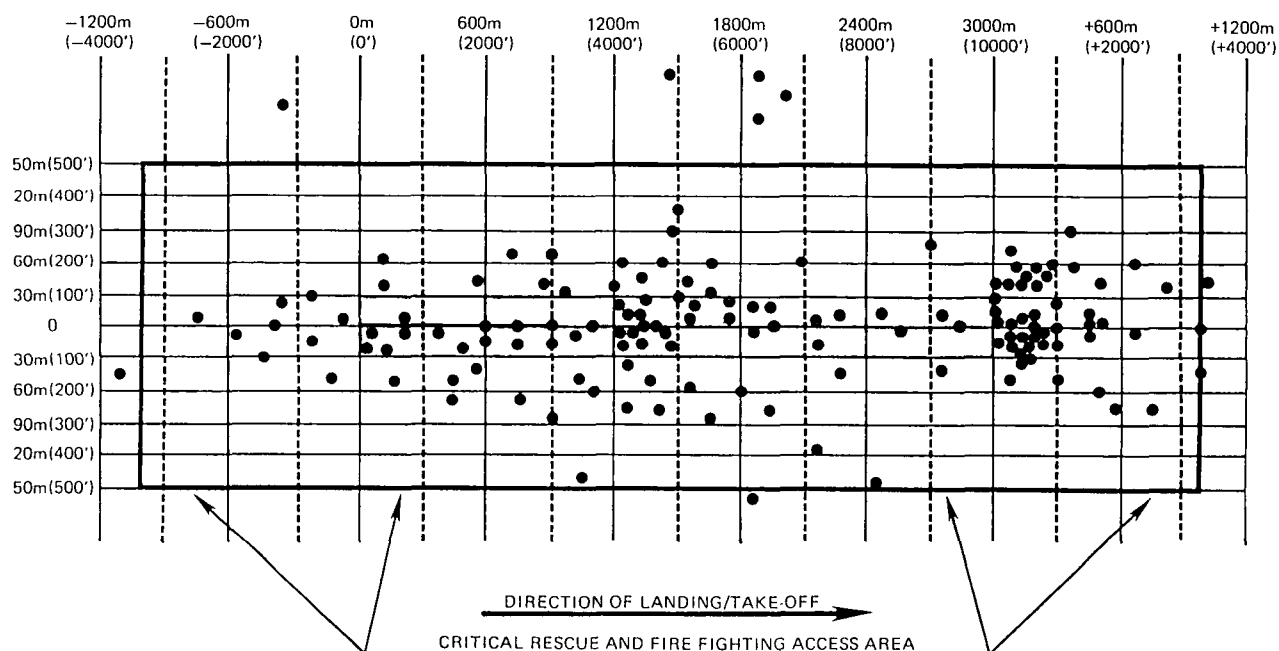


Figure 2-1.1 Critical Rescue and Fire Fighting Access Area.

water which would delay or preclude the required access of emergency vehicles. However, accident records clearly indicate that many accidents do occur in these areas. It is very important to eliminate or reduce these obstacles to response whenever possible. When this cannot be accomplished, preplanning for alternatives is essential to assure the fastest possible response time under the circumstances involved. The method used should take into account occupant survival capabilities as well as terrain conditions. This may require additional mutual aid agreements with outside jurisdictions, to assure the availability of special vehicles or personnel with special skills.

2-1.2 To obtain the desired response, preplanning should include a wide range of topics such as adequate alarm systems, fire station location or prepositioning of resources, driver training, and airport familiarization under all weather conditions and all periods of flight operations.

2-1.3 Primary response time should be for the first responding fire fighting vehicle. Other required major fire fighting vehicles should arrive at the scene within a maximum of thirty (30) second intervals thereafter.

2-1.3.1 To expedite rescue and fire fighting response, airport management should have agreements with air traffic control services to stop all aircraft ground movements and nonemergency ground vehicle traffic.

2-1.4 Access to the critical rescue and fire fighting access area should be available with surfaces suitable for airport rescue fire fighting vehicles, and should be maintained in usable condition while flight operations are in progress.

2-1.5 Airports should include items which would improve response times when updating their master plan for airport development. Response time factors which should be given serious consideration include airport fire station(s) location(s), two-way access roads in the approach and overrun areas and obstruction clearance in the critical rescue and fire fighting access area. Response routes from the fire station(s) should be designed with a turning angle of 45 degrees or less. (See Figure 2-1.5.)

2-2 Low-Visibility Operations.

2-2.1 New and improved techniques for instrument landing and takeoff permit operations to continue under adverse weather conditions. Low-visibility operations criteria vary from one airport to another depending on the type of instrument landing systems available, the level of natural and man-made obstructions in surrounding terrain, and the type of runway lighting. Such operational minimums may vary from 5 km (3 mi) visibility to 200 m (700 ft) for landings with similar restriction for takeoff. Airport fire department personnel should ascertain operational restriction levels from their local Air

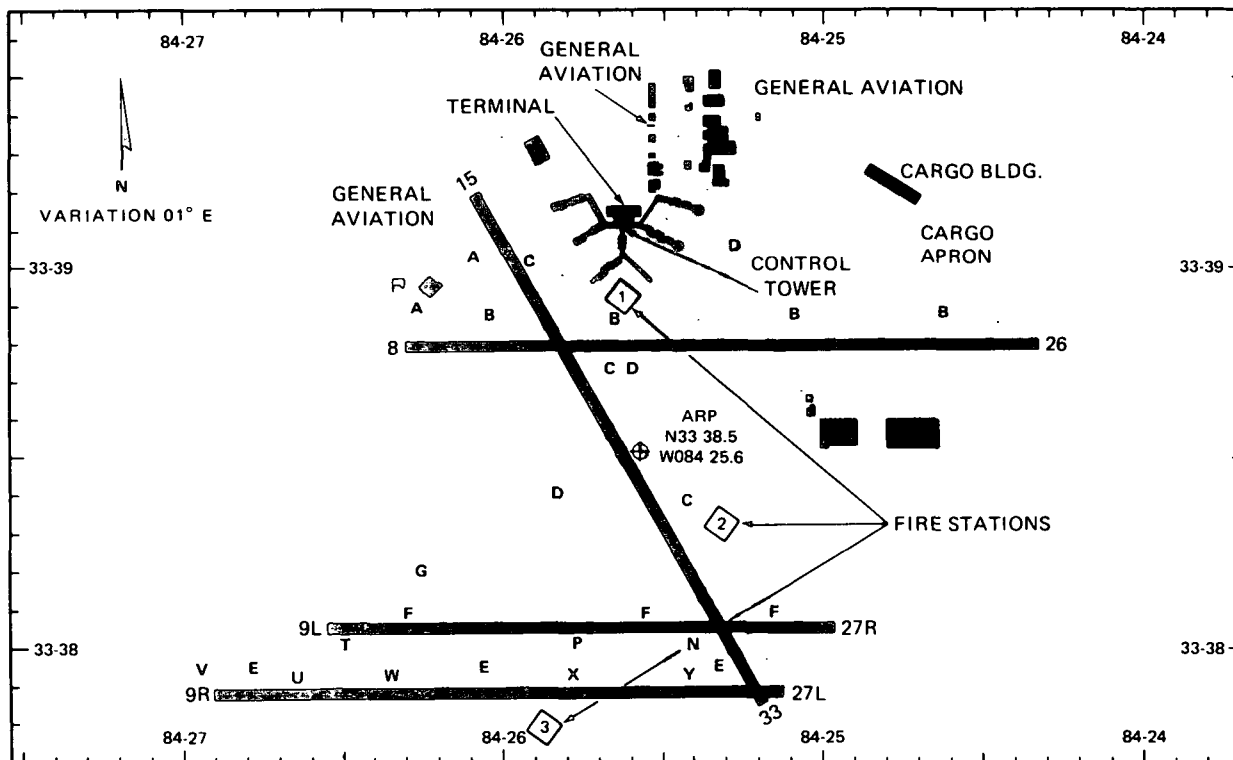


Figure 2-1.5 Optimum Airport Fire Station Location.

Traffic Control agency in order to establish response capability under minimum visibility conditions.

2-2.2 Although aircraft operational navigational weather minimums may not be in effect, fully manned Alert 1 or Standby procedures should be initiated when aircraft operations are in progress and surface visibility and conditions are less than 800 m ($\frac{1}{2}$ mi). (See Part I, 4-2.1.)

2-2.3 Alert 1 Standbys during low-visibility operations and adverse weather should have at least one major rescue and fire fighting vehicle located adjacent to the mid-point of the active runway unless the fire station locations permit the response times in Part I, 2-1.1. (See Figure 2-1.5.) The distance from the runway centerline should be about 300 m (1,000 ft); vehicle engines should be running and all emergency lights operating.

2-2.4 A suitable all-weather access route should be provided from vehicle standby positions to active runways being protected.

2-2.5 Rescue and fire fighting personnel assigned to Alert 1 Standby should monitor all applicable radio frequencies.

2-2.6 Air traffic control should be made aware of the exact location of the vehicle(s) assigned to standby duty. Where available, surface navigational aids, such as ground radar (ASDE) should be fully utilized through coordination between rescue personnel and the tower.

Chapter 3 Preplanning for Aircraft Emergencies

3-1 General Policies.

3-1.1 Preplanning and regular practice drill sessions for these recommended operational procedures are needed to achieve and maintain a high degree of efficiency. Guidance on simulated aircraft emergency exercises is provided in NFPA 424, *Recommended Practice for Airport/Community Emergency Planning*. In addition, the airport emergency services should hold annual drills. Frequent command level, mini drills, or tabletop exercises designed to develop effective command, control, and communications are also encouraged.

3-1.2 Command authority at any accident site should be predetermined according to the jurisdictional responsibilities of the departments involved, and as designated in the airport/community mutual aid protection.

3-2 Preplanning Responses to Potential Accident Sites.

3-2.1 All rescue and fire fighting 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 to assure such performance. Special training should be given to enhance the skills of all vehicle operators as driver performance is critical to successful vehicle utilization particularly under unfavorable conditions.

3-2.2 Each rescue and fire fighting vehicle should make trial runs to all areas of the airport in all weather conditions under which flight operations take place. These runs will demonstrate each vehicle's operational capability and time required to reach each site. Since many aircraft accidents occur in the overrun areas of the runways (see *Figure 2-1.1*), it is important to provide suitable routes for use by the vehicles to enable them to reach these areas. Bridges (e.g., over gullies, streams and drainage ditches) where needed should be capable of supporting 120 percent of the weight of the heaviest emergency equipment.

3-2.3 In the event of temporary construction work in these areas, the access routes should not be obstructed during flight operations periods. If obstruction is unavoidable, the airport emergency services should be specifically advised of the condition so that preplanning can reduce any response delays.

3-2.4 In order to provide multi-vehicle access to the accident site, roads should be so constructed that one vehicle cannot block ingress or egress for other fire and/or rescue vehicles. This can be accomplished by providing a wider road or suitable passing and turn-around areas.

3-2.5 Frangible fence gates or fence sections should be located at strategic locations to allow rapid penetration by rescue and fire fighting equipment to land areas outside the airport boundary. Keys to gate locks should be carried on each emergency vehicle, by airport security personnel and designated local authorities.

3-2.6 Grid maps should be provided for each airport and its environs. Grid maps should be ruled with numbered and lettered grids (see *Figure 3-2.6*) to permit rapid identification of any response area. The area beyond the airport boundaries covered by the grid map should be a distance of 8 km (5 m) from the center of the airport but may vary depending on the type of terrain or location of the airport in relation to other emergency facilities. Map nomenclature should be compatible with that used by off-Airport Public Safety Authorities. Two or more maps may be required, one of which should display medical facilities, heliports or other features according to the Airport/Community Emergency Plan where the area exceeds an 8-km (5-mi) radius. Where more than one grid map is used, grid identifications should differ by color and scale to ensure use of correct grid map. Prominent local features, access routes and staging areas should be shown, as well as compass headings to facilitate locating accident and medical facility sites. Copies of these grid maps should be prominently displayed at air traffic control, airport operations office, each airport and community fire department station, all mutual aid services and carried on all emergency services vehicles.

3-2.7 At airports which frequently experience fog conditions, surface movement guidance systems should be used by the airport emergency services to assist in locating aircraft on the ground or to track its course while landing, taking off, or taxiing.

3-2.8 If fire station vehicle bay doors are electrically operated, alternate means should be available and periodically tested to permit rapid operation of the doors.

3-2.9 A communication system from the airport to community or regional emergency services should be provided to initiate appropriate response. The reliability of the communication system should be tested daily.

3-2.10 Off-airport emergency services responding to an on-airport accident should preplan access to the airport, particularly the designated staging areas and should be trained in the special procedures that they should follow once on the airport. (See *Part I, Chapter 4*.)

3-2.11 Aircraft rescue and fire fighting equipment should be provided for required protection on the airport during all flight operations. ARFF vehicles which are surplus to required protection may be dispatched off the airport for fire emergencies.

3-3 Airport Fire Fighter Basic Knowledge.

3-3.1 To assure 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*.

3-3.2 Comprehensive, continuous in-service training and refresher courses should be provided to maintain proficiency. For further information on these subjects, see the references listed in Appendix A. The following specific basic training needs are given here for emphasis.

3-3.3 Aircraft Familiarization. The complexity of modern aircraft and the variety of types in service make it virtually impossible to train fire fighting personnel in all of the important design features of each model. However, rescue and fire fighting personnel should be as familiar as possible with each type of aircraft normally using the airport. Particular emphasis should be placed on the following:

- (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) Location of batteries, hydraulic and oxygen systems.
- (f) Positions of break-in points on the aircraft.
- (g) Location of rapidly activated standby generators or turbines.

For additional information on subparagraphs (a) through (g), consult Appendix B.

3-3.4 Aircraft crews are trained to handle in-flight fires; however, airborne fire control agents are limited and protect, in general, only localized hazardous areas within the aircraft. Emergency landings or accidents can be the result of uncontrolled fires experienced in flight. The most frequent type of in-flight fires involve: (1)

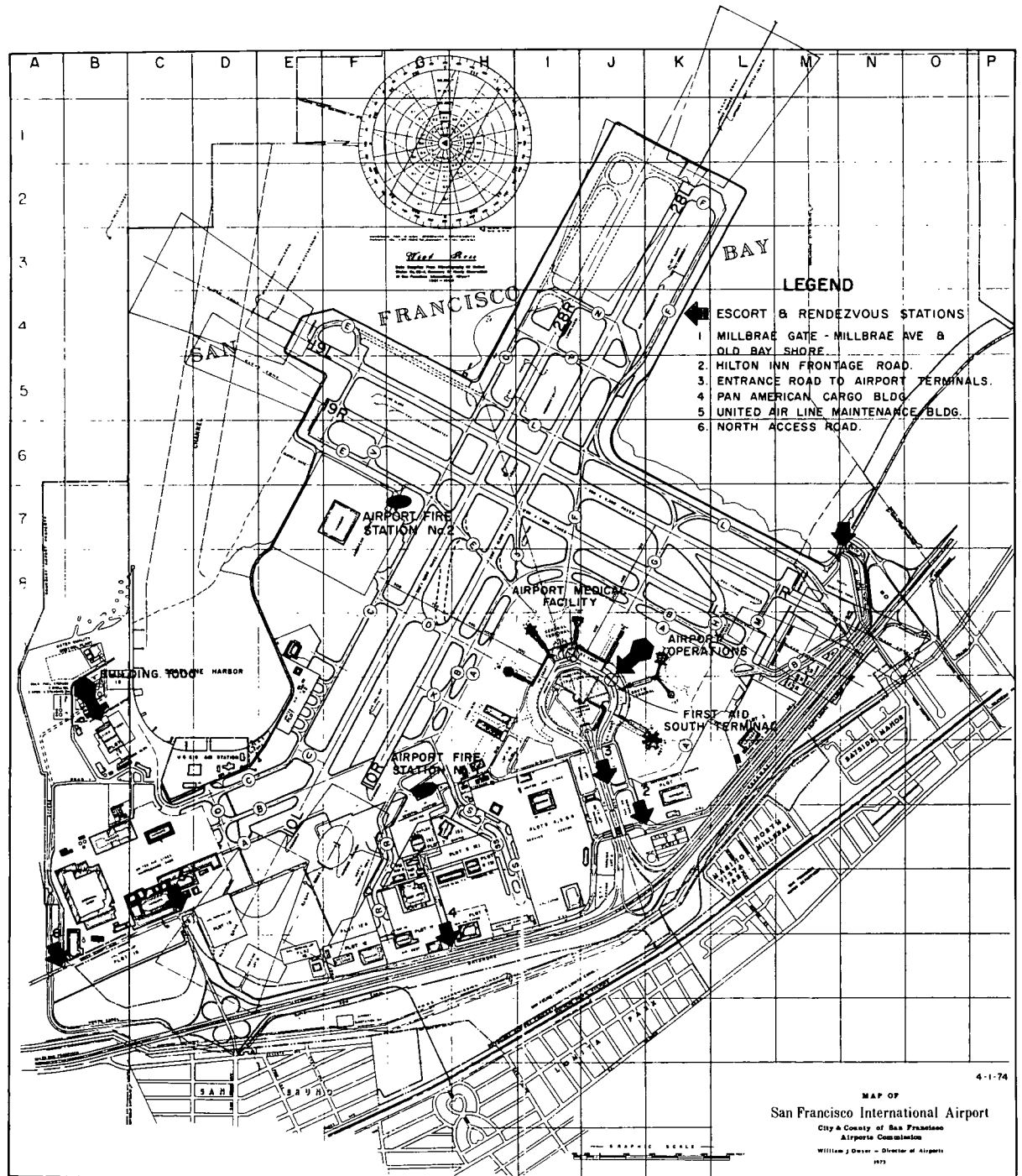


Figure 3-2.6 Typical Airport Grid Map.

engines; (2) cabin areas; (3) restrooms; (4) heaters; and (5) cargo areas.

In addition to fixed extinguishing systems, all aircraft are equipped with one or more hand fire extinguisher. These devices can only be expected to handle incipient fires. For further information see NFPA 408, *Standard on Aircraft Hand Fire Extinguishers*.

3-3.5 Engine Fires. It is reasonable for airport fire fighters responding to aircraft emergency originating within a power plant to expect that the following actions have probably been accomplished by the flight crew:

- (1) Engine shutdown.
- (2) Engine fire extinguishing system (if any) utilized.
- (3) Electrical power to the affected engine(s) turned off.
- (4) Fuel and hydraulic fluid supply to the affected engine(s) turned off.

These conditions should be orally or visually verified as conditions permit. It should be noted that turbine engines, following shutoff of power and fuel, can remain a potential hazard during "winddown" with high heat retention continuing for as long as thirty minutes. This can constitute a potential ignition source in the presence of 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.

When jet engines are started or shut down in certain wind conditions, hot starts and/or tail pipe fires may occur. These fires can usually be controlled by the flight crew. In some cases, however, fire department intervention may be necessary. (See *Part I, 9-5.1.*)

3-3.6 Cabin Fires. The variety of conditions which cause the emergency landing of the aircraft because of a cabin fire precludes responding airport fire fighters anticipating what conditions will exist upon touchdown. If the air crew has initiated emergency evacuation procedures, it might be assumed that the occupants have the ability to self-evacuate. The responding emergency crew should allow such procedures to be carried out to their full potential without attempting a forcible entry or compromising the self-evacuation by interference with slide deployment or other onboard emergency egress equipment. Deployment of fire fighters and equipment into rescue and fire fighting position should be conducted simultaneously. If there is no evidence of air crew or passenger self-evacuation, immediate steps should be taken to make entry for rescue or extrication. Entry could cause an inrush of air into an unstable cabin atmosphere causing rapid propagation of an existing fire or accelerating the ignition of smoldering materials. Entry into the aircraft interior should be made by fire fighters wearing self-contained breathing apparatus and equipped with suitable fire suppressing equipment. Toxic gases may be present. Ventilation and a cabin search for survivors is the immediate task. This would be especially true under the cover of darkness in a smoky atmosphere wherein a longer period of time may be necessary for search and rescue. Fire may travel into concealed spaces within the fuselage. Unchecked, this could lead to total destruction

of the aircraft because of the usual lack of fire stopping structural components. Smoke extraction equipment should be available to assist in creating an atmosphere more tenable for search, rescue, and overhaul. Since on-board egress equipment may or may not be usable or available, it is prudent to provide such ground support equipment as quickly as possible at the time of an incident.

3-3.7 Heater Fires. Heaters located in wings, fuselage and tail sections of aircraft may be protected with a fire extinguishing system. It may be assumed that in the event of an airborne heater compartment fire any such system has been activated.

3-3.8 Aircraft Evacuation. The need to assist in aircraft occupant evacuation or extrication in an aircraft accident and/or fire depends on a variety of factors. For example, the degree of occupant survivability, the type and occupant capacity of the aircraft, the utilization of the aircraft's emergency evacuation facilities and the fire conditions. In transport category fixed wing aircraft, the flight crew has established emergency procedures that are to be implemented to the extent possible depending on the extent of injuries, interior derangement, fuselage deformity and/or fire conditions. In general aviation types of fixed and rotary wing aircraft, such provisions may not be available. In any event, the rescue efforts may very well begin with fire control. In that case, every opportunity for the occupants to utilize the available aircraft emergency egress facilities should be permitted without interference from exterior fire fighting and rescue equipment. Moreover, initial fire fighting efforts should be directed toward maintaining a safe escape route from the aircraft egress points.

In transport category aircraft with normal door heights above 5 ft, aircraft evacuation slides are provided to expedite occupant evacuation. Flight crews are trained in the operation of these slides. If slides are deployed and are in use when rescue and fire fighting crews arrive at an accident site, they should not be disturbed unless they have been damaged by use or fire exposure. Apparatus arriving before slide deployment should be positioned so as not to interfere with such deployment. (See *Part I, Chapter 8 and Appendix B for further information.*)

Assistance in slide off-loading and evacuation of occupants from the aircraft is an important function for available rescue personnel since evacuees frequently suffer injuries from use of the slides. When high winds or unusual aircraft attitudes cause slides to invert or malposition, rescue personnel should attempt to align them properly. It does, however, require four persons to properly hold a deflated slide in an extended position (two at each side). (See *Appendix B.*)

3-3.9 Command and Control. All airport emergency equipment should be provided with two 2-way radios, one operating on the airport's assigned ground control frequency and the other on the airport emergency frequency. It is sometimes desirable for the Airport Crash Fire Fighting and Rescue Services to be able to monitor or be in direct voice communication with the aircraft in an emergency situation so that apparatus positioning may be established, and data relayed as to type of aircraft,

nature of the emergency, number of occupants aboard, amount of fuel aboard or other pertinent information. This procedure is especially important when airport control towers are not in operation.

In these instances, enroute Air Traffic Services should request that the aircraft change to the radio frequency monitored by the Crash Fire Fighting and Rescue Services.

Due to noise and confusion at an accident site, power megaphones can be valuable tools to coordinate air-crew/ground-crew activities, to give operational commands, to direct survivors to places of refuge, etc. Portable radios are also desirable at accident sites to communicate with the airport base radio, airport management, arriving back-up equipment, etc. Where personnel and equipment from more than one agency will operate in mutual support, it is desirable that common radio frequencies be available. If this is not possible, procedure should be established so that messages may be relayed through the command post.

3-4 Mutual Aid Considerations.

3-4.1 As indicated previously, it is frequently vital to have mutual fire fighting arrangements with community and regional (off-airport) fire departments. Successful handling of aircraft fire accidents (on or off the airport) depends on preplanning the most effective use of mutual aid fire fighting services (*see Appendix F*). The following considerations are significant:

3-4.2 Special attention should be given to assuring compatibility in equipment designs (e.g., fire hose threads, radio communications equipment) and to fire control operational techniques to assure that agent applications achieve optimum results.

3-4.3 It is important to familiarize structural fire department personnel with the special problems relating to aircraft rescue and fire fighting including access to airport movement areas and operations on airports.

3-4.4 Airport orientation visits should be arranged by fire departments bordering airports. Consultation with the Airport Authority, airlines, the military services and private operators as may also be appropriate. Studies should include aircraft emergency exits, seating, fuel systems and other structural features. The general topography of the airport should be understood with particular reference to airport entrance points, staging areas, active runways and water supply. In-service training should make use of the aircraft emergency diagrams in Appendix B.

3-4.5 Structural fire fighting vehicles normally carry small amounts of water as compared to the amounts usually carried on major aircraft rescue and fire fighting vehicles. However, they are useful in relaying water from hydrants, reservoirs, or other sources to maintain fire fighting operations.

3-4.6 Structural fire fighters can supply needed manpower to handle tools and equipment for fire control, to assist in rescue operations and to protect exposures.

3-5 Auxiliary Water and Extinguishing Agent Supply. Auxiliary water tankers should be dispatched whenever there is any indication for need and especially when the accident site is known to be beyond water relay capability. Pre-arrangements should be made to assure that additional supplies of extinguishing agents are brought to the scene by general purpose vehicles. Prudent utilization of agents under these circumstances is particularly important and application methods should be carefully selected to ensure their most effective use. It is important that preplanning also include the response, when needed, of a ladder truck, an elevated platform vehicle, portable lighting equipment or other specialized equipment. (*See Appendix D.*)

Chapter 4 Aircraft Emergencies

4-1 General. The life safety hazard and fire propagation rate of aircraft fire necessitates initiating a maximum effort. Patterns of behavior in aircraft emergencies are too varied to permit standardized response procedures.

An emergency that is prejudged to offer only a potentially minor problem can evolve into a major accident by circumstances that could not have been predicted even by experienced flight crew personnel.

It is therefore vital to initially respond to each emergency with the full complement of available equipment and personnel.

4-2 Types of Alerts.

4-2.1 The terms used to describe various categories of aircraft alerts are not standardized. The Federal Aviation Administration (FAA) terms — Alert I, Alert II, or Alert III — and the International Civil Aviation Organization (ICAO) terms — Local Standby, Full Emergency, and Aircraft Accident — are equivalent.

4-2.2 Alert I — Local Standby. An aircraft that is known or suspected to have an operational defect should be considered an Alert I. This defect should not normally cause serious difficulty in achieving a safe landing.

Alert I should also be initiated when an aeromedical evacuation aircraft is approaching or departing (*see Part I, Chapter 10*).

Airports should have management policies for implementation of Alert I procedures whenever required response times cannot be achieved. Factors that may affect response time include construction work, field maintenance, and adverse weather conditions such as snow, ice or low visibility (*see Part I, 2-2.1*).

Airports should have management policies for implementation of Alert I procedures during arrival and departures of certain categories or types of aircraft not normally utilizing the airport.

Under Alert I conditions, at least one aircraft rescue and fire fighting vehicle should be manned and positioned to permit immediate use in the event of an incident. The ARFF personnel should be advised of the (1) type of aircraft, (2) number of passengers and crew, (3) type and amount of fuel, (4) nature of the emergency, (5) type, amount and location of dangerous goods, and (6) number of nonambulatory passengers on board, if any. All other ARFF vehicles should be available for immediate response.

4-2.3 Alert II — Full Emergency. An aircraft that is known or is suspected to have an operational defect that affects normal flight operations to the extent that there is danger of an accident is an Alert II — Full Emergency. ARFF personnel should be provided with detailed information which allows preparation for likely contingencies. A full response should be made with the emergency equipment manned and positioned with engines running and all emergency lights operating so that the fastest response to the incident/accident site can be accomplished. It is important that appropriate radio frequencies be continuously monitored by ARFF personnel. One or more major aircraft rescue and fire fighting vehicles should be able to initiate fire suppression within the briefest period of time following the aircraft's coming to rest. Standby positioning of vehicles should be established for a variety of anticipated circumstances. The ARFF personnel should be informed of any changes in a distressed aircraft's emergency conditions which could affect the touchdown point or the ultimate behavior of the aircraft.

4-2.4 Alert III — Aircraft Accident. This Alert denotes an aircraft accident has occurred on or in the vicinity of the airport. Regardless of the source of this alarm, full airport fire and rescue response procedures should be put into effect. When possible, all known pertinent information should be relayed via radio by air traffic control (ATC) to responding emergency units and include as accurately as possible the location of the accident using grid map coordinates and landmarks. (See Figure 3-2.6.)

When such information is not available, the ARFF personnel should anticipate the worst situation and prepare accordingly. Mutual aid assistance should be initiated in accordance with the Airport/Community Emergency Plan (see NFPA 424, *Recommended Practice for Airport/Community Emergency Planning and ICAO ASM-7*).

The officer in charge should advise ATC of conditions at the site, particularly if such conditions could interfere with flight operations.

Chapter 5 Factors Common to All Aircraft Fire Emergency Responses by Airport Fire Departments

5-1 Protective Clothing and Equipment. All airport fire fighting and rescue personnel should be provided with, and be required to wear, when appropriate, 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 trousers, boots, gloves and a self-contained breathing apparatus unit. Personnel should be fully trained in the use, limitations and value of such protective clothing and equipment and utilize them in frequent fire fighting drills (see NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports*).

5-2 Approaching the Accident/Incident.

5-2.1 Route to Be Selected. Rescue and fire fighting vehicles should approach any aircraft accident by the route providing the quickest response time (see Part I, Section 2-1.1). This may not necessarily be the shortest distance to the scene. Traversing rough unimproved areas may take longer than traveling a greater distance on paved areas such as taxiways, ramps and roads. Total response time is vital. Preferred routes, especially within the Critical Rescue and Fire Fighting Access Area, should be preselected. When nearing the incident scene, vehicle operators should be extra cautious to avoid occupants of the aircraft who may have escaped, been thrown free and/or are walking away from the area in dazed condition. Nighttime or low-visibility responses will require extra diligence by drivers and observers and intelligent use of spot- or floodlights.

5-2.2 Need for Alternate Routes. In some cases, runways and taxiways are blocked by parked aircraft awaiting takeoff or taxi clearance. Vehicle operators should be aware of alternate routes that can be used so as not to delay the response.

5-2.3 Soil Trafficability. The load-bearing characteristics of the airport soil structure under various weather conditions should be known and drivers should be trained to deal with off-road driving problems.

5-2.4 Special Precautions for Gear Emergencies. For emergencies involving gear malfunctions or tire difficulty, there is always a possibility of the aircraft veering off the runway and hitting the standby emergency equipment. It is difficult to predict the touchdown point. Therefore, one vehicle should be located, if there are two or more vehicles available, on each side of the runway at a suitable distance from the runway edge. After the aircraft's touchdown, the vehicle should follow the aircraft to its resting place.

5-3 Positioning of Equipment.

5-3.1 Positioning of Rapid Intervention Vehicles (RIV) or Combined Agent Vehicles.

The mission of the RIV or first arriving vehicle and its crew is to prevent fire outbreak, assist in rescue operations, and control or extinguish any initial fire. The crew should immediately establish an evacuation area and size up the rescue and fire fighting problem so as to be able to position the other vehicles upon their arrival.

Initially, RIVs should be positioned to permit the most rapid access to the principal egress route from the aircraft in distress except when it is obvious that occupants are

evacuating safely without assistance and the fire or threat of fire is otherwise controlled. Caution must be taken to avoid placing the vehicle in locations that, in the event of a sudden extension of flame, could place evacuees, fire fighters, and vehicles in a hazardous position.

5-3.2 Positioning of Major Fire Fighting Vehicles.

Vehicles should be positioned to make effective and efficient use of all agent systems. Most efficient use may require movement of the vehicle during turret operations. The pump and roll concept is especially effective with AFFF agent. It is vitally important to avoid overapplication of the limited amounts of agent available. Turrets should be used only as long as they are being effective. Frequently, hand lines can maintain control of the rescue areas and can be the key to successful rescue operations.

When selecting vehicle position for applying foam, remember that the wind has considerable influence upon the rate of fire and heat travel; utilizing the wind whenever possible will thus assist in achieving the objective. Generally, foam streams should not be directed toward the fuselage at right angles as this may tend to drive burning fuel toward the occupied areas, jeopardizing survival of trapped occupants. The main object is to safeguard the escape areas.

5-4 Methods of Applying Foam Extinguishing Agents.

5-4.1 Aqueous Film Forming Foam (AFFF) — Turret Application.

AFFF concentrate consists of a fluorochemical surfactant with a foam stabilizer which is diluted with water in either a 3 percent or a 6 percent solution. It acts both as a barrier to exclude air or oxygen and, in addition, produces an aqueous film which spreads over the fuel surface. This film-forming activity will continue as long as solution remains in the foam bubble. The fast draining of the aqueous film from the foam blanket accounts for the fast knockdown of a hydrocarbon fuel fire but contributes to its limited burnback resistant characteristics. Positioning of the equipment to permit maximum effective use of turrets and hand lines is equally important with AFFF as with protein foam; however, the method of application differs when applying AFFF from the turret. The basic principal is to distribute a visible AFFF blanket of sufficient thickness over the burning liquid area to act as a film source for vapor suppression. The original foam blanket should not be relied upon to be permanent and should be renewed as necessary until such time as the fuel/vapor hazard no longer exists. Because of limited water supplies, turret operators should concentrate on the practical critical area and maintain this area fire free after extinguishment.

AFFF and protein-based foam concentrates should not be mixed. Where AFFF is used in equipment that formerly contained protein foam concentrate, the foam tank and system must be thoroughly flushed.

AFFF is compatible with protein and fluoroprotein foams in the applied form. The equipment normally used for applying protein or fluoroprotein foam can be used for AFFF application; however, the use of nonaspirating equipment, such as conventional spray nozzles, has proven to be effective in the application of AFFF. Extreme caution should be taken when using the straight

stream method as this may cause an increase in the liquid pool surface and/or splatter of the flammable liquid.

AFFF agents are compatible with dry chemicals. The agents may be applied simultaneously to improve flame knockdown and control fire spread.

5-4.2 Fluoroprotein Foam — Turret Application.

Fluoroprotein foam concentrates consist of the basic protein foam concentrate, modified by the addition of fluorochemical surfactants which improve the foam blanket flowing characteristics, and improve the tolerance properties and compatibility with dry chemical powders. Fluoroprotein foam concentrates are used as either a 3 percent or 6 percent concentrate.

Fluoroprotein foam's primary extinguishing method is smothering, by forming a cohesive free-flowing foam blanket which suppresses fuel vapor.

Equipment normally used for protein foam must be used for fluoroprotein foam application and may utilize straight stream or dispersed patterns to distribute the foam over a wide area, or indirect deflection techniques. Extreme caution should be taken when using the straight stream method as this may cause an increase in the liquid pool surface, cause greater flame intensity and splatter of the flammable liquid.

Although the foam may have a high degree of tolerance to contamination by fuel, direct plunging of the foam stream should be avoided. The improved compatibility demonstrated by fluoroprotein foams with dry chemical powders over protein foam, together with their compatibility with AFFF, allows twin agent or two-point application to be employed. The user should be assured that the foam and dry chemical compatibility is adequate to meet operational requirements or the manufacturers may be contacted for additional information.

5-4.3 Protein Foam — Turret Application.

Protein foam concentrate consists primarily of protein hydrolysate, plus stabilizing additives, and is used as a 3 percent or 6 percent concentrate. Because of protein foam's extinguishing characteristic, which is primarily smothering by forming a cohesive stable foam blanket, care should be taken when directing the turret foam stream.

The initial discharge of protein foam should be along the line of the fuselage and then directed to drive the fire outwards. Care must be exercised to avoid the possibility of disturbing an established protein foam blanket by the careless application of additional protein foam, or any other agents. Protein foam should be applied to a liquid fuel fire so that it gently forms a uniform and cohesive blanket with the least possible turbulence to the fuel surface.

Extreme caution should be taken when using the straight stream method as this may cause an increase in the liquid pool surface and cause greater flame intensity.

5-4.4 Hand Line Applications.

Supportive protective measures with hand lines are usually necessary to provide access to egress routes for both evacuees and rescuers. A word of caution, however, is necessary if the attack method requires both turret and

hand line operation. Whether or not there is an immediate need for hand lines, they should be charged for use when equipment is properly positioned irrespective of the extent of the fire at time of arrival. This should assure an immediate discharge capability in case of fuel flash fire which could endanger emergency crews and equipment at the scene as well as occupants of the aircraft. If no fire is visible, all equipment should be placed in immediate readiness for service.

5-5 Special Extinguishing Techniques.

5-5.1 Exposed Fuel Spills or Fuel Fires. All spills of flammable liquids in the area surrounding the occupied areas of the aircraft should be neutralized or blanketed with foam (protein, fluoroprotein, or AFFF solutions or combinations thereof) as quickly as possible, taking into consideration the total supply available. General purpose vehicles should be available on prearranged schedules to bring additional supplies of foam concentrates to the scene. Water should not be used where foam has been applied since this could wash away the existing foam blanket.

5-5.2 Combined Agent Usage. The main attack on the fire will normally be by mass application of foam, or alternately, by the combined use of foam and a dry chemical agent. Even where foam alone is used, a suitable complementary agent should be available to deal with pockets of fire which may be inaccessible to direct foam application. Protein foam should be employed only with compatible dry chemicals.

Complementary agents include dry chemical powders, carbon dioxide, or a halogenated extinguishing agent, and are generally used on spilled liquid fuel fires or in concealed spaces, such as wing voids, in an engine nacelle, or wheel well.

5-5.3 Uninvolved Fuel Tanks. If fire threatens exposed aircraft structures containing fuel, they should be protected by foam or water spray streams to prevent their involvement. Water spray systems should not be allowed to destroy the blanket covering any fuel spilled in critical areas.

Experience has shown that dry chemical tends to be more effective than CO₂ or Halon when used in the open to combat three-dimensional fires.

5-5.4 Ignition Source Elimination. If a large fuel spillage occurs without fire, it is important to eliminate as many ignition sources as possible while the spill is being stabilized or covered with foam.

There may be enough residual heat to ignite fuel vapors up to thirty (30) minutes after shutdown, in turbine aircraft engines, or ten (10) minutes after shutdown in piston engines.

5-5.5 Aircraft Engine Hazards. Rescue and fire fighting personnel should stay at least 8 m (25 ft) from the intake of an operating turbine engine to avoid being injured by the suction effects, and 45 m (150 ft) from the rear to avoid being injured or burned by the blast effects. (See Figure 5-5.5.) On piston or turbo-prop aircraft, the propellers should never be touched, even when at rest.

5-5.6 Combustible Metals. Burning magnesium or titanium parts should be ISOLATED and extinguished using a Class D agent. Where this is not possible, extinguish by covering with dry, uncontaminated sand or dirt.

5-5.7 Broken Flammable and Combustible Liquid Lines. Broken fuel, hydraulic fluid (flammable type), alcohol and oil lines should be plugged or crimped, when possible, to reduce the amount of spill and extent of fire.

5-5.8 Confined Reciprocating Engine Fires (Piston). When engine fires are confined within the nacelle, but cannot be controlled by the aircraft extinguishing system, dry chemical, carbon dioxide, or a halogenated fire extinguishing agent should be applied first as these agents are more effective than water or foam inside the nacelle. Foam or water spray should be used externally to keep adjacent aircraft structures cool.

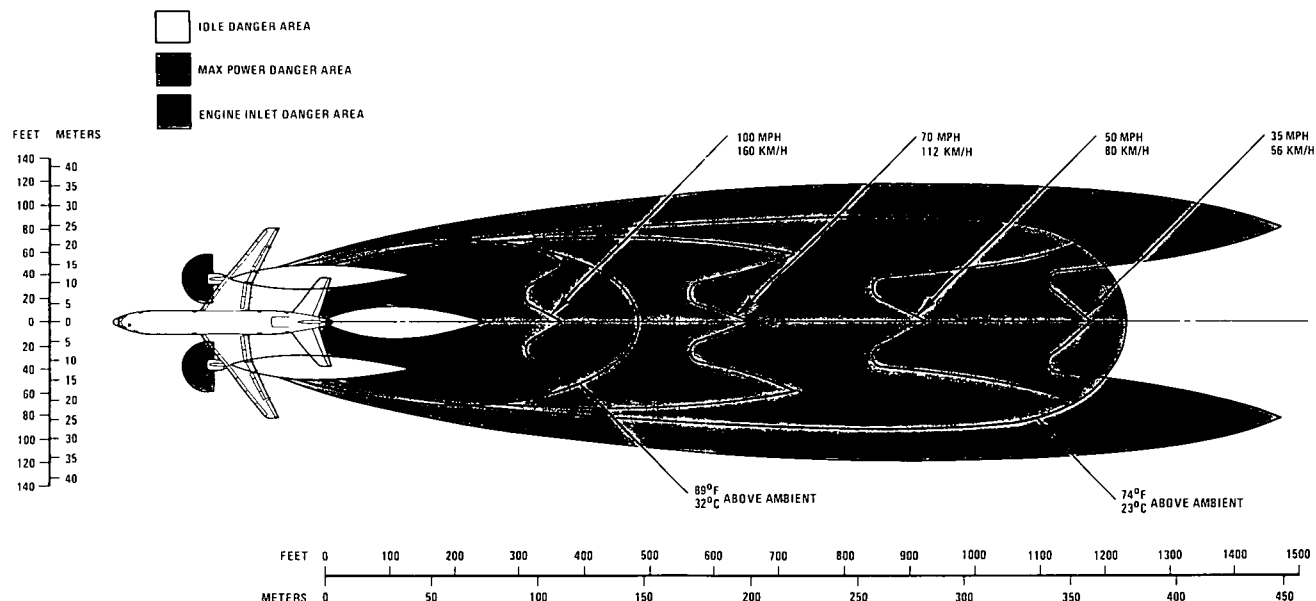
5-5.9 Turbine (Jet) Engine Fires. Fires confined to the hot section of engines may be best controlled by keeping the engine rotating. Such action must be considered in the context of necessary aircraft evacuation and other safety considerations. Fires outside the combustion chambers, but confined within the nacelle, are best controlled with the aircraft's built-in extinguishing system. If the fire continues after the system has been exhausted, or if reignition occurs, a halogenated fire extinguishing agent or carbon dioxide or dry chemical agent may be applied through maintenance access openings to attempt extinguishment. The aircraft operator should be advised of the type of extinguishing agent used in order for appropriate maintenance action to be taken.

Also, avoid using foam in the intake or exhaust system unless control cannot be secured with other agents and the fire cannot be confined to the engine nacelle. Fire fighters should stand clear of the exhaust and intake chambers when protecting exposed combustibles from the impinging flames.

Some engines have magnesium or titanium parts which, if ignited, cannot be extinguished with the conventional extinguishing agents available to most aircraft rescue and fire fighting crews. If these fires are contained within the nacelle, it should be possible to allow them to burn out without seriously threatening the aircraft itself as long as (1) there are no external flammable vapor-air mixtures which could be ignited by the flames or hot engine surfaces and (2) foam or water spray is available to maintain the integrity of the nacelle and surrounding exposed aircraft structures. (See Part II, Section 3-2 and NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports*.)

5-6 Rescue Assistance.

5-6.1 Basic Principles. Evacuation of personnel involved in aircraft accidents/incidents and assistance to those who cannot remove themselves should proceed with the greatest possible speed. While care is necessary in the evacuation of injured occupants so as not to aggravate their injuries, removal from the fire-threatened area is the primary requirement.



ENGINE RUN DANGER AREAS

Figure 5-5.5 Engine Run Danger Areas.

5-6.2 Methods of Evacuation/Rescue. Evacuation and rescue assistance should be accomplished through regular aircraft doors and hatches wherever possible. If this is not possible, breaks in the fuselage or the use of cockpit windows should be considered. Airport fire department personnel should be trained in forcible entry procedures and should be provided with the necessary tools. Precautions should be taken so that hot metal sparks caused by power tools do not ignite flammable vapors or other combustibles. Aircraft windows are often used for evacuation, rescue, or for ventilation, especially those designed as emergency exits. Most exits have latch release devices on both the outside and inside of the cabin. Most window exits open **TOWARD THE INSIDE**. Aircraft cabin doors are also used as emergency exits except those incorporating air-stairs. When positioning ladder or portable ramps to attempt to open cabin doors from the outside, extreme care should be taken since all aircraft cabin doors do not open in the same direction. Some travel to the left, some to the right, some upward, others downward and some will not open at all if any pressure is still within the aircraft (as low as .015 psi). The doors on most wide-body aircraft are opened automatically with pneumatic or mechanical-assist features with a sequential automatic deployment of the slides. Doors on most existing aircraft have been modified to prevent automatic deployment of the slides if the door is opened from the outside. However, extreme caution should be taken to avoid being struck by the doors, slides or stairs in the event of a malfunction which might permit an automatic release when doors are opened. When opening the doors of wide-body aircraft, elevated platform vehicles or mobile passenger loading steps are very desirable both for efficiency and reduction of fire fighter

injury. Rescue and fire fighting personnel should have a sound knowledge of these design features of aircraft normally using the airport (*see Appendix B*).

5-6.3 Moving Aircraft Wreckage. If it is necessary to use power equipment to move portions of a damaged aircraft, either to assist in rescue operations or to control the fires, caution must be used to avoid changes in aircraft orientation or strains which might liberate quantities of fuel from partially damaged tanks, cause collapse or rollover of the fuselage, or cause greater injuries to trapped personnel.

5-6.4 No Smoking Rule. Assure that the "No Smoking" rule is rigidly enforced at the scene of the accident/incident and in the immediate vicinity.

Chapter 6 Aircraft Accidents in the Water

6-1 General.

6-1.1 Where airports are situated adjacent to large bodies of water (such as rivers or lakes) or where they are located on coastlines, special provisions should be made for rescue and fire fighting operations in the water. Examples of specialized equipment for rescue and fire fighting 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 D illustrates some typical water fire/rescue equipment in service.

6-1.2 Many transport aircraft not engaged in intercontinental overwater flights are equipped only with flotation-type seat cushions as emergency flotation equipment. Survivability of passengers using this equipment is limited. They are susceptible to hypothermia in water below 70°F, or ingestion of fuel vapors from floating fuel. Hence, rapid response is important.

6-1.3 Probability of Fire. In water landing incidents, the possibility of fire is normally reduced because of the likely suppression of ignition sources by the water contact and the cooling of heated surfaces. In situations where fire is present, its control and extinguishment present unusual problems unless the proper equipment and skilled personnel are available.

6-1.4 Fuel on Water Surface. It should be anticipated that the impact of the aircraft into the water might rupture fuel tanks and lines. It is reasonable to assume that fuel may be floating on the surface of the water. Boats having exhausts at the waterline or above may present an ignition hazard if operated where this condition is present. 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 or initiate fire. As soon as possible, pockets of fuel should either be broken up or moved from the rescue area with large velocity nozzles, covered with foam, or boomed to contain the fuel in a safe area prior to absorption, emulsification or removal. Preplanning with the local Water Pollution Control Agency can establish emergency assistance during this operation.

6-2 Organizing Diving Units/Use of Divers.

6-2.1 Diving units should be dispatched to the scene. When available, helicopters can be used to expedite the transportation of divers to the actual area of the crash. All divers who may be called for this type of service should be highly trained in both SCUBA diving and underwater search and recovery techniques. In areas where there are no operating governmental or municipal underwater search and recovery teams, agreements may be made with private diving clubs. The qualifications of the individual divers should be established by training and practical examination.

6-2.2 In all operations where divers are in the water, standard diver's flags should be flown and boats restricted from operating in the rescue diving area.

6-2.3 Where fire is present, approach should be made after wind direction and velocity, water current and site accessibility are taken into consideration. Fire may be moved away from the area by using a sweeping technique with hose streams. Foam and other extinguishing agents should be used where necessary.

6-2.4 Victims are more apt to be found downwind or downstream. This should be anticipated when planning the attack. Where only the approximate location of the crash is established upon arrival, divers should use standard underwater search patterns marking the locations of the 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.*

Enough air may remain in large submerged occupied sections of the aircraft to maintain life. Entry by divers should be made carefully at the deepest point possible.

6-3 Other Considerations.

6-3.1 Where the distance offshore is within range, synthetic fiber-covered, rubber-lined fire hose can sometimes be floated into position by divers or boats and used to supplement other means of fire attack.

6-3.2 Where occupied sections of aircraft are found floating, great care should be exercised not to disturb their watertight integrity and the attachment of supplemental floating devices may be desirable. Removal of the occupants should be accomplished as smoothly and quickly as possible. Any shift in weight or lapse in time may result in the aircraft sinking. Rescuers should use caution so that they are not trapped and/or drowned in these situations.

6-3.3 A command post should be established on an adjacent shore, in a position to facilitate implementation of the Airport/Community Emergency Plan in accordance with guidelines established by the authority having jurisdiction. (*See NFPA 424, Recommended Practice for Airport/Community Emergency Planning.*)

Chapter 7 Rescue and Fire Fighting Post Aircraft Accident Procedures

7-1 Fire Department Authority.

7-1.1 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 investigation of cause is most important, efforts consistent with the duty described above may involve moving parts and operating controls. When this is done, rescue and fire fighting personnel should be prepared to subsequently advise responsible investigative authorities of the action they took in carrying out their rescue, fire control, or fire prevention responsibilities which may be of importance in the accident investigation report.

7-1.2 Rescue and fire fighting personnel should familiarize themselves with all regulations, national and local, regarding movement of wreckage and disposition of human remains (*see Appendix E*).

7-2 Preservation of Evidence.

7-2.1 Following extrication and rescue of occupants from an aircraft, preservation of evidence at the accident site is of vital importance in determining the probable cause. Fire fighting and rescue personnel should be aware of this precaution and it should be stressed in training exercises.

7-2.2 Rescue and fire fighting personnel should take note of condition and position of the aircraft structure prior to beginning any significant cutting or shifting of any portions of the aircraft. If time permits, a photographic record of initial conditions should be made for later study.

7-2.3 The accident area should be roped off and perimeter security provided to prevent the entry of unauthorized persons. Any person not actively engaged in operations should be denied entry to the area and those inside the controlled area should be fully equipped with protective clothing and equipment. (*See Part I, Section 5-1.*)

7-3 Fatalities.

7-3.1 The location of all deceased persons should be clearly identified by the use of a wooden stake and numbered to coincide with a number securely attached to the body. Triage/medical tags may be used for this purpose.

7-3.2 Removal of bodies of fatally injured victims remaining in wreckage after fire has been extinguished or essentially controlled should be accomplished only by or under the direction of the responsible medical examiner (coroner). Premature body removal can interfere with identification and destroy pathological evidence required. (If body removal is necessary to prevent further incineration, the original location and the body should be identified with a number and the fact reported to investigators.)

7-4 Preservation of Mail, Baggage, and Cargo.

7-4.1 The location of mail sacks, baggage and cargo should be observed and this information given to investigation and postal authorities. If necessary, they should be protected from further damage by removal to a secure location such as the command post.

7-4.2 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 the mail and cargo as possible. This applies to domestic as well as foreign mail and regardless of whether or not the mail has cleared through customs.

7-4.3 When notified, postal inspectors will immediately proceed to the scene of any aircraft accident where the aircraft is licensed to carry mail. Where such postal inspectors are not available, the command post should con-

tact the postmaster at the nearest office and ask that person to assume custody of the mail.

7-4.4 The fire chief should be satisfied that the individual identifying himself/herself as a postal inspector or postal official is such, in fact.

7-4.5 All baggage, diplomatic mailbags, mail and cargo on air transport aircraft should be removed from the site of the accident under customs' or local authorities' supervision and stored in a safe place under strict surveillance until officials of the air carrier arrive. After release by government officials, the air carrier should assume its responsibility for the disposition of these items.

7-5 Flight Data and Cockpit Voice Recorders.

7-5.1 Fire fighting personnel should be trained to recognize flight data and cockpit voice recorders in the event that they come upon them while engaged in operations at the scene of an aircraft accident. They should not attempt recovery of these recorders as they may be damaged by such efforts. Every effort should be made to minimize post-accident damage to such recorders unless it seems likely that failure to recover may result in total loss of the recorders (e.g., in a swampy area or in the water). Where recovery is not immediately necessary, the recorders should be safeguarded until the official aircraft accident investigators arrive at the scene. These recorders are located in the aft fuselage area of most commercial aircraft.

7-6 Hazards to Rescue and Fire Fighting Personnel.

7-6.1 Rescue and fire fighting personnel should always remain alert to the possibility of ignition of flammable vapors which are most always present in the area of damaged aircraft. Elimination of ignition sources and maintenance of an unbroken foam blanket is the best procedure in preventing the ignition of these vapors.

7-6.2 Aircraft structures damaged by fire or impact forces are often very unstable and subject to collapse or rollover. If these conditions are suspected to exist, precautions in the form of blocking or shoring should take place as soon as practicable to ensure the safety of rescue and fire fighting personnel working in the area.

7-6.3 If dangerous goods are believed present, procedures should be carried out as prescribed in Appendix C.

7-6.4 Aviation fuels and hydraulic fluids may cause dermatitis by contact with the skin. Emergency personnel who have had these fluids spilled on them should immediately drench all contaminated clothing before removal, then wash all affected parts of the body thoroughly with soap and water.

7-7 Removal of Damaged Aircraft.

7-7.1 If life safety dictates that the aircraft or parts must be moved prior to release to the investigating authority, a record should be made of all the actual locations of all parts and care exercised to preserve any evidence available that might help determine the cause of the accident. As an example of the importance of this

fact, in the United States, aircraft cannot normally be moved without the authority of the National Transportation Safety Board or its designated agents (*see Appendix E*).

7-7.2 When the investigative authority having jurisdiction decides that the aircraft can be moved, interior portions of the aircraft should first be ventilated to remove all flammable vapors; then runway and ground surfaces should be thoroughly flushed of all flammable liquid and thoroughly rechecked after the removal before permitting normal traffic to resume. Aircraft defueling should be performed by qualified technicians using approved methods (*see NFPA 407, Standard for Aircraft Fuel Servicing, and NFPA 410, Standard on Aircraft Maintenance*). Fuel removed should be measured and samples retained for later analysis in connection with the accident investigation. At least one rescue and fire fighting unit should be retained at the site while the aircraft is being defueled.

Chapter 8 Flight Crew and Airport Emergency Personnel Duties and Responsibilities in Handling Aircraft Incidents and Emergencies

8-1 General. The purpose of this guidance material is to eliminate confusion and assure proper understanding between flight crews and airport emergency personnel in handling aircraft incidents and emergencies. To assure that all efforts are clearly directed towards a common goal, many factors must be taken into consideration before action is taken on emergencies such as hydraulic failures, bomb threats, fire warnings, and other such aircraft incidents where fire or aircraft damage is not evident.

8-2 Responsibilities of Flight Crews and Airport Fire Department Personnel.

8-2.1 The prime mission of all concerned is the life safety of all persons aboard the aircraft and any others involved in the incident/emergency. Duties and responsibilities can generally be defined as follows:

8-2.2 Flight Crews. Flight crews hold the primary responsibility for the aircraft and 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 crew members are able to function in the normal manner at the time of the accident or emergency.

8-2.3 Airport Fire Department Personnel. It is the airport fire department personnel's responsibility to assist the flight crew in any way possible. Since flight crew visibility is restricted, airport emergency crews should make an immediate appraisal of the external portions of the aircraft and report unusual conditions to the flight crew when possible. External protection of the overall operation is the primary responsibility of the airport fire

department. In the event the flight crew is unable to function, the airport fire department personnel should initiate the necessary actions. In some incidents (such as where hijacking threats exist, are in progress, or where bomb threats have been made), federal authorities may preempt primary responsibility and the fire department personnel may provide support services. Airport emergency plans should include provisions and procedures for these special situations.

8-3 Communications.

8-3.1 Effective communications between flight crew and the airport fire department personnel are very important; hence, immediate steps should be taken to establish direct contact between persons in charge of each crew. This will assure that all factors are properly considered before actions are initiated. Several methods of providing this direct communication are generally available.

8-3.2 Radios. Most aircraft rescue and fire fighting vehicles are equipped with the airport control radio frequency and, through cooperation with the control tower, aircraft can be requested to change to this frequency during emergencies. Other frequencies may be available on equipment which will respond such as airline vehicles which have radios on a so-called "company" frequency.

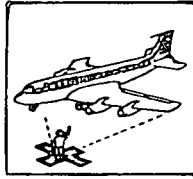
8-3.3 Aircraft Intercom. Where aircraft engines are running, radio communication near the aircraft may be very difficult. Most aircraft are equipped with intercom systems provided with plug-in jacks which are generally located under the forward portion of the aircraft near the nose gear. Airport fire department 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 running, direct communications with the flight crew can be established by use of this system as long as power to the system is on.

8-3.4 Other Communication Means. Where a more direct means of communication cannot be established, the officer in charge of the responding fire fighting and rescue 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 a portable amplifier is not available, it may be necessary to resort to hand signals to communicate. Figure 8-3.4 depicts Standard International Ground to Aircraft Hand Signals which may be used by rescue and fire fighting personnel to communicate with the pilot during emergencies.

8-4 Incidents Where Aircraft Fire Warnings Occur. 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 and fire fighting and rescue personnel should inspect the area involved prior to parking at the terminal where fire could endanger other aircraft or buildings. This inspection can usually be accomplished without opening aircraft compartment doors, by visual inspection of affected areas or by checking external evidence of smoke or heat.

Location of Signaller in Relation to Aircraft

Signaller 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 out-stretched 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 out-stretched 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 8-3.4 Standard International Ground to Aircraft Signals.

8-5 Bomb Threats.

8-5.1 When a bomb threat involving an aircraft is declared an emergency, the aircraft should be evacuated by the quickest means possible. The flight crew should direct passengers to leave their carry-on baggage and depart the aircraft as quickly as possible. This may dictate the use of the emergency evacuation slides or built-in stairs. Mobile loading stairs positioned by fire fighting and rescue personnel may be the safest and most practical alternative.

8-5.2 If not already so located, immediately after evacuation has been completed, the aircraft involved in the bomb threat should be moved to a location at least 300 m (1,000 ft) away from structures and other aircraft.

8-5.3 Airport Security (police) should have the primary responsibility for initiating protective measures utilizing, as available, trained bomb disposal specialists within their ranks or those of local law enforcement agencies. Military authorities have explosive ordnance disposal specialists located throughout the country whose services may be enlisted.

8-5.4 The airline (where involved), under auspices and observation of airport police, should have the responsibility for the safety of the passengers and any needed search of luggage or aircraft. Directing and moving aircraft on the airport is the responsibility of ATC (or airport management where there is no ATC). Security, crowd control, and organizing bomb disposal actions are a function of Airport Security. Command and control of any fire incident and coordination of any associated rescue operations is a function of the airport crash fire fighting and rescue service. Appropriate governmental regulating authorities should be contacted for guidance when necessary.

8-6 Aircraft Engines Running. It is often the practice to keep at least one engine operating after the aircraft has come to a stop at a remote location where ground-power generators are not available. Propellers turning on turbo-prop or reciprocating engine aircraft present a hazard to evacuees and rescue personnel. Turbojet engines present additional problems. For example, the areas directly ahead of and for a considerable distance behind the engines should be avoided by both rescue personnel and evacuating passengers because they will rotate for a considerable time after shutdown. These areas should be avoided when positioning airport emergency vehicles (*see Part I, 5-5.5*).

8-7 Emergency Vehicle Positioning. Reciprocating engine aircraft provide more options for positioning emergency vehicles upon approach than do the turbojet aircraft due to the swept-back wing configuration and the jet blast potential behind turbine engines; therefore, rescue and fire fighting personnel generally favor an approach and set-up on the nose of jet aircraft where fire conditions are least likely to exist. This should not be considered a standard procedure as many factors influence the most favorable approach. Wind conditions, terrain, type of aircraft, cabin configurations and other factors, including security considerations, can dictate the op-

timum approach in a given circumstance. The flight crew may be in the best position to recommend proper positioning of the emergency vehicles dependent upon the nature of the incident, the aircraft type and occupancy. On combined cargo-passenger aircraft, rescue and fire fighting personnel should be notified of cabin configurations, since some cargo areas extend as far aft as the overwing exits, making these exits unavailable for emergency evacuation.

8-8 Fire in Progress Upon Arrival. Priority should be given to controlling any fire in the critical fire area of the aircraft as this is the beginning step of any rescue operation. On first arrival, emphasis must be placed on control of any fuel spill fires in the likely evacuation path. In the case of minor fuel spills, and where small aircraft are involved, this attack may be sufficient to control both the exterior fire and eliminate the threat of extension of the fire to the aircraft interior. At incidents involving wide-body aircraft, ignited fuel may extend over a large area with the aircraft centered in the fire and resembling a fully involved three-story structure. Fire attack in these situations may call for initially positioning fire fighting vehicles and applying foam to achieve external fire control in the practical, critical fire area. After any required forcible entry, an immediate internal attack using water spray should follow, applying structural fire fighting techniques. Ventilation of the fuselage should be accomplished as soon as possible. Personnel conducting overhaul of any aircraft interior fire should understand the structural characteristics of the aircraft. The absence of fire stops at the floor, behind wall paneling, and above ceiling spaces in aircraft cabins causes fire to spread into concealed spaces. The toxicity of cabin furnishings demands the use of self-contained breathing apparatus. Since aircraft interior fires are principally Class A fire situations, selected structural fire fighting techniques and appliances can be effective. These techniques include applying large-volume water spray nozzles for direct interior application or using penetrating nozzles, cellar pipes, etc., in conjunction with ventilation, for indirect application to areas not immediately accessible. (See *Part I, Chapter 9* and *Part II, Chapter 5*.)

8-9 Aircraft Evacuation.

8-9.1 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 any emergency situation. They also have direct contact with those aboard the aircraft to direct the operation. The exception, of course, is when a flight crew may be incapacitated for any reason. Under these circumstances evacuation responsibility would shift to ground personnel.

8-9.2 Emergency Landings — Flight Crew Considerations. Prior to any transport category aircraft planned emergency landing, flight crews normally will consider passenger relocation within the cabin. This procedure is used to expedite use of potential emergency exits, thereby lessening overcrowding at any one. The practice of placing a crew member, or person knowledgeable in evacuation procedure, at each exit to direct evacuation is commonly followed where time and circumstances permit.

Forward exiting is natural for the occupants since most passengers entered the aircraft at terminals through forward doors and will instinctively attempt to exit in the same manner. Other exit potentials are apt to be bypassed, especially under any mental strain or sense of panic. Overwing exits and other emergency exits requiring physical agility may be shunned by those doubting their ability to use them effectively. If visibility in the cabin interior is impaired to any appreciable extent by darkness or the presence of dense smoke, disorientation of passengers can further complicate orderly evacuation. Collapse of overhead panels, partitions and seats or dislodged materials from overhead racks/compartments can cause injuries and impede orderly evacuation. If the nose gear fails in abnormal landings, the aircraft may come to rest in a tail-high attitude. In some aircraft, the failure of one or more main landing gear may result in a nose-high attitude. Often an aircraft fuselage will be broken open by impact forces and failure of a main landing gear. In other words, the flight crew can be faced with a myriad of decisions in the seconds before or after an accident and ground crews cannot expect that standard procedures will be used in each case.

8-9.3 Evacuation Procedures. Most aircraft are equipped with emergency evacuation equipment and this equipment will be selected by the flight crew in emergencies where speedy evacuation is deemed essential. The use of this equipment involves a degree of personal injury risk to the aircraft occupants; therefore, if time and conditions permit, alternate aircraft evacuation stairs may be requested by the flight crew. Evacuation stairs should be used wherever possible because of their safety advantages. Evacuation stairs and fire department ladders are advantageous in rescuing persons from wing surfaces where the distance above ground level involves potential leg or body injuries. Evacuation conditions may be complicated when the aircraft is in the normal landing gear down position if the flaps are not in a down position and the spoilers are extended or, in some aircraft, if the off-wing slide has failed to operate normally. If existing fire conditions or fuel spills in the area present a distinct flash fire hazard, alternate evacuation routes might have to be chosen. Ground personnel are often in a better position to evaluate such problems than is the flight crew whose line of sight from the flight deck or cabin is restricted. The officer in charge of the rescue and fire fighting personnel should not hesitate to communicate such information to the flight crew. The choices by the flight crew to initiate the evacuation can be limited by circumstances aboard. For example, emergency exits can be jammed because of impact stresses placed on the fuselage; exits may be blocked by loose galley equipment; and the failure of internal structures due to the deceleration forces may make some exits unserviceable. Although normal evacuation procedures call for the use of all available exits, flight crews are trained to remain flexible in planning for emergencies and to be prepared to select the best means as circumstances dictate. Airport rescue and fire fighting personnel should not depend on the standardized procedures being used in each case and should be flexible to provide protection for evacuees. Properly deployed evacuation slides should not be disturbed unless they are subsequently damaged through use or by external forces.

Noninflated type slides will require manual support where they contact the ground and those evacuating may need assistance in getting to their feet at the bottom of the slide (*see Appendix B*). If airline personnel are not available to perform such services, other persons may be needed to provide this assistance. Airport rescue crews should, in all cases, have available at accident sites, emergency evacuation equipment to be utilized if the aircraft equipment cannot be satisfactorily deployed. Inflatable slides are very susceptible to wind conditions and radiant heat which can melt and deflate the slides, rendering them unusable.

8-9.4 Flight Crew Personnel and Rescue and Fire Fighting Personnel Coordination. Pre-emergency planning is obviously necessary. Airport/Community Emergency Planning should include the type of coordination recommended in NFPA 424, *Recommended Practice for Airport/Community Emergency Planning*. Additionally, under the jurisdiction of the airport operator, the emergency services included in the plan should meet with the air carrier representatives utilizing the airport to coordinate respective roles and acquaint each other with the capabilities and limitations of their equipment and personnel.

Chapter 9 Aircraft Ground Fires; Cabin Fires; Brake and Wheel Fires; Fuel Servicing Fires

9-1 General Purpose. The recommendations in this chapter are for the guidance of the officer-in-charge when responding to aircraft fires that occur during servicing or in parked aircraft or to provide standby protection where a fire hazard exists.

9-1.1 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 hotel or motel, cargo buildings, and other facilities. Procedures for these fire prevention and protection operations are not covered herein.

9-2 Aircraft Passenger Cabin Fires on the Ground (Class A Fires).

9-2.1 Regardless of ignition cause, aircraft passenger cabin fires on the ground normally involve ordinary combustibles, such as cabin upholstery, paneling, refuse, paper toweling, and electrical insulation. The intensity of such a fire will depend on a number of variables; for example, the time of discovery, the amount and form of the materials ignited, the amount of air (oxygen) present, draft conditions, the involvement of other fire hazardous materials, (e.g., flammable liquids, oxygen, incendiary devices) and whether or not there was a delay in fire detection or fire suppression activity. Methods to be used for effective extinguishment of the fire depend largely on

proper training, the advanced state of the fire when initially attacked and the availability of adequate extinguishing agents and equipment.

9-2.2 Sometimes aircraft interior fires originate in aircraft system components below the cabin floors or in the cabin wall or ceiling cavities (between the interior cabin liners and exterior fuselage skin). Such concealed spaces may extend throughout the aircraft and may allow the fire to spread uncontrolled in the presence of combustible materials. It may be very difficult, under such conditions, to determine the source of ignition, to combat the fire or to estimate the extent of fire spread from either outside or inside the aircraft without the removal of large sections of the cabin floor, wall, or ceiling components.

9-2.3 When flight deck or cabin fires occur while the aircraft is on the ground and occupied, or while passengers are embarking or disembarking, they are normally detected in the early stages, permitting a prompt alert of the airport fire department. Aircraft flight crew and the airline service personnel should be periodically trained in the utilization of all available fire extinguishing devices to handle such emergencies.

9-2.4 Fires occurring in unoccupied aircraft on the ground often present a delayed detection problem. An unattended aircraft with doors closed may contain a smoldering fire which can be unnoticed for an extended period of time. Opening an aircraft for fire control under such conditions can be extremely hazardous because of the buildup of fire gases within the aircraft. The sudden introduction of outside air can result in a backdraft explosion. The configuration of an aircraft is not dissimilar to a long, narrow corridor in an ordinary structure where large amounts of combustibles are present. The backdraft potential is very serious; therefore, extreme caution should be used when opening doors and emergency exits under these conditions. Fire fighters should always have charged hose lines in position to immediately combat the potential of an explosive, complete involvement of the aircraft interior.

9-2.5 Each fire situation will differ; therefore, explicit guidance on fire extinguishing techniques for interior aircraft fires on the ground is most difficult. Normally, if backdraft conditions exist, best results can be obtained by applying an indirect attack utilizing water spray through narrow openings, such as partially opened doors, emergency exits, small openings cut into the fuselage or by the use of penetrating nozzles (*see Figure 9-2.5*). If backdraft conditions do not exist, care still should be taken when advancing spray nozzles to avoid driving the fire into previously uninvolved areas of the fuselage. Multiple points of attack may be more effective. The points of entry and method of attack selected should be dependent upon an evaluation of the interior conditions. For example, observations made through cabin windows, paint blistering on the fuselage, or smoke concentrations can all help identify fire location and intensity. Agents other than water which might be used include medium or high expansion foam, Halon 1301, Halon 1211, carbon dioxide, or all-purpose dry chemical. However, if oxygen systems are damaged which could create an oxygen-enriched at-

mosphere, or total involvement of the interior occurs, water spray should be used to extinguish the fire.



Figure 9-2.5 Aircraft Skin Penetrator Nozzle.

9-2.6 Where it is obvious that fire has extensively involved an aircraft interior and where exposure fire problems do not preclude such action, breaching (forced ventilation) of an aircraft may be necessary as the only practical way to deal with the situation. This may require cutting into the fuselage at selected points (avoiding fuel tank areas and oxygen lines) when the fire has obviously reached concealed spaces behind cabin linings. Breaking windows at strategic points may be sufficient where fire is confined to the main cabin area. Ventilation through the top of the fuselage is difficult to achieve while an interior fire is in progress. An elevated platform device may be required as a stable position to perform this task. (See *Appendix D*.)

9-2.7 Priority attention should be given to applying water spray or foam streams over fuel-containing portions of the aircraft. Wing structures and fuselage fuel tanks which are exposed to heat or flame should be cooled whenever possible. Available foam products should be conserved for use if, and when, fuel does escape from the tanks.

9-2.8 Fire fighting crews must use positive pressure, self-contained breathing apparatus whenever entering a burning aircraft. Dangerous concentrations of toxic gases, such as hydrogen cyanide, phosgene, carbon monoxide, etc., are produced by the burning or charring of cabin interior materials.

9-2.9 Fire extinguishment operations dictate prompt ventilation of the cabin interior. During the overhaul phase of the fire, hose lines should remain charged and available to deal with any deep-seated fire, hidden fire or

re-ignition. A thorough investigation should be made to assure that the fire has not extended into concealed spaces within the aircraft.

9-3 Hot Brakes and Wheel Fires.

9-3.1 The heating of aircraft tires presents a potential explosion hazard especially when fire is present. Good judgment must 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., shutdown of engines, extending flaps, evacuation preparation, etc.).

9-3.1.1 In order to avoid endangering the fire fighters and aircraft occupants and cause undue 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.

9-3.1.2 When a hot brake condition occurs on a propeller-driven aircraft it is usually beneficial to keep the propeller forward of the wheel turning until the brakes have cooled. Larger modern aircraft have fusible plugs mounted in the wheels which melt around 300°F to 400°F, allowing the tires to deflate before dangerous pressures develop due to heat.

9-3.2 When working at a wheel fire emergency, fire fighters should remain clear of the sides of the wheel assemblies that are in line with the axles. An approach should be made only in a fore or aft direction of the wheel. Since heat is transferred from the brake to the wheel, extinguishing agent should be applied to the brake area. The primary fire fighting objective is to prevent the fire from spreading upward into the wheel wells, wing trailing edges and the fuselage.

9-3.2.1 Foam, waterfog and dry chemicals are effective for direct application on brake fires. In an emergency situation, however, availability may dictate the type of extinguishing agent used.

9-3.2.2 Dry chemical agents and Halon 1211 may extinguish fires involving hydraulic fluids and lubricants but reignition may occur since these agents lack sufficient cooling effect. Halon agents, notably Halon 1211, are particularly effective in extinguishing undercarriage fires. Halon 1211 permits application from a safer operating distance.

9-3.2.3 Where magnesium wheel components are involved in fire, Halon agents should not be used.

9-3.2.4 Effectiveness of any gaseous extinguishing agent may be severely reduced if wind conditions are such that sufficient concentration cannot be maintained to extinguish the fire.

9-3.3 Solid streams of water or carbon dioxide should be used only as a last resort on wheel fires since the rapid cooling may cause an explosive failure. Fires involving magnesium wheels, however, 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, thus extinguishing the fire. Fire fighters should exercise extreme caution when this method of extinguishment is used, as explosive failure of the wheel components is likely.

9-4 Aircraft Fuel Servicing Fires.

9-4.1 The record of aircraft fires occurring during aircraft fuel servicing shows that there are a number of these incidents. Ignition has been caused by flowing fuel, surface-generated static within an aircraft fuel tank or refueling vehicle, defective fuel pumps, existence of an external source of ignition, and other improper fueling procedures. Enforcement of fire prevention standards and supervision over equipment maintenance is a vital concern. Defueling and fuel transfer operations can also introduce serious fire potentials.

9-4.2 Fuel spills exterior to the aircraft should be handled in the manner described in NFPA 407, *Standard for Aircraft Fuel Servicing*, if ignition does not immediately occur. Following ignition, such fires are handled in a manner similar to that occurring in any other kind of aircraft accident with primary emphasis on any life safety problems that may exist. This is followed by controlling the fire before damage can occur to the aircraft, particularly the fuel-containing wing structures and main fuselage, or any adjacent structures or aircraft. The practice of fueling transport category aircraft while passengers are aboard necessitates that, in event of a fuel spill fire, an immediate check of aircraft cabins should be conducted for any occupants.

9-4.3 A number of incidents have occurred starting with wing fuel tank explosions caused by faulty fuel pumps, surface static discharges, and improper maintenance practices. Results of such ignitions are variable depending on the forces involved but are frequently followed by subsequent explosions in adjacent fuel-containing structures and extensive fuel spills. Turret foam streams on fuel-fed fires and/or protective water curtains to cover exposures may be needed when such events occur in the proximity of terminal or hangar structures.

9-4.4 Many transport category aircraft have ganged fuel tank vents near wing tips. Vented JET A-type fuel vapors (kerosene grades) normally present very little hazard; however, if tanks are overfilled because of improper procedures, the fuel is likely to discharge from such vents causing a fuel spill. With JET B-type fuels, there is a greater potential for a flammable vapor-air mixture being present in the immediate proximity of such vents. Vehicles should not be positioned within a 3-m (10-ft) radius of aircraft fuel system vent openings.

9-5 Tail Pipe Fires.

9-5.1 Tail pipe fires often occur during engine start due to wind conditions or malfunctions of the ignition or fuel systems. Most of these fires do not cause damage and are rapidly extinguished by the flight crew. If, however, the fire persists, fire fighters should, if time permits, consult with the flight crew before taking any action.

9-5.2 If discharge of an extinguishing agent is required, the aircraft operator should be advised of the type of agent used so that appropriate inspections for damage can be made.

9-5.3 When tail pipe fires occur in the elevated center engine of three-engine wide-body aircraft or B-747 auxiliary power unit, special elevating equipment may be required to effectively discharge agent on the fire (*see Appendix D*).

9-6 Operational Hazards to Fire Fighters.

9-6.1 Some modern jet aircraft are equipped with Ram Air Turbines (RAT) designed to provide backup electrical and hydraulic power during in-flight failure of the primary systems. Often these devices are designed to deploy from flush fuselage or engine-mounted storage with explosive force. Fire fighters should become aware of aircraft employing these systems and their locations. Serious injury could result should this device accidentally deploy and strike a fire fighter during emergency operations. (*See Figure 9-6.1 for typical RAT installation.*)

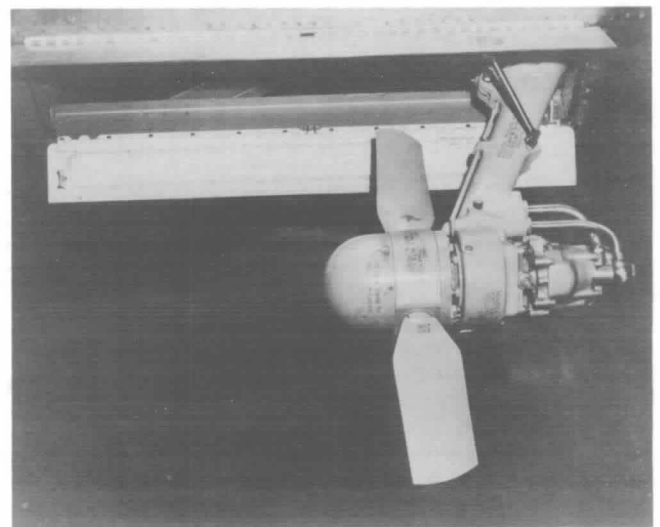


Figure 9-6.1 Ram Air Turbine (RAT).

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

9-6.2 At a fire involving some part of an undercarriage assembly, there is a risk of undercarriage collapse or the explosive disintegration of the affected components. It also should be noted that steerable nose wheels and castoring multi-wheel bogies can produce wheel and axle alignments which are not always at right angles to the longitudinal axis of the fuselage. Therefore, the overall aim should be to avoid operations beneath the aircraft and to remain clear of other potential hazard areas.

9-6.3 Caution should always be used in the placement of vehicles and personnel as the possibility of an unannounced evacuation of the aircraft always exists. Deploy-

ment of evacuation slides from exits could injure a fire fighter in their path and, if a vehicle were positioned too near an opening, the slide would be rendered useless or evacuating passengers could be seriously injured.

9-6.4 Fire fighters should also conduct their operations from positions which minimize the risk of injury if an explosion occurs. Extinguishing agent should be applied so as to avoid spot cooling of a heated component which may lead to stress failure and disintegration. Choice of agent will be dependent on availability but, if possible, spray streams of water should be employed so that a more even surface cooling can be achieved. The short-range application of carbon dioxide should be avoided as ice particles can cause rapid spot cooling of surfaces. Dry chemical or halogenated agents may extinguish fires involving hydraulic fluids or lubricants but they lack the cooling and securing effect necessary to prevent the reignition.

9-6.5 Complete protective clothing and equipment should be worn when approaching all aircraft incidents regardless of whether or not a fire is believed to exist. Hydraulic fluids may be escaping at very high pressure, which can cause serious injuries to the eyes or result in other physiological damage if inhaled, ingested, or injected into the skin. Any contamination sustained from any source relating to aircraft systems should be treated as soon as possible under competent medical supervision.

Chapter 10 Military Aeromedical Evacuation, Air-Ambulance Aircraft, and Scheduled Carriers with Nonambulatory Passengers

10.1 General.

10-1.1 When occasions demand military aeromedical evacuation, aircraft utilize airports normally serving commercial or general aviation only. Although, at this writing, there is no established criteria for the handling of air-ambulances, a term for civilian aircraft engaged in the transporting of the sick or injured, each day brings closer a demand for the special protection requirements recommended for these specialized transport aircraft.

10-1.2 Recent regulatory and policy changes by governments and airlines relative to transportation of the physically handicapped have resulted in an increase in the numbers of nonambulatory passengers permitted on scheduled carriers, e.g.,

B-747	12 nonambulatory passengers
L-1011	10 nonambulatory passengers
DC-8	8 nonambulatory passengers

Additional nonambulatory passengers may also be carried providing they have personal attendants, resulting in up to a total of twenty-four (24) nonambulatory passengers on a B-747.

10-1.3 If requested, the following procedures for the protection of air-ambulance aircraft should be observed when nonambulatory or litter patients are aboard aeromedical evacuation aircraft:

(a) Prior to the takeoff of an aeromedical or air-ambulance aircraft containing nonambulatory or litter patients, 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 commander should report the number of litter and or nonambulatory patients aboard and request that aircraft rescue and fire fighting vehicles be alerted.

(c) One or more vehicles, as the situation warrants, should be strategically positioned for the landing. Upon landing of the aircraft, at least one vehicle should follow the aircraft to its parking position and remain in that position during transferral of patients. The normal position for following is to the aft and off the wing tip of the off-loading side of the aircraft.

(d) If the aircraft is to be refueled, or any minor difficulty was experienced prior to landing and/or parking, a fire fighter should stand at the exit side with a charged hose line.

(e) If an emergency is declared by the aircraft commander prior to landing, all available fire fighting and rescue personnel and equipment should respond to strategic standby positions, regardless of the potential significance of the emergency.

(f) If an anticipated crash alert is received, the action described in Part I, 3-3.6 (Cabin Fires) and 9-2.5 should be implemented.

Chapter 11 Foaming Runways for Aircraft Emergency Landings

11-1 General.

11-1.1 After many years of analysis of available data, coupled with the observation of perceived benefits of runway foaming, it has been concluded that intentional wheels-up landings of jet aircraft can be accomplished as safely on unfoamed runways as they can on foamed runways. Runway foaming, however, may provide a degree of safety when an aircraft is forced to land with a malfunctioning nose gear.

11-1.2 Protein-based foam is the only foam suitable for runway foaming. Aqueous Film Forming Foam (AFFF), because of its drainage characteristics, is not considered suitable.

11-1.3 A nose gear stuck in the retracted position is often the result of broken hydraulic lines. Spilled hydraulic fluid can ignite in the wheel well due to the presence of friction sparks and runway foaming may successfully suppress the ignition potential.

11-1.4 When the nose gear is extended but cocked, the foam blanket should permit the wheel to hydroplane, reducing the possibility of gear shearing, and enable the pilot to keep the aircraft on the runway.

11-1.5 Runways which are either grooved or coated with porous friction course material or process intended to facilitate water drainage, and reduce hydroplaning in inclement weather, should not be used for runway foaming service. The improved drainage characteristics create a wet surface wetting, and use of foam in this condition.

11-2 Operational Considerations of Runway Foaming.

11-2.1 Initiation of a request to foam a runway should be a joint operational decision. The request to take such action should first come from the person in command of the aircraft or the aircraft operator after the consideration of the capability of the airport to provide runway foaming, within the time available.

11-2.2 Determination as to the feasibility of foaming a runway is a joint decision between the airport authorities and the aircraft operator. Receipt of the official request for assistance from the pilot or operator requires consideration of the overall fire protection and all other airport operational problems. For example, will aircraft operations continue elsewhere on the airport? What circumstances may cause the pilot to make an emergency landing prior to the completion of the foam laying operation? What effect will it have if the foam making vehicles have not been replenished prior to the landing? In any case, it is essential that the minimum aircraft rescue and fire fighting vehicles recommended in NFPA 403, *Recommended Practice for Aircraft Rescue and Fire-Fighting Service at Airports and Heliports* be maintained in fully operational condition to perform their emergency function. Therefore, when runway foaming is to be provided as a matter of policy, specially designed equipment should be provided and maintained.

11-2.3 Communications should be maintained between the officer responsible for the foaming of the runway and the pilot of the distressed aircraft to assure full understanding and knowledge of the operating plans and the dimensions of the foam blanket.

11-2.4 Primary aircraft rescue and fire fighting vehicles as recommended in NFPA 403, *Recommended Practice for Aircraft Rescue and Fire-Fighting Service at Airports and Heliports*, should not normally be used to foam runways. They could be used, however, if the number of such vehicles held in reserve is sufficient to provide the minimum protection recommended. Auxiliary tank trucks equipped to dispense protein foam through ground sweep nozzles, special boom nozzles, or other additional special foam laying equipment may be used for runway foaming. See *Appendix D*.

11-2.5 A realistic operational preplan should be established to work out the scheduling of the foam laying operation and the vehicle reload requirements. Adequate extra quantities of protein foam concentrate should be prepositioned and arrangements made for rapid vehicle

reservicing. Periodic operational drills should be conducted to assure effectiveness of the preplan and proper performance of the foam laying equipment.

11-2.6 Experience has shown, and should be recognized, that, when making a nose gear up landing, the aircraft nose contacts the runway much further from the threshold than normal.

11-2.7 When visibility conditions are such that the pilot cannot distinguish from the air where the protein foam on the runway starts, a reference point should be established that is easily distinguishable. A clear indication of where the foam pattern has been laid is needed to aid the pilot in positioning the aircraft for the landing.

11-2.8 All unnecessary persons, including the news media, should be required to stay clear of the landing area until evacuation is completed, occupant counts have been accomplished and full fire control and fire preventative measures taken. This function should be preassigned to airport police or guards and may be augmented by local police and volunteers.

11-2.9 For a defective or cocked nose wheel with main gear fully operational, the foam pattern should be approximately one half the width of the total main gear tread, but not more than 5 m (10 ft). It should follow the center of the runway, begin at a point agreed by the pilot (usually further down from the threshold than for a normal landing), and run continuously the full length of the projected landing zone. It is essential that the main gear track remain clear of the foam area to ensure full braking capability of the aircraft.

11-2.10 The protein foam should be aged prior to use for a period of ten to fifteen minutes to permit water to drain from the foam and create effective runway surface wetting within the foam pattern. Aging should not be longer than thirty-five (35) minutes prior to use on a hot summer day due to excessive drying and water loss.

11-2.11 Depth of the protein foam should preferably be 2 in. (50 mm) to achieve even distribution and so that the foam has good holding characteristics (capable of holding the water at the runway interface without excessive drainoff due to runway slope or because of its "crown"). Protein foam expansions of eight to twelve appear to be satisfactory for this purpose.

Due to variations in foam-metering devices, possible inaccurate proportioning of the protein foam liquid concentrate, and the varied characteristics of local water supplies, and to ensure a stiffer foam, it is normally prudent to increase the amount of protein foam-liquid concentrates to above those theoretically required. For example, a ten percent protein foam-liquid concentrate for the six percent type and five percent for the three percent type. Figures on protein foam-liquid concentrate quantities are based on forming a 2-in. (50 mm) depth of finished foam.

11-2.12 Following foam-laying operations, airport fire crews should leave the aircraft operational runway and take up standby positions out of range of all collision

hazards. After the aircraft touches down, rescue and fire fighting vehicles should follow the aircraft and be ready to operate. It is extremely important that all other vehicles remain clear of the immediate vicinity of the aircraft to permit rescue and fire fighting vehicles to maneuver as the need dictates.

PART II — STRUCTURAL FIRE DEPARTMENTS

Chapter 1 Administration

1-1 Scope.

1-1.1 Part II of this manual provides recommended aircraft rescue and fire fighting operational procedures for structural fire departments using available apparatus, equipment, and resources.

1-1.2 The types of aircraft for which these procedures are designed are those involved in nonmilitary operations.

1-2 **Purpose.** Part II of this manual is intended primarily for the guidance of structural fire departments to assist them in the preplanning and training required to effectively handle aircraft accidents occurring within their jurisdiction. It is also intended to establish a basis for understanding the aircraft rescue and fire fighting problems on airports which would enhance their effectiveness in mutual aid responses to on-airport incidents.

1-3 General.

1-3.1 These procedures cover what structural fire departments should be able to accomplish when they encounter an aircraft accident and must handle the incident using structural fire fighting apparatus and equipment. The recommendations also provide techniques for utilizing resources that are available to most structural fire departments. Emphasis is placed on aircraft occupant rescue and fire control. Aircraft fires require extinguishing agents and fire fighting techniques common to other Class B fires, such as tank truck and fuel storage fires. Structural fire fighters should, therefore, be trained to effectively combat these types of fires utilizing available equipment and extinguishing agents. **IT IS IMPERATIVE THAT STRUCTURAL FIRE DEPARTMENTS LOCATED NEAR AIRPORTS OR AIRCRAFT FLIGHT PATHS BE THOROUGHLY FAMILIAR WITH THE PROCEDURES AND RECOMMENDATIONS IN PART I OF THIS MANUAL.**

1-3.2 The recommendations presented herein should not be interpreted as a substitute for adequate airport-based crash-rescue and fire fighting services as outlined in NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports*.

1-3.3 Fire departments located adjacent to airports should take particular care to implement these recommendations and should participate in the airport emergency preplan with the appropriate airport authority. The structural fire department's services should be made available to the airport during any special events (e.g., air shows) or during periods of unusually heavy aircraft traffic. Since no community is immune to an aircraft accident, all fire departments should implement effective preplanning and training for this type of incident.

1-4 Aircraft Familiarization.

1-4.1 Structural fire departments should take seriously the need to preplan for aircraft accident emergencies. Knowing pertinent facts about different aircraft will, in the event of an incident, expedite the speed of fire control, thus permitting effective rescue operations.

1-4.2 Fire departments located adjacent to airports should contact the airport fire department to arrange for qualified persons to take fire fighters through the various aircraft using the airport. When inspecting aircraft, the following facts should be noted: location of fuel, hydraulic oil, lubricating oil and their storage capacities; seating arrangements; passenger and emergency exits; emergency hatches and windows and how they can be opened from both inside and outside. Important also are the locations of batteries, oxygen storage and various system shutoff controls.

1-4.3 Fire departments should avail themselves of crash crew charts of all aircraft using the airport. Airlines and aircraft manufacturers provide these charts which depict all the pertinent information mentioned above (see *Appendix B*).



Figure 1-3.1 On April 4, 1978, a DC-9 with 85 persons on board 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 twenty-three on the aircraft and limiting further property loss to exposures.

Chapter 2 Basic Fire Control

2-1 General. The primary hazard associated with aircraft accidents is that liquid fuels may be released to the atmosphere and ignited during the accident sequence. A secondary hazard is that fuels released but not ignited during the accident sequence could subsequently be ignited prior to or during the egress of occupants of the aircraft. In addition, fires involving ordinary combustible materials, such as seat cushions, galley equipment and electrical system components, may occur. Further complications could result if the aircraft comes to rest in such a manner that forcible entry into the fuselage may be required.

2-2 Basic Fire Control Methods. The following facts should be understood regarding basic aircraft fire control methods. Specific implementation will depend upon the fire fighting equipment and types or quantities of agents available to individual fire departments.

2-2.1 Aqueous Film Forming Foam (AFFF) concentrates, fluoroprotein foam concentrates, or protein foam concentrates properly proportioned into fresh water are more effective than plain water when facilities are available for the bulk discharge of such foaming agents at rates designed to secure control of large area fuel spill fires of the type commonly experienced in aircraft accidents. At off-airport accident sites, however, it is most likely that water only will be available in quantity for bulk discharge utilizing structural apparatus. Foam-liquid concentrates may be added to the water discharge with beneficial results if the necessary proportioning and discharge equipment is available.

2-2.2 Water Available in General Quantities from Established Underground or Surface Sources, Supplied by Pumps.

Water should be applied as a spray from at least 1½-in. or 2½-in. lines at approximately 100 psi nozzle



Figure 2-2.2 Photo shows a variety of typical spray nozzles currently used by structural fire departments. All have the feature of adjustable spray patterns from straight stream through a ninety-degree cone. Most fire chiefs agree that a nozzle setting of thirty degrees provides the best pattern for flammable liquid fire fighting with water or AFFF solutions.

pressure on any burning liquid fire resulting from the accident.

Master streams from deluge sets, deck guns, or ladder pipes may be used to cover exposures.

Straight streams should not be aimed into burning flammable or combustible liquids as this will accelerate burning and spread the fire to exposures. Straight streams should only be aimed into burning liquids when the objective is to wash such burning liquids away from the aircraft fuselage to the perimeter of the area when no exposures are jeopardized. Straight streams can also be used advantageously to cool the aircraft fuselage when radiated heat is too intense to approach using fog patterns. This may prevent the fuselage burning or melting through.

On hard surfaces such as asphalt or concrete, large straight streams can be used effectively to sweep both burning and nonburning fuel spill away from exposed areas.

2-2.3 Water Available on Apparatus Only.

Water should be applied from 1½-in. lines at approximately 100 psi nozzle pressure on any burning liquid fire resulting from the accident.

Straight streams should be avoided since their use frequently accelerates burning of flammable or combustible liquids and can spread the fires to exposures. Straight stream discharge also usually requires more water.

With only limited water available on responding apparatus, a supplemental source of water should be established from either a hydrant, static water supply source, or tank vehicles.

2-3 Portable Extinguishers. Portable carbon dioxide, dry chemical, foam, or halon extinguishers approved for Class B fires 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 the hose streams. NFPA 10, *Standard for Portable Fire Extinguishers*, should be consulted for guidance on the use of such portable fire extinguishers.

In some instances, bulk supplies of carbon dioxide, dry chemical, foam or halon are made available to fire departments by local suppliers on an emergency basis. This resource should be considered when preplanning for aircraft accidents.

2-4 Foam-Liquid Concentrates. Use of a foam concentrate and foam proportioning equipment will increase the effectiveness of the available water supply in controlling and extinguishing flammable or combustible liquid fires or to prevent such liquid spills from igniting. The concentrates can be used in one of the following ways:

2-4.1 General Application Rules. Techniques for application of foam vary with the foam-liquid concentrate used. Protein and fluoroprotein foam solutions should be applied with a nozzle pressure of about 100 psi. 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.

2-4.2 Protein and fluoroprotein foam solutions may be applied holding the nozzle in a low, horizontal plane, moving it from side to side gradually and smoothly (at an even rate) to progressively coat the burning fuel or spill with a visible blanket of foam until the fire is extinguished or the spill is covered. As fire conditions and equipment permit, a dispersed pattern would promote more rapid extinguishment.

2-4.3 Aqueous Film Forming Foam (AFFF) solutions may be applied with foam handling nozzles or with water spray nozzles. Straight streams from a variable spray nozzle can be used by a skilled fire fighter for initial knockdown of the fire, but a spray pattern of approximately thirty (30) degrees is recommended to minimize fuel surface disruption, reduce vapor release and achieve rapid extinguishment. A more rapid sweeping motion can be used in applying AFFF than with protein-based foam, but the blanket produced should be of such thickness as to be visible before it is assumed to be capable of suppressing fuel vapors. The blanket should not be relied upon to be permanent and should be renewed as required.

2-4.4 Foam-liquid concentrate may be drawn into the water stream directly from a foam-liquid concentrate container by means of a pickup tube. This can be accomplished by using: (1) a nozzle with a built-in eductor, or (2) by using an in-line eductor (proportioner). The eductor may be of the fixed capacity type or of the selective orifice type. The device should be chosen or set to meter the correct solution rate [three (3) or six (6) percent].

2-4.5 To use an eductor nozzle, the pickup tube is inserted into the concentrate supply container once the proper nozzle pressure is reached (usually 100 psi). (See Figure 2-4.5.) A hose line shutoff butt may be used between the eductor nozzle and the working end of the hose line. The nozzle operator, in order to be mobile and dispense foam in the most effective manner, requires the assistance of at least one fire fighter to operate the pickup tube, open cans of agent and assist in advancing the agent supply hose.

2-4.6 The use of an in-line eductor (line proportioner) offers an alternate attack method with the following procedural guidelines:

(a) The eductor must be properly matched with the foam nozzle to obtain the proper solution concentrations and foam quality.

(b) If the eductor has a variable orifice, the proper setting for the concentrate being dispensed should be selected (e.g., 3 percent or 6 percent).

(c) The working range of the eductor is usually between 75 to 200 psi and, ideally, 125 to 150 psi at the inlet.

(d) A positive action check valve should be provided between the eductor and pickup tube. This will prevent dilution of foam concentrate in the supply container if the hose stream is shut off at the nozzle.

(e) The eductor should be manned to provide a constant supply of foam. The in-line eductor provides the nozzle operator greater freedom of movement, but team-

work is essential with a fire fighter at the eductor to ensure continuity and the safety of the entire operation. Possible arrangements will vary with the specific in-line eductor utilized. With some models, the eductor can be positioned as far as 150 ft upstream from the nozzle.

2-4.7 Around-the-Pump Proportioners. Many structural pumpers now utilize "around-the-pump proportioners" installed on the trucks. This equipment generally is more versatile in respect to operation with long hose lays or changes in elevation. The systems also may be capable of operating at variable concentrations of foam concentrate. Periodic practice is required to assure that metering systems and foam tank resupply methods will produce optimum results when called upon.



Figure 2-4.5 Foam Eductor and Equipment.

2-5 Premix Solutions.

2-5.1 AFFF Premix Solution. If a proportioning device is not available, AFFF concentrate may be mixed in a fire apparatus water tank or in a folding tank and the foam can then be applied through conventional hose lines and spray nozzles. To create a solution in a truck tank, drain an appropriate amount of water from the tank to accommodate the concentrate required. A conventional (1½-in.) spray nozzle set at a thirty (30) degree cone may be used for application.

2-5.2 Premix Solution — Protein and Fluoroprotein Foams. A premix solution using protein or fluoroprotein foam can be made up in the following manner: After draining the appropriate amount of water from the tank, add the required 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 water through the pump and tank to ensure a good mix. It is essential when using protein or fluoroprotein foams to use a conventional air-aspirating nozzle for application. After use, any unused solution should be flushed out before refilling the water tank for regular use.

2-6 Medium Expansion/High Expansion Foams. Medium or high expansion foams may be useful in controlling interior cabin fires in unoccupied parked aircraft. An exit point for displaced air and combustion products remote from the foam entry point should be provided. Where possible, fresh air should be supplied to the foam generator as combustion products tend to break down the foam.

2-7 Special Combined Agent Equipment. Some fire departments may have purchased combined agent equipment for special services (such as for expressway and turnpike motor vehicle accidents). Some are equipped with a dry chemical or halon (for quick knockdown) and a foam (for securing the fire). One such effective combination utilizes a potassium bicarbonate based dry chemical and aqueous film forming foam (AFFF) premixed solution dispensed through twin agent nozzles. Such combined-agent equipment must use agents which are mutually compatible to avoid any breakdown of the foam.

Chapter 3 Aircraft Construction and Hazards

3-1 General. Fire fighters 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. Penetrating aircraft surfaces may sometimes be difficult and time consuming, which can vitally affect successful fire fighting and rescue operations.

3-2 Aircraft Construction Materials.

3-2.1 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 and will not withstand heat or flame exposure for a very long period. It will melt under the exposure conditions found in aircraft fires. For this reason, it is essential to keep fuselage surfaces cool prior to completion of rescue operations as otherwise the occupants will be subjected to direct fire exposure.

3-2.2 Magnesium alloys are used for landing gear and wheels, engine mountings, brackets, crankcase sections, coverplates and other engine parts. The appearance of this metal is silvery white or grayish. It is about two thirds the weight of aluminum. This metal introduces a serious additional problem in fire extinguishment when it ignites in an aircraft fire. While it is not easily ignited, ignition is dependent on its mass, thickness and shape. When it is ignited, it burns violently and cannot be extinguished readily. Thus, it presents a serious reignition source if flammable vapors are present. Magnesium friction sparks developed when in contact with paved surfaces, as might occur in a wheels up landing, have the capability of igniting flammable vapors. Where special magnesium extinguishing agents are not available, water in coarse, heavy streams provides 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 hazard areas.

3-2.3 Steel is used in engine parts, around engine nacelles to increase the fire resistance of the nacelle, for engine fire walls, and for tubing and structural framing on fabric aircraft. It presents no fire hazard nor does it contribute to a fire except that it may 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 saws, but it is a time-consuming and potentially hazardous operation in the presence of flammable vapors. Stainless steel may be found on some fuselage surfaces of jet aircraft.

3-2.4 Titanium is used primarily in engine parts, (e.g., turbine blades), nacelles and for engine fire walls. This metal 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 and other liquids are ineffective. Turbine engine fires involving titanium cannot normally be extinguished by external fire fighting techniques within the time period necessary to effect rescue operations. Where encountered during evacuation, such burning engines should be shielded from the escape path. Titanium metals are a friction spark hazard when the metal is in contact with a paved surface as during a wheels-up landing. If flammable vapors are present (as might be the case in an accident), this spark hazard can be serious. Titanium surfaces are most difficult to cut or penetrate, even with power equipment. Attempts should not be made to cut through titanium with a manual cutting axe as the risk of injury from the axe rebounding is severe.

3-2.5 Fabric is used as skin surfaces over metal or wood framework or over plywood surfaces. This is commonly used on many personal light aircraft. It is extremely combustible and some dopes used for shrinking and waterproofing are cellulose nitrate-based materials.

3-2.6 Composite Structures. To improve the payload vehicle weight ratio without compromising structural strength, increasing use is being made of composite materials made of small, fine fibers embedded in epon epoxy materials. The fibers usually are boron, fiberglass, aramid, or carbon in the form of graphite. These composite fiber-plus-plastic materials have replaced many aircraft components. Composite materials do not present unusual fire fighting problems from the standpoint of extinguishment.

3-2.7 Cabin Interior Materials. Most aircraft seating is made of polyurethane materials. Vinyl plastics are used in some furnishings. These materials, when heated, emit high concentrations of toxic gases. When these conditions exist, self-contained, positive pressure breathing apparatus must be worn.

3-3 Aircraft Structural Precautions.

3-3.1 Wing to Fuselage Mountings. In some aircraft where the wing joins the fuselage, there is no substantial fire wall to provide for the desired separation. As all aircraft have wing tanks, many without separate metal tanks or bladder tanks within the wing cavities, the existence or absence of this fire barrier is very important. Some air-

craft also have fuel in the center wing section which, in effect, places fuel storage within the fuselage. It is thus possible for fuel or vapors from damaged tanks to leak into the fuselage. Such leakage increases the danger of ignition within the aircraft and increases the hazard to the air crew and passengers.

3-3.2 Landing Gear Strut. A wing tank located directly above or on the side of the mounting for the aircraft's landing gear may constitute a serious hazard. If the landing gear strut is dislocated in crash landings or ground loops, it may be driven upward or sideways and penetrate the wing tank.

3-3.3 Aircraft Piping and Electrical Wiring. Throughout most aircraft there is extensive piping to carry fuel, hydraulic and lubricating oils, oxygen, anti-icing fluids, alcohol, etc., and a great deal of electrical wiring. If these lines break or fail, they can be the source of a fire, constitute an ignition source or, in the case of escaping oxygen, intensify a fire. While not of the same order of magnitude as the potential of a fuel tank failure, many aircraft have been destroyed because of difficulty with piping or electrical systems. To aid in the installation and maintenance of aircraft, color banding is used to identify the various piping systems. Fire fighters should know this color-coding scheme and should use proper caution when they are confronted with such piping while making entry into a damaged aircraft. The color codings used are shown in Appendix G.

3-4 Aircraft Access and Openings.

3-4.1 Doors or Hatches for the Regular Use of Aircraft Personnel. Doors on most unpressurized aircraft open outwards; doors on old pressurized aircraft either open inward or push in and slide aft; on current turbine-powered pressurized aircraft, the doors push in slightly, then pull out (known as plug-type doors) or retract upwards into the ceiling. Most of the current turbine-powered transport category aircraft have inflatable evacuation slides attached to the door; if the slide is actuated automatically or by the aircraft crew or occupant (normally by a handle to release the contents of a compressed gas cylinder), the slide extends in less than fifteen (15) seconds with considerable force. Fire fighters should exercise caution when positioned directly outside the door. (See Appendix B for illustrations of this type aircraft evacuation equipment.)

Chapter 4 Extrication and Rescue Tools

4-1 General.

4-1.1 The seating arrangement of a transport aircraft will determine the number of people it will carry. Fire fighters should be aware that the density of the seating in air carrier aircraft varies between cabin sections (first class vs. coach) and between carriers. In military aircraft, the location of crew members will depend on the type

(fighter, bomber, etc.) and can sometimes be determined by the exterior design (location of canopies, gun positions, etc.).

4-1.2 Aircraft involved in ground accidents may come to rest in almost any attitude. Any abnormal landing force can jam regular and emergency access and escape openings. In other cases, the fuselage may be broken open by the impact forces or doors and windows can be dislodged. It is difficult to anticipate the various accident conditions that can be encountered and each accident presents different rescue and fire control problems. Survivable accidents, where at least one person survives the impact forces, are most frequent when an aircraft is under a degree of pilot control prior to impact. Even in these cases, disarrangement of the aircraft can be severe, necessitating improvisation of rescue efforts. Therefore, fire fighters should be skilled in the use of appropriate tools for emergency access to aircraft.

4-2 Forcible Entry Tools and Equipment. The following pictures show some of the tools designed for emergency access into aircraft.

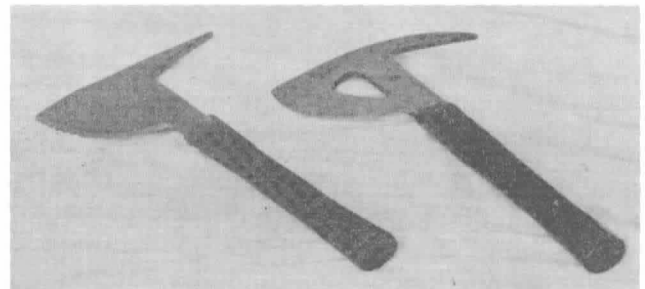


Figure 4-2(a) Crash Axe.

Crash Axe. This axe is normally found on all military and commercial aircraft. This is a handy cutting tool and will cut light metal sheets, light stringers, wood, light cables, wires, fabric, and will break some thicknesses of plexiglass (strike at or near corners).

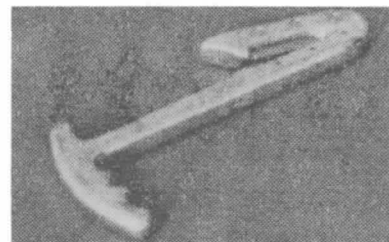


Figure 4-2(b) Parachute Harness Knife.

Parachute or Harness Cutting Knife. This knife can easily cut webbing and safety belts without danger to persons being rescued. An upward pull on the knife wedges the webbing against the blade and cuts it in the process.

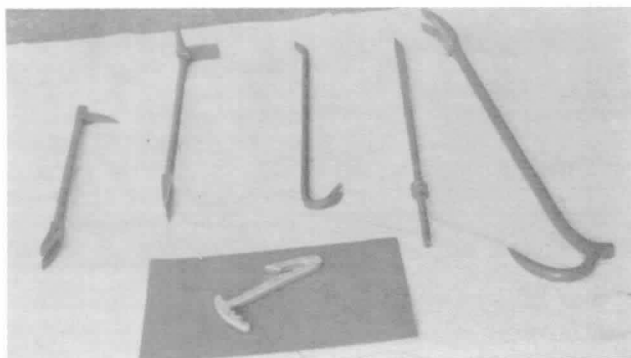


Figure 4-2(c) Other Tools.

Other Tools. Claw tools and pry tools, such as the Halligan and Kelley tools, are recommended for forcing open doors and emergency exits that may become jammed when an aircraft crashes. These tools are small and compact and can be used in confined quarters.

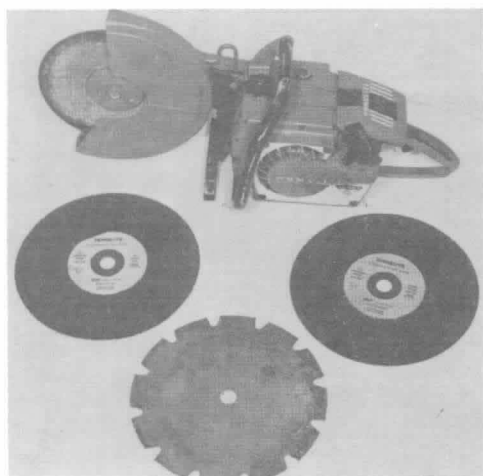


Figure 4-2(d) Rescue Saw.

Rescue Saws. A multipurpose saw can be useful for cutting through most aircraft structural materials. Caution should be exercised so that hot metal sparks do not ignite exposed fuel vapors.

4-3 Areas for Cutting into Aircraft. If cutting of fuselage skin is the only means to remove trapped personnel, the following should be observed:

4-3.1 Most low-wing general aviation aircraft and fixed-wing aircraft with reciprocating engines may be cut in the area above the windows from the hatrack line to the top of the fuselage without severing wires, cables, or tubing or coming in contact with heavy construction.

4-3.2 Turbine-powered (jet and turbo-prop) aircraft have heavier skin and structure than the older reciprocating engine aircraft. Most designs also incorporate rip stoppers. Due to this heavier construction, it is almost impossible to use hand tools to cut into the fuselage during a rescue operation. The only practical method of entry, other than using normal or emergency exits, is through the use of portable power tools. These

power tools take the form of electric-, pneumatic-, hydraulic-, or gasoline-powered saws or portable shifting tools [see Figure 4-2(d)]. They can best be used to cut areas around any normal or emergency exits which might be jammed or rendered inoperable by the impact forces. On these aircraft, cutting any other area may result in severing fuel and oxygen lines, wires or cables.

4-4 Military Aircraft. Military, combat-type aircraft present additional hazards due to jettison equipment and ejection seat mechanisms. Their armament may consist of guns, cannons, missiles, rocket engines and nuclear weapons. This type of aircraft is always assumed to be armed. Fixed guns or rockets may be found on many types of military aircraft and caution should be used to stay away from front of aircraft and out of line of fire. However, unless there is a round of ammunition in the fixed gun chamber or a defect in the firing circuit, there is more of a tendency for the shells to burst in the magazine due to heat. Rockets may be lost upon impact. However, if they are found intact upon their launchers, they should be considered very dangerous, both from the front and the back. If exposed to fire, ignition will occur very rapidly in the rocket motor blowing fire violently to the rear. As with other ammunition, keep rockets cool with water or foam. Further unclassified information can be obtained from commanding officers of the nearest military installation.

4-5 Agricultural Spraying Aircraft and Hazardous Cargo/Dangerous Goods Aboard Aircraft.

4-5.1 Aircraft Used in Agricultural Spraying Carrying Toxic Chemicals. When approaching fires involving these chemicals, the smoke and fumes should be avoided and the downwind area should be cleared at least as soon as rescues have been completed. Any person's clothing or body contaminated by contact with toxic materials should be thoroughly washed with water to reduce or eliminate any harmful effects. Each fire fighter involved in extinguishment or overhaul of such fires should wear self-contained breathing apparatus and complete protective clothing. As soon as possible, each fire fighter should thoroughly scrub down his body and wash the clothing exposed to the chemicals. Special note should be taken that some toxic symptoms might not manifest themselves until several hours after exposure. Should such symptoms occur, medical assistance should be sought immediately.

4-6 Hazardous Materials/Dangerous Goods Warning Labels. (See Appendix C.)

Chapter 5 Fire Fighting Plans

5-1 Objective.

5-1.1 The primary objective in any aircraft accident is assuring the life safety of persons trapped in the aircraft wreckage or in any structure which might be involved.

5-1.2 Operational objectives should be established by the fire officer-in-charge on arrival at the accident scene. Vital operational decisions based on the initial size-up should be made without delay. Realistic objectives are critical and consideration should be given to the equipment and manpower immediately available. The size-up should be continuous throughout the operation to meet changing needs and to best utilize later arriving resources.

5-1.3 An on-scene command post should be established as soon as possible.

5-2 Size-Up.

5-2.1 The size-up process is started by the first responding officer and is carried forward in terms of depth and scope by responding chief officers. Assessments of task and resources are not fixed, but are modified as the event develops and may result in a complete change in objectives. For example, if a reported small aircraft crash turns out to be a small agricultural aircraft with pesticides crashed into a high-density mercantile or residential area, the retrieval of a probable corpse would have less importance than the threat presented to many living people in the vicinity.

5-2.2 The following factors are among those that are important to the size-up process:

Occupant survival is generally limited to accidents where the fuselage has not severely broken up and fire has not developed. Aircraft fires that have been burning for two minutes or more are often lethal due to production of toxic gases, searing of lungs, and finally, flame contact. Survivors may be in a tree, on a ledge, or under a collapsed house. In some instances, survivors may have parachuted and landed at some distance from the crash site.

Environmental and geographical factors have a major impact on response capability. A crash in a wooded area in a December snowstorm presents different problems than a similar crash in the summer dry season. Similarly, time is a factor; a forced landing into a shopping center parking lot has a different fire and life potential at 4:00 am on a Sunday than a similar event at 4:00 pm on a Friday.

Magnitude and nature of the problem. An aircraft crash in a farmer's field may set off a serious field fire; but a crash in a built up area may generate a problem of great magnitude and complex nature. If structures have been impacted, their occupancy, construction type and structural stability should be evaluated. In addition, there should be a prompt evaluation of the probable damage to public utility services including electricity, gas, and water. Because of this probability, it is generally good practice to have a water tanker respond to aircraft crash scenes.

The nature of the aircraft operation at time of the incident. If a crop dusting aircraft accident occurs, the fire department should take steps to limit pesticide contamination. Aircraft crashes on takeoff usually involve large amounts of fuel so steps must be taken to prevent fire or fuel vapors from entering waterways, streets, storm drains and sewers.

5-2.3 Size-up begins with the fire department's first notification of the incident. Multiple calls from various sources in the vicinity of an airport should alert fire alarm personnel of a probable major aircraft accident and warrants an immediate first alarm response. Exact definition of problem and location is unnecessary. A full response is needed to assure arrival at the scene of at least one responding unit despite the likelihood of blocked streets, debris, and traffic. During the initial response, preplans should be activated and all pertinent information should be transmitted to the responding units which can affect the initial size-up. (In some jurisdictions, preplans can be presented on video screens mounted in responding vehicles.)

5-2.4 Fire departments receiving a report of an aircraft experiencing an in-flight emergency in the vicinity of the airport should cause immediate alert and standby of fire forces adjacent to the expected flight path. Fire and police field units should communicate with each other and coordinate their efforts. (Making use of a police helicopter, if available, could help coordinate operations and maintain a communication link between the field units and the control tower.) Should an off-airport accident occur, fire and police units would be in position to take immediate action.

5-2.5 Many situations are possible. In all cases, effective initial size-up begins with the first information received and observations upon arrival at the scene. The size-up process should continue throughout the duration of the incident. As in major structural incidents, effective communications are essential to a successful operation.

5-3 Basic Rescue Plan (Assuming Fire in Progress). Consider first and foremost the survivability of any trapped occupants under existing fire exposure conditions. Operations directed toward positive extinguishment are preferable where size-up justifies this approach as presenting the best chance for accomplishing the rescues. The precise method of attack is the critical decision which must be made immediately upon arrival. Preconnected (1½-in.) lines should be laid into the area selected and utilized to their best advantage until additional layouts can be made and the fire fighting tactics described in Section 5-4 carried out.

5-4 Examples of Strategy and Tactics.

5-4.1 Comparison of Aircraft and Structural Fire Problems.

5-4.1.1 Fire fighters should be very aware that aircraft differ from most other structures in ways that make fire more dangerous for the occupants and for themselves. Aircraft occupants are enclosed, usually in a thin aluminum shell, and are surrounded by large amounts of fuel that can release heat at about five times the rate that develops in the average structural fire. In addition, some aircraft have limited access compartments roughly equivalent to an unsprinklered furniture store of 3,000 sq ft or more. Large aircraft also have hollow wall construction; however, the void is often filled with blanket-type insulation. Fire walls and draft stops are usually nonexistent, except for areas in proximity to the power plants. Where fire separations are designed, such as at galleys

and cargo bays, they are not comparable in fire resistance to the fire barriers used in building construction.

5-4.1.2 In large aircraft and many small models, plumbing, electrical, heating, and cooling services are provided. Consequently, there are aerospace vehicle equivalents of pipe chases, electrical load centers, busbars, etc. The energy handled by these devices is enormous compared to household applications.

5-4.1.3 In addition, there are high 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 violent rupture of tanks and wings.

5-4.1.4 Aircraft also differ from other structures in the critical aspect of stability. Most structures are cubical in shape and collapse in place. Aircraft are cylindrical, conical, and usually on wheels. Therefore, movement, tilting and rotation must be considered. Guy lines, chocks and cribbing may be required when working around damaged aircraft. Current modern aircraft may weight 800,000 lbs or more and can reach an overall height in excess of a five-story building.

5-4.2 A typical training exercise should assume that gasoline or jet fuel is burning around the fuselage and that the persons are trapped inside the aircraft. (See *Figure 5-4.2.*)

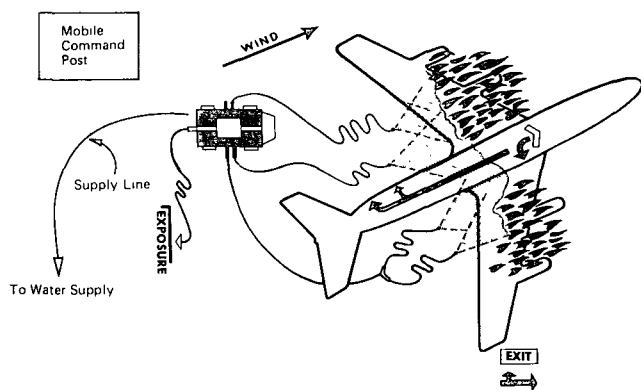


Figure 5-4.2 Example of multiple hand line attack on an aircraft with a severe fuel spill fire and trapped occupants. Note existence of mobile command post upwind from accident site.

5-4.2.1 Approach should be made along the fuselage from the most advantageous direction. Where there is a perceptible wind, approach from the windward side. The slope of the terrain should also be considered. If the aircraft is resting on the side of a hill, approach from the upper side in order to take advantage of gravity in washing the fuel away from the critical area. Fire fighters should be especially alert to vehicle approach techniques and placement.

5-4.2.2 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 if the affected surfaces of the fuselage exposed to flame or heat can be kept wet, the heat input into the occupied portion will be reduced. If, on arrival, the fire has penetrated the fuselage, a direct internal attack should be initiated. Care should be taken to see that water runoff from hose streams does not cause the fire to spread, as this can endanger fire fighters as well as extend the area of fire involvement.

5-4.2.3 Normally, hose streams should be directed along the fuselage (usually from nose or tail section) and efforts concentrated on driving flames outward allowing occupants to escape and permitting rescue entry. Keep the fuselage cool. Occasionally, it may be necessary to blast a rescue entry path from the side perimeter of a spill fire toward a selected fuselage entry point (usually a door). In the latter case, advance should be rapid so that cooling streams might reach the fuselage before occupants are overcome or the fuselage is penetrated by the driven fire.

5-4.2.4 There is sometimes the possibility of diverting pools of burning liquid under or close to the fuselage by cutting drainage channels away from aircraft.

5-4.2.5 All available hose lines should attack the fire from the same general direction. Heat and flame should be driven away from the fuselage while making rescue paths. Crews operating on opposite sides of the fuselage should be cautious not to push fire toward each other. Because prompt action is necessary, the first hose line in operation should be advanced immediately to keep the fuselage cool. Additional lines should be added as they become available and should reinforce the advance of the initial line.

5-4.2.6 The number of hose lines and quantity of water will be determined by the availability of water, equipment and fire fighters. Upon arrival, all lines should be charged regardless of the fire situation. This point cannot be overemphasized.

5-4.2.7 The technique of using multiple spray nozzles with overlapping thirty (30) degree patterns creates a solid mass of water spray. They should be advanced directly to the aircraft. The lower portion of the spray patterns should be kept just above the surface of the ground to avoid stirring up the fuel which increases the risk of reignition. The burning vapors should be "swept" off the surface of the fuel spill. This procedure will open an area for rescue. The advancement to the nose or tail section depends on wind direction. Hose lines should be advanced with the wind at the fire fighters' backs as greater reach is obtained with the spray streams, and less heat exposure is experienced. Fire fighters can also monitor their progress if the attack is made from the upwind side with the smoke moving away from them. If there is an adequate water supply, a large fog nozzle attached to a deck gun or a portable deluge set may be used to keep the fuselage cool.

5-4.2.8 A procedure preferred by some fire departments is to have an additional hand line operator with a spray nozzle to protect the rescue team through the entire operation. Two fire fighters wearing self-contained breathing apparatus follow the hand line operators to assist evacuating passengers, begin forcible entry or enter the aircraft for ventilation and physical rescue, if necessary.

5-4.3 Protein, fluoroprotein, or aqueous film forming foam (AFFF) solutions are the primary extinguishing agents preferred for aircraft rescue and fire fighting.

5-4.3.1 Using Protein and Fluoroprotein Foam. These foaming agents must form a blanket over the surface of any flammable liquid spill fire to extinguish it. The foam should be applied with hand lines or turrets on spill fires by directing the foam at the near edge of the fire, letting the foam build up, and then pushing the foam with more foam in a sweeping motion until the entire spill area is covered. This special technique is most effective on paved surfaces such as runways and ramp areas. Straight foam streams should not be directed into burning liquids as the flammable liquids may then splash on top of foam and reduce its effectiveness. Foam from hand lines should be applied on a spill fire in such a manner so as not to break up any established foam blanket. If isolated openings in the blanket occur, they should be covered with foam as soon as possible to maintain the seal over the entire spill area.

5-4.3.2 Using Aqueous Film Forming Foam (AFFF). AFFF agent solutions may either be applied with air-aspirating nozzles or turret nozzles as used for protein and fluoroprotein foams or conventional water spray nozzles. Either spray or straight foam streams may be used as the situation dictates. It is desirable to approach the fire area as close as possible and apply the foam in a wide spray pattern initially and changing to a thirty (30) degree pattern after the heat has been reduced. The foam streams should be applied in a gentle manner to avoid unnecessary plunging of the stream into the burning fire. 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 fuel. Advance as the fire is controlled, always applying the foam to the nearest burning fuel surface. Fire fighters should be certain that a continuous unbroken foam cover is present before advancing into the fire area.

5-4.4 If dry chemical or halons are used, a fire area once extinguished could reflash. This also can occur when foam has been applied if it does not cover the spill completely or if it is washed away by subsequent use of water streams. If the fire is not completely extinguished with these agents before the supply is depleted, it may be necessary to use water spray streams. If this is the case, avoid bringing hose lines into any area that is secured.

5-4.5 Protection of Exposures.

5-4.5.1 Although rescue of aircraft occupants is the primary objective, the protection of exposed property should be considered, whether fire exists or not. Exposure protection plans should include drains, sewers, water-

ways, power lines and other properties where a flowing fire or unignited fuel may cause fire extension or contamination. Public utility operators should be notified of any significant entry of fuel into facilities under their control.

5-4.5.2 As soon as rescue operations are completed, all efforts should be concentrated on protection of exposed property and the extinguishment of structural fires, if any, caused by the crash. Where sufficient resources are available, this should be a simultaneous operation.

5-5 Accidents without Fire.

5-5.1 When an aircraft accident occurs and no fire exists, appropriate fire prevention procedures should be initiated.

(a) All spilled fuel should be covered with foam. Hot engines and other heated metals also should be covered with foam to prevent heat from coming in contact with fuel vapors. Heat of sufficient quantities to cause ignition from jet or reciprocating engines can be given off for as long as 30 minutes after crashes. Care should be exercised to prevent causing sparks that may ignite fuel vapors. This can occur when moving wreckage due to electrical arcing of any energized source aboard the aircraft.

(b) When foam is not available, use waterfog to cool hot engines and any heated metal. The washing away of spilled fuel from around the fuselage requires caution. Attention should be given to exposures and low areas, such as ditches or sewers, because of the movement of flammable vapor concentrations.

(c) Wreckage should be stabilized against movement. Sources of potential ignition should be prohibited from the area. Battery and other power systems should be de-energized provided this can be accomplished without sparking which might ignite flammables. This may be a considerable threat if fuel system components have been damaged.

5-5.2 Valuables, such as mail, jewelry and cargo should also be protected pending transfer of custody to the owners or other legal custodian(s).

5-5.3 Cargo information should be obtained to assure that dangerous goods are not on board and, if they are on board, they should be examined to discover any breach of container(s). Where dangerous goods are released, a containment and decontamination procedure may be required. This might well affect survivors, casualties, and responding emergency forces.

5-5.4 If contamination of any sort is suspected, a specific entry and control point should be established in order to limit the spread by controlling access and ensuring proper decontamination of all on-scene personnel.

5-6 Probability of a Successful Operation.

5-6.1 Always assume that there are survivors of an aircraft accident until it is confirmed that this is not the case. In some instances, however, rescue of occupants cannot be accomplished because of the remoteness of the accident site or the severity of the impact forces. In these instances, fire fighters should attack and extinguish the

fire, protect exposures, and preserve the scene until proper authorities arrive to assume responsibility.

5-7 Preplanning and Training.

5-7.1 Teamwork is so important that fire department officers should view preplanning and training as the one absolutely indispensable element in aircraft fire fighting and rescue.

5-7.2 The psychological factors involved in aircraft rescue and fire fighting operations can be successfully overcome only by realistic preplanning and training. Therefore, 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.

5-7.3 Actual fires should be built using aviation grades of fuel or contaminated fuels having similar properties consistent with local environmental regulations. Aircraft accidents should be simulated using discarded aircraft fuselages or by constructing aircraft mock-ups using junk automobile bodies, oil drums and sheet metal shapes.

5-7.4 The volume of smoke, fire and intense heat accompanying an aircraft fire can appear to be an overwhelming situation to untrained fire fighters when confronted with it for the first time. They may be reluctant to attack with limited water supply and conventional equipment. However, actual tests have proven that rescues can be effected, even where large quantities of spilled aircraft fuel are involved. 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.

5-7.5 Training coordination between military, civil airport and structural fire departments is most desirable and is encouraged. Execution of mutual aid agreements between these agencies will help assure well-coordinated plans for fire fighting and rescue. In the United States of America 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 aircraft fire fighting and rescue operations.

5-8 Type and Size of Hose and Nozzles.

5-8.1 For aircraft rescue and fire fighting, there are too many variables to establish any 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.

5-8.2 An effective attack on an aircraft fire would be the use of multiple 1½-in. hose lines with spray nozzles maintaining 100 psi nozzle pressure.

Approach the aircraft from the direction which rescue is to be made using at least one line to protect the rescuers and the aircraft occupants.

5-9 Where Water Supplies Are Limited.

5-9.1 Complementary extinguishing agents, such as carbon dioxide, dry chemicals, or halon can be used effectively on small flammable or combustible liquid fires to achieve a quick knockdown of the flames. Use of these agents involves the danger of reignition where the entire fuel spill area cannot be extinguished or where ignition sources persist. Care should also be exercised to assure the compatibility between these extinguishing agent(s) used.

5-9.2 Addition of a wetting agent will increase effectiveness of the available water. Tests to date indicate that a two percent solution of approved types of wetting agents produces best results. Certain wet water additives may destroy some foams; hence, they should be carefully checked for compability before they are employed in the presence of the principal foam agents.

5-9.3 Trained personnel employing proper operating techniques can accomplish a successful rescue operation with a limited amount of water if rescue operations begin immediately. If only limited water supplies are available, all efforts should 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 on the scene.

5-10 Vehicle Operational Limitations. Fire fighting vehicles designed and intended for use on paved or improved surfaces should not be committed to cross-country routes. Extended hose lines from a position on a satisfactory road surface should be used rather than risking vehicle immobilization enroute. Once immobilized, a vehicle may not be movable if in danger from a sudden release of fuel or a developing fire situation. Vehicles may also block access to the accident site for vehicles arriving subsequently which do have cross-country capability.

5-11 Medical Operations.

5-11.1 Modern trauma medical procedures require that stabilization of the seriously injured should be carried out at the accident scene. The immediate transportation of the seriously injured before stabilization should be avoided.

5-11.2 In accidents occurring on or off the airport, rescue and fire fighting personnel are generally the first emergency personnel on the scene. Seriously injured casualties should be located and stabilized as quickly as possible. In cases where fire control and prevention does not require the efforts of all rescue and fire fighting personnel, casualty stabilization should commence immediately under the direction of the most qualified trauma-trained individual on the scene. First response rescue vehicles should carry initial supplies of victim care equipment, including artificial airways, compresses, bandages, oxygen and other related equipment used for the stabilization of smoke inhalation casualties and severe trauma. Fire fighting personnel should be trained in basic life support measures including cardio-pulmonary resuscitation.

5-11.3 The first few minutes of medical treatment should aim at triage and stabilizing casualties until more qualified medical care is available.

5-11.4 The triage procedure and subsequent medical care should be placed under the command of one authority, the designated medical coordinator, upon his/her arrival. Prior to his/her arrival, the command of triage should be assumed by the designee of the commanding rescue and fire fighting chief until relieved by the predesignated medical coordinator.

5-11.4.1 The medical coordinator should be responsible for triage and for implementing the Airport Medical Emergency Plan. *The medical coordinator's primary function in implementing the plan should be as an administrator and not as a member of the medical team treating the injured.*

5-11.4.2 The casualties should be separated into three categories: Category 1 - immediate care; Category 2 - delayed care; Category 3 - minor care. Category 1 requires immediate stabilization and then transportation to the appropriate medical facility. Category 2 are casualties sustaining injuries which do not need immediate emergency medical treatment to sustain life and can be delayed until Category 1 casualties are stabilized. Transportation of Category 2 casualties should be performed following minimum care at the site. Category 3 casualties can be treated when resources are available.

5-12 Post-Accident Procedures (*see Part I, Chapter 7 and Appendix E*).

5-12.1 Defueling Accident Aircraft. A fire protection standby should be provided during post-accident aircraft defueling.

5-12.1.1 Fuel will most probably be spilled from small aircraft during a crash and will drain away or soak into the ground during the initial fire and rescue activity. For large aircraft, and sometimes the smaller aircraft, considerable quantities of fuel may remain on board. Crash recovery operations on or off the airfield almost always involve removal of such fuel. In some situations, hidden fuel system damage may not be apparent until lifting of the aircraft is attempted. Accomplishing defueling safely is a matter of proper interest for the fire department and needs to be coordinated among all jurisdictions on the scene. Whatever problems exist as a result of the crash will certainly become worse if further injury or loss occurs during this phase of the accident sequence. Therefore, the fire department should provide or augment, depending on local preplanning, the surveillance of the defueling operation.

5-12.1.2 An area free of any ignition source should be established a minimum of at least 15 m (50 ft) from any fuel spill and the number of personnel in the controlled area should be limited to those necessary for the work being done. Open flames, power carts, floodlights and radio transmissions except from known low power units should be prohibited in areas close to the wreckage and the defueling equipment. Fire fighters should also be aware that vehicles and equipment may be ignition sources and take necessary precautions.

5-12.1.3 Concurrent operations such as jacking, removing panels for investigation, etc., should not be con-

ducted during defueling operations. Transfer of fuel can cause changes in weight distribution and balance; therefore, stability of the aircraft may be uncertain. Cribbing, jacking, airbags, or other stabilizing equipment should be readily available. Safe access for fueling vehicles should also be provided as vehicles that safely pass over soft ground when empty may have a problem when loaded.

5-12.2 Defueling operations and techniques should be under the direct supervision of an aircraft systems specialist qualified in the fuel system of the aircraft. Generally, power should not be applied to a damaged airplane and, therefore, the fuel system control valves will not be operable. Suction would thus be necessary through top filler access points. Where fuel system rupture has occurred and dripping is uncontrolled, fuel cell sealant, clay or other material may be used to make mini-dams on smooth surfaces to direct flow of fuel into containers. Pegs and plugs may also be used to diminish or stop flow of fuel. When all else fails, it may be possible to shovel a trench to a collecting spot and thus limit the surface area of fuel exposed to chance ignition.

5-12.3 The fire and rescue service should also seek the advice of aircraft systems specialists concerning other items that may present a threat during the overhaul and salvage process. Liquid and pressurized gaseous oxygen are generally allowed to bleed off by opening onboard valves. System accumulators or tanks may remain pressurized indefinitely at hundreds or even thousands of pounds of pressure, until relieved by systems specialists.

5-13 Preservation of Evidence. Fire fighters should be aware of the importance of conducting aircraft rescue and fire fighting operations in a manner that will minimally disturb the accident scene. Preservation of investigative evidence, mail, cargo and minimum destruction of the aircraft should be given priority after life safety and rescue operations have been concluded.

5-13.1 If possible, note position of the aircraft structure prior to moving or cutting to remove occupants.

5-13.2 The entire accident area should be roped off and patrolled. A control point should be established to permit only authorized persons to enter the accident area.

5-13.3 Deceased victims need not be removed from the aircraft wreckage. If it is necessary to do so, photographs, if possible, should be taken, or the area tagged prior to removal. This will greatly assist the investigating authorities.

Appendix A Informatory Referenced Publications

This Appendix lists publications which are referenced within this NFPA document for information purposes only and thus is not considered part of the recommendations of the document.

A-1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 403-1978, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports*

NFPA 407-1980, *Standard for Aircraft Fuel Servicing*

NFPA 408-1984, *Standard on Aircraft Hand Fire Extinguishers*

NFPA 409-1979, *Standard on Aircraft Hangars*

NFPA 410-1980, *Standard on Aircraft Maintenance*

NFPA 412-1974, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*

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

NFPA 422M-1984, *Aircraft Fire Investigators Manual*

NFPA 424-1978, *Recommended Practice for Airport/Community Emergency Planning*

NFPA 1003-1978, *Standard for Airport Fire Fighter Professional Qualifications.*

A-2 International Civil Aviation Organization (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 (Annex 14), 7th Edition, June, 1976

Airport Services Manual, Part I: Rescue and Fire Fighting, First Edition, 1977

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

A-3 Federal Aviation Administration Publications. In the United States of America, the Federal Aviation Administration (FAA) mandates the provision of a minimum level of airport fire fighting services at certain land airports serving certified air carriers. These provisions may be found in:

Federal Aviation Regulations (FAR), Part 139.49

FAA Advisory Circular 150/5210-6B, (with changes 1 and 2).

A-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 U.S. 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 Document Department, U. S. Government Printing Office, Washington, D. C. 20402

A-5 Other Publications.

ASTM E380-1976, *Standard for Metric Practice*, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

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

Appendix B 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.

B-1 Aircraft Familiarization.

B-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.

B-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.

B-2 Aircraft Access Points, Fire Hazard Zones and Interior Fuselage Arrangements.

B-2.1 The following charts depict typical aircraft exits, hazardous locations, interior fuselage arrangements and methods by which rescue and fire fighting personnel may make entry into an aircraft:

Figure B-1	Normal Aircraft Exit Points
Figure B-2	Typical Window Exits
Figure B-3	Preferred Forcible Entry Locations
Figure B-4	Fire Hazard Zones
Figure B-5	Typical Aircraft Interior Fuselage Arrangement

B-3 Crash Crew Charts.

B-3.1 The following list of charts identifies specific information relative to various aircraft currently in use as commercial carriers:

Figure B-6 Bell 206L Helicopter

Figure B-7 Boeing 707

Figure B-8 Boeing 727

Figure B-9 Boeing 737

Figure B-10 Boeing 747

Figure B-11 Boeing 747 SP

Figure B-12 Boeing 757

Figure B-13 Boeing 767

Figure B-14 Canadair CL-44D4 (cargo/passenger)

Figure B-15 CC115 Buffalo

Figure B-16 CC117 Falcon

Figure B-17 Concord

Figure B-18 DeHaviland Dash 7

Figure B-19 DeHaviland Twin Otter

Figure B-20 Douglas DC-3

Figure B-21 Douglas DC-4

Figure B-22 Douglas DC-8

Figure B-23 Douglas DC-9

Figure B-24 Douglas DC-9-80

Figure B-25 Douglas DC-10 "Wide Body"

Figure B-26 Fairchild F-27

Figure B-27 Lockheed L-1011 "Wide Body"

Figure B-28 Short Dash 30

Figure B-29 FAA evacuation test

Figure B-30 Proper use of evacuation slides

Figure B-31 Assisting evacuees at bottom of slide

Figure B-32 Concord Supersonic Jet evacuation slides

Figure B-33 A-300 Air Bus

Figure B-34 Shorts SD 3.60

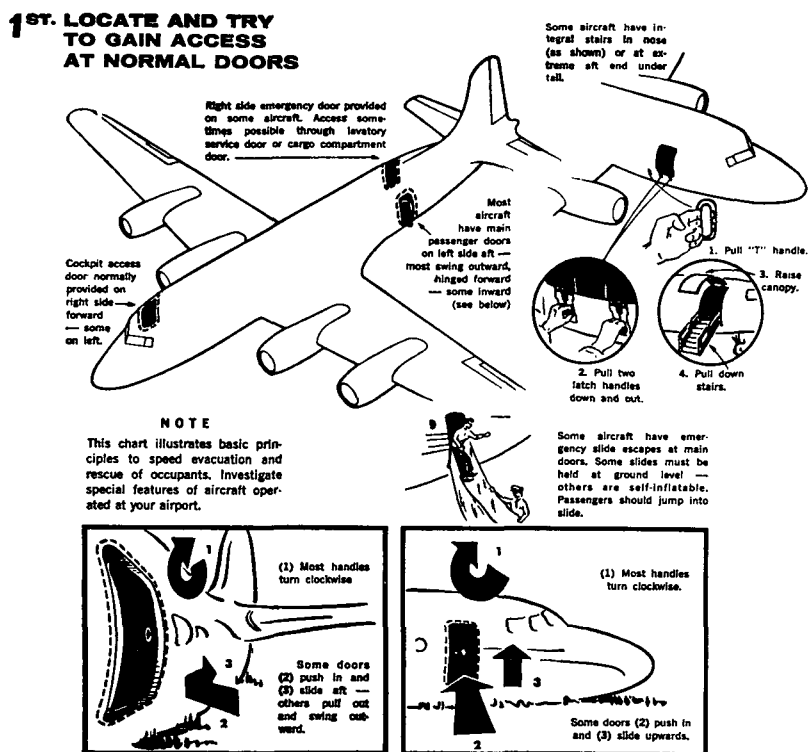


Figure B-1 Chart highlights principal points of access to typical transport aircraft.

2ND. LOCATE AND TRY TO OPERATE WINDOW EXITS

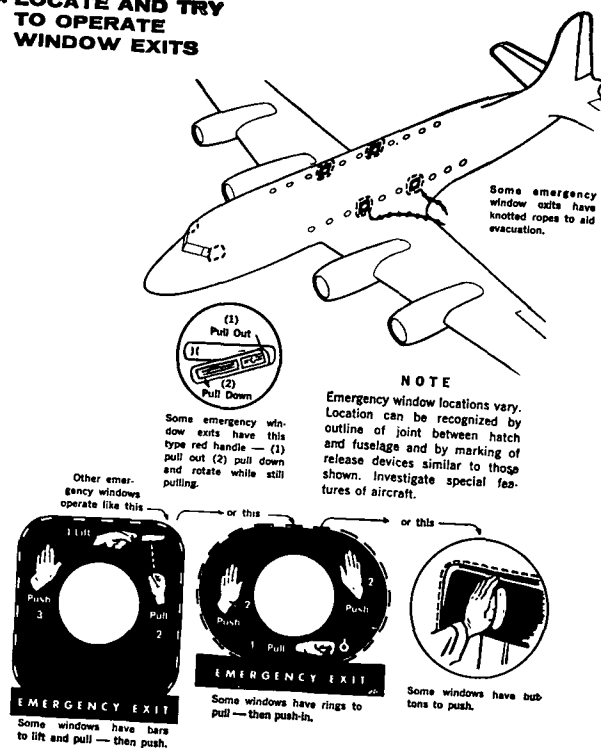
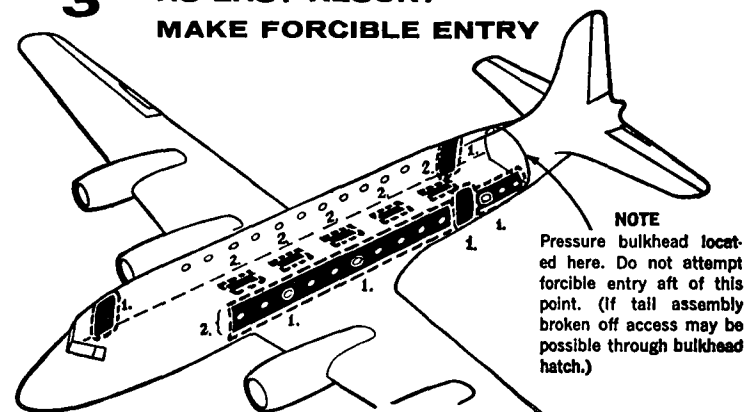


Figure B-2 Window exits on typical transport aircraft; method of operation and routes of evacuation are shown.

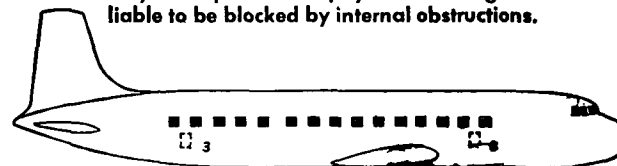
3RD AS LAST RESORT MAKE FORCIBLE ENTRY



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 B-3 Preferred forcible entry locations for typical transport aircraft.

ALWAYS KNOW THE PRINCIPAL FIRE HAZARD ZONES IN CIVIL AIRCRAFT

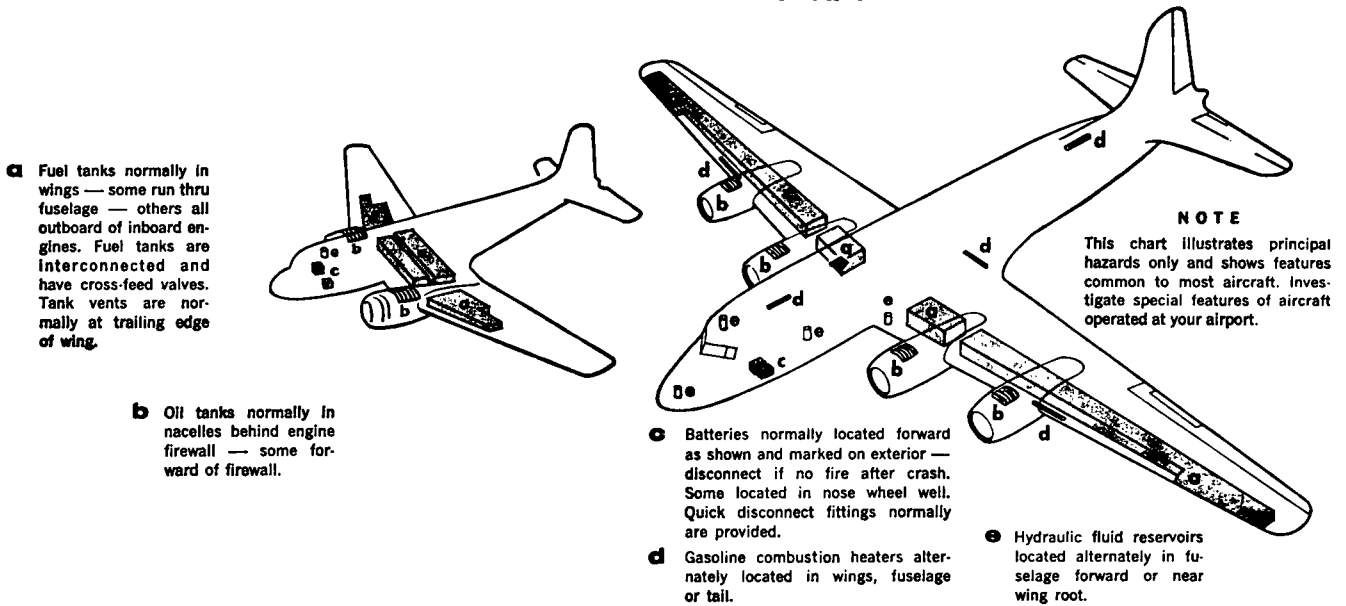


Figure B-4 Principal fire hazard zones on typical reciprocating engine-type transport aircraft.

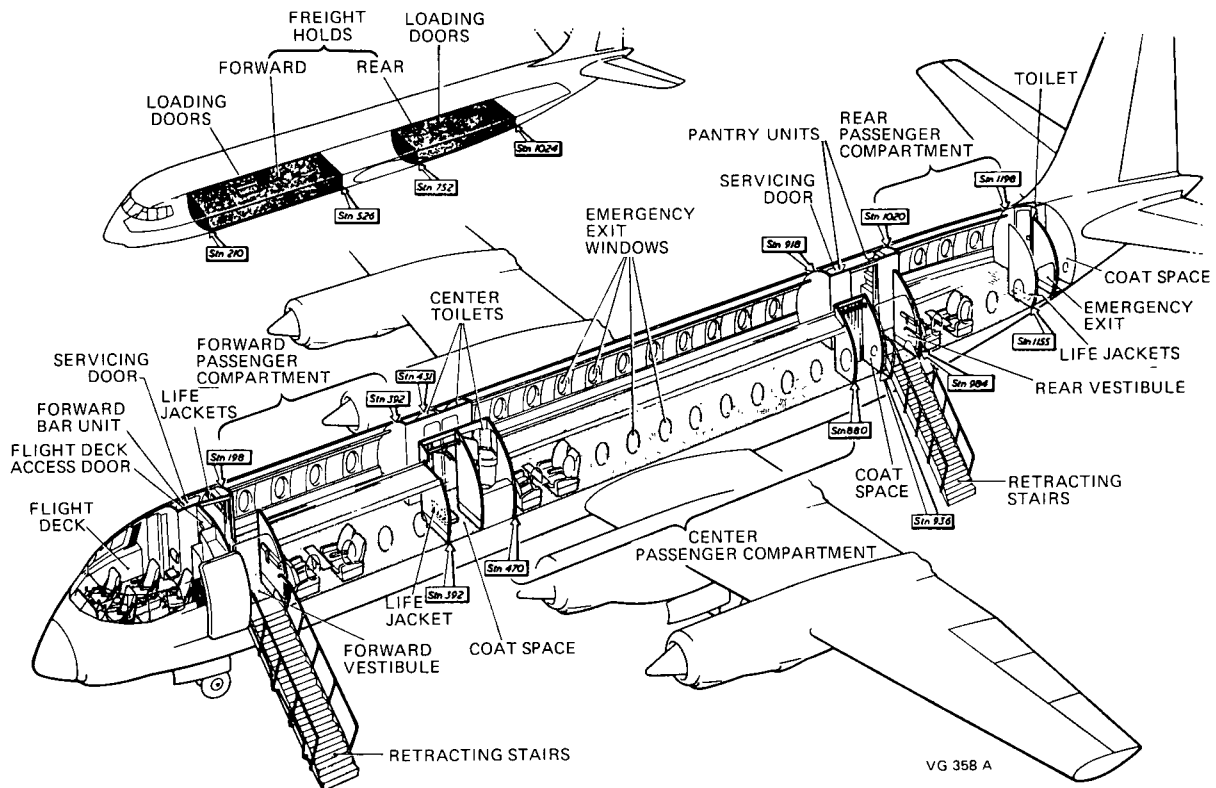


Figure B-5 Typical interior arrangement of transport aircraft.

- 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

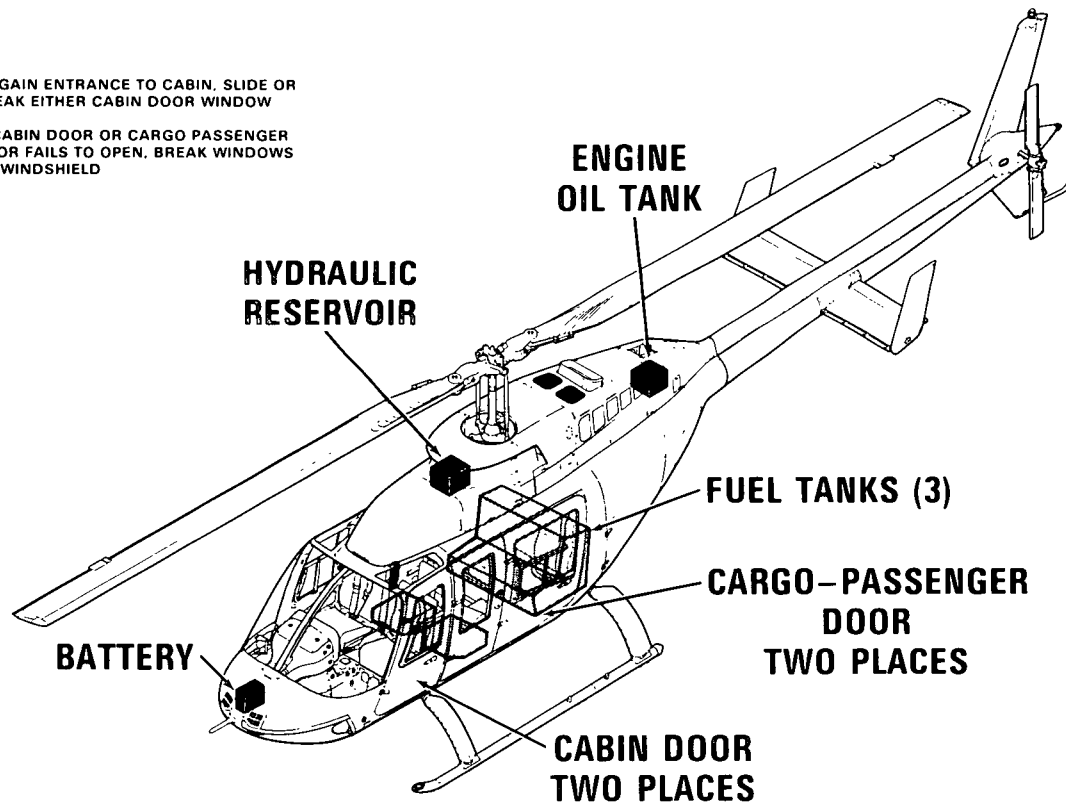


Figure B-6 Bell 206L Helicopter.

EMERGENCY RESCUE ACCESS

BOEING 707-100 & 200
USAF C-137B

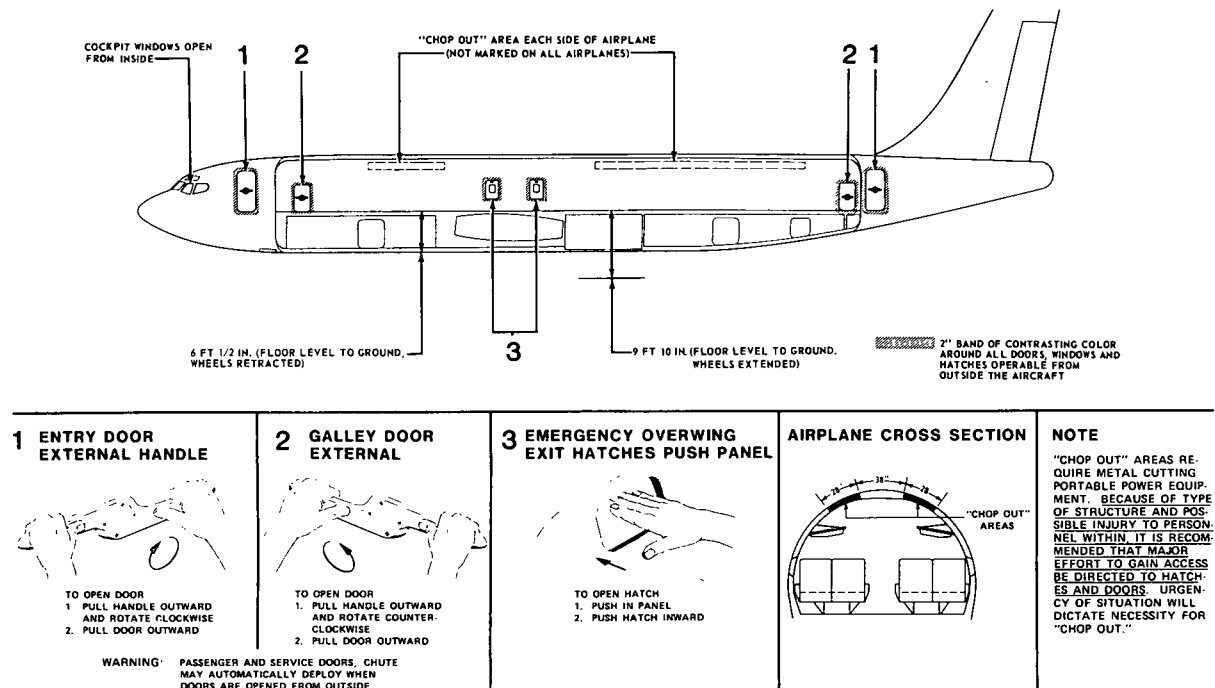


Figure B-7 Boeing 707.

EMERGENCY RESCUE ACCESS

BOEING 727 100-200

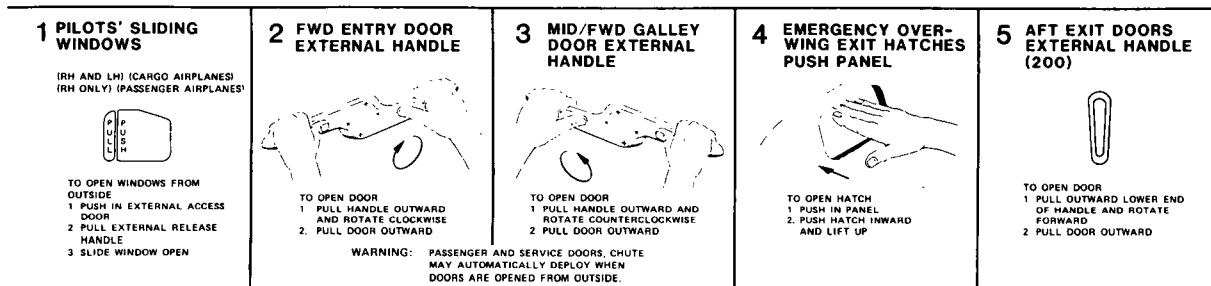
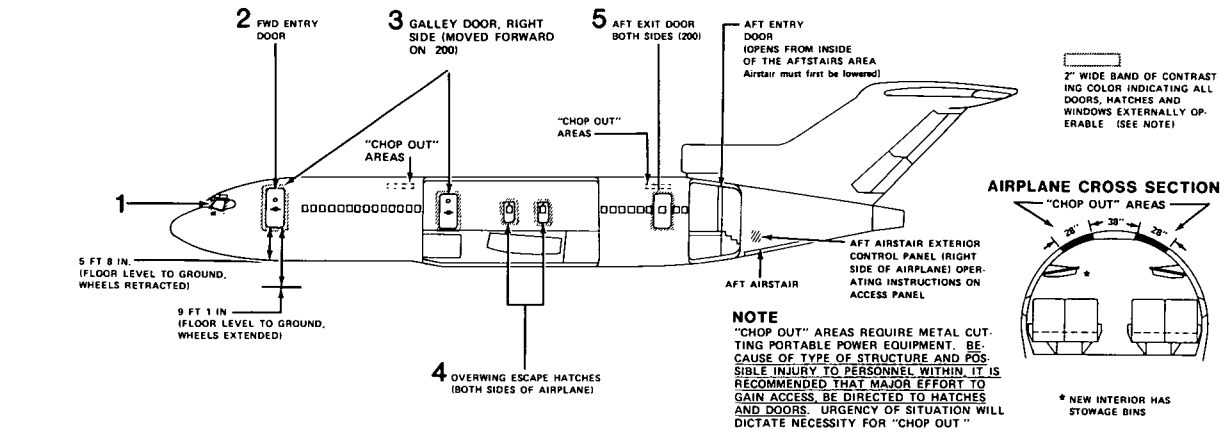


Figure B-8 Boeing 727.

EMERGENCY RESCUE ACCESS

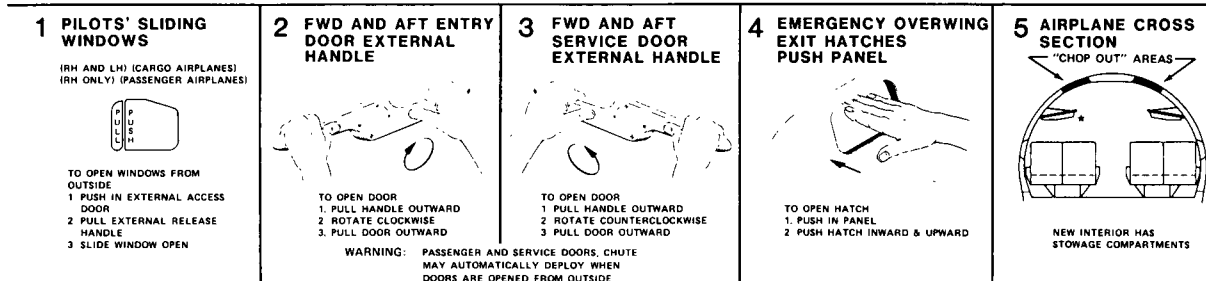
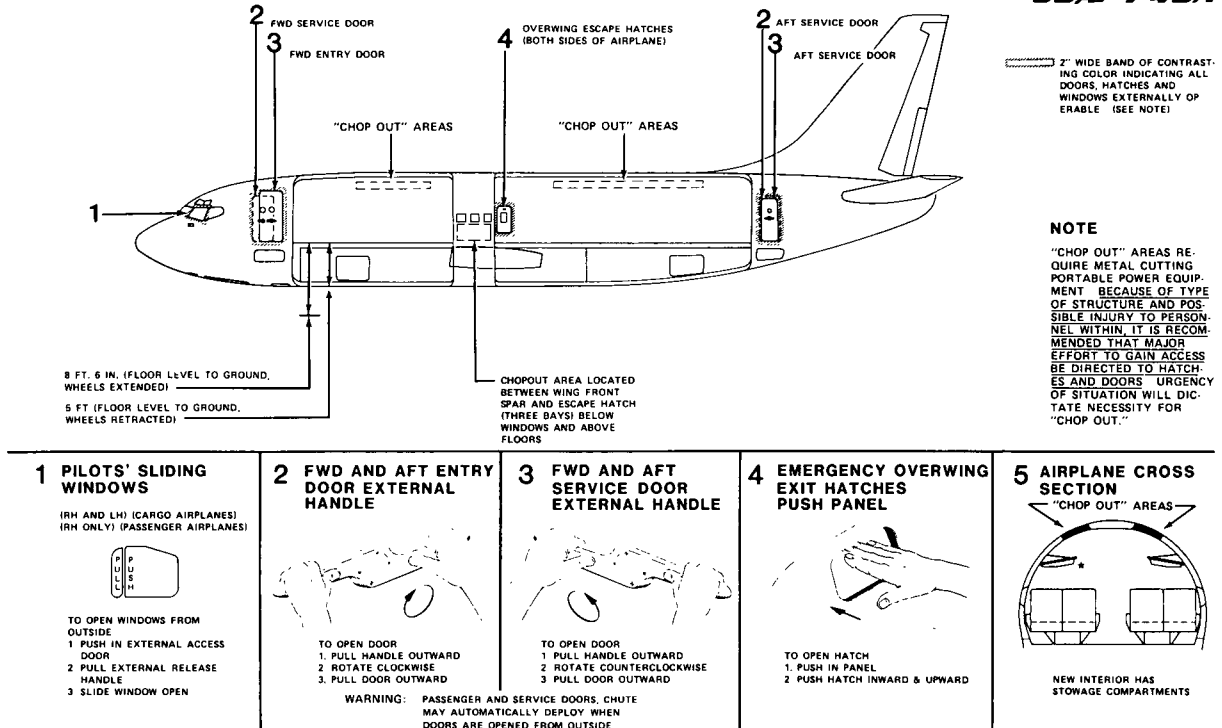
BOEING 737 100-200-200C
USAF T-43A

Figure B-9 Boeing 737.

EMERGENCY RESCUE ACCESS

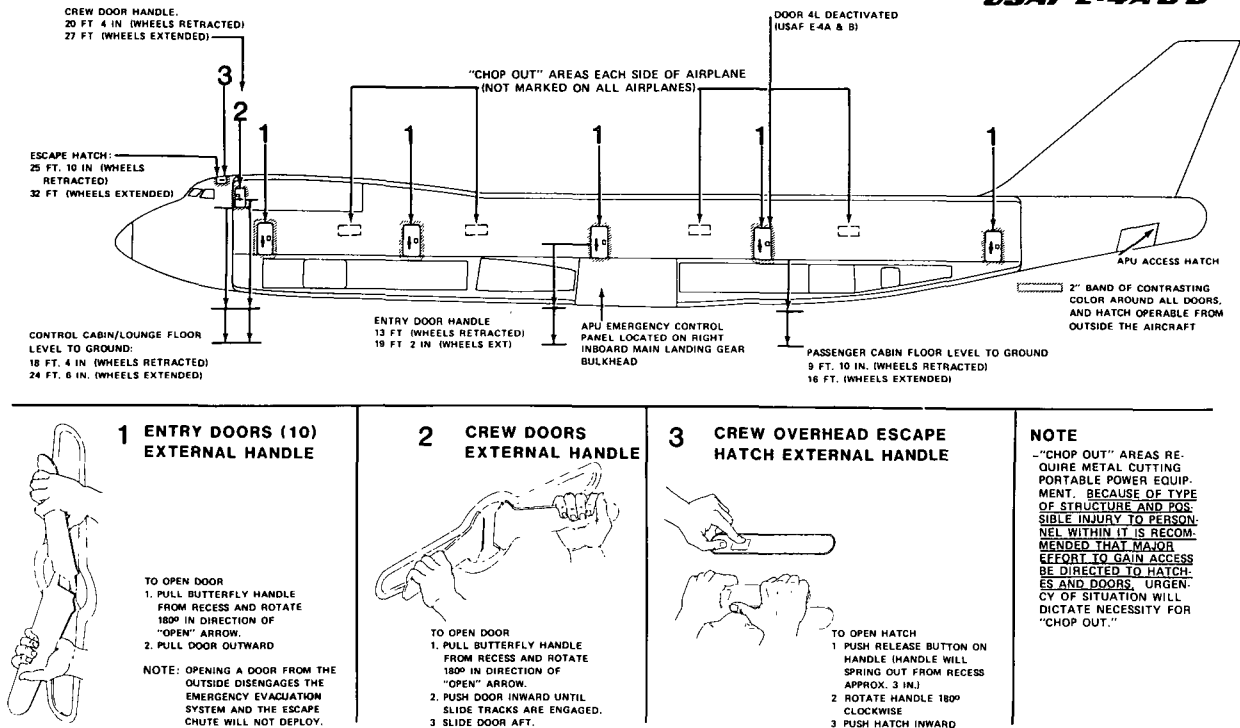
**BOEING 747-100 & 200
USAF E-4A & B**

Figure B-10 Boeing 747 Flammable Material Locations.

EMERGENCY RESCUE ACCESS

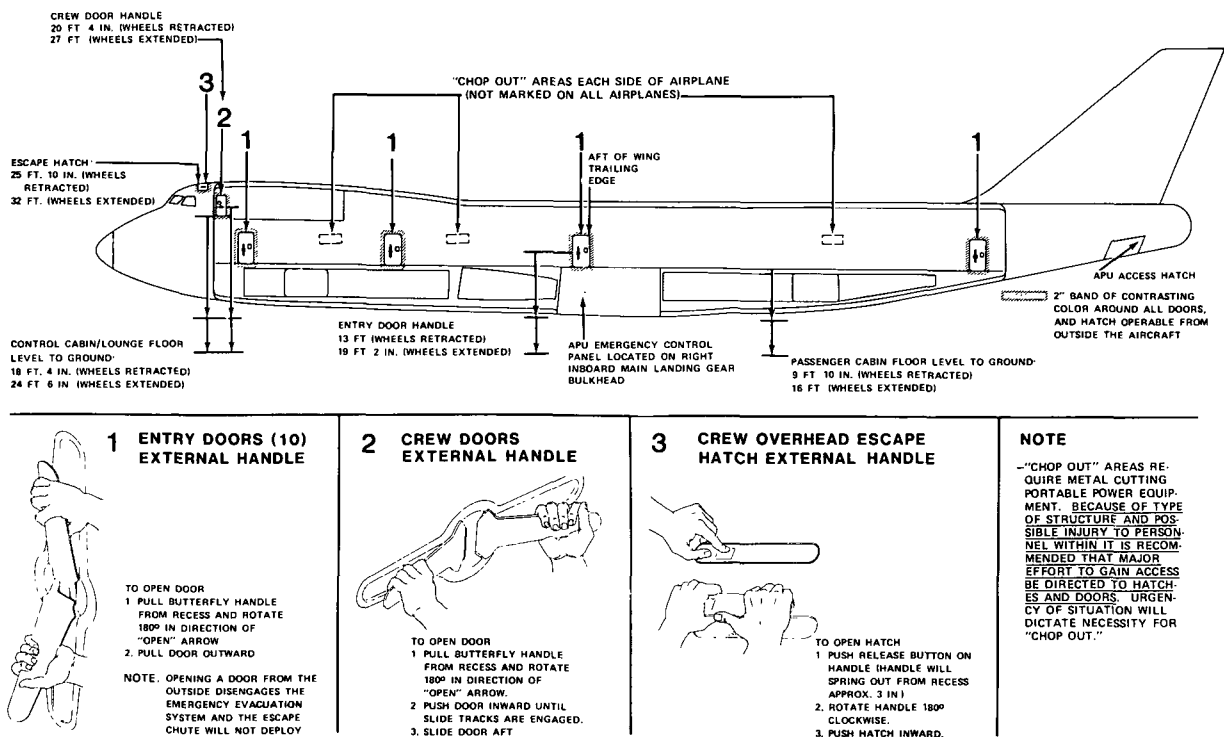
BOEING 747-SP

Figure B-11 Boeing 747 SP.

EMERGENCY RESCUE ACCESS

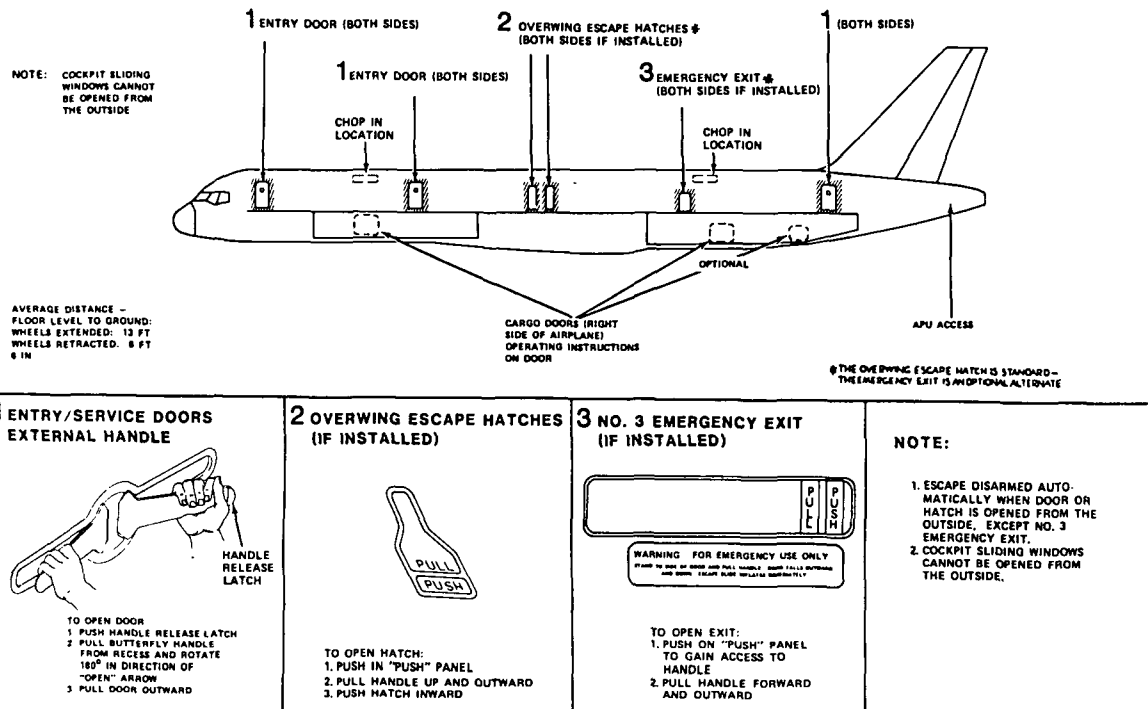
BOEING 757-200

Figure B-12 Boeing 757.

EMERGENCY RESCUE ACCESS

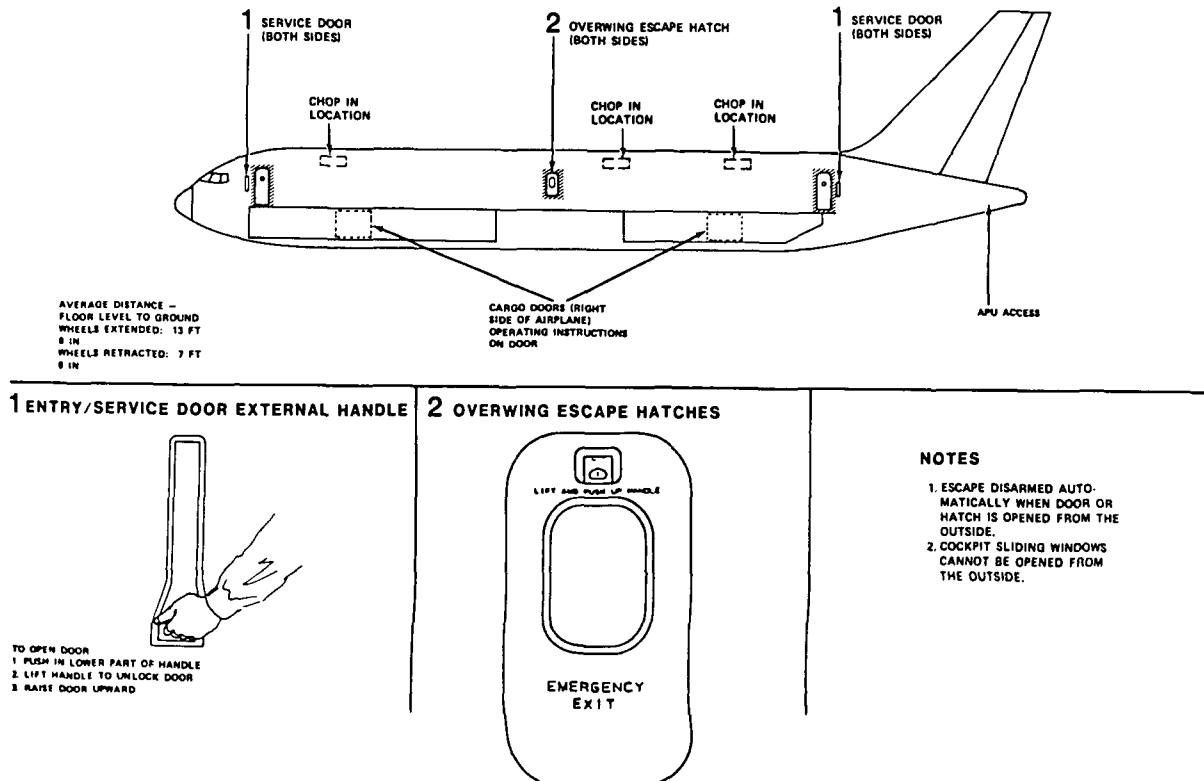
BOEING 767-200

Figure B-13 Boeing 767.

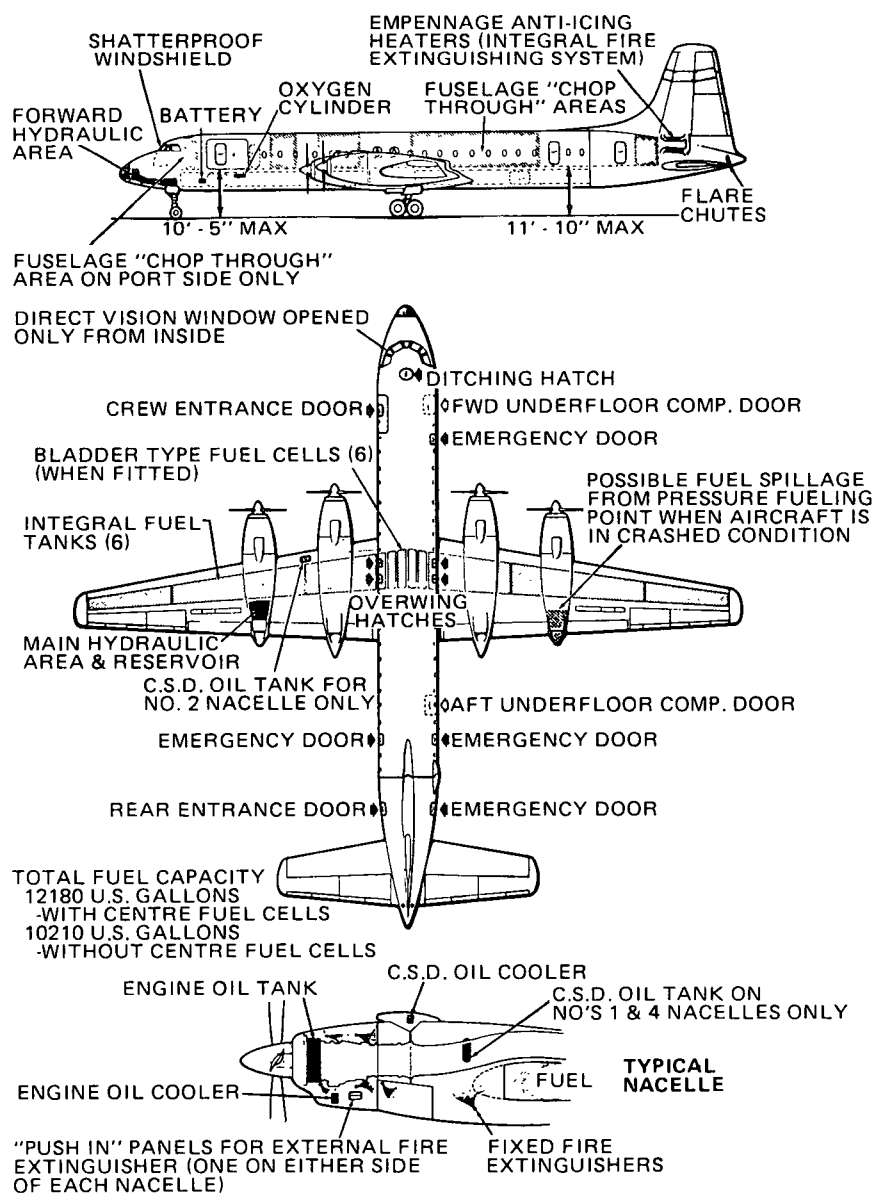
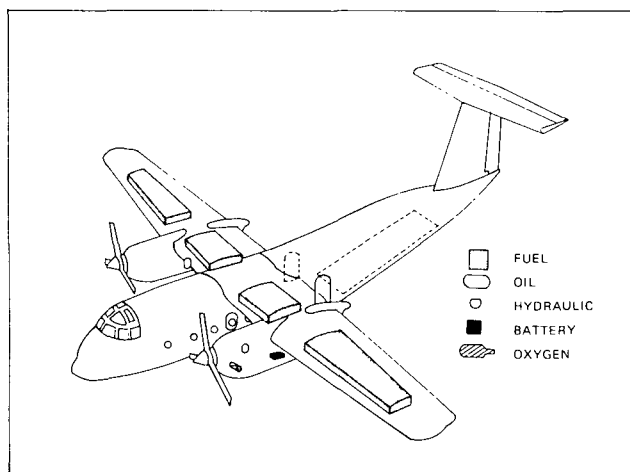


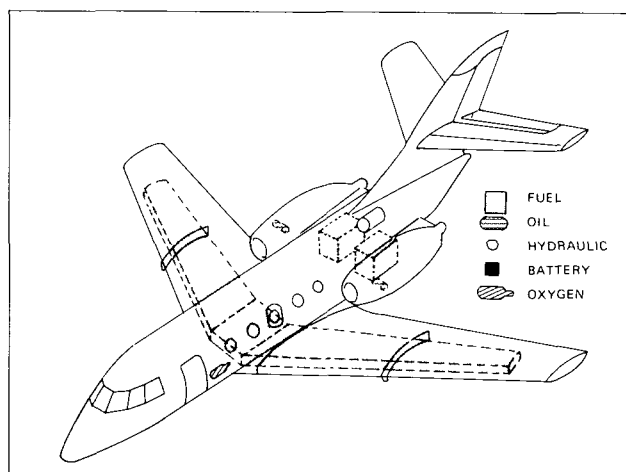
Figure B-14 Canadair CL-44D4 cargo/passenger aircraft.



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 B-15 CC115 Buffalo.

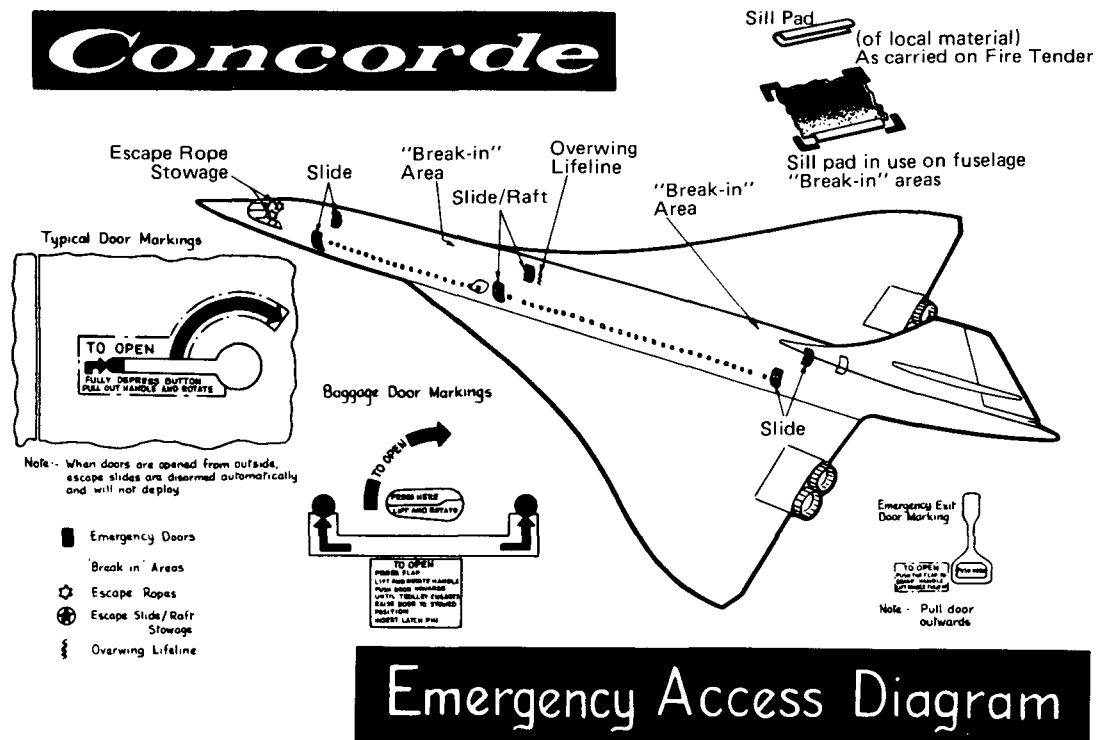


GENERAL INFORMATION

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 B-16 CC117 Falcon.



Courtesy of British Airways

Figure B-17 Concorde.

PASSENGER & CREW ESCAPE SYSTEMS

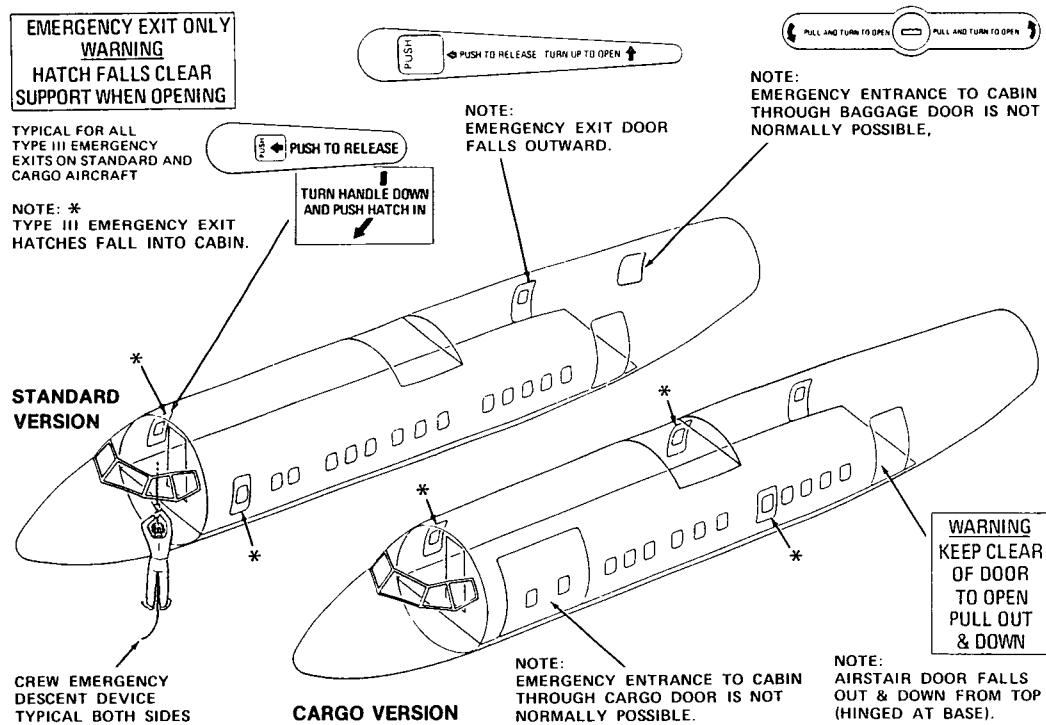


Figure B-18 DeHaviland Dash 7.

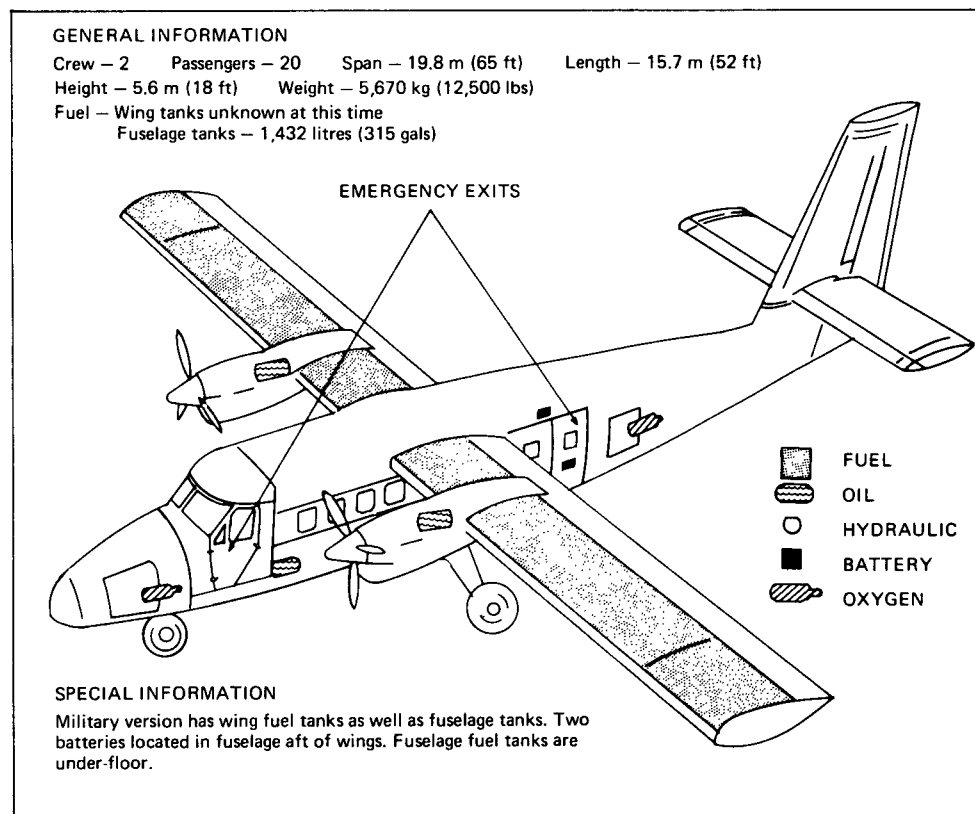


Figure B-19 DeHaviland Twin Otter.

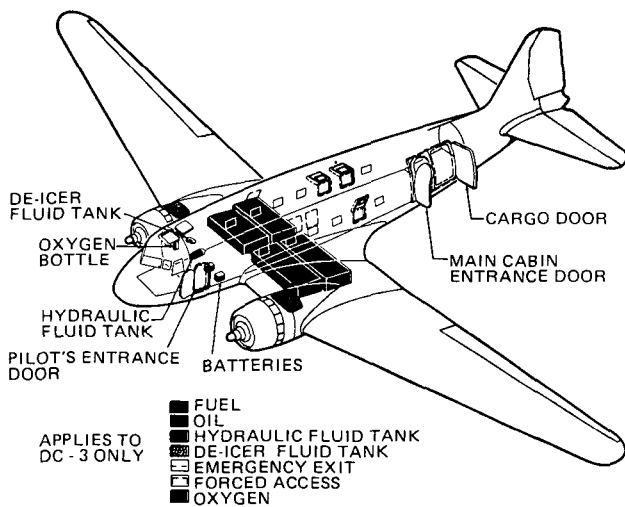


Figure B-20 Douglas DC-3.

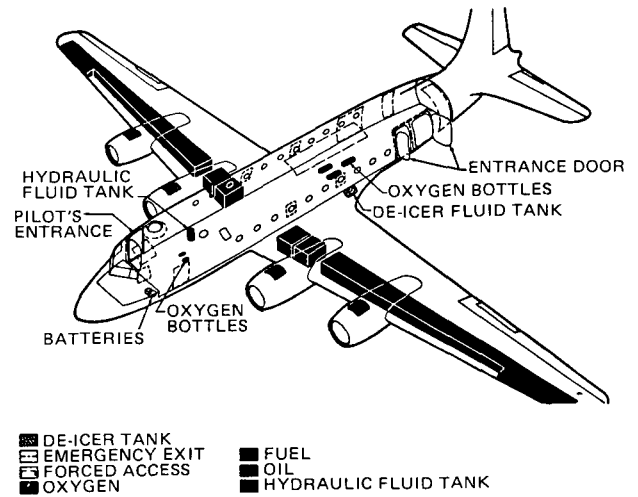


Figure B-21 Douglas DC-4.

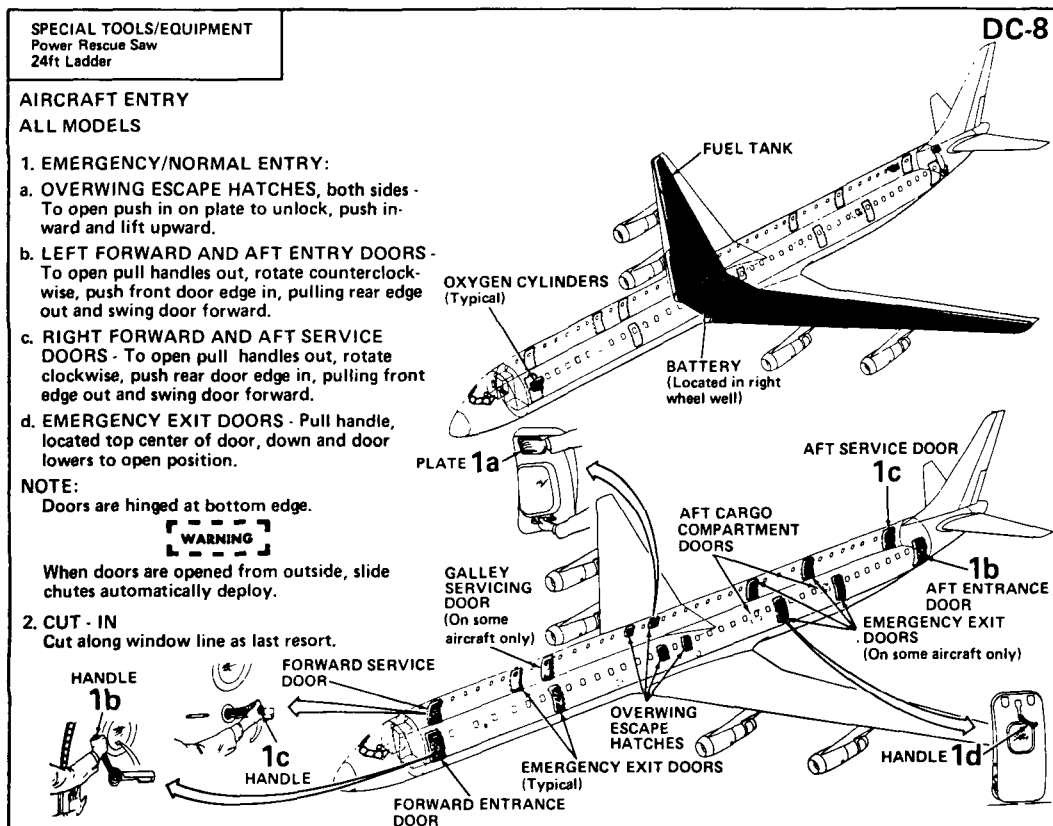


Figure B-22 Douglas DC-8.

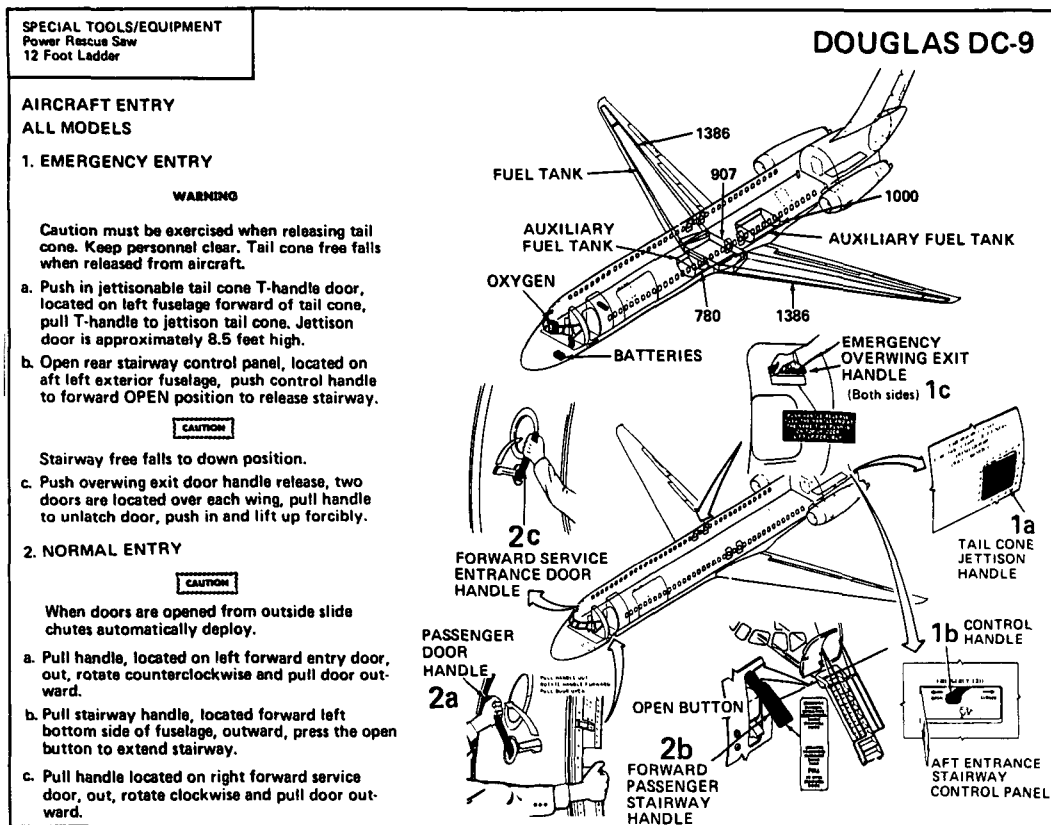


Figure B-23 Douglas DC-9.

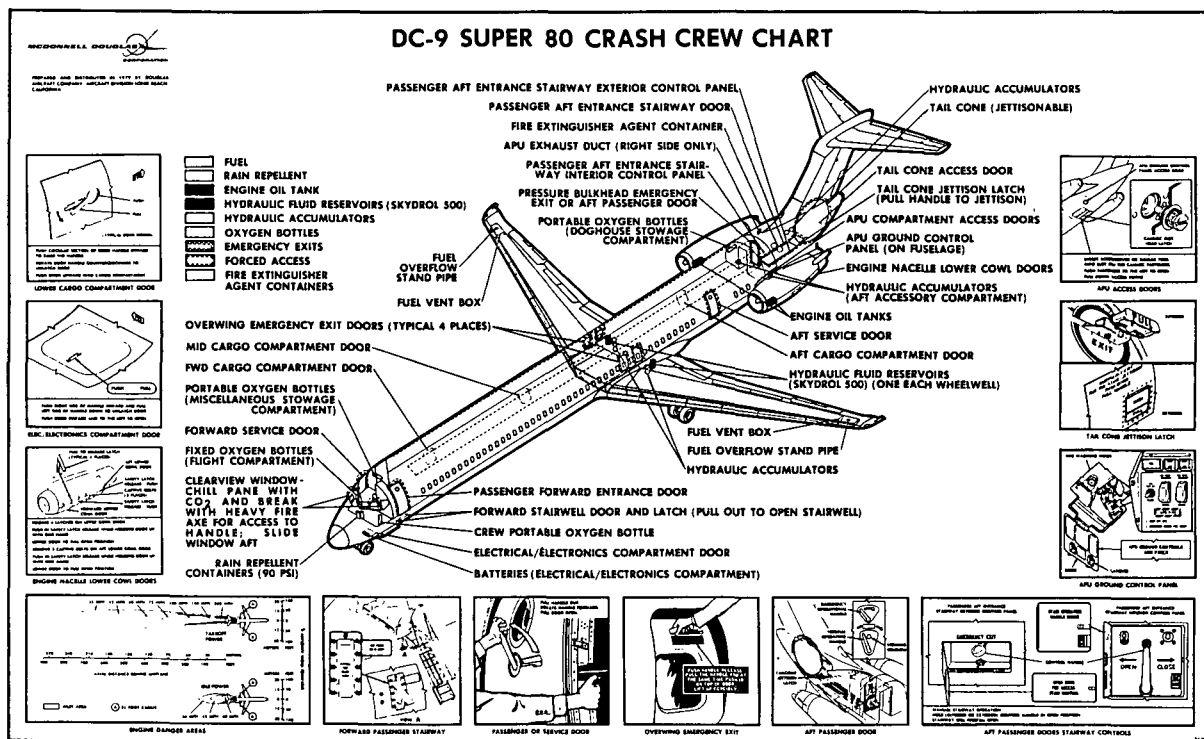


Figure B-24 Douglas DC-9-80.

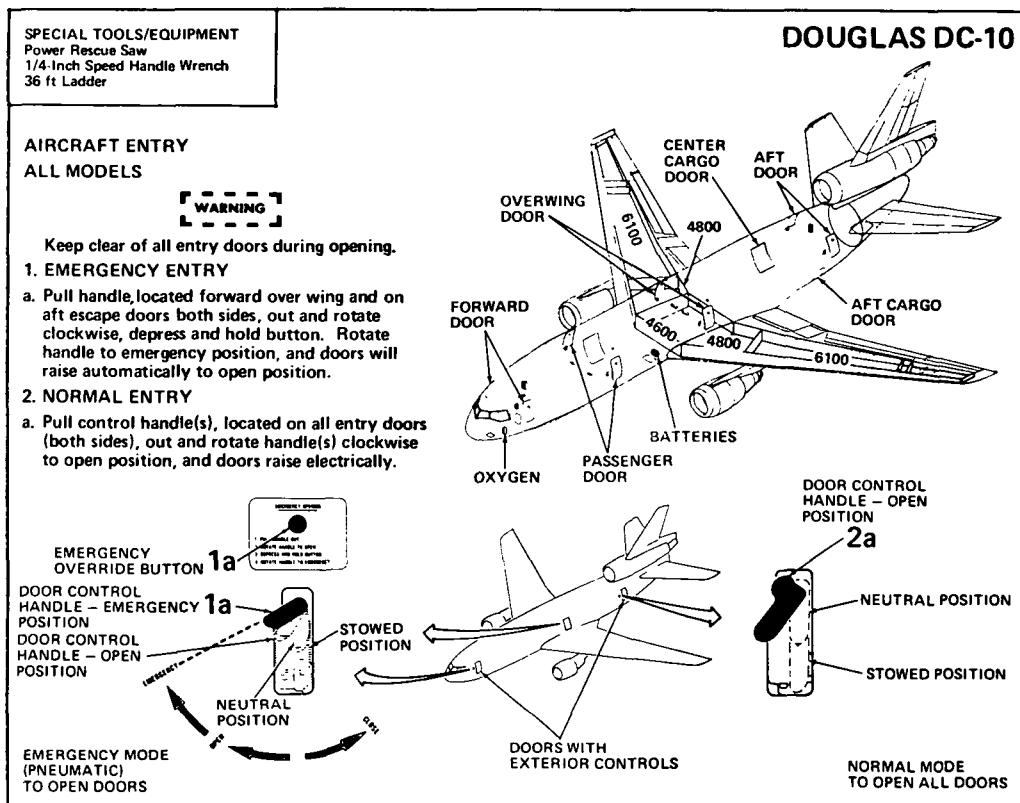


Figure B-25 Douglas DC-10 "Wide Body."

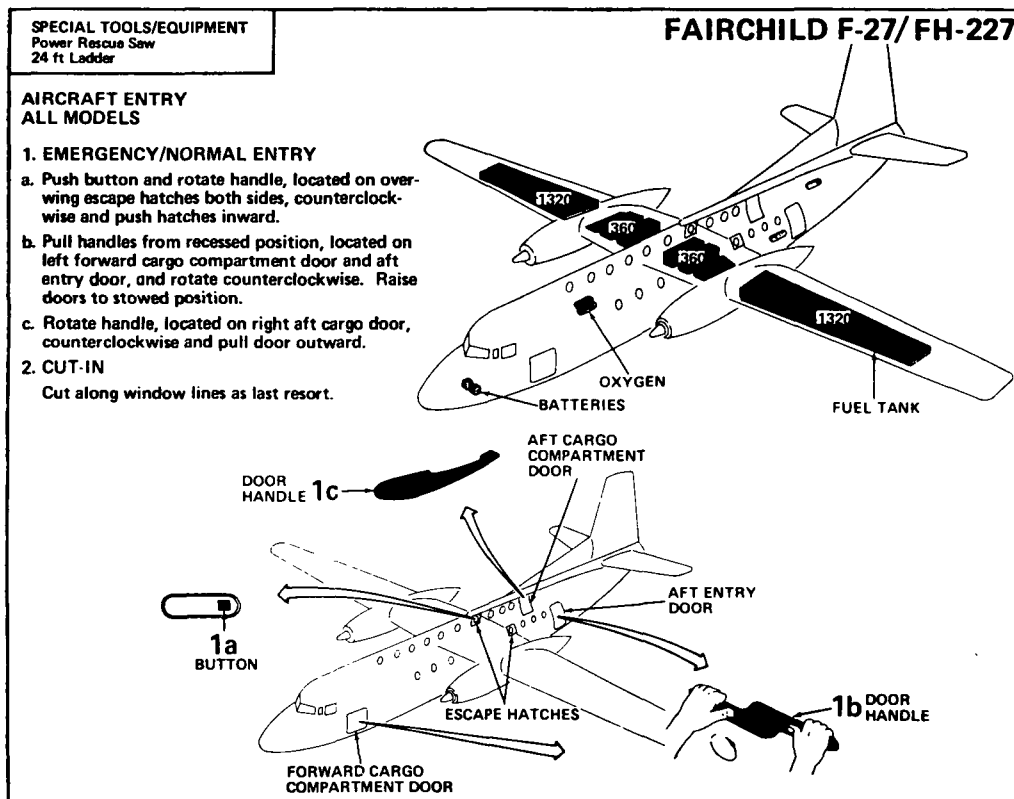


Figure B-26 Fairchild F-27.

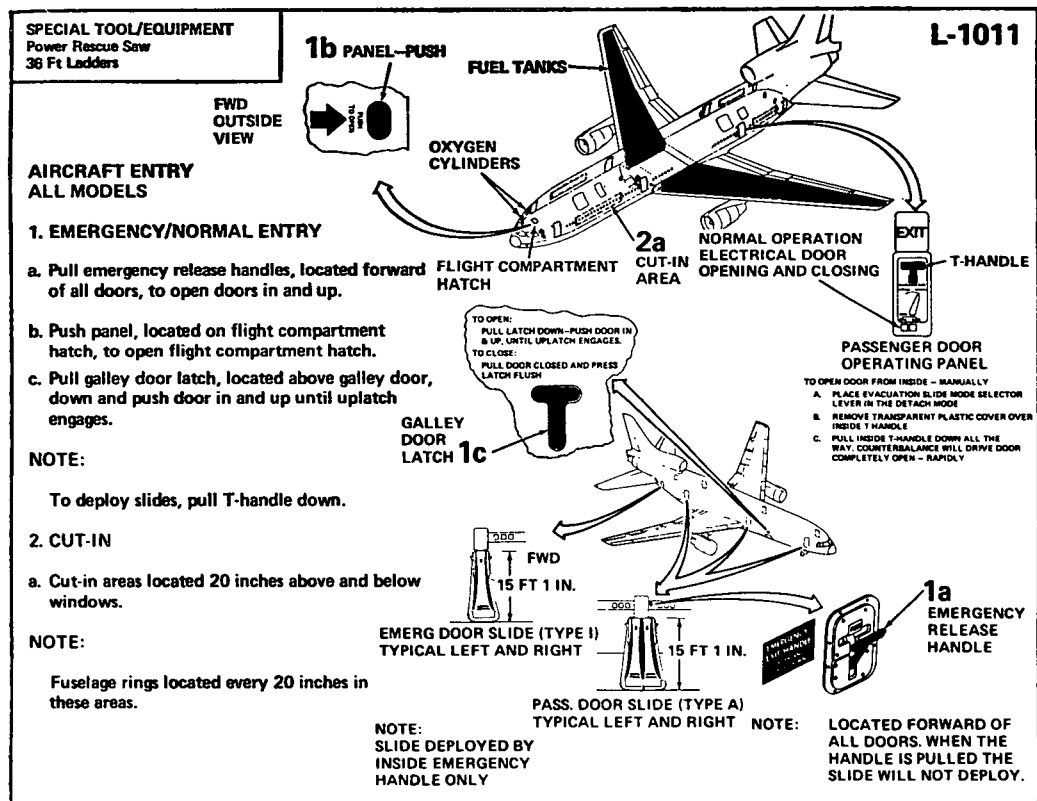


Figure B-27 Lockheed L-1011 "Wide Body."

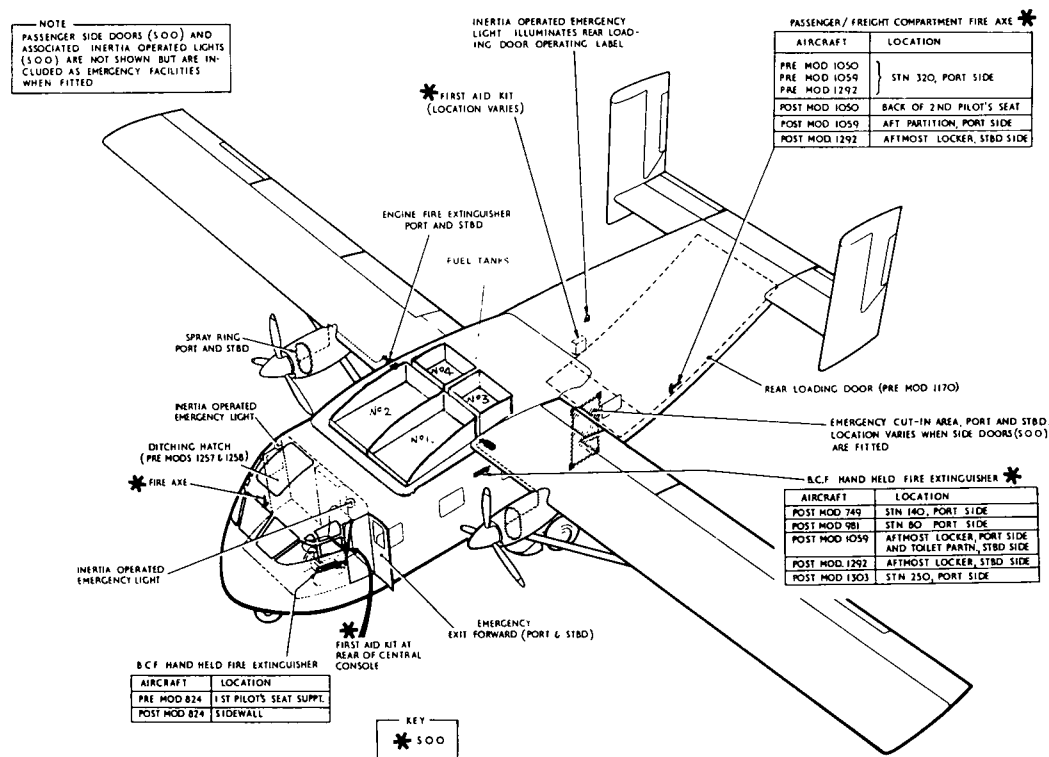


Figure B-28 Short Dash 30.



Figure B-29 An FAA-conducted evacuation test of a DC-8; 157 passengers and 7 crew members were evacuated within the required 90 seconds.

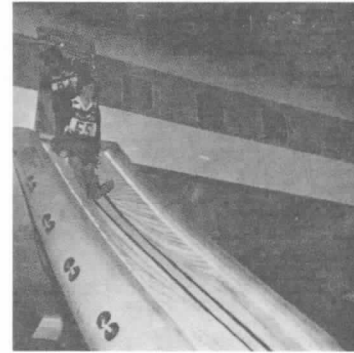


Figure B-30 Proper entry into evacuation slide.



Figure B-31 Assisting evacuees at bottom of the evacuation slide.

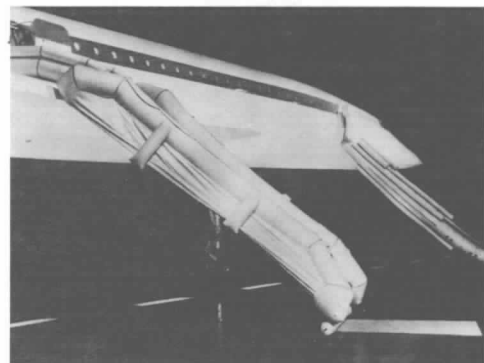


Figure B-32 Two evacuation slides deployed from exits of the Concorde Supersonic Jet Transport.

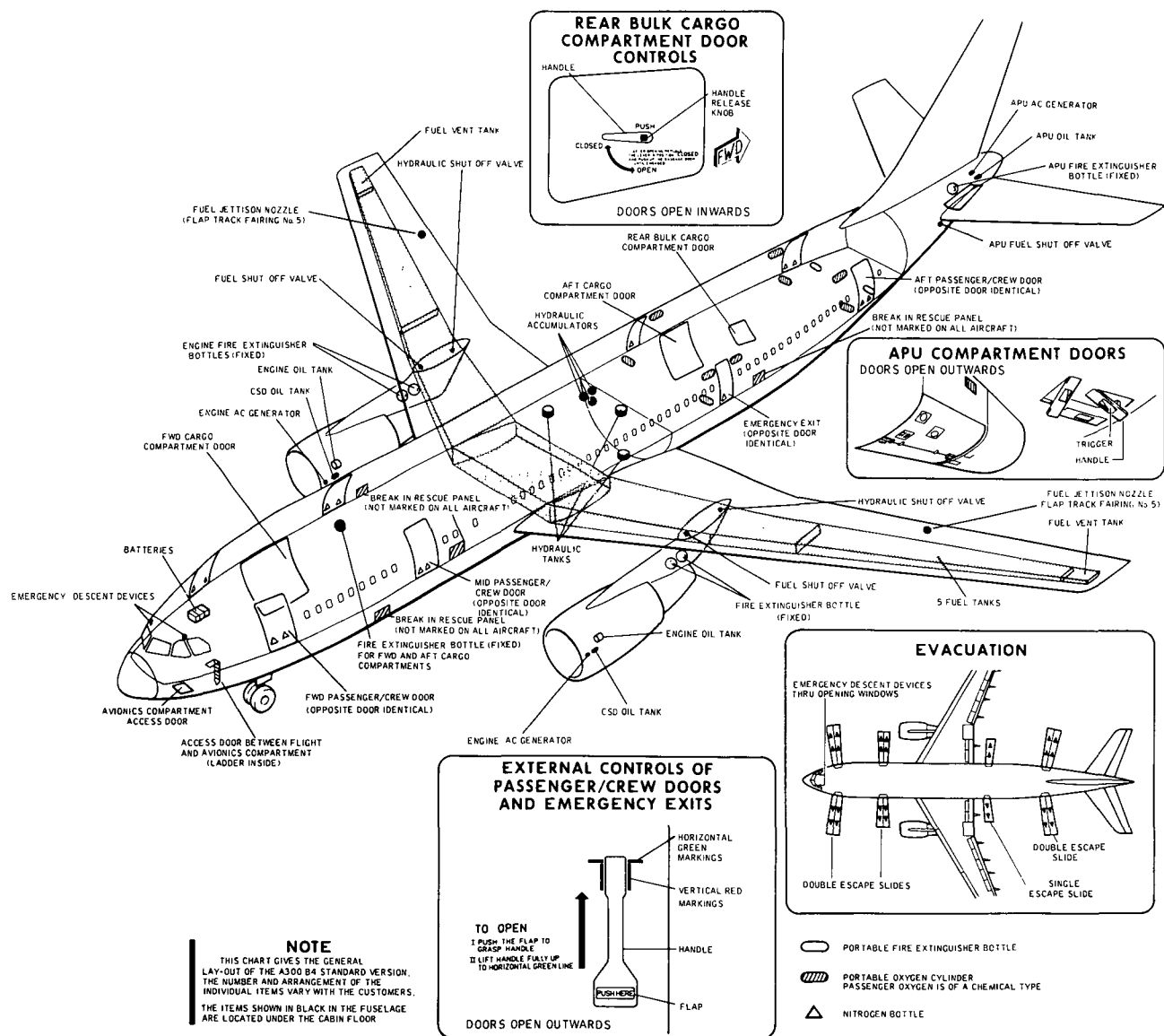


Figure B-33 A-300 Air Bus.

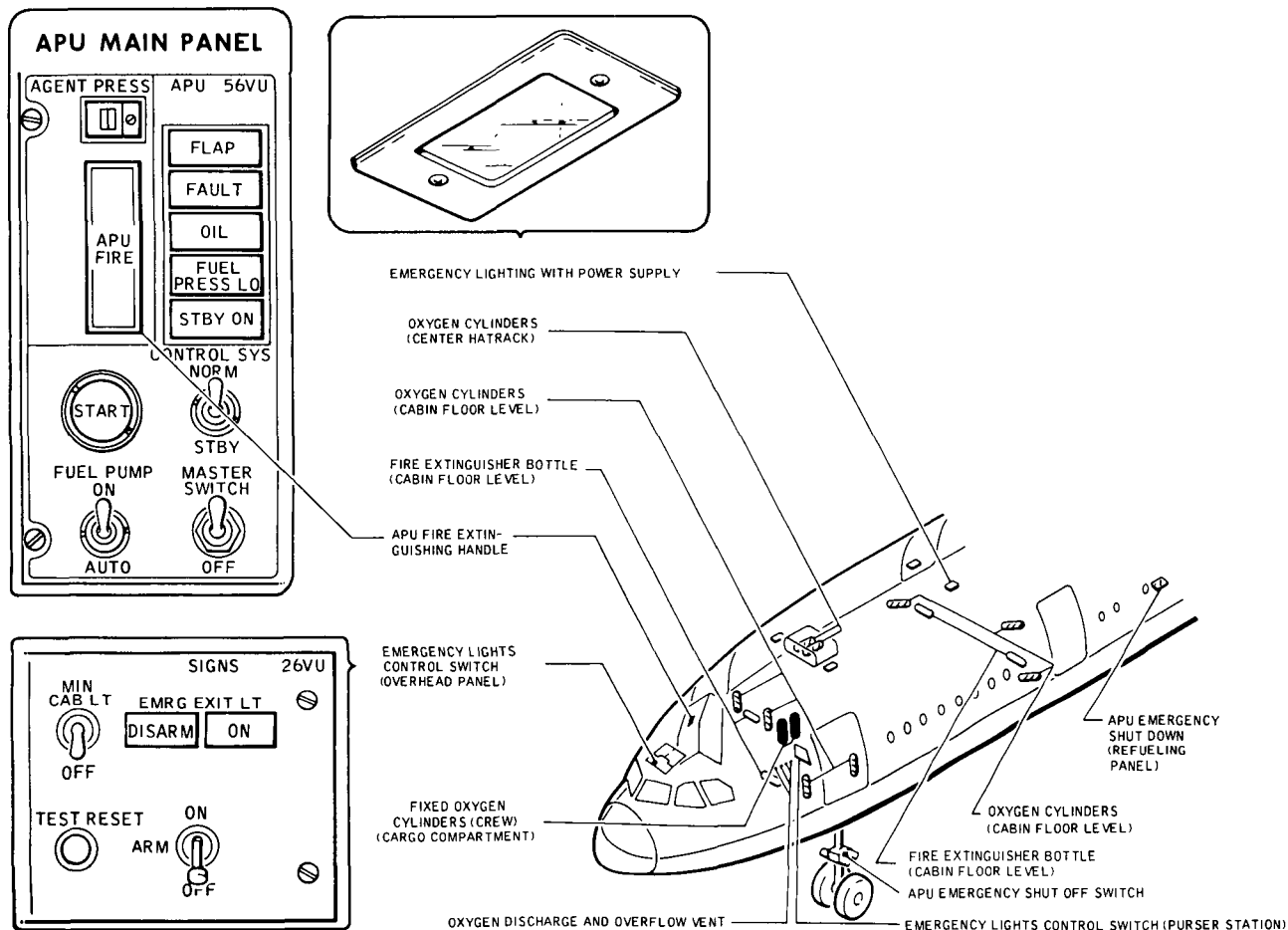


Figure B-33 Continued.

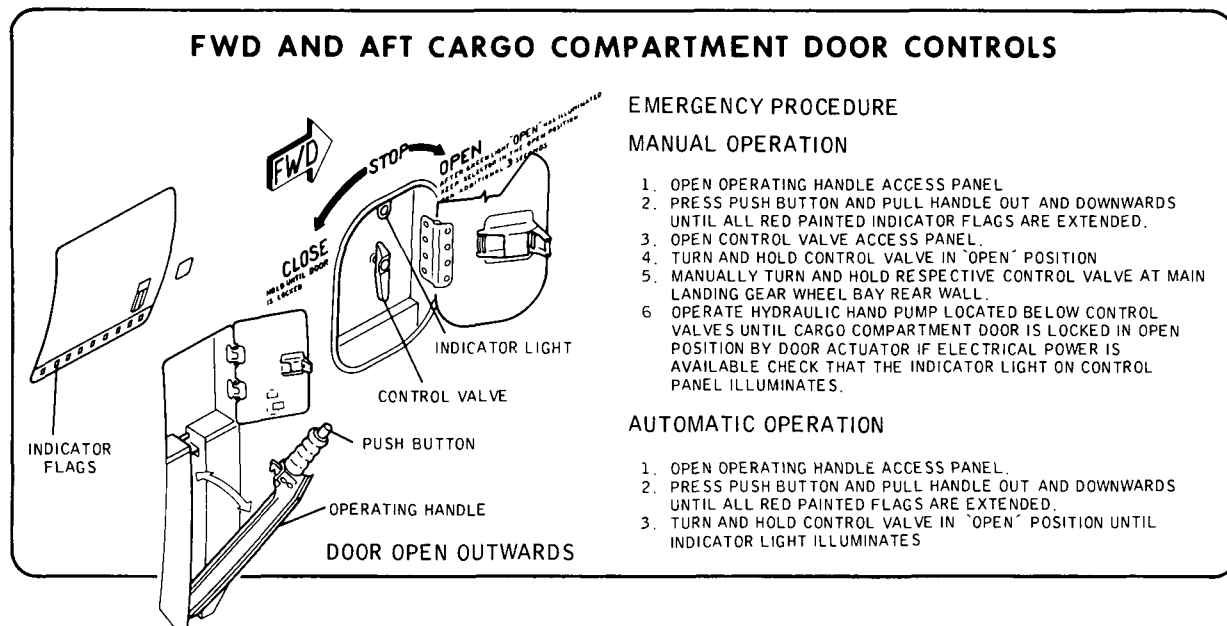


Figure B-33 Continued.