NFPA

402

RECOMMENDED PRACTICE FOR

AIRCRAFT RESCUE AND FIRE FIGHTING OPERATIONAL PROCEDURES FOR AIRPORT FIRE DEPARTMENTS 1978

NATIONAL FIRE PROTECTION ASSOCIATION
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Recommended Practice for

Aircraft Rescue and Fire Fighting Operational Procedures for Airport Fire Departments

NFPA 402 — 1978

1978 Edition of NFPA 402

This document was prepared by the Technical Committee on Aircraft Rescue and Fire Fighting and this present edition was adopted by the Association on November 15, 1978 at its Fall Meeting in Montreal, Quebec, Canada. It was released by the Standards Council for publication on December 4.

This 1978 edition is a complete rewrite of the 1973 edition. The title has been changed from *Standard Operating Procedures Aircraft Rescue and Fire Fighting* to *Recommended Practice for Aircraft Rescue Operational Procedures for Airport Fire Departments.* This 1978 edition has been rewritten according to the NFPA Manual of Style and SI units have been included.

Origin and Development of NFPA 402

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. Companion publications of special importance are NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports;* NFPA 406M, *Manual on Aircraft Rescue and Fire Fighting Techniques for Fire Departments Using Structural Fire Apparatus and Equipment;* NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles;* NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles;* and NPFA 422M, *Aircraft Fire Investigators Manual.*

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Recommended Practice for

Aircraft Rescue and Fire Fighting Operational Procedures for Airport Fire Departments

NFPA 402-1978

Chapter 1 Purpose and Procedures

1-1 Purpose. This recommended practice provides aircraft rescue and fire fighting operational procedures for airport fire departments to assure the efficient utilization of the available aircraft rescue and fire fighting equipment and personnel provided.

1-2 Premises.

1-2.1 Basic Premise. The basic premise on which this recommended practice is predicated is that survival of aircraft occupants takes precedence over all other operations and that fire control is frequently an essential condition to assure such survival. Emphasis is thus placed on the need to respond to aircraft emergencies in the minimum possible time and to employ the rescue and fire fighting techniques recommended herein with maximum skills. These objectives can be accomplished with properly trained personnel working together as a team while employing these operational practices, as applicable, with the best available equipment for this type service.

1-2.2 Equipment and Personnel Premise. This recommended practice is also predicated on having available at the airport, equipment, and personnel to operate such equipment needed for the protection of aircraft operations at airports and heliports as recommended in the following:

1-2.2.1 NFPA 403 (ANSI), *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports.*

NOTE 1: See also the provisions for rescue and fire fighting equipment and services at aerodromes as contained in the *International Standards and Recommended Practices: Aerodromes* (Annex 14), 7th Edition, June 1976, promulgated by the International Civil Aviation Organization (1000 Sherbrooke Street West, Montreal, Quebec, Canada H3A-2R2).

NOTE 2: In the United States of America, the Federal Aviation Administration mandates the provision of airport fire fighting equipment at certain land airports serving CAB-certificated air carriers in *Federal Aviation Regulations,* Part 139.49 and in *FAA Advisory Circular* 150/5210-6B (with Changes 1 and 2).

1-2.2.2 NFPA 414 (ANSI), *Standard for Aircraft Rescue and Fire Fighting Vehicles.*

1-2.2.3 NFPA 412 (ANSI), *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

1-2.2.4 NFPA 424, *Recommended Practice for Airport/Community Emergency Planning.*

1-2.2.5 NFPA 422M, *Aircraft Fire Investigators Manual.*

NOTE: NFPA 406M, *Manual for Aircraft Rescue and Fire Fighting Techniques for Fire Departments Using Structural Fire Apparatus and Equipment,* may be a useful reference for equipment and techniques to deal with aircraft fires where specialized aircraft rescue and fire fighting vehicles (as recommended in NFPA 414) are not available.

1-2.3 Equipment and Personnel Response Premise. As indicated in 1-2.1, rapid response and fire control are often necessary to assist in the survival of aircraft occupants. An added premise of this recommended practice is that airport based fire fighting equipment is available and so located 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 (*see Figure 2-2.2*) is no more than three minutes whenever flight operations are in progress.

This recommended response time is based on international accident location statistics and practical occupant survival and evacuation times obtained from the latest accident and research data available.

In order to obtain this rapid response, many factors should be taken into consideration including adequate alarm systems, fire station and/or vehicle positioning relative to the runway in use, fire fighter training, vehicle acceleration rate and top speed, etc.

At many airports parts of the Critical Rescue and Fire Fighting Access Area may be outside the airport boundaries. It may also contain obstructions, such as: highways, railroads, ravines, bodies of water, etc., which would delay or preclude the required access of emergency vehicles. However, since many accidents do occur in these overrun areas, it is very important to eliminate or reduce these hazards whenever possible. When this cannot be accomplished, preplanning is essential to provide the fastest possible response time under the circumstances involved. The method used should take into account occupant survival capabilities as well as terrain conditions and may require special vehicles, mutual aid agreements with outside authorities, or other procedures best determined by the airport authority and the CFR unit involved.

Primary response time is for the first responding fire fighting vehicle. Other fire fighting vehicles should be able to respond at 30-second intervals thereafter.

Access roads to the Critical Rescue and Fire Fighting Access Area of the runway in use should be maintained in suitable condition for use by the emergency equipment while flight operations are in progress.

NOTE 1: Response time is herein defined as the time elapsed between initial notification of the incident and the time of the first discharge of extinguishing agent at the incident site.

NOTE 2: The Critical Rescue Fire Fighting Access Area is defined as a rectangular area surrounding a runway. Its width extends 500 ft (150 m) outward from each side of the runway centerline, and its length 3300 ft (1000 m) beyond each threshold. (*See Figure* 2-2.2.)

NOTE 3: An evacuation time of 90 seconds for all occupants must be demonstrated for the certification of most aircraft. However, aircraft accident records show that this demonstrated time is often exceeded under conditions of actual emergency.

NOTE 4: Airports should, when updating their Master Plan (Airport Development Plan), include items which would improve response times and facilitate compliance with this Recommendation wherever possible. Such items as Airport Fire Station(s) relocation, two-way access roads (especially in the approach and overrun areas), etc. should be considered.

NOTE 5: The runway diagram in Figure 2-2.2 is based on flexible conversion, with 10,000 ft (3000 m) as a nominal length representative of a major jet airport. The runway end is determined by the threshold lights. Accident locations are determined by reference to the runway end regardless of actual runway length. Hence, the Critical Rescue and Fire Fighting Access Area length requirements should be measured from the threshold lights position.

1-2.4 Premise as to Type Aircraft Covered. This recommended practice is designed as an aid to airport authorities. It is based on the premise that the types of aircraft for which these procedures are designed are those involved in nonmilitary operations.

NOTE: For U. S. Military and Naval Aircraft:

Air Force:	*Technical Manual* 00-105E-9, "Aircraft Emergency (Fire Protection Information)," available from Hq. WR-ALC (MMEOTD), Robins 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 Supt. of Documents, Public Document Dept., U. S. Government Printing Office, Washington, DC 20402.

1-3 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 (litre), outside of but recognized by SI, is commonly used in international fire protection.

NOTE: For additional conversions and information, see ASTM E 380, *Standard for Metric Practice.* (*See Appendix H.*)

1-3.1 If a value for measurement as given in this standard 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.

Chapter 2 Preplanning for Aircraft Emergencies — General Policies

2-1 Need for Preplanning. In order to achieve and maintain a maximum degree of efficiency, preplanning and practice sessions of the operational procedures recommended herein are necessary.

NOTE: NFPA 424, *Recommended Practice for Airport/Community Emergency Planning,* contains guidance on Simulated Aircraft Emergency Exercises. In addition the Airport Fire Department should hold regular drills.

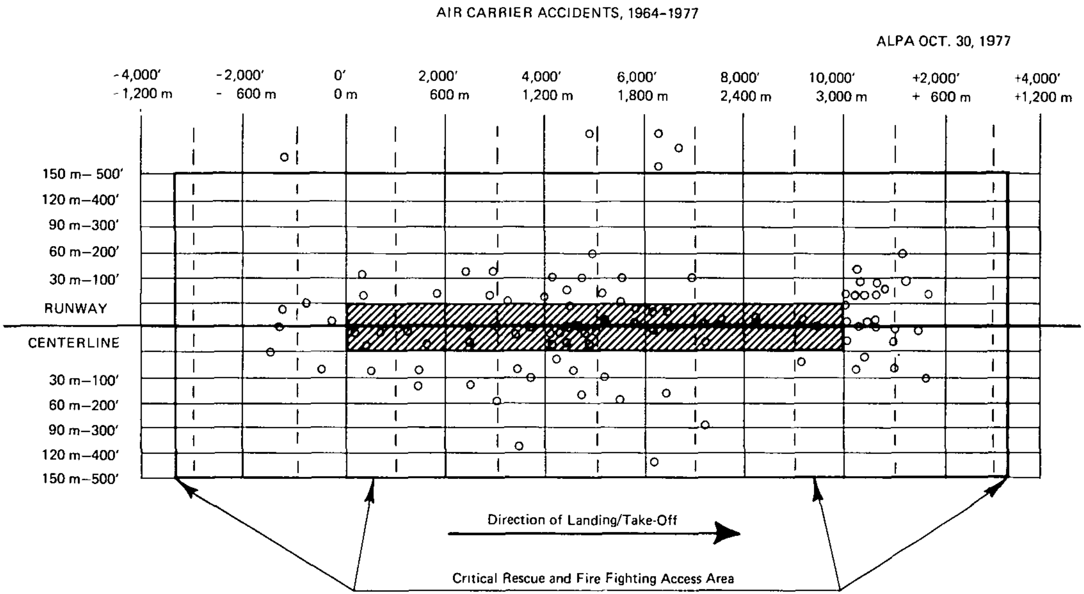
2-2 Preplanning Responses to Potential Accident Sites. To help assure meeting the basic premise as given in 1-2.1 and the equipment and response time premise in 1-2.3 the following preplanning is recommended:

2-2.1 Rescue and fire fighting vehicles should be able to meet the provisions of NFPA 414 to assure their mobility [particularly as regards acceleration, horsepower, drive, and trafficability (on unimproved as well as on paved surfaces)] and should be maintained to assure such performance. Special attention should be given to the skills of the vehicle drivers as their performance in operating the vehicle is critical to their successful utilization.

2-2.2 Trial runs should be made to all areas of the airport with each rescue and fire fighting vehicle to determine its operational capability to reach each site within the designated response time. Since many aircraft accidents occur in the overrun areas of the runways (*see Figure 2-2.2*), it is important to provide quick-access roads for use by the vehicles to enable them to reach these areas. Access roads should be useable under all weather conditions. Bridges (e.g., over gullies, streams, drainage ditches, etc.) where required should be capable of supporting 120 percent of the weight of the heaviest emergency equipment. In the event of temporary construction work in these areas, the access roads should not be impaired during flight operation periods. 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.

NOTE: If impairment is unavoidable, the Airport Fire Chief should be specifically advised of the conditions so that preplanning can reduce any response delays to a minimum.

2-2.3 If the airport is fenced, gates and/or frangible fence sections should be located at strategic locations to allow penetration



DEFINITION. The Critical Rescue And Fire Fighting Access Area is defined as a rectangular area surrounding a runway. Its width extends 500 ft (150 m) outward, each side of the runway centerline, and its length 3,300 ft (1000 m) beyond each threshold.

Figure 2-2.2 Accident Location Chart.

by rescue and fire fighting equipment to land areas outside the airport boundary. Gate locks should be frangible. Keys to gate locks should be carried on each emergency vehicle, by airport security personnel, and designated local authorities.

2-2.4 Grid maps (or similar useful equivalent) should be prepared for each airport and its environs. The area covered by the grid map beyond airport boundaries will vary depending upon the type terrain (or water), the population or structural density of the land area, etc. but a distance of 5 miles (8 km) extending from the center of the airport is frequently used as a norm. Copies of this grid map should be prominently displayed at Air Traffic

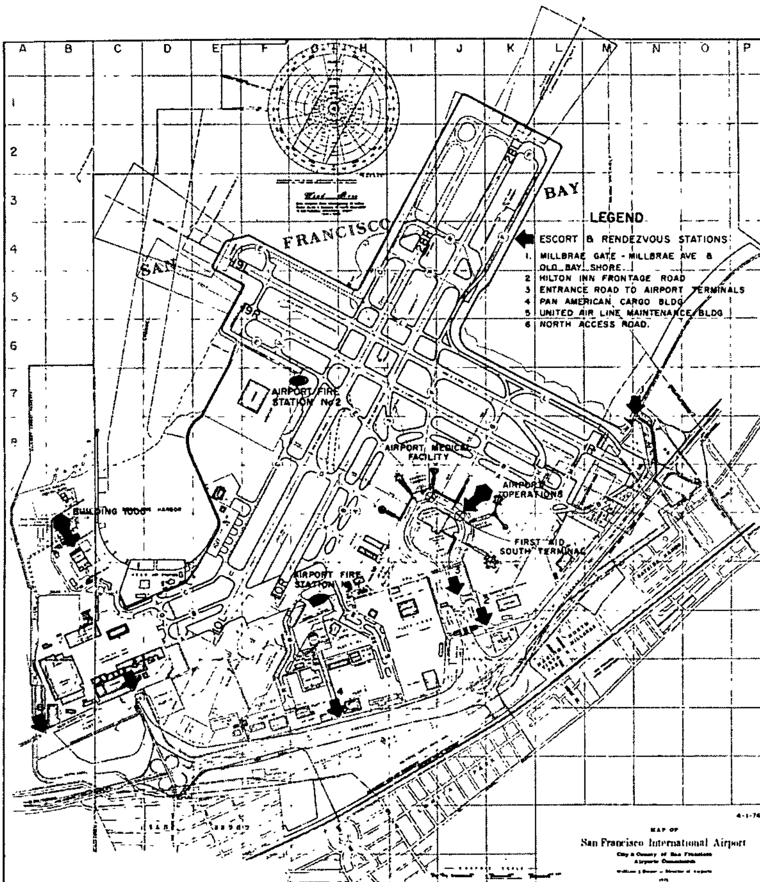


Figure 2-2.4 Typical Airport Grid Map.

Control, the airport operations office, all mutual assistance departments or agencies (police, medical service agencies, telephone exchanges) as well as at each airport and community fire department station. Maps of this type are ruled with numbered and lettered grids (*see Figure 2-2.4*) to permit rapid identification of any point within the map area. If two or more maps are required to encompass the area to be covered, the grid identifications should not be identical. Prominent local features and main roads should be shown as well as compass headings to facilitate locating accident sites.

2-2.5 At airports which frequently experience fog conditions, ground radar equipment would be invaluable to assist in locating aircraft on the ground or to track its course while landing, taking off, or taxiing.

NOTE: Detailed guidance material is covered in Chapter 10.

2-2.6 If fire station doors serving vehicles are electrically operated, standby mechanical means should be available to permit rapid operation of the doors.

2-2.7 A communication system to enlist aid from community or regional fire and rescue forces should be tied in with the airport emergency alarm services to initiate response by such personnel and equipment as needed. The reliability of the alarm services should be tested daily. Off-airport fire and rescue agencies responding to an on-airport accident site should preplan access to the airport property (aircraft movement area). Personnel operating off-airport emergency equipment should be trained in the special procedures that they should follow once on the airport through coordination with Airport Traffic Control (ATC).

NOTE: Subject matter relating to training of mutual aid fire department personnel is covered in Chapter 4.

2-2.8 To assure the availability of adequate protection being maintained on the airport during all flight operations, aircraft rescue and fire fighting equipment should not be dispatched off the airport for fire emergencies except in case of an off-airport aircraft incident/accident or following an evaluation that the level of aircraft protection remaining is adequate.

NOTE: Since the specialized equipment provided at airports is sometimes needed to help extinguish fires which community or regional fire departments may not be fully equipped to handle (e.g., such as those involving large spills of petroleum products) experience has shown that calls for "outside" assistance can be expected. It is difficult and ethically undesirable to deny such assistance, but it must be remembered that the airport department has an assigned mission and can be held, in some cases, to be legally responsible for maintaining a minimum level of protection during aircraft operations. Normally selected units and personnel from the airport department can respond when not otherwise engaged and plans for such contingencies should be prearranged. Back-up fire fighting vehicles carrying agent supplies in excess of those recommended in NFPA 403 (*see 1-2.2.1*) for the category of aircraft operations in progress at the time may be used for such purposes. For instance, if the airport fire fighting equipment is maintained for Category 8 aircraft, and Category 6 operations will be using the airport during the time the airport fire equipment may be needed at off-airport fire duties, then the surplus equipment may be dispatched for such service. A "Notice to Airmen" (NOTAM) must be issued indicating category level of protection.

2-3 Basic Training Needs.

2-3.1 These operational procedures presume that airport fire fighters have a suitable degree of basic training in aircraft rescue and fire fighting techniques, in the knowledge of fire behavior and its ancillary hazards, in the fire extinguishing equipment supplied for services to be rendered, in essential aircraft design features having influence on rescue and fire control operations, in extrication of aircraft occupants, and in the handling of injured survivors. Comprehensive, continuous on-the-job training and refresher courses need to be in existence to maintain proficiency.

NOTE: For further information on these subjects see the references listed in 1-2.2.1.

2-3.2 The following specific basic training needs are given here for emphasis:

2-3.2.1 Because of the complexity of modern aircraft and the variety of types in service, it is virtually impossible to train fire fighting personnel in all of the important design features of each. On occasion, in the early stages of rescue and fire control they may not know the exact type of aircraft involved, especially in unexpected accident situations where the only available information is that an aircraft has crashed. It is desirable, of course, for fire fighters and rescue personnel to be as familiar as possible with each type aircraft normally using the airport, particularly as to:

(a) Location and operation of normal and emergency exits.

(b) Seating configurations.

(c) Location of aircraft fuel tanks.

(d) Location of ejection seats and armament (military aircraft).

General information on subparagraphs (a) through (c) can be found in Appendix A herein and the documents listed in the Note to 1-2.4 provide data on subparagraph (d).

2-3.2.2 Most aircraft crews are trained in handling in-flight fires but 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 types of in-flight fires involve: (1) powerplants; (2) cabin areas; and (3) heaters.

(a) *Powerplant Fires.* It is reasonable for airport fire fighters responding to aircraft emergency originating with an in-flight powerplant fire to expect that the following actions have probably been accomplished by the flight crew:

1. Powerplant fire extinguishing system (if any) utilized.
2. Electrical power to the affected powerplant(s) turned off.
3. Fuel and hydraulic fluid supply to the affected powerplant(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 "wind-down" with high-heat retention continuing for some minutes (*see 4-5.4, Note*). This can constitute a potential ignition source in the presence of flammable vapors. On turboprop and reciprocating engine aircraft, contact with propellers, or entry into their path of rotation, should be avoided during all stages of the emergency.

(b) *Cabin Fires.* The variety of conditions which cause the emergency landing of the aircraft because of a cabin fire preclude responding airport fire fighters anticipating what conditions will exist upon touchdown. If there is immediate evidence of the air crew initiating 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 on-board emergency egress equipment. It is obvious that the deployment of men and equipment into fire fighting and rescue position is being affected 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 (*see 4-6.2*). Such entry could cause an inrush of air into a hostile cabin environment allowing further spreading of an existing fire or allowing smoldering materials to burst into flame. Entry into the aircraft interior should be made by fire fighters wearing self-contained breathing apparatus and prepared with suitable fire suppressing equipment (extinguishers, hose lines, etc.). Because toxic gases may be present, and a cabin search for survivors is the immediate task, respiratory protection is needed. 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. It is also likely, following a cabin fire, that fire may have travelled 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 less likely to inhibit 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.

NOTE: Also see Sections 7-8 and 8-2.

(c) *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.

(d) *Aircraft Cabin Hand Fire Extinguishers.* All aircraft normally carry one or more aircraft hand fire extinguishers, in addition to any installed extinguishing system; these devices can only be expected to handle incipient fires.

NOTE: For further information, see NFPA 408 (ANSI), *Standard on Aircraft Hand Fire Extinguishers.*

2-3.2.3 The need to assist in aircraft occupant evacuation or extrication in an aircraft accident and/or fire will vary with the degree of occupant survivability, the type and occupant capacity of the aircraft, the utilization of the aircraft's emergency evacuation facilities, the fire conditions existing, etc. In transport category aircraft, the flight crew has established emergency procedures that are to be implemented to the extent possible depending on the time-sequence of the accident, impact severity, and/or fire conditions. In general aviation aircraft, such procedures may not be established. In any event, the rescue efforts normally must follow any necessary fire control. 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.

NOTE 1: See also Chapter 7 on Air Crew Emergency Procedures.

NOTE 2: In the newest types of transport category aircraft, aircraft evacuation slides are provided to expedite occupant evacuation. Flight crews are trained in the operation of these slides. When these 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 chute deployment should not be positioned to interfere with such deployment. (*See Appendix D for further information.*)

NOTE 3: Assistance in slide off-loading and evacuating injured passengers from the incident site is an important function for available fire fighters. When high winds, as an example, cause slides to invert or malposition, they might align them properly. It does, however, require four men to hold a deflated slide in an extended position (two at each side).

2-3.2.4 All airport emergency equipment should be provided with 2-way radios, operating on the airport's assigned ground control frequency. It is desirable for the Chief of the Airport Fire Department to be able to be in direct voice communication with the Captain of an aircraft in an anticipated emergency situation so that landing information can be given, apparatus positioning established, and data relayed as to type of aircraft, nature of the emergency, number of occupants aboard, amount of fuel aboard, and other special conditions existing. "Bull-horns" (or "loud-hailers") are useful for communications at accident sites to coordinate air-crew/ground-crew activities, to give operational commands, to direct survivors to places of refuge, etc. Portable "walkie-talkie" radios are also desirable at accident sites to communicate with Airport Control, airport management, arriving back-up equipment, etc. Where apparatus from more than one agency will operate in mutual support, it is desirable that radio frequencies be coordinated or that there be cross-monitoring by base stations.

2-3.2.5 As indicated previously, it is frequently vital to have support fire fighting capability from community and regional (off-airport) fire departments to successfully handle aircraft fire accidents (on or off the airport). In preplanning the use of such support fire fighting services, the following considerations are significant:

(a) Command authority at any accident site should be predetermined according to the jurisdictional responsibilities of the departments involved.

(b) 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.

(c) It is important to familiarize structural fire department personnel with the special problems relating to access to airport movement areas and operations on airports.

(d) Structural fire fighting equipment seldom normally carries significant amounts of water as compared to the amounts normally carried on major aircraft rescue and fire fighting vehicles. They are useful in relaying water from hydrants, reservoirs, or other sources to maintain fire fighting operations.

(e) Structural fire fighters can supply needed manpower to handle tools and equipment for fire control, assist in rescue operations, and help in handling hose, protecting exposures, etc.

Chapter 3 Responses to Aircraft Emergencies

3-1 General. Airport Fire Department response to a call for assistance in an aircraft flight or ground emergency is based on the premise that dire consequences may result. The potential damage and fire propensities of aircraft, because of their inherent design characteristics, necessitates maximizing response to the limit of any airport fire department's capability. Patterns of behavior in aircraft emergencies are too varied to permit "standardized" response procedures. Often an incident that was prejudged to offer only a potentially "minor" problem can evolve into a "major" accident by circumstances that were not predicted even by experienced flight crew personnel. Limitations imposed on ground fire fighting operations, including both the economic restraints on the quantity and quality of airport fire department equipment and/or manpower provided and aircraft design factors permitting high fire risk by combining aircraft ignition sources and combustibles, makes it vital to respond to *each* emergency with the *full* complement of available equipment and manpower.

3-2 Types of Alerts.

3-2.1 General. Internationally the terms used to describe various "categories" of accident alerts are not standardized. In the U.S.A., for example, the Federal Aviation Administration (FAA) uses the terms Alert I, Alert II or Alert III. The International Civil Aviation Organization (ICAO) uses such classifications as: "Aircraft Accident," "Full Emergency," and "Local Standby." In this text both the FAA and ICAO terms are "matched."

3-2.2 "Local Standby" ("Minor Difficulty") — Alert I. This condition is when an aircraft approaching the airport is known or is suspected of having developed an operational defect but the trouble is not such as would normally involve serious difficulty in achieving a safe landing, when an aeromedical evacuation aircraft is approaching (*see Chapter 9*) or, when in accordance with airport management policies, employing standby procedure is judged desirable.

NOTE: Some airports will have "standing orders" for "standby" protection because of their configuration; because of temporary construction work going on in the airport movement area; because of adverse weather conditions [for example due to snow or ice conditions or during low-visibility aircraft operations (*see Chapter 10*)]; because they routinely consider it wise during landings and takeoff of certain categories of aircraft; or because the airport fire station is not strategically located to meet the response times specified (*see 1-2.3*).

Under these conditions, at least one major aircraft rescue and fire fighting vehicle will be driven to a predetermined position and be manned to permit instantaneous use in the event that an incident or accident subsequently does result. The standby crew and the Officer-in-Charge should be advised of the information specified in 3-2.2.1 through 3-2.2.5 in all cases if the nature of any known or suspected defect in the aircraft necessitates the indicated precautions. Equipment remaining at the Airport Fire Station should be placed in an "Alert" status, with apparatus doors open, engines running, and manpower assigned to such vehicles in a "ready-to-respond" attitude.

3-2.3 "Full Emergency" ("Major Difficulty") — Alert II. This condition is when an aircraft is, or is suspected to be, in such trouble that there is danger of an accident. Because this type of potential accident is "forecasted," the Airport Fire Department is usually provided with detailed information which allows the Officer-in-Charge to prepare for likely contingencies. The information sought in 3-2.2.1 through 3-2.2.5 should be made available to permit better preplanning of equipment utilization. A full response should be made with the emergency equipment positioned, during the programmed alert period, to provide the best possible coverage of the presumed potential crash site with the objective that at least one of the major aircraft rescue and fire fighting vehicles will be able to provide the required protection within the briefest period of time following the aircraft's coming to rest. Preplanning for such pre-emergency positioning of equipment should be worked out with Air Traffic Control (ATC) for the variety of circumstances that might be anticipated.

3-2.4 "Aircraft Accident" — Alert III. This condition exists when an aircraft accident has occurred on or in the vicinity of the airport. Regardless of whether this alarm is received from Air Traffic Control (ATC), from any other source, or is observed by Airport Fire Department personnel, full airport fire and rescue procedures should be put into effect. Wherever possible, information should be obtained by radio from ATC during response regarding:

(a) The location of the accident by a preplanned system such as grid map coordinates, on- or off-airport landmarks, etc.

(b) The type of aircraft involved (manufacturer and identification type number or common designation).

(c) The nature of the emergency (whether fire is involved; the aircraft wreckage is in one piece or scattered; the aircraft is level or upended, etc.).

(d) The number of passengers and crew aboard (and any data on the extent of their injuries and/or whether the crew has initiated evacuation procedures).

(e) An estimate of the amount of fuel aboard.

Sometimes much of the desired data will not be known to ATC or the reporting agency and the Airport Fire Department personnel must, in such cases, anticipate the most adverse situation upon arrival and mentally and physically prepare themselves for instant action. In cases when the Officer-in-Charge deems it advisable, he should initiate calls for mutual aid assistance in accordance with the Airport/Community Emergency Plan (*see NFPA 424*) during the response or upon arrival. On arrival he should also advise ATC of conditions found, particularly where such conditions might interfere with or introduce a hazard to any continuing or planned flight activity on the airport, and where it is obvious that the fire protection at the airport will be reduced or curtailed for the duration of the existing emergency period.

3-3 Communications Requirements. Air Traffic Control (ATC) and aircraft rescue and fire fighting equipment should have facilities to maintain radio contact with responding or standby equipment to assure full coordination of the emergency responses, or to alert the Officer-in-Charge of any changes in a distressed aircraft's flight plan or existing emergency conditions which could affect the touchdown point or ultimate behavior of the aircraft following ground contact. When and if it is determined that the "Alert" status has changed from an Alert I to an Alert II or Alert III condition, the Officer-in-Charge should upgrade his response capability immediately and ATC should notify the pilot of the distressed aircraft of the ground emergency precautions being implemented.

Conversely, if the "Alert" is "downgraded," or, the situation no longer dictates having any or all of the responding apparatus at the scene, the units should be returned to the fire station to be ready for redeployment.

Chapter 4 Factors Common to All Aircraft Fire Emergency Responses by Airport Fire Departments

4-1 Protective Clothing for Airport Fire Department Personnel. All personnel who may be required to conduct fire fighting operations or assist in rescue efforts at an aircraft fire accident/incident should be provided with and wear proper and complete protective clothing in accordance with the established policy of the Airport Fire Department. Personnel so equipped need to be well informed and fully trained in recognizing the *limitations* as well as the value of such protective equipment to avoid a false sense of security occasioned by the availability of such protection. Also, they must realize that they could unwittingly lead unprotected personnel through dangerous atmospheres unless additional protective measures are taken during rescue efforts. Such additional measures may include providing a "secured" route of egress achieved by establishing a foam "blanketed" rescue path and protective heat screens against lingering exposure fires. Care should be taken to avoid direct application of foam on rescuers, unless absolutely necessary, as foam can cover face shields and impair vision. Intermittent drenching of protective clothing with liquid could cause steam scalds under high heat exposure conditions. In cases where this occurs, either accidentally, or as a protective measure, application should continue until those affected are clear of the high heat area.

NOTE: See also Section 4-9 of NFPA 403 on protective clothing.

4-2 Approaching the Accident/Incident.

4-2.1 Route to be Selected. Equipment should approach to accident/incident by way of the route providing the *quickest* response time (*see 1-2.3, Note 1*). This may not necessarily be the *shortest* distance to the scene. Traversing rough ground, grassed areas, etc., may consume more time than traveling a greater distance on paved taxiways, ramps, roads, etc. Speed is vital. Preferred routes, especially within the Critical Rescue and Fire Fighting Access Area should be pre-selected. When nearing the incident scene vehicle operators should be extra cautious to avoid occupants of the aircraft who may have been thrown free and/or are walking away from the area in dazed condition. Nighttime responses will require extra diligence by drivers and observers and intelligent use of spot or floodlights.

4-2.2 Need for Alternate Routes. In some cases, runways and taxiways can be blocked by parked aircraft awaiting take-off, or taxi clearance, and vehicle operators must be aware of alternate routes that can be used which will not delay their response.

4-2.3 Soil Trafficability. The load-bearing characteristics of the airport soil structure under various weather conditions should be known and drivers should be trained to master off-road driving problems.

4-2.4 Special Precautions for Gear Emergencies. For emergencies involving gear malfunction or tire difficulty, there is always a possibility of the aircraft veering off the runway and possibly hitting emergency equipment. It is difficult to predict the touchdown point. Assuming that there are two or more vehicles available it may be discreet to locate vehicles on each side of the runway, at a suitable distance from the runway edge, and, following the aircraft's touchdown, follow the aircraft to its resting place.

4-3 Positioning of Equipment.

4-3.1 Positioning of Rapid Intervention Vehicles (RIV) or Light Rescue Vehicle(s):

4-3.1.1 Normally, the RIV reaches the accident site first. The mission of its crew can be to prevent fire outbreak and assist in rescue operations, and/or control or extinguish any incipient fire. Alternatively, the crew should try to secure an evacuation path or to size up the rescue and fire fighting problem and be in a position to direct the positioning of the major vehicles upon arrival.

4-3.1.2 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 located.

4-3.1.3 Since the RIV usually have limited extinguishing capability, caution must be taken to avoid placing the vehicle in locations that, in the event of a sudden extension of the flame, could put both vehicle and operators in a dangerous position.

4-3.2 Positioning of Major Fire Fighting Vehicles.

4-3.2.1 Major units equipped with turrets for the mass application of the extinguishing media should be positioned as to make effective use of the turret streams. It is vitally important to avoid wastage of the limited amounts of agent available so that turrets should be used only when they are being effective. Frequently, handlines control the rescue paths so it is equally important to locate equipment to permit the effective deployment of these lines. Proper positioning of apparatus is, in fact, the key to successful operations.

4-3.2.2 The main initial object is to safeguard the escape routes. The type and number of nozzles available will vary with the type and the scope of the equipment provided. Appendix A illustrates some useful techniques.

4-4 Methods of Applying Aqueous Extinguishing Agents.

4-4.1 Aqueous Film Forming Foam (AFFF) — Turret Application. AFFF acts both as a barrier to exclude air or oxygen, and in addition, produces an aqueous film which spreads over the fuel surface. Positioning of the equipment to permit maximum effective use of turrets and handlines is equally important with AFFF as with protein foam, however, the method of application differs. The basic principle is to distribute a visible blanket of sufficient thickness over the burning liquid area to act as a vapor suppressant. Because AFFF is compatible with protein foam in applied form, the two agents can be applied in sequence or simultaneously without ill-effects. The equipment normally used for applying protein foam can be used for AFFF application. The manufacturer of the equipment and agents should be contacted for futher information.

NOTE: AFFF and protein foam *concentrates* should not be mixed. Where AFFF is used in equipment that formerly used protein foam, the foam tank and system must be *thoroughly* flushed. (*See NFPA 412.*)

4-4.2 Fluoroprotein Foam — Turret Application. Fluoroprotein foam concentrates, while being basically similar to protein foam concentrates, are modified by the addition of fluorinated surfactant. They produce a very fluid air or oxygen-excluding foam blanket and may also deposit a vapor suppressing aqueous film on the fuel surface. Equipment normally used for protein foam should be used for fluoroprotein foam application and may utilize full range or dispersed patterns to distribute the foam over a wide area, or indirect deflection techniques. Although the foam has a high degree of tolerance to contamination by fuel, direct plunging of the foam stream should be avoided. Its inherent compatibility with dry chemicals and other foams, including AFFF, allows twin agent or two-point applications to be employed.

4-4.3 Protein Foam — Turret Application. The initial discharge of protein foam should be along the line of the fuselage and then directed to drive the fire outwards. When selecting the position to accomplish this purpose, 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, protein foam streams should not be directed towards the fuselage at right angles as this may tend to drive burning fuel toward the occupied areas, handicapping survival of trapped occupants. Similarly, care must be exercised to avoid the possibility of disturbing a 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 blanket with the least possible turbulence to the fuel surface. There are two basic methods of applying protein foam. One involves the use of a straight stream which can be applied directly or indirectly on a surface at some distance. The second is to use a spray or diffused stream at close range. This has the advantage of simultaneously isolating the fuselage from burning fuel by building up a protein foam cover. Whenever foam equipment is being subjected to a periodic routine check, the opportunity should be taken to train crew members in these methods of application.

NOTE: 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.

4-4.4 Hand Line Applications. Supportive protective measures with handlines are usually necessary to provide access to egress routes for both victims and rescuers. Illustrations of various patterns for this operation can be found in NFPA 406M. A word of caution, however, is necessary if the attack method requires both turret and handline operation. Care should be taken to avoid the application of protein foam or AFFF on the face shields of fire fighters as it will impair the handline operator's vision. Care also needs to be taken to avoid wetting the protective clothing of handline operators as drenching of protective clothing could cause steam scalding under extreme high heat exposure conditions. Whether or not there is an immediate need for handlines, 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.

NOTE: See also Section 4-1.

4-4.5 Auxiliary Water and Extinguishing Agent Supply. Auxiliary water tanks should be dispatched whenever there is an indication for any need and especially when the accident site is known to be beyond normal fire protected zones (underground water mains and hydrants) or where water relays may be required. Prearrangements should be made to assure that additional supplies of extinguishing agents are brought to the scene by general purpose vehicles. Careful utilization of agents supplied is particularly important in unprotected off-airport locations and techniques of employment must be carefully selected to permit most advantageous use. Airport maintenance equipment includes a ladder truck, an elevated platform truck, or portable emergency lighting equipment; it is important that prearrangements also include their response when needed.

4-5 Attack Methods.

4-5.1 Attacking 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 or AFFF solutions or combination 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.

4-5.2 Combined Agent Usage. The main attack on the fire will normally be by means of mass application of foam, or alternately by the combined use of AFFF, protein foam, and foam-compatible dry chemical. Where foaming agent alone is used as the principal agent, a suitable back-up agent must be available to deal with pockets of fire which may be inaccessible to direct application. This will generally be provided in the form of dry chemical, carbon dioxide, or a halogenated extinguishing agent, to be used on running liquid fuel fires or in concealed spaces, such as wing voids, in an engine nacelle, or wheel well.

4-5.3 Protecting Uninvolved Fuel Tanks. If exposure fires threaten exposed but not involved aircraft fuel-containing structures, they should be protected by foam or water spray streams to prevent their involvement. Water spray systems should not be allowed to dilute foam coverage of any fuel spill areas in critical areas.

4-5.4 Eliminating Sources of Ignition. Should a large fuel spillage occur without fire ensuing, it is important to eliminate as many ignition sources as possible while the spilll is being neutralized or covered with foam.

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

4-5.5 Precautions Around Powerplants. Rescue and fire fighting personnel should stay at least 25 ft (8 m) from the intake of an operating turbine engine to avoid being injured by the suction effects, and 150 ft (45 m) from the rear to avoid being injured or burned by the blast effects. On piston or turbo-prop aircraft the propellers should never be touched, even when at rest.

4-5.6 Handling Combustible Metals. Burning magnesium or titanium parts should be ISOLATED where possible; otherwise, cover with dry dirt, dry sand, or use special extinguishing techniques to prevent reflashes. (*See NFPA 403 for further information.*)

4-5.7 Handling 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. (*See 6-1.7 for added safety precautions.*)

4-5.8 Handling 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.

4-5.9 Handling Turbine (Jet) and Turbo-prop Fires. Fires confined to the combustion chambers of the subject engines may be best controlled if the aircraft crew is able to keep the engine rotating if such action is safe from the point 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 re-ignition occurs, a halogenated fire extinguishing agent or carbon dioxide may be used to attempt extinguishment or dry chemical may be used to attempt extinguishment. The aircraft operator should be advised of the type of extinguishing agent used.

Also avoid using foam in the intake or exhaust unless control cannot be secured with other agents and the fire appears to be spreading to previously uninvolved areas. Fire fighters should stand clear of the exhaust and intake chambers when protecting combustibles from impinging flames.

NOTE: 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 also NFPA 403, Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports.*)

4-6 Rescue Assistance.

4-6.1 Basic Principles. Evacuation of personnel involved in aircraft accidents/incidents and assistance to those who cannot remove themselves without help 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.

4-6.2 Methods of Evacuation/Rescue. Evacuation and rescue assistance should be accomplished through regular aircraft doors and hatches wherever possible or through breaks in the fuselage. Airport Fire Department personnel should be trained in forcible entry procedures and be provided with the necessary tools to achieve this mission. (*See NFPA 403 and 414 for further information on tools.*) Aircraft windows are often used for evacuation, rescue, or for ventilation, especially those designed as "emergency exits." These exits have latch release facilities on both the outside and inside of the cabin. Most of these exits open TOWARDS THE INSIDE. Aircraft cabin doors are also used as emergency exits except those incorporating air-stair facilities. With a FEW EXCEPTIONS, these doors OPEN OUTWARDS. When positioning ladders 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, and others downward. Further, extreme caution should be taken to avoid being struck by the escape slides or stairs that may automatically be released when doors are opened. Doors or windows should be opened on the downwind side for ventilation. It is essential that Airport Fire Department personnel have a sound knowledge of these design features of aircraft normally using the airport. (*See also Appendix A.*)

4-6.3 Moving Aircraft Wreckage. When it is necessary to use power equipment to move portions of a damaged aircraft, to assist in rescue operations, or to control the fires, discretion must be used lest such procedure result in strains which might release quantities of fuel from partially damaged tanks or cause greater injuries to entrapped personnel. (*See Chapter 6.*)

4-6.4 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 5 Aircraft Accidents in the Water

5-1 General. 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 event of an aircraft accident/incident in the water. Specialized equipment for rescue and fire fighting may include fire/rescue boats; air-cushion vehicles (ACV); helicopters; coastal patrol boats; etc.

NOTE: Appendix B illustrates some typical water fire/rescue equipment in service.

5-2 Probability of Fire. In such incidents the possibility of fire is normally reduced because of the hopeful 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 is available.

5-3 Spillage of Fuel on Water Surfaces. 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 quantities of fuel will be thus found floating on the surface of the water. Boats having exhausts at the waterline may present an ignition hazard if operated where this condition is present. Wind and water currents should be taken into consideration in order to deal effectively with floating fuel 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 with large velocity nozzles, neutralized by covering them with foam or a special inerting material, or boomed to contain the fuel in a safe area prior to absorption, dilution, or removal.

NOTE: Preplanning with the EPA-Water Pollution Control — may provide emergency assistance during this operation.

5-4 Organizing Diving Units/Use of Divers.

5-4.1 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 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.

5-4.2 In all operations where divers are in the water, standard diver's flags should be flown and boats operating in the area should be warned to exercise extreme caution.

5-4.3 Where fire is present, approach should be made after wind direction and velocity, water current and swiftness 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.

5-4.4 It should be anticipated that victims are more apt to be found downwind or downstream. This should be taken into consideration in 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.

5-4.5 Where occupied sections of the aircraft are found submerged, there remains the possibility that there may be enough air trapped inside to maintain life. Entry by divers should be made at the deepest point possible.

5-5 Other Considerations.

5-5.1 Where the distance offshore is within range, synthetic fibre-covered, rubber-lined fire hose can sometimes be floated into position by divers or boats and used to supplement other means of fire attack.

5-5.2 Where occupied sections of aircraft are found floating, great care should be exercised not to disturb their watertight integrity. Removal of the occupant should be accomplished as smoothly and quickly as possible. Any shift in weight or lapse in time may result in its sinking. Rescuers should use caution so that they are not trapped and/or drowned in these situations.

5-5.3 A command post should be established at the most feasible location on adjacent shore. This should be located in a position to facilitate implementing the airport/community emergency plan in accordance with guidelines established by the authority having jurisdiction.

NOTE: See NFPA 424, *Recommended Practice for Airport/Community Emergency Planning.*

Chapter 6 Aircraft Post-accident Procedures

6-1 After fire suppression and survivor rescue have been completed, the following procedures should be observed.

6-1.1 Rescue units should familiarize themselves with all regulations, national and local, regarding movement of wreckage and disposition of human remains (*see Appendix C*).

6-1.2 When it has been decided by the investigative authority having jurisdiction that the aircraft can be moved, interior portions of the aircraft should first be ventilated. Runway and ground surfaces should be thoroughly flushed of all flammable liquid spills before moving aircraft and thoroughly rechecked after the removal before permitting normal traffic to resume. Fuel should be drained by qualified technicians using approved methods (*see NFPA 407, Standard for Aircraft Fuel Servicing*) prior to removing fuel containing elements of the damaged aircraft, if conditions necessitate and permit. Fuel removed should be measured and samples retained for later possible analysis in connection with the accident investigation. One rescue and fire fighting unit should be retained at the site while this defueling work is performed.

6-1.3 If the aircraft or parts must be moved prior to completion of full investigation, a record should be made of the accident 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 be moved without the authority of the National Transportation Safety Board or their designated agents (*see Appendix C*).

6-1.4 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 responsible medical authorities. Premature body removal has, in many cases, interfered with identification and destroyed pathological evidence required by the medical examiner, coroner or authority having investigational jurisdiction. (If body removal is necessary to prevent further incineration, the original location should be noted, and the body so labelled and reported to investigators.)

NOTE: See NFPA 424, Recommended Practice for Airport/Community Emergency Planning, for futher information.

6-1.5 The location of mail sacks and pouches should be observed and this information given to postal authorities. If necessary, the mail should be protected from further damage by removal to a secure location such as the operations command post.

6-1.6 If radioactive materials are believed present, procedures should be carried out as prescribed in Appendix B.

6-1.7 Aviation fuels and hydraulic fluids may cause dermatitis by contact with the skin. Emergency personnel who have had these fluids spilled on them should wash thoroughly with soap and water as soon as possible. Fuel-wetted clothing should be changed promptly.

Chapter 7 Flight and Airport Emergency Personnel Duties and Responsibilities in Handling Aircraft "Incidents" and Emergencies

7-1 General Purpose. 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. Unlike major aircraft emergencies where crew efforts are clearly directed to a common goal, many factors must be taken into consideration before action is taken on emergencies such as "hydraulic failures," "bomb scares," "fire warnings" and other such aircraft "incidents."

7-2 Responsibilities of Flight Crews and Airport Fire Department Personnel. The responsibilities of aircraft flight crews and airport fire department personnel should be clearly defined and under all conditions the prime concern is directed to the safety of those persons aboard the aircraft and any others involved in the incident/emergency. In many cases, this will necessitate aircraft emergency evacuation procedures. Duties and responsibilities can be generally defined as follows.

7-2.1 Flight Crews. Since conditions and facilities differ at airports, flight crews hold the primary responsibility for the aircraft and its occupants. The final determination to evacuate an aircraft and the manner in which the evacuation is carried out is thus at the discretion of the flight crew, provided crew members are able to function in the normal manner at the time of the accident or emergency.

7-2.2 Airport Fire Department Personnel. It is the airport fire department personnel's responsibility to assist the flight crews in any way possible. Since flight crew visibility can be restricted, airport emergency crews should make an immediate appraisal of the external portions of the aircraft and report unusual conditions to the flight crews. 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 may have to initiate the necessary actions, hopefully with prior consultation of the aircraft operator's representative(s) at the airport. In some incidents (such as where hijacking threats exist, are in progress, or where bomb threats have been made), special security forces may be available to assume the primary responsibility and the fire department personnel may provide support services.

7-3 Communications. Because of the necessity for effective communications between flight crew and the airport fire department personnel, 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.

7-3.1 Radios. Most aircraft rescue and fire fighting equipment is on a fixed radio frequency and through cooperation with the control tower the aircraft can be requested to change to this frequency. Other frequencies may be available on equipment which will respond, such as airline vehicles which have radios on a so-called "company" frequency.

7-3.2 Aircraft Intercom. Where aircraft engines are running, radio communication near the aircraft may be very difficult. Most aircraft are equipped with "intercom" systems where "jacks" are generally located under the forward portion of the aircraft, behind an access door. Airport Fire Department personnel should investigate this possible means of communication and carry the necessary head-set and microphones to plug into these facilities. Even with the engines running, direct communications with the flight crew can be established by use of this system.

7-3.3 Other Communication Means. Where other means of communications cannot be established, it is advisable for the officer in charge of the Airport Fire Department personnel to report to the left side of the aircraft nose and establish direct voice communcations with the captain of the flight crew. Portable amplifiers may prove valuable for this type of communication. It may be necessary to resort to hand signals to relay the information.

7-4 Incidents Where Aircraft Fire Warnings Occur. Since it is sometimes difficult for the flight crews to make an accurate appraisal of fire conditions following actuation of an aircraft fire warning indicator, it is advisable to bring the aircraft to a stop and allow Airport Fire Department personnel to 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 inspections of affected areas or by checking external evidence of smoke or heat.

7-5 Bomb Scares. Aircraft involved in "bomb scare" incidents should be parked in an area at least 1,000 ft (300 m) away from terminal buildings and other structures and a similar distance from other aircraft until proper investigations are completed. If passengers are aboard and the scare is determined to be "real," the aircraft should be evacuated by the fastest means feasible, via the method selected by the aircraft captain (pilot) or highest ranking crew member aboard at the time. It may be necessary to use aircraft emergency evacuation slides or built-in stairs in cases where time-urgency exists. It may be feasible to use mobile aircraft loading stairs. In the U.S.A., Air Traffic Control (ATC) has procedures for such incidents in FAA Handbooks which should be followed. 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 or departments. The United States Army has Explosive Ordnance Disposal Specialists located throughout the country whose services may be enlisted. Passengers evacuated from aircraft because of a bomb scare should be advised to leave their baggage aboard the aircraft. 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. 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. Control of any fire and assisting in any associated rescue operations is a function of the Airport Fire Department. The FAA Office of Air Transportation Security (SE-1) should be contacted for further guidance.

7-6 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) unless the aircraft has installed auxiliary power units (APUs) in order to provide lighting and communications aboard the aircraft. This may hamper any needed aircraft rescue operations to some extent and consideration should be given to this problem. In addition to the normal hazards involved with propellers turning on the turbo-prop or reciprocating engine aircraft, the turbojet engines present additional problems which may adversely affect rescue operations. Areas directly ahead of and for a considerable distance behind the turbojet engines, should be avoided by persons on the ground and evacuating passengers. In addition, the turbojet engines will turn for a considerable time after shut-down. This must be considered in positioning of airport emergency equipment and in evacuating passengers from the aircraft.

7-7 Emergency Equipment Positioning. Reciprocating engine aircraft provide more diversification for approach positioning of airport emergency equipment than do the turbojet aircraft. Due to the swept-back wing configuration and because of the heated atmospheres behind turbine engines, most airport emergency crews favor an approach and set-up on the nose of jet aircraft where fire conditions do not exist. This will not always be considered a standard approach as many factors influence this determination. Wind conditions, terrain, type of aircraft, cabin configurations and perhaps other factors (including security considerations), can dictate the optimum approach in a given circumstance. The flight crew may be in the best position to recommend proper positioning of the emergency equipment dependent upon the nature of the emergency, the aircraft type and occupancy. On combined cargo-passenger aircraft, the airport crews should be notified of cabin configurations, since some cargo areas extend as far aft as the overwing exits, making them unavailable for emergency evacuation.

7-8 Handling Fire Situations. Priority must be given to controlling any fire on the exterior of the aircraft before beginning rescue activities and thus emphasis must be placed on control of any fuel spill fires on first arrival. 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. Where transport-category aircraft are involved, however, particularly the "wide-body" types, the burning fuel spill may extend over a large area with the aircraft (resembling a highly combustible three-story building) in the middle of the fuel spill. Fire attack in the latter situation may call for initially positioning the aircraft fire fighting vehicles to achieve the external fuel fire control and suppression, using foam, followed by utilization of the available water supply following "structural fire fighting techniques" to cover forcible entry, introduction of water spray into the interior of the aircraft for fire suppression, and for ventilation/smoke removal, where possible. Personnel conducting size-up of any aircraft interior fire situation following evacuation or extrication of occupants should recognize the peculiarities of aircraft structures, such as the absence of fire stops at floor lines, behind wall paneling, and above ceiling spaces in aircraft cabins, as well as the combustibility and toxicity of cabin furnishings. Since aircraft interior fires are principally Class "A" fire situations, certain structural fire fighting techniques and appliances will be found effective. These techniques include applying large-volume water fog nozzles for direct interior application or using partition nozzles, cellar pipes, etc., for indirect application to areas not immediately accessible.

NOTE: See also 2-3.2.2(b) and Section 8-2.

7-9 Aircraft Evacuation.

7-9.1 Determinations regarding evacuation of the aircraft are normally made by the flight crew with available Airport Fire Department personnel providing whatever assistance is needed. Flight crews receive extensive training in aircraft emergency procedures and are thus in the best position to make decisions involved in the optimum evacuation procedures to be used 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 one reason or another or are being held incommunicado. Under these circumstances the burden may shift to ground personnel.

7-9.2 Emergency Landings — Flight Crew Considerations. Prior to any transport category aircraft emergency landing, flight crews normally will consider passenger distribution within the cabin. With the advent of multiple-class service such as first class and economy, dual usage of the aircraft for cargo as well as passengers, distribution of passengers into smoking and nonsmoking zones, and the practice to leave "middle" seats in 3-seat configurations vacant when load factors permit, it is possible that some cabin areas will have a higher passenger density than others during normal flight routines. Distribution of passengers to expedite use of potential emergency exits thereby lessening overcrowding at any one, and placing a crew member at each exit to facilitate its use are practices commonly followed where time and circumstances permit. Most "standard" airline evacuation procedures call for emergency evacuation to be "weighted" toward the rear of the aircraft on the valid theory that impact damages and fire location are more likely to adversely effect forward portions (forward of the wing trailing edges). This practice may, however, cause the aircraft to shift its position if such an action is taken after touchdown. Some other factors indicate need for flexibility in planning; forward exiting is more "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, bypassing other exit potentials, especially under any mental strain or sense of panic. Overwing exits and other emergency exits requiring physical agility may be shunned by those fearing their ability to use same effectively. If the cabin interior is obscured to any appreciable extent such as by darkness, the presence of dense smoke, tumbling of baggage from overhead racks, etc., disorientation of passengers can further complicate orderly evacuation. If the nose gear fails in abnormal landings, the aircraft may be in a "tail-high attitude." Often an aircraft fuselage will "open-up" due to impact forces and failure of main gears. 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.

7-9.3 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, however, can involve a degree of personal injury risk to the aircraft occupants and if time and conditions permit, alternate aircraft evacuation stairs may be requested by the flight crew. Such evacuation stairs should be used wherever possible because of their safety advantages. Such stairs and even fire department ladders may be advantageous also for evacuation of personnel from wing surfaces where the distance from the wing to the ground involves potential leg or body injuries to those forced to use this means. Evacuation conditions may be serious when the aircraft is in the normal "landing gear down" position if the flaps are not in a "full down" position, the spoilers are in an "open" position, or, on some aircraft, if the inflated ramp device in the wing area has failed to operate. If the fire conditions existing or fuel spills in the area present a distinct flash fire hazard alternate escape routes might have to be chosen. Ground personnel may be in a better position to evaluate such problems than the flight crew whose lines of sight may be restricted from the cockpit or cabin. The Officer-in-Charge of the airport crew should not hesitate to communicate such information to the flight crew. The choices by the flight crew to commence the needed evacuation can be limited by circumstances aboard; emergency exits can be jammed because of stresses placed on the fuselage upon or following impact; exits may be blocked by loose galley equipment; failure of internal structures dislodged by the deceleration forces, etc. While operation evacuation procedures normally stipulate utilization of all available exits, flight crews are required 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 escapees. If escape slides are used, they should not be disturbed once properly deployed unless they are subsequently damaged by misuse or by external forces. Nonself-inflatable slides may require manual support where they contact the ground and those escaping may need assistance in getting to their feet at the bottom of the slide. If airline personnal are not available to perform such services, ground personnel 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. (*See equipment list in NFPA 414.*)

7-9.4 Flight Crew-Airport Fire Department Personnel Coordination. To maximize the coordination needed, pre-emergency planning is obviously necessary with the various contingencies considered. Airport/Community Emergency Planning (*see NFPA 424 for guidance*) should include the type coordination suggested, with local initiative by the Chief of the Airport Fire Department to meet with the air-carrier representatives and pilots utilizing the airport to coordinate respective roles and acquaint each other with the capabilities and limitations of their equipment and personnel.

Chapter 8 Aircraft Ground Fires; Cabin Fires Brake and Wheel Fires; Fuel Servicing Fires

8-1 Basis for This Chapter. Most Airport Fire Departments are organized and trained to handle aircraft accidents' fires coincident with landing and takeoff mishaps. The provision of equipment and manpower allocated are normally based on such potentials. (*See NFPA 403 as referenced in 1-2.2.1.*) However, many times airport fire departments are called upon to fight aircraft fires that occur during servicing or in parked aircraft or to provide standby protection when a fire hazard exists. The recommendations in this chapter are for the guidance of the Officer-in-Charge when responding to the subject emergencies.

NOTE: 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 motels, cargo buildings, and other facilities. Procedures for these fire prevention and protection operations are *not* covered herein.

8-2 Aircraft Passenger Cabin Fires on the Ground (Class "A" Fires).

NOTE: See also 2-3.2.2(b) and Section 7-8.

8-2.1 Aircraft passenger cabin fires on the ground normally involve ordinary combustibles (cabin upholstery, cabin liners, refuse, paper toweling, electrical insulation, etc.) regardless of the source of ignition. The intensity of any such fire at the time of discovery will depend on a number of variables, such as, the amount and form of the materials ignited, the amount of air (oxygen) present, draft conditions, the involvement of other fire hazardous materials (flammable liquids, oxygen, incendiary devices, etc.), and whether there has been a delay in fire detection or fire suppression activity. Methods to be used for effective extinguishing action depend largely on proper training, the advanced state of the fire when initially attacked, the availability of proper and adequate amounts of extinguishing agents, and their accessibility.

8-2.2 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 the length or width of 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 either the source of ignition or 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.

8-2.3 When cockpit or cabin fires occur while the aircraft is on the ground and occupied, as during pre-flight checks, maintenance operations, or while passengers are embarking, debarking, or awaiting aircraft movement, they are normally detected promptly permitting prompt alerting of the airport fire crew. Aircraft flight crews and line service personnel should be trained in the utilization of all available fire extinguishing devices to handle such emergencies (*see NFPA 408, Standard for Aircraft Hand Fire Extinguishers*). They should be trained in aircraft emergency evacuation procedures to restrict the potential life hazards involved. The toxicity of fire gases should be considered by flight crews, particularly in relation to the safety of passengers.

8-2.4 Unoccupied aircraft on the ground present the particular problem of delayed detection. An aircraft with doors closed and unattended may sustain a smoldering fire resulting in buildup of fire gases and smoke which can go unnoticed for some period of time. Opening an aircraft for fire control under such conditions can be extremely hazardous because of pressure buildup within the aircraft due to the combustion process and the introduction of fresh air from outside which can result in a flash-over or a fire-gas 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 flash-over potential can be very serious. Extreme caution is needed when opening doors and emergency exit windows for fire control purposes. Fire fighters should have the necessary charged hose lines in position to immediately combat the potential fire outbreak.

8-2.5 Each fire situation will differ, therefore, explicit guidance on fire extinguishing techniques for interior aircraft fires on the ground is most difficult. Normally, best results can be obtained by applying an indirect attack utilizing water spray through narrow openings at doors, etc. Obviously, care must be taken in the positioning of the water-spray nozzles to avoid merely driving the flame front to previously uninvolved sections. Multiple points of attack may be preferred to a single point with the locations selected dependent upon an evaluation of the interior conditions from exterior observations through cabin windows, by paint on the fuselage blistering, and smoke generation concentrations. Optional agents which might be used (assuming no occupants are aboard) would be high-expansion foam, Halon 1301, Halon 1211, carbon dioxide, or all-purpose dry chemical extinguishants.

NOTE: If oxygen systems are damaged and create a localized oxygen-enriched atmosphere, only water fog should be used in fire control efforts.

8-2.6 In extreme cases, where it is obvious that fire has extensively involved an aircraft interior and where exposure fire problems do not mitigate against such action, breaching (forced ventilation) of an aircraft may be necessary as the only practical way to deal with the situation. This normally means 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, or by breaking windows at strategic points 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 to offer a stable position to achieve this mission where doing so offers a tangible benefit.

8-2.7 Priority attention should be given to providing protective fire fighting diffused water or foam streams over fuel-containing portions of aircraft wing structures where these areas are exposed to heat or flame from the cabin fire. Available foam products should be conserved for use if, and when, fuel does escape from the subject wing structures.

8-2.8 Fire fighting crews should use their self-contained breathing apparatus whenever entering a burning aircraft. Dangerous toxic gases are produced by the burning or charring of many cabin interior materials.

8-2.9 Post-fire extinguishment operations may dictate prompt use of smoke ejector equipment and, following a thorough inspection, ventilation with clean air. Personnel monitoring the aircraft's interior should have fire suppression capability on hand to deal with any re-ignition.

8-3. Hot Brakes and Wheel Fires.

8-3.1 The heating of aircraft wheels and tires presents a potential explosion hazard, greatly emphasized when fire is present. To avoid endangering the crew, it is important not to mistake hot brakes for brake fires.

8-3.2 If there has been no fire, hot brakes will normally cool by themselves without the use of an extinguishing agent. Most aircraft operating manuals for propeller driven aircraft recommend that flight crews keep the propeller forward of the wheel turning fast enough to provide ample cooling airflow. Most jet aircraft's wheels have fusible plugs which will melt at about 350°F (177°C) and deflate the tire before dangerous pressures are reached.

8-3.3 On arrival at a fire involving some part of an undercarriage assembly and in the positioning of vehicles and manpower, one must consider the risks of undercarriage collapse or the explosive disintegration of the affected unit or units. With modern, large transport aircraft, due regard must be given to steerable nosewheels and the castoring capability of multi-wheel bogies, which may produce wheel and axle alignments which are not always at right-angles to the longitudinal axis of the fuselage. The overall aim must be to avoid operations beneath the aircraft and to keep clear of potential hazard areas. Too, caution should be taken regarding placement of vehicles, recognizing the possibility of an evacuation of the aircraft if the captain decides this is necessary.

8-3.4 Fire fighters should also conduct their operations from positions which minimize the risk of injury if an explosion occurs. The aim of any application of an extinguishing agent should be 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 *solid streams of water should be avoided,* as should the short-range application of carbon-dioxide gas where dry-ice particles may prove to be a hazard. Water-spray is effective provided it is applied uniformly to all parts of the affected unit. Dry chemical agents may extinguish fires involving hydraulic fluids or lubricants but they lack the cooling effect necessary to prevent re-ignitions in tires. Halon agents, notably Halon 1211 (BCF), are particularly effective on undercarriage fire situations and if delivered at 3–5 lbs/sec (1.5–2.5 kg/sec) give the range which may allow a stand-off position for safety purposes. Any of the agent which reaches the fire situation in liquid form serves as an *inhibitor* against re-ignitions.

Full details of any agent used should be given to the airline engineering staff so that any preventive treatment may be considered. This is particularly important where dry chemical agents are used.

8-3.5 Protective clothing should be worn when approaching undercarriage incidents, regardless of whether a fire situation is believed to exist. Hydraulic fluids may be escaping at very high pressures and these can cause serious injuries to the eyes, as well as some damage if inhaled, ingested, or injected into the skin. Any contamination sustained should be dealt with as soon as possible under medical supervision.

8-4 Aircraft Fuel Servicing Fires.

8-4.1 Most fires of record, occurring during aircraft fuel servicing result from hose or coupling failure, static ignition caused by flowing fuel or surface-generated static within an aircraft fuel tank or refueling vehicle, defective fuel pumps, existence of an external source of ignition in the presence of flammable fuel vapor concentrations, or improper fueling procedures. Enforcement of fire prevention standards and supervision over equipment maintenance is a vital concern (*see NFPA 407 (ANSI), Standard for Aircraft Fuel Servicing*). Defueling and fuel transfer operations can also introduce serious fire potentials (*see NFPA 410C, Recommendations for Safeguarding Aircraft Fuel System Maintenance*).

8-4.2 Fuel spills exterior to the aircraft should be handled in the manner described in A-2-2 of NFPA 407 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 (*see Chapters 2 through 4 of these Procedures*) 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 suggests that, in event of a fuel spill fire, an immediate check of aircraft cabins should be conducted for any occupants.

8-4.3 A number of incidents have occurred starting with wing fuel "tank"/cell 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.

8-4.4 Many transport category aircraft have "ganged" fuel "tank"/cell vents near wing tips. JET A-type fuels' (kerosine grades) vapors discharged normally present a lesser hazard, but if tanks are overfilled because of improper procedures, the fuel is likely to discharge from such vents. 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 10-ft (3-m) radius of aircraft fuel system vent openings (*see 2-14.2 of NFPA 407*).

Chapter 9 Military Aeromedical Evacuation and Air-ambulance Aircraft

9-1 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 a closer demand for the special protection requirements recommended for these specialized transport aircraft.

9-2 The following procedures, to be observed when litter or nonambulatory patients are aboard aeromedical evacuation aircraft operated by the designated military air arm of government (the U.S. Air Force) should be followed, when requested, for the protection of air-ambulance aircraft.

9-2.1 Prior to the takeoff of an aeromedical or air-ambulance aircraft containing nonambulatory or litter patients, one vehicle will follow the aircraft to the departure runway and stand by until the aircraft has left the airport ATC area.

9-2.2 Prior to landing, the aircraft commander will report the number of litter and/or nonambulatory patients aboard and request that aircraft rescue and fire fighting vehicles be alerted.

9-2.3 One (or more, as the situation warrants) will be strategically positioned for the landing. Upon landing of the aircraft, at least one vehicle will follow the aircraft to its parking position and remain in that position during transferal of patients. This position is normally to the aft end and slightly off the wing tip of the off-loading side of the aircraft.

9-2.4 If the aircraft is to be refueled, or any minor difficulty was experienced prior to landing and/or parking, a fire fighter will stand at the exit way with a charged hose line.

9-2.5 If an "alert" was given by the aircraft commander prior to landing, regardless of the inconsequence, the total complement of fire-rescue men and equipment will respond to their strategic positions.

9-2.6 If an "anticipated crash" alert is received, the action in 9-2.5, plus the action in 3-2.3 will be implemented.

Chapter 10 Low-visibility Operations

10-1 General. Airport emergency services should be capable of performing rapid response rescue/fire fighting procedures at all times, and under all weather conditions, especially when aircraft are authorized to operate.

10-2 New and improved techniques for instrument landings and take-off 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, natural and man-made obstructions in surrounding terrain, and runway lighting and marking identification. Such operational "minimums" may vary from three miles (5 km) "visibility" to seven hundred ft (200 m) for landings with similar restriction for take-off.

10-3 Airport fire department personnel should learn these operational restriction levels from their local Air Traffic Control agency in order to establish training programs to develop response capability under minimum weather conditions.

10-4 Standby Requirements.

10-4.1 Standby requirements for aircraft rescue and fire fighting vehicles should be put into effect when aircraft operations are in progress with surface visibility conditions of less than one-half mile (0.8 km) and at other times when turbulent weather may inhibit normal landings (although aircraft operational navigational weather minimums are not in effect).

10-4.2 All equipment deployed for "Low-visibility Operations," or for other precautionary purposes, should be fully manned.

10-4.3 Vehicles deployed, usually at least one major rescue and fire fighting vehicle, should be located approximately at the mid-point of the active runway. The distance from the runway centerline should be about 100 ft (30 m).

10-4.4 Where the fire station is located in a position equidistant to the distances in 10-4.3, relocation of the vehicles may not be necessary since it may be assumed that the vehicles can meet the normal maximum response time noted in 1-2.3.

10-4.5 A suitable hard surface access route should be provided from vehicle standby positions to active runways being protected. Where severe temperatures do not permit the vehicles to remain at standby positions, quickly assembled temporary frangible covers can be provided. Electrical connection at the pre-selected sites can be installed to provide energy for engine heaters and/or other heaters for protecting extinguishing agents aboard the vehicle.

10-4.6 Constant monitoring of provided radio frequencies (ground control, air traffic control, assigned fire department channel, etc.) is vital. The "tower" should be made aware of the exact location of the vehicle(s) assigned standby duty.

10-4.7 Where available, surface navigational aids, such as ground radar (ASDE) should be fully utilized through coordination between rescue personnel and tower control.

Chapter 11 Foaming Runways for Aircraft Emergency Landings

11-1 Introduction.

11-1.1 A number of aircraft emergencies (mostly wheels-up landings or aircraft with defective nose gear) have occurred at airports where *protein* foam has been used on runways with the thought that such action would mitigate the extent of damage likely to result and reduce the likelihood of fire occurring following the impact. In the event that protein foam is not available, water may be used to some advantage for nose wheel malfunctions. Aqueous film forming foam (AFFF) is *not* considered suitable for runway foaming. A number of these operations have been successful. Likewise, a number appear to have failed to accomplish their purpose (in the majority of cases, aircraft have missed or overrun the foam blanket). Similar aircraft emergencies have occurred at airports on runways not coated with protein foam and in a number of these cases no major fires have occurred and the damages sustained by the aircraft have been moderate.

11-1.2 The U.S. military services did much of the original work in connection with developing the concept and techniques for using protein foam on runways to reduce the fire and impact damages to military aircraft which had sustained landing gear damage. This was done essentially for propeller-driven aircraft. The practice spread to other countries. The concept was also advanced significantly by the publicity given to a number of isolated incidents, by television and newspaper coverage of the technique, and by the psychological and theoretical advantages which the technique seems to inspire.

11-1.3 Unfortunately, it has not been possible to date to conduct full-scale tests of wheels-up aircraft landings on various types of runway surfaces with and without protein foam coatings. To evaluate the technique at this time, therefore, it is necessary to apply the test data that are available, to analyze aircraft impact behavior from actual incidents of record (where protein foam has and has not been used), and to relate the use of protein foam for this purpose to its known qualities.

11-2 Theoretical Benefits of Foaming Runways.

11-2.1 Four basic possible benefits from protein foaming of runways for crash protection are:

(a) **Reduction in Extent of Aircraft Damage.** That the protein foam will reduce the extent of damage to an aircraft which may be forced to make a wheels-up emergency landing or where the nose gear is defective.

(b) **Reduction in Deceleration Forces.** That a protein foam-coated runway will reduce the coefficient of friction and thus decrease (by permitting slippage) either the deceleration forces imposed on the aircraft and its occupants or its ground-looping tendencies.

(c) **Reduction in Friction Spark Hazard.** That the protein foam or water retained by the foam at the runway interface will reduce the known friction spark hazard of certain aircraft metals on dry runways. Such friction sparks constitute a possible ignition source following impact-imposed damages to an aircraft's fuel tanks or system.

(d) **Reduction in Fuel Spill Fire Hazard.** That a protein foam-coated runway will reduce the extent of the fire hazard in the event of a fuel spill following impact-imposed damages to an aircraft's fuel tanks or system.

11-3 Analysis of Theoretical Benefits.

11-3.1 Analysis of the four basic possible or theoretical benefits described in Section 11-2 on the basis of the test data available and the experience record to date leads to the following conclusions:

(a) **Extent of Aircraft Damage.** A number of well-executed emergency landings on protein foam-coated runways have been accomplished with minimum damages to the aircraft involved. Unfortunately, these incidents do not prove that, conversely, the damage would have been appreciably greater had no protein foam been used. Controlled emergency landings on dry runways have also been completed with relatively minor damages to the aircraft. A number of variables are indicated.

1. The design of the aircraft (such factors as "crash-resistance" of the fuselage, whether the aircraft is of high or low wing design, the hazard presented by propeller fragmentation, whether it is turbine-powered or propeller-driven, etc.).

2. The skill of the pilot (his ability to land the aircraft under emergency conditions by virtue of his training and/or his psychological or physical state at the time the emergency occurs).

3. The type and condition of the runway surface.

4. The landing weight of the aircraft.
5. The weather, temperature and visibility conditions, etc.

To date, no incident has occurred where foaming of the runways has increased the extent of damages. Under favorable conditions, foaming of the runway should not result in greater aircraft impact damages. No test data are available which permit a more complete evaluation of this feature.

(b) **Extent of Deceleration Forces.** Protein foam or water on a runway may decrease the normal braking ability of an aircraft and increase the stopping distances up to 100 percent, depending on the depth of water and/or foam, and the type of runway surface.

(c) **Reduction of Friction Spark Hazard.** Scale research tests have shown that aluminum alloy metals produce no friction sparks capable of igniting aircraft fuel vapors under the simulated bearing pressures and contact speeds likely to be encountered in actual aircraft emergencies on either dry or wet (protein foam-covered) concrete or asphalt runway surfaces. According to these same scale research tests, protein foam, properly applied, is capable of holding a water layer at the runway interface which is effective in suppressing sparks in from 57 to 100 percent of the tests where magnesium alloys, stainless steel and other aircraft steels produced sparks capable of igniting aircraft fuel vapors from friction with dry asphalt or concrete runways. Titanium friction sparks capable of igniting aircraft fuel vapors could not be effectively suppressed by runway foaming in any of the scale research tests and constitute the greatest hazard. The roughness of runway surfaces was found to be a factor in the production of the incendiary sparks generated by abrasion of all the metals (except aluminum) and the friction impact with expansion joints between concrete slabs was found to result in momentary increases in the energy release from the sparks.

(d) **Reduction of Fuel Spill Fire Hazard.** From all that is known of the fire suppression qualities of protein foam and the scale research tests, it is clear that a protein foam-coated runway would have no appreciable effect on the fire hazard of fuel vapors in the atmosphere over the foam. These vapors could still be ignited above the foam blanket by an engine fire, electrical arcs or sparks, static discharges or other ignition sources. Should liquid fuel be released over the protein foam blanket, it will fall through and spread under the foam, reducing the release of flammable vapors. In case of ignition, the burning area may be reduced, depending on the age and condition of the protein foam. Fire crews should be prepared to fight such a fire.

11-3.2 From the above analysis, it can be seen that protein foaming of runways for crash protection involves variables not easily assessed in advance of the incident and that its effectiveness in reducing the friction spark and fuel spill hazards likewise cannot be guaranteed. On the other hand, any possible means of mitigating the impact severity or the crash fire hazard should not be overlooked.

11-4 Operational Problems.

11-4.1 There are other considerations which should be evaluated to determine the feasibility of using protein foaming of runways for crash protection in any individual case. They are:

(a) The actual nature of the airborne emergency; i.e., whether the aircraft cannot lower its main gear, whether only one gear is down and cannot be retracted, whether one or more tires or wheels have been damaged or lost, whether the nose gear is "cocked," or a combination of one or more of these circumstances or some other related condition exists.

(b) The time element available for accomplishing the production and distribution of the protein foam covering (which may take up to an hour or more). This will be related to the nature of the aircraft emergency (the safety factors involved in the aircraft's remaining airborne during the foam-laying operation), the number and the types of protein foam-making appliances available.

NOTE 1: Airports not having adequate equipment should not attempt to lay a protein foam blanket. Where only AFFF type foam is available, it should not be used for this purpose.

NOTE 2: Other air traffic must be considered unless alternate landing areas are available.

NOTE 3: Normally the time required to lay a runway protein foam blanket permits the dumping of fuel by the air crew (where considered necessary or desirable) to reduce the hazard during the emergency landing.

(c) The reliability of information on the landing techniques to be used. This will be related to wind and visibility conditions, pilot experience and skill, runway instrumentation factors and aircraft operational problems under the existing emergency conditions.

(d) The protein foam-making capability of the equipment available on the airport for runway foaming [not including the minimum equipment for aircraft rescue and fire fighting (*see 11-4.3*)] plotted against the prudent holding time of the aircraft involved in the emergency.

NOTE: At airports where foaming of runways is programmed as may be required (*see 11-4.4*) preplanning will be necessary to assure the availability of adequate protein foam liquid concentrate to meet this need in addition to the normal quantities required for fire control and training purposes.

(e) The effect the protein foam-laying and clean-up operations will have upon the aircraft movements at the airport and how this will affect the safety of all aircraft operations in progress.

(f) Whether the ambient temperature conditions make the laying of a protein foam blanket feasible. During very cold weather, freezing could create a serious problem because of freezing of the liquid content of the foam on the cold runway surface. The protein foam itself would be slow to freeze but the formation of ice beneath the foam would be undesirable if subsequent aircraft braking was to be attempted and for further normal use of the runway after the emergency was over.

(g) The length of the runway and the nature and condition of the runway surface at the time the emergency occurs.

11-4.2 Considering the factors mentioned in 11-4.1, it is clear that initiation of a request to foam a runway for any given flight emergency situation should be a flight operational decision. The request to take such action should thus come from the pilot in command of the aircraft or the aircraft operator, assuming that they are familiar with the aforementioned considerations.

11-4.3 Determination as to the feasibility of applying protein foam to a runway is a decision which the airport manager or his representative (the Chief of the Airport Fire Department) must make after receipt of the official request for such services from the pilot or operator and an evaluation of the fire protection and other airport operational problems involved. Since aircraft operations must continue elsewhere on the airport, and/or that circumstances may cause the pilot to make an emergency landing prior to the completion of the foam-laying operation, or the foam-making vehicles have not been replenished, etc., it is essential that the minimum aircraft rescue and fire fighting vehicles recommended in NFPA 403, *Aircraft Rescue and Fire Fighting Services at Airports and Heliports*, should be maintained in fully operational condition to perform their emergency function. Tank vehicles or specially designed equipment should normally be used for runway foaming (*see Appendix F*).

11-4.4 The designation of one airport in a region or predetermined geographical area to which aircraft might be safely dispatched when in need of runway foaming is recommended. Selection of these regional airports should be based not only on the availability of adequate runway foaming equipment and supplies, emergency aircraft rescue and fire fighting services, and allied support services (cranes and aircraft repair services), but also on the physical condition of the runways to be employed, the climatic conditions, aircraft traffic interruption effects, and the security of the airport to assure control of curious spectators in event of public awareness of the impending emergency landing.

11-5 Techniques of Runway Foaming.

11-5.1 After evaluating the theoretical and operational problems involved as discussed in Sections 11-2 through 11-4, if foaming of a runway is to be accomplished in an attempt to safeguard a particular emergency landing, the following recommendations are advanced for consideration by those responsible:

NOTE: Each case will differ depending on the numerous variables involved but the following basic principles are important considerations.

(a) That radio contact 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 protection established.

(b) Primary aircraft rescue and fire fighting vehicles as recommended in NFPA 403, *Aircraft Rescue and Fire Fighting Services at Airports and Heliports,* should not be used to foam runways unless the number of such vehicles held in reserve is sufficient to provide the minimum protection recommended in NFPA 403 for that particular operation being conducted at the airport. Auxiliary tank trucks equipped to dispense protein foam through ground sweep nozzles, special boom nozzles, or other additional specialized foaming equipment should be used for runway foaming (*see Appendix F*).

(c) That a time study be conducted prior to any emergency to work out the scheduling of the foam-laying operation and the vehicle reload requirements. Under any condition, adequate extra quantities of protein foam concentrate must be preplanned and prearrangements made for rapid vehicle re-servicing.

(d) Previous experience has shown that, when making a gear-up landing, the aircraft contacts the runway much further from the threshold than normal. This is due to increased lift caused by "ground effect" and, in some cases, by the reduced stalling speed of the aircraft with the gear up. The point of aircraft touchdown can be 500 to 2,000 ft (150–600 m) further down the runway than normal, depending on the size and speed of the aircraft involved.

(e) When visibility conditions are such that the pilot cannot distinguish from the air where the protein foam applied to the runway starts, a reference point should be established in a clearly distinguishable manner to indicate where the foam pattern commences to aid the pilot in getting the aircraft positioned for the landing.

(f) All unnecessary people, press and photographers should be advised to stay clear until all evacuation and occupant counts have been accomplished and full fire control or fire preventive measures taken. (This is a function of airport police or guards as may be augmented by local police and volunteers.)

(g) The length, width and depth of the protein-foam pattern will vary with the type of emergency, the type of aircraft, the length of the runway, the quantities of agent available, and the time factors involved. Table 1 may be used for estimating the approximate water and protein liquid requirements for foaming a runway for reciprocating engine or turbine powered aircraft. The needed supplies for longer or wider strips may be readily calculated from the figures in the Table by using an appropriate multiplying factor.

(h) For a wheels-up landing, the protein foam should be laid down the center line of the runway beginning at a point agreed to by the pilot and should be so calculated to run continuously the full length of the projected slide.

Table 1 Water and Protein Foam Liquid Requirements for Runway Foaming.

		Wheels-up Landing	
Factors	Malfunctioning Nose Wheel	2-Engine Prop Driven or Jet	3-4-Engine Prop Driven or Jet
Width of Blanket in Feet	10	40	75
Length of Blanket in Feet	1,500	2,000	2,500
Runway Area Covered in Square Feet	15,000	80,000	187,500
Water Required in Gallons	1,500	8,000	18,750
Foam Concentrate Required in Gallons			
3 Percent Type	45	240	562
6 Percent Type	90	480	1,124
Distance from Threshold to Leading Edge of Foam Blanket in Feet	2,500	1,500	1,500

For SI Units 1 ft = 0.3048 m

NOTE: Due to variations in foam-metering devices, possible inaccurate proportioning of the protein foam-liquid concentrate, and the varied characteristics of local water supplies, it is normally prudent to increase the amount of protein foam-liquid concentrates to above those theoretically required, figuring perhaps on 10 percent protein foam-liquid concentrate for the 6 percent type and 5 percent for the 3 percent type. Figures on protein foam-liquid concentrate quantities are based on forming a 2-in. (50-mm) depth of finished foam.

(i) For a defective or "cocked" nose wheel with main gear fully operational, it is recommended that the runway foam pattern should be approximately one-half the width of the main gear tread, but not more than 10 ft (3 m), laid down the center of the runway, beginning at a point agreed to by the pilot (usually further down from the threshold than for a main gear or wheels-up landing) and calculated to run continuously the full length of the projected landing. It is essential that the main gear be clear of the foamed area to insure that full braking can be utilized without fear of skidding or hydroplaning.

(j) Where gear malfunction involves only one main gear and the pilot elects to land with only that gear retracted, the foam pattern should be laid down on the appropriate side of the runway, beginning at a point 3,000 ft (900 m) from threshold and run continuously a further 3,000 ft (900 m). Width of foam strip and placement from center line should take into account the type of aircraft involved and the anticipated distance and width of metal contact of either the wing-tip and/or engine pod with the runway.

(k) Aging of the protein foam prior to use for a period of 10 to 15 minutes is desirable to permit water to drain from the foam and create effective runway surface wetting within the foam pattern. Aging for too long a period prior to use on a hot summer day may be disadvantageous due to excessive drying and water runoff.

(l) To be effective a continuous layer of protein foam in the proposed slide path is essential as any interruptions, holes or breaks might result in the formation of incendiary sparks of sufficient duration and intensity to cause ignition of any flammable vapors which were present.

(m) Depth of the protein foam should preferably be two inches to achieve even distribution and so that the foam has good "holding" characteristics (capable of holding the water at the runway interface without excessive drain-off due to runway slope or because of its "crown"). Protein foam of less depth may be satisfactory if continuous, if it drains properly, and if it has the ability to retain the water content at the runway surface. Protein foam expansions of 8 to 12 appear to be satisfactory for this purpose.

(n) 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.

Appendix A Civil Aircraft Data for Fire Fighters and Rescue Crews

This Appendix is not a part of this Recommended Practice, but is included for information purposes only.

This Appendix presents information on the *principles* of rescue and fire fighting incident to aircraft fire emergencies and data on *representative* air carrier aircraft which are in common current usage. The purpose is to give those concerned *some* of the essential information needed to permit them to assess the true nature of the specialized problems involved in performing effective aircraft rescue and fire fighting services.

It is *strongly* emphasized that *personal* inspections by aircraft rescue and fire fighting personnel of the aircraft in service at the airport on which they serve is essential to assure proper operational techniques and to conduct realistic drills.

The following listing identifies the contents of Appendix A:

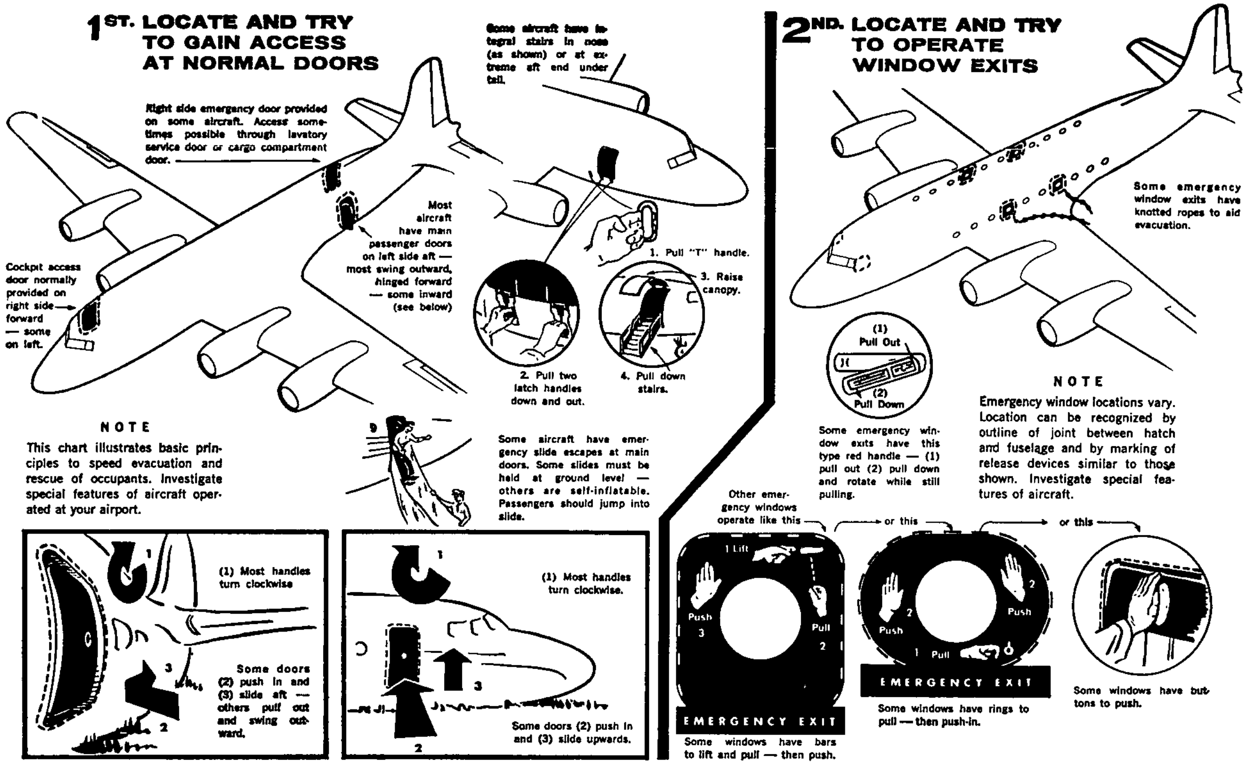
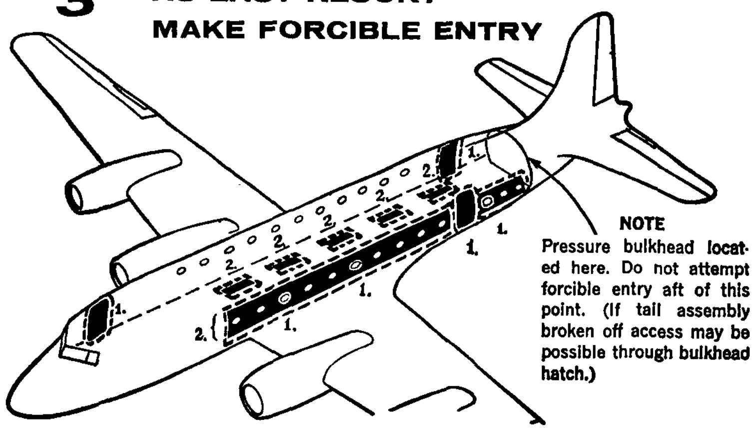


Figure A-1. The principal points to consider in gaining access to civil transport aircraft. Each aircraft must be examined individually to know how doors and windows may be most easily opened from outside.

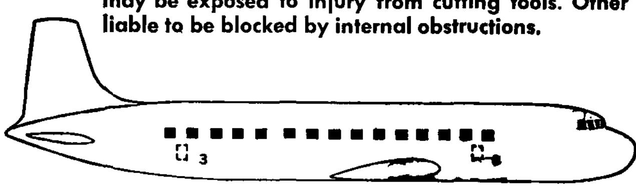
3RD AS LAST RESORT MAKE FORCIBLE ENTRY



PREFERRED FORCIBLE ENTRY LOCATIONS

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

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



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

Figure A-2. These illustrations show reciprocating-engine aircraft. See other Figures for forcible entry locations on modern turbine-powered transport aircraft. These latter aircraft are most difficult to cut into because of the thickness of the metals used, the extensive framing of the fuselage, the insulation, etc.

ALWAYS KNOW THE PRINCIPAL FIRE HAZARD ZONES IN CIVIL AIRCRAFT

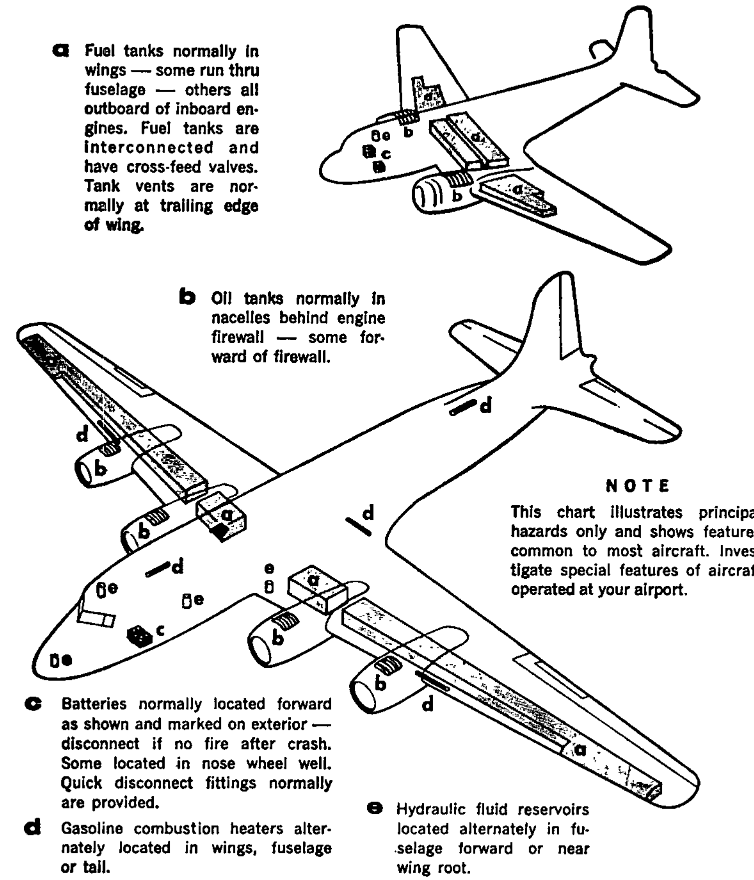


Figure A-3. These are simplified drawings of the principal fire hazard zones on reciprocating engine aircraft. Typical turbine aircraft are illustrated elsewhere in this Appendix.

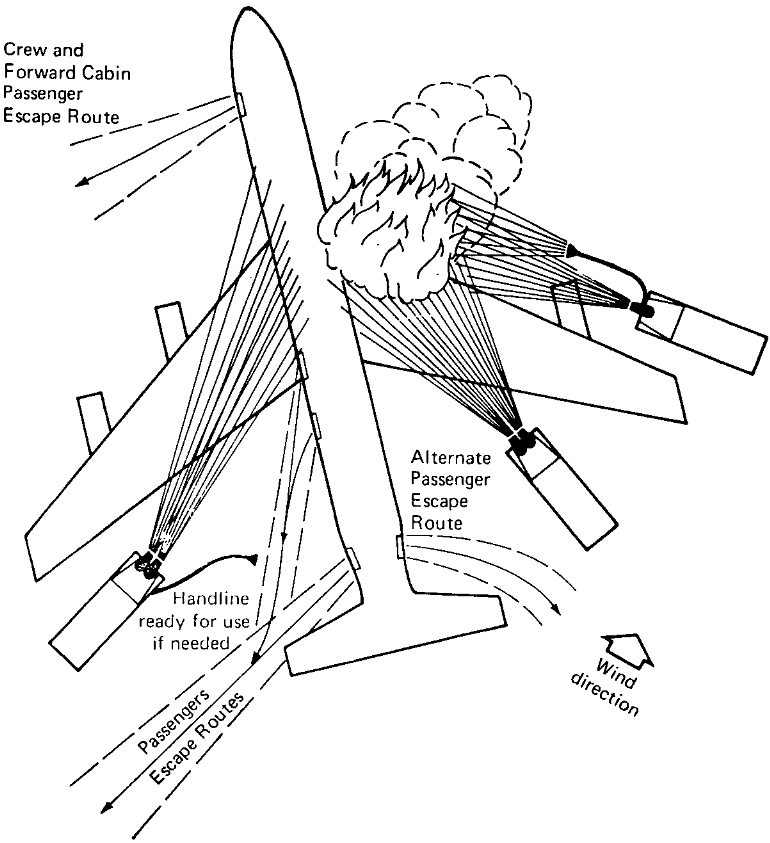


Figure A-4. Principles of fire fighting for civil transport aircraft using two major vehicles dispensing foam with fire in wing-root area on one side and a near cross wind. See 4-5.5 regarding blast from turbine aircraft engines; if port engines are still operating at time fire fighting commences, the attack from the port side would have to be shifted forward of the wing.

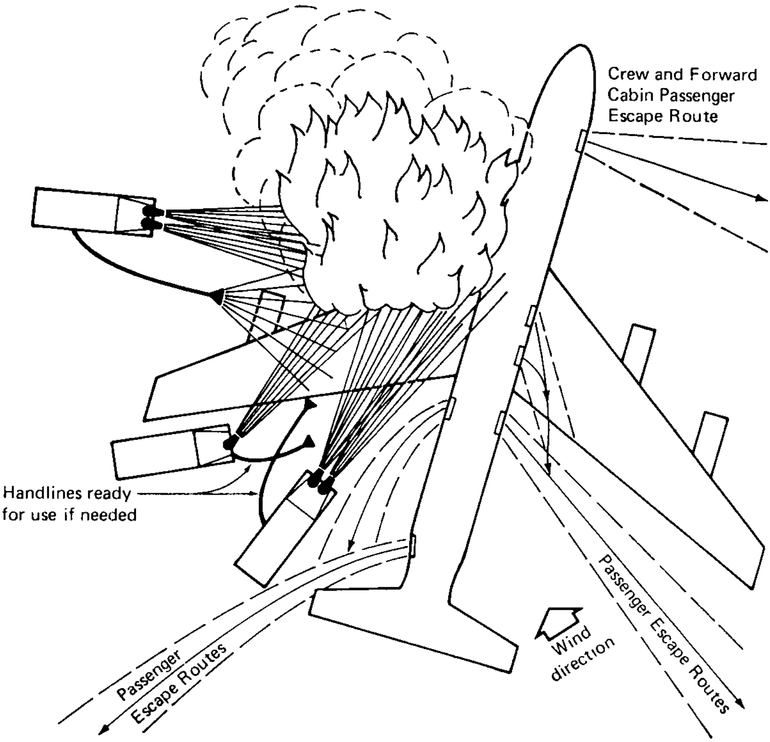


Figure A-5. Principles of fire fighting for civil transport aircraft using three major fire fighting vehicles with fire involving port inboard engine and integral fuel tank area. See comment on operating turbine engines in caption to Figure A-4. Maintaining fuselage integrity is the first principle to allow passenger evacuation.

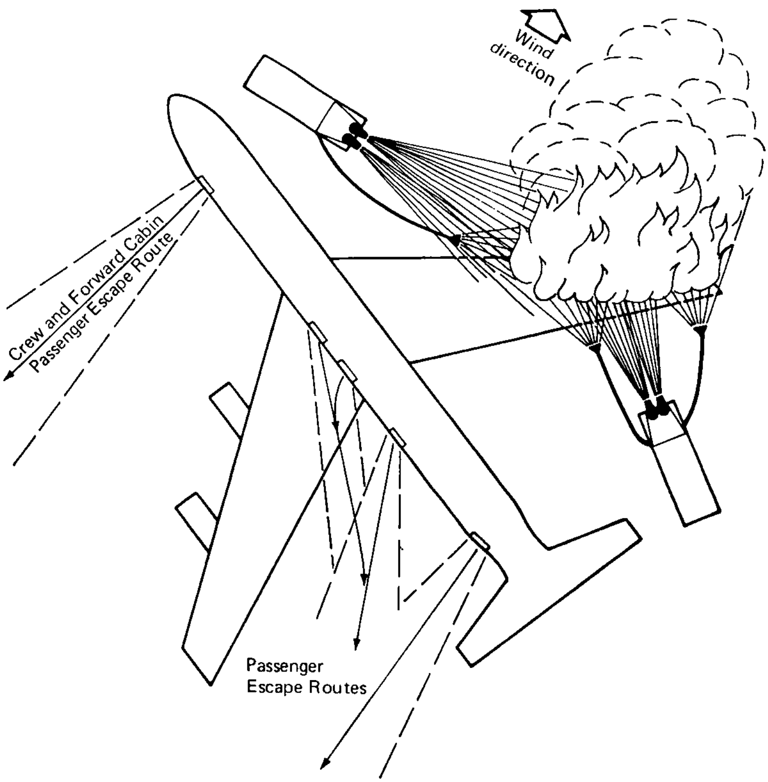


Figure A-6. Principles of fire fighting for civil transport aircraft with fire in the outboard engine on starboard side. Here the attack is with three major fire fighting units concentrating on controlling the fire and keeping the fuselage shielded from radiant heat and avoiding any direct flame contact which could cause breaching of the fuselage.

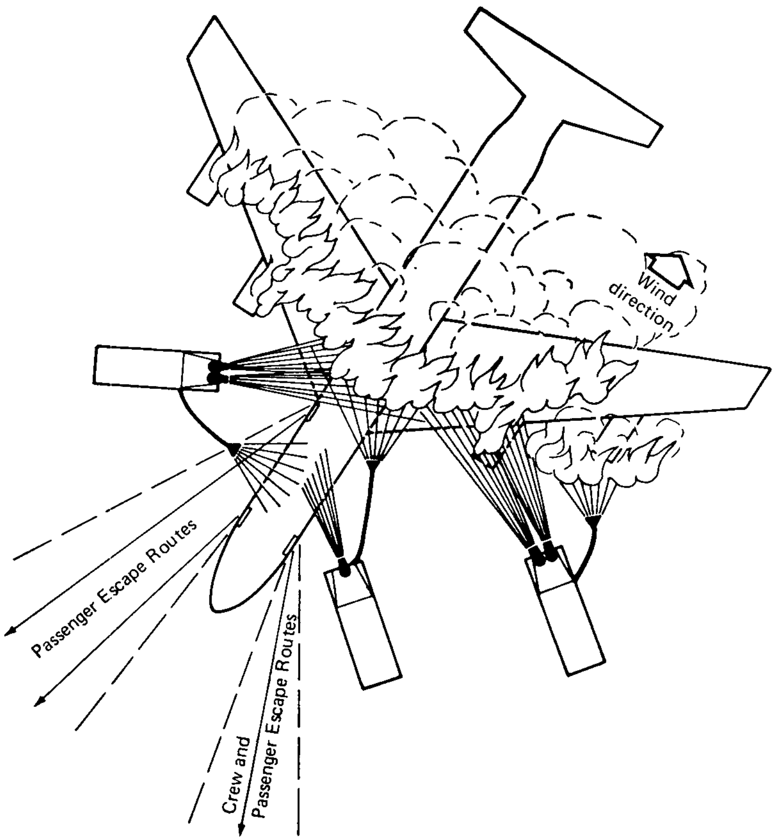
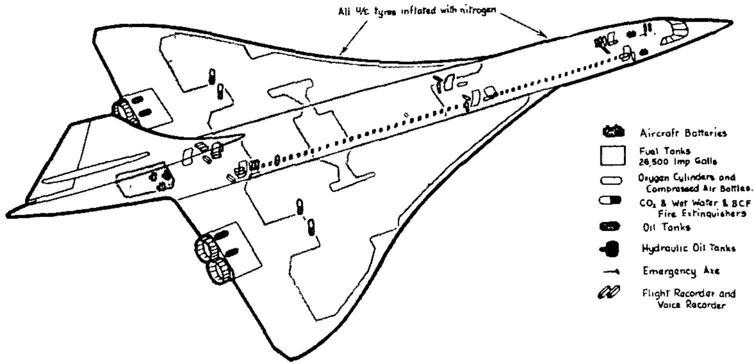


Figure A-7. Principles of fire fighting for civil transport aircraft using three major rescue and fire fighting vehicles under one of the most adverse conditions where fire involves the entire wing-span of the aircraft. The attack is aimed with the wind and the effort is to keep the fuselage intact while the crew and passengers escape via the forward doors.

Concorde

Ground clearance at maximum taxi weight	
Tip of nose (Fully up)	13' 11"
Tip of nose (Fully down)	6' 2"
Forward entrance door	14' 8"
Lower baggage hold	10' 7"
Mid entrance door	14' 7"
Rear service door	13' 4"
Rear baggage hold	12' 6"
Top of fin	36' 11"
Lowest point of nacelle	5' 11"
Outer alevon (Drooped)	7' 8"



Maximum Accommodation

128 Passengers

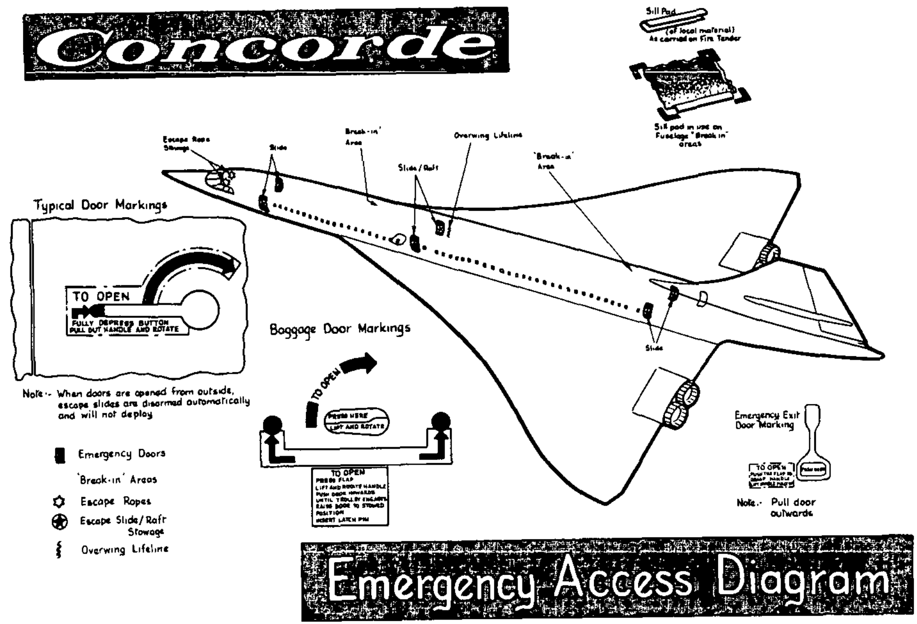
11 Crew

British Airways Fire Protection Data for Ground Staff

Issue A

Courtesy of British Airways

Figure A-8A. Concorde — Flammable Material Locations.



Courtesy of British Airways

Figure A-8B. Concorde — Emergency Rescue Access Points.

FLAMMABLE MATERIAL LOCATIONS

BOEING 707-100 & 200

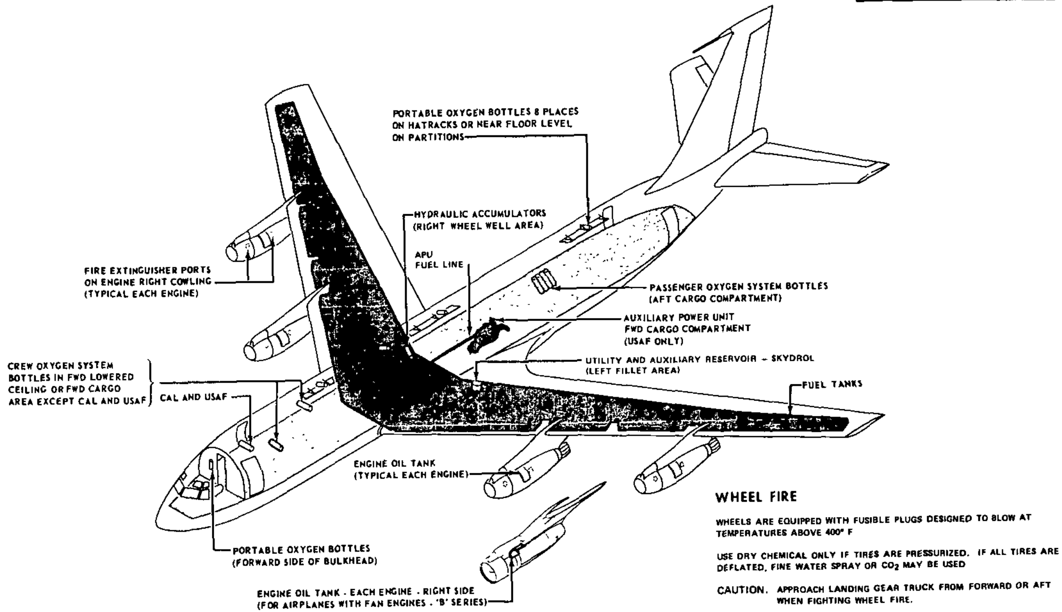


Figure A-9A. The Boeing 707 Stratoliner showing the flammable material locations. Other models (the Intercontinental and the 720 series) vary somewhat in size and fuel capacity.

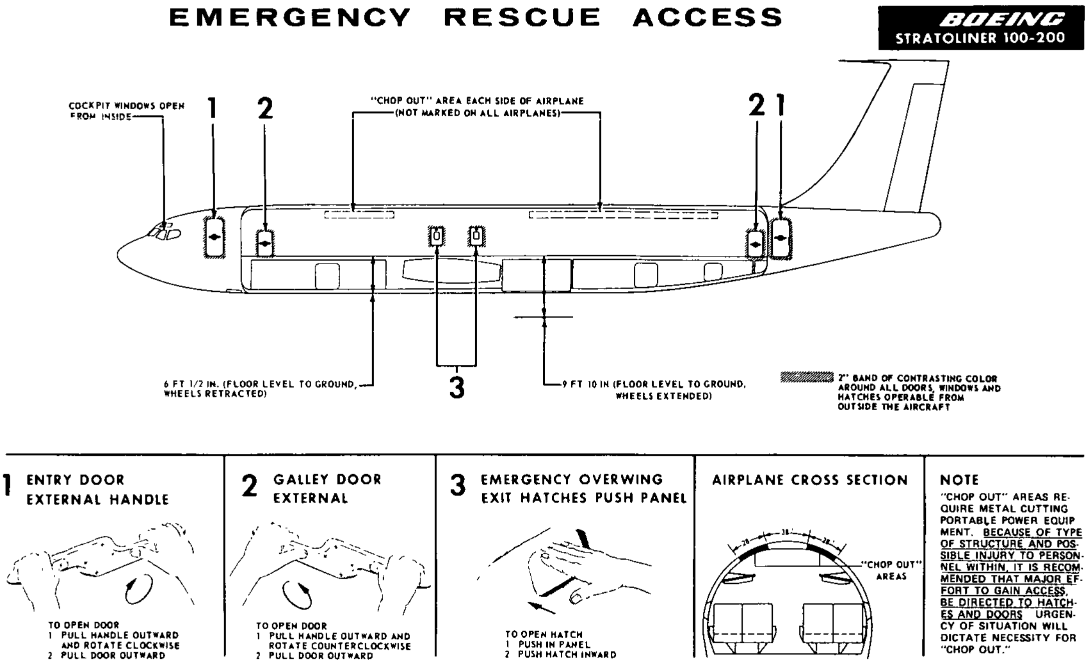
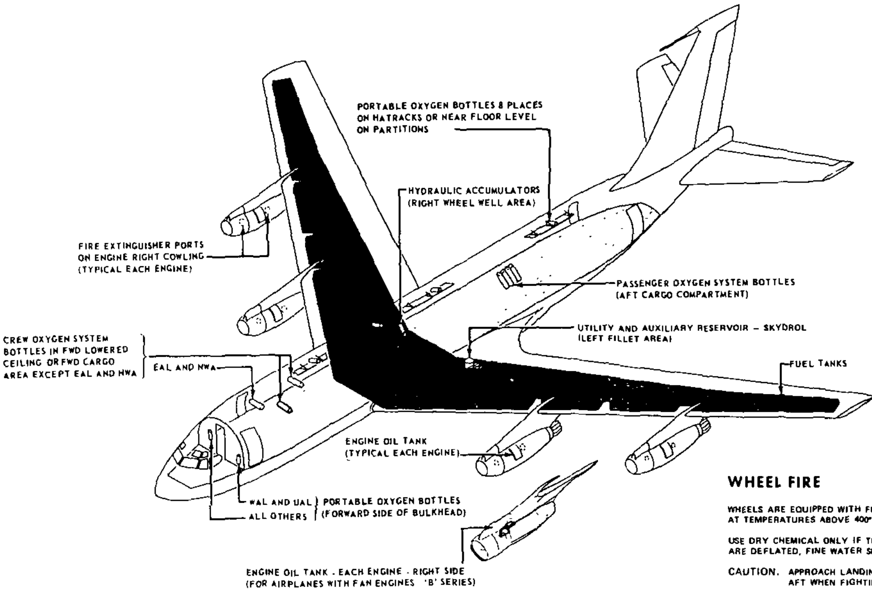


Figure A-9B. The Boeing 707 Stratoliner showing emergency rescue access points and how they are operable from the exterior.

FLAMMABLE MATERIAL LOCATIONS

BOEING
720-720B



WHEEL FIRE

WHEELS ARE EQUIPPED WITH FUSIBLE PLUGS DESIGNED TO BLOW AT TEMPERATURES ABOVE 400° F.

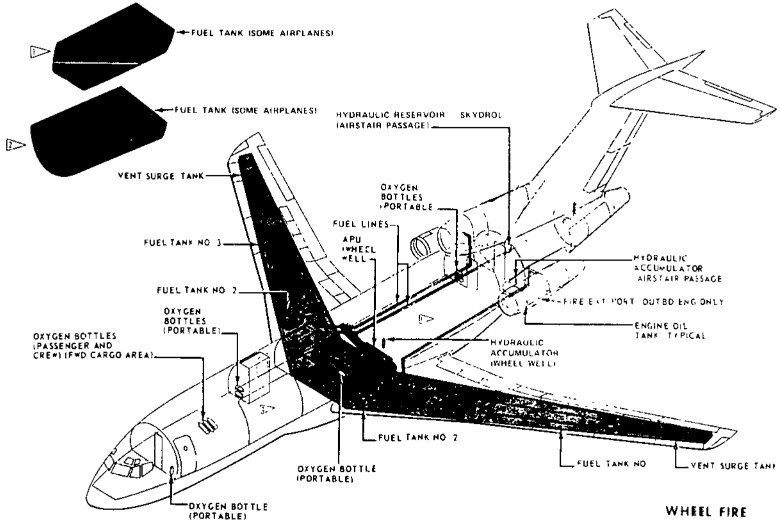
USE DRY CHEMICAL ONLY IF TIRES ARE PRESSURIZED. IF ALL TIRES ARE DEFLATED, FINE WATER SPRAY OR CO_2 MAY BE USED

CAUTION. APPROACH LANDING GEAR TRUCK FROM FORWARD OR AFT WHEN FIGHTING WHEEL FIRE.

Figure A-10. Boeing 720 — Flammable Material Locations.

FLAMMABLE MATERIAL LOCATIONS

BOEING 727 100-200



WHEEL FIRE

WHEELS ARE EQUIPPED WITH FUSIBLE PLUGS DESIGNED TO BLOW AT TEMPERATURES ABOVE 350°F

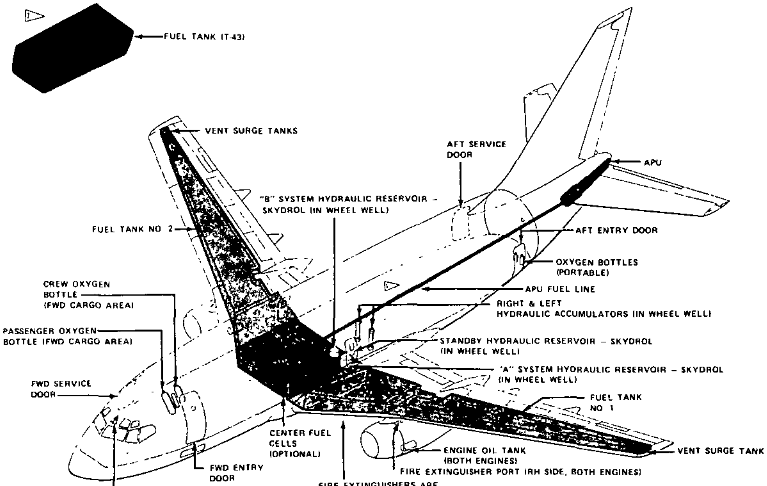
USE DRY CHEMICAL ONLY IF TIRES ARE PRESSURIZED. IF ALL TIRES ARE DEFLATED, FINE WATER SPRAY OR CO_2 MAY BE USED

CAUTION APPROACH LANDING GEAR TRUCK FROM FORWARD OR AFT WHEN FIGHTING WHEEL FIRE

Figure A-11. Boeing 727 — Flammable Material Locations.

FLAMMABLE MATERIAL LOCATIONS

BOEING
737 100-200-200C



WHEEL FIRE

WHEELS ARE EQUIPPED WITH FUSIBLE PLUGS DESIGNED TO BLOW AT TEMPERATURES ABOVE 350°F (ESTIMATED)

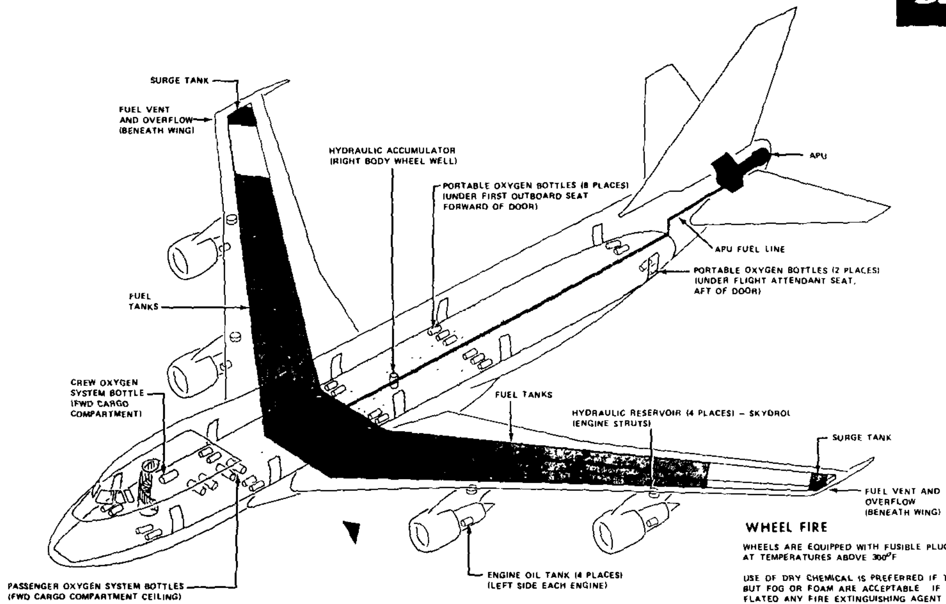
USE DRY CHEMICAL ONLY IF TIRES ARE PRESSURIZED. IF ALL TIRES ARE DEFLATED, FINE WATER SPRAY OR CO_2 MAY BE USED

CAUTION: APPROACH LANDING GEAR FROM FORWARD OR AFT WHEN FIGHTING WHEEL FIRE.

Figure A-12. Boeing 737 — Flammable Material Locations.

FLAMMABLE MATERIAL LOCATIONS

BOEING 747



WHEEL FIRE

WHEELS ARE EQUIPPED WITH FUSIBLE PLUGS DESIGNED TO BLOW AT TEMPERATURES ABOVE 300°F

USE OF DRY CHEMICAL IS PREFERRED IF TIRES ARE PRESSURIZED, BUT FOG OR FOAM ARE ACCEPTABLE IF ALL TIRES ARE DEFLATED ANY FIRE EXTINGUISHING AGENT MAY BE USED

CAUTION. APPROACH LANDING GEAR TRUCK FROM FORWARD OR AFT WHEN FIGHTING WHEEL FIRE AS WHEELS & TIRES MAY EXPLODE

Figure A-13A. Boeing 747 — Flammable Material Locations.

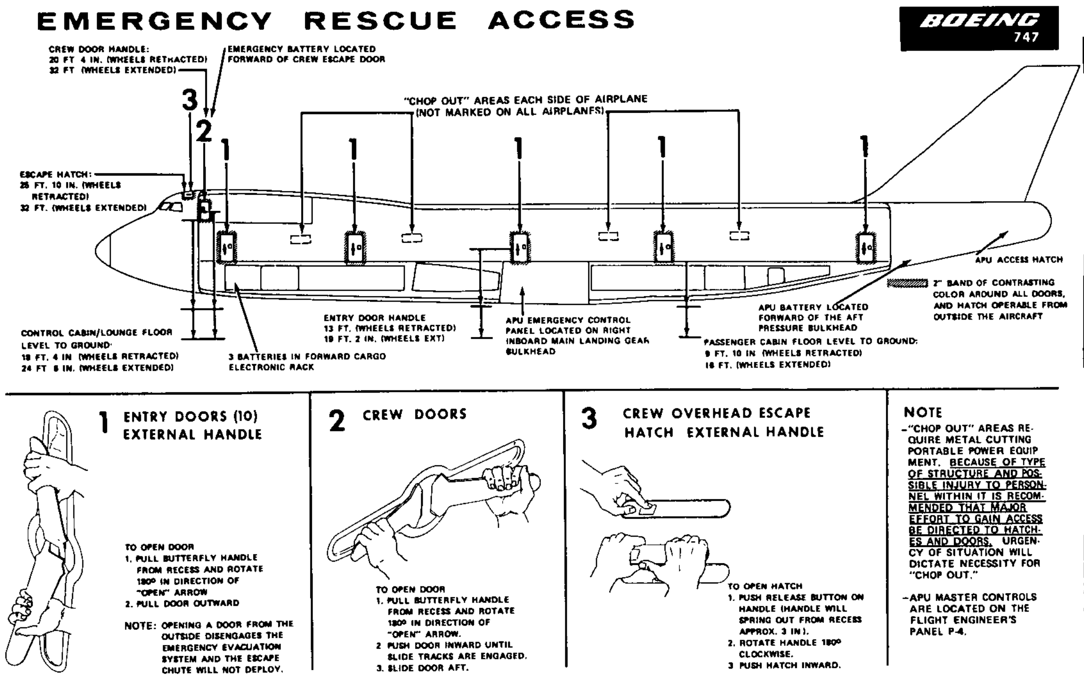


Figure A-13B. Boeing 747 — Emergency Rescue Access Points.

SPECIAL TOOLS/EQUIPMENT
Power Rescue Saw
1/4-Inch Speed Handle Wrench
36 ft Ladder

DOUGLAS DC-10

AIRCRAFT ENTRY
ALL MODELS

WARNING

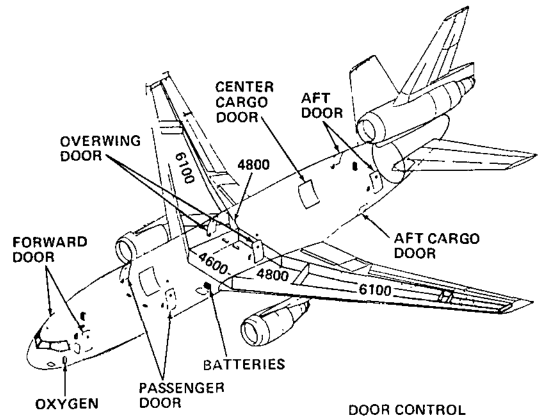
Keep clear of all entry doors during opening.

1. EMERGENCY ENTRY

   a. Pull handle, located forward over wing and on aft escape doors both sides, out and rotate clockwise, depress and hold button. Rotate handle to emergency position, and doors will raise automatically to open position.

2. NORMAL ENTRY

   a. Pull control handle(s), located on all entry doors (both sides), out and rotate handle(s) clockwise to open position, and doors raise electrically.



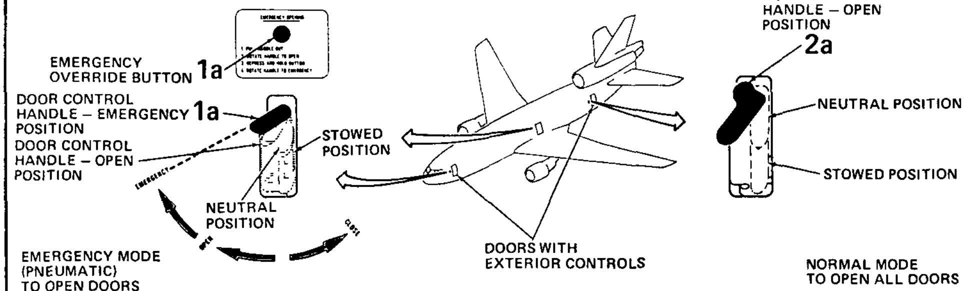


Figure A-14. The Douglas DC-10 "wide-bodied" transport.

SPECIAL TOOLS/EQUIPMENT
Power Rescue Saw
12 Foot Ladder

DOUGLAS DC-9

AIRCRAFT ENTRY
ALL MODELS

1. EMERGENCY ENTRY

WARNING

Caution must be exercised when releasing tail cone. Keep personnel clear. Tail cone free falls when released from aircraft.

a. Push in jettisonable tail cone T-handle door, located on left fuselage forward of tail cone, pull T-handle to jettison tail cone. Jettison door is approximately 8.5 feet high.

b. Open rear stairway control panel, located on aft left exterior fuselage, push control handle to forward OPEN position to release stairway.

CAUTION

Stairway free falls to down position.

c. Push overwing exit door handle release, two doors are located over each wing, pull handle to unlatch door, push in and lift up forcibly.

2. NORMAL ENTRY

CAUTION

When doors are opened from outside slide chutes automatically deploy.

a. Pull handle, located on left forward entry door, out, rotate counterclockwise and pull door outward.

b. Pull stairway handle, located forward left bottom side of fuselage, outward, press the open button to extend stairway.

c. Pull handle located on right forward service door, out, rotate clockwise and pull door outward.

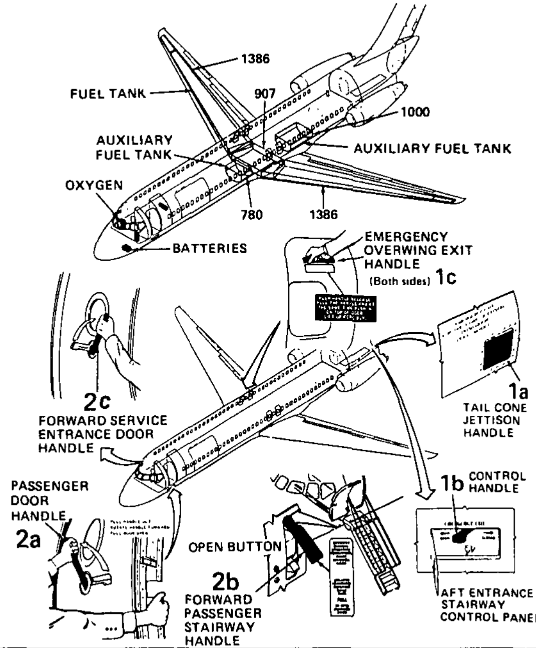


Figure A-15. The Douglas DC-9 twin engine jet.

SPECIAL TOOLS/EQUIPMENT
Power Rescue Saw
24ft Ladder

DC-8

AIRCRAFT ENTRY
ALL MODELS

1. EMERGENCY/NORMAL ENTRY:

a. OVERWING ESCAPE HATCHES, both sides - To open push in on plate to unlock, push inward and lift upward.

b. LEFT FORWARD AND AFT ENTRY DOORS - To open pull handles out, rotate counterclockwise, push front door edge in, pulling rear edge out and swing door forward.

c. RIGHT FORWARD AND AFT SERVICE DOORS - To open pull handles out, rotate clockwise, push rear door edge in, pulling front edge out and swing door forward.

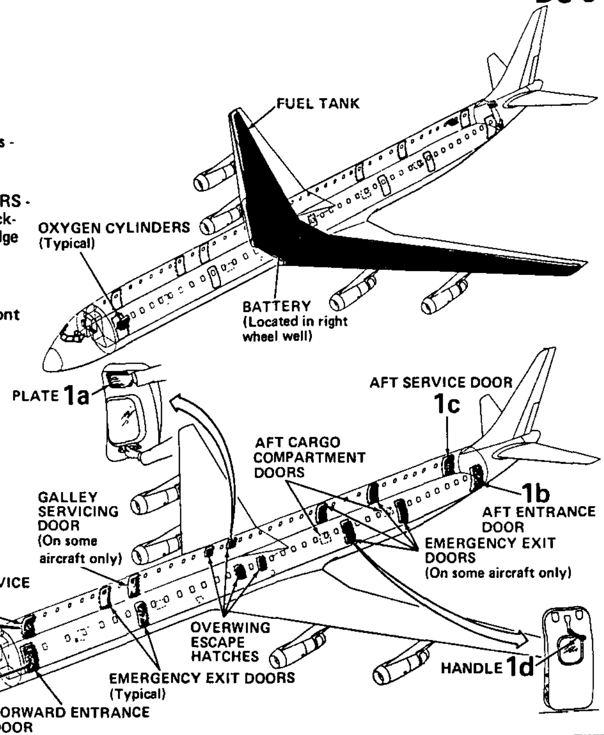
d. EMERGENCY EXIT DOORS - Pull handle, located top center of door, down and door lowers to open position.

NOTE:
Doors are hinged at bottom edge.

WARNING

When doors are opened from outside, slide chutes automatically deploy.

2. CUT - IN
Cut along window line as last resort.



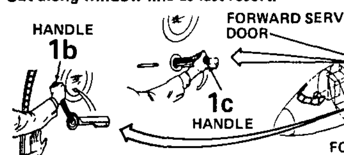
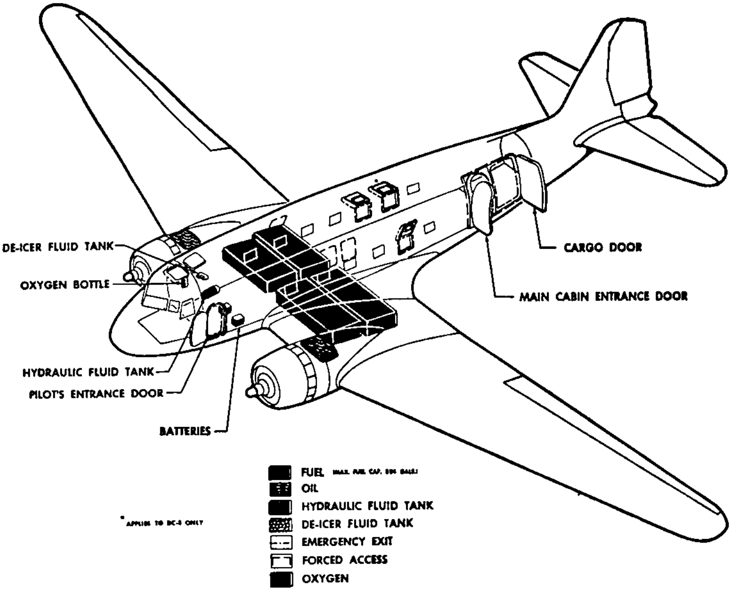
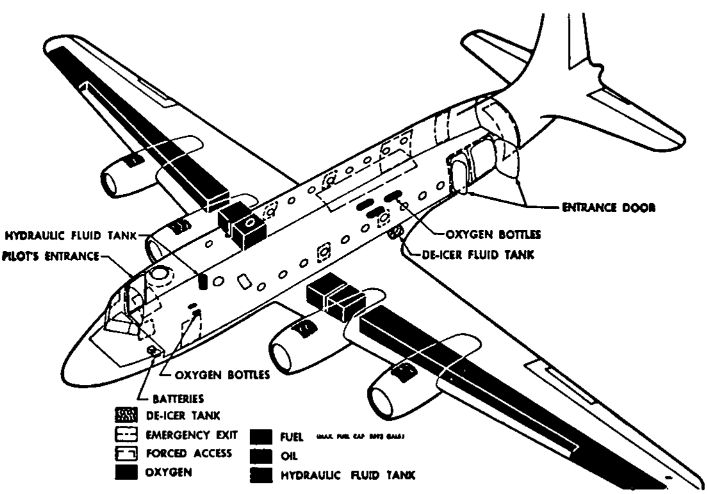


Figure A-16. The Douglas DC-8 four-engine jet.



Courtesy Douglas Aircraft Co., Inc.

Figure A-17 The DC-3 (C-47) crash crew chart.



Courtesy Douglas Aircraft Co., Inc.

Figure A-18 The DC-4 (C-54) crash crew chart.

SPECIAL TOOL/EQUIPMENT
Power Rescue Saw
36 Ft Ladders

AIRCRAFT ENTRY ALL MODELS

1. EMERGENCY/NORMAL ENTRY

a. Pull emergency release handles, located forward of all doors, to open doors in and up.

b. Push panel, located on flight compartment hatch, to open flight compartment hatch.

c. Pull galley door latch, located above galley door, down and push door in and up until uplatch engages.

NOTE:

To deploy slides, pull T-handle down.

2. CUT-IN

a. Cut-in areas located 20 inches above and below windows.

NOTE:

Fuselage rings located every 20 inches in these areas.

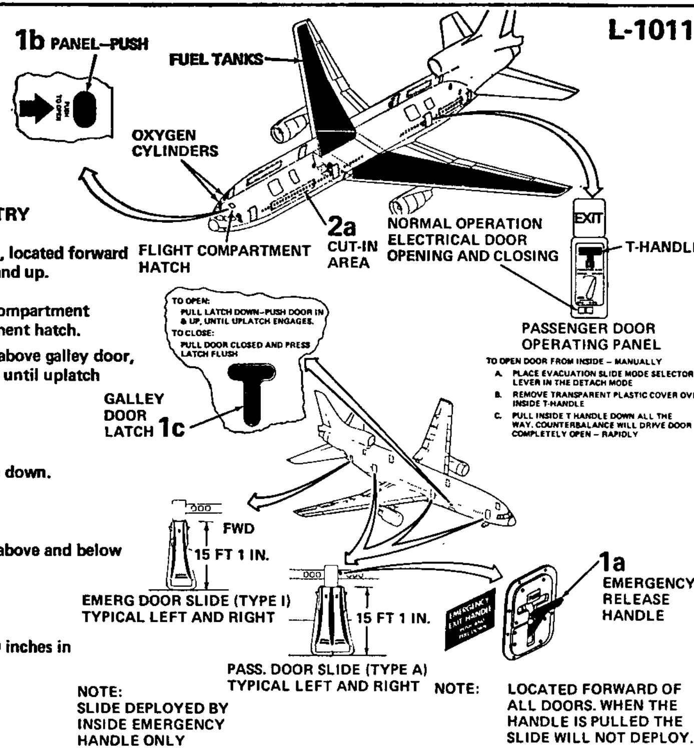
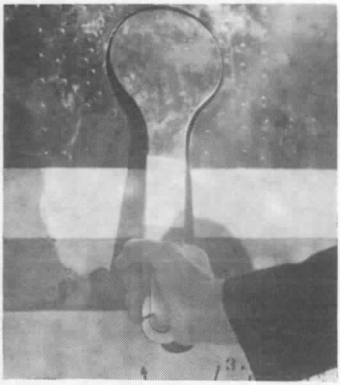
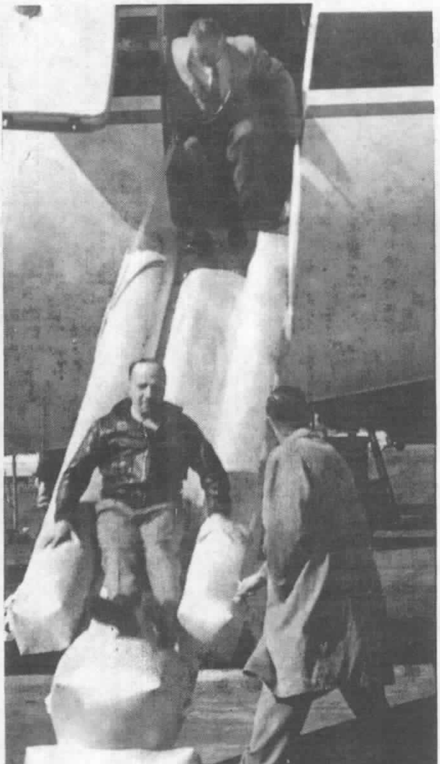


Figure A-19. The Lockheed L-1011 "wide-bodied" jet.





Upper Left

Figure A-20A

Upper Right

Figure A-20B

Courtesy Delta Air Lines

Figures A-20A, B and C illustrate the main cabin door opening mechanism from the exterior on the Convair 880 Jet Airliners and the integral self-inflating slide used for emergency evacuation. This aircraft has these slides at forward and rear main doors. The emergency window hatches have an exterior plate which should be pushed; the hatch will then release inwards.

Lower Left

Figure A-20C

SPECIAL TOOLS/EQUIPMENT
Power Rescue Saw
24 ft Ladder

FAIRCHILD F-27/ FH-227

AIRCRAFT ENTRY ALL MODELS

1. EMERGENCY/NORMAL ENTRY

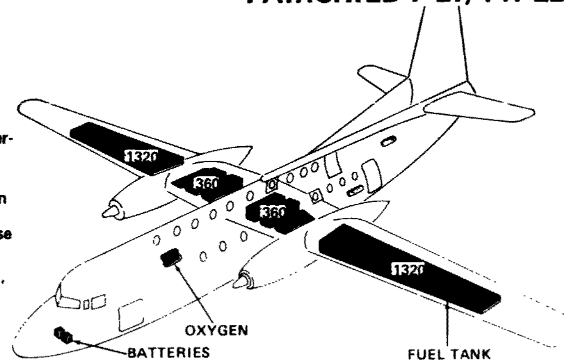
a. Push button and rotate handle, located on over-wing escape hatches both sides, counterclockwise and push hatches inward.

b. Pull handles from recessed position, located on left forward cargo compartment door and aft entry door, and rotate counterclockwise. Raise doors to stowed position.

c. Rotate handle, located on right aft cargo door, counterclockwise and pull door outward.

2. CUT-IN

Cut along window lines as last resort.



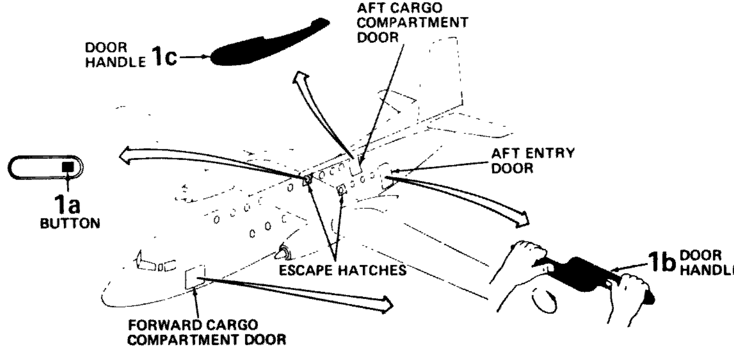


Figure A-21. Fairchild F-27/FH-227 twin (high wing).

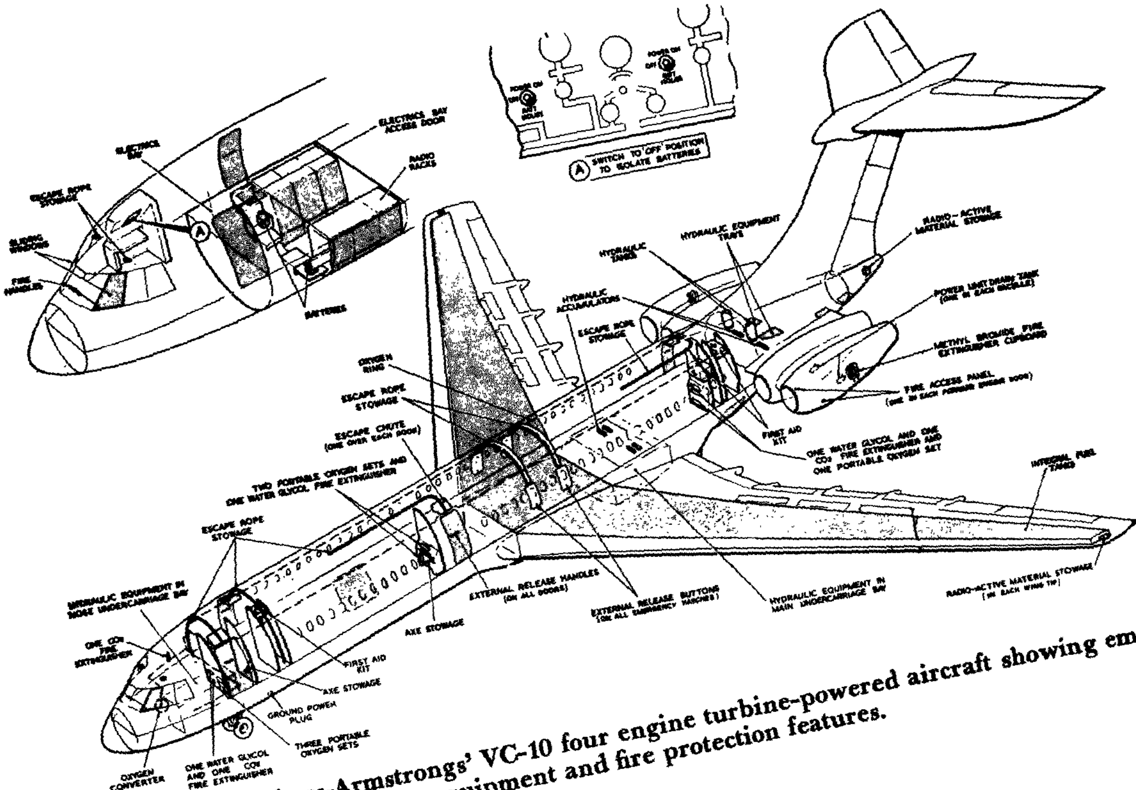


Figure A-22. Vickers-Armstrongs' VC-10 four engine turbine-powered aircraft showing emergency equipment and fire protection features.

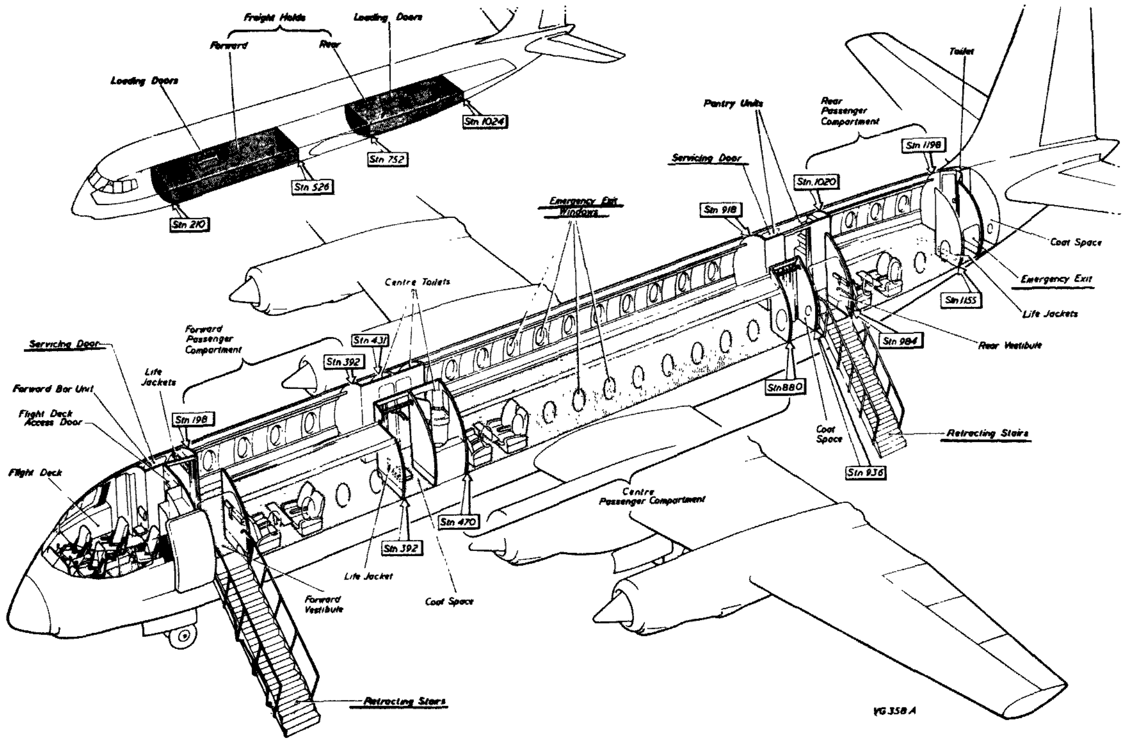
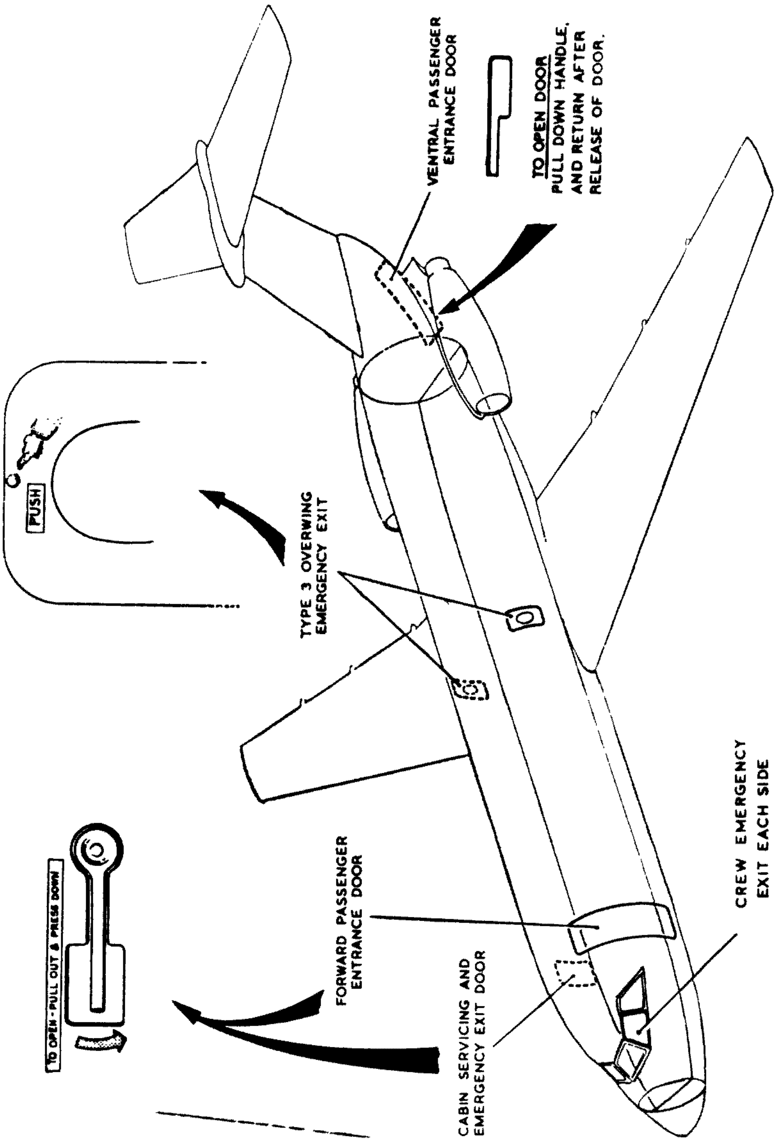
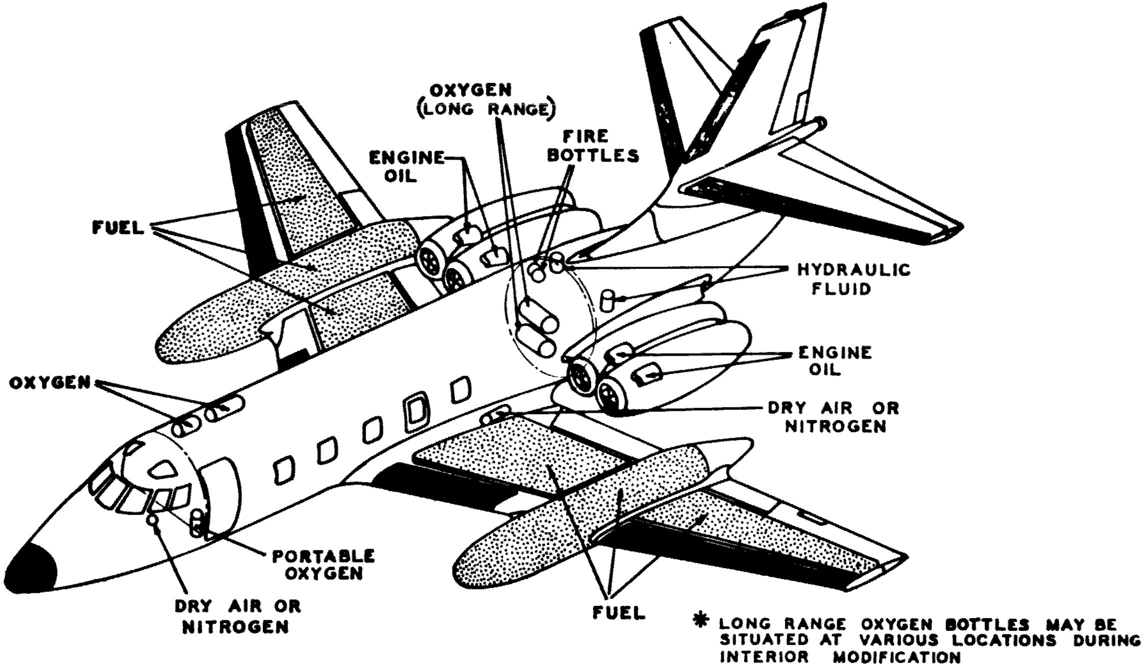


Figure A-23. The Vanguard aircraft showing general arrangements and emergency equipment.



British Aircraft Corp.

Figure A-24 The emergency doors and hatches on the BAC 1-11.



Courtesy Lockheed Georgia Company

Figure A-25A. The Lockheed JetStar's total fuel capacity is 2,654 gallons.

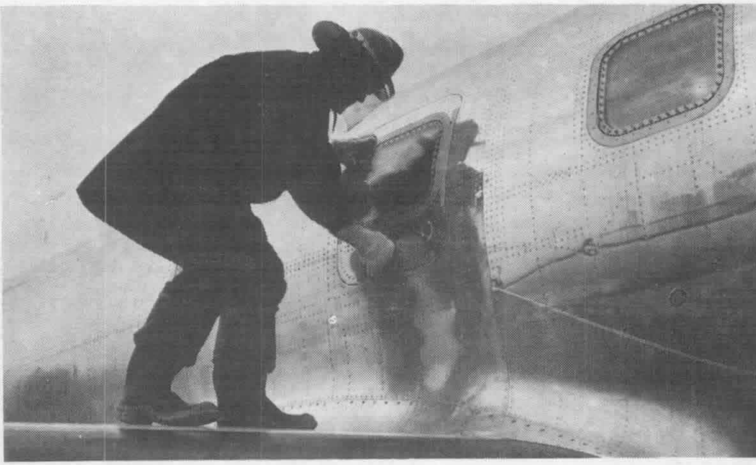
Courtesy Lockheed Georgia Company

Figure A-25B. The JetStar is typical of modern turbine powered jet transports carrying a two-man crew and up to eight passengers.

Figure A-25C. Normal entry at main entry door — first pull door handle outward.

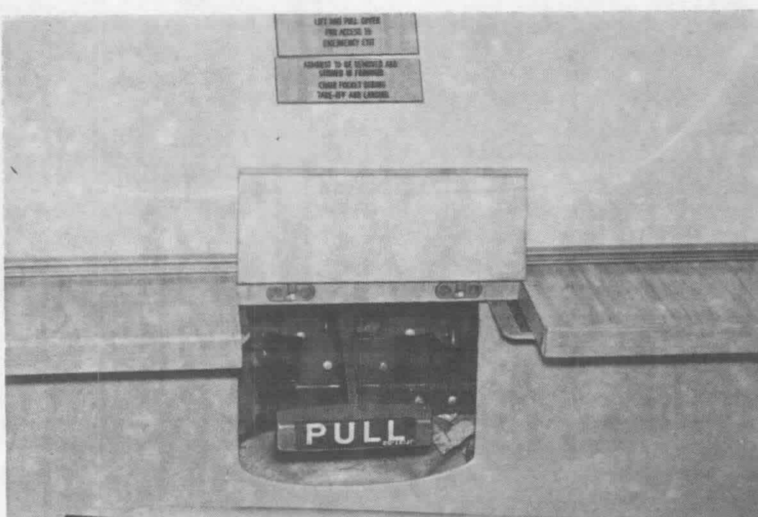
Figure A-25D. (Cont'd. from Fig. A-25C.) Then rotate one quarter turn clockwise.

Figure A-25E. (Cont'd. from Fig. A-25D.) Then push in, slide aft.



Courtesy Lockheed Georgia Company

Figure A-25F. The fourth window from the front on each side of the JetStar fuselage is an emergency hatch. To open from the outside, push in on the bottom of the flush latch plate underneath the bottom edge of the window. Push inward.



Courtesy Lockheed Georgia Company

Figure A-25G. From the inside of the JetStar pull on release handle to unlock and release the hatch (will fall inward).

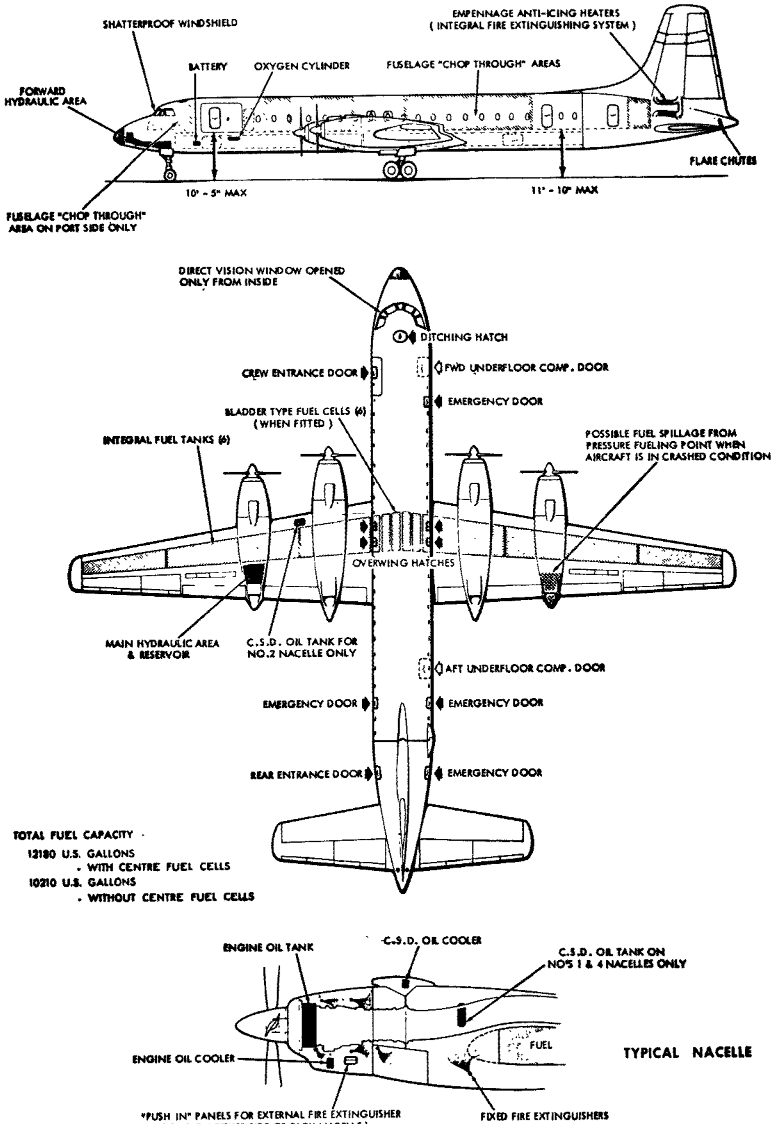
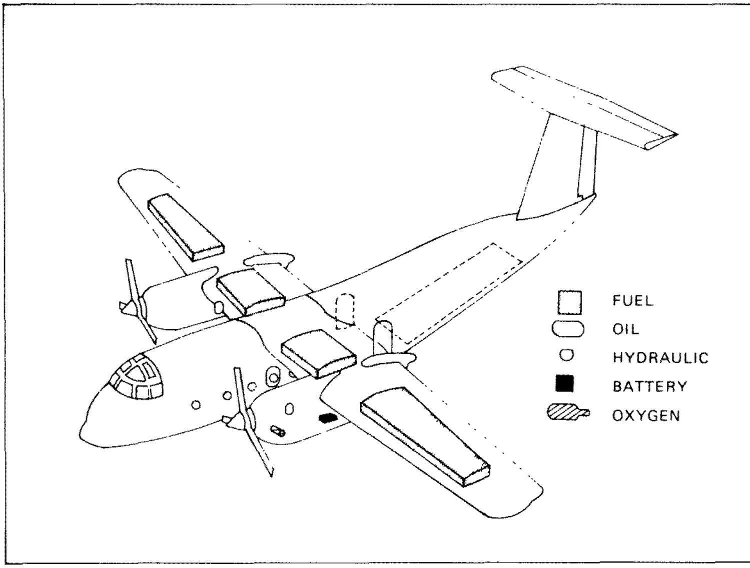


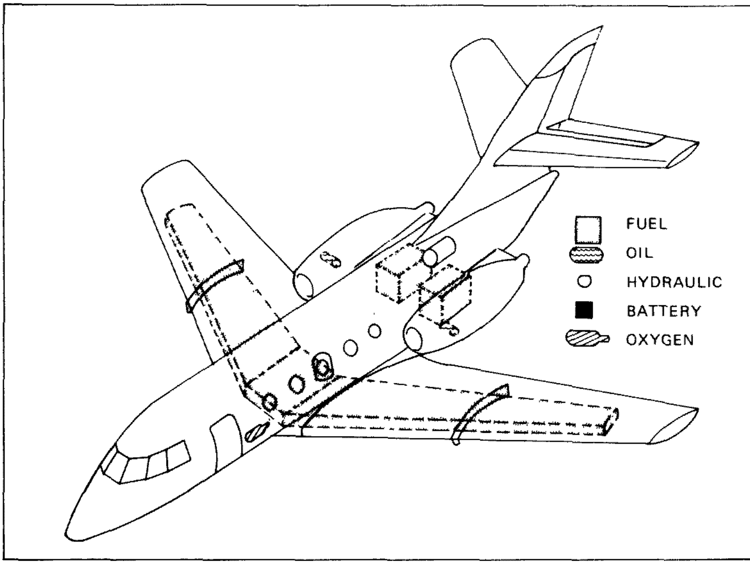
Figure A-26. Canadair CL-44D4 cargo/passenger aircraft rescue and fire fighting data. (Courtesy: Canadair Ltd.)



GENERAL INFORMATION

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

Figure A-27. CC115 Buffalo — Flammable Material Locations.



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 m^3 (76 cu ft)

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

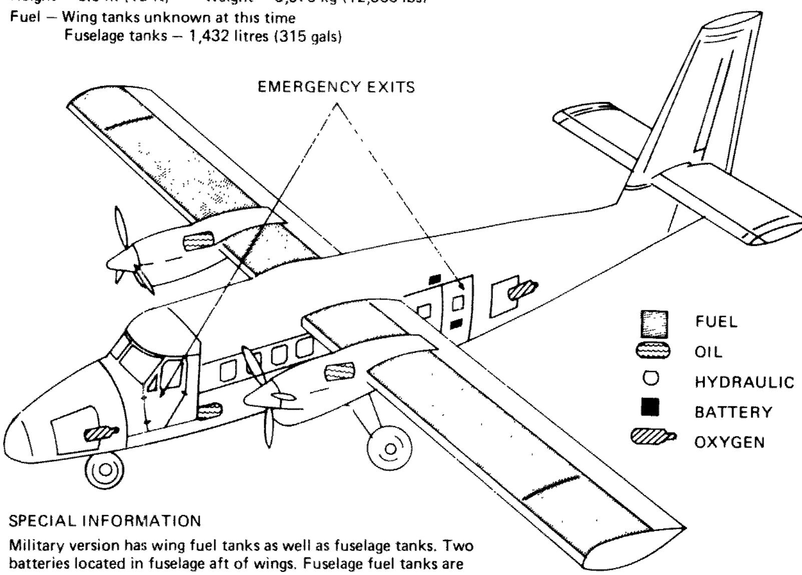
Figure A-28. CC117 Falcon — Flammable Material Locations.

GENERAL INFORMATION

Crew – 2   Passengers – 20   Span – 19.8 m (65 ft)   Length – 15.7 m (52 ft)

Height – 5.6 m (18 ft)   Weight – 5,670 kg (12,500 lbs)

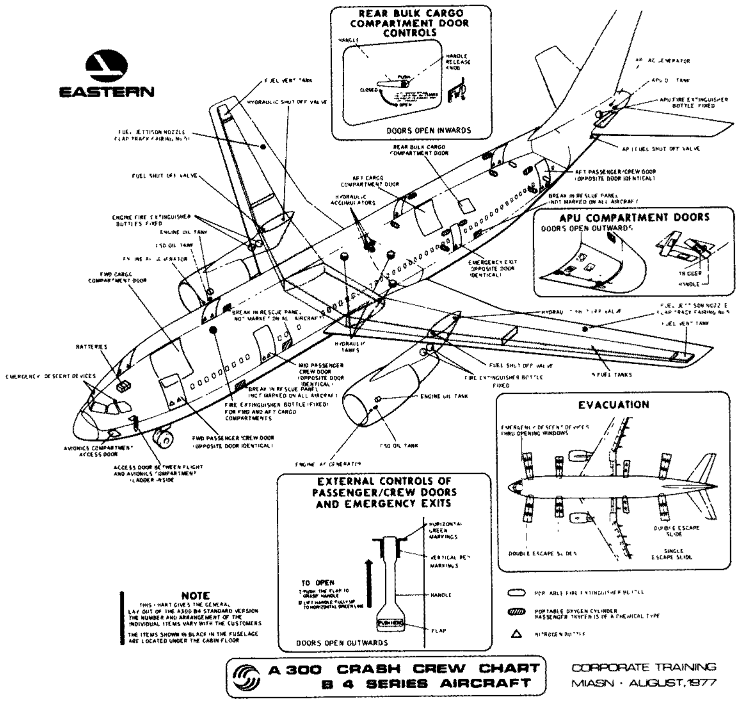
Fuel – Wing tanks unknown at this time
Fuselage tanks – 1,432 litres (315 gals)



SPECIAL INFORMATION

Military version has wing fuel tanks as well as fuselage tanks. Two batteries located in fuselage aft of wings. Fuselage fuel tanks are under-floor.

Figure A-29. Twin Otter — Flammable Material Locations.



(Courtesy of Eastern Airlines)

Figure A-30. Crash Crew Chart for A300 B4 Aircraft.

Appendix B
Air Transport of Radioactive Materials and Nuclear Weapons

This Appendix is not a part of this Recommended Practice, but is included for information purposes only.

B-1 Commercial Air Transport of Radioactive Materials.

B-1.1 The carriage in commercial transport aircraft of radioactive cargo is closely controlled by national and international regulations.* Reference should be made to the applicable regulations for full details.

B-1.2 Radioactive materials are being carried in commercial transport aircraft, particularly in cargo aircraft, regularly. While the containers used to transport these materials are rugged, the possibility of breakage cannot be overlooked and this introduces the hazard of radioactive contamination of an accident site.† By knowing and recognizing the radioactive symbols (see references), fire fighters can be alerted to this hazard. The following procedures should then be followed in the U.S. (similar procedures are followed in other countries):

B-1.2.1 Notify the nearest Department of Energy office or military base of the accident immediately. They in turn will respond with a radiological team to the accident scene.

B-1.2.2 Restrict the public as far from the scene as practical. Souvenir collectors should be forbidden in all accidents.

B-1.2.3 Segregate fire fighters who have had possible contact with radioactive material until they have been examined further by competent authorities.

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*In the U.S. an Official Air Transport Restricted Articles Tariff has been issued by the Airline Tariff Publishers Inc., 1825 K Street, N.W., Washington, D. C. 20006. Code of Federal Regulations, Title 14, Part 103 on Transportation of Dangerous Articles and Magnetized Materials is published by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 in Title 14, Parts 40 to 199. Policy decisions on all transportation modes in the U.S.A. are promulgated by the Hazardous Materials Regulations Board, U. S. Department of Transportation, 400 Sixth Street, S.W., Washington, D. C. 20590. The International Air Transport Association has issued "IATA Regulations Relating to the Carriage of Restricted Articles by Air"; this is available from IATA, Terminal Centre Building, Montreal 3, Quebec, Canada.

†See "Fire Protection Handbook" for a discussion of radiation hazards, available from the NFPA and "Radiation Control" by A. A. Keil, also published by the NFPA.

B-1.2.4 Remove injured from the area of the accident with as little contact as possible and hold them at a transfer point. Take any measures necessary to save lives, but carry out minimal (no more than necessary) first aid and surgical procedures until help is obtained from the radiological team physicians or other physicians familiar with radiation medicine. Whenever recommended by a doctor, an injured individual should be removed to a hospital or office for treatment, but the doctor or hospital should be informed when there is reason to suspect that the injured individual has radioactive contamination on his body or clothing.

B-1.2.5 In accidents involving fire, fight fires upwind as far as possible, keeping out of any smoke, fumes, or dust arising from the accident. Handle as a fire involving toxic chemicals (using self-contained gas masks and gloves). Do not handle suspected material until it has been monitored and released by monitoring personnel. Segregate clothing and tools used at fire until they can be checked by the radiological emergency team.

B-1.2.6 Do not eat, drink or smoke in the area. Do not use food or drinking water that may have been in contact with material from the accident.

B-1.2.7 The use of instruments such as Geiger counters, ionization chambers, dosimeters, etc., is the only accurate means of determining if radioactive radiation is being given off.

B-1.2.8 To the extent possible, run-off water and other agents used in fire fighting and cleaning should be channeled, collected, and dammed to prevent entry into water courses and the possible spread of contamination.

B-2 Military Aircraft Carrying Nuclear Weapons.

B-2.1 While most military aircraft will attempt to return to a military airbase in case of emergency, this is sometimes impossible and landings are frequently made at non-military airports. There are also many cases where "joint-use" airports serve both the military and civil aircraft operations. For these reasons it is advisable for aircraft rescue and fire fighting crews to be familiar with the various types of military aircraft operating in the area. For this purpose, training visits to promote knowledge of the special features of military aircraft at nearby military installations are of value. Such liaison is encouraged by the military.

B-2.2 Any person receiving information of a military aircraft accident should immediately notify the base operations office at the nearest military establishment giving all relevant information. Telephone numbers of such military installations should be kept on hand at civil airports and nearby municipal fire stations and in airport control towers.

B-2.3 Care should be exercised by the rescue and fire fighting crews when approaching any military aircraft involved in fire. Armament, ejection seats, hazardous or other dangerous cargoes may present severe hazards during such operation.

B-2.4 The possibility of a nuclear contribution (atomic explosion) from the detonation of a nuclear weapon or warhead involved in a fire, inadvertent release, or impact accident is so small as to be practically nonexistent. Safety features and devices have been carefully designed and incorporated in nuclear weapons and warheads to make this assurance possible. The danger from a nuclear weapon is associated with the high explosive (HE) used plus radiation from the components.

B-2.5 The presence of nuclear weapons in aircraft generally creates no greater hazard than does the presence of conventional high explosives. Most weapons do contain a high explosive which could detonate upon moderate to severe impact or when subject to fire. In fact, exposure to heat may make the high explosive more sensitive. In nuclear weapons the amount of high explosive is considerably less than that found in conventional high explosive bombs. Chemical and/or radiological hazards may exist during and after an accident or fire where a nuclear weapon is involved.

B-2.6. Basically, the same techniques are used for fighting aircraft fires involving nuclear weapons as those in which conventional high explosive bombs are involved; special extinguishing agents are not required to control and extinguish such fires. The brief length of time available to control or extinguish the fire, before an explosion might be expected, is the only special factor to be considered.

B-2.6.1 Description. In general, nuclear weapons resemble conventional bombs in that they are enclosed in a shell or casing that is generally cylindrical in shape, with tail fins. The weapon or warhead casings are of various thickness and may or may not break up upon impact. Most weapons contain a conventional type of high explosive which may detonate upon moderate to severe impact or when subject to fire. The quantity of high explosive involved in a detonation, if one occurs, may vary from a small amount to several hundred pounds and constitutes the major hazard in such an accident. If the casing breaks upon impact, the exposed and unconfined pieces of high explosive can ignite and burn or may explode if stepped on or run over. Some minor radiological hazards may exist regardless of the type of weapon, if the weapon burns or if detonation of high explosive occurs.

B-2.6.2 Time Factors. The length of time available to fight a fire involving nuclear weapons safely depends largely upon the physical characteristics of the weapon or warhead case, the intensity of the fire and the proximity of the fire. Since weapon and warhead cases vary in thickness, fire fighting "time factors" range from three minutes to an indefinite period if the fire impact incident does not detonate the high explosive immediately. The time element for each type of nuclear weapon and/or component is an important factor in fighting these fires. As soon as fire envelops the weapon area these "time factors" become effective. For weapons or warheads within a fire impact incident area, and subject to extreme heat but not enveloped in flames, a time factor of fifteen minutes will apply; if the fire fighting time factor is unknown to the fire fighters, the minimum time factor should be observed. Military flight communications procedures normally provide for notification of control towers of pertinent information regarding such time factors. When a weapon or warhead has been involved in fire and the time factor has expired, even though the fire has been extinguished or burned out, safe evacuation distances should be observed until the arrival of authorized Explosives Ordnance Disposal personnel.

B-2.6.3 High Explosive Blast and Fragmentation. The radius of a weapon high explosive blast varies, depending on the amount of high explosive which actually detonates; high explosive blast fragmentation distances for these weapons range from a minimum radius of 400 ft (122 m) to a maximum of 1000 ft (305 m). Personnel within these areas may be seriously injured from blast or fragmentation upon detonation of the high explosive. These areas and distances must be considered in evacuating fire fighting personnel and during the initial fire department approach to an accident where weapons have been enveloped in flames for a period approximating or exceeding the weapon time factor limitations. All except experienced fire fighting personnel should immediately evacuate to a minimum distance of 1500 ft (450 m) for protection against blast or fragmentation.

B-2.6.4 Precautionary Measures. Under no circumstances should any high explosive material from ruptured weapons that have been exposed to fire (or any components that have been scattered) be handled, stepped on, driven over, or disturbed in any manner. This material is extremely sensitive to minor detonations from shock or impact and may cause serious injury. Protective clothing and breathing apparatus (self-contained) must be worn during fire fighting operations to provide the fire fighter maximum protection from any chemical or minor radiological hazards that may be present. Additional protection is afforded by fighting any fire from an upwind position. All exposed clothing, apparatus, and equipment used during a fire or impact incident where nuclear weapons or components have been involved should be monitored for possible radiological contamination by specialized recovery personnel equipped for this purpose.

B-2.6.5 Associated Hazards.

(a) *Radiological.* In the event of a high explosive detonation or burning of a weapon, one has to concern himself principally with Alpha-emitting contamination which is serious only when ingested. Other types of radiation, which are harmless at the low levels produced in a weapon, may be detected with the use of sensitive detection instruments. (The effect of this radiation may be likened to the effects of radiation emanating from a luminous dial wristwatch.) Since Alpha-emitting particles are so fine that they are carried as smoke or dust from the burning or high explosive detonation of a nuclear weapon, some Alpha-emitting contamination may be expected in the immediate accident area and downwind. Although this material may present a minor radiation problem, danger from these particles exists only when they are inhaled in significant amounts. Protection against highest expected Alpha levels from such burning or high explosive detonation incidents is afforded fire fighting personnel by the prescribed protective clothing and breathing apparatus.

(b) *Fire.* Hazards associated with the burning of nuclear weapons and components are generally the same as those presented by conventional high explosives.

(c) *Impact.* Weapon or warheads may break up and the high explosive detonate from impact. Detonation and break-up is contingent to a large degree upon the characteristics of the weapon or warhead case, the impact velocity, and the location of aircraft suspension devices.

(d) *Sympathetic Detonation.* Detonation of a weapon or warhead, by fire or by impact, is also likely to induce detonation (non-nuclear) of any other weapon or warhead in the open within a 50 to 300 ft (15-90 m) radius of the incident area.

(e) *High Explosive Burning Characteristics.* Flame and smoke characteristics of burning high explosives vary, and provide no specific pattern upon which to determine when the high explosive is about to detonate. Burning high explosives produce flames of various colors; they may be bright red, yellow, greenish-white or combinations of no predominant color. Some give off a white smoke, while others burn with no trace of smoke.

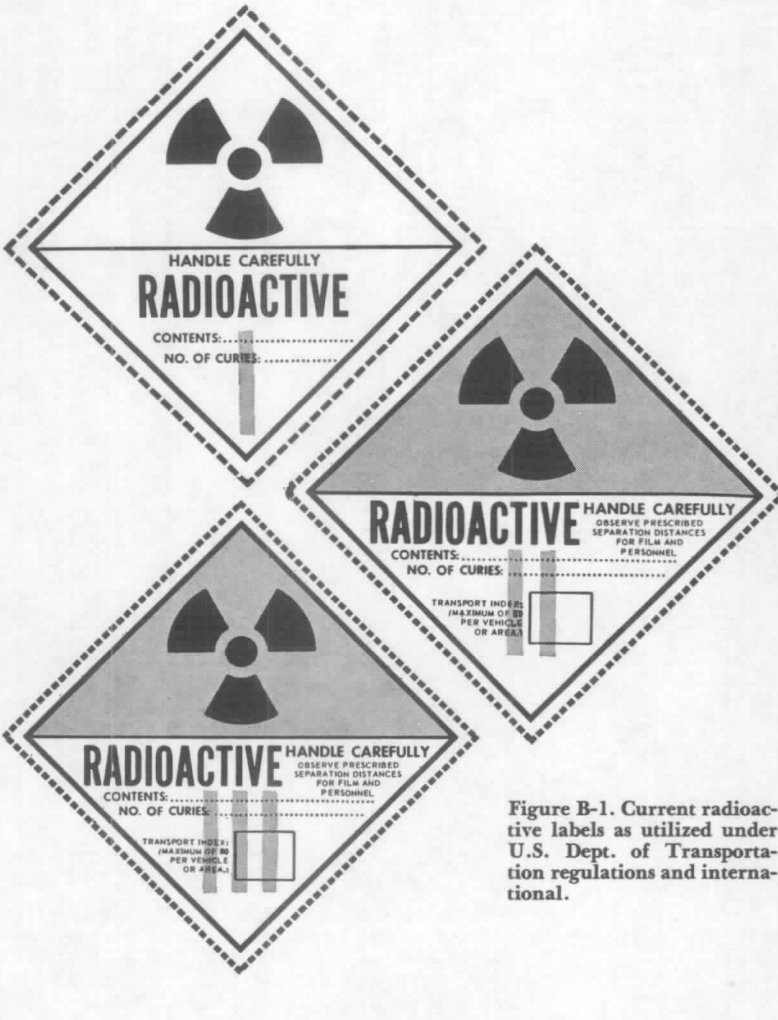

Figure B-1. Current radioactive labels as utilized under U.S. Dept. of Transportation regulations and international.

Appendix C

This Appendix is not a part of this Recommended Practice, but is included for information purposes only

C-1 Civil Aircraft Accident Investigation.

C-1.1 Civil aircraft accident investigation is normally conducted by a number of investigators interested in establishing the probable cause. Federal or state governments are usually charged with the official responsibility but the operators, pilot groups, airport management, and others may be active in accident investigation work. Fire officials normally make their own investigation. To aid them, the NFPA's *Aircraft Fire Investigators Manual,* NFPA 422M, has been prepared to guide them in their study of the fire factors involved and cooperating agencies send one copy of NFPA Form No. 422F to the Association to aid in the international study conducted by the NFPA in this field.

C-1.2 It is the duty of fire fighters to extinguish fires and to protect property and life from fires. No person, including the owner of the property or any governmental regulatory authority, has the right to interfere with or hinder a fire fighter in the performance of his duty and a fire fighter has the right to resort to any reasonable measures, including force, necessary to enable him to perform his duties. 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, fire fighters should be prepared to subsequently advise responsible investigative authorities of the actions they took in carrying out their rescue, fire control, or fire prevention responsibilities which may be of importance in the accident investigation report.

C-1.3 In the United States of America major aircraft accidents are investigated by the National Transportation Safety Board, 800 Independence Avenue S.W, Washington, D.C. 20591, except those delegated by the Board to the Federal Aviation Administration. Part 430 (Rules Pertaining to Aircraft Accidents, Incidents, Overdue Aircraft, and Safety Investigations) of the National Transportation Safety Board, Section 430.10, reads:

§430.10 Preservation of aircraft wreckage, mail, cargo, and records.

(a) The operator of an aircraft is responsible for preserving to the extent possible any aircraft wreckage, cargo, and mail aboard the aircraft, and all records, including those of flight recorders, pertaining to the operation and maintenance of the aircraft and to airmen involved in an accident or incident for which notification must be given until the Board takes custody thereof or a release is granted pursuant to §430.11.

(b) Prior to the time the Board or its authorized representative takes custody of aircraft wreckage, mail, or cargo, such wreckage, mail and cargo may be disturbed or moved only to the extent necessary:

(1) To remove persons injured or trapped;
(2) To protect the wreckage from further damage, or
(3) To protect the public from injury.

(c) Where it is necessary to disturb or move aircraft wreckage, mail or cargo, sketches, descriptive notes, and photographs shall be made, if possible, of the accident locale including original position and condition of the wreckage and any significant impact marks.

§430.11 Access to and release of aircraft wreckage, records, mail and cargo.

(a) *Access to aircraft wreckage, records, mail and cargo.* Only the Board's accident investigation personnel and the persons authorized by the Investigator-in-Charge or the Director, Bureau of Aviation Safety, to participate in any particular investigation, examination or testing shall be permitted access to aircraft wreckage, records, mail or cargo which is in the Board's custody.

(b) *Release of aircraft wreckage, records, mail and cargo.* Aircraft wreckage, records, mail and cargo in the Board's custody shall be released by an authorized representative of the Board when it is determined that the Board has no further need of such wreckage, mail, cargo or records.