

Doc 9137
AN/898



Airport Services Manual

Part 5 Removal of Disabled Aircraft

Approved by the Secretary General
and published under his authority

Fourth Edition — 2009

International Civil Aviation Organization

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AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

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FOREWORD

The specifications in Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*, recommend that States establish a plan for the removal of an aircraft disabled on or adjacent to the movement area of an airport. The plan is based on the characteristics of the aircraft normally expected to operate at the airport. In addition, the Annex recommends that a coordinator be designated to implement the plan when necessary.

As newer generations of aircraft commence operation at airports, the problem of removal of a disabled aircraft becomes increasingly serious. Most airports find it economically impossible to store all the equipment necessary for the removal of a disabled aircraft. It has been generally agreed that the most feasible approach to the problem is for States, in consultation with operators, to prepare a plan for each airport for the removal of a disabled aircraft and to make arrangements with other States and airports for pooling the required specialized equipment. To this end, airlines have made arrangements so as to make specialized equipment available on short notice on a worldwide basis, and kits have been strategically placed around the world.

This manual contains updated guidance on the removal of disabled aircraft and is intended to be used by airport and aircraft operators planning for the processes required to recover an aircraft. It has been expanded to include guidance material relating to the removal of new larger aircraft, categorized under the new ICAO aerodrome reference code F, such as the Airbus A380 and Boeing 747-8. This manual is to be used in conjunction with the aircraft recovery manual published by the respective aircraft manufacturer. The information in this document is not intended to be used for any commercial purposes.

In developing this manual, ICAO wishes to acknowledge the assistance of the International Air Transport Association (IATA).

It is intended that this manual be kept current. Future editions will improve on this edition on the basis of experience gained and of comments and suggestions received from users of the manual. Readers are therefore invited to send their views, comments and suggestions on this edition, in writing, to:

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ACRONYMS AND ABBREVIATIONS

ACN/PCN	Aircraft classification number/pavement classification number
ARM	Aircraft recovery manual
ATC	Air traffic control
CBR	California bearing ratio
HAZ-MAT	Hazardous material
HBV	Hepatitis B virus
IATA	International Air Transport Association
IATP	International Airline Technical Pool
MAC	Mean aerodynamic chord
MEW	Manufacturer's empty weight
MZFW	Manufacturer's zero fuel weight
NLA	New larger aeroplane
NOTAM	Notice to all airmen
NRW	Net recoverable weight
OEW	Operating empty weight
PSI	Pounds per square inch
RAT	Ram air turbine
RC	Reference chord
REW	Recoverable empty weight
VHF	Very high frequency

Chapter 1

INTRODUCTION

1.1 PURPOSE

1.1.1 The purpose of this manual is to assist States, aerodrome and aircraft operators in addressing the issues related to immobilized and disabled aircraft in an aerodrome environment. In the past, minor incidents have been handled with relative ease. As the size and mass of aircraft increase, the complexities of the removal process have increased proportionately. With the advent of the new larger aeroplane (NLA), categorized under a new aerodrome reference code letter F, additional, larger and more complex recovery equipment is required. This manual is designed to assist both aerodrome and aircraft operators in identifying the relevant problems, then preparing and implementing an adequate plan of action to remove the disabled aircraft.

1.1.2 Although information regarding the removal of larger aircraft will dominate in this manual, recovery of smaller aircraft such as regional jets, due to their increasing numbers, will also be addressed.

1.2 GENERAL

1.2.1 Disabled aircraft that interfere with normal activity of an aerodrome require prompt removal actions. The travelling public, other aircraft operators, the aerodrome operator and the operator of the incident aircraft are all affected to varying degrees. In addition, runway and taxiway closures can substantially reduce the number of arrivals and departures and restrict movement around the aerodrome, resulting in loss of revenue to the airport as well as to the aircraft operator.

1.2.2 Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*, 9.3.1, specifies that each aerodrome must draw up a comprehensive plan for the removal of a disabled aircraft on, or adjacent to, the movement area and a coordinator designated to implement the plan, when necessary. In addition, the removal plan should include the following:

- a) a list of equipment and personnel available on or in the vicinity of the aerodrome;
- b) a list of additional equipment available from other aerodromes on request;
- c) a list of nominated agents acting on behalf of each operator at the aerodrome;
- d) a statement of the airlines arrangements for the use of pooled specialist equipment; and
- e) a list of local contractors (with names and telephone numbers) able to supply heavy removal equipment on hire.

1.2.3 The information described in 1.2.2 will be contained in the relevant aerodrome disabled aircraft removal plan. Furthermore, in accordance with Annex 14, Volume I, section 2.10, aerodrome authorities are required to make available to the appropriate aeronautical information service units information on the capability to remove a disabled aircraft on or adjacent to the movement area. This may be expressed in terms of the largest type of aircraft that the aerodrome is equipped to remove. For instance, an Airbus A380 or a Boeing B747 can be reported as being the largest type of aircraft

that the aerodrome is equipped to remove. This capability should be based on the equipment available at the aerodrome and on equipment which, according to the disabled aircraft removal plan, can be available at short notice. Should the plan take into account an airline pooling arrangement, the determination of the capability to remove a disabled aircraft should also take into consideration the specialized aircraft recovery kits available from the aerodromes mentioned in Appendix 9.

1.2.4 In addition, there is a requirement that contact information concerning the office of the aerodrome coordinator of operations for the removal of a disabled aircraft be made available, on request, to aircraft operators.

1.2.5 It is also recommended that aircraft operators have a plan for the removal of disabled aircraft. The suggested form is an internal aircraft removal process document containing all relevant company information and required contact information regarding the removal of disabled aircraft (see Appendix 5).

1.3 OBJECTIVE

The objective of this document is to identify the issues involved in removing immobilized or disabled aircraft. The processes and procedures required to return the aircraft to a hard surface are described. The aircraft recovery process is dependent on a number of variables. Even so, there are five generally accepted major steps identified with the removal process, that will be covered in detail:

- survey
- planning
- preparation
- recovery
- reporting processes

1.4 IMPORTANT NOTES

1.4.1 Aircraft should not be moved without the approval of the accident investigation authority. Except as specified in Annex 13 — *Aircraft Accident and Incident Investigation*, wreckage of aircraft should be left undisturbed until the arrival of the Investigator-in-Charge of the accident investigation. Detailed guidance on the initial action at the scene of the accident, preservation of the evidence, etc., may be found in the *Manual of Aircraft Accident Investigation* (Doc 6920).

1.4.2 In exceptional circumstances, where safety of other aircraft is imperilled, the disabled aircraft should be removed as quickly as possible. If the aircraft or parts thereof must be moved prior to completion of the investigation, it is important that such an operation not be carried out until:

- a) photographs are taken;
- b) the location and position of all major components are marked on the ground; and
- c) a diagram of the accident site including ground scars is drawn.

1.4.3 The photographs should include general views of the aircraft from four directions. Photographs of the flight deck showing the position of all switches and controls should also be included. The location and position of the aircraft and

its separated parts should be indicated by driving stakes into the ground or by markings on the surface, as appropriate. The diagram of the accident site, preferably prepared on squared paper, should record the location of all major components and their relative position with respect to a reference point or line. Detailed information on photographs to be taken and preparation of diagrams is contained in Doc 6920. If, in the removal operation, the aircraft or any part thereof is further damaged, such damage, referred to as secondary damage, should be recorded so that it can be distinguished from impact damage.

1.4.4 Other notes:

- a) This document provides only general aircraft removal information; it is imperative therefore that the aircraft manufacturers' Aircraft Recovery Manual (ARM) be consulted prior to initiating the aircraft recovery process (see 2.7);
- b) This document follows the format and general guidelines of the ATA iSpec 2200 specification, which provides the industry-wide standard of numbering aircraft systems;
- c) Only experienced people must manage the removal process; and
- d) Safety precautions must predominate and take precedence over all other parameters and removal pressures.

1.5 TYPES OF OCCURRENCES

An aircraft removal incident can occur at any time and in any weather conditions with varying degrees of magnitude. These removal incidents can range from minor debogging to major events including damaged or missing landing gear. The recovery process may take from a few hours to many days depending on the severity. While recovery incidents cannot be predicted, they can be anticipated and prepared for.

1.6 RESPONSE

The removal of some disabled aircraft can be a complex scenario involving a number of specific procedures including multipart levelling and lifting actions. These procedures can be dangerous, and safety precautions must take precedence over all other constraints. Prevention of secondary damage must also be a priority (see 4.3). In some cases, the removal process cannot begin until a lengthy investigation by the on-site investigative authority has been completed, and the aircraft is formally released. Because of these issues, it is not always possible for the aerodrome to be cleared as quickly as desired by the aerodrome operator.

1.7 COST TEMPLATE

The direct costs associated with a removal incident are fairly easy to assess and record, but the indirect costs are much more difficult to appraise. Attempts should be made to capture these costs and make them available for further study. An Aircraft Removal Cost Template is provided in Appendix 8.

1.8 GENERAL REMOVAL TERMS AND DEFINITIONS

There are three general terms used in the removal of disabled aircraft: aircraft debogging, aircraft recovery and aircraft salvage. These terms are defined as follows:

- a) *Aircraft debogging.* The removal of an aircraft from a runway or taxiway excursion where the aircraft has become bogged down but has relatively little or no damage is considered a “debogg”.
- b) *Aircraft recovery.* Any aircraft that is unable to move under its own power or through the normal use of an appropriate tow tractor and tow bar will be considered an “aircraft recovery”, examples are:
 - one or more landing gear off the hard surface of a runway, taxiway or apron;
 - aircraft bogged down in mud or snow;
 - one or more landing gear collapsed or damaged;
 - an aircraft that is considered to be economically repairable; and
- c) *Aircraft salvage.* An accident or incident in which the aircraft sustains substantial damage and the insurer considers the hull a constructive loss will be considered “aircraft salvage”.

1.9 RESPONSIBILITIES

1.9.1 Responsibilities for the removal of a disabled aircraft lie not only with the aircraft operator, but also with the State and the aerodrome operator. For an aircraft removal operation to begin and be completed as quickly as possible, all parties must be expeditiously facilitated and already have the proper procedures in place. An efficient removal operation requires sufficient planning and readily accessible recovery equipment.

State

1.9.2 Annex 9 — *Facilitation*, Chapter 8, section B, contains international Standards and Recommended Practices (SARPs) to facilitate, inter alia, the removal of damaged aircraft, as follows:

- a) States shall make arrangements to ensure without delay into their territories on a temporary basis of qualified personnel required for, among others, salvage in connection with a damaged aircraft; and
- b) States shall facilitate the temporary entry into its territory of all aircraft, tools, spare parts and equipment required in the, among others, repair or salvage of the damaged aircraft of another State.

Aerodrome operator

1.9.3 The aerodrome operator must have an officer designated to coordinate the aircraft recovery operation and a disabled aircraft removal plan available (see Appendix 1). In addition, a copy of the aircraft operator's removal plan should be on file for every regular user of the aerodrome.

1.9.4 The aircraft must be removed in a timely and efficient manner. If the aircraft operator fails to take responsibility for the removal operation, the aerodrome operator may take over the responsibility and contract the removal to a third party. It is suggested that the aerodrome operator, in conjunction with the aircraft operators, hold regular tabletop exercises in order to anticipate various aircraft removal scenarios and their projected outcomes.

1.9.5 When aircraft recovery operations are carried out at an operating aerodrome, the recovery devices such as large mobile cranes may penetrate the obstacle limitation surfaces or interfere with radio navigational aids, etc. Therefore, consideration should be given to mitigating risks associated with the recovery operations to ensure the aerodrome's operational safety.

Aircraft operator

1.9.6 It is imperative that the aircraft operator notify the relevant investigative authority of the incident as quickly as possible. Annex 13 contains international SARPs on the mandatory reporting of certain types of accidents/incidents and the responsibilities of the various parties involved.

1.9.7 The registered owner or aircraft operator retains complete responsibility for the removal. Notification of the accident or incident must also be transmitted to the operator's insurance representative. The aircraft operator must have an aircraft recovery process document available for review. Information within the document must be filed with the aerodrome operator and include all relevant contact numbers as well as information on who the aircraft operator will use to remove the aircraft.

Investigation authority

1.9.8 The investigation authority must be notified of the incident as soon as possible to ensure that the investigation of the accident or incident is concluded, and the aircraft is released in a timely matter. In some cases, the aerodrome operator or the local air traffic control (ATC) unit advises the investigation authority. It is important to remember that even though it may impede the removal operation, the regulations of the investigation authority of the State of Occurrence must be complied with at all times.

1.9.9 The investigation authority may request the aircraft operator to carry out a number of initial tasks such as removal of the flight data recorder and removal of the cockpit voice recorder. These tasks may be requested and can be completed even though the aircraft has not been released. Under no circumstances can the aircraft removal process begin until this authority has given formal release.

Insurance underwriter

1.9.10 The aircraft operator is ultimately responsible for his aircraft, which includes its removal after an accident. The insurance underwriter generally, through a representative, will be involved in the aircraft removal process. The aircraft operator, with the assistance of the underwriter will arrange for removal of the aircraft and, in the case where the aircraft operator possesses the necessary qualifications, the operator will perform the aircraft removal. Every effort must be made during the recovery operation to avoid further damage to the aircraft as well as the accident site.

1.10 RUNWAY EXCURSIONS

There are numerous factors contributing to aircraft recovery events arising from runway excursions, and these can be generalized as follows:

- a) flight control system failures;
- b) power plant such as actual engine failure or failure of the thrust reverse system;
- c) landing gear such as hydraulics, brakes, tires, steering;
- d) weather such as rain, snow, ice, crosswinds, visibility, runway friction;
- e) maintenance, weight and balance; and
- f) Human Factors such as flight crew.

Most runway excursions are minor in context but can still cause significant damage to the aircraft resulting in major recovery initiatives to be taken.

1.11 NEW LARGER AEROPLANES (NLAs)

1.11.1 In the late 1990s, plans were announced by the two major aircraft manufacturers that they were planning to develop aircraft larger than the B747-400, which was then the largest commercial civil passenger aircraft. In response, ICAO undertook a study of these NLAs, and the results of this study led to Amendment 3 to Annex 14, Volume I, which became applicable in November 1999. Consequently, a new aerodrome reference code letter F was established. This new code included aircraft with wingspans from 65 metres up to but not including 80 metres, with an outer main gear wheel span from 14 metres up to but not including 16 metres. The Airbus A380 and the B747-8 fall into this new category. However, other aircraft such as the Airbus A340-600 and Boeing B777-300, which belong to code letter E, are very close in length to the new code letter F aircraft. (See the aerodrome reference code system in Appendix 2). Additionally, a detailed list of aeroplane classification by code number and letter, available in *Aerodrome Design Manual*, Part 1 — *Runways* (Doc 9157), is also reproduced in Appendix 2.

1.11.2 It should be noted that aircraft in the upper area of code letter E and code letter F may cause greater logistical problems in expediting their removal and also impose longer operational constraints at major aerodromes. Two examples of these constraints are: the blocking of more than one access route to the apron areas and the use of the runway and taxiway where their separation distances are minimal.

Removal of NLAs

1.11.3 The added restrictions relating to the size and weight of the NLA increases the pressure for the speedy removal of the aircraft. With the advent of these NLAs, many new requirements were needed in the area of aircraft removal. As a result, aircraft removal equipment manufacturers have responded with the following:

- higher capacity pneumatic lifting devices
- higher capacity aircraft removal jacks with arc movement control capabilities

- new technology designs in lifting equipment
- higher capacity lifting and towing equipment
- larger temporary fuel storage equipment

1.11.4 Some of the major issues relevant to aircraft removal concerning the new code letter F aeroplanes will be identified in Chapters 2 and 5 of this document. For details on the operation of NLAs at existing aerodromes, see *Operation of New Larger Aeroplanes at Existing Aerodromes* (Cir 305).

1.12 SMALLER AIRCRAFT

1.12.1 The advent of the regional jet has a number of implications regarding aircraft removal. Although these aircrafts are relatively small when compared to NLAs, the removal problems are similar. These aircraft types generally fall into the aerodrome reference code letters B and C. Aircraft in the aerodrome reference code letter A usually present fewer aircraft removal problems.

Recovery of smaller aircraft

1.12.2 Due to the smaller size, weight and minimal wing height above the ground, regional jets present unique aircraft removal problems that must be addressed, such as the requirement for smaller aircraft removal jacks and smaller pneumatic lifting device as well as lack of information in the ARM for lifting with cranes.

1.13 RELATED DATA

The following documents must be reviewed for additional information on removal of disabled aircraft:

- Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*
- Annex 13 — *Aircraft Accident and Incident Investigation*
- Annex 9 — *Facilitation*;
- *Airport Services Manual* (Doc 9137):
 - Part 1 — *Rescue and Fire Fighting*
 - Part 7 — *Airport Emergency Planning*
 - Part 8 — *Airport Operational Services*
- *Manual of Aircraft Accident Investigation* (Doc 6920)
- *Operation of New Larger Aeroplanes at Existing Aerodromes* (Circ 305)
- Regulations of the State of Occurrence of the accident/incident



- Local airport operator disabled aircraft removal plan and related emergency plans
- United States Federal Aviation Administration Advisory Circular 150/5200-31A
- Specific ARM of the manufacturer
- Specific Weight and Balance Manual
- Aircraft removal process document of the aircraft operator

1.14 RELATED WEBSITES

The following websites are suggested for additional information:

- International Civil Aviation Organization (ICAO): <http://www.icao.int>
- International Air Transport Association (IATA): <http://www.iata.org/workgroups/emg>
- International Airlines Technical Pool (IATP): <http://www.iatp.com>

Chapter 2

SITE SURVEY

2.1 INTRODUCTION

The objective of this chapter is to clearly identify the major steps involved in the aircraft removal process and to assist in developing and implementing an appropriate removal plan. It must be noted that if initial conditions and parameters change during the process, each step of the implemented plan may have to be revised, which could be a continual process.

2.2 PRIOR TO RELEASE OF THE AIRCRAFT BY THE INVESTIGATION AUTHORITY

There is a time period between notification of the accident/incident to the aircraft accident investigation authority and release by the investigation authority to allow access to the aircraft. During this time a number of preliminary tasks can be completed in preparation for removal; some of these tasks include the following:

- a) Recording of the initial accident/incident data;
- b) Preparations for site security including fire, theft and access control;
- c) Confirmation of the availability of the removal team members;
- d) Arrangement for delivery of local recovery equipment;
- e) Preparations for movement of specific removal equipment such as IATP kits from other sources (see Appendix 9);
- f) Establishment of communication with the aerodrome operator and the investigative authorities;
- g) Identification of what types of dangerous goods were being carried on board as cargo;
- h) Obtaining current drawings/maps of the aerodrome to assess access routes to the site;
- i) Transportation of the required personnel to and from the removal site;
- j) Confirmation of shipping details for the required recovery equipment;
- k) Visas, passports, vaccinations and related certificates; and
- l) Hotel accommodations and local transportation.

2.3 RELEASE BY THE INVESTIGATION AUTHORITY

Once the investigation authority has formally released the aircraft, an initial survey can be carried out. A report on the general condition of the aircraft and its systems must be completed as soon as possible (see 2.4).

2.4 INITIAL AIRCRAFT SURVEY

2.4.1 As mentioned in 2.3, an aircraft survey can only be carried out once the investigation authority has released or granted access to the aircraft. Items to be recorded can include the following:

- a) the integrity of the aircraft structure and landing gear;
- b) an appraisal of the soil conditions;
- c) forecast of current and future weather conditions;
- d) relevant health and safety issues of personnel; and
- e) expected environmental concerns.

2.4.2 In a minor incident where no injuries have occurred, the investigative authorities may not respond to the notice of the accident/incident but will give verbal approval to commence the removal process. In this case the investigation authorities will usually require a detailed report on the removal once completed.

2.4.3 Before allowing personnel to carry out the initial inspection of the aircraft or to enter or move under the aircraft, the aircraft must be properly stabilized. Once stabilized, a general visual inspection must be carried out paying particular attention to the condition of the fuselage, wings, engines and landing gear. Any visible damage or fluid leaks must be recorded. This documentation, which forms part of the recovery records, can be in the form of photographs, sketches, measurements and notes, etc.

2.4.4 If the accident/incident is major, the aircraft operator, pending the investigation, may lockout any computer-based aircraft technical documentation. In this case the fuel and cargo loads will be unknown, and it will be necessary to wait until the aircraft is properly stabilized to establish these factors.

2.4.5 This initial survey is important when carrying out preliminary discussions with the investigative authorities, the insurance adjusters, the aircraft manufacturer's representatives and, ultimately, the repair facility. As these discussions would normally take place by telephone; having access to this initial survey material is invaluable.

2.4.6 Usually the investigation of the accident/incident generates much more activity than the removal process itself. Because the objective of the investigation is to determine the cause of the accident/incident and provide details to prevent a reoccurrence of the event. The investigation authority may ask the aircraft operator's engineers to remove the flight data and voice recorders from the aircraft and release them to the investigative authorities who will issue a receipt for them, including the aircraft registration and the serial numbers of the units.

2.5 INSPECTION

2.5.1 Visual inspection of the aircraft without climbing on, entering or moving under the aircraft, a visual inspection of the aircraft must be carried out, taking note of any obvious and visible damage. Such damage must be recorded using stringer and fuselage frame or station numbers as references. Possible types of damage observed can include:

- a) cracked, creased, buckled, distorted or torn fuselage and wing skin panels;
- b) broken and missing fasteners; and
- c) signs of overheating of any fuselage or wing panels or other components.

2.5.2 Any of the preceding types of damage are signs of failed structural components that must be considered questionable since failed structural components cannot be relied on to carry their designed loads. Prior to any levelling or lifting, a more detailed inspection of these areas is required.

2.5.3 If any damaged or loose components that will interfere with the removal process have been identified, plans must be made to either remove or secure them in place. These components may include:

- landing gear
- flap sections
- engine cowlings
- other non-structural parts such as damaged fairings, which can be a sign of hidden damage to other structural components

Electrical system

2.5.4 Further inspection of the electrical system is warranted if structural damage to the aircraft is evident. The decision to disconnect the aircraft's main batteries must not be taken lightly as it can greatly affect the recovery process. The ability to defuel the aircraft in a timely manner is greatly improved with aircraft power available.

Fluid leaks

2.5.5 Fluid leaks must be identified during this initial inspection. These leaks may include fuel, hydraulic fluid, wastewater, potable water or leaking cargo. Fuel leaks of any kind would mandate the defuelling of the aircraft as a primary task. Other than potable water, fluid leaks must be immediately reported in order for a quick response by the hazardous materials clean-up crew. In the mean time, attempts can be made to cap lines, temporarily plug any leaks and contain the fluids with the use of absorbent materials or containers.

Landing gear

2.5.6 When inspecting the landing gear, identify any landing gear that appears serviceable. Landing gear in the extended position must be secured, by installing landing gear down-lock pins. Once the aircraft has been levelled and lifted, it is sometimes possible to extend the landing gear and secure it by installing landing gear down-lock pins. It is also sometimes possible to perform temporary repairs on failed, folded or retracted landing gear or to replace a damaged landing gear assembly if spares are available. In certain cases, repairs or replacement will take less time than attempts to move the aircraft using trailers, which will increase the chance of inflicting secondary damage to the aircraft.

2.6 INITIAL SITE SURVEY

2.6.1 A thorough inspection the area surrounding the incident/accident site must be carried out. The path of the aircraft from where it left the hard surface to where it came to rest will be quite clear. Using this information, the direction the aircraft will be moved needs to be considered, keeping in mind the shortest distance to a hard surface may not always be the best choice. A current aerodrome topographical site map will help when making these decisions.

Terrain

2.6.2 The removal process will be more straightforward where the ground is reasonably flat. In an area where the ground consists of hills, slopes, streams and/or drainage ditches, the difficulty and complexity of the recovery process will increase. The aerodrome site map can be used to note any irregularities or conflicting information. Buried electrical conduits, drainage pipes and culverts must be discussed with the aerodrome field maintenance department and will be important when planning the extraction route of the aircraft. Any type of animal life, including rodents and snakes, must be investigated and reported accordingly.

Soil characteristics

2.6.3 One method used to evaluate soil conditions and load-bearing capability is the California Bearing Ratio or CBR. The CBR test measures the load necessary to force a plunger or penetrometer into a soil sample, thus identifying the inherent strength of the soil. Certain factors can affect the load-bearing capacity such as:

- type of soil and substrate
- any signs of recent excavations
- disturbed ground
- excessive rain
- drainage problems

2.6.4 Ruts left by the landing gear can be used to determine the load-bearing capacity of the soil. Some ARMs correlate these rut depths to the load-bearing capacity of the soil. There are many factors that are dependent on the load-bearing capacity of the soil. The strength of the soil will determine the choice of:

- materials when building temporary roadways capable of supporting the aircraft's weight
- earth anchors for tethering purposes

Aerodrome map

2.6.5 It is preferable to use an aerodrome topographical site map to identify obstacles such as fences, concrete footings, streams, drainage ditches, both surface and underground, culverts and buried electrical conduits. These obstacles must be considered when preparing the removal plan. The aerodrome field maintenance department can assist in identifying on the map any recent excavations near the incident/accident site and also use the map to plan a detailed removal route for the aircraft.

Access routes

2.6.6 Access routes to and from the incident site will normally be a concern and must be planned with the help of the local ATC unit and aerodrome map. The local ATC unit will provide direction and in some cases the aerodrome operator will provide escort vehicles, eliminating the requirement for radio contact. When choosing the removal route for the aircraft, it is necessary to evaluate the distance to the closest hard surface that can support the aircraft, the type of soil in the area, rut depth and physical obstacles.

2.6.7 Actual pavement specifications must be taken into account for code letter E aircraft and especially for new code letter F aircraft. For example, a taxiway in proximity to the disabled aircraft that is not rated for the aircraft's weight cannot be used without causing possible damage to the pavement. The bearing strength of pavements rated for various aircraft loads are reported using the aircraft classification number/pavement classification number (ACN/PCN) system. Information on the ACN/PCN system can be found in Annex 14, Volume I; and the *Aerodrome Design Manual*, Part 3 — *Pavements* (Doc 9157). Further consideration is required when one or more of the landing gear is missing, causing uneven distribution of the aircraft's weight. Further information on aircraft weight and footprint loads can be found in each specific ARM.

Weather

2.6.8 General weather conditions play a major part in the recovery process. Current and forecast weather conditions must be considered in properly planning the recovery process. These weather conditions include the following:

- a) *Precipitation*: in any form will have major consequences on surface grading, soil load-bearing capacity and general recovery operations.
- b) *Temperature*: both extreme heat and cold will determine the type of clothing and shelter required.
- c) *Wind*: wind speed must be monitored to ensure that ARM limits on levelling/lifting operations are not exceeded. Wind will also determine the types and amounts of tethers to be used.

2.7 NLAs

Due to their size and weight, disabled aircraft that are classified under the code letters E and F require further evaluation and consideration when planning the removal process. Factors influencing the removal process of NLAs are:

- a) increased fuselage length and wingspan;
- b) increased weight;
- c) substantial increases in volume of fuel and cargo;
- d) access height for various components including engines, doors, wings and tail surfaces may be compounded by unusual aircraft attitudes;
- e) general accessibility to the aircraft, which may require large areas of soil to be prepared and stabilized in order to move removal equipment and equipment for offloading cargo and fuel; and
- f) the need to substantially increase the load-bearing capability of any roads being built.

2.8 ARM

2.8.1 The specific ARM produced by the aircraft manufacturer provides detailed information regarding the specific aircraft, which can include:

- weight and balance information
- maximum loads for lifting and towing operations
- locations for lifting bags and associated skin pressures
- the location and numbering of fuselage frames and stringers
- the location and type of composite materials
- the size and location of all doors and openings
- ground clearances
- ground connections
- grounding points

2.8.2 It is imperative that an ARM for the specific aircraft be consulted for required information during the removal process. Failure to access and properly use the required information can result in secondary damage to the aircraft and resultant delays in returning the aircraft to service. It is suggested that access to an ARM for all aircraft normally operating into an aerodrome be made available. This availability can be through the aircraft operator, the aircraft manufacturer, the contracted recovery company or a copy held by the aerodrome operator.

2.9 HEALTH AND SAFETY ISSUES

2.9.1 During any aircraft recovery operation, emphasis must be placed on the safety of all personnel involved. All necessary steps must be taken to avoid personal injury and to ensure that these personnel are not subjected to any unnecessary dangers.

Protective equipment for personnel

2.9.2 Appropriate personal protective equipment must be made available for aircraft removal personnel. The type of equipment will vary according to the severity of the incident/accident and the existing and anticipated weather conditions. All aircraft removal personnel need to be aware of the various types of equipment available and to use it to the required degree. Protective equipment can include hard hats, safety boots, protective gloves, coveralls such as Tyvek or equivalent, particulate dust masks, respirators, parkas and rain-suits, etc. Other factors that must be considered in providing the appropriate protective equipment are local poisonous plants, insects and snakes.

Contracted equipment operators

2.9.3 All contracted personnel and equipment operators must be included in the safety approach of the aircraft removal team including all safety briefings. Since most heavy equipment operators will have little experience working closely around aircraft, many basic aircraft safety issues may have to be explained or discussed, including concerns of overloading equipment and the subsequent dangers involved as they relate to aircraft. These safety discussions must also include subjects such as maximum lifting loads during crane lifts, and the need to follow the instructions of a clearly identified authority.

Removal equipment

2.9.4 The aircraft removal manager must ensure that all aircraft removal equipment is appropriately rated for the anticipated loads. All aircraft removal equipment must be visually inspected prior to use and attached tags attesting to appropriate load ratings and test dates should be examined.

Hazardous materials

2.9.5 Hazardous materials at an accident/incident site can include various aircraft parts made from composite materials and dangerous goods being carried as cargo. Another example of hazardous material is depleted uranium, which is sometimes used for balance weights. Cracked, broken and torn metals also present significant hazards from their sharp and jagged edges. In most cases these materials present no dangers to the removal team in their serviceable state. However, composite aircraft materials must be approached with caution when they are broken, torn or burned. Most manufacturers' ARMs will identify the location of any composite materials on the aircraft.

Biohazards

2.9.6 The dangers of blood-borne pathogens at an accident/incident site can vary in accordance with the severity of the incident. In an increasing number of jurisdictions, access to an accident/incident site can be restricted to individuals with a current blood borne pathogen training certificate. It is suggested that aircraft removal personnel familiarize themselves with local regulations and the regulations of States or areas where they may be required to recover aircraft. Blood borne pathogen training should be considered for all aircraft recovery personnel. Important areas of this training include:

- a) biohazard risks associated with aircraft accident/incident investigation and the subsequent recovery operation;
- b) recognition of biohazards;
- c) exposure control plan, including procedures used to control exposure to blood-borne pathogens;
- d) modes of blood-borne pathogen transmission;
- e) Hepatitis B virus (HBV) vaccination information; and
- f) personal protective equipment.

Oxygen system

2.9.7 Only experienced personnel must be involved when handling or working with the onboard oxygen system, and all applicable safety precautions must be taken with this system.

2.9.8 Once the aircraft has been stabilized, any oxygen bottles on board the aircraft must have their valves manually closed and, if possible, the bottles should be removed from the aircraft. Cabin oxygen generators must be either secured or removed depending on the condition of the aircraft, the anticipated dangers and the time required to remove them, as it is both a time-consuming and labor-intensive job.

Electrical system

2.9.9 Only experienced personnel must be involved when working on the electrical system, and all applicable safety precautions must be taken with this system.

2.9.10 Once the aircraft has been stabilized, and prior to energizing the electrical system, a comprehensive check of the electrical system must be carried out. First, a cockpit check must be carried out to confirm that all relevant switches and selectors are in the appropriate position and that the aircraft electrical system is serviceable and secure. If changes are made to switches or selectors, they must be properly documented. All applicable cautions and warnings pertaining to the specific aircraft must be adhered to.

2.9.11 The main aircraft batteries must be disconnected if the aircraft electrical system is found to be unserviceable. Fire extinguishers in remote locations are activated by explosive "squibs". If there is any doubt about the integrity of the aircraft electrical systems, these systems should be disconnected or removed. For safety reasons, whether the electrical system is serviceable or not, the aircraft must still be properly grounded. Emergency power ram air turbines (RAT) systems are often heavy and have substantial deployment mechanisms, usually utilizing springs. These systems should be fitted with specific safety-retaining devices.

Fuel system

2.9.12 Only experienced personnel must be involved when handling or working with the onboard oxygen system, and all applicable safety precautions must be taken with this system.

2.9.13 On the initial aircraft survey, specific inspections will indicate whether there are any fuel leaks from the wings, fuselage or engines. All leaks must be identified and reported to the appropriate aerodrome personnel concerned for immediate action. In some cases minor leaks can be temporarily plugged or repaired. Any evidence of fuel leaks will only escalate the importance of defueling the aircraft.

2.9.14 Once the aircraft is stabilized and if no leaks are evident, a detailed review of the fuel system can be carried out. After being declared serviceable, the fuel can be removed or used for stability control. If the electrical system is considered to be serviceable, the components of the fuel system can be used either for defuelling purposes or for fuel movement between tanks.

Dangerous goods crew

2.9.15 Due to the widespread concern for environmental issues, especially around aerodromes, a dangerous goods clean-up crew, sometimes also known as a hazardous material (HAZ-MAT) crew, must be available to contain any fluid spills or leaks. In most cases, aerodromes require all spills or leaks to be contained and properly cleaned up. Dangerous

goods clean-up crews must be equipped with the required materials for various fluid spills and leaks, including fuel, hydraulic fluid and waste systems. Aerodrome operators usually have standing contracts with companies to provide these services. In most cases the aerodrome operator, at the first sign of a spill or leak, alerts the dangerous goods clean-up crews. Aircraft operators must include dangerous goods clean-up crews in their contact information or aircraft recovery process document.

Fire safety

2.9.16 Aerodrome rescue and fire fighting service personnel and vehicles must be in place at the incident site during any defuel or levelling/lifting operations. During this time no smoking zones must be adhered to at all times.

Other safety-related issues

2.9.17 Another important safety issue is the inspection of aircraft wheels. Aircraft wheels must be inspected by qualified persons to ensure the wheels, particularly the rims, have not been damaged. The pressure and volume of gas in the tires could pose serious risks if the wheels/wheel rims fail.



Chapter 3

WEIGHT AND CENTRE OF GRAVITY MANAGEMENT

3.1 GENERAL

3.1.1 An accurate determination of the weight and centre of gravity location of the aircraft is essential in determining:

- a) the levelling/lifting technique to be used;
- b) the type and capacity of the selected equipment;
- c) the expected loads;
- d) any anticipated changes to the stability of the aircraft; and
- e) that the lateral and longitudinal balance limits not be exceeded during the recovery operation.

3.1.2 It is necessary to calculate the weight of the aircraft and its centre of gravity location in order to anticipate changes in the stability of the aircraft. Both weight and centre of gravity location are also used to calculate the expected loads and to assist in the selection of the appropriate removal technique. Most ARMs provide worksheets to assist in calculating the net recoverable weight (NRW) and/or recoverable empty weight (REW) and the associated moments.

3.1.3 The actual weight of every aircraft will vary according to specific equipment and options; therefore, in most cases it will be necessary to obtain weights for the specific aircraft from the relevant weight and balance manuals. Without this information, the use of generic weights will be necessary, and only approximate calculation results will be obtained.

3.1.4 In cases involving a serious accident/incident, the aircraft operator is required to freeze or lockout all computerized information and quarantine all hard copy material or other data related to the specific aircraft involved. This will cause difficulties in obtaining load figures and weights for the flight involved. In this case estimated and generic weights will need to be used, and the recovery manager must take this into consideration when carrying out centre of gravity calculations, as these figures will only be approximate. Accurate calculations require data based on the serial number of the specific aircraft, information from the weight and balance manual and the operator's load sheets for the flight.

3.1.5 If the aircraft electrical system is serviceable, the onboard computers may be used to obtain flight information such as the amount and location of fuel on board and in some cases, the actual centre of gravity location available as a percentage of the reference chord (RC). Information from other areas of the airline's operation, such as weight and balance or flight dispatch departments, will most likely provide figures expressed in terms of percentage of reference chord (% RC) or percentage of mean aerodynamic chord (% MAC), which may also be available from the aircraft's onboard computers.

3.1.6 The ARM will provide details on how to convert from percentage RC or percentage MAC to a centre of gravity location measured from the aircraft datum point. The aircraft's datum point is usually located forward of the aircraft's nose and is normally measured in metres moving aft from the datum. Fuselage frames and fuselage stations are recorded using the distance from the datum. Information related to the datum, fuselage frames and station numbers are all detailed in the applicable ARM.