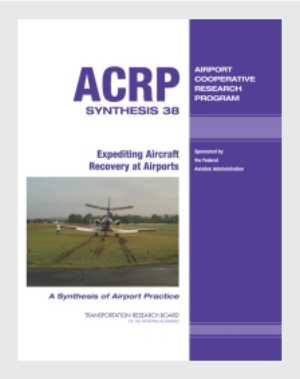

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AIRPORT COOPERATIVE RESEARCH PROGRAM

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Expediting Aircraft Recovery at Airports

A Synthesis of Airport Practice

CONSULTANT

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

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Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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Cover figure: Runway excursion.
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ACKNOWLEDGMENTS

The research report herein was performed under ACRP Project A11-03 by Prather Airport Solutions, Inc. Dr. C. Daniel Prather, Principal, was the Project Director and Principal Investigator. Mr. Brian Clifton was a research assistant participating in the project.

FOREWORD

Airport administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the airport industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire airport community, the Airport Cooperative Research Program authorized the Transportation Research Board to undertake a continuing project. This project, ACRP Project 11-03, "Synthesis of Information Related to Airport Practices," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an ACRP report series, *Synthesis of Airport Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Gail R. Staba
Senior Program Officer
Transportation
Research Board

This synthesis study is intended to provide guidance in the area of aircraft recovery, as gained through a thorough review of the literature and interviews with key personnel involved with selected disabled aircraft events.

C. Daniel Prather, Prather Airport Solutions, Inc., Riverside, California, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

EXPEDITING AIRCRAFT RECOVERY AT AIRPORTS

SUMMARY

All airports, by their very nature, may experience an aircraft excursion from a runway or taxiway. Whether the excursion occurs during takeoff or landing, is categorized as a veer-off or overrun, is intentional or unintentional, such an event typically results in an aircraft that is unable to move using its own power—in other words, it becomes a disabled aircraft. Once an aircraft becomes disabled, it must be removed or recovered. During this process, certain procedures must be followed not only to expedite the recovery of the aircraft, but also to avoid injury to personnel, damage to airport equipment, or secondary damage to the aircraft. These events tax the resources of the airport operator and call for cooperation among the airport, aircraft owner/operator, and other local parties.

This synthesis focuses on the recovery of disabled aircraft. More specifically, it addresses what airports can do to expedite the recovery of disabled aircraft. Typically, this is paramount, as disabled aircraft may result in the closure of pavement or even entire airports. Although it is difficult to determine the number of delayed flights or the costs of the delays due specifically to closed runways as a result of disabled aircraft, with overall costs of domestic flight delays exceeding $30 billion in 2007, it is imperative for airport operators to reduce the causes of delays as much as possible. With one or more runways closed because of disabled aircraft, the airport's capacity is adversely affected and delays will often result. It is important, therefore, for airport operators to recover a disabled aircraft as soon as practical. To that end, this report provides guidance in the area of aircraft recovery, acquired by means of a thorough review of the literature and interviews with key personnel involved with selected disabled aircraft events.

Most of the regulatory guidance on the recovery of disabled aircraft is produced not by the FAA, but by the International Civil Aviation Organization (ICAO), in the form of *Airport Services Manual, Part 5—Removal of Disabled Aircraft.* Although practices at international airports, such as those in the European Union, typically place significant responsibility for the recovery of disabled aircraft on the airport operator, in the United States this responsibility is typically placed on the aircraft owner/operator. Thus, it is important to keep this in mind when reviewing ICAO guidance on the topic of aircraft recovery. Chapter two of this report provides suggestions on the recovery of disabled aircraft.

Although the personnel typically involved in the recovery of disabled aircraft may vary between airports, they generally include the aircraft owner/operator, airport operator, independent contractor, aircraft maintenance personnel, aircraft manufacturer, insurance adjustor, and accident investigator. Chapter three of this report discusses the distinct roles that each has to play in the recovery process.

Owing to the complexities involved with recovering a disabled aircraft, various complications can arise during the recovery process, including:

- Secondary damage to the aircraft,
- Damage to airport structures,
- Severing of underground utilities during excavation,

- Difficulties in recovering large aircraft,
- Difficulties with acquiring local resources in an expedited manner necessary for the recovery effort,
- Transporting passengers from the disabled aircraft to the terminal or collection point, and
- Costs associated with the recovery process.

Numerous complications can be encountered during the recovery process, but experience has shown which complications may be expected. These complications are presented in chapter four of this report.

Although disabled aircraft events may be rare, airports will find it useful to prepare for such an event. Through survey and case study interviews, airport operators that have experienced an aircraft recovery have found that rather than being unprepared for a disabled aircraft event, respondents found it beneficial to develop an Aircraft Recovery Plan (ARP). Such a plan will allow an airport operator to better prepare for a disabled aircraft event by considering typical complications and the steps involved with aircraft recovery. These steps may include conducting an aircraft survey, conducting a site survey, managing weight and center of gravity of the aircraft, preparing for the move, lifting the aircraft, and moving the aircraft. Chapter five presents the process of developing an ARP and the removal of disabled aircraft.

To summarize lessons learned from literature and case studies conducted during this synthesis research airports endeavoring to better prepare for the recovery of disabled aircraft may wish to consider the following elements:

- For the airport operator—knowing what the aircraft owner/operator recovery plans are.
- Considering that a disabled aircraft event can occur at any airport and expecting a disabled aircraft event to occur and thus planning appropriately. For everyone on the airport's staff, understanding the benefits of developing an aircraft recovery plan and staff familiarity with the airport operator's plan to handle disabled aircraft. Clearly defining roles during a disabled aircraft event, including the airport operator, Aircraft Rescue Firefighting, NTSB/Flight Standards District Offices, and aircraft owner/operator. With a leader in each of these groups, developing a flowchart clearly defining when control of the aircraft is being handed over to the next leader may be beneficial.
- The key role of communication during the recovery process.
- Familiarity with the regulatory and nonregulatory guidance on the recovery of disabled aircraft (chapter two)
- For the airport operator, using good judgment to weigh expeditious recovery of the aircraft versus the liability associated with causing secondary damage to the aircraft.
- Familiarity with possible complications that may arise during the aircraft recovery process (chapter four) and developing an Aircraft Recovery Preparedness Airport Checklist to overcome possible complications and expedite disabled aircraft recovery (chapter five).
- Transportation—not only of passengers and crew from the disabled aircraft, but also of recovery personnel, aircraft owner/operator representative, insurance adjustor, and investigative personnel. Considering, as part of an airport's disabled aircraft recovery plan, how to handle a large number of passengers that need to be transported from the disabled aircraft to a staging/sterile area (i.e., blankets and other accessories to comfort passengers, as well as agreements with transportation companies to supply buses, etc.).
- Giving attention to smaller aircraft operators. One approach might be to require all operators to have a recovery plan on file before being permitted to operate an airport. A disabled small regional jet can result in a runway closure just as easily as a large transport category aircraft.

- Knowing about materials availability on site for aircraft recovery operations and local resources that may be called on during a disabled aircraft recovery event, including having qualified personnel in place or assisting in identifying qualified recovery resources and materials if so requested by the aircraft owner/operator. Airport operators may wish to include legal counsel when developing this list to avoid restrictions on showing preference to vendors.
- Benefits for airport operators visiting airports in other countries, such as in Europe, to learn how they conduct aircraft recovery.

CHAPTER ONE

INTRODUCTION

> "Let's face it, none of us, whether we are an airline or airport operator, are immune to the challenges that a disabled aircraft brings" (Olsen 2009, p. 31).

Aviation has inherent risks. Although substantial resources are invested industry-wide to mitigate these risks, accidents and incidents do occur in the aviation industry. Aircraft accidents and incidents can occur during any phase of flight, as well as during ground maneuvering of aircraft. According to *Advisory Circular* (*AC*) *150/5200-31C, Airport Emergency Plan* (AEP), an aircraft accident is

> Any occurrence associated with the operation of an aircraft that takes place between the time a person boards the aircraft with the intention of flight and the time such person has disembarked, in which a person suffers death or serious injury as a result of the occurrence or in which the aircraft, including cargo aircraft, receives substantial damage (FAA 2009, p. 109).

This same AC defines an incident as "an occurrence other than an accident that affects or could affect the safety of operations" (FAA 2009, p. 109). Whether defined as an accident or incident, such events may involve multiple aircraft types, sizes, and configurations. Airport operators have learned that there is no "one size fits all" approach to accident/incident response and resolution. There are common phases and considerations, but airport operators know that, even with planning and preparedness, each aircraft incident/accident is unique, a concept that airport operators, as well as aircraft owners/operators, must be aware of.

According to the Flight Safety Foundation (FSF) (2009), the challenge of runway safety can be divided into three areas: runway incursions, runway confusion, and runway excursions. Runway incursions are defined as "any unauthorized intrusion onto a runway, regardless of whether or not an aircraft presents a potential conflict" ("Runway Safety" 2009, para. 2). Runway confusion results when a pilot uses a runway other than the one assigned. Runway excursions occur when an "aircraft on the runway surface departs the end or the side of the runway surface" (FSF 2009, p. 4). A runway excursion can occur during takeoff or landing and can be intentional or unintentional.

Of the 1,429 commercial transport aircraft accidents involving major or substantial damage from 1995 through 2008, 30% were runway-related, and 97% of those were runway excursions (FSF 2009, p. 5). The number of runway excursion accidents was "more than 40 times the number of runway incursion accidents, and more than 100 times the number of runway confusion accidents" (FSF 2009, p. 5).

There are five types of runway excursions ("Runway Excursion" n.d., para. 3):

- A departing aircraft fails to become airborne or successfully reject the takeoff before reaching the end of the designated runway.
- A landing aircraft is unable to stop before reaching the end of the designated runway.
- An aircraft taking off, rejecting takeoff, or landing departs the side of the designated runway.
- An aircraft attempting a landing touches down within the undershoot area of the designated landing runway within the airport perimeter.
- An aircraft uses a runway or taxiway other than the designated one for a takeoff or a landing.

According to the FSF, 79% of excursions studied during 1995 through 2008 occurred during landing. Of the excursions that occurred during landing, 53% were veer-offs and 47% were overruns (FSF 2009). A veer-off is an excursion in which "an aircraft departs the side of a runway" (FSF 2009, p. 4), whereas an overrun is defined as an excursion in which "an aircraft departs the end of a runway" (FSF 2009, p. 4). Of the 21% of excursions that occurred during takeoff from 1995 through 2008, 37% were veer-offs and 63% were overruns (FSF 2009). Figure 1 suggests that overruns are the most common type of takeoff excursion, while veer-offs are the most common type of landing excursion. Regardless of whether an excursion occurs during takeoff or landing, or is categorized as a veer-off or overrun, it typically results in a disabled aircraft. A disabled aircraft is one that "cannot or should not be moved using its own motive power, but can be towed using its own serviceable under-carriage" [or if unserviceable, by means of cranes, trailers, and other specialized equipment] (Air Mobility Command 2006, p. 8).

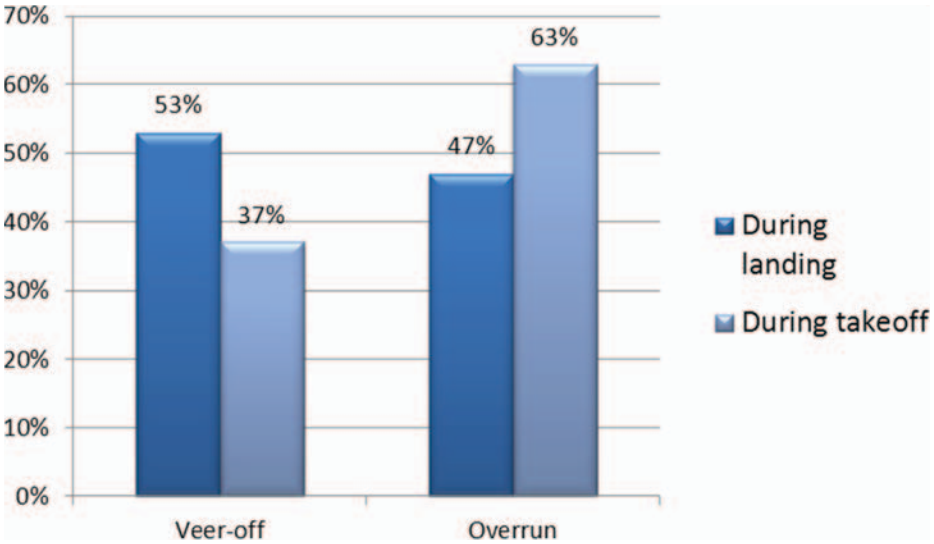

FIGURE 1 Aircraft Excursions, 1995–2008, by type. *Source:* Flight Safety Foundation (2009).

Lessons Learned from Transport Airplane Accidents (*Source:* www.faa.gov)

According to the FAA, runway excursions during takeoff or landing have been a factor in a number of high-profile accidents. Additionally, some of these departures from the end or sides of a runway during takeoff or landing have resulted in severe aircraft damage and passengers and crew fatalities. Several high-profile accidents categorized as landing/takeoff excursions by the FAA are profiled here.

United Airlines Flight 227, Salt Lake City, Utah, November 11, 1965

United Airlines Flight 227, a Boeing 727, crashed during an attempted landing at Salt Lake City Airport. The captain failed to recognize and arrest an excessive sink rate on final approach, resulting in a touchdown 335 ft short of the runway. The main landing gear sheared off, causing a breach in the fuselage, and the airplane caught fire while sliding down and off the right side of the runway. Failure of the main landing gear ruptured fuel lines and generator leads, causing the fire. The entire roof and cabin area forward of the fuselage breach was consumed by fire. Forty-three of the 85 passengers aboard were killed. All six crew members survived. The Civil Aeronautics Board (CAB) determined that the accident was survivable—none of the passengers sustained any traumatic injuries that would have precluded their escape. All 43 fatalities were attributed to the fire that was caused by a broken fuel line. The CAB also established that similar future events could not be ruled out, and that the airplane should be designed to have a higher degree of survivability in these types of events.

Pacific Western Airlines Flight 314, Cranbrook, British Columbia, Canada, February 11, 1978

A Boeing Model 737-275, powered by two Pratt & Whitney JT8D-9A engines, and operated by Pacific Western Airlines, crashed during landing at Cranbrook, British Columbia, Canada. The accident was determined to be the result of a loss of control during an attempted go-around after touchdown. This loss of control was the result of a thrust asymmetry following an incomplete stowage of the thrust reversers. The accident killed 42 of the 49 people on board.

Reverse thrust was selected on both engines upon touchdown, then immediately cancelled because of a need for a go-around in order to avoid collision with a snow removal vehicle on the runway. The aircraft lifted off and cleared the vehicle. However, the thrust reverser stow sequence was interrupted at liftoff, leaving the reversers in a partially deployed position. By design, hydraulic pressure used for the thrust reverser deploy/stow cycle was shut off as the aircraft became airborne. The thrust reverser on the right engine stowed fully and regained forward thrust, while the reverser on the left engine failed to fully stow and, following liftoff, gradually deployed fully due to aerodynamic loads. The resulting thrust asymmetry caused a loss of roll control and the subsequent crash.

Continental Airlines Flight 603, Los Angeles, California, March 1, 1978

At approximately 0925 Pacific Standard Time on March 1, 1978, Continental Airlines Flight 603, a McDonnell Douglas Model DC-10-10 airplane, overran the departure end of Runway 6R at Los Angeles International Airport, California following a rejected takeoff. As the airplane departed the wet, load-bearing surface of the runway, the left main landing gear collapsed and fire erupted from the wing area. The airplane slid to a stop approximately 664 ft beyond the departure end of the runway. The left side of the airplane was destroyed. Of the 184 passengers, two infants, and 14 crewmembers on board, two passengers were killed and 28 passengers and three crewmembers were seriously injured during the evacuation of the airplane.

Air Ontario Flight 1363, Dryden, Ontario, Canada, March 10, 1989

Flight 1363, a Fokker 28 airplane operated by Air Ontario, departed Thunder Bay (Ontario) about one hour behind schedule, on a flight to Winnipeg, with an intermediate stop in Dryden.

During the stop in Dryden, heavy snow fell, covering, and freezing on the wings. Flight 1363 arrived from Winnipeg with an inoperative auxiliary power unit; because the airport had no ground start equipment, the flight was required to keep one engine running during passenger loading and unloading. With an engine running, it was not possible to deice the airplane even with the heavy snowfall at Dryden. At 12:09 local time, with ice accumulations on the wings, the airplane started its take-off roll using slush-covered runway 29. The pilot flying rotated the airplane at the prescribed speed; however, the airplane lifted off momentarily and then settled back onto the runway. Following a second rotation, the airplane lifted off at the 5,700 ft point of the 6,000-ft runway. No altitude was gained and the aircraft settled in a nose-high attitude, striking trees. The aircraft crashed and came to rest in a wooded area approximately 3,200 ft past the departure end of the runway catching fire. Both pilots, one flight attendant, and 21 passengers were killed. Forty-four passengers and one crew member survived with injuries.

The investigation commission concluded that the captain, "as the pilot-in-command, must bear responsibility for the decision to land and take off in Dryden on the day in question. However, it is equally clear that the air transportation system failed him by allowing him to be placed in a situation where he did not have all the necessary tools that should have supported him in making the proper decision" (accidents-ll.FAA.gov n.d.).

Air France Flight 072, Papeete, French Polynesia, September 13, 1993

Air France Flight 072, a flight from Los Angeles, California to Tahiti was assigned the VOR DME (VHF omnidirectional radio range/distance measuring equipment) approach to runway 22 at Faa'a International Airport. It was night, and the weather conditions were clear. The airplane was on a stabilized approach in the landing configuration with the auto pilot disconnected, and auto-throttles engaged. At the missed approach point, the automatic flight system initiated a go-around. The pilot physically held the throttles back with his hand, countermanding the automatic flight system, and continued the approach. During landing, the thrust lever for the left outboard engine slipped out of the pilot's hand and, commanded by the automatic flight systems, increased to full forward thrust. During the landing rollout, the thrust asymmetry generated with multiple engines in reverse thrust and one engine at forward takeoff thrust caused the airplane to veer to the right and depart the runway on the right-hand side, near the end, coming to rest in a lagoon adjacent to the runway. All passengers were successfully evacuated with only four minor injuries.

Southwest Airlines Flight 1248, Chicago, Illinois, December 8, 2005

On December 8, 2005, Southwest Airlines Flight 1248 overran the runway during landing at Chicago Midway International Airport. The airplane rolled through a blast fence and an airport perimeter fence, and onto an adjacent roadway where it collided with an automobile before coming to a stop. A passenger in the automobile was killed, one passenger received serious injuries, and three others received minor injuries. Of the 103 passengers and crew aboard the airplane, 18 passengers received minor injuries, and the airplane was substantially damaged.

NTSB "determined that the probable cause of the accident was the pilots' failure to use available reverse thrust in a timely manner to safely slow or stop the airplane after landing, resulting in a runway overrun. This failure occurred because the pilots' first experience and lack of familiarity with the airplane's autobrake system distracted them from using reverse thrust during the challenging landing.

Listed contributing factors were Southwest Airlines' (1) failure to provide its pilots with clear and consistent guidance and training regarding company policies related to arrival landing distance calculations; (2) programming and design of its onboard performance computer which did not present inherent assumptions in the program critical to pilot decision making; (3) plan to implement new autobrake procedures without a familiarization period; and (4) failure to include a margin of safety in the arrival assessment to account for operational uncertainties" (www.ntsb.gov n.d.).

Also contributing to the accident, as stated by NTSB, was the pilots' failure to divert to another airport with more favorable landing conditions and the absence (at Midway Airport) of an engineering materials arresting system, which was needed because of the limited runway safety area beyond the departure end of the runway.

Comair Flight 5191, Lexington, Kentucky, August 27, 2006

On August 27, 2006, at approximately 6:06 a.m. local time, Comair Flight 5191, a Bombardier CL-600-2B19, crashed during takeoff from Lexington, Kentucky's Blue Grass Airport. All 47 passengers and two of three crew members were killed. The first officer survived with serious injuries. This airport has two runways: one identified as runway 8/26, and designated for "daytime VFR use only," and intended primarily for general aviation operations; the other identified as 4/22, intended for commercial airline operations. At the time of the accident, runway 8/26 was 3,501 ft long, and runway 4/22 was 7,003 ft long.

Despite being directed by FAA air traffic control to taxi and takeoff from runway 22, the crew of Flight 5191 incorrectly taxied to runway 26 and attempted to takeoff from the shorter runway (8/26). Night visual meteorological condition prevailed at the time of the accident. Investigators determined that without sufficient runway length to attain the target rotation speed of 142 kts, Flight 5191 was unable to takeoff. The airplane struck a perimeter fence, trees, and terrain at the end of the runway, where it was destroyed by impact forces and fire (accidents-ll.faa.gov n.d.).

Although each of these accidents has different causal factors, they are each categorized as landing/takeoff excursions. Each also resulted in a disabled aircraft that needed recovering. Whether or not the airports involved were prepared for such an event, they were faced with a disabled aircraft and the complexities associated with the recovery of that aircraft.

According to Olsen (2008), on average, a disabled aircraft event (whether categorized as an accident or incident) occurs weekly somewhere in the world. Although the majority of disabled aircraft events involve small aircraft, in most instances, the disabled aircraft results in a runway closure. According to the Bureau of Transportation Statistics, 4.19% of all national aviation system delays during the January through October 2011 period were the result of a closed runway(s). Depending on the airport, the delays caused by runway closure can be significant. For instance, during this same period, 8.98% of airline flight delays at Salt Lake City International Airport were caused by runway closure(s) (BTS 2011).

Once an aircraft becomes disabled, it is necessary to initiate recovery. According to *AC 150/5200-31C,* recovery is defined as "the long-term activities beyond the initial crisis period and emergency response phase of disaster operations that focus on returning all systems at the airport to a normal status or to reconstitute these systems to a new condition that is less vulnerable" (FAA 2009, p. 256). According to *AC 150/5200-31C,* the recovery phase is the third and final phase of an emergency, after the response phase and the investigatory phase.

These three phases of an emergency are:

1. Response phase—The portion of the initial response effort when activities are focused on the dispatch and arrival of emergency first responders, initial fire suppression, rescue operations, and dealing with any hazardous materials issues.
2. Investigatory phase—An aircraft incident or accident usually entails some type of activity specific to the gathering and analysis of information, and the drawing of conclusions, including the determination of cause. This activity may, depending on conditions, begin during the response phase and continue through the recovery phase. The investigation is normally the responsibility of the NTSB. Although at some airports the fire department is not under airport operator control, emergency first responders are responsible for meeting the criteria in *AC 150/5200-12, Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident.* Currently, there is no analogous AC directed at airport operators.
3. Recovery phase—Returning the airport to a normal operational condition as soon as possible is extremely important. Airports will likely have a separate set of plans, standard operating procedures, to cover this activity. Recovery activities can begin during the response phase and continue through the investigatory phase, depending on the situation. It is helpful to describe the relationship between the AEP and other emergency response plans [e.g. the local jurisdiction(s) Emergency Operations Plan] regarding aircraft accident response and recovery actions on the airport (FAA 2009, pp. 111–112).

The recovery phase, according to Traiforos (1990), can be divided into three additional phases (which are all discussed in chapter five of this report from both the airport operator and aircraft owner/operator perspectives):

1. Pre-recovery or planning phase—The planning that takes placed in preparation for a disabled aircraft event.
2. Recovery phase—The actual process of recovering a disabled aircraft.
3. Post-recovery phase—The process of removing all materials and equipment, inspecting, and reopening any closed areas for operations.

Although planning by the airport operator and aircraft owner/operator takes place during the pre-recovery or planning phase in anticipation of a disabled aircraft event, the recovery phase places responsibility on the aircraft owner/operator. Generally, the airport operator will play a support role by assisting the aircraft owner/operator with acquiring local resources and coordinating activity on the airport. However, the aircraft owner/operator is ultimately responsible for removing the disabled aircraft. Even though this report provides information on the removal of disabled aircraft and the benefits of developing an ARP from an airport operator perspective, the aircraft owner/operator is responsible for removing disabled aircraft in a timely manner, with disabled military aircraft being recovered by the military. Finally, during the post-recovery phase, the aircraft owner/operator will ensure that materials and equipment are removed from the site, which the airport operator will verify by inspecting and reopening closed areas.

If the recovery phase involves recovering a disabled aircraft, several goals typically guide the process. First, it is important to ensure the safety of all personnel involved in the recovery process. This is made possible by involving qualified personnel, using the proper equipment and procedures, and adhering to safety practices. A second goal is to recover the aircraft without causing secondary damage. Primary damage is that caused by the accident itself, whereas secondary damage is that damage caused during the recovery process. Secondary damage can be avoided by selecting the appropriate recovery methods based on a thorough survey of the particular situation. Finally, airport operators are well aware of the need to keep any pavement closures (runways in particular) to a minimum.

The recovery of disabled aircraft therefore involves competing objectives. The main objective of the airport operator is to have the aircraft moved as soon as possible to allow a return to normal operations. Expediting this process will minimize the impact on airport operations, subsequently resulting in fewer aircraft delays. Although it varies among airports, a closed runway can have significant consequences on the national airspace system, and a rapid return to normal operations will reduce these national impacts.

Although this goal of the airport operator is admirable, it is not the primary goal of the aircraft owner/operator and its insurance company. Although the value of the aircraft may dictate whether the insurance adjustor arrives on the scene, the aircraft owner/operator and its insurance company are both focused on preventing secondary damage to the aircraft. The aircraft owner/operator and insurance company will make every effort to ensure that no additional damage to the aircraft is caused during the recovery process, even if the aircraft remains on the runway another 12 hours as a result. It is therefore crucial to consider these two competing objectives in any aircraft recovery effort (Olsen 2008).

Although several goals are common among all recovery efforts, each disabled aircraft event is unique. According to Bombardier (2005, p. 1), the aircraft recovery process is also unique because of—

1. The accident or the incident itself.
2. The location of the aircraft.
3. The amount of aid that is locally available.
4. The weather conditions when the accident/incident occurred, as well as the effects of weather before and during the recovery operation.
5. The personnel available to help with the recovery.

As a result, response and recovery operations may vary. Aircraft recovery can be divided into the following categories, based on the location and extent of aircraft damage (Traiforos 1990; Olsen n.d.):

1. Minor or light recovery
2. Major or medium recovery
3. Heavy recovery
4. Salvage.

A "minor" or "light" recovery involves minor or no apparent damage to the aircraft. In these instances, the aircraft either remains on the paved surface or departs the runway with one or more of its landing gear (see Figure 2). The landing gear are fully extended and locked, seldom requiring specialized equipment for recovery. Although the aircraft may need to be towed for repair, a recovery of this magnitude can typically be handled by airline or fixed base operator (FBO) personnel using ordinary ground-handling equipment. Examples of minor or light recoveries include an aircraft with a blown tire, loss of steering, or inoperative brakes (Traiforos 1990; Olsen n.d.).

A "major" or "medium" recovery refers to an event involving serious damage to the aircraft. These instances may involve an aircraft that remains on the runway or has departed structural pavement (see Figure 3). One or more landing gears are not, or are only partially, extended. The aircraft may have landed long and skidded off the runway, resulting in a runway excursion, or the aircraft may remain on the pavement, disabled as the result of a collapsed landing gear or a gear-up landing. Specialized equipment and skilled personnel are needed to lift the aircraft, after which the compromised gear can be extended, locked, or repaired, thus allowing the aircraft to be towed (Olsen n.d.; Traiforos 1990).

FIGURE 2 Minor aircraft recovery. *Source:* Anonymous. Used with permission.

A "heavy" recovery is necessary when one or more landing gears are separated from the aircraft or are so heavily damaged that the aircraft cannot be towed on its own landing gear (see Figure 4). Almost all heavy recoveries involve an aircraft that has departed structural pavement. Often, the aircraft is bogged in mud, snow, sand, or soft earth, requiring extensive excavation to free the landing gear. In these instances, specialized equipment and personnel are necessary to lift and move the aircraft. Typically the aircraft landed short, overran the runway, or had an excursion from the side of the runway (Olsen n.d.).

A "salvage" operation occurs when an aircraft is severely damaged or destroyed by impact with the ground or water, or when a fire occurs. In these situations, the aircraft is con-

FIGURE 3 Major aircraft recovery. *Source:* Anonymous. Used with permission.

FIGURE 4 Heavy aircraft recovery. *Source:* Anonymous. Used with permission.

sidered beyond repair. The salvage process is then designed to remove and relocate the airframe and/or pieces of aircraft. Secondary damage is not a concern with a salvage operation, although preserving evidence may need to be considered. Depending on the size of the aircraft, a salvage process will justify a considerable amount of supplies and equipment, as well as skilled recovery personnel. This process may take place over several days under the supervision of investigative personnel such as NTSB and/or FAA (Traiforos 1990).

Although these four categories of aircraft recovery are common at U.S. airports, the International Civil Aviation Organization (ICAO) suggests only three categories of aircraft recovery (2009a, pp. 1–4):

1. 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 (referred to as a "debogg").
2. 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. Examples include—
    1. One or more landing gear off the hard surface of a runway, taxiway, or apron;
    2. Aircraft bogged down in mud or snow;
    3. One or more landing gear collapsed or damaged; or
    4. An aircraft that is considered to be economically repairable.
3. Aircraft salvage—An accident or incident in which the aircraft sustains substantial damage and the insurer considers the hull a constructive loss.

Regardless of how an aircraft recovery operation is categorized, it is important for airport operators to be aware of the many facets surrounding the recovery of disabled aircraft. As Olsen (2009) was quoted as saying at the beginning of this chapter, airports are "not immune to the challenges that a disabled aircraft brings" (p. 31). Therefore, this Synthesis Report has been written to inform airport operators of the many complexities of aircraft recovery, albeit by means of a slightly different methodology than a typical ACRP synthesis. For instance, the data collection performed for this synthesis did not include a survey, as is typically the case, primarily because not all airports have experienced disabled aircraft events. Additionally, the goal was to obtain unique information about specific disabled aircraft events, which justified a case study approach. The various cases were chosen based on panel input and the author's professional experience. Specific roles were targeted for interviews, although not all personnel were available for interviews. This synthesis also focused primarily on the few references available on this topic.

The report is organized as follows:

- Chapter two discusses the regulatory and nonregulatory guidance currently available on this topic.
- Chapter three presents the roles of personnel typically involved in aircraft recovery.
- Chapter four discusses various complications that may arise during the recovery process.
- Chapter five introduces the concept of an Aircraft Recovery Plan to be developed by an airport operator and discusses, in detail, typical aircraft recovery procedures.
- Chapter six presents five case studies of disabled aircraft events, including the results of interviews with personnel involved with these events.
- Chapter seven presents concluding thoughts and topics for further research.
- Appendix A is a planning chart that can be useful in understanding the basic recovery steps.
- Appendix B presents a sample form for Disabled Aircraft Recovery Operations and Emergency Contact Information.
- Appendix C is a sample ARP.
- Appendices D–I contain the interview frameworks used for the personnel interviewed for the case studies.

CHAPTER TWO

AIRCRAFT RECOVERY GUIDANCE

Currently, there is regulatory and nonregulatory guidance on the recovery of disabled aircraft at both the U.S. and international levels. This chapter presents a compilation of this guidance for the benefit of airport operators and others involved in the recovery of disabled aircraft.

U.S. REGULATORY GUIDANCE FOR AIRPORT OPERATORS

In the United States, there are three main sources of regulatory guidance associated with the recovery of disabled aircraft. First, 14 CFR Part 139.325, Airport Emergency Plan (AEP), requires certificated airports to develop an AEP that contains instructions for response to—

1. Aircraft incidents and accidents;
2. Bomb incidents, including designation of parking areas for the aircraft involved;
3. Structural fires;
4. Fires at fuel farms or fuel storage areas;
5. Natural disaster;
6. Hazardous materials/dangerous goods incidents;
7. Sabotage, hijack incidents, and other unlawful interference with operations;
8. Failure of power for movement area lighting; and
9. Water rescue situations, as appropriate (FAA 2004).

Part 139.325(c)7 requires the AEP to include "Procedures for removing disabled aircraft, including, to the extent practical, the name, location, and telephone numbers of agencies with aircraft removal responsibilities or capabilities." Part 139.325(d)2 requires the AEP to provide for "the removal of disabled aircraft." It is clear, therefore, that AEPs at certificated airports are required to address procedures for the removal of disabled aircraft (FAA 2004).

A second source of guidance for airports is found in *AC 150/5200-31C, Airport Emergency Plan*. Although not technically considered regulatory guidance, "for certificated (Part 139) airports, the use of guidelines and standards in this Advisory Circular is mandatory" (FAA 2009, p. 1). This lengthy AC contains the following chapters:

- Chapter 1: The Airport Emergency
- Chapter 2: Concepts and Principles
- Chapter 3: The Planning Process
- Chapter 4: Plan Format
- Chapter 5: Basic Plan
- Chapter 6: Functional Sections
  - Command and Control
  - Communications
  - Alert Notification and Warning
  - Emergency Public Information
  - Protective Actions
  - Law Enforcement/Security
  - Firefighting and Rescue
  - Health and Medical
  - Resource Management
  - Airport Operations and Maintenance.
- Chapter 7: Hazards
  - Aircraft Incidents and Accidents
  - Terrorism Incidents
  - Structural Fires, Fuel Farm, and Fuel Storage Areas
  - Natural Disasters
  - Hazardous Materials Incidents
  - Sabotage, Hijack, and Other Unlawful Interference with Operations
  - Failure of Power for Movement Area Lighting
  - Water Rescue Situations
  - Crowd Control.

Although *AC 150/5200-31C* is a comprehensive emergency planning and management guidance document, it provides little guidance on the recovery of disabled aircraft. The word "recovery" in this AC mainly refers to the recovery phase of comprehensive emergency management, which includes actions that restore the airport/community to pre-emergency conditions, rather than the recovery of disabled aircraft.

The AC does, however, suggest that in the section of the AEP detailing responsibilities, the aircraft owner/operator "should provide for the timely removal of the wrecked or disabled aircraft as soon as authorized by the appropriate authority" (FAA 2009, p. 117). Also, Section 7-1-10(c) of the AC recommends the formation of a situation analysis team consisting of representatives from various airport organizations, functional areas, and tenants. According to the AC, an incident action plan will aid in the recovery process. This plan should include long- and short-term considerations for:

1. Final damage assessment (written, pictorial, including video)
2. Public information announcements
3. Facility repair

4. Supply inventory and restoration
5. Cost documentation
6. Economic impact
7. Documentation of actions taken
8. Personnel utilization by time on duty
9. Critical incident stress debriefing requirements, if necessary
10. Equipment utilization documentation
11. Overall cleanup activities
12. Air operations area inspections, if appropriate (FAA 2009).

AC 150/5200-31C provides significant guidance to airports in developing AEPs and planning for the response to and recovery from aircraft accidents. However, it does not provide a great deal of guidance in the recovery of disabled aircraft; therefore, chapter five of this report has been included to provide significant insight into this topic.

The third source of U.S. regulatory guidance regarding disabled aircraft is found in 49 CFR Part 830, Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft, and Preservation of Aircraft Wreckage, Mail, Cargo, and Records:

> The operator of any civil aircraft, or any public aircraft not operated by the Armed Forces or an intelligence agency of the United States, or any foreign aircraft shall immediately, and by the most expeditious means available, notify the nearest National Transportation Safety Board (NTSB) office when:
>
> A. An aircraft accident or any of the following listed serious incidents occur:
> a. Flight control system malfunction or failure;
> b. Inability of any required flight crewmember to perform normal flight duties as a result of injury or illness;
> c. Failure of any internal turbine engine component that results in the escape of debris other than out the exhaust path;
> d. In-flight fire;
> e. Aircraft collision in flight;
> f. Damage to property, other than the aircraft, estimated to exceed $25,000 for repair (including materials and labor) or fair market value in the event of total loss, whichever is less.
> g. For large multiengine aircraft (more than 12,500 pounds maximum certificated takeoff weight):
> i. In-flight failure of electrical systems which requires the sustained use of an emergency bus powered by a back-up source such as a battery, auxiliary power unit, or air-driven generator to retain flight control or essential instruments;
> ii. In-flight failure of hydraulic systems that results in sustained reliance on the sole remaining hydraulic or mechanical system for movement of flight control surfaces;
> iii. Sustained loss of the power or thrust produced by two or more engines; and
> iv. An evacuation of an aircraft in which an emergency egress system is utilized.
> h. Release of all or a portion of a propeller blade from an aircraft, excluding release caused solely by ground contact;
> i. A complete loss of information, excluding flickering, from more than 50 percent of an aircraft's cockpit displays known as:
> i. Electronic Flight Instrument System (EFIS) displays;
> ii. Engine Indication and Crew Alerting System (EICAS) displays;
> iii. Electronic Centralized Aircraft Monitor (ECAM) displays; or
> iv. Other displays of this type, which generally include a primary flight display (PFD), primary navigation display (PND), and other integrated displays;
> j. Airborne Collision and Avoidance System (ACAS) resolution advisories issued either:
> i. When an aircraft is being operated on an instrument flight rules flight plan and compliance with the advisory is necessary to avert a substantial risk of collision between two or more aircraft; or
> ii. To an aircraft operating in class A airspace.
> k. Damage to helicopter tail or main rotor blades, including ground damage, that requires major repair or replacement of the blade(s);
> l. Any event in which an operator, when operating an airplane as an air carrier at a public-use airport on land:
> i. Lands or departs on a taxiway, incorrect runway, or other area not designed as a runway; or
> ii. Experiences a runway incursion that requires the operator or the crew of another aircraft or vehicle to take immediate corrective action to avoid a collision (NTSB 1998).
>
> B. An aircraft is overdue and is believed to have been involved in an accident.

Although the aircraft owner/operator is responsible for notifying NTSB, it is good practice for the airport operator to verify the notification. In addition to notifying the NTSB, it is important for the airport operator to notify the FAA Communication Center. Depending on the notification responsibilities outlined in the AEP, the air traffic control tower (ATCT) may handle this notification. According to Part 830.6, the notification should contain:

> A. Type, nationality, and registration marks of the aircraft;
> B. Name of owner, and operator of the aircraft;
> C. Name of the pilot-in-command;
> D. Date and time of the accident;
> E. Last point of departure and point of intended landing of the aircraft;
> F. Position of the aircraft with reference to some easily defined geographical point;
> G. Number of persons aboard, number killed, and number seriously injured;
> H. Nature of the accident, the weather, and the extent of damage to the aircraft, so far as is known; and
> I. A description of any explosives, radioactive materials, or other dangerous articles carried.

Although NTSB Part 830 does not necessarily address the recovery operation, it does detail the events that take place prior to commencing the recovery operation (NTSB 1998).

ICAO REGULATORY GUIDANCE FOR AIRPORT OPERATORS

Aircraft recovery is handled differently at airports in Europe and other countries than it is in the United States. For instance, it is not uncommon for a European airport operator to assume the responsibility for aircraft recovery. In fact, airport operators in countries other than the United States may manage or control aircraft servicing, concessions, and more. Even with these differences, it is helpful to consider aircraft recovery guidance in other countries. Specifically, regulatory guidance

at the international level is promulgated by ICAO. A specialized agency of the United Nations, ICAO serves as the forum for cooperation in all fields of civil aviation among its 190 contracting states. In the United States, FAA Manages ICAO compliance: It represents the contracting state and provides all regulatory guidance that airport operators are obliged to follow. All references to ICAO guidance in this report are for informational purposes only and are not intended to replace, or be equivalent to, FAA regulations and/or FAA guidance on the topic of aircraft recovery.

ICAO develops both Standards and Recommended Practices (SARPs) and guidance materials. The SARPs, with which contracting states are obliged to comply, are applicable to both regulators (such as FAA) and aerodrome (airport) operators. Guidance materials, on the other hand, are supplementary to the high level SARPs and may be equated to ACs in the United States. For aerodromes (airports), the SARPs can be found in *Annex 14—Aerodromes, Volume I—Aerodrome Design and Operations* (ICAO 2009b).

In the area of disabled aircraft removal, Chapter 9, section 9.3 of *Annex 14, Volume I* contains the following two recommended practices (RPs) for disabled aircraft recovery:

9.3.1 Recommendation—A plan for the removal of an aircraft disabled on, or adjacent to, the movement area should be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.

9.3.2 Recommendation—The disabled aircraft removal plan should be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:

a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose; and

b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes (ICAO 2009b, p. 9-9).

Further, Chapter 2, section 2.10 of *Annex 14, Volume I,* contains the following two RPs related to the need for promulgation of information concerning disabled aircraft recovery:

2.10.1 Recommendation—The telephone/telex number(s) of the office of the aerodrome coordinator of operations for the removal of an aircraft disabled on or adjacent to the movement area should be made available, on request, to aircraft operators.

2.10.2 Recommendation—Information concerning the capability to remove an aircraft disabled on or adjacent to the movement area should be made available.

In addition to the RPs in *Annex 14, Volume I* related to the recovery of disabled aircraft, the bulk of ICAO guidance on this topic is found in *Airport Services Manual, Part 5—Removal of Disabled Aircraft.* This 115-page manual begins by specifying the following contents for an aerodrome's disabled aircraft removal plan:

1. A list of equipment and personnel available on or in the vicinity of the aerodrome;
2. A list of additional equipment available from other aerodromes on request;
3. A list of nominated agents acting on behalf of each operator at the aerodrome;
4. A statement of the airline's arrangements for the use of pooled specialist equipment;
5. A list of local contractors (with names and telephone numbers) able to supply heavy removal equipment on hire (ICAO 2009a, p. 1-1).

The remainder of the guidance in *Airport Services Manual, Part 5—Removal of Disabled Aircraft,* presents detailed methods for removing disabled aircraft. Much of this guidance is discussed in chapter five of this report.

NONREGULATORY GUIDANCE FOR THE AIRCRAFT OWNER/OPERATOR

Because the airport operator will typically oversee the recovery of disabled aircraft, it is beneficial to understand guidance provided to aircraft owner/operators on this topic. Aircraft manufacturers provide a significant amount of guidance to the aircraft owner/operators on the recovery of aircraft they manufacture. Specifically, one manufacturer "provides recovery resources from documents and tools to comprehensive airplane recovery services" (Paluszek 2009, p. 20). Often, the manufacturer has a team of recovery experts that provide expert guidance for recovery team personnel. According to this same manufacturer, aircraft recovery is considered even during the aircraft design process; specifically, it pertains to the following five areas:

1. Weight and center of gravity
2. Emergency defueling with no power on
3. Lifting/shoring
4. Tethering
5. Transporting (Paluszek 2009, pp. 21–23)

Additionally, aircraft manufacturers typically have designed specialized tools and equipment to assist in recovering their aircraft once they become disabled. Most important, aircraft manufacturers develop airplane recovery manuals or documents specific to each aircraft model to detail the best recovery tools and methods for to recovering one of their aircraft (Paluszek 2009).

In addition to guidance offered by aircraft manufacturers, an industry group involved in generating guidance on this topic is the International Air Transport Association (IATA) Aircraft Recovery Task Force (ARTF). This group, "the most

important organization in the recovery profession," assists the IATA Engineering & Maintenance Group in addressing aircraft recovery requirements for new larger aircraft. The ARTF includes experts from airports, airlines, aircraft manufacturers, recovery specialists, and tooling manufacturers, within the following roles:

- Working with original equipment manufacturers (OEMs) to develop practical and safe aircraft recovery procedures to minimize secondary damage to the aircraft structure and exposure to health and safety risks.
- Working with OEMs and making recommendations for the development of new recovery tools.
- Recommending updates for the ICAO *Airport Services Manual, Part 5—Removal of Disabled Aircraft.*
- Increasing awareness of the economic and operational impacts of aircraft recovery ("IATA's Aircraft Recovery Task Force" 2010).

The ARTF meets annually. Membership is open to airlines, OEMs, and aviation suppliers and service providers (known as IATA Strategic Partners) ("IATA's Aircraft Recovery Task Force" 2010).

Additionally, various companies, organizations, and associations offer specialized training in the recovery of disabled aircraft. This training is available from both industry associations and independent recovery companies and may prove beneficial for airport operators, specifically for personnel designated to coordinate a recovery event. The training curriculum may include both theoretical and practical subjects, allowing participants to experience the aircraft recovery process. A proposed curriculum, according to one training provider, is as follows ("Aircraft Recovery Training Task Force" 2011):

Theoretical Subjects:

- Legal Aspects of Disabled Aircraft Recovery
- Aircraft Recovery Equipment
- Determine Type of Aircraft Recovery Category
- Aircraft Recovery Operation Process
- Aircraft Stabilization
- Load Calculation and Monitoring
- Ground Reinforcement and Stabilization
- Tethering Methods
- Aircraft Lifting Methods
- Aircraft Lifting Procedures
- Aircraft Recovery Operation Documentation
- Case Study
- Table-Top Exercises
- Aircraft Transport
- Administration Issues
- After Use Inspection.

Practical Subjects:

- Aircraft Recovery Situation Assessment
- Familiarization with Aircraft Recovery Equipment
- Developing an Aircraft Recovery Plan
- Identify the Required Equipment
- Ground Reinforcement and Stabilization Concept
- Tethering Methods
- Placement and Operation of Aircraft Lifting Equipment
  - Lifting Bags
  - Spreader Bar
  - Jacks
- Conducting of Live Aircraft Recovery Operations
- Aircraft Towing and Winching.

Whether guidance is considered regulatory or nonregulatory, or is obtained from industry associations, manufacturers, or training providers, it is important for airport operators and others involved in the recovery of disabled aircraft to be aware of the significant amount of guidance and assistance available on this issue. This is important because of the many complexities involved with recovering disabled aircraft.

CHAPTER THREE

AIRCRAFT RECOVERY PERSONNEL

The process of disabled aircraft recovery often involves multiple personnel. These personnel assume specific roles during the recovery process, each requiring a unique skillset and sufficient resources to effectively contribute to the recovery operation. Although additional roles may be represented by personnel during a recovery operation, this chapter highlights the most common personnel.

AIRCRAFT OWNER/OPERATOR

Typically, the aircraft owner/operator specifies an aircraft recovery coordinator to represent the interests of the aircraft owner/operator during the recovery process. Although this individual may be the pilot [especially in general aviation (GA) events], or an airline station manager, airlines typically designate a recovery coordinator who is prepared to make all technical and financial decisions on behalf of the aircraft owner/operator concerning the recovery. Some airlines have dedicated recovery teams, with specific individuals on the team able to serve as the recovery coordinator. It is in the best interest of aircraft owners and operators to compile a list of the individuals authorized to serve as recovery coordinator. According to Traiforos (1990) typical questions that this individual is responsible for resolving may include:

1. What methods will be used to lift the aircraft?
2. Should fuel/baggage/cargo be offloaded first?
3. What local resources (supplies, equipment, personnel) are available?
4. Should an independent contractor be called?
5. What assistance is needed from the airport operator?

An aircraft owner/operator (airline) may also request assistance from another operator (airline) at an airport. This is more typical if the airline with the disabled aircraft does not have a maintenance facility or significant operations at the airport involved. Airlines are generally willing to assist their competitors with equipment or personnel in a time of need if requested.

AIRPORT OPERATOR

Typically, the airport operator specifics an airport recovery manager to represent the airport operator during the recovery process. As a disabled aircraft may substantially interfere with airport operations, and the airport operator is most concerned with ensuring a fully operational and safe airport, it is in the interest of the airport operator to designate a recovery manager to oversee the recovery process. This individual is responsible for making decisions regarding the safety of the airport during the recovery process, as well as ensuring compliance with applicable regulations and policies. As Olsen (2009, p. 32) explains,

> When an aircraft becomes disabled, we have an automatic "lose-lose" situation for both the airline and airport involved. Airports and airlines need to turn this 'lose-lose' situation into a 'win-win' situation by working together. . . .

The aircraft recovery coordinator is the authorized representative of the aircraft owner/operator, and as such is typically the only representative of the aircraft owner/operator with whom the airport recovery manager communicates during the recovery. By coordinating any services provided by the airport operator, the Airport Recovery Manager serves as the "point person" to oversee the recovery process (Traiforos 1990).

Additionally, the airport operator may request and receive assistance with aircraft recovery from the regional airport disaster operations group (DOG). Created as a voluntary airport-to-airport mutual aid group, a DOG is designed to meet specific personnel or equipment needs at an airport affected by a disaster. As of early 2012, two DOGs were in existence in the U.S. SEADOG is the Southeast Airports Disaster Operations Group. WESTDOG is the Western Airports Disaster Operations Group. Currently, the Midwest, New England, and Middle Atlantic regions do not have a DOG, although airports in those regions may send aid coordinated through SEADOG. Although DOGs were developed with hurricanes, earthquakes, and other natural disasters in mind, it is possible that a DOG could provide an airport operator with support in the form of heavy lift equipment and other specialized aircraft recovery equipment and personnel. That being said, the recovery of disabled aircraft is not part of the mission of SEADOG or WESTDOG. It is more likely that an aircraft owner/operator would request assistance directly from a nearby airport, from another operator (airline), or from a contractor rather than from a DOG (J. Smith et al. 2010; J. Smith, personal communication, Jan. 5, 2012).

INDEPENDENT CONTRACTOR

Numerous independent contractors serve as aircraft recovery experts, providing specialized services. Dozens of companies throughout the United States specialize in the recovery of disabled aircraft. Often, aircraft owners and operators use the services of these independent contractors to assist with the recovery of a disabled aircraft. Many of these companies also offer aircraft disassembly, aircraft transportation, scene management, and environmental clean-up and restoration. Whether the contractor specializes in complete recovery services, or provides only cranes or other specialized equipment, some aircraft owners/operators rely greatly on the services of independent contractors. Airport operators can develop a list of independent contractors to provide assistance (Traiforos 1990). This list is usually part of the AEP and/or the airport's ARP. Specifically, *AC 150/5200-31C* recommends that the AEP "should include provisions for identifying agencies and contractors that could be involved in aircraft removal and/or clean-up of any hazardous materials associated with the emergency" (FAA 2009, p. 231).

An airport operator may wish to enter into an agreement with one or more independent contractors to ensure that expertise, materials, and supplies will be available when needed. Although aircraft owner/operators, particularly air carriers, may decide to use their own personnel and equipment for recovery, it is beneficial for the airport operator (recovery manager) to encourage aircraft owners/operators to rely on experienced and well-equipped independent contractors if it becomes obvious that such assistance is needed.

AIRCRAFT MAINTENANCE

Aircraft maintenance personnel are also typically relied on for the removal of disabled aircraft. Depending on the severity of the event and the degree of recovery operation, maintenance personnel may be necessary to provide expertise and personnel support. For aircraft owners/operators with no maintenance equipment or personnel at the airport (such as would occur with diversions, transient, and small GA operators), assistance will likely be requested from other airlines, the FBO, and the airport operator to arrange for nonroutine maintenance and/or recovery coordination. Thus, it is beneficial to include a list of airlines and FBOs capable of performing maintenance at the airport in the ARP. As explained by Traiforos (1990, p. 10), "Possessing a maintenance list will save the time of trying to find someone to perform maintenance while an aircraft sits on the arrival runway."

Additionally, many major air carriers have developed well-coordinated recovery teams that include personnel, equipment, and supplies ready to respond to a disabled aircraft event. Generally, these teams have a great deal of expertise and access to large amounts of specialized recovery equipment. These teams will also be able to rent or otherwise procure heavy equipment and supplies locally. It may be helpful for the ARP to include a list of these recovery teams and determine whether they are willing to assist with the recovery of aircraft not operated by their company.

AIRCRAFT MANUFACTURER

Although an Aircraft Recovery Manual specific to the aircraft being recovered will provide a great deal of information that will be helpful to the recovery process, such a manual may not be readily available. The aircraft owner/operator typically consults with the aircraft manufacturer as needed during the recovery operation. The airport operator may, however, include a contact list for various aircraft manufacturers, particularly recovery experts with each manufacturer, in the ARP. It is helpful for this contact list to be developed with 24/7 accessibility as a focus. Recovery experts with an aircraft manufacturer may be able to respond to the incident/accident site (Traiforos 1990).

INSURANCE ADJUSTOR

As damage to the aircraft either has occurred or can occur during recovery, the aircraft owner/operator's insurance adjustor will likely be involved in the aircraft recovery process. The insurance adjustor may not arrive on scene if the aircraft value is below a certain level, or may send a representative. If on scene, the insurance adjustor will be intensely focused on preventing any secondary damage to the aircraft during the removal process. The airport wants to minimize the possibility of secondary damage as well, because of the liability from causing additional damage to the aircraft. For this one reason, airports tend to require that aircraft owners and operators remove their aircraft. In any event, it is important to consider the perspective of the insurance adjustor during the recovery process.

ACCIDENT INVESTIGATOR

Once notification occurs, either NTSB or FAA will respond. Although not necessarily part of the recovery process, an accident investigator from either FAA or NTSB will likely be on scene. Once emergency procedures are complete, the investigation into the incident/accident will commence. According to 49 CFR Part 830, the aircraft owner/operator is responsible for "preserving to the extent possible any aircraft wreckage, cargo, and mail aboard the aircraft, and all records, including all recording mediums of flight, maintenance, and voice

recorders, pertaining to the operation and maintenance of the aircraft and to the airmen until the Board takes custody thereof or a release is granted" (p. 601). Generally, the airport operator provides security at and around the accident/incident site.

Even after the NTSB notification has occurred, until release has been granted, the wreckage, mail, or cargo must not be moved or disturbed (meaning aircraft recovery cannot begin) unless necessary to:

A. To remove persons injured or trapped,
B. To protect the wreckage from further damage, or
C. To protect the public from injury (49 CFR Part 830 1988).

Owing to the importance of the accident investigator in the recovery process, it is beneficial to include NTSB reporting procedures and priority for aircraft removal in the airport's ARP (Traiforos 1990).

CHAPTER FOUR

AIRCRAFT RECOVERY COMPLICATIONS

Although some complications encountered during the recovery process can be overcome relatively easily, others present significant obstacles. It is beneficial for airport operators to be aware of some of these complications to avoid extended delays and additional costs during an actual aircraft recovery event. This chapter highlights some of the most common complications associated with the recovery of disabled aircraft, although it does not provide an exhaustive list of complexities that may be encountered.

DELAY COSTS

Aircraft recovery, as a complex process, often involves significant costs and complications. Although a relatively simple recovery operation (such as a blown tire on a Cessna 150 upon landing rollout) may be resolved within minutes, a heavy recovery operation may take days, and a major salvage operation may take weeks. For a major airport, even several hours of runway closure during a peak time can be significant, causing flight delays to skyrocket. Olsen (2008) estimates that an airport could lose in excess of $3,000 per minute in landing fees alone as a result of closures associated with a disabled aircraft event, especially if inbound aircraft are diverted to other airports because of capacity constraints. The Port Authority of New York and New Jersey and FAA modeled delays at JFK International Airport (an airport with four runways) to determine delay costs to the airlines serving JFK. Modeling was based on only one runway being available (resulting in 222,104 minutes of delay per day) and only two runways being available (resulting in 11,344 minutes of delay per day). Using an average delay cost to each airline of $42.66 per minute, with only two runways available, delay costs to the airline would average $483,935 per day. With only one runway available, delay costs would increase to $9,474,956 per day. Based on these numbers, the Port Authority developed the following conservative liquidated damages for a project requiring the rehabilitation of one of JFK's runways:

- $3,000 for the first 15-minute interval if the contractor fails to complete the runway work and return bay runway to operations as scheduled.
- $4,500 for the second 15-minute interval if the contractor fails to complete the runway work and return bay runway to operations as scheduled.
- $6,000 for the third 15-minute interval if the contractor fails to complete the runway work and return bay runway to operations as scheduled.
- $300,000 per day (after the first day) if the contractor fails to complete the runway work and return bay runway to operations as scheduled (K.B. Bleach, personal communication, November 9, 2011).

Although delay costs (in terms of lost airport revenues or expense to the airlines) are difficult to predict accurately, it is clear that delays resulting from runway closures do result in additional costs, which may be quite significant. Complications encountered during the recovery process will only exacerbate these costs.

COMPETING PRESSURES

It is necessary to understand the many competing pressures in a disabled aircraft event. It may seem that each of the personnel involved in the aircraft recovery process has conflicting goals. The airport operator, in an effort to minimize delays and return the airport to normal operation, wants to reopen the runway as soon as possible. The aircraft owner/operator and insurance adjustor want to avoid damaging the aircraft during the removal process, even if this delays the reopening. The independent removal contractor wants to take charge of the removal, avoid damaging the aircraft, and complete the work quickly to get paid. These competing pressures complicate the recovery process.

Second, avoiding secondary damage to the aircraft can complicate the removal process. If the aircraft is not lifted and/or moved properly, secondary damage may occur. To avoid this, it is best to allow qualified and experienced personnel appointed by the aircraft owner/operator to lift and move the disabled aircraft. In addition, proper equipment is necessary. It is also important to calculate the weight and center of gravity of the aircraft to anticipate changes in its stability. Changes in stability may surprise personnel, resulting in injuries to personnel and secondary damage to the aircraft. To determine the best way to recover the disabled aircraft, it is helpful for the aircraft owner/operator to survey the site, review the appropriate Airplane Recovery Manual, and consult with specialists as needed.

CLOSURES AND DELAYS

Single runway airports face an additional complexity. The removal of a disabled aircraft can be more urgent at a single-runway airport, because if an aircraft becomes disabled on that one runway, the airport is effectively closed until the aircraft can be removed and the runway cleared of any debris. Similarly, at congested airports the closure of a runway because of a disabled aircraft can significantly reduce the airport's capacity, likely resulting in delays that may reverberate throughout the National Airspace System. As a result, both single runway airports and congested airports face an additional urgency, at the same time that the aircraft owner/operator is focused on preventing secondary damage to the aircraft, regardless of how long the aircraft occupies the runway.

COMMUNICATIONS

The primary responsibility of the airport during an aircraft recovery operation is, first and foremost, communication. Proper communications are essential during the aircraft recovery process. First, this includes communication between the airport operator and the aircraft owner/operator, as well as additional recovery personnel. As the recovery process gets underway, it is important for the airport operator and the aircraft owner/operator to have one person representing their interests and properly communicating needs and issues. Second, proper communications involves disseminating changed airfield conditions to airport users. The digital Notices to Airmen (NOTAM) can make this process more efficient. Airports likely have well-developed NOTAM procedures in place. In both instances, insufficient or improper communications can be a complicating factor to the recovery process.

PERSONNEL ACCESS

Yet another factor complicating the aircraft recovery effort involves providing site access to recovery personnel. Typically, personnel are escorted to and from the site, especially if the site lies within the movement area. If this is not closely controlled, a vehicle–pedestrian deviation may occur. Often, airports dedicate a police officer or other individual to conduct escorts for personnel authorized to gain access to the site.

UTILITIES

Underground or above-ground utilities could be severed as the aircraft lands short or overruns the runway. If this occurs, the aircraft may become energized, which would result in a very dangerous situation for recovery personnel. This may be mitigated with a thorough site survey and aircraft inspection before commencing removal. Additionally, underground utilities may become severed during any excavation that is necessary to remove the aircraft. Before excavation of soil to debog landing gear, for instance, it is beneficial to consult utility and navaid composite drawings and mark the location of any underground utilities (including navaid and communications cables). If utilities are not identified before the start of aircraft recovery efforts, and utilities are interrupted because connections are severed, this may result in extended closures if navaids and other airfield lighting are affected. It is important, therefore, to identify utilities prior to commencing any necessary excavation work. An ACRP Synthesis, *Subsurface Utility Engineering information Management for Airports,* has been issued to aid airports in this area (Anspach and Murphy 2012).

STRUCTURES

Airport structures may be damaged during aircraft excursions. There have been instances when an aircraft veered off the runway and came to a stop on the ramp, after striking a loading bridge and/or the main passenger terminal building. Damage to airport structures can complicate the recovery process and delay a return to normal operations.

LARGE AIRCRAFT

The recovery of larger aircraft (such as the B747-8, 777, 787 Dreamliner, or A380) typically presents greater logistical challenges in their removal, which may also result in airport impacts of longer duration. According to ICAO (2009a, p. 1-6), two examples of these constraints include (a) "the blocking of more than one access route to the apron areas and (b) the use of the runway and taxiway where their separation distances are minimal." Additional factors influencing the removal process of these aircraft include—

1. Increased fuselage length and wingspan
2. Increased weight
3. Substantial increases in volume of fuel and cargo
4. Access height for various components including engines, doors, wings and tail surfaces, which may be compounded by unusual aircraft attitudes
5. Low-allowable skin pressures
6. General accessibility to the aircraft, which may require large areas of soil to be prepared and stabilized to move removal equipment and equipment for offloading cargo and fuel
7. The need to substantially increase the load-bearing capability of any roads being built (Olsen 2008, p. 32; ICAO 2009a, p. 2-5).

Aircraft manufacturers have, however, developed specialized equipment to aid in the recovery of large aircraft. This equipment includes higher capacity pneumatic lifting devices, higher capacity aircraft removal jacks with arc movement control capabilities, higher capacity lifting and towing equip-

ment, lightweight temporary roadway systems, and larger temporary fuel storage equipment (ICAO 2009a, pp. 1-6, 1-7; Olsen 2009).

SMALL AIRCRAFT

Smaller aircraft can also present challenges to the recovery process. For instance, owing to their smaller size, weight, and minimal wing height above the ground, regional jets need smaller aircraft removal jacks and smaller pneumatic lifting devices (ICAO 2009a). Experience has shown that airports may not know what to have on hand for disabled aircraft events involving regional jets, Dash 8s, and other small aircraft. Although some generic pieces of recovery equipment may be used, specific tow bars and other tools may be necessary. Additionally, many newer generation GA aircraft have composite construction. If damaged, the aircraft may break into large pieces of composite laminate debris with jagged edges. If this is the case, there is a risk of puncture wounds at the accident site for response, investigative, and recovery personnel. Additionally, many of these newer generation GA aircraft (especially Cirrus Design aircraft and some light sport aircraft) are equipped with parachutes and airbags. It is important for personnel to take the necessary precautions to avoid inadvertently activating one of these devices during the recovery effort.

REMOVAL RESPONSIBILITIES

Experience has shown that the GA aircraft owner/operator typically expects the airport operator to lead the aircraft recovery effort. Airports often require the FBO to timely respond to and recover GA disabled aircraft as part of their lease/operating agreement. However, any type aircraft can be operated under Part 91 and considered a GA aircraft. Thus, an FBO with recovery equipment designed only for aircraft that typically frequent the FBO will encounter complexities if FBO personnel are called on to recover an aircraft type for which recovery equipment is not on hand.

UNLOADING AIRCRAFT

Another complication is associated with unloading the aircraft before beginning any lifting procedures. This process may involve unloading cargo and/or deplaning passengers. On passenger aircraft, air stairs will likely be necessary to deplane passengers if the aircraft has remained intact. Of course, passengers may have already deplaned through evacuation slides and window exits. A complication can also arise if the airport is not prepared to move uninjured passengers from the aircraft to a collection/staging point. In establishing an uninjured care site or staging area as part of irregular operations, it is important to consider the possible number of passengers and the how to provide for their isolation. Agreements with local transportation companies to transport passengers may prove useful in these situations.

HAZARDOUS MATERIALS

Although hazardous materials are rare on passenger flights, if the cargo involves hazardous materials, it is important to take additional precautions to ensure the safety of recovery personnel and prevent an uncontained release of hazardous materials. Traditionally, the number one hazardous material that confronts Aircraft Rescue Firefighting (ARFF) crews is fuel. Likewise, many accident sites contain biohazards, requiring proper personal protective equipment for recovery personnel. Therefore, an event involving hazardous materials may require a hazardous materials team that is trained and fully capable of resolving a hazardous materials event, with proper personal protective equipment.

SITE SECURITY

Site security of the site is also very important and may complicate the recovery process. It is important to consider managing the media and crowds that will surely congregate to view the disabled aircraft. This is especially true for larger aircraft that seem to have a greater visual impact on the public. In addition to the media and public, it is important to maintain site security for the benefit of investigative authorities, recovery personnel, and the aircraft owner/operator.

WEATHER

Weather conditions can be an additional set of complicating factors. Meteorological elements such as snow, rain, sleet, and hail can severely hamper recovery efforts. An already bogged aircraft can be much more difficult to remove in heavy rains; likewise, a 3-ft snow bank will make cranes difficult to maneuver. Depending on the severity of the conditions, recovery efforts may need to be delayed until conditions improve. The temperature may also complicate recovery efforts. Severely cold temperatures can drastically delay recovery operations and make other provisions necessary, including a heated trailer, to ensure that recovery personnel do not succumb to extreme cold.

RECOVERY COSTS

Depending on the severity, the actual recovery process may take a few hours or a few days. During this time, equipment is being utilized and personnel are spending time on the recovery. Therefore, the recovery process can be expensive. Although the direct costs associated with the recovery are easily determined, indirect costs may be more difficult to gauge. ICAO (2009a) has created an Aircraft Removal Cost Template that may prove helpful in calculating these costs (Table 1).

TABLE 1
AIRCRAFT REMOVAL COST TEMPLATE

Airline direct costs	*Man-hours*	*Cost $*	*Totals $*
Removal costs:			
Labour man-hours			
Manager man-hours			
Specific recovery equipment rental:			
– Flat rate			
– Per day			
– Shipping costs			
Heavy equipment rental:			
– Flat rate			
– Per day			
Emergency response clean-up, fuel spills			
Return incident site to normal			
Total direct costs			
Airline indirect costs			
Environmental assessment			
Environmental clean-up			
Loss of use of aircraft			
Cost of diversion of flights			
Reduction in flights due to runway closures			
Total indirect costs			
TOTAL AIRLINE REMOVAL COSTS			

Airport costs	*Cost $*
Flight reduction revenue loss	
Additional manpower costs	
Additional equipment costs	
TOTAL AIRPORT COSTS	

CHAPTER FIVE

AIRCRAFT RECOVERY PLAN

> "The implementation of a well-developed [aircraft] recovery plan is the airport operator's only defense [during a disabled aircraft event]" (Traiforos 1990, p. i).

A disabled aircraft may result in a runway closure. Even for short periods this may result in metering of aircraft, flight delays, aircraft diversions, and loss of revenue to the airport operator and aircraft owners/operators (Olsen n.d.). Ironically, "even though the aircraft [owner/] operator is responsible for the removal of a disabled aircraft, the burden of a closed airfield lies on the airport operator" (Traiforos 1990, p. 26). Therefore, the main goal of the airport operator during such an event is to return the airport to normal operating capacity in the shortest amount of time. Delays, however, may result during the recovery process. These delays are often the result of lack of information and planning (Traiforos 1990).

According to Olsen (2008, p. 32), "90% of airports and airlines are not adequately prepared to handle even the simplest [aircraft] recovery situation." Since disabled aircraft events can wreak havoc with airport operations, it is beneficial for airports to be prepared, and an ARP is the preferred method of preparation for airports. As Olsen (2009, p. 32) explains, "The need [for airports] to develop their own 'organic' recovery capability, to support the airline in the recovery effort, is becoming apparent." According to Olsen (2008, p. 33), "When your airport is closed by an aircraft sliding off the runway and getting bogged down, it is a little late to start thinking about your recovery procedures!"

AIRCRAFT RECOVERY PLAN OVERVIEW

Even though an aircraft owner/operator is responsible for the removal of its disabled aircraft, the burden of closed pavement and a restricted airport rests on the airport operator, affecting all potential users of the airport. As a result, it is in the best interest of the airport operator to oversee the recovery process that the aircraft owner/operator is carrying out. Although overseeing this process may be guided by the airport's AEP, the airport may wish to consider developing an ARP, either as part of the AEP or as a stand-alone document. Typically, the ARP is unique to that airport and is in addition to any recovery plans an aircraft owner/operator may have in place.

Findings from the literature review and interviews with personnel indicate that developing an ARP has advantages for the airport. At a minimum, the ARP could guide airport personnel in providing or acquiring resources for aircraft owners/operators in recovering their disabled aircraft. Rather than having to "feel their way" through a disabled aircraft event, airport personnel would have a plan that would guide their efforts in expediting the recovery of the disabled aircraft, and also would contain available resources and plans for collaboration. According to Traiforos (1990, p. 2), "Possessing such information in a recovery plan will [help the] . . . the airport operator [more fully support the aircraft owner/operator] in the performance of a trouble-free recovery."

The main purpose of an ARP is to provide procedures, resources, and plans that allow the airport operator to support the safe recovery of a disabled aircraft by the aircraft owner/operator with minimal delay. This is accomplished with the following considerations:

1. Safety of personnel involved with recovery operation
2. Preservation of evidence for accident investigation
3. Prevention of unnecessary secondary damage to the aircraft
4. The requirement to reopen the runway for operational use as expeditiously as possible (Air Mobility Command 2006, p. 1).

Of the previous considerations, safety is imperative during the recovery process. To ensure a safe recovery operation, it is important that all personnel adhere to safety precautions. Although causing secondary damage to the aircraft is to be avoided, causing injuries to personnel must be avoided at all costs.

DEVELOPING THE AIRCRAFT RECOVERY PLAN

Although each airport will have a unique ARP, developed in consultation with local aircraft owners/operators and other stakeholders, and taking into consideration local conditions, there are general considerations in developing the ARP. These considerations, while taken into account by the airport operator developing the ARP, concern both the airport operator and the aircraft owner/operator. It is quite helpful for an airport operator, for example, to understand the recovery

procedures that either the aircraft owner/operator or an independent recovery contractor will take to recover the aircraft. Although the aircraft owner/operator's responsibilities may not be included in the ARP, the ARP could form the basis of recovery training/education for airport personnel to enable full preparation for a disabled aircraft event.

AIRPORT OPERATOR RESPONSIBILITIES

Planning Phase

Airport Policy

Written policy regarding aircraft recovery states who assumes the responsibility for the removal of disabled aircraft. Formally, the aircraft owner/operator is responsible for removing their disabled aircraft. Commonly, airports (such as Seattle–Tacoma International Airport) place this responsibility solely on the aircraft owner, although they may reserve the right to intervene at any time to expedite the recovery process (Port of Seattle 2008). However, if the aircraft owner/operator cannot be immediately identified or reached, the airport operator may have to evaluate other alternatives. Airport policy may include a specific time period in which recovery needs to begin after the incident/accident. Some airport operators include a statement in the policy that explains what corrective action may be taken by the airport operator in the absence of removal by the aircraft owner/operator that will provide flexibility to the airport operator. Airport operators sometimes include a statement that requires airport operator approval before the aircraft owner/operator may commence recovery efforts.

Los Angeles World Airports, in their Rules and Regulations (Los Angeles World Airports 2010, pp. 3-1, 3-2), have the following disabled aircraft policy:

> Any owner, lessee, operator or other person having the control, or the right of control of any disabled aircraft on the Airport shall be responsible for the prompt removal and disposal thereof, and any and all parts thereof, subject, however, to any requirements or direction by the NTSB, the FAA, or the Executive Director that such removal or disposal be delayed pending an investigation of an accident. Any owner, lessee, operator or other person having control, or the right of control, of any aircraft does, by use of the Airport, agree and consent, notwithstanding any provision in any agreement, lease, permit or other instrument to the contrary, that the Executive Director may take any and all necessary action to effect the prompt removal or disposal of disabled aircraft that obstructs any part of the Airport utilized for aircraft operations; that any costs incurred by or on behalf of the Airport for any such removal or disposal of any aircraft shall be paid to the City; that any claim for compensation against the City of Los Angeles, the [Board of Airport Commissioners] BOAC, and any of their officers, agents or employees, for any and all loss or damage sustained to any such disabled aircraft, or any part thereof, by reason of any such removal or disposal is waived, and that the owner, lessee, operator or other person having control, or the right of control, of said aircraft shall indemnify, hold harmless and defend the City of Los Angeles, the BOAC, and all of their officers, agent and employees, against any and all liability for injury to or the death of any person or for any damage to any property arising out of such removal or disposal of said aircraft.

The Port Authority of New York and New Jersey (operator of JFK International Airport, Newark Liberty International Airport, LaGuardia Airport, Stewart International Airport, and Teterboro Airport) includes the following statement in its Rules and Regulations:

> The pilot or operator thereof shall be responsible for the prompt disposal of Aircraft wrecked or disabled at an Air Terminal and parts of such Aircraft as directed by the Manager; in the event of his failure to comply with such directions such wrecked or disabled Aircraft and parts may be removed by the Port Authority at the operator's expense and without liability for damage which may result in the course of such removal (K.B. Bleach, personal communication, October 31, 2011).

Traiforos (1990) also suggests a policy regarding disabled aircraft:

> Aircraft owners, their pilots or agents shall be responsible for the prompt [removal or] disposal of disabled aircraft and parts thereof, unless required or directed to delay such action pending an investigation of an accident. If [the aircraft owner, their pilots or agents] . . . does not move it within a 'reasonable' amount of time, the Airport Manager (city) [airport operator] may direct the FBO to remove it at the owner's expense and without liability for additional damage resulting from the removal (p. 9).

Regardless of the exact wording of a recovery policy, having a policy that clearly spells out the airport's expectations and requirements in the event of a disabled aircraft and dismisses airport liability during the recovery operation is important.

Media

An airport will likely receive many requests from the media during a disabled aircraft event; thus, a plan for handling the media is important. For obvious reasons, a disabled aircraft is a newsworthy story. An airport's ARP that includes a component on interacting with the media will allow an airport operator to anticipate and be prepared for the media interest that is sure to follow such an event. First, it is helpful to include a designated representative of the aircraft owner/operator in all media responses. As such, the airport operator may wish to include a list of individuals designated for media response for all aircraft owners and operators (especially airlines) in the ARP. Second, it is helpful to anticipate media inquiries. Airports can expect media questions such as the following:

1. Is the airport open or closed?
2. How has the incident affected airport property?
3. What should passengers do at this point?
4. When will the airport return to normal operations?

5. In what way is the airport prepared to handle this incident?
6. What are the details surrounding this event?

Last, although it is almost impossible to predict the exact location of a future disabled aircraft event, it is possible and a good idea to plan a media staging area (or several) so that media vans and camera crews can base their operation to gain a visual of the disabled aircraft and the recovery effort. Some airports are fortunate to have multi-level garages or other structures that can provide convenient rooftop access for the media. Once media staging areas are selected, it is beneficial for the airport to share this information with the media so their personnel will know exactly where to respond for an on-airport event. This will lessen confusion among the media and reduce workload in handling the media during an event.

Transportation Routes

Before the recovery effort can commence, recovery personnel and aircraft owner/operator designees will need access to the site. The recovery of a disabled aircraft will typically involve many vehicles and pieces of equipment needing to gain access to the site, some making multiple trips between the terminal/FBO/hangar area and the accident/incident site. These vehicles may be those not normally allowed access to the movement area, such as tugs, cranes, and vehicles with inadequate marking and lighting, lack of contact with ATCT, or driver not authorized to enter the movement area. It is helpful, therefore, to pre-determine transportation routes. Rather than creating routes to each specific area at which a disabled aircraft event may occur (which is difficult to predict), it is more effective to determine routes to sections of the airfield. A grid pattern can be overlaid on an airfield diagram, dividing the airport into smaller sections. When determining transportation routes, it is important to make allowance for equipment that is too wide for existing roads (such as wide-load trailers), as well as equipment that is too high to safely pass under a canopy or overhead power lines, for example. Specialty vehicles may need additional considerations when establishing transportation routes (Traiforos 1990).

Rather than developing transportation routes designed to cross active taxiways and runways, it is best to avoid these areas or, if unavoidable, plan on closing certain sections of pavement to accommodate personnel and equipment. Service roads and perimeter roads may be quite effective as transportation routes. Typically, the airport operator can expect to escort personnel and equipment to and from the site. A staging area may be effective in allowing personnel and equipment to stage, awaiting an escort to the site. Such an area will likely minimize confusion and unwanted vehicular traffic. Alternatively, personnel and equipment can stage at predetermined perimeter gates (Traiforos 1990).

Utility Composite Drawings

If the disabled aircraft event involves an aircraft excursion from the runway in which the aircraft departs structural pavement, excavation may be necessary. Whether this involves digging, trenching, or other actions, exercising care is important. Because airports have significant underground utilities, especially at runway ends with various lighting and navaid cables, any activity that disturbs the soil may inadvertently interrupt utilities and could cause shutdown of airfield lighting and/or navaids. Although the aircraft owner/operator and/or recovery personnel may not consider the role of utilities in the recovery process, it is important for the airport operator to consider utilities that may be affected by the disabled aircraft and/or the recovery operation. As a result, airport operators will find utility composite drawings to be helpful during a disabled aircraft recovery off the structural pavement. Such drawings illustrate underground utilities, thereby contributing necessary knowledge to the recovery process. Because these drawings are generally numerous, it is best if the ARP states that the drawings are available, can be consulted, and the location at which they may be referenced.

Support Equipment

To support the recovery operation, it is beneficial for airport operators not only to develop a support equipment list, but also to have on hand specific types of materials that may be used to recover the aircraft. According to Traiforos (1990, p. 16), "developing a support equipment list is one of the most important measures an airport operator can take to prepare for an aircraft recovery." If this list is not prepared ahead of time, a great deal of time can be lost during a disabled aircraft event as personnel attempt to locate needed resources (including equipment and tools). The following types of equipment should be included on the support equipment list:

1. Aircraft-related—Includes tow bars, tow tractors, jacks, and engine-removal equipment.
2. Recovery kits—Include slings and fixtures, which are required to raise aircraft (normally maintained by recovery teams and large-aircraft owners/operators).
3. General aviation—Includes an aircraft landing gear dolly to facilitate removal of light aircraft.
4. Heavy machinery—Includes flat-bed trucks, tow wreckers, dozers, front-end loaders, graders, forklifts, winches, and cranes.
5. Materials—Includes plywood, railroad ties, steel plates, aggregate, cable, rope, and chain.
6. Communication—Includes cellular phones, satellite phones, and two-way radios.
7. Lighting—Includes self-contained lighting powered by generator.
8. Personnel support—Includes shelter, food and beverages, and portable toilets (Traiforos 1990).

Boeing recommends that airports planning for an aircraft recovery have on hand certain general purpose equipment and materials that, based on Boeing Airplane Recovery Documents, will be beneficial in the recovery of disabled aircraft (Table 2). Although the types and quantities of materials recommended by Boeing (such as up to 1,500 railroad ties) could be considered quite burdensome by an airport operator, the recommendations are designed to aid in the recovery of transport-category aircraft. An airport serving smaller aircraft will likely find it sufficient to have on hand a lower quantity of materials than Boeing recommends. Another option, although it may delay the recovery effort, is to determine local providers of these materials and equipment and have 24-hour contact information for them. The ARP is an excellent place to record this contact information. If not, the airport operator may be forced to look through the Yellow Pages or online in a last-minute attempt to locate a local source of railroad ties or steel plates, for instance. Yet another option for acquiring these resources lies with the airlines themselves. In recognition of the financial burden of acquiring and storing such an extensive list of equipment, airlines have strategically located specialized aircraft recovery kits around the world. Although these kits are available on short notice, through the International Airlines Technical Pool (IATP), the requesting aircraft owner/operator is responsible for paying any fees associated with their use and coordinating their delivery to the recovery site. Depending on the location of the disabled aircraft event, it may take significant time to receive the equipment (ICAO 2009a; Olsen 2009; Boeing 2011).

Support Personnel

In addition to locating support equipment for an aircraft recovery, it is prudent for the airport operator to develop a list of general or specialized independent contractors that may be contacted to provide aircraft recovery services. Contact information, as well as available materials and equipment, would be included on this list. Although the aircraft owner/operator is responsible for arranging for such services, the airport operator may be called on to assist in securing support personnel for the recovery operation.

One such independent recovery company advertises the following on their website:

> Our company maintains an extensive arsenal of specialized aircraft recovery equipment. Included in the equipment inventory is the 'Aircraft Recovery and Transport System,' special aircraft towing devices, aircraft lifting bags and crane recovery devices, portable road systems and ancillary equipment. With the exception of the Aircraft Recovery and Transport System, all aircraft recovery equipment is stored in specially designed, mobile container systems which allow them to be transported quickly to the site of the incident by road or air.
>
> An Overview of our Services:
>
> - 24-hour hotline, 365 days a year
> - Advice on aircraft recovery measures, also by phone or E-Mail
> - Drawing up an individual aircraft recovery operation plan at your airport
> - Sending recovery specialists to the site of the accident
> - Conducting the entire rescue operation for the damaged aircraft on site
> - Support with the selection and acquisition of your recovery equipment
> - Training your personnel in the recovery of damaged aircraft with annual refresher courses
> - Annual review and updating of your concept for the recovery of damaged aircraft ("Aircraft Recovery Worldwide" 2010).

Recovery Phase

Although most of the airport operator's work occurs in the planning phase, preparing for a disabled aircraft event, the recovery phase will also involve the airport operator. Recovery is the most important phase of disabled aircraft recovery, for if this phase is delayed due to lack of equipment, materials, and/or personnel; encounters other significant complications; or results in secondary damage to the aircraft, the recovery process will have significant adverse impacts on airport operations. Thus, it is important for the airport operator to maintain authority during this phase, even while the aircraft owner/operator actually removes the aircraft.

Documentation

Maintaining an accurate, chronological log of the entire recovery operation is important. This log will begin with the initial notification of a disabled aircraft. Usually a dispatcher or operator will assist with recording information in the log, as responding personnel may be too burdened during the recovery operation to maintain an accurate log. Such event logs are helpful when debriefing personnel after the event and may also actually be helpful in improving future recovery operations. Additionally, recording the events with photographs is useful; photographs will greatly aid in discussions and formulating lessons learned (Traiforos 1990).

Notify NTSB

Although the aircraft owner/operator is responsible for notifying NTSB in the event of an accident or any of the events listed in NTSB Part 830.5, it is prudent for the airport operator to follow up to make certain this notification has occurred. Additionally, it is important to notify the FAA Communications Center.

Incident Command Post

Whenever an emergency situation occurs at an airport, it is beneficial to establish an incident command post. *AC 150/5200-31C* now incorporates the National Incident Management System and the Incident Command System. A disabled

TABLE 2
BOEING MATERIAL RECOMMENDATIONS FOR AIRPORTS PLANNING
FOR AN AIRCRAFT RECOVERY

No.	Item	Quantity
1	Fencing, with protective signage	As necessary
2	Steel plate, 1 in. (25 mm) thick, 4 ft x 6 ft (122 x 183 cm)	12
3	Steel plate, 1 in. (25 mm) thick, 3 ft x 3 ft (91 x 91cm)	12
4	Manila rope, 3/4 in. (19 mm) diameter	500 ft (152 m)
5	Pulley block, Double sheaves for 3/4 in. (19 mm) diameter rope	4
6	Hardwood beam, 6 in. x 6 in. x 4 ft (15 x 15 x 122 cm)	2
7	Felt padding, or equivalent material	200 sq ft (20 sq m)
8	Mattress, household type	8
9	Plywood sheet, 3/4 in. (19 mm) thick, 4 ft x 8 ft (122 x 244 cm)	50
10	Plywood sheet, 1 in. (25 mm) thick, 4 ft x 8 ft (122 x 244 cm)	125
11	Shoring timber, hardwood, 6 in. x 3 in. x 8 ft (15 x 8 x 244 cm) and, 12 in. x 12 in. x 10 ft (30 x 30 x 305 cm)	500
12	Mobile electrical power unit, 5 kw or larger	1
13	Floodlights with stands, Use with the above power unit, which includes leads, junction box, and 50 ft (15 m) extension cords	4
14	Flashlights, standard, 1 per person	As necessary
15	Work lights, Engine driven	4
16	Low-height flat bed trailer, 150 ton (136 metric ton) capacity 4 ft (1.2 m) maximum height	2
17	Tow cable, 20 ton (18 metric ton) capacity wire rope 100 ft (30 m) length, splice ends at each end	4
18	Lifting cable, landing gear structure assembly, 50 ton (45 metric ton) capacity 20 ft (6 m) length, with splice eyes and thimbles	3
19	Tethering cable, or 3 in. (7.6 cm) diameter rope, 20 ton (18 metric ton) capacity 80 ft (24 m) length, with splice eyes and thimbles	8
20	Rachet chain hoist, 3 ton (2.7 metric ton) capacity	8
21	Ground anchor, 10 ton (9 metric ton) capacity	8

(*continued on next page*)

TABLE 2
(*continued*)

No.	Item	Quantity
22	On-site communication equipment, Portable radios, interphone headsets, or mobile phones	5
23	Railroad ties	Up to 1,500
24	Crushed rock, 1.5 in. (3.8 cm)	30 cubic yards (23 cubic meters)
25	Pit run gravel	50 cubic yards (38 cubic meters)
26	Planking, steel or aluminum, 2 in. x 8 in. x 8 ft (5 x 20 x 244 cm) *or* equivalent epoxy filament cloth ground cover	500
27	Mobile crane, 12 ton (10.8 metric ton) capacity; height 28 ft (8.53 m) Reach 10 ft (3 m) for airplane component lifting, including engines	1
28	Bulldozers, bucket loaders, etc., for excavation	As necessary
29	Winching vehicles, forklifts, flat-bed trucks, etc., for tethering, moving, loading, unloading	As necessary
30	Ladders, At least 24 ft (7.3 m) extension	2
31	Miscellaneous tools: Shovels, picks, crowbars, sledge-hammers, hoes, chainsaws, hammers, nails, handsaws, small hydraulic jacks, shackles, etc.	As necessary
32	Ballast, Sand bags, cement blocks, scrap iron, drums filled with water, etc.	3,000 lb (1360 kg)
33	Trailers or workshop tent	As necessary
34	Quick-set concrete	As necessary
35	Large mobile cranes, for airplane wing and body lifting	As necessary
36	Used rubber tires	30
37	Grounding rod, Coppertone-coated steel with 60 ft (18 m) cables and clips	10 ft (3 m)
38	Fuel off-load capacity of 20,000 gallons (75,710 liters), Fixed mobile or bladder fuel tanks	As necessary
39	Water pump for draining ditches, 2 in. (5 cm) diameter pump with a 50 to 100 gpm (189 to 379 liter/min) capability. Pump power supply with 3 in. (7.6 cm) diameter, 100 ft (30 m) suction hose so the pump may clear the fuel vapor area.	2
40	Soil penetrometer	1

Source: Boeing, "Boeing Material Recommendations for Airports Planning for an Aircraft Recovery," 2011. Retrieved from http://www.boeing.com/commercial/airports/faqs/aircraft_recovery_planning.pdf.

aircraft event, regardless of the severity, also benefits from the incident command system. Staffed by the recovery manager, this post is best established as close to the accident/incident site as possible. In this way, an effective communication link is established among responding personnel, the recovery team, the airport, and any other agencies (Traiforos 1990).

Closures

If, upon inspection, personnel recognize the need to close pavement or other areas, it is important to close affected areas promptly in coordination with air traffic control. This ensures the safety of ARFF personnel, NTSB/FAA personnel, and recovery personnel, as well as other users of the airport. When making a determination on closures, it is important to consider the height of cranes that may be used to lift the disabled aircraft, as well as airfield hazards association with the disabled aircraft. Remember, however, "whenever possible, all areas of the airfield not affected by the aircraft should be kept open, allowing the airport to operate as close to normal as possible" (Traiforos 1990, p. 20).

NOTAMs

It is important to coordinate any necessary closures with FAA and issue appropriate NOTAMs. The airport operator is responsible for disseminating airport condition information to users. Part 139.339 details requirements for reporting airport conditions at certificated airports.

Escorts

Whenever an aircraft becomes disabled on the movement area or safety areas, escorts often will be needed for personnel who are not movement-area authorized to access the site. Initially, escorts may be needed to provide access to representatives of the aircraft owner/operator. As the investigation and recovery progresses, investigative personnel, recovery teams, equipment operators, and others may need to be escorted to the site. It is important to arrange for vehicles in advance and consider dedicating one or more individuals to this task so that others can concentrate on the actual recovery process (Traiforos 1990).

Obstacles

It is also important to determine if the aircraft and any support equipment penetrate any of the imaginary surfaces in 14 CFR Part 77 (Part 77). With the height of cranes and other equipment (including the aircraft), obstacles to air navigation are possible and should be closely controlled. This may require certain sections of the movement area to be closed, FAA advised, and users advised through the NOTAM system.

Utilities

Damage to utilities is possible during excavation to free a disabled aircraft. As planned for during the planning phase, the composite utility drawings would be consulted to prevent inadvertent damage to utilities during any excavation necessary for the recovery.

Additional Services

The airport operator may be called upon to provide additional services, such as ARFF (emergency services), police (security of the site/wreckage and crowd control), electrical (lighting, and repairs to damage airfield lighting), construction (locating underground utilities and perform pavement repairs), and general labor (erect barricades and other duties). It is advantageous to anticipate pre-arrange this support (Traiforos 1990).

Meetings

Communication is integral to any aircraft recovery effort. Proper communication will aid in coordination, and this coordination is best achieved through meetings. Although meetings are effective prior to an event to ensure that all responders, aircraft owners and operators, and the airport are on the same page for the recovery of a disabled aircraft, an initial meeting is also effective once an aircraft becomes disabled. According to ICAO, this meeting should include the aircraft owner/operator, investigative authority, and additional recovery personnel, and should cover the following points:

- Escort routes to/from the accident site
- Defueling to lighten the weight of the aircraft
- Requirements and availability of equipment for the removal of the aircraft
- Use of the airport and aircraft owner's/operator's equipment
- Dispatch of aircraft operator ancillary support devices to the site
- Weather conditions, particularly for crane-lifting or pneumatic-lifting bag operation
- Lighting of the site
- A contingency plan, should difficulties develop (ICAO 2009a).

This meeting will devise an initial "plan of attack," arrange resources, discuss transportation routes, confirm NTSB notification and media communication plans, and the like. Since all required personnel may not yet be on-site for this initial meeting, additional meetings may be coordinated to include personnel such as the NTSB/FAA, aircraft manufacturer, and independent recovery contractors. It is important to keep aircraft operators informed of the progress of the aircraft

removal operation, as well. And, while keeping aircraft operators informed will likely not require NOTAMs, it is important nonetheless (Traiforos 1990).

Postrecovery Phase

Once the disabled aircraft has been moved or extracted from the site, the post-recovery phase has begun. According to Traiforos (1990), the post-recovery phase has only a few components:

1. Documentation
2. Inspection
3. NOTAM cancellation and reopening closed areas
4. After-action critique or debriefing.

Although a log of the recovery efforts was likely started after the initial notification of the disabled aircraft, the post-recovery phase is a good time to verify the completeness of the log. This documentation may prove helpful for the aircraft owner/operator, airport operator, recovery team personnel, insurance adjustor, and investigative authorities. Details to be recorded may include the following:

1. The initial survey and inspection report, including diagrams and photographs
2. Initial calculations of the aircraft weight, anticipated loads and center of gravity calculations
3. Information on the weight reduction procedures
4. The technique used to level and lift the aircraft (e.g., jacks, cranes, or lifting bags)
5. The loads imposed during leveling and lifting
6. The loads imposed on tethers
7. The loads imposed on the landing gear during the movement of the aircraft to a hard surface
8. Details on any resultant secondary damage
9. The total time of the event, including time of closures, runway downtime, etc. (ICAO 2009a, p. 8-1).

In addition, once the disabled aircraft has been removed from the airfield, it is important to inspect all areas affected by the event. This requirement is contained in Part 139.327:

> In a manner authorized by the Administrator, each certificate holder must inspect the airport to assure compliance with this subpart according to the following schedule:
>
> 1. Daily, except as otherwise required by the Airport Certification Manual;
> 2. When required by any unusual condition, such as construction activities or meteorological conditions, that may affect safe air carrier operations; and
> 3. Immediately after an accident or incident.

All materials, including aggregate, lumber materials, and steel plates will need to be removed. Safety areas will also be inspected to ensure that they are free from any hazardous ruts, depressions, or humps. It is also important to inspect airfield lighting, navaids, and pavement surfaces. It is imperative that all personnel and equipment are clear of movement areas and remain clear before reopening any areas.

Next, once the inspection confirms that any closed areas can be returned to service, applicable NOTAMs will need to be cancelled. However, NOTAMs may need to remain active for issues not yet resolved. As part of the NOTAM cancellation process, closed areas can be reopened.

Finally, it is helpful to conduct an after-action critique or debriefing of the event and the recovery operation. This critique could be held in the week of or following the accident; it is most effective not to delay it much longer. If it is delayed, memories may have faded and the critique will lose its effectiveness. According to Traiforos (1990, p. 25), "a formal critique is the best way to review the recovery operation." Such a critique is most effective if it includes all personnel involved in the recovery operation (or as many as possible) and a review of the investigation, the chronological incident log and accompanying photographs, and the procedures and equipment used during the recovery operation. The debriefing is useful if it addresses possible problem causes and areas for improvement, and results in a revision of the airport's ARP as appropriate. Once an area has been identified for improvement, it is beneficial to identify corrective action items with a planned implementation date (Traiforos 1990).

Aircraft Owner/Operator Responsibilities

The aircraft owner/operator's primary role is to recover the disabled aircraft, which requires removing the aircraft and/or parts of the aircraft from the airfield (or other site). The actual aircraft recovery process may vary, even among different disabled aircraft events at the same airport, especially when they involve different aircraft owners/operators. Recovery procedures will also vary depending on the extent of the recovery required. The order in which these procedures are performed will also vary, with some tasks being performed simultaneously. Although the following points describe the important issues to keep in mind when recovering a disabled aircraft, the procedures outlined may be the responsibility of the aircraft owner/operator or airport operator, depending on each situation. The aircraft recovery information here is substantially derived from the ICAO *Airport Services Manual.*

Planning Phase

Generally, although the bulk of work for the airport operator occurs during the planning phase, the bulk of work for the aircraft owner/operator occurs during the recovery phase. Nonetheless, the aircraft owner/operator is tasked with being prepared for a disabled aircraft event that may occur in

the multiple airports this operator serves, which necessitates planning. Experience has shown that it is beneficial for aircraft owners/operators to have a list of recovery resources (including supplies, equipment, and personnel) available locally for each airport at which they operate. Specifically, it is important for the aircraft owner/operator to develop an Aircraft Recovery Preparedness Airport Checklist. This list, which will be unique to each airport served, is recommended by the IATA. Airport operators can typically play a significant role in developing this list and may even wish to have a similar list in their ARP (discussed in chapter five). Once this list is developed, the recovery coordinator will be more knowledgeable and better able to affect the recovery. A template is provided here.

Aircraft Recovery Preparedness Airport Checklist

The intent of this checklist is to identify local resources, equipment, and tooling available should an Aircraft Recovery event occur. The checklist will be updated annually and completed & maintained jointly by Airport Operations and Aircraft Maintenance.

A completed/updated copy will be forwarded to: _____.

AIRPORT = _____. **DATE = _____-_____-_____**

General Information:

Is there an Airport Aircraft Recovery Plan? Yes – No
Are any contracts required? Yes – No
Any outside vendor contracts? Yes – No
(If yes to the above, provide a copy to _____)

Airport Telephone Numbers:

Airport Ground Operations Office #_____ Cell #_____

Airport Aircraft Maintenance Office # _____ Cell #_____

Airport Authority (24-hour contact) Office # _____ Cell #_____

TSA/Airport Security (emergency temp access/IDs)

Contact # _____

Airport CFR # _____

Control Tower # _____ Ground Radio Frequency _____

Fuel Supplier # _____ Defueling Capacity? _____Lbs/Gals

Internal Airline Recovery Equipment? (include tugs, tow bars, etc.) None = _____

_____

_____

_____

Airlines

- Are there major airlines operating on the airport? Yes – No
- If yes, do they have aircraft recovery capabilities? Yes – No

1) Airline: _____ 24-hr Contact # _____ Cell #_____

Recovery Capabilities/Equipment? _____

Hangar/s—Base Mx? (aircraft size capable) _____

2) Airline: _____ 24-hr Contact # _____ Cell #_____

Recovery Capabilities/Equipment? _____

Hangar/s—Base Mx? (aircraft size capable) _____

3) Airline: _____ 24-hr Contact # _____ Cell #_____

Recovery Capabilities/Equipment? _____

Hangar/s—Base Mx? (aircraft size capable) _____

Military

- Are there military operations on the airport? Yes – No
- Are there military operations on adjacent airports? Yes – No
- If yes, do they have aircraft recovery capabilities? Yes – No

Branch: _____ 24-hr Contact # _____ Cell #_____

Recovery Capabilities/Equipment? _____

Hangar/s—Base Mx? (aircraft size capable) _____

AIRPORT Authority Recovery Equipment? (include ropes, mats, etc.) None = _____

_____

_____

_____

CFR (Crash, Fire & Rescue) Recovery Equipment? None = _____

_____

_____

_____

Local City Fire Department/Brigade Capabilities?

_____

_____

_____

Local Vendors

Towing Companies (large vehicle capability)

1) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

2) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

Heavy Equipment Operators (caterpillars and ground work capabilities)

1) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

2) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

Crane/Heavy Lift Operators

1) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

2) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

Local Vendors

House and Building Moving/Heavy Trailering Companies

1) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

2) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____
   Capabilities/specialties _____
   _____
   _____

Equipment Rental Companies (generators, temporary lighting, etc.)

1) Name: _____ 24-hr Contact # _____ Cell #_____
   Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

2) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

Lumber Supplier (plywood, timbers, planking)

1) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

2) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

Environmental/Hazmat Cleanup Vendors

1) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

2) Name: _____ 24-hr Contact # _____ Cell #_____

Tonnage capabilities? _____ Working lengths? _____

Capabilities/specialties _____

_____

_____

Checklist Completed by (Print Name): _____

Date Checklist Completed (Month & Year): _____

Date and Time Copy Was Forwarded: _____

Additional Notes/Airport information/Comments:

_____

_____

_____

[*Source:* Jack Marcoski.]

Recovery Phase

The recovery phase is the time when an aircraft owner/operator plays the lead role. Although the actual recovery operation may be contracted out to an independent recovery contractor, the aircraft owner/operator is still responsible for removing their aircraft in a timely and safe manner. According to ICAO (2009a), there are specific steps during the recovery phase.

Aircraft Survey

Once the accident or incident has occurred, and the NTSB/FAA has been notified, there will be a period of time during which the investigation takes place and the aircraft cannot be moved. During this time, and prior to release of the aircraft by the investigative authority, the aircraft owner/operator can complete a number of preliminary tasks in anticipation of the aircraft recovery process. According to ICAO (2009a, p. 2-1) these tasks include:

1. Recording the initial accident/incident data;
2. Preparing for site security including fire, theft, and access control;
3. Confirming the availability of the removal team members;
4. Arranging for delivery of local recovery equipment;
5. Preparing for movement of specific removal equipment such as IATP kits from other sources;
6. Establishing communication with the aerodrome operator and investigative authorities;
7. Identifying what types of dangerous goods were being carried on board as cargo;
8. Obtaining current drawings/maps of the aerodrome to asses access routes to the site;
9. Transporting the required personnel to and from the removal site;
10. Confirming shipping details for the required recovery equipment;
11. Coordinating visas, passports, vaccinations, and related certificates; and
12. Arranging hotel accommodations and local transportation.

Once the aircraft has been released by the investigative authority, the aircraft owner/operator can perform an initial aircraft survey. The findings from this survey will prove helpful in preparing for the recovery process with appropriate personnel. According to ICAO (2009a, p. 2-2), such a survey will consist of:

1. The integrity of the aircraft structure and landing gear
2. An appraisal of the soil conditions
3. Forecast of current and future weather conditions
4. Relevant health and safety issues of personnel
5. Expected environmental concerns.

It is important, before allowing personnel to carry out this initial survey, that the aircraft be stabilized. This stabilization is not to remove the aircraft (which will occur later), but rather to ensure the safety of personnel who may need to enter or move around the aircraft.

Once the initial survey is complete, a more thorough inspection can occur. A thorough inspection will focus on the fuselage, wings, and landing gear, but will also include the aircraft electrical system and any fluid leaks. During this inspection, existing damage to the aircraft is determined. Such damage may include cracked, creased, or otherwise distorted fuselage or wing skin panels; broken or missing fasteners; and signs of overheating of any fuselage, wing panels, or other components. It is important to either remove or secure damaged or loose components (especially landing gear, flap sections, or engine cowlings) before commencing the recovery operation (ICAO 2009a).

Site Survey

Once the aircraft owner/operator understands the condition of the aircraft, it is important to conduct a survey of the accident site. The main purpose of this survey is to determine how best to recover the aircraft. This survey will focus on the (1) terrain, (2) soil characteristics, (3) access routes, and (4) current and forecast weather. It is important to take into account areas of uneven ground, possibly with drainage ditches and/or streams, and any hazardous wildlife, such as venomous snakes. The load-bearing capability of the soil is also important to verify. The California Bearing Ratio (CBR) is one test that can be used to measure the inherent strength of the soil. Developed by the California Department of Transportation before World War II, the CBR method involves measuring the pressure necessary to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure necessary to achieve an equal penetration on a standard crushed rock material. A topographical map will prove a helpful reference during this site survey. Recommended access routes will most likely be identified in the airport's ARP; nonetheless, specific routes will likely be determined for each recovery operation. Finally, current and forecast weather will be important to recovery personnel, as changing weather conditions can either benefit or hinder the technical aspects of a recovery operation. Additional rain may soften already muddy ground, making the recovery of an off-pavement aircraft even more difficult, and high winds may preclude the use of cranes (Traiforos 1990; "California Bearing Ratio" 2007; ICAO 2009a).

It is also beneficial during the site survey to ascertain health and safety issues to fully protect personnel involved in the recovery operation. These issues may include the following (ICAO 2009a, pp. 2-6–2-9):

1. Personal protective equipment—May include hard hats, safety boots, protective gloves, coveralls, particulate dust masks, respirators, parkas and rain-suits, and the like.
2. Contracted equipment operators—Need to understand safety concerns associated with overloaded equipment, especially involving aircraft, as well as maximum lift-

ing loads during crane lifts, and the need to follow the instructions of a clearly identified authority.
3. Removal equipment—Must be appropriately rated for the anticipated loads and visually inspected prior to use, including an examination of equipment tags attesting to appropriate load ratings and test dates.
4. Hazardous materials—May include composite materials, dangerous goods carried as cargo, depleted uranium (sometimes used for balancer weights), and sharp pieces of metal.
5. Biohazards—Includes blood-borne pathogens, requiring personnel to be fully protected and trained to deal with blood-borne pathogens.
6. Oxygen system—Includes onboard oxygen generators, which are to be secured or removed by experienced personnel.
7. Electrical system—Main aircraft batteries must be disconnected by experienced personnel if the aircraft electrical system is unserviceable.
8. Fuel system—Minor fuel leaks can be temporarily plugged or repaired by experienced personnel.
9. Dangerous goods crew—Hazardous material crew must be available to clean any fluid spills or leaks, including those from fuel, hydraulic fluid, and waste systems.
10. Fire safety—ARFF personnel and equipment must be available during any defuel or leveling or lifting operations.
11. Aircraft wheels—Must be inspected by qualified personnel to ensure that the wheels and/or rims have not been damaged to avoid risks to personnel if the wheels or rims fail.

Aircraft Recovery Manuals

The aircraft owner/operator will also ensure that the Aircraft Recovery Manuals (ARM) or documents specific to the aircraft involved are available. The ARM illustrates the technical procedures of recovering specific aircraft as recommended by the aircraft manufacturer. These types of manuals are provided directly to the aircraft owner/operator for each new aircraft sold. Owing to the proprietary nature of these documents, they are made available only to owners/operators of that manufacturer's aircraft.

Weight and Center of Gravity Management

Before moving a disabled aircraft, it is important to determine the aircraft's weight and center of gravity. With this information, the following can be determined:

1. The leveling/lifting technique to use
2. The type and capacity of the selected equipment
3. The expected loads
4. Any anticipated changes to the stability of the aircraft
5. The lateral and longitudinal balance limits (ICAO 2009a, p. 3-1).

This step is important to avoid changes in the stability of the aircraft, which may result in injuries to personnel and secondary damage to the aircraft. Thus, calculating the weight and center of gravity of the aircraft is crucial in anticipating stability changes. Typically, the ARM will contain worksheets to assist in calculating the new recoverable weight and/or recoverable empty weight and the associated moments (ICAO 2009a). If the expected loads are not within allowable limits, it will be necessary to:

1. Find alternate leveling or lifting procedures to ensure that aircraft and tooling loads are within their stated limits
2. Adjust the aircraft weight to allow the loads to fall into allowable limits
3. Reduce the weight of the aircraft (ICAO 2009a, p. 3-3).

The weight and center of gravity of the aircraft can be altered by removing fuel and/or cargo, transferring fuel from one tank to another, or adding ballast. It is important to remember that galley catering units and trolleys can have a significant influence on the center of gravity (ICAO 2009a).

Reducing the weight of the aircraft, either through removal of fuel and/or cargo and other heavy components, is a standard principle in aircraft recovery. Generally, baggage and/or cargo are removed first. There are several important issues to consider during the removal of fuel and/or cargo:

1. Fuel and cargo removal must take place only after the damage survey has been completed and stability and center of gravity issues have been taken into account.
2. A proper defueling procedure must be chosen only after a thorough damage survey of the aircraft to determine the functional status and serviceability of the fuel system.
3. In most cases, fuel is the largest removable weight component, followed closely by cargo.
4. Aircraft weight change will affect center of gravity, aircraft stability, and expected loads.
5. Personnel must be prepared for and anticipate sudden attitude changes as fuel or cargo are removed. The changes can affect both the longitudinal and lateral axis of the aircraft.
6. Unusual attitudes caused by collapsed, missing, or heavily bogged landing gear will increase the difficulty of removing both fuel and cargo.
7. Once the aircraft is stabilized, and before any leveling/lifting operations are performed, it is common to remove baggage and cargo from compartments in the following order:
   a. The aft bulk compartments
   b. The forward compartments
   c. The center section cargo compartments (ICAO 2009a, p. 5-2)

By utilizing appropriately trained personnel to handle all defueling operations, a safe defueling operation can be ensured. Although it may be feasible to leave some amount of fuel onboard the aircraft, specifically to help stabilize the

aircraft, if defueling is decided upon, one or more of the following methods may be chosen:

1. Normal pressure defueling, with all applicable aircraft systems serviceable;
2. Suction defueling, with all applicable systems serviceable and battery power available;
3. Suction defueling, with no electrical power available;
4. Pressure defueling, using an external boost pump harness to supply power to the aircraft fuel pumps;
5. Suction defueling, through over-wing fuelling ports; and
6. Gravity or suction defueling, using water drain valves (ICAO 2009a, p. 5-3).

Because of the large amounts of fuel that may need to be stored, once removed from the aircraft, it is beneficial for the airport operator, aircraft owner/operator, and fueling contractor to discuss possible storage options. Some options may include empty tank trucks, empty rail tank cars, tanks, or portable fuel tank bladders (ICAO 2009a).

Preparing for the Move

In preparing to move the aircraft, it is beneficial to consider each of the following issues:

1. Aircraft stability
2. Soil stability
3. Wind loads
4. Communications
5. Preventing secondary damage.

First, to ensure safety of personnel and prevent secondary damage the aircraft must be properly stabilized. Stability, defined as "the resistance of the aircraft to uncontrolled movement cause by destabilizing forces," is important to prevent a sudden shift in the aircraft's center of gravity during recovery operations (ICAO 2009a, p. 4-1). Typically, tethers and shoring are relied upon to stabilize the aircraft. Although the number of tethers will vary based on the amount of instability, the specific removal process being used, and the wind speed and direction, it is important to securely attach tethers to a ground anchor equipped with load-tensioning devices. Shoring, which is used to stabilize the aircraft before removing fuel and/or cargo or to hold the aircraft in position while lifting equipment is repositioned, typically involves placing large, padded timbers in load-bearing areas.

When relying on tethers, it is necessary to securely attach them to adequate ground anchors. Ground anchors may include commercial ground anchors, dead-man anchors, or the use of heavy vehicles as anchors. The holding capacity of the anchor, which may vary according to the type, depth of the anchor, and moisture content of the soil must be considered.

To determine that the soil at the incident site, including transport routes, is capable of supporting the loads of equipment and the aircraft, it is important to conduct soil stability testing. The CBR method is one option to determine the stability of the soil (ICAO 2009a).

Winds at the incident site can be unpredictable, resulting in possible damage to equipment, aircraft, and personnel. Because of the high profile of the aircraft vertical stabilizer, winds can literally turn the aircraft in mid-air, seriously complicating the recovery effort. To minimize wind impacts on longitudinal and lateral stability, it is important to consult the ARM to determine maximum wind velocity limits when lifting with jacks, cranes, and/or pneumatic lifting devices. Although the vertical fin can be removed from the aircraft, this operation is labor-intensive, calling for a careful consideration of the advantages versus the time and effort necessary for removal (ICAO 2009a).

As previously stated, the removal of a disabled aircraft typically involves multiple personnel and large pieces of equipment. As a result, communications among personnel (including ARFF, police, and aircraft recovery personnel) are integral to a successful recovery. This may involve various pieces of communication equipment, such as two-way and very high frequency (VHF) radios, cell phones, and possibly even satellite phones, as well as regular briefing sessions. Efforts to ensure effective communication will likely be rewarded during the recovery operation (ICAO 2009a).

A final consideration in preparing to move the aircraft is the concept of preventing secondary damage. Secondary damage, which can occur at any point during the removal process, can add to the repair costs and increase aircraft downtime. Insurance adjustors clearly oppose any recovery methods that will cause secondary damage to the aircraft. According to ICAO (2009a, p. 4-5), "the significant reduction of aircraft weight by removal of fuel, cargo, and other items is the single, most important factor assisting in the minimizing of secondary damage." Table 3 presents various methods of recovery.

Leveling and Lifting

The process of leveling and lifting a disabled aircraft is unique to each incident. However, the order of these two steps is the same. First, the aircraft is leveled to ensure stability. This involves ensuring a level aircraft attitude about the lateral and longitudinal axis. Once this is accomplished, leveling can occur about the lateral axis (wings) and the longitudinal axis (fuselage) (ICAO 2009a).

Next, the aircraft is lifted to a height where maintenance jacks can be positioned, thereby allowing landing gear to be extended, repaired, or replaced, or for a recovery trailer to be properly positioned. During the lifting phase it is important to ensure that the aircraft is lifted to a sufficient height to allow landing gear to be extended and locked into position or for a recovery trailer to be positioned under the wings and/or fuselage. It is beneficial to determine this height before

TABLE 3
TYPICAL METHODS OF AIRCRAFT RECOVERY

Condition	Method of Recovery
Collapsed nose landing gear	Jacking and use of pneumatic lifting bags; hoisting with cranes and the use of specially designed slings
Collapsed or retracted main landing gear, with nose landing gear intact and extended	Jacks, pneumatic lifting bags, or cranes
Collapsed main landing gear, one side only	Jacks, pneumatic lifting bags, or cranes
Collapse of all landing gear	Jacks, pneumatic lifting bags, and cranes
One or more main landing gear off pavement, no aircraft damage	Assuming the aircraft has the landing gear bogged down in soft soil or mud, extra towing or winching equipment or use of pneumatic lifting bags will usually suffice for this type of recovery. It may be necessary to construct a temporary ramp from timbers, matting, etc.
Nose landing gear failure and one side of main landing gear failure	Jacks, pneumatic lifting bags, or cranes
Tire failures and/or damaged wheels	Jacks and parts replacement

Source: The Disabled Aircraft Removal Plan at Rafic Hariri International Airport (2008).

beginning the lifting operation. Depending on the lifting height of the equipment, it may be necessary to lift the aircraft in stages; if so, extra support, in the form of shoring or cradles, will be necessary (ICAO 2009a).

Typically, jacks are used to lift a disabled aircraft (Figure 5). Aircraft have designated reinforced points on the wings and fuselage for this purpose. Usually there is at least one jack point under each wing and one forward or aft on the fuselage.

FIGURE 5 Jacking an aircraft. *Source:* Anonymous. Used with permission.

The ARM will specify approved jacking points. Jacks must lift from a stabilized base, such as steel plates (ICAO 2009a). The following types of jacks may be used for an aircraft lifting operation:

1. Specialized aircraft recovery jacks. These are capable of freely following the arc movement within specified limits and must be operated according to applicable operating instructions. Two different designs are available:
   a. Monopole design: consisting of a single cylinder attached to a large flexible base plate; and
   b. Tripod design: consisting of three multi-stage legs that are individually controlled and operated. Pressure gauges are installed on each leg, allowing independent operation and control of the loads on the individual leg. This allows the operator to ensure that the arc movement is kept within the specified limits. Note—Standard maintenance tripod jacks are not capable of any arc movement and are not recommended for use during recovery operations.
2. Bottle- or wheel-type jacks. These can be useful for initial leveling and lifting in constricted areas. They have the same limitations as the standard maintenance jacks.
3. Recovery jacks for new larger aircraft. These can provide continuous measuring and recording of loads during the entire jacking process and can automatically control side loads as they extend (ICAO 2009a, p. 6-3).

ICAO provides the following precautions when lifting with jacks:

1. Ensure that all safety instructions are complied with.
2. Monitor and ensure that wind speeds are not exceeded.
3. Ensure that the aircraft is tethered if required.
4. Ensure that all weights and loads have been calculated.
5. Ensure that the platform area for the jack is large enough to change jack position as the aircraft is lifted, if necessary.
6. Determine the type of jack to be used and ensure that it is capable of supporting the required load.
7. Ensure that all the manufacturer's operating instructions are complied with.
8. Install fittings or jack pad adapters at the jack points.
9. Ensure that landing gear down-lock pins are installed in any serviceable landing gear.
10. Discuss with the jack operators and other personnel what is expected to happen as the aircraft is raised and what is expected of each operator.
11. Ensure that no unnecessary personnel are in the safety zone.
12. Ensure that adequate communication is available among the jack operators, the recovery manager, and the lifting coordinator.
13. Attach plumb bobs to various fuselage and wing locations to assist with monitoring the relative attitude of the aircraft as it is lifted.
14. Ensure that personnel are available to monitor and adjust the tension loads as the aircraft is lifted, if tethers are being used.
15. Provide tail tip protection.
16. Follow the aircraft manufacturer's recommendations regarding whether the parking brakes must be set.
17. Install wheel chocks and determine whether it is necessary to deflate the landing gear shock struts.
18. If the required lifting height is greater than the jack extension height, place shoring while a platform is fabricated to provide additional lift.
19. Ensure that jack operators monitor the jacking loads at all times during the jacking operation.
20. Carry out the jacking operation in a controlled and steady movement.
21. Install landing gear down-lock pins in any serviceable landing gear (ICAO 2009a, pp. 6-4, 6-5).

In addition to, or in lieu of, jacks, recovery personnel may utilize pneumatic lifting devices. The most common of these devices uses bags with multiple elements or compartments rated at 15, 25, and 40 tons or more. With this device, the expansion of each individual element is restricted, thereby creating a flat shape with uniform thickness. By placing pneumatic lifting devices under the wings, forward, and aft fuselage, the aircraft can be lifted. ICAO provides the following precautions when lifting with pneumatic devices:

1. Ensure that all safety instructions are complied with.
2. Monitor and ensure that wind speeds are not exceeded.
3. Ensure that the aircraft is tethered if required.
4. Ensure that all weights and loads have been calculated.
5. Ensure that all the manufacturer's operating instructions are complied with.
6. Ensure that landing gear down-lock pins are installed in any serviceable landing gear.
7. Determine the necessary lifting capacity and the number of bags required.
8. Confirm the placement of the lifting bags on the ground and provide protection from sharp objects with rubber mats or tarpaulins, keeping in mind that ground preparation may be required.
9. Protect the lower wing or fuselage from minor protrusions using rubber mats; however, it may be necessary to completely remove antennas and drain masts.
10. Ensure that the area around the wing jack point is not encroached upon, as failure to provide an area for the jacks may require the aircraft to be shored once the lifting process is complete, to allow for the removal of the lifting devices and positioning of wing jacks.
11. Place the lifting bags with the inflation fittings facing the inflation console, if possible.
12. Position the inflation console with a good view of the lifting bags.
13. Discuss with the console operators and other personnel what may occur as the aircraft is raised and what is expected of each operator.
14. Ensure adequate communication is available among the console operators, the recovery manager, and the lift coordinator.
15. Ensure that unnecessary personnel are not in the safety zone.
16. Ensure that the compressor and console have adequate moisture traps.
17. Unroll the inflation hoses and connect them to the console.
18. After purging, connect the hoses to the appropriate lifting bag inflation fitting and confirm the correct hose sequence.
19. Attach plumb bobs to various fuselage and wing locations to assist in monitoring the relative attitude of the aircraft as it is lifted.
20. If tethers are being used, ensure that personnel are available to monitor and adjust the tension loads as the aircraft is lifted.
21. Provide tail tip protection.
22. Follow the aircraft manufacturer's recommendations as to whether the parking brakes are to be set and wheel chocks installed and whether it is necessary to deflate the landing gear shock struts (ICAO 2009a, pp. 6-7, 6-8).

In addition to jacks and pneumatic lifting devices, cranes are often utilized to lift a disabled aircraft, especially transport category aircraft. Although large mobile cranes can effectively and easily lift portions of the aircraft, tethering is crucial, because winds can cause large swings in the aircraft during the lift. Lifting straps may be placed near jack points, fuse-

lage frames, bulkheads, fuselage production joints, or doorframes, with specific locations identified in the ARM (ICAO 2009a). Three types of cranes can be used in an aircraft lifting operation:

1. Mobile cranes—Mobile cranes require a prepared surface/pad from which to operate. Depending on the size and lifting capacity of the crane, the requirements for the surface/pad and access road can be substantial.
2. All-terrain cranes—All-terrain cranes with high flotation tires provide good site access with less of a requirement for prepared surfaces, although lifting capacity is limited.
3. Crawler cranes—Crawler cranes are available with substantial lifting capacities but require a prepared pad to operate from. The major problem with crawler cranes is the time required for transport and set-up (ICAO 2009a, p. 6-9).

ICAO provides the following precautions when lifting with cranes:

1. Ensure that all safety instructions are complied with.
2. Monitor and ensure that wind speeds are not exceeded.
3. Ensure that the aircraft is tethered if required.
4. Ensure that all weights and loads have been calculated.
5. Ensure that landing gear down-lock pins are installed in any serviceable landing gear.
6. Determine the necessary lifting capacity and the number of sling straps required.
7. Ensure that the prepared roadway and crane pad can support the anticipated loads.
8. Ensure that cranes are placed as close to the aircraft as possible.
9. Confirm the placement of lifting straps and provide protection from sharp objects with rubber mats.
10. Protect the lower fuselage from minor protrusions using rubber mats; however, it may be necessary to remove antennas and drain masts.
11. Discuss with the crane operators and other personnel what will occur as the aircraft is raised and what is expected of each operator.
12. Ensure adequate communication among the crane operators, the recovery manager, and the lift coordinator.
13. Ensure that unnecessary personnel are not in the safety zone.
14. Attach plumb bobs to various fuselage and wing locations to assist in monitoring the relative altitude of the aircraft as it is lifted.
15. If tethers are being used, ensure that personnel are available to monitor and adjust the tension loads as the aircraft is lifted.
16. Provide tail tip protection.
17. Follow the aircraft manufacturer's recommendations as to whether the parking brakes are to be set and wheel chocks installed, and whether it is necessary to deflate the landing gear shock struts (ICAO 2009a, pp. 6-10, 6-11).

Moving the Aircraft

The final phase in the aircraft recovery process involves moving the aircraft back onto a hard surface. This can only be done once the aircraft has been appropriately stabilized, leveled, and/or lifted. If possible, it is best to move the aircraft on its own landing gear to minimize the possibility of secondary damage. Although an aircraft may become disabled on the paved surface, such as possibly from a gear collapse upon rollout, these incidents often result in an excursion from the paved surface. In these instances, a temporary roadway may need to be constructed (Figure 6).

In simple terms, it is important for a roadway constructed for the removal of a disabled aircraft to be capable of supporting the weight of the aircraft and any recovery vehicles and equipment used to extract it. Such a roadway will need to be of sufficient width to accommodate the aircraft and vehicles. If the load-bearing ability of the soil is sufficient and any ruts are not too deep, it may be possible to fill the ruts with gravel and move the aircraft backward along these same tracks. Another option is to use composite mesh that is unrolled to create a temporary roadway surface. With this portable matting, large transport category aircraft can be supported as they are removed. If the load-bearing ability of the soil is poor, however, it may be necessary to remove soil, replace it with coarse gravel, and build a roadway using plywood sheets or steel plates. In extremely soft soils, railroad ties can be placed over the gravel, with plywood sheets or steel plates overlapped on top (Figure 7). Whatever materials are used, if the aircraft has come to rest too far away from a paved surface and sufficient materials are not available to build a roadway spanning the entire distance, a satisfactory option is to move the roadway in sections ahead of the aircraft as it is being moved back to a paved surface (ICAO 2009a).

FIGURE 6 Temporary roadway in place. *Source:* Anonymous. Used with permission.

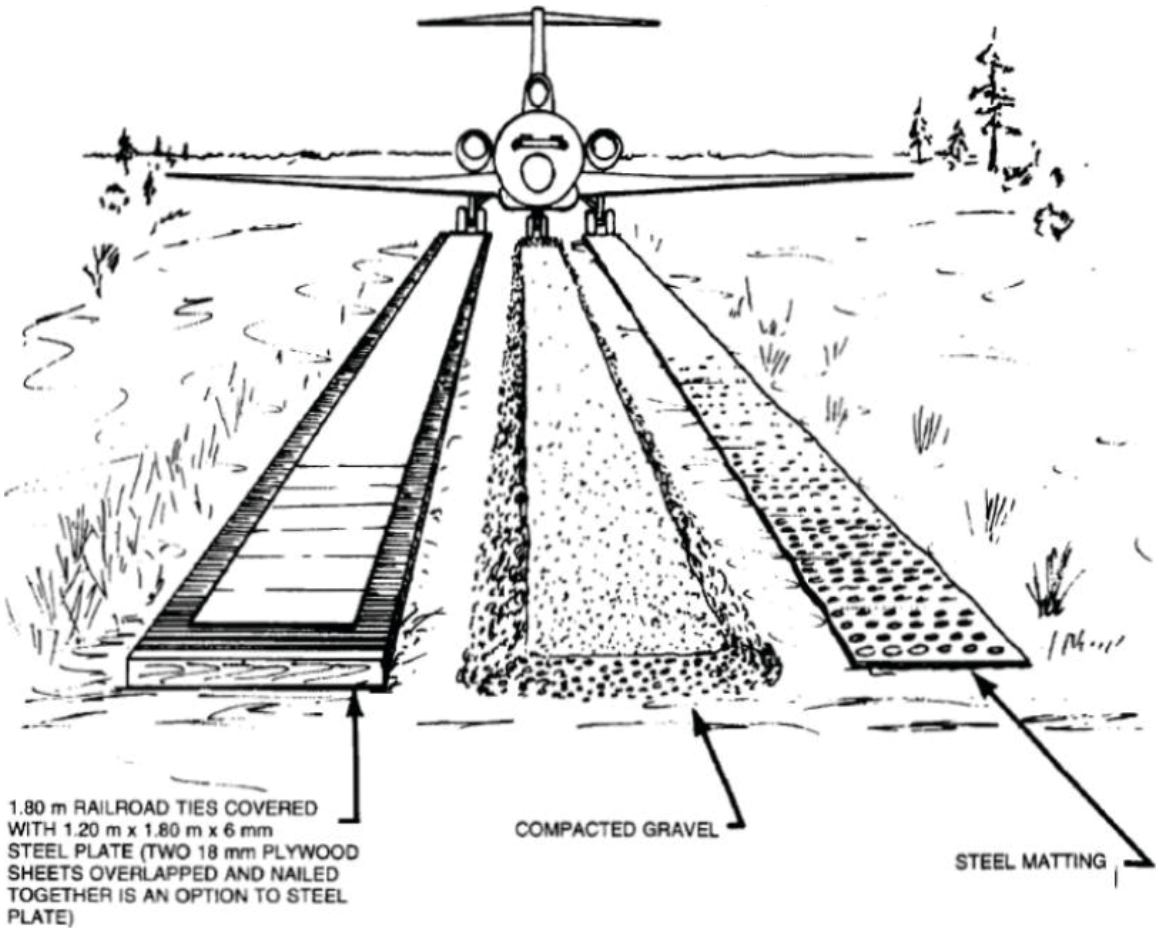

FIGURE 7 Typical prepared surfaces. *Source:* Rafic Hariri International Airport (2008), p. 44.

Although it is in the best interest of recovery personnel to either repair or replace damaged landing gear before moving the aircraft, when this is not possible and the landing gear cannot be made serviceable, several methods can be used to move the aircraft. First, flatbed trailers can be used in situations in which only the nose gear is missing (with the trailer installed under the forward fuselage) or in which one or more main landing gear are missing. It is important to determine the weight bearing ability of the trailer and ensure necessary shoring with adequate padding to prevent secondary damage (ICAO 2009a). Other methods of removal include general-purpose multi-wheel trailers, specialized aircraft recovery transport systems, and moveable cranes. Multi-wheel trailers are typically self-propelled and fully steerable with large load-carrying capacity. Specialized aircraft recovery transport systems typically consist of a series of multi-wheel trailers with hydraulically adjustable supports to conform to the contours of the aircraft. Moveable cranes, especially large crawler-type cranes, can be used to move an aircraft, but close coordination and communication are important to avoid problems (Figure 8). Generally, one crane is used to lift the forward fuselage, while two cranes can simultaneously support the wings. Moving an aircraft with cranes is generally considered as a last resort (ICAO 2009a).

Another consideration in moving a disabled aircraft involves winching or towing. Although winching is more controllable and exerts a greater stable force than towing, towing also provides benefits, such as greater maneuverability, flexibility, and the ability to tow uninterrupted over longer distances. If an aircraft is located off the paved surface, towing and winching are performed with nylon straps or carbon fiber loops wrapped around the main landing gear or attached to main landing gear tow lugs. Towing from the nose gear is not recommended for recovery operations unless absolutely necessary. Any landing gear used for a towing or winching operation must be serviceable with down-lock pins installed. Additionally, load-limiting or load-indicating devices are recommended for all towing operations. If the aircraft has deflated tires, it is important to replace the tires before moving the aircraft. Although this may become extremely difficult with bogged gear, deflated tires will create a dam effect when attempting to move the aircraft (ICAO 2009a).

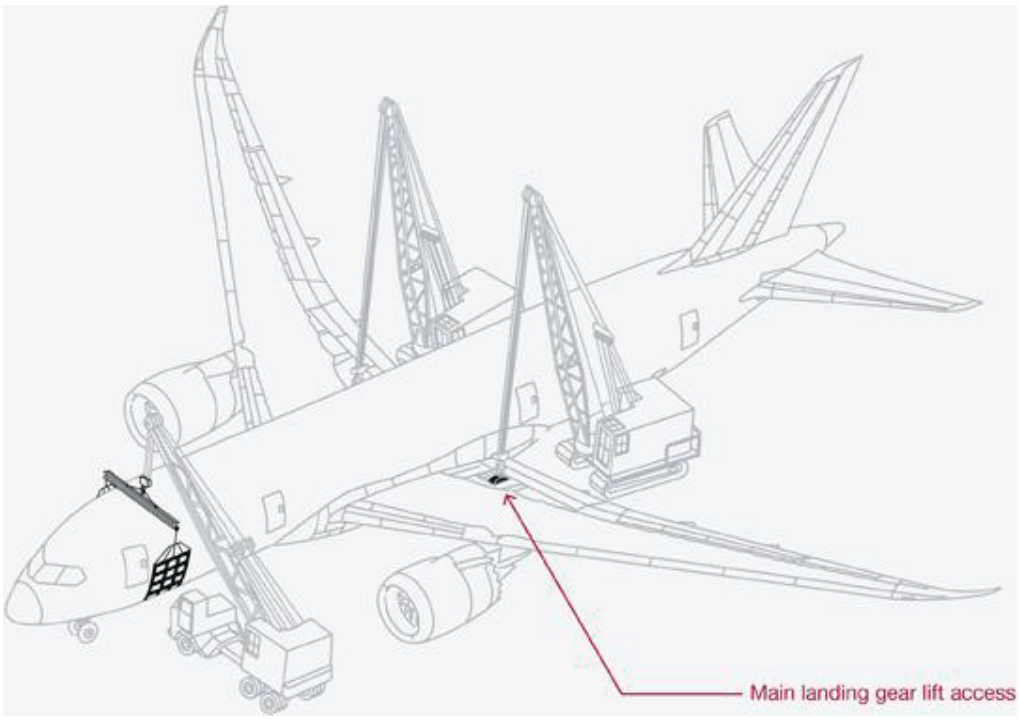

FIGURE 8 Utilizing slings and moveable cranes for lifting B777. *Source:* Paluszek 2009.

Debogging refers to the process of removing an aircraft that has left the hard surface and has bogged down in sand, mud, or snow (Figure 9). In a debogging incident, the following items must be considered:

1. Confirm the weight and center of gravity location.
2. Confirm that the aircraft is in a stable condition.
3. Install landing gear down-lock pins.

FIGURE 9 Bogged gear. *Source:* Anonymous. Used with permission.

4. Carry out a thorough inspection of the landing gear to ensure its serviceability and ability to support the weight of the aircraft.
5. Ensure that the wheels are chocked.
6. If one landing gear is bogged down more than another, move fuel from the low wing to reduce the weight on that gear.
7. Reduce the aircraft weight as much as possible.
8. Confirm the soil stability and prepare a roadway if required.
9. Excavate as much material as possible from around any bogged down landing gear (ICAO 2009a, p. 7-6).

Generally, it is most effective to extract a bogged aircraft in the opposite direction of its entry. The process of extracting a bogged aircraft includes:

1. Follow the manufacturer's instructions when using specialized equipment.
2. Attach shackles and cables to the landing gear tow lugs if specialized aircraft debogging equipment is not available.
3. Use a pulley between the main landing gear and the cables to equalize the loads on each landing gear.
4. Use a load-indicating device to monitor the loads imposed.
5. Place connecting bridging ropes or cables between the towing cables every 15 to 16 ft to reduce uncontrolled cable movement in event of cable failure.

6. Connect pulling cables to a heavy tow tractor or winch truck and, if possible, have the pulling vehicle positioned on a hard surface.
7. Reduce tire pressure to give a higher surface area and therefore a lower footprint load as suggested by some aircraft manufacturers.
8. Steer the aircraft by using a qualified person to steer the nose wheels from the cockpit or use a standard tow bar and tractor for steering purposes only.
9. Have wheel chocks available to stop the aircraft if necessary.
10. Ensure that the aircraft is moved at a constant speed with no jerky movements.
11. Stop the pull, if necessary, in order to reposition the following:
    a. Pulling vehicles and cable system; and
    b. Plywood, steel sheets, or other commercial roadway systems when there is an insufficient amount to form a continuous roadway (ICAO 2009a, pp. 7-6, 7-7).

It is important to secure landing gear in the extended position with landing gear down-lock pins. It may be possible to temporarily repair landing gear or even replace a damaged landing gear assembly on site. This decision will be guided by the time it takes to carry out such a repair or replacement versus an attempt to move the aircraft using trailers, which will increase the chance of secondary damage to the aircraft (ICAO 2009a).

Once the disabled aircraft has been moved or extracted from the site, the aircraft owner's/operator's work is done. However, the aircraft owner/operator will likely want to participate in any debriefing meetings held by the airport operator to discuss the event and share obstacles encountered and lessons learned.

SUMMARY

Whatever form an airport's ARP may take, the exercise of developing it can be beneficial. A proactive stance in this area is crucial to effectively resolving a disabled aircraft event in a timely manner. Without a plan, the negative impacts from such an event will likely be more pronounced, possibly resulting in extended downtime, injuries to personnel, and secondary damage to the aircraft.

CHAPTER SIX

CASE STUDIES

The research conducted for this synthesis report included investigating five separate disabled aircraft recovery events. The cases were chosen based on recommendations of members of the topic panel, in addition to cases that were known to the consultant. Each case was chosen to represent different aircraft types and situations where legal and other issues had been resolved. For each case, the consultant sought to interview several individuals who were involved during the recovery process in order to understand their role throughout the process and determine lessons learned. The consultant attempted to interview the aircraft owner/operator, recovery team personnel, airport management, and manufacturers for each case, in addition to an insurance adjustor for at least one case. Although the accident/incident highlighted in each case occurred within the past 9 years, all individuals and entities involved with each case could not be contacted owing to circumstances such as personnel changing employment, lost contact information, and lost memories. Despite these setbacks, the consultant was able to interview the vast majority of desired personnel involved in each of the cases. Owing to the sensitive nature of developing a case study of an aircraft accident/incident, the identities of those involved will remain anonymous, in addition to the exact location of the accident/incident, and type of aircraft involved. Although each individual who was interviewed was asked specifically about the case in question, many of their responses were made in general terms to any experiences they had with aircraft recovery. Additionally, the events leading up to the accident/incident are not presented, as this synthesis focuses only on the recovery of disabled aircraft (i.e., once the accident/incident has occurred).

CASE ONE—LARGE CARGO AIRCRAFT

The first case involved a large cargo aircraft operating at a large hub airport in the southern United States. With landing gear problems, the pilot locked up the brakes, blowing out all eight tires upon landing. The first individual interviewed was the aircraft owner/operator, whose company was also responsible for recovery of the aircraft and providing recovery personnel. The first order of business was to ensure the safety of the crew and the aircraft. Once it was deemed that a fire was not a threat and the aircraft was cleared by the governing bodies (FAA/NTSB) to be moved, the recovery effort commenced. This particular case was considered a minor incident by the aircraft owner/operator. Had it been more severe (with injuries, fire, etc.) the aircraft might have had to remain in place for initial investigation, possibly for more than one day. In this instance, the company was given permission to remove the aircraft from the runway shortly after the incident happened. The aircraft owner/operator then confirmed what happened and what resources, supplies, and personnel would be needed to recover the aircraft. As this operator pointed out, depending on the severity of the accident/incident, a recovery team may not be necessary. Maintenance personnel are well versed in the recovery process, as are other individuals employed by this aircraft owner/operator. Further, each maintenance facility that the company operates has some recovery tools on hand. This aircraft owner/operator generally does not contract out the recovery process to third parties unless there are no personnel on station at that airport. Generally, the aircraft owner/operator relies in the airport to assist in providing contact information for additional recovery supplies, including equipment that may be needed to tow or tug the aircraft. The aircraft owner/operator believed that this particular airport did a wonderful job in communicating between all involved parties, as well as providing transportation for the recovery team to the recovery site. This individual believes that facilitating communication is the most important aspect of the airport's role, and that most airports succeed in this area. Transportation is an important aspect of the recovery process because disabled aircraft often come to rest in the movement areas of an airport, which require air traffic control (ATC) clearance prior to entering. The aircraft owner/operator was also asked about the training their company conducts for aircraft recovery. Selected individuals, including the individual interviewed, attend accident investigation schools, run by the airline, in order to better understand the recovery process. Engineers and maintenance employees also attend training, and may assist during a recovery process.

The airport operator was also interviewed for this case. First, the airport operator stated that the airport does not require air carrier tenants to submit their company's Disabled Aircraft Recovery plan for airport review and/or approval. One important responsibility of the airport is to transport passengers and/or crew away from the disabled aircraft, usually by means of buses to the terminal or other waiting areas. The airport is also responsible for providing the aircraft owner/operator with the phone numbers of local towing companies and any other equipment providers/operators that may be needed. Airports will likely be asked to provide lighting equipment to assist the aircraft owner/operator or recovery personnel during night

recoveries. This particular airport has buses and air stairs on hand to help remove passengers from aircraft, but does not keep any recovery items (such as railroad ties, steel plates, or cranes) on site. The airport operator explained that it does not recommend any particular third-party recovery companies to the aircraft owner/operator, allowing the aircraft owner/operator to decide on the best course of action. When asked how airport operators can better prepare for aircraft recovery at airports, the airport operator had several recommendations. First, airlines need to better communicate recovery plans to the airport, regarding the transportation of passengers away from the aircraft. In this case, passengers were transported both to the terminal and to the airline's private lounge, which caused confusion in locating all passengers and in communicating to those waiting on the arrival of the flight what had happened to their friends and loved ones. The airport operator believed that this confusion was caused, in part, by not having a copy of the airline's recovery plan (which, according to the airport operator, are often kept at airline headquarters and not held locally). Additionally, the airport operator sees value in educating airport management staff to handle an aircraft recovery operation. This is important because if the "number 1" (i.e., the chief executive officer or airport director) is unavailable or not at work, it is important that the "number 2" or "number 3" be just as capable of handling the process. In closing, the airport operator reiterated that communication is generally the first thing to fail in any emergency, so it is important for the airport to work diligently to avoid communication errors and the resulting confusion. Specifically in this case, the airport operator stated that radios were "going off the hook" in the communication center, as people awaiting passengers were overwhelming the phone circuits, resulting in difficulty in communicating with the airline.

The manufacturer of the aircraft involved in this incident was also interviewed. This individual stated that the airline, or aircraft owner, is entitled to services such as aircraft recovery documents pertaining to each aircraft. The manufacturer also provides logistical recovery services and can provide recovery assistance. A contract may be relied on for on-site recovery assistance. Some airlines are exceptions, though, as they generally are well prepared with equipment and recovery teams to handle these situations on their own. Problems can arise when separate organizations (e.g., environmental, military, law enforcement, and governmental) interfere with one another. Other issues may include logistical issues involving cargo, hazardous materials, or fuel. This individual stated that no one at their company is involved full time in aircraft recovery, and all experts in the field have other responsibilities. The individual also pointed out that there are few recovery experts in the world owing to the lack of difficult situations from which they can gain experience. Regarding third-party assistance; one has to be careful when choosing a third party to assist with recovery operations. It is important for the aircraft owner/operator to verify the third-party's credibility and capability before hiring. This is where networking becomes important to gain the assistance and advice from colleagues who have used a third party in the past. Third parties usually provide support such as crane companies, heavy equipment operators, fueling companies, and raw material suppliers, or play supporting roles with items such as transportation. Many third-party recovery companies do not have the necessary experience to handle difficult situations and do not have the aircraft's current documentation on hand, as this information is given only to the aircraft owner. When asked to explain how the concept of aircraft recovery is integrated into the planning/design of an aircraft, the individual offered the following: Functionality and safety is always the most important aspect of designing an aircraft, but efforts are made to work with project engineers to integrate items that may assist in the recovery of the aircraft if it becomes disabled while in operation. The company also designs specific tools to assist with recovery operations, such as special recovery tooling to lift or tether the aircraft. The company also has procedures in place to limit any further damage to an aircraft while it is being pulled, pushed, lifted, and generally moved (reflected in the ARM).

Lessons learned from case one:

1. It is important for the airport operator to know what the aircraft owner/operator recovery plans are.
2. Everyone on the airport's staff needs to be familiar with the airport operator's plan to handle disabled aircraft.
3. Communication is integral during the recovery process.
4. Transportation is an important consideration, not only of passengers and crew from the disabled aircraft, but also of recovery personnel, aircraft owner/operator representative, insurance adjustor, and investigative personnel, to the disabled aircraft site.

CASE TWO—LARGE PASSENGER AIRCRAFT

The second case involves a transport category passenger aircraft at a large U.S. airport. In this case, the pilot of the aircraft had an indication that the right main gear had not deployed. After a low pass, it was confirmed that the right main gear appeared to be retracted. The aircraft landed and came to a stop on the runway centerline, resulting in the closure of one of two air carrier runways at this airport. The temperatures at the time were below freezing and remained at that level until the recovery operation was complete.

The first person to be interviewed for this case was the airline representative, who also serves as one of two engineers on this airline's dedicated recovery team. Although the aircraft landed at 9:15 a.m., and the Flight Standards District Office (FSDO) representative released the aircraft for recovery at 12:11 p.m., the aircraft was not removed from the runway until 4:49 a.m. the following morning, resulting in about 20 total hours of runway closure. The delay was caused by the need to arrange for a jack lift point adapter for this specific aircraft; although it arrived at 4:45 p.m., it did not include the jack point ball, which

was not secured until 11:30 p.m. Once proper equipment was on site and an independent recovery contractor was secured, the aircraft was removed in about 5 hours.

According to the airline representative, there was initially a great deal of confusion on the scene regarding who controlled the aircraft. Numerous individuals wanted to take control. Because of the many personnel involved, including the airport operator, aircraft owner/operator, ARFF personnel, law enforcement, and FSDO, this confusion caused delays that could have been avoided with a proper understanding of roles.

Additionally, there was a misunderstanding on the part of the airline as to the contents of the IATA kit that was secured for the event. Although larger airlines typically have operator-specific recovery items such as slings and jack point adapters, these are not located at every airport an airline serves. In this case, the airline needed additional equipment, which led to the need to secure the IATA kit. However, once the kit arrived, it became clear that the kit did not contain the jack point ball that was needed to recover the aircraft. An additional 7 hours of delays were experienced as this item was flown in from another airport.

In the interview, it was clear that the airport operator was not pleased with the length of time required to remove this aircraft from the runway. At several points during the lengthy process, growing quite frustrated by the extended runway downtime, the airport operator told the airline that the airport would take control of the situation by removing the aircraft. According to the airline representative, "If you move it, you buy it." The airline was not willing to let the airport operator move the aircraft owing to concerns about secondary damage to the aircraft. At the same time, the airport operator was cognizant of this possibility and the liability associated with moving an aircraft not owned by the airport; thus, it could be said that these "threats" were an effort on the part of the airport operator to motivate the airline to remove the aircraft.

However, the airport operator did assume a crucial support role to the airline. The airport immediately provided contact information for local recovery teams, providers of recovery equipment, and so on, to the airline. Additionally, the airport provided assistance in the form of ARFF response, site security, transport buses for passengers and crew, escorts of recovery team and other authorized personnel to the site, and light towers to illuminate the site. Portable toilets, heated buses, and food and beverages also provided relief to the personnel working in sub-freezing temperatures for extended hours.

Lessons learned from case two:

1. Airport operators could benefit by visiting airports in other countries, such as in Europe, to learn how they conduct aircraft recovery.
2. Airports would benefit by clearly defining roles during a disabled aircraft event, including the airport operator, ARFF, NTSB/FSDO, and aircraft owner/operator. Each of these groups has a leader and it would be beneficial to develop a flowchart that clearly defines when control of the aircraft is being handed over to the next leader.
3. Place an emphasis on smaller aircraft operators, possibly requiring all operators to have a recovery plan on file before being permitted to operate on airport. Consider that both small regional jets and large transport category aircraft can result in a runway closure.
4. Airports don't know what they don't know. Thus, it is crucial to educate personnel on the recovery of disabled aircraft.

CASE THREE—LARGE PASSENGER AIRCRAFT

The third case investigated involved a transport category passenger aircraft at a large Canadian airport. In this case, the aircraft, after landing during heavy rain, veered off the runway into the grass, with the front tires becoming bogged in the grass and mud. The airline representative contacted in this case is actually an aircraft recovery expert. As a result of this individual's expertise in aircraft recovery, a wide variety of issues were discussed during the interview pertaining to the recovery of disabled aircraft.

This aircraft recovery expert, who is a regional manager with the airline, stated that the first order of business for the airline during the recovery process is to contact company maintenance control (which is staffed 24/7), as well as the airline's recovery team lead. This particular airline has 50 individuals who may be dispatched to assist with an aircraft recovery. After the team has been chosen, they evaluate the situation and determine what type of equipment should be brought on site with them. Members of recovery teams, including the expert, all hold other roles with the airline, as no employee focuses solely on aircraft recovery. Recovery teams typically consist of management staff and aircraft mechanics. Members of management are included in recovery teams because they are not part of any union, and therefore do not need permission to work longer hours or tackle additional projects. This airline does not contract out any of its recovery process to third parties, with the exception of acquiring specific, locally available equipment that an airline may not have on hand. The airline does have two full pre-assembled IATA recovery kits on hand at two locations in the United States. The expert stated that the airline designs and builds much of its own recovery equipment and keeps ropes, jacks, and other equipment at all maintenance stations. Regarding assistance from the airport operator, this individual stated that it is important for an airport to know where materials and equipment can be quickly located to assist the airline. Further, since security requirements may not allow airline personnel from other stations or corporate headquarters to access the site, it is crucial for airports to arrange escorts or alternate plans for personnel access. In closing, this individual stated that his airline coordinates a semi-annual recovery exercise at an "aircraft graveyard" to allow airline personnel to practice recoveries

and try new equipment, as well as visit with equipment vendors specializing in aircraft recovery.

The insurance adjustor representing this airline was also interviewed regarding this case. This individual stated that the company's main purpose is to ensure that the aircraft is recovered without any secondary damage. This insurance company sends an adjustor on site to represent the aircraft owner/operator at any time one of its clients is undergoing a recovery. One important aspect of the recovery process is to ensure that knowledgeable and qualified personnel are in place to perform a safe and efficient recovery of the aircraft, resulting in no injuries or additional aircraft damage. In closing, this insurance adjustor mentioned that all adjustors employed by his company are experienced engineers and are more than capable of handling the recovery process themselves if needed.

Lessons learned from case three:

1. It is important, as part of an airport's disabled aircraft recovery plan, to consider how to handle a large number of passengers who need to be transported from the disabled aircraft to a staging/sterile area (e.g., blankets and other accessories to comfort passengers and agreements with transportation companies to supply buses).
2. Having knowledgeable and qualified personnel in place is most favorable.
3. It is important for airport operators to be knowledgeable of local resources that may be called upon during a disabled aircraft recovery event.

CASE FOUR—BUSINESS JET

The fourth case involved a business jet operation at a single-runway airport in the southwestern United States. In this instance, the aircraft departed the runway upon landing and came to rest in a grassy area off the runway edge. Only two individuals could be contacted regarding this incident, the aircraft owner/operator and the airport operator. Unfortunately, the two airport employees who were contacted could not remember this event. They did state, however, that they focus on facilitating communication, and trying not to impede with the recovery process. The airport also knows of three third-party companies that can assist in recovery (by providing pneumatic lift bags and other equipment) and will put the aircraft owner/operator in contact with these third parties upon request.

The aircraft owner/operator interviewed in this case is his company's only pilot and was the sole pilot (and occupant) on board the aircraft at the time. Thus, he was completely responsible for handling the recovery process. The pilot stated that his first order of business was to assess the situation and determine where the aircraft had come to rest. In this incident, the airport was closed, as the aircraft blocked the single runway at the airport. Fortunately, there were no passengers (other than himself) who needed to be evacuated from the aircraft. If passengers were on board, the pilot concentrates on removing passengers from the aircraft and arranging transportation for them to the terminal and away from the runway. In this case, the airport manager was notified of the incident by the pilot through ATC. This event was the pilot's first experience with a disabled aircraft, and he was not prepared for the many issues that needed to be addressed during the recovery process. With the single runway closed by the disabled aircraft, the airport operator was intent on moving the aircraft as expeditiously as possible. The pilot admitted that he was not proactive in this regard; as a result, the airport operator sent out maintenance personnel to move the aircraft, which subsequently caused $80,000 worth of additional damage as a result of a jack denting the wing. The pilot mentioned that the dent could have caused a larger problem if it had ruptured the fuel tanks; however, this was not the case. The pilot also stated that the airport manager initiated this recovery attempt to hurriedly reopen the runway. The pilot stepped in after the failed recovery attempt and called in an independent aircraft recovery company, which was well prepared for the situation. The contractor removed the aircraft from the site without delay and without causing any further damage.

When asked what the airport could have done differently to assist with the recovery, the pilot suggested that airports help pilots, especially of general aviation aircraft, in locating locally available resources (such as tools, equipment, or recovery teams) to assist with the recovery process. If the airport is not prepared in this manner, the pilot is tasked with tracking down these supplies and entities, which may result in longer runway downtime. The pilot believed that one well-equipped recovery company could service several general aviation airports within a specific region. Additionally, the pilot stated that the airport manager might feel obligated to use an airport maintenance tenant over an outside vendor, even though this tenant might not have the skills or equipment needed. In this case, hours were wasted during the first attempt and significant secondary damage was caused. In closing, the pilot mentioned that the great quandary associated with aircraft recovery is loss of revenue vs. aircraft damage. One could bulldoze an aircraft and expeditiously remove it from a movement area, but this would obviously cause great damage to the aircraft, which aircraft owners/operators and insurance adjustors are unwilling to accept. Thus, the objective in aircraft recovery is to balance the timely removal of aircraft without causing secondary damage.

Lessons learned from case four:

1. It is important for the airport operator to assist in identifying qualified recovery personnel if so requested by the aircraft owner/operator.
2. It is important for the airport operator to use good judgment to weigh expeditious recovery of the aircraft versus the liability associated with causing secondary damage to the aircraft.

3. Airports can expect a disabled aircraft event to occur and thus plan appropriately.
4. Single runway airports can be significantly impacted by a disabled aircraft.

CASE FIVE—SMALL GENERAL AVIATION EVENTS

An airport manager at a small, single-runway GA airport was interviewed because of his experience with multiple disabled aircraft events. This airport's one runway is 5,002 ft long, creating an environment that is conducive to runway excursions, especially for larger twin-engine aircraft and turbojets. This individual's first advice is: "It can happen at your airport." On one occasion, for instance, a Learjet, upon rollout and activation of thrust reversers, quickly veered 90 degrees and ran off the edge of the runway. This was caused by an inoperative thrust reverser. Although this airport manager and his personnel were able to ease the aircraft out of soft ground with a large tractor and tow straps, he admitted that they should have contracted with someone with more expertise in aircraft recovery. This airport has also seen collapsed nose gear events and full gear-up landings. He said that they usually improvise and somehow lift the aircraft, get the gear down, and then tow the aircraft to a paved surface. In one instance, however, this airport manager did contact a specialized crew to recover an aircraft. This instance involved a larger corporate jet that was taxiing down the taxiway to the departure runway. The pilot had been studying charts and had lost track of his progress, and inadvertently taxied the aircraft off the end of the taxiway, where it became bogged in the mud. Although this pilot initially tried to power out of the situation using engine thrust, it became clear that the aircraft was not going to move under its own power. The pilot then called the FBO and the airport manager (who owns and operates the FBO at this airport) responded. Although the pilot asked the airport manager for recovery assistance, the airport manager realized that he did not have anything heavy enough on-site to handle this recovery. After some phone calls, the airport manager arranged for a recovery crew to arrive the following morning. After jacking the aircraft and stabilizing a temporary roadway, an 18,000-lb wrecker was able to ease the aircraft out.

When asked for his perspective on how GA airports can best prepare for the recovery of disabled aircraft, this airport manager agreed that an ARP was a good idea, but cautioned that the plan could not anticipate every possible situation. Therefore, he believed the plan's strength would be in identifying locally available resources and general precautions (such as the issuance of NOTAMs when necessary). Additionally, he shared that GA pilots look to the airport and/or FBO for assistance when their aircraft becomes disabled, and, it is the airport's responsibility to offer and/or arrange assistance as needed.

Lessons learned from case five:

1. A disabled aircraft event can occur at any airport.
2. Expertise and experience is important in recovery personnel.
3. An aircraft recovery plan is beneficial for airport operators to develop.

ADDITIONAL INTERVIEWS

Independent Recovery Company

A representative of an independent aircraft recovery company was also interviewed. This individual stated that those involved with the recovery of GA aircraft are often unprepared to handle the recovery and generally have little knowledge of what needs to be done. The first person on the scene of an aircraft accident/incident (usually someone from the airport) is often focused on removing the aircraft from the runway, and as a result causes much more damage to the aircraft. Additionally, according to this representative, in most cases his recovery team receives an aircraft after it has already been removed from the airport, or at least from the runway or other operating area. His company is almost never included in the initial recovery stages because the airport is solely focused on removing the aircraft from the runway, and often uses whatever means necessary to drag the aircraft out of the way. In closing, this representative stated that pilots often may do a masterful job of landing and limiting the damage to the aircraft, only to have airport employees cause severe damage as they attempt to remove it from the runway using inexperienced personnel, inadequate preparation, and improper tools and equipment.

Flight Standards District Office

An FSDO employee at one of the airports involved in the case studies was also interviewed. This individual role is simply to investigate an aircraft accident/incident. Airports can assist in performing an investigation by taking as many photographs as possible of the accident/incident before investigators arrive on site. If it takes some time for investigators to reach the scene, photographs from the airport can assist them in deciding whether to classify the case as an accident or incident. The FSDO investigator also stated that recovery may not begin until the scene is released by NTSB. According to this FAA representative, airports should focus on assisting and/or removing victims from the scene of the accident/incident before undertaking any other responsibilities.

CHAPTER SEVEN

CONCLUSIONS

Although an airport may never experience a disabled aircraft event, the future is impossible to predict. As a result, it is in every airport's best interest to prepare for such an event. Although airports are generally prepared for an aircraft accident [as spelled out in the airport's Airport Emergency Plan (AEP)], the need to recover a disabled aircraft is generally given less thought. Aircraft recovery is the responsibility of the aircraft owner/operator. However, airports have much at stake when an aircraft becomes disabled. Therefore, it is important to plan ahead to prepare for such an event. Without preparation, the airport could experience significant negative impacts from disabled aircraft, including delays to aircraft using the runway and possible liability exposure if the airport is responsible for causing secondary damage to the aircraft.

To summarize lessons learned from literature and case studies conducted during this synthesis research, airports endeavoring to better prepare for the recovery of disabled aircraft may wish to consider the following elements:

- The airport operator knowing the aircraft owner/operator recovery plans.
- That a disabled aircraft event can occur at any airport and expect that a disabled aircraft event will occur and thus planning appropriately. For everyone on the airport's staff, understanding the benefits of developing an aircraft recovery plan and staff familiarity with the airport operator's plan to handle disabled aircraft. Clearly defining roles during a disabled aircraft event, including the airport operator, aircraft rescue firefighting, NTSB/Flight Standards District Office, and aircraft owner/operator. With a leader in each of these groups, developing a flowchart clearly defining when control of the aircraft is being handed over to the next leader may be beneficial.
- The key role of communication during the recovery process.
- Familiarity with the regulatory and nonregulatory guidance on the recovery of disabled aircraft (chapter two)
- For the airport operator, using good judgment to weigh expeditious recovery of the aircraft versus the liability associated with causing secondary damage to the aircraft.
- Familiarity with possible complications that may arise during the aircraft recovery process (chapter four) and developing an Aircraft Recovery Preparedness Airport Checklist (chapter five)
- Transporting passengers and crew from the disabled aircraft, and also of recovery personnel, aircraft owner/operator representatives, insurance adjustor, and investigative personnel, to the disabled aircraft site. Considering, as part of an airport's disabled aircraft recovery plan, how to handle a large number of passengers that need to be transported from the disabled aircraft to a staging/sterile area (i.e., blankets and other accessories to comfort passengers, as well as agreements with transportation companies to supply buses, etc.).
- Paying attention to smaller aircraft operators. One approach might be to require all operators to have a recovery plan on file before being permitted to operate on airport. A small regional jet can result in a runway closure just as easily as a large transport category aircraft.
- Knowing about materials availability on site for aircraft recovery operations and local resources that may be called on during a disabled aircraft recovery event, including having qualified personnel in place or assisting in identifying qualified recovery resources and materials if requested by the aircraft owner/operator. Airport operators may wish to include legal counsel when developing this list to avoid restrictions on showing preference to vendors.
- Benefits for airport operators visiting airports in other countries, such as Europe, to learn how they conduct aircraft recovery.

In the end, airport operators are responsible for developing contingency plans to handle any situation that may arise on their property. Whether this includes security breaches, bomb threats, aircraft accidents, or a disabled aircraft, proactively planning ahead is an airport's best tool to handle any situation that may arise. The goal of this synthesis report has been to shed some light on the topic of disabled aircraft recovery and provide information to enable airports to develop this tool.

At the present, there is not a wealth of information available in the United States to provide guidance to airports in effectively expediting the recovery of disabled aircraft. The following possible areas of further research associated with the topic of aircraft recovery would be beneficial for airports.

- Off-airport and water recovery—Although this report focuses on the recovery of disabled aircraft on airport, it would be helpful for airports to have information to help develop off airport and water aircraft

recovery plans. Recovering aircraft in these two situations presents additional complexities not addressed in this synthesis.

- Synthesizing guidance on aircraft recovery from other countries throughout the world. This report relied heavily on the International Civil Aviation Organization (ICAO) guidance. Further research could include synthesizing guidance on this topic among other countries. Awareness of international practices would provide additional insight for U.S. airports.
- Commonalities among U.S. airports—Although many airports have some guidance and/or plans regarding disabled aircraft recovery within their Airport Emergency Plan, ICAO guidance recommends a separate Aircraft Recovery Plan (ARP). Results from this reports review tends to favor a stand-alone ARP. Further research could determine the degree to which U.S. airports have developed stand-alone ARPs. Also, further research on current training practices among airports in preparation for aircraft recovery would be useful. It would be beneficial if this research provided insight into current drills and exercises, as well as methods of training, simulation, and role playing for personnel responsible for aircraft recovery.

GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS

AC—Advisory Circular
ACAS—Airborne Collision and Avoidance System
Accident—Any occurrence associated with the operation of an aircraft that takes place between the time a person boards the aircraft with the intention of flight and the time such person has disembarked, in which a person suffers death or serious injury as a result of the occurrence or in which the aircraft, including cargo aircraft, receives substantial damage.
AEP—Airport Emergency Plan
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.
ARM—Airplane Recovery Manual
ARFF—Aircraft Rescue Firefighting
ARP—Aircraft Recovery Plan
ARTF—Aircraft Recovery Task Force
BOAC—Board of Airport Commissioners
CBR—California Bearing Ratio
CFR—Code of Federal Regulations
Disabled aircraft—One that cannot or should not be moved using its own motive power, but can be towed using its own serviceable under-carriage or if unserviceable, by means of cranes, trailers, and other specialized equipment.
DOG—disaster operation's group.
FBO—Fixed base operator
FSF—Flight Safety Foundation
GA—General aviation
Heavy recovery—Recovery of a disabled aircraft with one or more landing gears separated from the aircraft or is so heavily damaged that the aircraft cannot be towed on its own landing gears.
IATA—International Air Transport Association
IATP—International Airlines Technical Pool
ICAO—International Civil Aviation Organization
Incident—An occurrence other than an accident that affects or could affect the safety of operations.
Major or medium recovery—Recovery of a disabled aircraft with minor or serious damage to the aircraft.
Minor or light recovery—Recovery of a disabled aircraft with little or no damage to the aircraft.
NOTAM—Notice to Airmen
NTSB—National Transportation Safety Board
OEM—original equipment manufacturer.
Overrun—An excursion in which an aircraft departs the end of a runway.
Recovery—The long-term activities beyond the initial crisis period and emergency response phase of disaster operations that focus on returning all systems at the airport to a normal status or to reconstitute these systems to a new condition that is less vulnerable.
Runway confusion—Results when a pilot utilizes a runway other than the one assigned.
Runway excursion—An aircraft on the runway surface departs the end or the side of the runway surface.
Runway incursion—Any unauthorized intrusion onto a runway, regardless of whether or not an aircraft presents a potential conflict.
SARPs—Standards and Recommended Practices
Salvage—Occurs when there is major destruction to an aircraft as a result of impact with the ground or water, and/or fire.
Secondary damage—Damage caused to the aircraft during the recovery process.
TP—Transport Canada
Veer-off—An excursion in which an aircraft departs the side of a runway.

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APPENDIX A

Planning Chart

Basic Recovery Steps				
1. Survey	**2. Plan**	**3. Prepare**	**4. Recover**	**5. Report**
Aircraft condition: – Recover or salvage – Attitude – Landing gear – Structure – Damaged components – Missing components – Unserviceable components – Cargo and fuel **Site:** – Terrain – Soil – Access routes **Weather:** – Current – Forecast **Equipment availability:** – Preparation – Leveling – Lifting – Moving – Stabilizing **Manpower availability:** – Number – Skills **Environmental issues:** – Fluid spills – Hazardous materials	**Rapid recovery:** – Important – Not important **Weight and balance:** – Calculate weight of fuel and cargo – Calculate center of gravity **Weight reduction:** – Unload cargo – Defuel – Remove major components **Recovery:** – Reduce weight – Prepare site – Level – Lift – Stabilize – Move **Schedule equipment and manpower required:** – Confirm delivery plan **Secondary damage:** – Prevent or – Accept to reduce recovery time	**Monitor and record:** – Loads – Actions performed **Assemble equipment and manpower:** – Confirm arrival dates **Weight reduction:** – Unload cargo – Defuel – Remove major components **Prepare site:** – Clear – Excavate – Fill – Stabilize **Roadway:** – Clear – Excavate – Fill – Stabilize – Manufactured temporary roadway	**Monitor and record:** – Loads – Actions performed **Stabilize:** – Tether – Ground anchors – Jacks – Shoring **Level/lift:** – Jacks – Airbags – Cranes – New technology equipment **Debogging:** – Confirm a lifting method **Move:** – Tow on gear – Move on suitable trailer	**Report:** Include in aircraft technical history: – Recovery details – Repair details – Record of loads

Source: *ICAO Airport Services Manual, Part 5—Removal of Disabled Aircraft,* Appendix 2.

APPENDIX B

Disabled Aircraft Recovery Operations and Emergency Contact Information

Los Angeles World Airports

Disabled Aircraft Recovery Operations (DARO) & Emergency Contact Information

Thank you for providing the following information. In the event an aircraft becomes disabled at LAX, the information that you have provided will assist the Airfield Operations staff in making prompt notifications and in facilitating the recovery operations. This information is **not** intended to replace the Airport's Emergency Procedures Manual or any aircraft owner/operator's internal procedures that have been established for emergency response. It is, however, intended to provide for the liaison that is needed between the affected Air Carrier, the Airport and other supporting agencies and organizations.

Company Information

Company:	
LAX Station Manager:	Phone:
Corporate Contact Information:	Phone:
Public Affairs Contact Information:	Phone:
Type of aircraft operated at LAX:	

Aircraft Recovery Operations

Description and location of available Aircraft Recovery Equipment:	
Contact information of company that will be contracted in the event aircraft recovery is needed:	
Name:	
Address:	
Phone:	

Aircraft Removal Authorization

In the event of an accident or incident involving your aircraft, please indicate below persons whom your company has empowered with the authority to facilitate removal after its release from the National Transportation and Safety Board, the FBI or any other investigative organization involved.

Name	Position	Business Phone	24 hour Phone
1.			
2.			
3.			
4.			
5.			

Company Representative Signature	Title	Date

5/8/2007

Source: Los Angeles World Airports.

APPENDIX C

Sample Airport Recovery Plan

Airport Recovery Plan

Note :
No procedures or actions described in the Airport Recovery Plan will interfere with or take precedence over the Emergency Plan.

Inquires concerning the Airport Plan should be directed to:

TABLE OF CONTENTS

Introduction

INTRODUCTION

SCOPE OF MANUAL

The possibility of disabled aircraft disrupting normal aircraft traffic at the airport concerns all airlines. To alleviate these concerns, the Authority has developed this manual, which identifies the type of recovery equipment available, its location, and basic communication procedures for requesting usage. This manual also outlines the responsibilities of user airlines, procedures of Federal Agencies and the Authority, during recovery operations.

Phases of Aircraft Accidents

The results of an aircraft accident occurring on the airfield during landing, take-off, or taxi operations can usually be divided into Emergency and Recovery Phases.

Emergency Phases begins at the first notification of a possible emergency and continues where an accident has occurred through the rescue operation, including the removal of passengers and crew and extinguishment of any fire. (Refer to Airport Emergency Plan for details.)

Recovery Phase begins when the Rescue Crew Chief has determined that all persons have been removed and the aircraft is safe for investigation, and when the NTSB (National Transportation Safety Board) assumes custody of the aircraft. The procedures and developments between this point and the removal of the aircraft from the airfield are the subject of this **RECOVERY PLAN.**

LIST OF ILLUSTRATIONS

FIGURE **PAGE**

Required Aircraft Emergency and Recovery Plan Information for Airlines Utilizing Airport.

Company Name: ARINC / SITA Address:

Local Address: Headquarters Address:

In the event of an aircraft incident or accident at Airport involving your airline:

1. a) Who would be the primary contact?

NAME **TITLE** **PHONE #**

Is this a 24 hour contact? Yes _____ No _____

b) Who would be the alternate contact when the primary contact is unavailable?

NAME **TITLE** **PHONE #**

Is this a 24 hour contact? Yes _____ No _____

2. When the above person(s) is notified, are any other notifications required by the Authority? If yes, please specify:

NAME **TITLE** **PHONE #**

3. Who handles press inquires / releases in the event of an emergency?

NAME **TITLE** **PHONE #**

4. Do you as an airline have an aircraft emergency or contingency plan in case of an incident at ?

No_____ Yes _____ If yes, please provides a copy of the plan.

5. Do you have any agreements for mutual aid with any other airline for parts, equipment, personnel, etc.?

No_____ If yes, please specify:

6. Does your airline provide parts or have an agreement to assist a commuter airline during an emergency?

No _____ Yes _____ Which commuter (s)? _____

7. Do you have any provisions to rent space on or off the airport in one of the local hotels where friends or relatives of victims can be directed for information, counseling and consoling ?

No _____ Yes _____ If yes, please specify:

8. In the event of a major aircraft accident, can you supply a passenger list and or manifests ?

No_____ Yes _____ If yes, please specify:

9. Recovery operations often require the support services of an outside contractor (labor, equipment, materials, etc.). Please identify the contractor you have selected for this purpose.

Contractor : _____

Address: _____

Phone # : _____

10. Please list any equipment which your company may have available for aircraft recovery operations (example: air bags, fork lifts, jacks, ballast, steel plates, steel cables, cherry picker, compressor, engine change equipment, floodlights and generator, lumber, plywood, rope, slings, stairs, strut retainer, tow bars, tractors, etc.). List only that equipment owned and operated by your company. Do not list equipment available through lease or subcontractor.

Type of Equipment	Location

11. Please indicate which service companies, if any, you use for fueling, catering, aircraft cleaning, towing, etc.

If there is any information or assistance you feel you could provide or require during an emergency, Please indicate below or on a separate sheet of paper if necessary.

Return To: Manager

Airport

CHAPTER 1

Responsibility For Aircraft Recovery

RESPONSIBILITY FOR AIRCRAFT RECOVERY

GENERAL

Authority Airport Rules and Regulations define responsibility regarding disabled aircraft and aircraft recovery as follows:

CHAPTER XI ITEM # 5 "The operator of any aircraft involved in any accident causing personal injury or property damage at an air terminal shall report promptly of said accident to the Manager."

CHAPTER XI ITEM # 6 "The pilot or operator thereof shall be responsible for the prompt disposal of an aircraft wrecked or disabled at an air terminal and parts of such aircraft as directed by the Manager. In the event of his failure to comply with such directions, such wrecked or disabled aircraft and parts may be removed by the Authority at the operator's expense and without liability for damage which may result in the course of such removal."

Your attention is also directed to the NTSB (National Transportation Safety Board) Investigation Regulation Part 430, Rules Pertaining to Aircraft Accidents, and also FAA Advisory Circular (AC) 150/5200-12A, same subject.

Airport Rules and Regulations also stipulate that any operator generating hazardous wastes (including fuel spills) shall comply with all applicable governmental laws and requirements.

PRE-PLANNING ESSENTIAL

Pre-planning, quick response and awareness of available facilities can greatly reduce the overall time necessary to remove a disabled aircraft. Each airline should develop a recovery plan, which would complement this plan and outline the transitional procedures. Consideration should be given to all types of possibilities from minor incidents to major accidents. Procedures for recovery of an aircraft with blown tires as well as aircraft seriously damaged should be covered. Where airlines do not have equipment to handle serious recovery situations, this manual should be consulted for possible means of locating such equipment, and necessary procedures should be developed to implement a recovery. Pre-planning, using this manual as a guide to available equipment and basic procedures, will prove invaluable to airlines requiring the recovery of their aircraft. Time spent in pre-planning will save time required during actual recovery.

AIRLINE REPONSIBILITY FOR REMOVING DISABLED AIRCRAFT

The airline or aircraft owner is responsible for choosing the procedures to remove disabled aircraft from air operating areas and for the cost of the recovery. In addition, the airline or aircraft owner is to expedite the recovery of the aircraft. **(The location of the disabled aircraft on or close to a runway out of service does not justify delay or minimize removal operations.)** If the aircraft is not being removed expeditiously, the airport manager may order its removal at the expense of the airline or aircraft owner.

NTSB RESPONSIBILITY

The NTSB, a Federal Agency, takes custody of the aircraft and its contents from the time the accident occurs to the completion of the investigation or written release. In most cases, the NTSB will issue a **"Permission to Move the Aircraft"** to the airline following the initial investigation of the accident. This permission to move allows the aircraft to be moved only from the location of the accident to a selected area for further investigation. The NTSB retains custody.

Upon completion of its investigation, or as determined by the Board, the NTSB will issue a "Release" of the aircraft to the operator. This "Release" permits the operator to move the aircraft as desired for repairs, etc. **NOTE** – Removal or recovery of the aircraft or parts can not be initiated until clearance has been received from the principal Safety Board representative.

The pilot or operator of an aircraft involved in an on-airport accident is responsible for immediate notification to the NTSB. Where this is not possible due to injuries or fatality, the Authority Airport Duty Manager will make such notification either by telephone to the Communications Center, or through the facilities of Ground Control, FAA Tower.

NTSB Regulation 831.11 Part. B. states, "Under no circumstances shall accident information be released to, or discussed with, unauthorized persons whose knowledge thereof might adversely affect the investigation."

The Airport Duty Manager will meet with the NTSB Investigators and authorized airline/aircraft owner representatives at the scene and recovery plans can be agreed upon at the time.

NOTE: It is important that any secondary damage (damage experienced during recovery) be recorded by the operator for investigation purposes.

NTSB NOTIFICATION REQUIREMENTS
ON ALL AIRCRAFT ACCIDENTS CALL :

NTSB

FAA Operations Center

24-HOUR COVERAGE

This will be the Duty Officer on call at FAA Regional Headquarters. The Duty Officer will be contacted by the Pilot/Operator, Station Manager, Dispatcher or other official and advised of the accident. Where possible, the Pilot should make the notification.

The Duty Officer will determine the NTSB Investigator and FAA Investigator on call and dispatch the respective Federal Officials for immediate action.

One call to this number is all that is required of the Operator for notification purposes.

Have available the following information, whenever possible; however; **DO NOT HOLD UP IMMEDIATE NOTIFICATION IF SOME OF THE ITEMS ARE MISSING:**

a. Type, nationality and registration marks of the aircraft;
b. Name of owner, and operator of the aircraft;
c. Name of the pilot-in-command;
d. Date and time of the accident;
e. Last point of departure and point of intended landing of the aircraft;
f. Position of the aircraft, with reference to some easily defined geographical point;
g. Number of persons aboard, number killed or injured;
h. Nature of the accident, including weather and the extent of damage to the aircraft;
i. Description of any explosives, radioactive material, or other dangerous articles carried;
j. Location and telephone number where pilot or official can be contacted.

NATIONAL TRANSPORTAION SAFETY BOARD (NTSB) – DEFINITIONS AND PROCEDURES

Aircraft Accident - an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which any person suffers death or serious injury as a result of being in or on the aircraft or by direct contact with the aircraft or anything attached thereto, or the aircraft receives substantial damage.

Total Injury – means any injury, which results in death within 7days.

Operator – means any person who causes or authorizes the operation of an aircraft such as the owner, lessee, or bailee of an aircraft.

Serious Injury – means any injury which:

1. requires hospitalization for more that 48 hours commencing within 7 days from the data the injury was received.
2. results in a fracture of any bone (except simple fractures of fingers, toes, or nose)
3. involves lacerations which cause severe hemorrhages, nerve, muscle, or tendon damage;
4. involves injury to any internal organ;
5. involves second or third degree burns, or any burns affecting more than 5 percent of the body surface.

Substantial Damage

1. Substantial damage means damage or structural failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which normally requires major repair or replacement of the affected component.

2. Engine failure, damage limited to an engine, bent fairing or cowling, dented skin, small puncture holes in the skin or fabric, ground damage to rotor or propeller blades, damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wing tips **are not considered "substantial damage."**

PRESERVATION OF WRECKAGE, MAIL, CARGO AND RECORDS

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

b) Prior to the time the Board or its authorized representative takes custody of the aircraft 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
   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 locate including original position and condition of the wreckage and any significant impact marks

d) The operator of an aircraft involved in an accident or incident as defined in this Part shall retain all Records and reports, including all internal documents and memoranda dealing with the accident or incident, until authorized by the Board to the contrary.

REPORTING OF AIRCRAFT ACCIDENTS, INCIDENTS, AND OVERDUE AIRCRAFT

Reports and statements to be filed:

1. **Reports.** The operator of an aircraft shall file a report as provided as provided in paragraph (3) of this Section on National Transportation Safety Board Form 6120.1 or 6120.2

   a) Within ten days after an accident for which notification is required or, when after seven days, an overdue aircraft is still missing.
   b) A report on an incident for which notification is required shall be filed only as requested by an authorized representative of the National Transportation Safety Board.

2. **Crew Member Statement.** Each crew member, if physically able at the time the report is submitted, shall attach thereto a statement setting forth the facts, conditions and circumstances relating to the accident or incident as they appeared to him/her to the best of his /her knowledge and belief. If the crew member is incapacitated, he/she shall submit the statement as soon as he/she is physically able.

3. **Where to File to Reports.** The operator of an aircraft shall file with the Field Office of the National Transportation Safety Board nearest the accident or incident any report covered in this section.

   Address : NTSB

Note The FAA recommends in an incident or accident that the airline has the uninjured passengers attended to by a doctor and nurse until it is relatively certain that all have passed the period where delayed shock might affect them. It is also probable that the NTSB investigation team may wish to interview the passengers at the terminal. The operator, whenever possible, should contact the NTSB Investigator before permitting the crew or passengers to depart.

AIRLINE RESPONSIBILITY- RECOVERY PHASE

1. Where an international flight is involved, advise the following Federal Inspection Agencies:
   Agriculture
   US Customs
   Immigration
   Public Health
   Postal Inspector

2. Arrange for transportation to bring uninjured passengers to the terminal.

3. Arrange for portable stairs and removal of mail, baggage and cargo. Authorization to remove these items must be secured from the NTSB investigator in charge.

4. Aircraft operator shall designate a **Chief Recovery Official** who shall have authority to make all decisions, technical and financial, necessary to recovery the aircraft and who shall be based at for the duration of the recovery. He/she shall provide a 24-hour number at which he/she can be reached.
   - He/she shall have all required company resources, including personnel and equipment, made available to him/her.
   - He/she or his/her appointed representative shall be continuously present at the aircraft site during all recovery activities.
   - He/she shall assign one or more mechanics or engineers to be continuously present at the aircraft site during all recovery activities. Such person(s) should have all expertise and authority necessary to advise recovery contractors on any matters relative to the aircraft's structure, systems, and servicing (including defueling).

5. The airline company should have a basic recovery plan ready to meet such an emergency. Each airline should prepare such a plan in advance of commencing service at the airport. A copy of the recovery plan should be sent to the Manager of
   Authority

6. The company Recovery Official will meet with the Authority Recovery Coordinator and NTSB Investigator (and Recovery Contractors, if hired) and employing the airline's basic recovery Plan, coordinate activities and institute the removal of the aircraft.

7. Shift change of personnel and commissary provisions should be considered. (For safety, work tours should not exceed 12 hours per person.)

8. Consultation with aircraft or engine manufactures should be considered.

9. Consultation with other airline representatives experienced in such incidents is available at The Authority Recovery Coordinator will make these arrangements, if requested.

10. Following the initial accident, the press will be notified (see Aircraft Emergency Plan). During the recovery period, the company should have a representative available to answer any questions from the press and to issue press releases as may be appropriat

NOTE :

NTSB Regulation # 831.11 – FLOW AND DISSEMINATION OF ACCIDENT INFORMATION

- Release of information during the field investigation, particularly at the accident scene, shall be limited to factual developments, and shall be made only through the Board member present at the accident scene, the representative of the Board's Office of Public Affairs or the Investigator-in-Charge.

- All information concerning the accident or incident obtained by any personnel participating in the field investigation shall be passed to the Investigator-in-Charge through appropriate channels. Upon approval of the Investigator-in-Charge, parties to the Investigation may relay to their respective organizations, information, which is necessary for purposes of preventive or remedial action. Under no circumstances shall accident information be released to, or discussed with, unauthorized persons whose knowledge thereof might adversely affect the investigation.

11. The prompt removal of the aircraft and all costs associated with the recovery, including contractor changes, airline rental and service company equipment charges, airport property damage, etc., is the responsibility of the airline involved. Airport property damage for which the airline is responsible includes, but is not limited to, damage to pavements, structures, signs, fences, lights and equipment; contamination of soil, sewer lines, and waterways.

12. Participate in recovery critique.

RULES GOVERNING RECOVERY OPERATIONS

Personnel and vehicles of the aircraft operator, its recovery contractor, subcontractors, or other over whom it has control shall comply with the following:

1. In accordance with FAR 107, 108 and 129, individuals must clearly display on their person, identification approved by the Authority ... indicating their name, company and physical description before applying for entry upon any Air Operations Area.

2. Do not enter upon the aircraft movement area without the consent of the Authority and unless escorted by a Authority Operations vehicle. Once in such areas, do not traverse between points within such area unless so escorted.

3. As directed by Authority Recovery Coordinator, upon completion of operations on an Air Operation Area, and at the end of each work period, remove all materials, equipment and any other obstructions away from such areas to tenant leasehold, or to an area designated by the Authority.

4. Do not enter upon or allow any material or equipment to be located upon any part of the Air Operations Area without specific prior approval of Authority Recovery Coordinator.

5. Limit the maximum height of equipment to 25 feet unless otherwise approved by the Authority Recovery Coordinator.

6. As directed by the Authority Recovery Coordinator, establish haul routes, maintain them in a satisfactory condition, and repair damage resulting from recovery operations. Clean haul routes each work period and remove materials which fall or are placed on such routes during recovery.

7. Take all precautions necessary for protection of persons, traffic and property during recovery and related work, including, but limited to, barricades, plates, hazard lights, and cones.

8. Do not burn or bury debris of any type on airport grounds, or wash waste material down sewers or into waterways.

9. Provide, locate and shield night illumination to prevent interference with air traffic control or impairment of safe aeronautical operations. Consult with Authority Recovery Coordinator to determine proper light location and shielding

AUTHORITY FUNCTION- RECOVERY PHASE

The Authority's role during the Recovery Phase is that of a coordinator with the vested interest in returning the airfield to its normal operation condition as soon as possible.

Upon notification of an aircraft crash on the airport, an aircraft off the runway, or other incident involving an aircraft, the following procedures will be initiated by the Authority:

Airport Duty Manager

1. Issues required NOTAMS or AIRADS as may be appropriate.

2. Coordinate all field operations with the FAA Control Tower for continuance of flight operation where possible.

3. Determines any obstructions to establish clearance criteria of Federal Air Regulations, Parts 77 121, and 139, and will direct the marking and lighting of the disabled aircraft, and will close sections of the aeronautical areas as necessary to maintain safe airfield operations.

4. Provides for security of the accident site and coordinates with NTSB to determine whether or not a wreckage site, or runway survey should be initiated. (Authority Survey Crew)

5. Provides vehicles and personnel to escort company, and equipment to the site.

6. Initiates Authority notification procedures.

7. Establishes a Recovery Communication Trailer at the site.

8. Maintains up-to-date information on the "Field Condition Phone" , and ARINC with pertinent information for airlines' dispatch use.

9. Contacts, and briefs Recovery Coordinator.

10. Inspects all areas prior to resumption of normal operations.

11. Re-opens the airport as expeditiously as possible after assuring that adequate rescue (ARFF) equipment is on-line and access to the incident area has been secured.

RECOVERY CRITIQUE

Following each significant recovery operation, the Manager , will schedule a Recovery Critique of all interested parties. The Critique will include a review of NTSB requirements, the Recovery Coordinator's chronological report, and a discussion by the affected airline's recovery specialist of the procedures and equipment he/she utilized during the recovery operation.

Problem areas encountered will be reviewed and appropriate changes to upgrade the Recovery Plan will be considered. All airlines, especially those operating the same type equipment involved, are invited to attend.

Recovery Coordinator

The Recovery Coordinator will coordinate all factions of the recovery effort as follows:

1. Convenes a meeting with the airline recovery official, NTSB Investigator, and where neces Fueling Supervisor, rigging contractor, and other parties as may be necessary to deve and implement and implement the Recovery Plan.

2. Provides for a fire watch when necessary.

3. Supervises Authority personnel and equipment assigned to the recovery operation.

4. Makes decisions on behalf of the Airport General Manager as may be necessary to expedite removal of the disable aircraft.

5. Notes further penetrations into the clearance zone created by cranes during the lifting of the aircraft.

6. Monitors present and forecasted weather conditions.

7. Maintains a chronological summary of the recovery operation, especially noting causes of a delays that would be detrimental in upgrading procedures.

8. Ensures photographs and video are taken of the recovery operation where possible.

9. Supervises the Communication Trailer

10. Keeps Authority staff including Media Relations advised of the progress of the recove operation

11. Where excavations are necessary, he/she will have the Authority Maintenance Facility

12. Resident Engineer's Office survey the area for underground utilities.

Aircraft Recovery Checklist

Principle Air Carrier Involved — Time / Data

1. Name of Carrier : _____ Time Contacted : _____

2. Flight # : Time of Accident : _____

a) # of pax / crew on board : _____ If you know
b) # of survivors pax : _____ crew : _____ If you know
c) # of injured pax : _____ crew : _____ If you know

(All other inquiries referred to Airline Representative)

3. Senior Airline Representative in charge _____ Time on field _____
contact # on field _____ alternate # for contact _____

4. Airline Public Relations Officer in Charge _____
contact # on field _____ contact # off field _____

5. Senior Airline Maintenance Representative in Change _____
contact # on field _____ contact # off field _____

6. Other Airline / Fixed Based Operator Involved ..... (Assisting Principle Carrier) _____
contact # on field _____ contact # off field _____

7. Outside Contractor Engaged _____ Time contacted _____

Contractor's Rep. In Charge _____ Time at scene _____
contact # on field _____ contact # off field _____

8. Outside Consultants Contacted _____ Time contacted _____

9. Aircraft Mfrs. / Engine Mfrs. _____ Time on scene _____

10. **Authority**

Recovery Coordinator _____ Time contacted _____
contact # on field _____ contact # off field _____
Mobile Communications Center #'s _____

Public Affairs Rep. Assigned _____ Time contacted _____
Contact # _____ Time on scene _____
Superior in change of Police Activities _____
Contact # _____

11. NTSB Investigator in Charge _____ Time contacted _____
contact # on field _____ contact # off field _____
Time on scene _____
Additional NTSB Investigators Involved _____

12. FAA Certification Inspector assigned _____ Time on scene _____
contact # on field _____ contact # off field _____

13. Postal Inspector in Charge _____ Time contacted _____
Time on scene _____ Time U.S. Mail removed _____

14. Defueling Rep. In Charge _____ / PA _____ contact # _____
Time defueling operations began _____ Gallons / lbs. _____

15. Baggage Rep. In Charge _____ removal began _____ complete _____

16. Cargo Rep. in Charge _____ removal began _____ complete _____

(include data, if applicable)

- Time rescue operations completed _____
- Time crash site secured by Police _____
- Time secured (if involved) _____
- Time secured (if involved) _____
- Time of release of aircraft by NTSB _____
- Time airlines(s) contractor began _____
- Time aircraft actually removed & clean of R/W _____
- Time aircraft clean of all aero areas (at assigned location) _____

20. RECOVERY OPERATION

- Method of recovery used (e.g., jacking/cranes/airbags, etc.) _____
- Extent of secondary damage to aircraft / if any _____
- Difficulties encountered (if any) _____
_____
_____
- Removal / Haul route _____
- Total recovery operation time _____

Effects on airport

- Airport closure time _____
- Runway closure time _____
- Airport material/equip. used _____
- Airport property damage _____
- Airport manpower utilized _____

CHAPTER 2

The Recovery Plan

THE RECOVERY PLAN

GENERAL

Experience has shown that valuable time is saved in the recovery operation through the development of a Recovery Plan.

As soon as is practical, the Authority Recovery Coordinator will meet with the responsible senior airline official and the NTSB Investigator at the site, and a broad plan of action should be agreed upon. They will cover the following points:

1. Escort routes between the airline area and the site. No airline vehicle is to proceed onto the aeronautical area without a Authority authorized escort.
2. De-fueling will probably be required to lighten the weight of the aircraft. In certain locations off hard surfaces, care will have to be exercised to prevent fuel trucks from bogging down.
3. Where heavy equipment or cranes are necessary, a contractor should be notified immediately to expedite movement to the airport.
4. All airline ancillary support devices required should be dispatched to the scene.
5. All requests by the airline for the use of ' Authority or other airline equipment should be discussed with the Recovery Coordinator.
6. Weather conditions should be evaluated when crane lifting, guying or air bag operations are necessary.
7. Lighting of the site should be discussed, and provisions made to obtain portable fixtures.
8. Each recovery plan should include a contingency plan, should difficulties develop in the initial plan.

RECOVERY PHASE OUTLINE

The recovery Phase usually follows the following pattern after clearance of the aircraft by the Emergency Rescue Crew chief:

1. NTSB surveys the aircraft.
2. Determination is made as to what part or parts of the aircraft are to be removed.
3. "Permission to Move" is given by the NTSB Investigator to the pilot or an authorized company representative.
4. Aircraft Recovery Plan developed.
5. Preliminary recovery operations begin.
6. It is the responsibility of the Aircraft Operator to inspect the cargo manifest for possible hazardous materials requiring special handling.
7. Mail, baggage, and possibly cargo are removed after receiving permission from the NTSB.
8. De-fueling begins (may take hours) after receiving permission from the NTSB.
9. Heavy equipment and personnel are on the scene.
10. Main recovery effort.
11. Aircraft is relocated to a hard surface.
12. Aircraft is escorted to company or contracted maintenance area.
13. Accident site is cleaned up and all excavations are filled in, (environmental survey, regarding as necessary).
14. Lighting and instrumentation facilities replaced or repaired as required.
15. Areas affected by the incident (runways, taxiways, ramps, etc...) resume normal operations.

AIRCRAFT RECOVERY COMMUNICATION TRAILER

During the initial rescue operation of a serious crash, the Authority will establish a Mobile Communications Trailer at the site. The Communication Trailer will serve as a communications center during rescue operations and as the Recovery Coordinator's headquarters and the center of activities during the aircraft recovery phase. The communications Trailer will specialize in aircraft recovery after the medical / rescue assistance phase is secured.

The Mobile Communications Trailer is a customized trailer, forty feet long, eight feet wide and twelve feet, six inches high. This Communications Trailer can be transported and or redeployed to various field locations as required.

The interior is partitioned into two sections, which are utilized as a conference room and a main operations area with six work stations.

Visual and communications equipment contained within the Communication Trailer include:

- One closed-circuit television system with two seventeen-inch color video monitor mounted one each in both sections of the trailer, with video recorder.
- Nine wall-mounted, touch-tone telephones (entire trailer is hardwired by . at site, Activating phones. Cellular phones utilized prior to hook-up).
- One facsimile machine
- Public address system
- Complete radio communications systems.

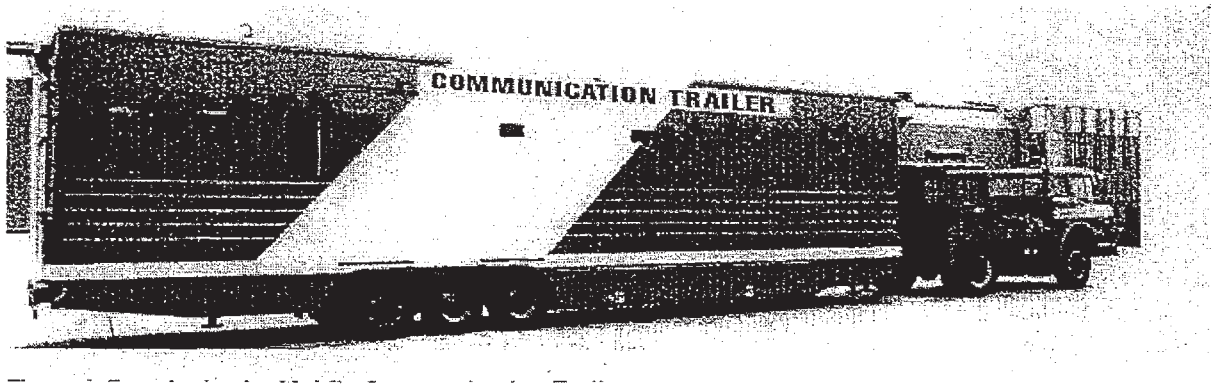


FIGURE I : Authority Mobile Communication Trailer

AIRPORT EMERGENCY TRAILER

The Authority Emergency Trailer is a customized trailer twenty-five long, eight feet wide and approximately eight feet high with two exterior deployable canopies. The extended dimension of each canopy are twenty feet long by ten feet wide with front enclosures to provide shelter from inclement weather. The trailer can be transported to various field locations as necessary. The interior is partitioned into two sections and can be utilized as an office or conference room during the Aircraft Recovery Operation.

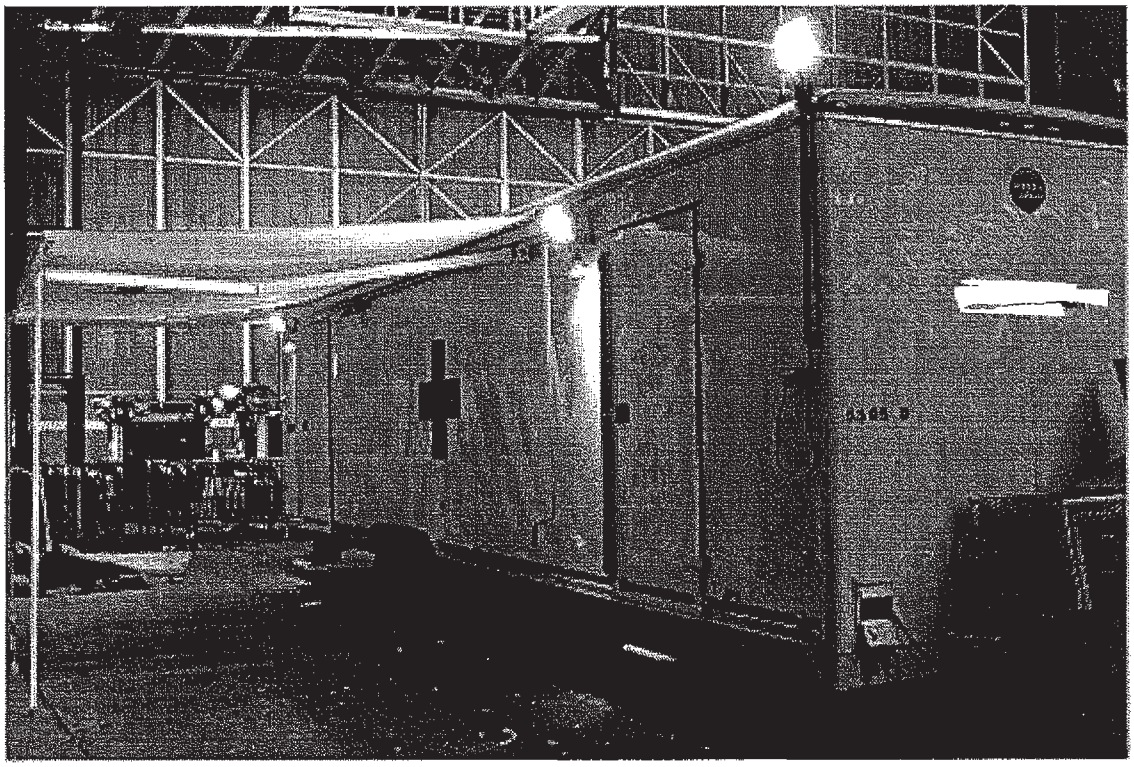
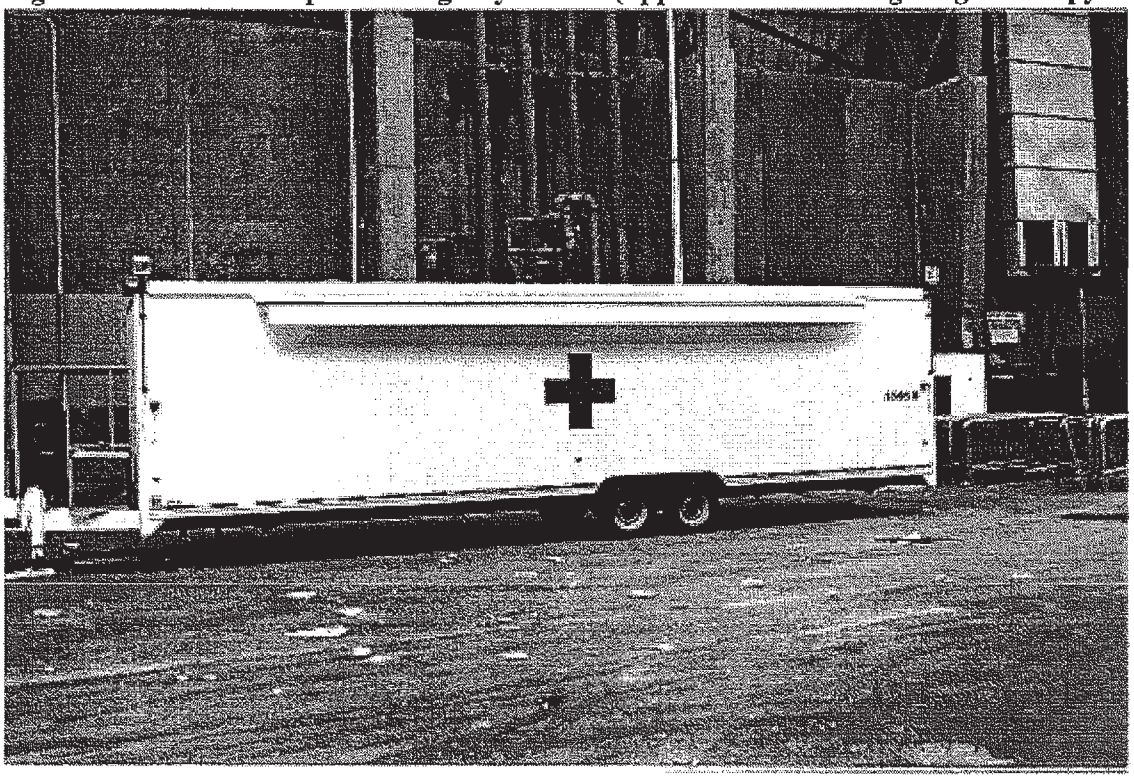


Figure II & III Airport Emergency Trailer (upper side external lighting & canopy deployed)



CHAPTER 3

Recovery Equipment

RECOVERY EQUIPMENT

GENERAL

Because of the high cost of recovery equipment which is often very specialized, several airlines have agreed to form a mutual pooling arrangement whereby airline provide the airport with recovery equipment. This Chapter lists the various equipment available on the airport.

WIDE-BODY RECOVERY EQUIPMENT

Airline has a Wide-Body Recovery Equipment Kit for recovery of wide-bodied aircraft at The contents of this kit are listed in the following pages.

AIRCRAFT PNEUMATIC LIFTING BAGS (See Figure IV)

Lifting bags enable the controlled raising of aircraft to be accomplished without further damage. They are especially useful for aircraft recovery from soft, uneven or marshy ground. Their use permits salvage operations to be conducted in situations where jacking is impractical. The bags are constructed of Neoprene-Nylon material and are transported in deflated condition. Inflation is achieved by remote inflation control through a compressor unit.

The compressor unit for the 25-ton bags is air-cooled and diesel driven.

The console permits inflation control of the bags in varying sequence and rapid deflation. As noted in the following listing, Airlines will make available supervisory personnel for an Air-Bag Operation.

AIRLINES WIDE-BODIES RECOVERY EQUIPMENT KIT

EQUIPMENT DESCRIPTION	QUANTITY HELD
Fiberglass Panel "MOMAT" 8'12", wt. 150 lbs	60
Jack 30' to 118', 80 ton, wt. 2500 lbs.	2
Pneumatic Bag, 25 ton, 9'6" x 6'6" x 7'6" high, wt. 400 lbs. (est)	12
Compressor-Diesel-Required to operate bags-one for up to 6 bags, wt. 900 lbs. (est)	2
Cable w/Tension & Earth Anchor, 100' x 5/8", wt. 130 lbs.	12

NOTE

1. Equipment will be available either through pooling or rental.
2. Equipment is intended for use on large wide-bodied aircraft but is usable on smaller aircraft.
3. Airlines furnished a Supervisor to assure proper use of the equipment.

The following items may be needed. In addition to the following, foregoing a major recovery operation, it may be necessary to procure these items from a contractor or some other available source:

1. On-site communications.
2. Planking – 500 pieces 2" x 8" x 8'
3. Cribbing timber – 500 pieces 6" x 8" x 8'

4. Bulldozers, cranes, winching vehicles, bucker loader for excavating (as required)

5. Miscellaneous material : crushed rock, steel beams (14" x 18" x 30'), padding to protect aircraft.

All Airlines equipment is stored in Cargo Building on dollies ready for use.

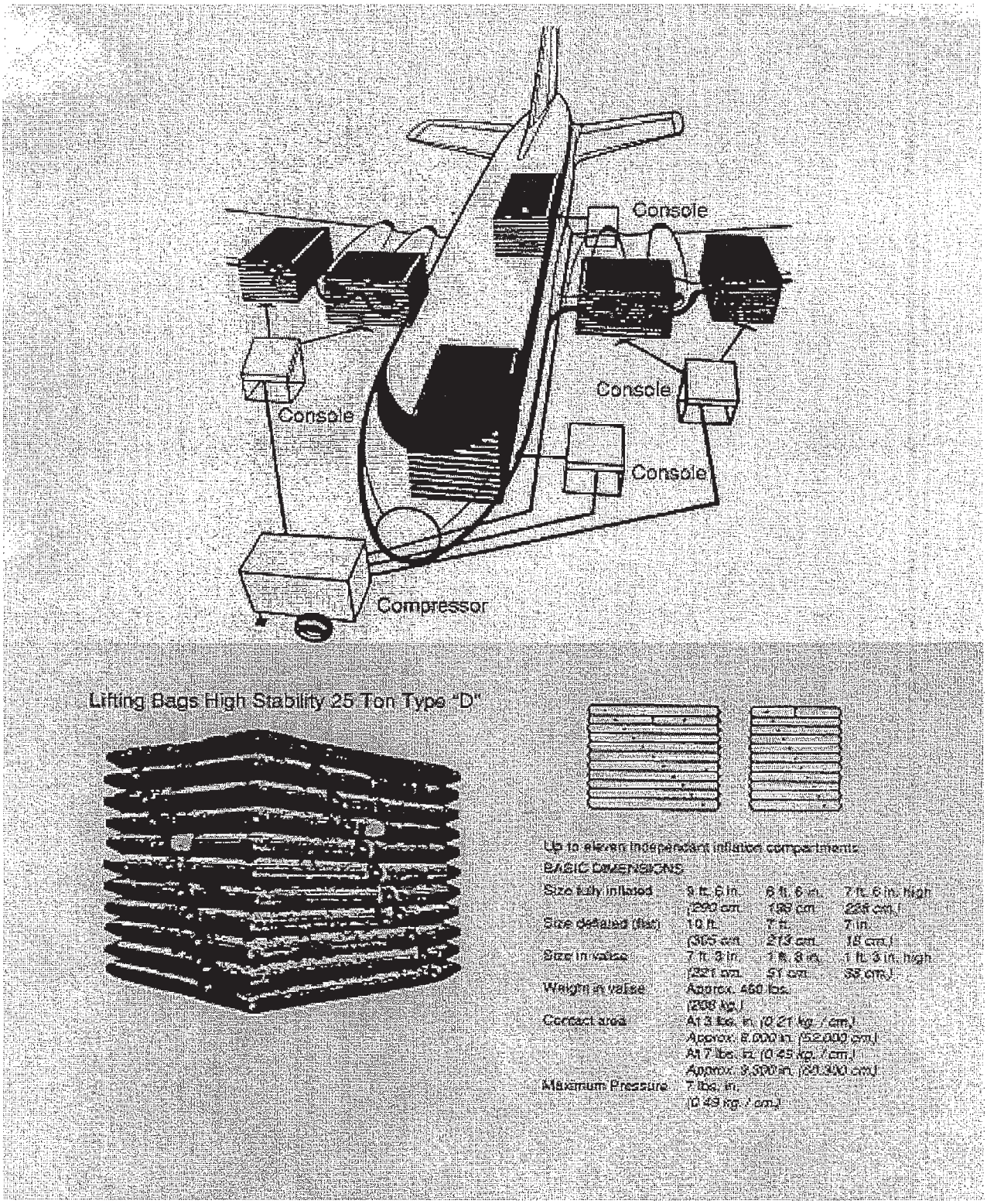
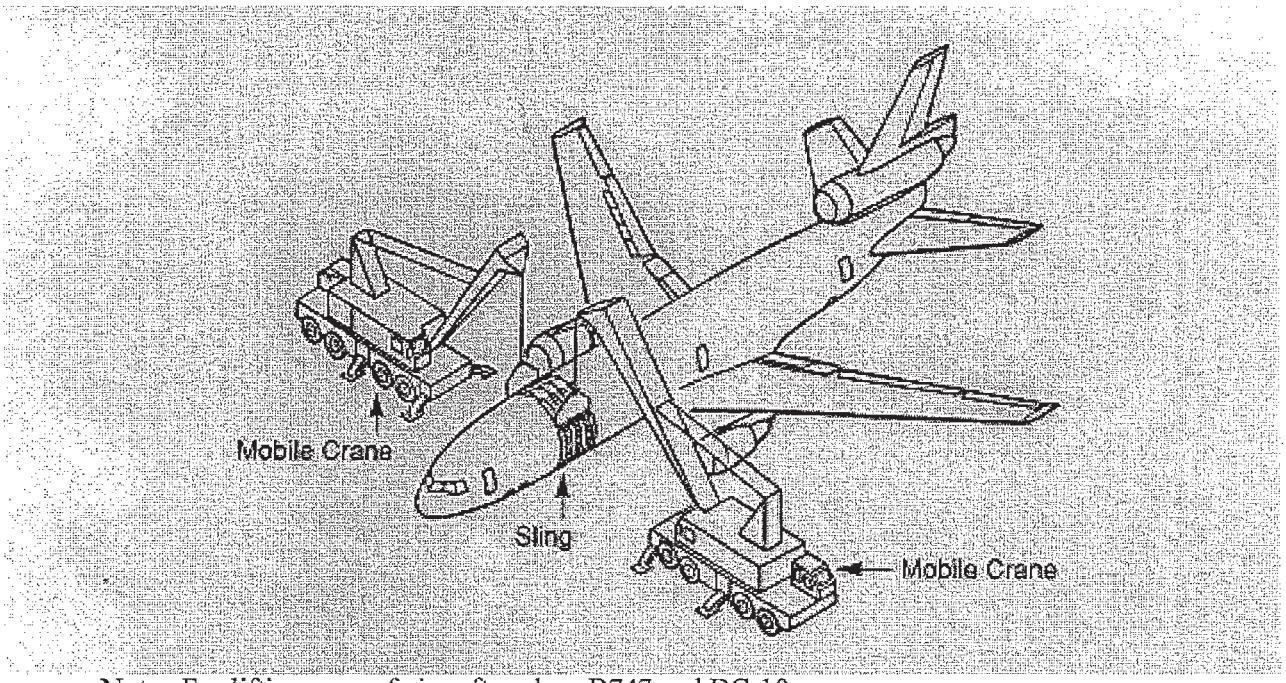
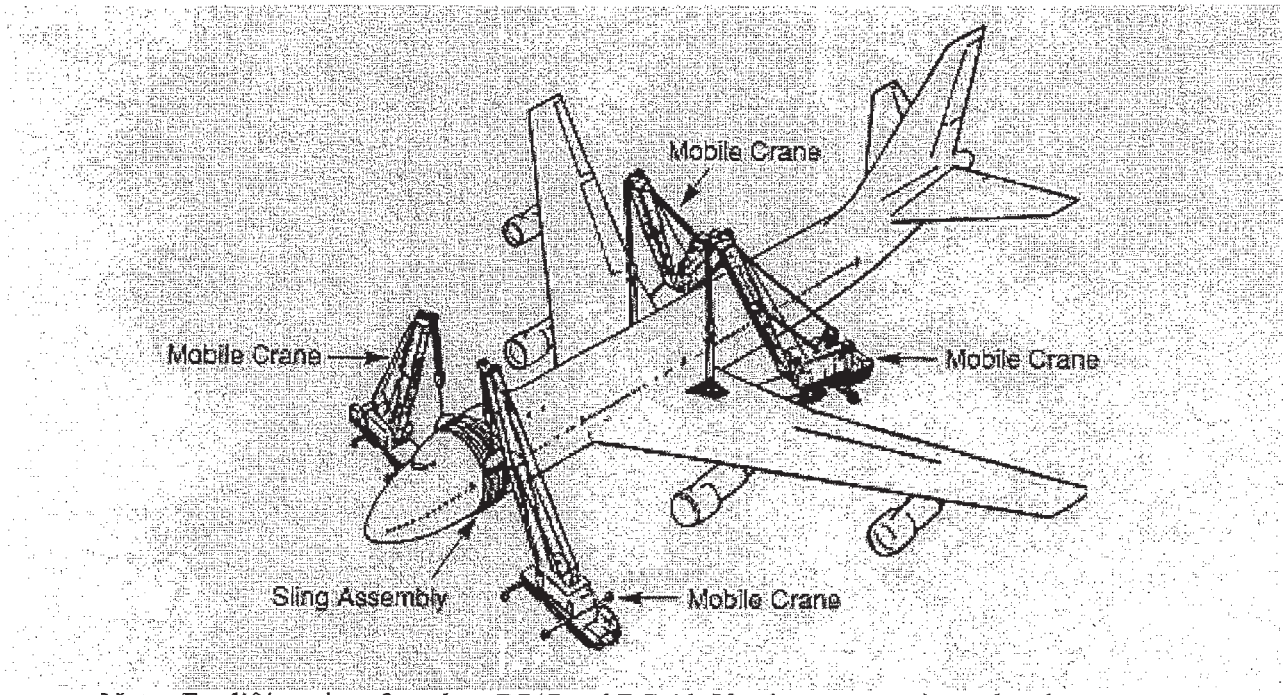


Figure IV : Aircraft Pneumatic Lifting Bags.



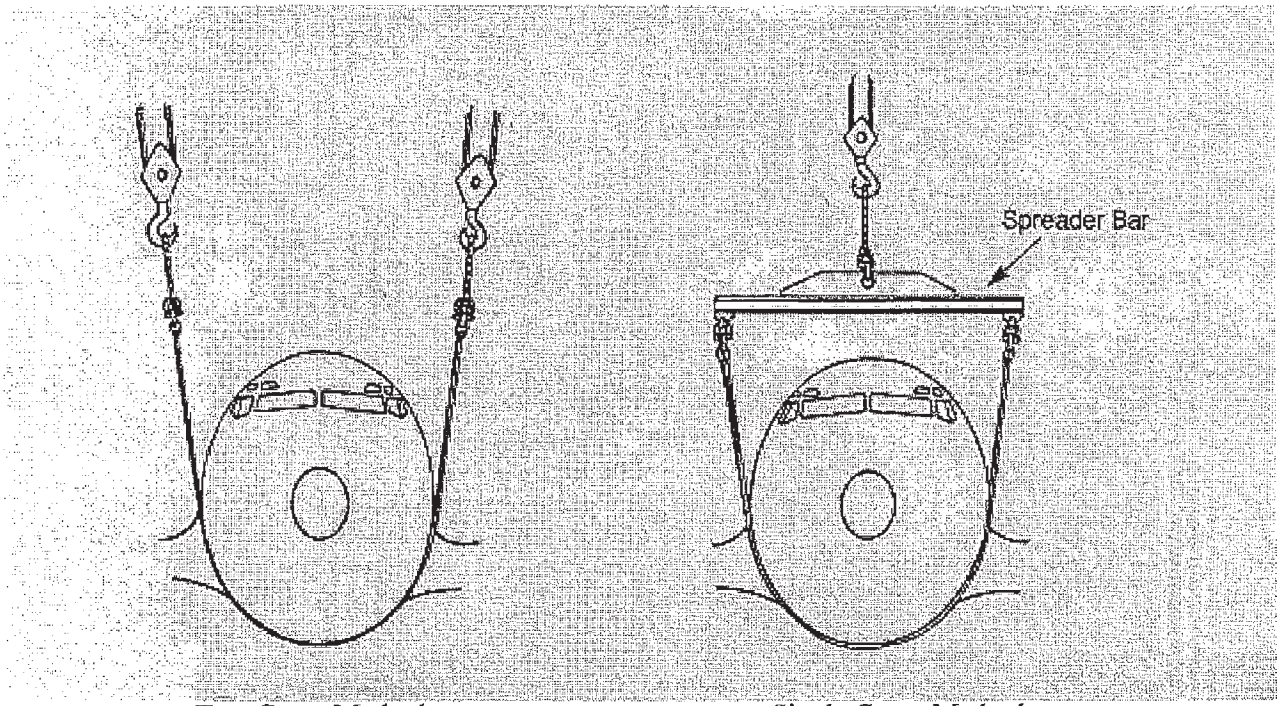
Note : For lifting nose of aircraft such as B747 and DC-10.

Figure V: Recovery Kit Sling With Two Cranes



Note : For lifting aircraft such as B747 and DC-10. If only one crane is used at the nose, some Type of spreader will have to be used with the sling to avoid crushing the fuselage.

Figure VI : Recovery Kit Sling with Four Slings



Two Crane Method Single Crane Method

Note : For lifting nose of aircraft such as B707 and DC-8

Figure VII : Use of Sling with spreader Bar

AIRLINE EQUIPMENT AVAILABLE FOR RECOVERY OPERATION

DESCRIPTION		AIRLINE AVAILABLITY
AUTO WRECKER	*1 each	TW, DL, AA
AIR BAGS	*4Bags 12 Ton Capacity (See Delta Recovery Kit)	AA
BALLAST	*5000 pounds (100-50 lb. Bags)	AA
CABLES, STEEL	*75' – ¾" cable with fittings.	AA
	*Tow with Shear Plates and Shackles, **2 Sets** adaptable to any aircraft, both narrow and wide-body.	TW
	*2" cable with fittings.	UA
	*100'-3/4" cable with hooks and shackles.	DL
	*4 each 50'-3/4" cable.	DL
	*One Set	BA
CHERRY PICKER	*1 Cherry Picker	AA, AM, BA, DL NW, SR, TW, UA, KL
DE-ICERS	*Trump De-icers	EI, SR
AERIAL PLATFORM	*1 each – portable with hoses	AA
COMPRESSOR	*2 each – portable with hoses	TW
COMPRESSORS, AIR	*Potable Gasoline Powered – 2 Each	TW, KL
DRUMS, STEEL	*55 gallon drums	AA, DL
	*Limited Quantity	TW
	*B 727 Engine Charge Equipment	UA, TW
	*747 Engine Change Kit	DL, TW, SW
	*DC-10 Engine Change Kit	AA, SW
	*L-1011	TW
	*747/136/236	BA
	*VC-10	BA
	*Concorde	BA
FLOODLIGHT& GENERATORS	* 1 Trailer-Mounted 115V 400 cycle Gen/Set 125 KVA	DL
	* 3 125 KVA with lights	AA
	* 3 Portable floodlight sets	DL
	* 2 5000 watt 110/220 volt 60cycle	DL
	* 1 60 KVA Capacity	FI
	* 1 90 KVA Capacity	FI
	* 1 Mobile Light Stand, Gasoline Driven	TW
	* 1 160 KVA Capacity	AA
	*Floodlights	KL

AIRLINE EQUIPMENT AVAILABLE FOR RECOVERY OPERATION

DESCRIPTION		AIRLINE AVAILABILITY
FORK LIFT	* 1–30,000 LBS. ; 2-2,000 lbs.,1-50,000 lbs.	DL
	* 1-7 ton Hyster	AA
	* 1-20 ton	AA
	* 1-14 ton Clark	DL
	* 1-Hyster	DL
	* 1-8 ton Forklift	DL
	* 1-10 ton Hyster	NW, BA
	* Various, up to 10 tons	TWA
FUNNELS	* 4 large Funnels	AA
JACKS	* 7-40 TON Rhino Jacks	AA
	*1 each – 25 &30 ton Tail Jack	BA
	* 1-40 ton Rhino Jack	DL
	* 1-30 ton Axle Jack (707)	BA
	* 1-40 ton Main Axle Jack	DL, FI
	* 1-35 ton Axle Jack (VC 10)	BA
	* 2-35 ton Alligator Jacks	AA, VA
	* 1-35 ton Sancor Jack	DL
	* 1-40 ton Alligator Jack	FI
	* 1-45 ton Alligator Jack	FI
	* 2-60 ton Malabar	DL
	* 2-60 ton Aircraft Jacks	VA
	* 1-60 ton	IB
	* 6-60 ton Axle Jacks	DL, SM, AM
	* 5-50 ton Axle Jacks	VA
	* 2-100 ton Wing Jacks	DL
	* 4-40 ton Wing Jacks	BA
	* 2-20 ton Wing Jacks	DL
	* 4-40 ton Tripod Wing Jacks	AA
	B-727 Wing Jacks	DL
	DC-8 Wing Jacks	DL
	*1 Set Wing Jacks B-727	DL
	* 2-40 ton Wing Jacks (54" height)	DL
	* 1-20 ton Jack	AM
	* 1-15 ton Tripod Nose Jack	AA
	* 1-45 ton Jack Axle	UA
	* 1-12 ton Tripod Tail Jack	AA
	* 1-65 ton Jack	AM
	* 3-80 ton Special Recovery Jacks	DL
	* 1-2 ton Tripod Tail Jack	AA
	* 1 Set L-1011 Jacks	DL
	Jacks, Nose & Wheel, Complete Set DC-8, 720,727,737	UA

AIRLINE EQUIPMENT AVAILABLE FOR RECOVERY OPERATION

DESCRIPTION		AIRLINE AVAILABILITY
	Jacks, Axle 35T, 45T, 50T, 60T, 65T	UA
	* 1-50 ton Jack	AM
	* 1-60 ton Mechanical Jack	DL, UA
	* 1 Complete Set DC-8, 720, 727 Jacks	UA
	* 1 Complete Set DC-8 Jacks	DL
	Wing & Axle Jacks – Varying Heights up to 40 tons	DL
	* 1 Tail (For SP)	DL
	* 1 Set – L-1011	TW
JACKS FOR 747	* 2-Wing/Body 100" H x 69" lift – 60 ton	DL
	* 1-Tail 233" H x 69" lift – 60 ton	DL
	* 1-45 ton Axle Cantilever Type	BA, DL
	* 2-Body 747-100 ton	AA
	* 1-Nose 747-30 ton	AA
	* 1-Wing/Body-100 ton	TW
	* 1-Tail-60 ton	TW
	* 1-Nose-30 ton	TW
LUMBER	*4 x 4 – Limited Supply	AA
	*6 x 6 – Limited Supply	AA
	* 8 – 6' x 6' x 9'	DL
	* 8 – 4' x 4' x 6'	DL
	Limited Supply	TW
PLYWOOD	*Matting Go Sheets " MOMAT" Fiberglass 8' x 12'	DL
	*Various – Sizes	AA, UA
ROPE	*500' – 2 ½" Manila	AA, TW
	*300' – 2" Manila	UA
SLINGS	*B-727 Nose Sling – 28,000 lb. Load	UA
	*B-707 Engine Sling	AA
	*DC-8	UA
	* 2-"Belly Bands"- for narrow and wide-body aircraft	TW
	*Universal (50,000 lbs.)	DL
STAIRS, MOBILE	*B-747	AA, NW, DL, TW
	*DC-10	NW, DL
	*L-1011	DL
	*Universal	TW
STEEL PLATES	* 8- 4' x 4' Plates	AA
	* 3- 2' x 3' x 1" Plates	DL
	*B- 727	NW, TW, DL, UA, AL, EI, FI
	*DC-9	TW, DL

AIRLINE EQUIPMENT AVAILABLE FOR RECOVERY OPERATION

DESCRIPTION		AIRLINE AVAILABILITY
	*B-747	TW, UA, NW, SR, SW, TV, BA, EI, AA, KL
	*L-1011	FI, TW, AA, DL
	*DC-10	NW, EI, UA, TV
	*A-300/310	DL
	*B-737	UA
	*CONCORDE	AF, BA
TRACTOR	*500 Hough, T-400	AF, DL, EI, BA, UA, SK, AM
	*TS 300 Hough	AA, UA, DL, SK TV, BA, AM, FL, KL
	*T-245	UA
	*4-Two Tugs	DL
	* 1-CT 80Tug	AL
	Hough Paymover	DL
	Model T225 Tractor	DL, AL
	Paymover	NW
	TS 245 Hough	UA
	47.5 ton	IB
	T-800 Tractor	UA, SR, SK, AM, KL
	*Towing Vehicle – 30,000 lbs. Capacity	TW
	*747 Unit Rig	NW, TW, AA
MISCELLANEOUS	*Sandbag Ballast	DL
	*Hydraulic Porta Power Set	DL
	*Banding Device – Small ½" Hand Type	DL
	*Assorted Main Lifts and Stands	DL
	*Aluminum Ladders- Various and Others	DL
	*Cherry Picker and Lift Platforms adaptable to any aircraft.	TW
	*Radio, Emergency Base Station and Walkie Talkies	TW
	*Hydraulic Platform Truck	TW

AIRCRAFT RECOVERY EQUIPMENT KIT LIST

1	Air Compressor Stored Bare Dimensions : 2438 x 1219 x 1219 mm (96 x 48 x 48 inches) Weight : 633 kgs. (1395 lbs.) Pallet No.: 1
1	Hose for jack, earth anchor, hand winch, wire rope, shackles, spare parts kit for air compressor. Stored in 1 wooden box Dimensions : 3352 x 914 x 914 mm (132 x 36 x 36 inches) Weight : 855 kgs. (1885 lbs.) Pallet No. : 1
NOTE : **PALLET 1**	Dimensions : 3175 x 2235 x 1193 (height) mm (125 x 88 x 47 inches) Weight : 1640 kgs. (3615 lbs.)
6	Pneumatic Bags (Rfd. 25 tons) Stored Bare Dimensions Each : 457 x 711 x 2133 mm (18 x 28 x 84 inches) Weight Each : 150 kgs. (330 lbs.) 3 each on Pallets No. : 2 and 3
6	Air Manifold for Pneumatic Bags Stored Bare Dimensions Each : 177 x 635 x 1905 mm (7 x 25 x 75 inches) Weight Each : 54 kgs. (120 lbs.) 3 each on Pallets No. : 2 and 3
2	Jacks – Malabar Model 8207 (80 ton, 30' to 118' range) Stored Bare – Muti-stage single base (not tripod) Dimensions Each : Each : 914 x 1117 mm Dia. (36 x 44 inches Dia.) Weight Each : 984 kgs. (2170 lbs.) 1 each on Pallets No. : 2 and 3
2	Pump Units For Recovery 2170 Stored Bare Dimensions Each : 838 x 533 x 1066 mm (33 x 21 x 42 inches) Weight Each : 240 kgs. (530 lbs.) 1 each on Pallets No. : 2 and 3
6	Hose Assembly For Compressor and Manifold Stored in 6 boxes (14 hoses per box) Dimensions Each : 381 x 787 x 711 mm (15 x 31 x 28 inches) Weight Each : 50 kgs. (110 lbs.) 3 each on Pallets No. : 2 and 3
6	Pads for Pneumatic Bags Stored Bare Dimensions Each : 25.4 x 2133 x 3048 mm (1 x 84 x 120 inches) Weight Each : 20 kgs. (45 lbs.) 3 each on Pallets No. : 2 and 3

AIRCRAFT RECOVERY EQUIPMENT KIT LIST

6	Pads for Pneumatic Bags Stored Bare Dimensions Each : 50 x 2133 x 3048 mm (2 x 84 x 120 inches) Weight Each : 32 kgs (70 lbs.) 3 each on Pallets No. : 2 and 3
2	Steel Plates for 80 Ton Jacks Stored Bare Dimensions Each : 12 x 1524 x 1524 mm (.5 x 60 x 60 inches) Weight Each : 238 kgs. (525 lbs.) 1 each on Pallets No. : 2 and 3
NOTE: **PALLETS 2**	Dimensions : 3175 x 2235 x 1270 (Height) mm (125 x 88 x 50 inches) Weight : 2533 kgs. (5585 lbs.)
NOTES: **PALLET 3**	Dimensions : 3174 x 2235 x 1397 (Height) mm (125 x 88 x 55 inches) Weight : 2533 kgs. (5585 lbs.)
6	Pneumatic Bags (Rfd.25 Ton) Stored Bare Dimensions Each : 457 x 711 x 2133 mm (18 x 28 x 84 inches) Weight Each : 150 kgs. (330 lbs.)
6	Air Manifolds for Pneumatic Bags Stored Bare Dimensions Each : 177 x 635 x 1905 mm (7 x 25 x 75 inches) Weight : 54 kgs. (120 lbs.)
1	Crash Jack (80 Ton, 30" – 118" Range) Stored Bare Dimensions : 914 x 1117 mm Dia. (36 x 44 inches Dia.) Weight : 240 kgs. (530 lbs.)
1	Pump Unit for Recovery 2170 Stored Bare Dimensions : 838 x 533 x 1066 mm (33 x 21 x 42 inches) Weight : 240 kgs. (530 lbs.)
1	Air Compressor Stored Bare Dimensions : 2438 x 1219 x 1219 mm (96 x 48 x 48 inches) Weight : 633 kgs. (1395 lbs.)
6	Hose Assembly For Compressor and Manifold Stored in 6 boxes (14 hoses per box) Dimension Each : 381 x 787 x 711 mm (15 x 31 x 28 inches) Weight : 20 kgs. (110 lbs.)
6	Pads For Pneumatic Bags Stored Bare

AIRCRAFT RECOVERY EQUIPMENT KIT LIST

	Dimension Each : 25.4 x 2133 x 3048 mm (1 x 84 x 120 inches) Weight Each : 20 kgs. (45 lbs.)
6	Pads For Pneumatic Bags Stored Bare Dimension Each : 50 x 2133 x 3048 mm (2 x 84 x 120 inches) Weight Each : 32 kgs. (70 lbs.)
1	Hose for jack, earth anchor, hand winch, wire rope, shackles, and spare parts kit for air compressor Stored Bare Weight : 855 kgs. (1885 lbs.)
NOTE:	**Complete kit is stored on shelves and not palletized.**

AIRCRAFT RECOVERY INTERNATIONAL INC.
HEAVY CONSTRUCTION EQUIPMENT – AVAILABLE ON CALL
COMPLETE INVENTORY TO RECOVER ANY AIRCRAFT

A. BULLDOZERS 70-340 HORSE POWER
6-way and straight blades.

B. LGB's 70-155 HORSE POWER
6-way and straight blades.

C. WHEEL LOADERS 70-260 HORSE POWER
1.5 yard to 5.0 yard buckets.

D. CRAWLER LOADERS 70-225 HORSE POWER
1.2 yard to 3.5 yard buckets.

E. HYDRAULIC EXCAVATORS 45-285 HORSE POWER
½ yard to 2 ½ yard buckets.

F. HYDRAULIC EXCAVATORS WITH HAMMERS 88-155 HORSE POWER
Assorted hammers available upon request.

G. LOADERS, BACKHOSES, ROLLERS, SCRAPERS AND ARTICULATED TRACTORS
All above available upon request.

H. TRACTORS
Regular Duty Tractors – 0 thru 80,000 # gross capacity.
Heavy Duty Trackors– 0 thru 120,000 # gross capacity.
Super Heavy Duty Tractors 100,000 # thru 950,000 # gross capacity.

I. TRAILERS*
High flat & high flat stretch trailers, air ride capability.
Drop frame & drop frame stretch trailer, air ride available
Double drop & double drop stretch trailers, air ride available.

* Assorted trailer configurations for Special or Super Load, 1 thru 500 ton trailers available in stock.

J. CRANES

1. 15 ton Ford Hydraulic truck-mounted cranes.
2. 20 ton Grove Hydraulic truck-mounted cranes.
3. 30 ton Tadano Hydraulic truck-mounted cranes.
4. 35 ton Tadano Hydraulic truck-mounted cranes.

5. 55 ton Grove Hydraulic truck-mounted cranes.
6. 75 ton Krupp Hydraulic truck-mounted cranes.
7. 120 ton Krupp Hydraulic truck-mounted cranes.
8. 140 ton GroveHydraulic truck-mounted cranes.

9. 250 ton Liebherr Hydraulic truck-mounted cranes.
10. 365 ton Krupp Hydraulic truck-mounted cranes.
11. 450 ton Krupp Hydraulic truck-mounted cranes.
12. 500 ton Liebherr Hydraulic truck-mounted cranes.

All above cranes provided with all required equipment upon request.

AIRCRAFT RECOVERY INTERNATIONAL INC.

K. RIGGING TRUCKS AND TRAILERS EQUIPPED WITH THER FOLLOWING:

1. Air Compressors
2. Alternators
3. Breakers
4. Cable Cutters

5. Chain Saws
6. Chipping Hammers
7. Circular Saw
8. Diggers

9. Drills
10. Drive Heads
11. Gas Purger
12. Grinders

13. Ground Rod Driver
14. Hammer Drills
15. High Pressure Cutter
16. Impact Wrenches

17. Miscellaneous Accessories and Hardware
18. Mounted Compactors
19. Pole Saws
20. Post Driver

21. Post Puller
22. Power Unit
23. Scaler
24. Sinker Drills

25. Submersible Pumps
26. Tampers
27. Welders
28. Miscellaneous Hand Tools

29. 3 fully-equipped Rigging Trucks
30. 3 fully-equipped Tool Trucks
31. 2 Service Trucks
32. 2 fully-equipped Tools and Rigging Trailers

L. SPECIAL EQUIPMENT

1. Lifting Bags
2. Belly straps
3. Assortments of Straps & Slings 10' thru 60'
4. Jacks
5. Pneumatic Lifting Bags

M. CRANES – FOR WATER USE – RECOVERY/SALVAGE

1.	Derrick Barge : 250 ton Capacity (Boom 110'–150')	2 each
2.	Spud Barge : 150 ton Capacity (Boom 100'-125')	2 each
3.	Spud Barge : 100 ton Capacity (Boom 100'-125')	5 each

N. STEEL DECK SCOW – FOR WATER USE – RECOVERY/SALVAGE

1.	80'-250' Long – Capacity from 250 tons – 2000 tons	5 each

O. MARINE TUGS – FOR WATER USE – RECOVERY/SALVAGE

1.	Tugs – 165 H.P. to 1000 H.P. Diesel	8 each

CHAPTER A

Air Carriers Notifications

MASTER LIST OF AIRCRAFT RECOVERY MANUAL

Mr.
Station Manager

Ms.
Manager

Mr
Station Manager

Ms.
Station Manager

Mr.
Station Manager

Mr.
Station Manager

Mr.
Station Manager

Mr.
Station Manager

Mr.
Station Manager

Mr.
Managing Director

Mr.
Station Manager

Mr
General Manager

Mr.
Station Manager

Mr.
Station Manager

Mr.
Station Manager

Mr
Station Manager

CHAPTER B

Aircraft Manufacturers Representatives

CHAPTER C

Aircraft Recovery Equipment-Operators

APPENDIX D

Aircraft Operator/Aircraft Recovery Personnel Interview Framework

NOTE: This framework assumes that airlines (operators) generally coordinate recovery of their own aircraft. However, if any aspect of the recovery was contracted out to a third party, Appendix D will also be utilized in interviewing that third party.

1. Once an aircraft becomes disabled on an airport movement area, what specific steps are taken by your company to initiate aircraft recovery? What steps are taken to affect a complete recovery? How much pre-planning is carried out?
2. Does your airline have personnel whose primary job duty is to facilitate aircraft recovery? If so, what is their role?
3. Do you contract any of the recovery process to third-party aircraft recovery companies? If so, which one(s) and for what actual activities?
4. Did you have a recovery kit preassembled or supplies on hand for potential recovery ops, and what are the items in it? Where is it located, and what was the amount of time it took to get from the kit location to the recovery location? If not, who did you rely upon for recovery kit items or supplies and getting the aircraft recovered quickly?
5. How much and what type of assistance do you expect from the airport prior to and during the recovery process?
6. In what manner can airports be better prepared for the recovery of disabled aircraft?
7. What should be included in an airport's Aircraft Recovery Plan?
8. What are the airport issues that come up that make aircraft recovery more complicated, and how could the airport assist?
9. How often and what type of training do members of recovery teams at your airline receive? Do you conduct regular aircraft recovery exercises for your personnel?
10. Please explain any agreements with air traffic control, or other agencies, that your airline has in order to prevent/lessen further delays during the process of aircraft recovery.
11. Would you be willing to share documents/plans that your airline has regarding the recovery of company disabled aircraft?

APPENDIX E

Airport Operator Interview Framework

1. Does your airport have a stand-alone Aircraft Recovery Plan? If so, would you be willing to share? If not, would you be willing to share the aircraft recovery section of your Airport Emergency Plan?
2. Does your airport require air carrier tenants to submit their company's Disabled Aircraft Recovery Plan? If so, which is responsible for obtaining these plans and making certain they are kept current?
3. Who at your airport is responsible for assisting the aircraft owner/operator in aircraft removal?
4. Please explain the type of assistance you provide the aircraft owner/operator with recovery/removal of disabled aircraft.
5. What type of equipment does your airport have on-hand or have easily accessible to assist in aircraft recovery? [*The thought is that airports may not always have lumber, railroad ties, kitty litter, straps, tow bars, etc., on hand, but have a series of on-call suppliers and wood, vehicle and machine shops that may be made available for fabrication activities. Airports may want to be put on notice that these items might need to be included in airline or aircraft owner tenant agreements*.]
6. Does your airport work with or recommend any third-party aircraft recovery companies to assist the aircraft owner/operator in the removal of disabled aircraft?
7. What, if any, prior agreements does your airport have in preventing further delays at your airport, in the case an aircraft recovery must be accomplished?
8. How can aircraft operators be better prepared for the recovery of their disabled aircraft at your airport?
9. Do you conduct regular aircraft recovery exercises for your personnel? What level of pre-planning takes place at your airport for recovery of disabled aircraft?
10. What command structure and communication lines are in place during the recovery of disabled aircraft at your airport?

APPENDIX F

Aircraft Manufacturer Interview Framework

1. What are the names and types/descriptions of documents that pertain to disabled aircraft recovery? What parts of these documents are proprietary? Where do these documents reside (aircraft owner, airframe manufacturer recovery engineer, etc.)?
2. Would you be willing to share any documents that pertain to the recovery of aircraft that you manufacture?
3. What, if any, assistance do you provide an airline during the recovery process of an aircraft you manufactured?
4. How much does enabling the expeditious recovery of an aircraft go into the planning/design of your aircraft?
5. Does your company perform any testing of the recovery process of the aircraft you manufacture?

APPENDIX G

Insurance Adjustor Interview Framework

1. What is your role in a disabled aircraft incident/accident?
2. What do you expect during the recovery process?
3. What role does an aircraft recovery company play?

APPENDIX H

Flight Standards District Office Personnel Interview Framework

1. What is your role in responding to a disabled aircraft incident/accident?
2. What can the airport do to support you?
3. When can aircraft recovery begin?
4. In your view, should all airports have an Aircraft Recovery Plan in place?

APPENDIX I

Third-Party Companies Specializing in Recovery of Disabled Aircraft Interview Framework

1. How do your company, and you specifically, get involved in aircraft recovery operations? [*The idea behind this question is to open the conversation and to understand how the contractor views their responsibility and how the company fits into a recovery operation. Also the types of resources that they typically think that they are called on to provide and how the communication goes.*]
2. Within what general time frame are you able to arrive at an airport and begin the recovery process?
3. Does your company have contracts/agreements in place with specific airlines, corporate operators, etc.?
4. Please explain the types of equipment you utilize during the recovery process.
5. How do you move equipment to the site?
6. What type of training do you utilize? How often is this training accomplished?
7. How can airports better assist you and aircraft operators prior to and during the recovery process?
8. In what ways do airports hinder the recovery process? Would you please provide some aircraft recovery stories with us (maybe successful, as well as not-so-successful stories)?

Abbreviations used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation