2015

Airport Emergency Post-Event Recovery Practices

James F. Smith

Kim Kenville
kimberly.kenville@und.edu

John M. Sawyer

Airport Emergency Post-Event Recovery Practices (2015)

DETAILS

76 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-27186-8 | DOI 10.17226/22151

CONTRIBUTORS

James F.: Kenville Smith, Kim and John M. Sawyer; Airport Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2015. *Airport Emergency Post-Event Recovery Practices*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22151.

AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP SYNTHESIS 60

Airport Emergency Post-Event Recovery Practices

A Synthesis of Airport Practice

CONSULTANTS
James F. Smith
Smith-Woolwine Associates, Inc.
Floyd, Virginia

Kim Kenville
Kim Kenville Consulting
Grand Forks, North Dakota

and

John M. Sawyer
JMS Airfield Safety Consulting LLC
Goodyear, Arizona

SUBSCRIBER CATEGORIES
Aviation • Safety and Human Factors

Research Sponsored by the Federal Aviation Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2015
www.TRB.org

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.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

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.

ACRP SYNTHESIS 60

Project A11-03, Topic S04-12
ISSN 1935-9187
ISBN 978-0-309-27186-8
Library of Congress Control Number 2015933594

COPYRIGHT INFORMATION

NOTICE

The project that is the subject of this report was a part of the Airport Cooperative Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the Airport Cooperative Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

Published reports of the

AIRPORT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Victor J. Dzau is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

Cover figure: Santa Paula Airport, January 2006 (Ventura County Sheriff's Air Unit photo).

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

Emergency management theory and practice has focused primarily on the top priority of safety, especially for aircraft rescue and firefighting. As a result, while many studies and plans address emergency preparedness, mitigation, and response at airports, on the whole the recovery phase receives at best a cursory treatment. The objective of this synthesis is to gather commonalities and effective practices from representative commercial and general aviation airports regarding post-event recovery.

Information used in this study was acquired through a review of the literature and interviews with airport operators and industry experts.

James F. Smith, Smith-Woolwine Associates, Inc., Floyd, Virginia; Kim Kenville, Kim Kenville Consulting, Grand Forks, North Dakota; and John M. Sawyer, JMS Airfield Safety Consulting LLC, Goodyear, Arizona, 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.

ACKNOWLEDGMENTS

The researchers wish to acknowledge the generous sharing of time and experience by the airport experts who contributed to this study by being interviewed or providing documentation:

Airport	Contributors
Aspen/Pitkin County Airport	Dustin Havel, Brian Grefe
Blue Grass Airport (Lexington)	Amy Caudill, Scott Lanter
Blue Ridge Regional Airport	Jason Davis
Bob Hope Airport (Burbank)	Patti Clark
Boise International Airport	Sarah Demory
Boston Logan International Airport	Bob Donahue, Catherine Obert
Buffalo–Niagara International Airport	William Major, Karen Renna
Centennial Airport	Lorie Hinton
Dallas–Fort Worth International Airport	Craig Mammel, David McCurdy
Denver International Airport	Jessica Birnbaum, Dave Cunningham, Lisa Gahm
George Bush Intercontinental Airport	Mark Bull, Cheryl Hamilton, Rich Albert, Steve Runge
Gulfport–Biloxi International Airport	Casey Lyons, Don Shepley
Jacksonville International Airport	Meaghan Smalley
John F. Kennedy International Airport	Susanne DesRoches
Joplin Regional Airport	Steve Stockam
LaGuardia Airport	Susanne DesRoches
Lambert–St. Louis International Airport	William Korte, Jeff Lea, Glen Pudlowski
Los Angeles International Airport	Katherine Alvarado, Nancy Castles, John Kinney, Gina Marie Lindsey, Jacqueline Yaft
Louis Armstrong New Orleans International Airport	Ron Nodal, Brian Raley
Memphis International Airport	John Greaud
Minneapolis–St. Paul International Airport	Kristi Rollwagen, Paul Sitchko
Newark Liberty International Airport	Susanne DesRoches, Sarah McKeon
North Little Rock Airport	Harry Barrett, Clay Rogers
Oakland International Airport	Craig Simon (background interview; airport not included in study)
Orlando International Airport	Tom Draper
Owatonna Degner Regional Airport	Dave Beaver
Page Municipal Airport	Rick Olson, Jeff Reed, Ray Varner
Phoenix Deer Valley Airport	Ed Faron, Joshua Ross
Rocky Mount Metro Airport	Kenny Maenpa
Saint Paul Downtown Airport	Kristi Rollwagen, Paul Sitchko
San Francisco International Airport	Christopher Birch, Dale C. Carnes, Antonio Eshabarr, Rob Forester, Toshia Shavies Marshall, Ralf Ruckelshausen
Santa Paula Airport	Rowena Mason
Savannah/Hilton Head International Airport	Greg Kelly, Fred McCosby
Sloulin Field International Airport	Steven Kjergaard
Soldotna Airport	Kyle Kornelis
Washington Dulles International Airport	Matthew Crosman, Alex Kashani
Yampa Valley Airport (Hayden)	Dave Ruppel
Yuma International Airport	Gen Grosse, Lona Schugart, Gladys Wiggins

Throughout the study, the topic panel and the ACRP project officer provided sound advice, practical assistance, and encouragement.

CONTENTS

List of Figures and Tables

AIRPORT EMERGENCY POST-EVENT RECOVERY PRACTICES

SUMMARY

The most directly accessible part of this report is the list of effective post-disaster airport recovery practices and lessons learned that was derived from interviews with 37 U.S. airports regarding specific recovery efforts following incidents that completely or partially closed the airport. The list, which ranges from broadly applicable practices to more detailed items, is designed to assist airport managers and planners in the development and implementation of recovery plans. The list appears as Appendix A to this report.

Many airports apply the same strategies they use in preparing for a response to an unforeseen incident or emergency to preparing for the recovery process that follows. Trouble-shooting, problem-solving, continuous improvement techniques, and planning well in advance can save airports stress, time, and money. Focused after-action reviews of past recovery efforts help airports improve preparedness for future ones. Sharing lessons learned within and among airports helps all stakeholders avoid reinventing the wheel and the painful process of learning things the hard way. A successful recovery from an emergency or disaster boosts staff morale, increases the public's trust in the airport, and improves the bottom line.

In addition to the list in Appendix A, four case examples of actual airport recovery operations as they played out in real time illustrate the complex dynamics of the recovery process, the challenges inherent in planning for unforeseen events, and the need for creativity and strong leadership under duress. Together, the list and case examples can help guide airport managers as they shape their own individual planning process for recovery after a serious incident.

Analysis of the data led to the following conclusions:

- The keys to a successful recovery are awareness, flexibility, and planning.
- Airports appear increasingly willing to share their detailed after-action review results and lessons learned with their stakeholders, their communities, peer airports, the media, and the public.
- Greater clarity is necessary in what statements are made about an airport being "closed" and "open," and greater control is required over who and how such statements are made.
- Building good working relationships, internal and external, are essential to airports' effective response and recovery.
- Risk-based and fact-based advance planning support successful recovery.
- The National Incident Management System (NIMS) and Incident Command System (ICS) provide sound guidelines for airport response and recovery.
- Airports recognize the need for more training on NIMS, ICS, and Unified Command.
- A Unified Command is the most effective means of command and control of recovery activities.
- Airports that have and use comprehensive crisis communications plans find them indispensable.
- The perceived level of success or failure of an airport's recovery affects its standing in the community.
- The speed of an airport's return to normal operations is key to the public perception of success.

CHAPTER ONE

INTRODUCTION

OVERVIEW

Over the past few decades, airports have substantially improved their ability to mitigate and respond effectively to emergency situations. However, the final aspect of the overall response scenario, recovery, is often overlooked during planning because of the strong historical emphasis on prevention, mitigation, and response. In particular, there has been a strong regulatory requirement for response planning but not for planning for recovery.

The classic model for emergency management is a four-step cycle of preparedness and prevention, mitigation, response, and recovery (Figure 1).

For decades, emergency management theory and practice has made a top priority of safety, especially for aircraft rescue and firefighting (ARFF). As a result, whereas many studies and plans address preparedness, mitigation, and response at airports, the recovery phase receives at best a cursory treatment. For example, the FAA's June 2009 Advisory Circular 150/5200-31C*, Airport Emergency Plan* (31C) details extensive planning and preparedness activities and requires airports to implement the National Incident Management System (NIMS) and Incident Command System (ICS). However, 31C does not explicitly address the recovery phase of emergency management except to say that a recovery plan may either be incorporated in the airport emergency plan (AEP) or be a stand-alone document. 31C states that the AEP "does not need to reflect all four phases of Comprehensive Emergency Management (CEM). Rather, its focus should be mainly on response and the initial recovery issues. Detailed Mitigation Plans, Administrative Plans, or Recovery Plans can be handled separately" (FAA 2009, pp. 2–3).

As was made clear in the 37 interviews and emphasized in the four case examples, every airport is different. Such differences are created by governance, geography, airport layout, nature of operations, media environment, and politics. Because of these variations, it is important that each airport clarify the responsibilities and roles of all key positions in its NIMS, ICS, emergency operations center (EOC), and command post in each specific response plan and the accompanying recovery plan. Furthermore, plans and training can clarify the relationships between the airport EOC and a command post, making clear who is doing what and who is in control. Lastly, there is a need to clarify how the rest of the airport will be managed while recovery is underway.

This study seeks to initiate a deeper conversation about approaches to planning for the recovery phase of emergency response that could lead to substantial improvement in the overall resiliency of airports. Currently, the connection between preparedness and recovery receives far less attention than that between preparedness and response. Most airports address recovery on a case-by-case, ad-hoc basis. However, recently some airport managers have learned that systematically improving recovery strategies and techniques can help them minimize disruption while caring for their employees, tenants, travelers, and stakeholders, leading to significant savings in time and money following a major event or incident.

This study depends on surveyed airports' accurate reporting and insights into extremely challenging incidents. Four case examples illustrate the complex dynamics of the recovery process. A list of the most effective post-emergency recovery practices that emerged from the airports' hard-won experience is presented in Appendix A.

FIGURE 1 Emergency management cycle.

Preparedness, Mitigation, Response, Recovery, and Their Relation to Resiliency

In the traditional emergency management cycle, "preparedness" (used interchangeably with or in conjunction with "prevention") refers to actions taken in advance to be ready to respond to and recover from a specific type of risk, hazard, or incident. "Mitigation" refers to actions that moderate or lessen the impact of a damaging incident. "Response" encompasses actions taken in the immediate aftermath of an incident to save lives, meet basic human needs, reduce the loss of property, and preserve evidence.

The fourth phase, "recovery," is frequently neglected in the planning stage. In the context of this report, an airport's "full recovery" is achieved when the prescribed safety and security standards have been regained and capacity for aircraft operations is restored to the level that existed prior to the incident. A phased recovery may occur in which aircraft operations resume at a reduced level, or when some facilities or functions are still in the response phase while other parts of the airport are in recovery.

In its 2011 *National Disaster Recovery Framework*, FEMA focused on nine significant themes and recommendations for recovery:

- Individual and family empowerment
- Leadership and local primacy
- Pre-disaster recovery planning
- Partnerships and inclusiveness
- Public information
- Unity of effort
- Timeliness and flexibility
- Resilience and sustainability
- Psychological and emotional recovery.

These nine principles serve as the foundation of the 37 surveyed airports' approach to recovery from an accident, emergency, or disaster.

An airport's ability to recover effectively is the measure of its resiliency. The term "resiliency" is a relative newcomer to emergency management theory and practice. Literally meaning "to rebound," the term traditionally carries two connotations: the ability to resist damage or degradation; or the ability to degrade gracefully and to be restored to some adequate level of function afterwards (Smith and Mastrangelo 2008). More usefully, resiliency can be defined as a combination of those two concepts—the ability to resist damage from a disaster and/or to recover quickly to an acceptable level of function afterwards (Smith 2013).

Smith discusses the interrelations among response, recovery, preparedness, and resiliency in the Caribbean Maritime Exchange blog:

> If a facility or organization seeks to be prepared, it must have clearly defined operational goals, a realistic and comprehensive risk or hazard analysis, an implementable plan to face those risks and hazards, and a staff that is trained and ready to carry out the plan before, during, and after a disaster. The same four components are necessary for making a facility or organization resilient, but some other aspects must be considered:
>
> - Time—how long does the entity have to recover; how much warning will there be for an impending disaster?
> - Will—does the entity have the will to make the investments in structures, equipment, people, procedures, and training to create preparedness?
> - Robustness—is the facility or organization robust enough to take a major hit and either continue operations at an acceptable level or quickly recover?
> - Redundancy—does the facility have adequate duplicate systems or alternative systems to support an acceptable level of function after a disaster?
> - Flexibility/Agility—can the facility or organization do work-arounds when it has been damaged?
> - Money—is the facility or organization willing to invest in training, planning, robustness, redundancy, and flexibility/agility? Does it have the resources to make this investment?

Modern transportation and logistics risk management focuses on strengthening systems so that they are more robust, redundant, and flexible—in a word, resilient—in the face of traumatic events. This overall ability of airports to bounce back permeates all phases of emergency management, including recovery; and is an important consideration in the design and operation of any critical infrastructure (Link et al. 2014).

As has been seen in previous studies (Smith 2010; *ACRP Report 73*—IEM et al. 2012; *ACRP Synthesis 45*—Smith and Kenville 2013; *ACRP Synthesis 50*—Smith 2014; *ACRP Report 95*—IEM et al. 2014a), relationships matter greatly and are worth fostering in advance of any incident. Such relationships may be among airport departments, between the airport and its mutual aid partners, or between the airport and its other stakeholders such as airlines and tenants. For relationships to remain vital and useful, they require focus and purpose; in this study, that purpose is the shared need for effective recovery of the airport after a serious incident.

How Recovery Matters

Recovery and its elements, such as duration, completeness, cost, and effectiveness, affect the level of economic and emotional hardship incurred after an event or incident by the airport, airlines, passengers, shippers, tenants, concessionaires, etc. Recovery efficiency is likely the greatest factor in determining the success of an airport's business continuity plan (BCP). The potential effects of an extreme incident can range from local to worldwide, affecting the social and economic health of the airport's catchment area, the national aviation system, the nation, or the world, as was seen during the 2010 Eyjafjallajökull volcanic eruptions in Iceland.

A poor airport recovery—whether assessed internally by the airport and its tenants or externally by the public, media, and politicians—can damage an airport's professional reputation. Conversely, a successful recovery can substantially enhance both employee morale and commitment and public perception of the overall quality of an airport.

In the aftermath of a disaster, victims and responders often invoke Friedrich Nietzsche's observation "That which does not kill us makes us stronger." Such strength relies upon a dedication to study the incident, determine the characteristics and pattern of the recovery, extract lessons learned, and apply those insights to reform or reinforce plans, programs, procedures, training, and facilities to ensure better recovery efforts in the future.

Types of Incidents That Require Recovery

Any incident forcing the closure of all or a significant part of an airport requires a combination of decisions, procedures, and steps necessary to return the airport to full normal operations and

capacity. This study addresses four major types of incidents that may cause large operational disruptions at airports:

- Aircraft accidents such as crashes, fires, or collisions;
- Natural disasters, for example, hurricanes, floods, windstorms, tornados, earthquakes, ice storms, blizzards, wildfire, volcanic eruptions, dust storms, or sandstorms;
- Criminal acts (also widely called manmade incidents), such as terrorist actions, shootings, bombings, threats, sabotage, hostage-taking, or hijacking; and
- Systems failures such as electrical failure, baggage handling systems failure, air traffic control issues, airfield lighting outages, or fuel farm fires.

The primary focus of this study is on events and incidents occurring at the airports. Two exceptions are worth noting:

- Sometimes an incident entirely off the airport can disrupt airport operations to the point where recovery procedures are necessary. For example, a major regional disaster such as a flood may not damage an airport physically, but could put extraordinary operational stresses on an airport.
- Crashes can happen off the airport property that directly and indirectly affect the airport; such crashes are included in this study because they require recovery actions.

Irregular Operations and Recovery

Irregular Operations (IROPS) responses by airports have been the focus of public and congressional scrutiny beginning with weather-related multi-hour disruptions in 2007 and 2008, as well as the topic of several recent major ACRP studies and guidebooks (*ACRP Report 65*—Mead and Hunt et al. 2012). IROPS, by their very nature, are perturbations of normal passenger service that do not permanently affect the physical or operational capabilities of an airport but still require action. In a typical IROPS scenario, an incident occurs off the airport site, but the airport has to cope with extra duties caring for stranded passengers—its own and/or others diverted to the airport—in addition to sustaining ordinary functions.

Today, most Part 139 airports have IROPS plans, and many reliever and general aviation (GA) airports are in the process of developing them. Such specialized plans guide the airport in coping with the extra duties imposed by an IROPS situation or needed to help airlines minimize negative effects on passengers and fulfill their duties under 14 CFR 234 Airline Service Quality Performance Reports. Some airports refer to their IROPS plans as tarmac delay contingency plans.

If an incident occurs on the airport and the airport sponsor must manage the incident and its consequences, then it is an emergency. If an incident happens off the airport and the airport operator faces collateral but not direct damage, then it is IROPS. With emergencies, recovery is always an integral component of management. With IROPs, the situation is endured until it ends; recovery may or may not be required.

Figure 2 illustrates the relationship among normal operations, IROPS, and recovery. An IROPS situation almost always comes into play at an airport capable of or partially open for normal operations, since the initial incident disrupting flights and the resulting demand to redirect passengers most often occurs at another airport or elsewhere in the National Airspace System (NAS). If an IROPS situation and a full closure of the airport coincide, then it is no longer an IROPS situation; rather, it is a recovery that involves not just taking care of passengers but potentially every aspect of the airport's operations and facility.

For example, on September 26, 2014, a fire at the FAA Chicago Air Route Traffic Control Center caused major disruptions at the two major Chicago airports, O'Hare International Airport and Midway Airport, which required recovery that would fall within the scope of this study (St. Martin 2014). O'Hare and Midway had to manage the incident and its consequences far more intensively than any other NAS airports. For other airports in the NAS that experienced disruptions, the incident fell under the umbrella of IROPS, and did not require major response and recovery actions.

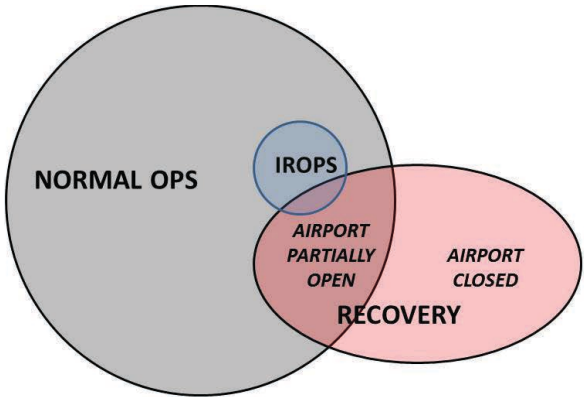

FIGURE 2 Normal operations, IROPS, and recovery.

SCOPE OF THIS STUDY

This study examines specific actions 37 U.S. airports took to recover from incidents, events, emergencies, disasters, and catastrophes that completely or partially closed the airports sufficiently to require recovery. In emergency management terms, either an event or an incident can disrupt normal operations, the distinction being that while an event is planned, an incident is not planned. The focus of this study and the resulting report is on passenger operations, not cargo.

Incidents can be further typed by the degree of disruption. "Emergencies" are potential or actual incidents that routine responses can handle. "Disasters" are actual incidents that take extraordinary efforts for response but can be addressed effectively by the usual responding (local) agencies. "Catastrophes" are disasters with results so extreme that local response is overwhelmed and long-lasting impacts spread far and wide, for example, the 2011 Tōhoku earthquake and tsunami. Hurricane Katrina was widely considered a catastrophe. Hurricane Sandy, on the other hand, is generally seen as a disaster that came very close to being a catastrophe.

STUDY METHODOLOGY

Selection of Airports

The 37 airports were selected based on the researchers' and the topic panel's professional experience with and knowledge of the airports. Choices were finalized in consultation with the panel of experts guiding this project. As shown in Table 1, airports from all size and type categories in the National

TABLE 1
TYPES AND SIZES OF AIRPORTS IN STUDY

NPIAS Category	Airports in Study	Airports in U.S.	Percentage in Study
Large Hub Airports	12	30[1]	40.0%
Medium Hub Airports	6	33[1]	18.2%
Small Hub Airports	4	71[1]	5.6%
Non-Hub Primary Airports	6	250[1]	2.4%
Commercial Service Airports (non-primary)	0	117[1]	0%
Total of Service Airports	28	501[1]	5.6%
Reliever Airports	4	268[2]	1.5%
General Aviation Airports (public use airports only)	5	2,563[2]	0.2%

Source: Smith, Kenville, and Sawyer data.
[1] FAA. (2014). Preliminary CY13 enplanements.
[2] FAA. (2014). National Plan of Integrated Airport Systems.

Plan of Integrated Airport Systems (NPIAS) were selected. Appendix B lists the 37 airports in the study and some of their major characteristics.

Cargo airports were not a primary focus of this study, although several very important cargo airports are among the 37 surveyed, because it was decided that passenger operations and the related issues of customer care and communications posed more urgent recovery issues. However, researchers also recognized the great economic importance of cargo airports. While most recovery procedures and lessons learned apply to both passenger and cargo operations, there are some issues that are unique to cargo airports.

Literature Review

Available literature on topics associated with airport recovery from emergencies and other disruptions was reviewed using both the open web and the deep web (TRB database, ProQuest, EBSCO, Lexis-Nexis, and LLIS). While peer-reviewed literature in the field of airport recovery theory, techniques, and practices is severely limited, an aggressive search strategy on more than 30 topics revealed a number of pertinent documents. Previous ACRP research and synthesis reports form the most comprehensive library of research that presently exists on airport issues and provided very useful information for this report. Sources for the incidents themselves are listed in the bibliography following the list of references at the end of this report.

Interviews and Data on Responses

Interviews using a questionnaire were conducted with the 35 airports proposed in the approved work plan for this study, with a 100% response rate. Two airports were added in the course of the study.

The majority of the interviews were conducted as teleconferences; one was conducted in person and two by e-mail. The typical interview lasted 25–35 minutes, with the longest lasting 75 minutes. Most interviews were conducted by one of the three investigators with one manager at an airport. However, interviews regarding more complex incidents, including the four major case examples described in chapters two through five, involved as many as three of the investigators with two to seven officials from the airport. Most of the airports supplied requested documents and/or other evidence discussed in the interviews. Appendix C reproduces the questions used to guide each interview.

Figure 3 shows the job titles among the 67 persons interviewed for this study. Typically, at small airports managers serve several roles. For those interviewees, their roles have been apportioned among the categories.

It is important to note that five of the 37 airport interviews included members of the topic panel: Mr. Kashani (Metropolitan Washington Airports Authority), Ms. Marshall (San Francisco International Airport), Ms. Smalley (Jacksonville Aviation Authority), Mr. Runge (Houston Airport System), and Ms. Yaft (Los Angeles World Airports). The five interviews with panelists were conducted in exactly the same manner as were the others.

To provide a case example, the airports identified the one disruptive incident in their recent history that required the greatest effort during recovery. In general, the time frame was limited to incidents occurring after 2004. The 10-year time span was chosen because it began with Hurricane Ivan, a seminal incident which yielded major insights into response and recovery procedures leading to the formation of the Southeast Airports Disaster Operations Group (SEADOG). Information about recovery from other types of incidents was obtained during the interviews and subsequently from reviewing documents provided by the airports.

The typology of incidents addressed in this study includes four major categories and 13 subcategories as shown in Table 2; however, only the single most disruptive incident—the primary topic of the interview—is reflected in the table.

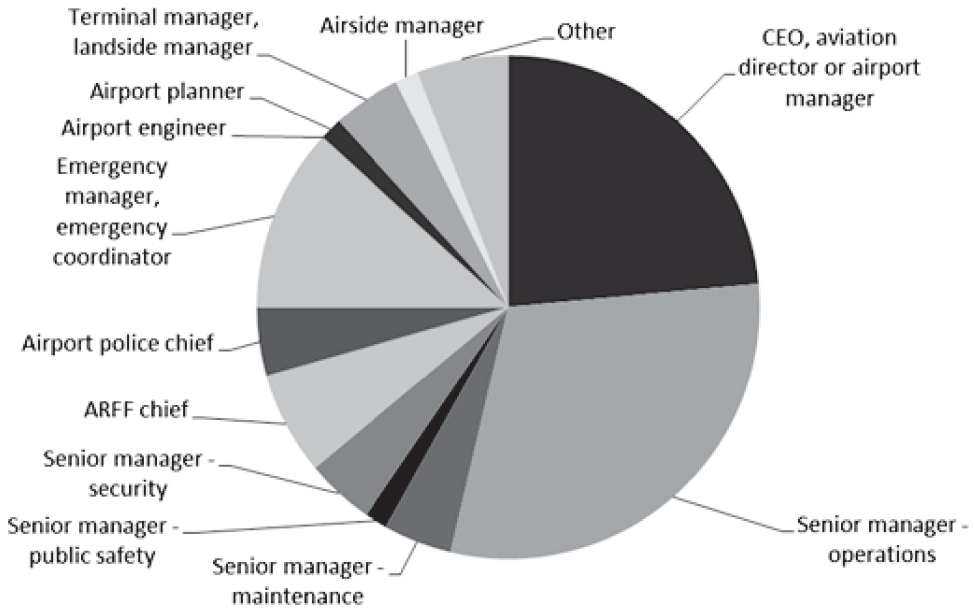

FIGURE 3 Position titles of interviewees.

Case Examples

The following criteria were applied to determine four case examples to illustrate post-incident recovery efforts:

- Quality of the hotwash and after-action review (AAR);
- Comprehensiveness of information available about recovery from the incident;
- Shortest amount of time elapsed since the incident;
- Magnitude of the incident;

TABLE 2
TYPOLOGY OF INCIDENTS AND AIRPORTS IDENTIFYING EACH TYPE AS PRIMARY TOPIC FOR INTERVIEW

Major Category	Subcategory	Airport(s)
Aircraft Accidents (crashes)	On-airport	APA, ASE, BJC, BOI, DEN, DVT, HDN, LEX, MEM, OWA, PGA, SFO, SXQ
	Off-airport	ASE, BUF, MTV, OWA
Natural Disasters	Earthquake	IAD
	Flood	LGA, STP, SZP
	Hurricane	JFK, MSY, SAV, GPT
	Ice storm	DFW
	Tornado	JLN, ORK, STL
Criminal Acts	Shooting	IAH, LAX
	Bomb threat	JAX
	Suspicious behavior	ISN
System Failures	Airfield lighting system	BUR
	Electrical outages	EWR
	Baggage handling systems	MCO
No Incident Requiring Recovery		BOS, MSP

Source: Smith, Kenville, and Sawyer data.

- Risk of occurrence of that incident subcategory (for natural disasters, criminal acts, and systems failures);
- Clarity of lessons learned;
- Intensity of efforts to apply and share lessons learned; and
- Strength of evaluation methods.

Four large hub airports—San Francisco International, Dallas–Fort Worth International, Los Angeles International, and Newark Liberty International—emerged with optimal real-world scenarios and learning opportunities that could beneficially be applied to similar incidents at small hubs, non-hub primary airports, relievers, and GA airports:

- Aircraft accident: The crash of Asiana 214 at San Francisco International Airport (SFO), July 2013
- Natural disaster: The ice storm at Dallas–Fort Worth International Airport (DFW), December 2013
- Criminal act: The shooting at Los Angeles International Airport (LAX), November 2013
- Systems failures: Electrical outages at Newark Liberty International Airport (EWR) following Hurricane Irene (August 2011) and Hurricane Sandy (October 2012).

These examples illustrate the complex dynamics of the recovery process, the challenges inherent in planning for unforeseen events, and the need for creativity and strong leadership under duress.

The original intent was to provide case studies from all sizes of airports. However, the far greater number of operations at larger airports inevitably led to large-hub airports dominating the consideration for case examples.

Data Analysis

As a result of the interviews and analysis of after-action reports, revised plans, and other documents supplied by the 37 airports, 508 discrete recovery procedures were extracted: that is, effective approaches, alternative approaches, identified gaps, necessity for organizational or policy reform, necessity for plan revision, or, more generally, a lesson learned. These procedures were analyzed for common themes and alternative solutions to a given issue, and the data arranged in a spreadsheet which allows isolation of procedures from any airport pertinent to a case example or to the synthesis of effective practices and major lessons learned. Timelines for recovery at each airport were developed.

RESULTS

Pertinent findings from the interviews, case examples, literature review, and data analysis are presented in three formats:

- Case examples from SFO, DFW, LAX, and EWR are presented in chapter two. Following a concise description of each incident and the subsequent response, the recovery process is discussed in detail, using information from interviews, documents provided by the airports, and sources in the literature. Chapter two also presents timelines constructed from information gleaned from interviews, airport documents, and media accounts.
- Chapter three presents lessons learned from the interviews and literature organized by topic, and the most effective practices determined by the airports.
- A list of Airport Emergency Post-Event Recovery Practices for procedures, information, and plan components necessary to develop an effective recovery plan is also introduced in chapter three and presented as Appendix A. Airports of any size or type can follow this list to develop their own unique plans for recovery.

Conclusions from the study and suggestions for further research are presented in chapter four.