Airport Emergency Post-Event Recovery Practices

DETAILS

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

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP SYNTHESIS 60

Airport Emergency Post-Event Recovery Practices

A Synthesis of Airport Practice

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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.

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ACRP SYNTHESIS 60

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

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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
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Printed in the United States of America

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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.

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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.

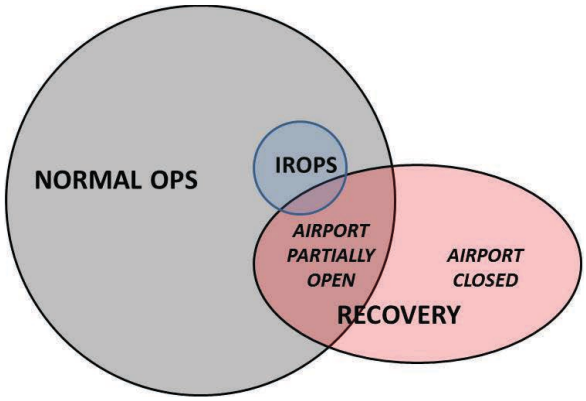

FIGURE 2 Normal operations, IROPS, and recovery.

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.

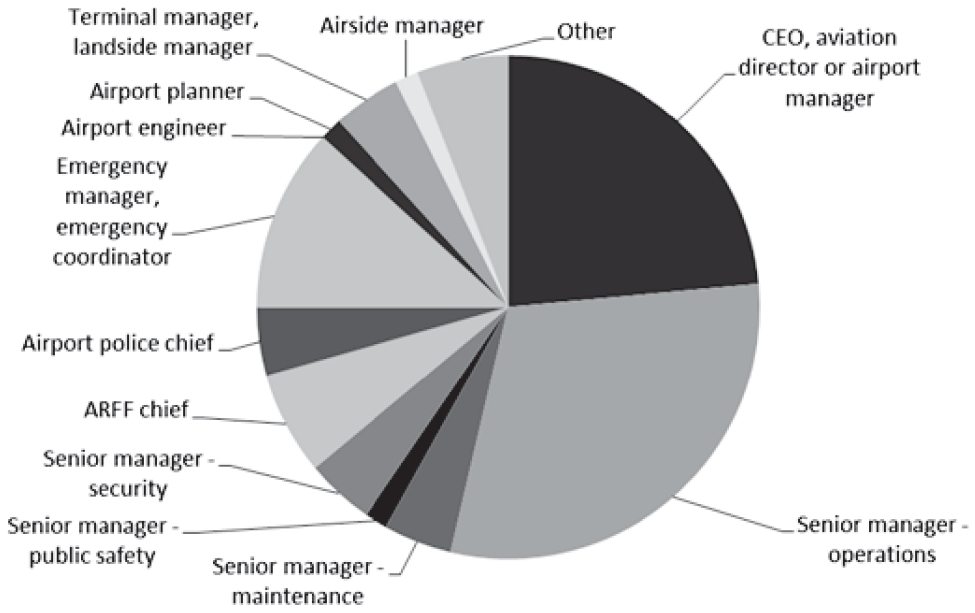

FIGURE 3 Position titles of interviewees.

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.

CHAPTER TWO

CASE EXAMPLES

While the 37 interviews clearly indicated the most informative case examples were the Asiana crash at San Francisco International (SFO), the ice storm at Dallas–Fort Worth (DFW), the shooting at Los Angeles International (LAX), and the electrical outages at Newark Liberty (EWR), that does not mean that other airports offered less compelling examples. For example, the two crashes at Memphis International Airport, the bomb threat at Jacksonville International and the shooting at George Bush Intercontinental Airport in Houston, the tornado at Lambert–St. Louis, and the baggage system failure at Orlando International, all posed different issues while offering similar insights. Those results, as well as information from incidents at 26 other airports, appear in chapter three, where they are combined with the analytical results from the four case examples.

As will be seen in the case examples, especially in the timeline graphics (see Figures 7, 10, 14, and 18), recovery has slightly different meanings at different airports. In the context of this report, "full recovery" occurs when the prescribed safety and security standards have been regained and the airport's capacity for aircraft operations is restored to the level that existed before the incident. However, the complexity of the range of activities at an airport means that various functions or parts of the airport may recover at different times. In the timeline graphics, "recovery" means full recovery of aircraft operations: Investigations, administrative functions, and procurement may continue past that point. As seen in the Newark Liberty example, major repairs may extend for months or years beyond full recovery of aircraft operations.

CASE EXAMPLE 1: AIRCRAFT ACCIDENT

San Francisco International Airport (SFO): Asiana 214 Crash of July 6, 2013

The primary source for this case example was the group interview conducted on July 24, 2014, with SFO Acting Associate Deputy Director for Safety and Security Services Ralf Ruckelshausen, Assistant Deputy Director for Safety and Security Services Rob Forester, ARFF Chief Dale C. Carnes, Emergency Planning Coordinator Toshia Shavies Marshall, Director of Guest Experience Christopher Birch, and Risk Management Auditor Antonio Eshabarr, along with primary documents provided by SFO or found in the literature review.

Incident and Response

On July 6, 2013, at about 11:27 a.m. PDT, Asiana Airlines flight 214, a Boeing 777-200ER, on approach to SFO Runway 10R/28L, struck a seawall and sustained a crash landing (Figure 4). Three hundred and seven (307) persons were aboard: 291 passengers, 12 flight attendants, and four crewmembers. Three passengers were killed and 49 persons were seriously injured—40 passengers, eight flight attendants, and one crewmember. The other 255 persons aboard received minor injuries or were not injured (NTSB 2014, p. 1; ICF 2013).

After striking the seawall, the plane skidded down the runway. A fire started in the right engine, which had separated and come to rest next to the fuselage. A flight attendant noticed the fire and initiated evacuation. Nearly all the passengers, 98%, successfully self-evacuated. When the fire spread to the fuselage, firefighters entered the plane and extricated five passengers, one of whom subsequently died. Six persons were ejected from the plane during the crash, two passengers who were not wearing seatbelts, and four cabin attendants thrown from the plane still strapped in their seats when the aft

FIGURE 4 San Francisco International Airport (SFO) Asiana 214 crash of July 6, 2013.

galley was ripped open. The two ejected passengers died of injuries from the crash. The third fatality occurred when an ejected passenger was run over by two firefighting vehicles (NTSB 2014, p. 1).

Fire rescue vehicles arrived within three minutes, and the fire was extinguished within 19 minutes, by which time all passengers had evacuated. The wreckage remained immediately adjacent to Runway 10R/28L, and debris was scattered on and around it. Injured survivors, escorted by SFO employees, were transported to nine area hospitals in ambulances. The uninjured survivors were taken to SFO's International Terminal, pre-empting use of critical gates and customs spaces (ICF 2013, p. 57). Mass care was complicated by the small number of Asiana employees at SFO, so care for both injured and uninjured passengers was managed by airport and fire department responders. The airport set up a family reception center and a media center in separate parts of the International Terminal. Figures 5 and 6 show the location of key elements of the response.

People and media outlets around the world became almost instantly aware of the crash and the situation of the survivors through social media message posted within minutes of evacuation (e.g., Eun 2013).

FIGURE 5 Satellite image of SFO.

FIGURE 6 SFO airport diagram.

The on-scene commander at the Incident Command Post (ICP) was in place and operating within three minutes. SFO activated its EOC within three minutes, and normal NIMS and ICS procedures were used. The EOC was active until full operations were restored and stood down at 5:15 p.m. on the sixth day after the crash; altogether it was active for seven days. The Unified Command (UC) initially consisted of ARFF, Airfield Operations, and law enforcement during the response phase, but transitioned to include customer care and maintenance upon for the recovery phase.

SFO and the FAA stopped all landings and takeoffs immediately upon the crash, causing the cancellation of 433 flights the first day. The two perpendicular runways (01L/19R and 01R/19L) reopened at 3:38 p.m., about four hours after the crash, marking the beginning of the transition into recovery mode (ICF 2013, pp. 8–9). Flight cancellations continued for six more days but in much lower numbers (55, 100, 140, 119, 114, and 96 flights cancelled per day July 7th through 12th, respectively).

Recovery

The recovery process for the crash was straightforward and typical. SFO had an exemplary recovery plan in place and executed it within the constraints of the NTSB investigation and the imperative to preserve forensic evidence (ICF International 2013).

Parallel runway 10L/28R reopened at 12:53 p.m. on the next day, about 28 hours after the crash. Normal flight schedules resumed on July 12, 2013, after the accident runway (10R/28L) was repaired, repaved, and repainted, with electrical systems and lighting systems repaired and the FAA final inspection completed. SFO resumed full normal operations and the use of all runways, including 28L, at 5:50 p.m. on July 12th.

Figure 7 shows the major milestones in the recovery at SFO from the Asiana crash.

Common Incident Objectives

SFO's overriding objectives in the response were to protect life and property and to preserve evidence for the NTSB investigation.

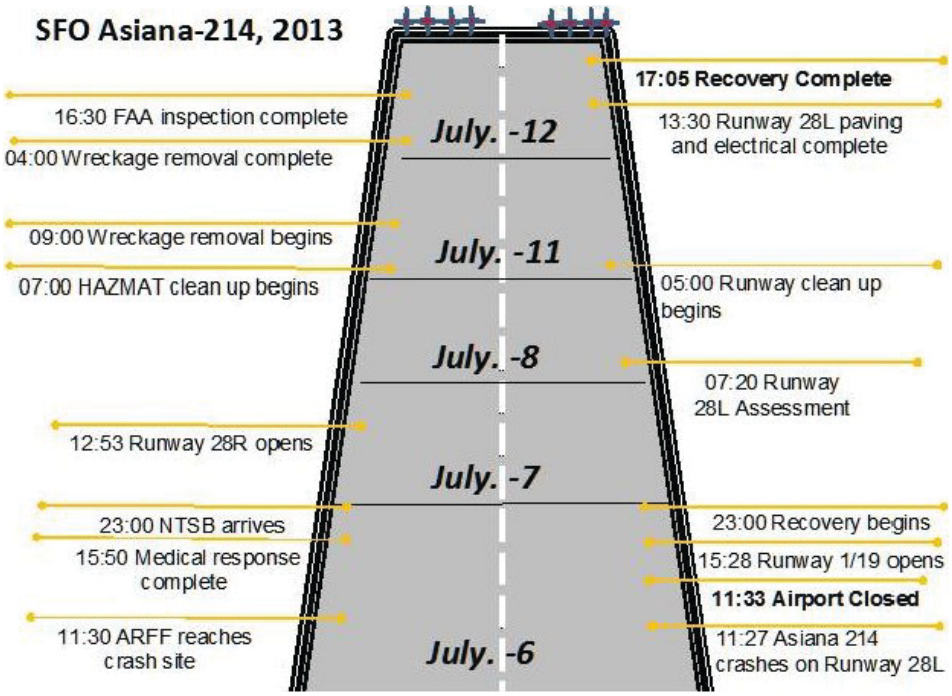

FIGURE 7 Timeline for SFO recovery.

SFO used seven of the National Preparedness Goal (NPG) mission areas to organize the detailed objectives of recovery (ICF 2013, pp. 14–15; FEMA 2011):

- Economics
- Health and social services
- Infrastructure systems
- Natural and cultural resources
- Operational coordination
- Planning
- Public information and warning.

Focusing on these seven mission areas not only improved recovery outcomes, but also led to revised procedures and policies that "result[ed] in a more resilient [airport] with an improved ability to withstand, respond to, and recover from disasters, with an associated reduction in loss of life, recovery time, and cost" (ICF 2013, p. 14). SFO and its mutual aid partners, tenants, and contractors worked together to identify lessons learned and apply them to improve overall response capabilities in each of these seven mission areas.

Among the mission areas, public health and healthcare preparedness were prioritized, with actions taken in nine capabilities most relevant to a mass casualty incident such as Asiana 214 (ICF 2013, p. 15):

- Emergency public information and warning
- Fatality management
- Healthcare system and community recovery; i.e. the ability of the airport and airline to collaborate with community partners including public health, medical, and mental/behavioral health systems
- Emergency operations coordination—universal use of NIMS by all parties involved in the response and recovery
- Information sharing
- Mass care
- Medical surge
- Responder health and safety
- Volunteer management.

SFO managers pointed out that emergency public information and warning, emergency operations coordination, and information sharing will all be elements of the airport's comprehensive crisis communications plan (CCCP) which is under development. This plan, which is essential for all phases of emergency management including recovery, outlines protocols and systems for internal and external communications, including robust alternative systems for connectivity; policy guidance for maintaining message discipline; reinforcement of the importance of the role of the Public Information Officer (PIO); and policies and procedures for the use of social media and other systems for communicating to the public during response and recovery.

Lessons Learned

SFO's AAR and its recommendations, developed by ICF International, a management, technology, and policy consulting firm based in Fairfax, Virginia, are divided into observations related to the response and observations related to recovery (ICF 2013). Any observations applying to both response and recovery and appearing in the response section are included in the present study.

Safety and Health

Recovery operations create unique or intensified safety and health risks. SFO sets operational safety as a priority as it updates safety plans and procedures for recovery operations (ICF 2013, p. 54) and incorporates effective practices for Critical Incident Stress Management (CISM) (*ACRP Report 22*—Kenville et al. 2009).

Communication

Solid, straightforward, and reliable communication is essential to effective recovery management. Information must be accurate and timely. Ideally, the information is in a highly integrated yet quickly understandable form, most often a graphic depiction or series of graphics.

A common operating picture (COP) is an online graphic representation of an event, scene, location, or situation that can enhance coordination and collaboration and increase efficiency among all stakeholders during emergency responses (and recovery operations) as well as day-to-day operations. Geographic information system (GIS), sensors, cameras, and wireless devices can be integrated into a COP. Web-based tools that are already in use and interoperable with internal and external agencies can be employed (*ACRP Report 94*—IEM et al. 2013).

Having a good COP allows stakeholders to update and understand the incident in real time. Information on different systems and from different actors can be merged to "identify issues and requirements, establish priorities and decide the allocation of resources, and better manage the overall emergency to achieve operational objectives" (ICF 2013, p. 21). Figure 8 shows a typical COP (not at SFO or for the Asiana incident). Crisis management systems can be very useful for resource mobilization and interagency coordination, not just for coordination within the airport (ICF 2013, p. 31; *ACRP Report 94*—IEM. et al. 2013).

Emergency communications must be fully interoperable and sustainable despite disruptions from the incident. To effect a smooth recovery, all airport staff, airlines, agencies, and mutual aid partners would benefit from a communications infrastructure that provides easy connectivity as well as training on plans, command systems, and communications tools to remove barriers to communication (ICF 2013, p. 32).

Clear and timely communication with the public is critical. SFO's successes in the Asiana 214 incident during response and recovery are currently being captured as lessons learned. These include stronger integration of the PIO and expanded use of the joint information center (JIC) as part of the incident command (ICF 2013, p. 41). SFO is also optimistic of working more closely with San Francisco and Mateo county emergency management agency PIOs to create advance coordination of

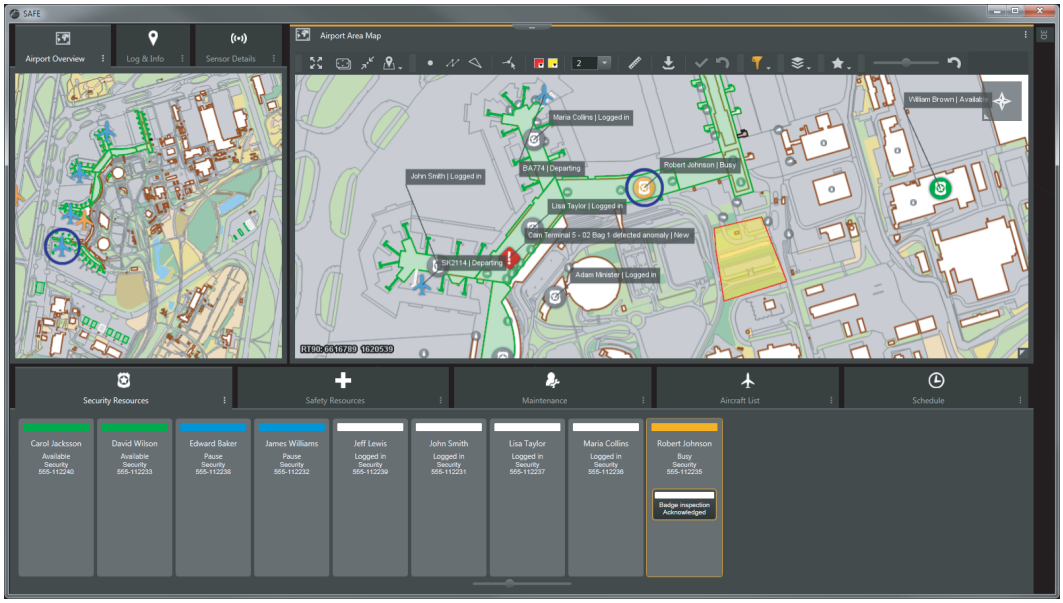

FIGURE 8 Typical common operating picture display during emergency operations.

public information planning, which includes implementation of the Bay Area Emergency Public Information and Warning Strategic Plan (ICF 2013, p. 42).

Clearly, a CCCP is a vital element of recovery following an emergency. SFO has updated its AEP as a result of the real-time lessons learned.

Command and Control

The ICS was not fully implemented in the Asiana 214 response. The main deficiency was that an operations section chief had not been established; in addition, some civilian partners had not been incorporated into the ICS structure. As it stood at that time, the ICS structure at SFO would probably have been inadequate in a more severe crisis, for example, an earthquake.

Incident Commanders, other leaders, and mutual aid partners would benefit from training in the full implementation of ICS, including the delegation of key roles emphasizing the inclusion of civilian partners such as airlines, utilities, and nongovernmental organizations in the ICS structure, and possibly in the EOC; and to direct the proper transfer of command as the incident evolves, including the transition to recovery and the recovery itself.

Following the Asiana incident, the ICF analysis suggested that SFO's EOC plans could be revised to better organize and monitor recovery activities. Clearer definitions of roles, responsibilities, and procedures are called for, especially those dealing with resource management. SFO's EOC plans worked well for the actual response, but were less effective during the transition to recovery and the recovery process (ICF 2013, pp. 46–47). During the incident and its recovery, the airport EOC functioned smoothly largely because personnel had established good working relationships and were familiar with the airport's facilities and operations. However, the SFO EOC's lack of adequate structure limited its effectiveness in dealing with the on-scene response and recovery operations (ICF 2013, p. 30). ICF found that the Policy Group could have been more effective had its composition been more appropriate and its members trained more thoroughly in NIMS and ICS procedures.

SFO is committed to identifying and adopting the principles and structure of the ICS and to sustaining the strong training program for designees assigned to manage response and recovery efforts from the various internal and external divisions, agencies, and organizations.

Logistics and Resource Management

Standardization of resource management, asset tracking and control, and resource typing benefits recovery as well as response. Timely, precise records support incident management and evaluation, and costs may be reimbursable through FEMA, insurance, or litigation, depending on the case.

SFO is developing a systematic project management approach for future EOC-coordinated efforts. Procedures for urgent repair and construction during recovery from the Asiana 214 incident worked fairly well; to improve future recovery efforts, effective practices would be identified and incorporated into SFO's existing plans. Procedures for managing projects, including those in the planning section of the EOC, require focused revision to speed decision-making and efficiency (ICF 2013, p. 47). Some aspects of the Asiana 214 recovery—for example, repaving Runway 10R/28L, lighting systems, and the seawall—involved major construction projects that would have run more smoothly with application of effective practices.

Planning

The after-action review at SFO led to a thorough review and critique of the airport's Emergency Procedures Manual and AEP by a joint agency planning group that included airlines, tenants, concessionaires, and mutual aid partners. This revision brought SFO's plans into closer alignment with FAA and FEMA guidance. Such joint efforts generate long-lasting, ongoing benefits, building relationships and facilitating integration with other local and regional emergency management plans (ICF 2013, p. 39). (Note: SFO no longer uses the term "emergency management plan" and has consolidated its contents in a revised AEP. For the rest of this section, "AEP" will be used.)

An effective business continuity program is "based on risk and business process analyses, coordinated plans and procedures, anticipated resource requirements, and organizational systems for implementation and management" (ICF 2013, pp. 43–44). *ACRP Report 93: Operational and Business Continuity Planning for Prolonged Airport Disruptions*, provides useful guidance for integrating BCPs with AEPs (Corzine 2013). As with the AEP and mutual aid agreements, regular review and updating of the BCP ensures that airport recovery is optimal after an emergency.

Coordinating with Investigators

The scale of the Asiana 214 incident required coordination with NTSB and the Federal Bureau of Investigation (FBI). The NTSB played the lead role in investigating the crash, as it does for all civil aviation incidents. The FBI was involved until it was determined that no criminal act was involved. The FBI cleared the reopening of runways 01L/19R and 01R/19L at SFO's request after the airport reported the negative impact that the total closure of SFO was having on other airports (ICF 2013, p. 49). NTSB began its investigation while response was still underway, but most of the investigation transpired during recovery.

At their peak, some of the investigation teams totaled 100 members. Airports may be challenged to understand and anticipate the needs of investigators; for example, evidence collection, witness interviews, and site documentation. To support such efforts, airports can be prepared to provide clear, accurate information regarding its capabilities and the urgency of recovery. Cooperation facilitates the smoothest possible investigation and recovery and is essential for the safety of all parties (ICF 2013, p. 50).

Customer Service

As an organization, SFO places a priority on customer service second only to its commitment to safety. Even following a major accident such as Asiana 214, the airport hopes that customer care will be disrupted for only the minimum amount of time necessary to facilitate response and recovery. Analysis of the incident revealed a possible need for an Airport Community Emergency Response

Team (A-CERT) in which trained volunteers could supplement customer service airport staff (ICF 2013, p. 53; IEM Inc. et al. 2014a).

Such incidents may require special types of customer care, such as counseling for victims and protection from the media. Following the Asiana 214 incident at SFO, passengers needed information, translation services, and medical services, along with assistance rebooking flights, contacting families, and finding local accommodations. These special services will be a consideration in SFO's future plans, with an emphasis on keeping customers informed through public engagement and timely communication (ICF 2013, p. 52).

Leadership

Strong leadership drove SFO's successful recovery. Application of lessons learned and effective changes in the AAR provided even greater support for future response and recovery leadership efforts.

Other Topics

SFO and its partners in the AAR identified a number of other lessons learned and areas for improvement that pertain overwhelmingly to the response phase but may continue to be a concern during recovery and even beyond full resumption of normal operations:

- Medical operations coordination with regional providers
- Patient tracking
- Family reunification and privacy laws—sharing of patient status information
- Mass care at the airport
- Family Assistance Center
- Demobilization and stand-down notification
- Coordination of Immigration and Customs for victims
- Caring for unaccompanied and separated minors (ICF 2013, pp. 56–71).

The interview and literature review showed these issues and delays in addressing related problems were clearly seen to affect the overall public opinion of SFO. SFO is upgrading its plans and procedures to address these topics.

Summary

For the most part, the recovery of San Francisco International Airport in the six days following the crash of Asiana 214 went very well. However, in a facilitated AAR, SFO and its partners identified 27 lessons learned ("Observations" in the AAR) and made more than 40 recommendations for improvement, change, and reform (ICF 2013). The most important needs identified involved:

- Improvements to the structure, inclusiveness, and training of the airport's EOC;
- Better working, communicating, and planning relationships with emergency management partners in San Francisco and San Mateo counties; and
- The creation of a comprehensive crisis communications plan.

CASE EXAMPLE 2: NATURAL DISASTER

Dallas-Fort Worth International Airport (DFW): Ice Storm of December 5–7, 2013

The primary source for this case example was a group interview conducted on August 1, 2014, with DFW Emergency Management Coordinator David M. McCurdy and Craig Mammel, AAE, Interim Assistant Vice President for Operations. Investigators also relied on primary documents provided by DFW or found in the literature review, especially "December Ice Storm Cost DFW $2 Million," by Andrea Ahles and Caty Hirst for the *Fort Worth Star-Telegram.*

Incident and Response

On Thursday, December 5, 2013, an ice storm hit the Dallas/Fort Worth area, causing the cancellation of more than 2,100 flights at the airport and stranding more than 9,500 passengers in the terminals. Freezing rain began falling Thursday evening, earlier than forecast, and persisted for the next three days. This storm, with temperatures remaining at or below freezing, was unprecedented for the region.

The airport's EOC stayed open from Thursday evening until Monday afternoon. Runway icing was the main issue at DFW because the deicing agent used to pretreat the surfaces was washed away by rain. The rain subsequently froze, rendering runways unusable. Despite deicing efforts that started early and continued virtually around the clock, only one of seven runways remained operational.

The runway maintenance issue significantly reduced airport capacity, causing the airlines to cancel flights. Stranded passengers quickly caused congestion issues in the terminals, aggravated when "cobblestone ice" on the roadways into and out of DFW contributed to travel disruption, and at several points literally cut the airport off from any access via roads (Figure 9). Passengers who wanted to spend the night at a hotel could not find rooms, or transportation to a hotel, and had no choice but to stay in the terminal. On Thursday night, approximately 4,000 people spent the night at the airport; by Friday evening, that number was down to 2,400.

Recovery

The DFW airport emergency plan identifies the first arriving unit in the field as the IC for most site-specific events. The IC develops the overall incident action plan, which is then communicated to and carried out by the supporting sections and agencies. For this event, however, because it was "an airport-wide event," the airport's EOC served as both the EOC and the Incident Command Center, with the EOC manager assuming a combined role as EOC coordinator and IC. In this mode, the EOC provided both tactical direction and communication to field responders as well as the traditional communication, coordination, and resource management support to the IC and field units. The EOC/ICC developed the incident action plan (IAP) that established priorities and objectives for the overall management of the event.

The main recovery effort at the airport first involved the deicing of runways, taxiways, and roadways. Runways opened and closed continuously throughout the event as staff worked around the clock to keep runway friction within standards on at least two runways. During the first two days of the storm (December 6–7), DFW was only able to keep one or two of their seven runways (Figure 10) operational. By December 8, four runways were operational, and by December 9, six of the seven runways were open. Throughout the airfield deicing effort, the EOC/Command Center coordinated with critical airport departments to ensure that necessary logistical and administrative support was provided.

Once airlines started canceling flights and roadway icing began to affect airport access, the response evolved into a customer service and care operation. The EOC quickly deployed the "stranded

FIGURE 9 Cobblestone ice in Dallas area.

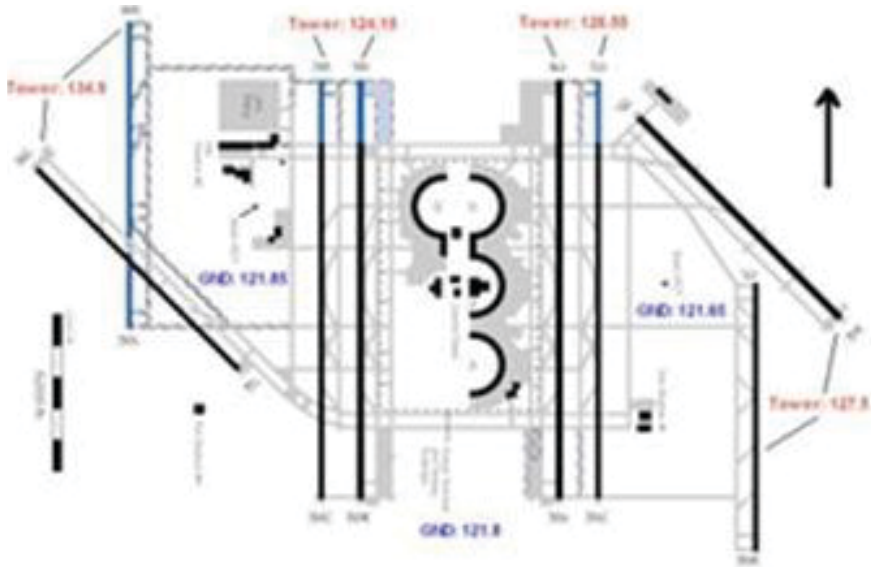

FIGURE 10 DFW airport diagram.

passenger" section of the airport's IROPS, which had been tested a number of times over the years and worked well because most staff knew their roles and responsibilities.

By all accounts, the IROPS passenger care plan effectively addressed the needs of those stranded in the terminals. Terminal care teams distributed customer care kits with personal hygiene items such as toothpaste, toothbrushes, and hand sanitizer, as well as more than 6,700 cups of coffee, bottles of water, and snacks. All of these support services were managed under the direction of the customer service branch within the EOC's Operations Section, while an airfield branch managed airfield snow and ice removal. Once the roadway access issues were resolved, the airport's EOC helped book more than 450 hotel rooms for passengers at discounted rates.

DFW used an internally developed technology tool called the "C-3 Portal" to communicate with both internal and external customers. This tool builds a COP of the event that helps maintain situational awareness. The C-3 Portal sends e-mail and text notifications to critical players and can be viewed by multiple groups in different areas, providing a user-friendly, frequently updated dashboard. Radios and telephones were also used for internal communications.

During this challenging event, the city of Fort Worth, Tarrant County, and the state of Texas provided exceptional support, especially with regard to logistical issues. Mutual aid support was timely and effective. DFW has a formal agreement with the American Red Cross for sheltering support, and bedding and cots are normally provided through the combined mutual aid effort of the county and the Red Cross. However, due to the weather and road conditions, DFW had to look to the city, county, and state to fulfill that need. The wide impact of the storm in the region initially delayed the state Department of Transportation's ability to provide immediate support to clear the airport roadways. After communication among DFW and city and county officials, road access to the airport was given high priority, thus expediting the recovery.

Figure 11 shows the milestones in the recovery from the ice storm at DFW.

Common Incident Objectives

- Safety is top priority.
- Keep runways open.
- Keep roadways open.
- Provide care for affected customers.
- Restore normal airport operations.

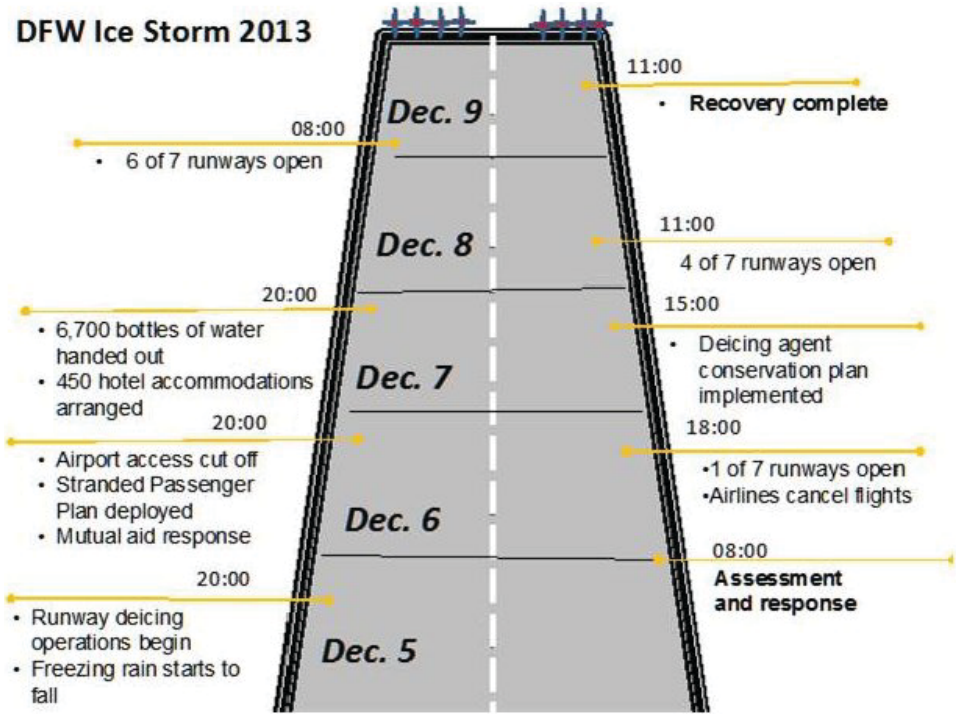

FIGURE 11 Timeline for DFW recovery.

Lessons Learned

Customer and Employee Care

The airport tested its IROPS a number of times over the years. In actual practice, this plan worked well, effectively addressing the needs of people stranded in the terminals. The airport implemented terminal customer service procedures that allowed stranded passengers access to cots, bedding, care kits, coffee, bottled water, snacks, etc. The EOC also monitored social media to help assess the demands.

Employees faced a number of issues during this storm. The operation of heavy equipment in and around an active runway and taxiway environment requires specifically trained and certified staff. Like many other airports, DFW has only a limited number of qualified personnel to perform these functions. Long hours spent continually deicing the runways required effective schedule management for critical staff. It was necessary to develop a staff rotation strategy that ensured both adequate employee rest and continual maintenance of runways and taxiways. The DFW EOC directed the affected work groups to develop and implement their own interim schedules until recovery was complete and normal schedules resumed.

Interim scheduling was complicated by regional travel issues that hampered employees trying to get to and from work; for example, some employees could not even get their cars out of their driveways. The EOC group managed its own staffing well and clearly communicated the need for field groups to proactively manage their human resources.

EOC Support

Before the ice storm, DFW included only NIMS-trained section chiefs from law enforcement and fire staff within its EOC. In practice, the airport realized that this EOC structure fell short, especially in the recovery phase. As a result, during the ice storm, DFW implemented a newly restructured EOC that included the branch directors from key departments such as customer service, parking and busing, and airfield and asset management. In its post-event evaluation, DFW found that this new

structure generated positive change; to take that improvement to the next level, it identified a need for additional EOC training and quarterly exercise involvement for branch-level representatives. DFW reports that recent involvement of department representatives within its EOC is supporting more effective collaboration and coordination across the airport.

Documentation of Asset and Resource Management

DFW identified resource management as an area requiring improvement. A major issue during the incident was the limited amount of deicing agent on hand, with no plan in place for emergency replenishment. In hindsight, the airport realized it could have managed resources more effectively from the beginning to ensure that the deicing agent would last throughout the expected duration of the incident. Using too much solution too early unnecessarily compounded the runway deicing issue.

In extreme events, supplies run out more quickly; a major ice storm in a warm climate can reach a scope beyond ordinary expectation, affecting any consumable supply or resource. DFW identified the need to quickly assess supplies and resources being used and, if necessary, implement a conservation plan. It is important that conservation of critical materials such as deicing agents, fuels, and manpower be understood fully and addressed early. If DFW's supply of deicing agent had run out before the storm subsided, the situation could have closed down the airport. Including critical work groups such as Airfield and Environmental Affairs in the EOC can help airports address these types of issues before they arise.

The financial burden of emergency response, especially in extreme events, can be considerable. The estimated total direct financial impact from this storm for DFW was about $2 million. It follows that management and documentation of resource expenditure is a critical aspect of any emergency management event. Detailed real-time documentation of expended resources is critical for post-event tracking and reimbursement; state and federal funding is often available to help local jurisdictions recover from emergencies. According to emergency coordination McCurdy, "We struggled to gather good numbers at the onset of the event. However, tracking of resources and expenditures was identified as a priority for the EOC during the event. It is imperative to incorporate this tracking from the beginning of the operations to ensure resources and expenditures are tracked accurately."

Post-Event Exercises

DFW has a longstanding practice of using recent events as topics for exercises to leverage lessons learned directly into subsequent training. McCurdy observed, "The airport is always recovering from some kind of infrastructure or weather-related event. These events allow us many opportunities to gather a wealth of lessons learned" (interview, August 12, 2014). Quarterly multi-agency EOC tabletop exercises (TTX) typically focus on past events and involve all available responders and stakeholders. For example, the airport's September 2014 quarterly tabletop exercise employed a scenario similar to the December 2013 ice storm and provided a review and sharing of lessons learned from incident.

Summary

The 2013 ice storm caused unprecedented disruption to airport operations. Passengers were seriously inconvenienced, but DFW staff minimized passenger frustration by providing comfort, necessities, and accurate information. DFW activated its EOC and effectively managed the event by using ICS and NIMS practices and by collaborating with city, county, and state EOCs. DFW developed an appropriate action plan that it then effectively communicated and executed, greatly minimizing the potential impacts of the storm. After the event, DFW gathered lessons learned and identified corrective actions which it continues to review and share through exercises.

The DFW ice storm drives home the point that airports need to train employees not only to respond to probable local disasters but also to prepare for rarer occurrences or unprecedented disasters.

CASE EXAMPLE 3: CRIMINAL ACT

Los Angeles International Airport (LAX): Active Shooter Incident of November 1, 2013

The primary source for this case example was an interview conducted on August 15, 2014, with Los Angeles World Airports (LAWA) and LAX Director of Emergency Management John Kinney, along with primary documents provided by LAWA and LAX or found in the literature review, especially the LAX-LAWA "Review of Airport Response Operations: LAX Active Shooter Event: Lessons Learned" (Kinney 2014). Additional information was provided by Jacqueline Yaft, Deputy Executive Director for Operations, Maintenance and Emergency Preparedness.

Incident and Response

At 09:19 a.m. on Friday morning of November 1, 2013, a man armed with a semi-automatic high-powered weapon walked into LAX's Terminal 3 and approached the TSA checkpoint. He shot and killed one TSA agent and wounded two other agents and one passenger.

People in the terminal immediately self-evacuated or sheltered in place (Figure 12). Many on the secure side (airside) evacuated by means of stairs onto the apron. In response to the initial emergency notifications, staff quickly halted airport operations, including a ground stop, issuance of a Notice to Airmen (NOTAM), and lockdown of the airport perimeter. Initial command and control centered exclusively on law enforcement but also included non-law enforcement airport responders. In the initial stages, one single tactical objective prevailed: Secure the shooter or shooters immediately.

Employees, tenants, passengers, and other members of the general public in terminals 1 and 2 also self-evacuated or sheltered in place (Figure 13). The LAWA AAR estimates that approximately 4,500 individuals self-evacuated and approximately 20,000 sheltered in place either on an aircraft or in a terminal. Passengers who self-evacuated were directed to transport staging areas by police and operations personnel, whence they were subsequently bused to the Tom Bradley International Terminal in accordance with the airport's Terminal Evacuation Plan.

No formal evacuation notification was ever issued for this incident; the only immediate notification was from employees and passengers who grasped the situation communicating through gesture, action, and word. First responders issued simple, clear verbal orders to passengers; that is, "Show your hands;" and, as soon as they were cleared, "Take shelter." Throughout the incident, law enforcement used bullhorns and vehicle PA systems to inform evacuated passengers about the status of the airport recovery efforts. Airlines used the PA systems in each terminal to communicate with sheltered passengers within their respective areas.

The lack of a functional airport-wide emergency PA system severely hampered the airport's ability to communicate with and direct evacuating and sheltered people. While the airport's evacuation and repopulation plan provided guidance for the airport on the handling and management of a mass

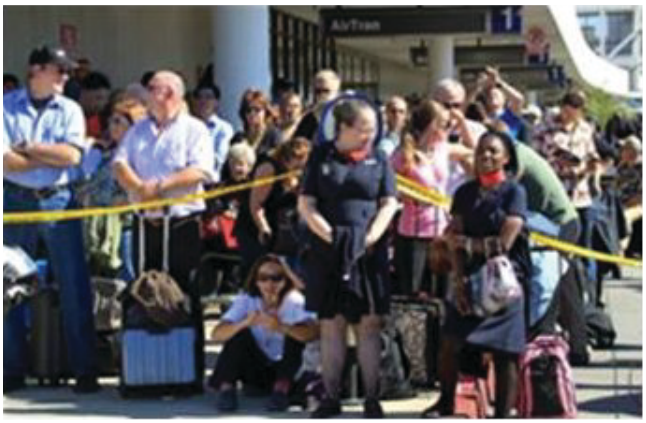

FIGURE 12 Terminal evacuees.

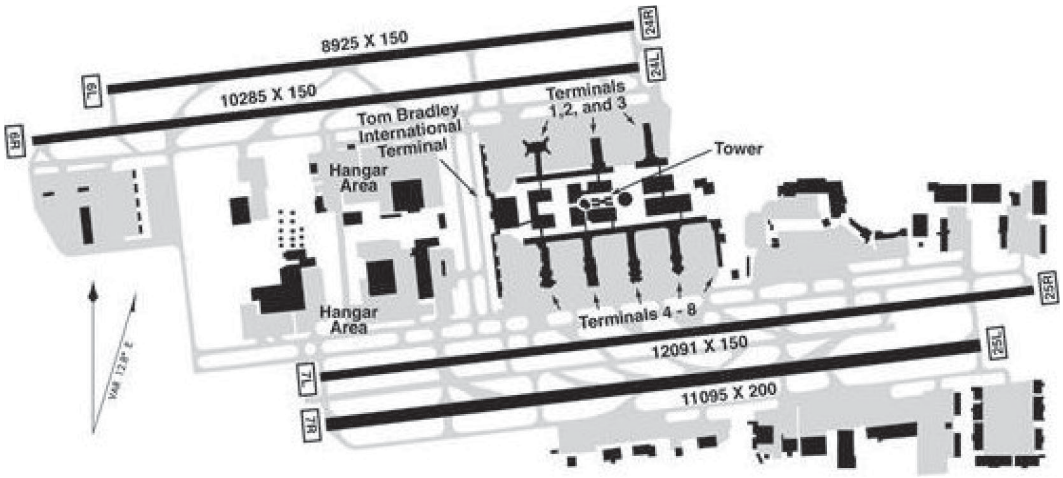

FIGURE 13 LAX Airport diagram.

self-evacuation event, the simultaneous evacuation of multiple terminals quickly overwhelmed available field staff as well as those in the Airport Response Coordination Center (ARCC). (Note: Under California law, a subunit of local government cannot call something an EOC; only the main unit of local government can have an EOC.) The sheer scale of the event resulted in the airport's having little to no control of the evacuating or sheltering public. LAWA's AAR stated that after the initial reaction to the incident, most passengers simply loitered in the main terminal core and waited for the situation to be resolved.

As the incident evolved and law enforcement personnel secured the suspect, the airport's operational managers gradually allowed uninvolved areas to return to operational status. The partial reopening of the airport at 4 p.m., less than five hours after the initial incident marked the beginning of the transition from response to recovery. After that, response activities and recovery activities occurred in tandem.

Recovery

After the safety of passengers and employees, the immediate objectives for airport personnel were communication and notification regarding the incident. LAX used the airport radio system and its critical communication system technology to notify pre-identified key personnel. These notifications triggered the immediate initiation of protocols identified within the AEP, quickly and effectively shutting down at-risk areas of airport operations. AEP-triggered actions included the following:

- LAX Movement Area closure, resulting in the FAA issuing a "Tier 1 Ground Stop" for all aircraft inbound to LAX;
- Closure of all north complex terminals;
- Closure of Central Terminal Area (CTA) roadways including upper and lower levels;
- Establishment of a Unified Command (UC);
- Activation of the Airport Department Operations Center (DOC);
- Activation of the City EOC by the City of Los Angeles Emergency Management Department.

The airport also utilized the emergency notification function of the terminals' PA systems. However, these systems had limited effect because many employees and passengers took refuge in areas beyond their reach. In other areas, modifications made over the years to accommodate airline day-to-day operations had inadvertently impaired emergency notification capabilities.

Once airport responders reached the field command post, they quickly developed two major objectives: to support police and fire efforts to the fullest extent possible, and to begin planning for the phased recovery of normal airport operations. LAX ARCC and Department Operations Center (DOC)

staff focused on supporting responders and communicating the big picture to airport senior managers, the mayor, the city EOC, and state and federal agencies; for example, "The airport is not closed," "Aircraft are still arriving and departing," "The airport is still operating on the south side," and "The airport is trying to minimize negative impacts to the aviation system and the community." As soon as the police IC team became assured that the situation was no longer critical, it shrank the incident perimeter and returned portions of the airport to operational status.

The nature of the situation facilitated a "warm start." While the police and fire departments conducted tactical operations and investigations and cleared the crime scene, airport staff at the field command post concentrated on resuming normal operations. This provided the airport time to develop and communicate an effective action plan for the recovery of impacted areas once given the green light. During the planning process, airport staff had to anticipate which areas would be returned to them for recovery in which sequence. Once an area was determined to be outside of the incident perimeter, resumption of normal operations in that area could begin.

In this event, LAX underwent three separate phases of recovery, each phase effectively requiring its own recovery plan.

The International Terminal and terminals 4 through 8 were reopened for normal operations as soon as the retracted incident perimeter was determined. Fortuitously, no international flights were delayed because of the time of day and existing flight schedules.

Terminals 1 and 2, as well as their associated roadway systems, resumed operations around 6:30 p.m. the day of the shooting, just over nine hours after the incident began.

The Terminal 3 crime scene was reopened the next day (November 2, 2013) around 6:00 p.m., almost 33 hours after the initial incident.

Figure 14 shows the timeline for recovery at LAX.

FIGURE 14 Timeline for LAX recovery.

The UC worked well to execute an efficient recovery. The IC role was transferred to airport staff at the beginning of the official recovery phase. LAX staff attributed their effective command and control during recovery to well-established working relationships built long before the incident. Key personnel clearly understood expected roles and responsibilities and were familiar with the recovery plan, allowing them to anticipate next steps. Overall, the incident at LAX resulted in 252 cancelled flights, 86 diversions, and 74 delayed flights; these numbers were kept to a minimum as a result of the warm start and the phased reopening of the airport's terminals and aircraft movement areas.

Common Incident Objectives

- Stop the shooter.
- Address immediate life and safety issues.
- Establish and maintain a perimeter (shrink it down when possible).
- Communicate effectively both internally and externally.
- Care for customers.
- Restore normal operations as soon as possible.
- Communicate with the policy groups through their on-site representatives.
- Monitor and prioritize social media and respond as appropriate.

Even though the response and recovery went as smoothly as could be anticipated, LAX elected to conduct a thorough post-incident evaluation, resulting in two key documents: "Active Shooter Incident and Resulting Airport Disruption" (LAWA 2014a) and "After Action Report and Implementation Plan" (LAWA 2014b). These reports encompass a comprehensive review of the incident and document several post-incident action items as well as a number of lessons learned. LAWA knows the aviation industry is keenly interested in lessons learned from this incident, and has shared them widely both in the United States and worldwide. Lessons learned and post-action items shared in these LAX reports are incorporated into the findings of this report.

Lessons Learned

Public Emergency Notification System

The PA systems within the terminals performed poorly during the incident. LAX determined that over time, these systems had been modified to meet the day-to-day needs of airlines. In many cases, the airport had delegated maintenance and control of PA systems to the airlines. As a result, some areas were without emergency communication capability. The airport is now working on recovering these systems. LAWA and LAX Emergency Management director Kinney observed, "Hopefully, other airports can learn from this and evaluate their systems. It's too painful to wait until you have an incident to discover that you have issues."

The airport also realized during the incident that it had no effective way to communicate with people who self-evacuated or sheltered in place. The AAR report stated, "While major efforts were made to utilize social networks and commercial media to communicate with the general public, public mass notification capabilities within the airport were lacking and must be addressed." This reality led to investigating effective methods of communication with all affected individuals, including with people sheltering in areas outside the core facilities.

Following the incident, LAX worked through local emergency management groups to access FEMA's Wireless Emergency Alert (WEA) system. This system sends alerts through cell phones and mobile devices to inform the public of an emergency. This is the same system used for Amber and Silver alerts, and does not require downloading an application or subscribing to a service.

Staffing Bench Strength

Command and Control worked very well despite some notable issues regarding the support function of the ARCC and DOC. During the early critical phase of the incident, ARCC/DOC attempted to

transition from day-to-day ARCC systems to DOC systems kept in a "cold state," but insufficient qualified staff were available at the time the transition was necessary; this situation quickly led to a gap in the expected support from both the ARCC and DOC and in effective use of available technologies to create a COP during emergency incidents. Some communications failures resulted in dropped notifications.

LAX's post-action report states that "During LAWA's response to the incident on November 1, 2013, gaps in DOC/ARCC procedures and staffing inhibited it from reaching its full potential as an information and coordination clearinghouse." By most accounts, the DOC/ARCC played a minimal role in support of the ICP ICP, and the ARCC never produced a common operational picture (LAWA, 2014a, b).

Mutual Aid Coordination

Mutual aid for law enforcement worked very well during the incident. Multiple police departments responded, and the airport had plenty of help with good coordination and distribution of duties. Mutual aid response is managed through the Los Angeles County Sheriff's Office. Although the Los Angeles Police Department (LAPD) Incident Command made no formal request for mutual aid, the sheriff's department coordinated a multi-agency response when the LAWA Police requested assistance.

Access and Credentialing

During the incident, a problem developed when police officers, responding under mutual aid, were given perimeter security duties and did not understand the airport's credentialing system. This difficulty greatly delayed delivery of some essentials resources and also impeded the work of certain airport officials and employees. For example, aircraft were loaded and ready to go but could not take off because their crews were blocked from entering the airport. Similarly, delivery of supplies requested by command, for example, bottled water, was delayed as a result of this access control issue.

It is important that airports have a focused plan for providing and maintaining essential access during emergencies. LAX is investigating effective emergency response credentialing systems and is considering the use of incident-specific passwords.

Interoperability

Interoperability worked relatively well for this active shooter incident, but there is always room for improvement. The lack of interoperable radio communications between LAPD and Los Angeles Fire Department (LAFD) personnel, combined with the struggles in the ARCC and the DOC, caused problems early on because key LAFD command personnel were not aware of the field command post established by LAPD, thus delaying response of LAFD command personnel to the UC. Once face-to-face command post communications were established, interoperability was in place and sustained throughout the incident.

Employee Care

Within the first hour of the incident at LAX, mental health and disabilities aid departments from mutual aid partners responded. Care was available to all airport and tenant employees and continued for nine days. LAWA's Human Resources Department conducted one large meeting designed to communicate the availability of these services. All other counseling was provided either one-on-one or in small groups.

Summary

The LAX active shooter incident had sudden and significant impacts on the airport. First responders quickly resolved the threat. While the airport encountered significant difficulties regarding the ARCC and DOC, the field command team was able to work around these shortcomings and effectively manage

the life safety aspects of the incident. Airport staff working through the field command post developed an action plan for recovery which they deployed effectively. After the incident, LAX conducted a comprehensive review which identified lessons learned and necessary corrective actions, and made these available to the aviation industry in the hope that they will benefit future response and recovery efforts.

The major issue LAX faced was the lack of a method for communicating quickly and efficiently with the public in the areas affected by the incident. As a result of the LAX incident, airports industry-wide are analyzing their own systems, with the expectation that airports worldwide will be better prepared to communicate during response and recovery efforts for future incidents.

CASE EXAMPLE 4: SYSTEMS FAILURE

Newark Liberty International Airport (EWR): Electrical Outage from Hurricane Sandy on October 29, 2012

The primary source for this case example is a group interview conducted on August 19, 2014, with EWR Manager of Airport Maintenance Sarah McKeon and Port Authority of New York and New Jersey (PANY&NJ) Assistant Chief, Resilience and Sustainability, Susanne DesRoches. Secondary sources include primary documents provided by PANY&NJ or found in the literature review, especially "Hurricane Sandy: The Port Authority Airports' Story" (PANY&NJ 2013), which focused on the recovery of the five PANY&NJ airports—Newark Liberty, John F. Kennedy International, LaGuardia International, Teterboro Airport in Bergen County, New Jersey, and Stewart International Airport in Newburgh, New York—from the effects of Hurricane Sandy.

This case illustrates the point that most natural disasters generate at least one and perhaps more systems failures. Many of the lessons learned by EWR apply to both systems failure recovery and recovery from the general effects of a storm.

Incident and Response

Hurricane Sandy made landfall in southern New Jersey on the evening of October 29, 2012, battering the New Jersey and New York coasts with heavy rain, strong winds, and record-breaking storm surges of up to 14 feet above normal high tide. More than 8.5 million people lost electrical power. Communities, roads, and other transportation facilities, including the three major PANY&NJ airports, were flooded (FEMA 2012; PANY&NJ 2013).

At EWR, the airport lost electrical power as well as functionality of the city-owned pump station that drains the airport of water collected behind the airport's tide gate (Figure 15). The pump station

FIGURE 15 EWR at height of flooding.

has just one feed and no backup generator. EWR's weather response plans and procedures had been modified after Hurricane Irene in 2011, which was a severe rain event (approximately 12 inches of rain in less than half a day) with extensive freshwater flooding. However, Sandy was a storm surge event, which put different demands on the tide gate and pump station and created saltwater flooding at the airport. Figures 16 and 17 show EWR's layout.

The air traffic control (ATC) tower was not available as a result of high winds and a loss of power to EWR. This loss of air traffic control, not flooding, was the factor that closed the airport. The highest priorities during response were the restoration of power to essential systems including the pump station, ATC tower, the airfield lighting systems, and terminal operation systems. In preparation for the storm, and to address emergencies that might arise as a result, EWR staff began rotating in 12-hour shifts the day before landfall was forecast. EWR provided at-airport berthing and messing for essential staff.

Recovery

Lessons learned from Hurricane Irene just a year earlier provided a strong advantage in preparedness for response and recovery following Hurricane Sandy. Hurricane Irene made it clear which areas of EWR were prone to flooding, and engineers had completed a topographic and water infiltration study. At the time Sandy occurred, EWR had already initiated purchasing procedures for an emergency power generator for the city-owned pump station, topographically mapped the airport to identify flood-prone areas, developed a plan for targeting sandbagging to protect critical facilities, and developed a relocation plan for vehicles and other movable equipment to more secure areas on airport property, preventing damage and protecting many of the airport's capabilities for response and recovery.

Lessons learned about coordination in response and recovery during Irene were tested in the snowstorm of October 29–30, 2011, nicknamed "Snowtober," but other practices either did not apply or had yet to be fully implemented. Both Irene and Snowtober allowed EWR and PANY&NJ to gain experience in recovery, and the planning, physical, and operational improvements made in the year following Irene facilitated and perhaps speeded up recovery after Sandy.

Following both hurricanes Irene and Sandy, EWR lost electrical power caused by events that happened off airport property and outside EWR's control. Although the loss of power affected every function at the airport including air traffic control, terminal operation systems including mechanized

FIGURE 16 Google Earth view of EWR.

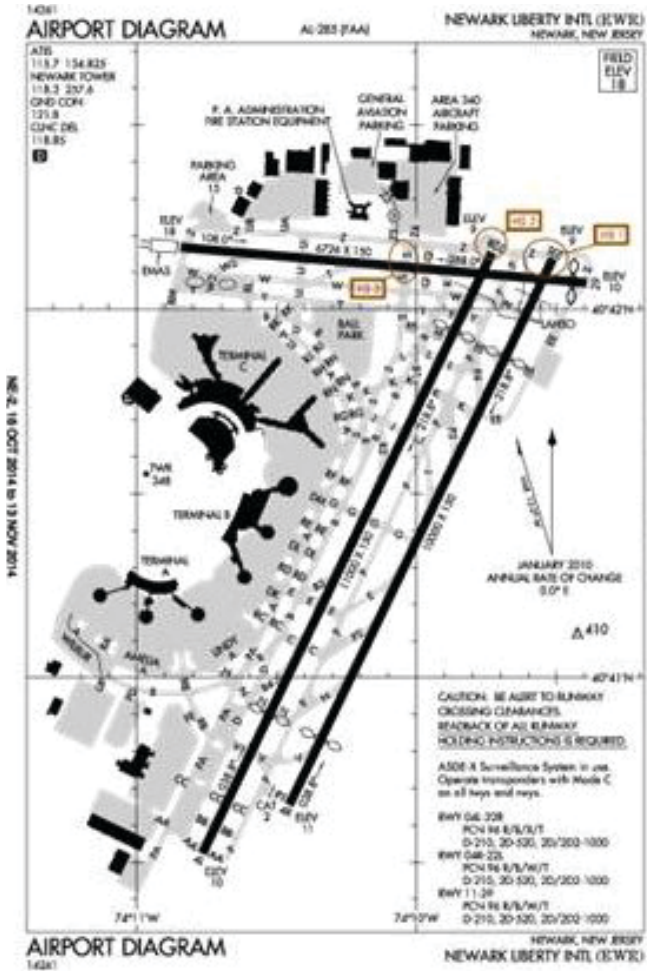

FIGURE 17 EWR Airport diagram.

people movers, and baggage handling systems, the largest and potentially longest lasting impacts originated from flooding of the airport operations area and its lighting and electrical systems. After Irene, EWR purchased sufficient emergency generators to facilitate partial terminal operation, airfield lighting, and operation of an on-site EOC. In addition, the airport began upgrading the base electrical systems throughout the passenger terminals. Perhaps the most significant change that made a major difference in the recovery after Sandy when compared with the recovery after Irene was the addition of a representative from Public Service Electric & Gas to the EWR EOC, who was able to provide real-time utility recovery information to on-site staff so that airport electricians could focus local recovery practices in a systematic manner.

Flood control and drainage at EWR are complicated by several factors: low elevation, close proximity to tidally influenced waterways, a high proportion of paved surfaces at the airport and in areas adjacent to the airport, and the dependence on a pump station and a tide gate to remove or keep water out of the airport. The tide gate is owned and managed by PANY&NJ. The pump station is in position to remove water from a peripheral ditch whose banks touch approximately half of the airport's overall perimeter. In addition to the peripheral ditch receiving stormwater runoff from the airport property, it also receives runoff from approximately 14 square miles of urban communities adjacent to the airport. The pump station is owned, operated, and managed by the city of Newark.

The EWR EOC coordinated all preparations starting 12 hours before the forecast landfall and continuing through recovery until all electrical systems and terminals were fully operational, a total of about 60 hours. Gridlock on highways, disruption of mass transit, and a lack of fuel for private vehicles throughout the region impeded the airport's recovery by making it impossible or difficult

for employees to report to work even after the physical issues at EWR were all addressed. Although EWR was able to resume a normal flight schedule within less than 48 hours, it was another 120 hours before all employees were able to work on a regular basis. EWR and the PANY&NJ paid close attention to human factors and the needs of their employees throughout the recovery from Sandy, which paid off in both the short and long term.

EWR, as part of PANY&NJ, has an unusual EOC arrangement. The airport EOC handles nearly all the typical EOC functions during response and recovery under the direction of the manager of Physical Plant and Redevelopment or the manager of Operations, who work on opposing shifts throughout the life of the emergency. The main PANY&NJ EOC serves to coordinate support, communications, logistics, and other functions, therefore serving almost as a multi-agency coordination center. The EWR EOC does not handle public information duties. The PIO at the main PANY&NJ EOC handles all outgoing public information, and EWR refers all public and media inquiries to the main EOC. EWR found this an effective and productive strategy for decreasing demand on airport staff while implementing recovery.

A major complication in the early stages of the recovery for PANY&NJ staff departments arose from a jammed e-mail system. EWR did not have this problem since the airport had access to network computers that were on emergency power. One of the adjustments made to accommodate transportation problems owing to gridlock and a lack of mass transit was to encourage non-essential PANY&NJ employees to work from home. The e-mail system did not allow remote purging, so employees at home could not clear their inboxes. This high volume of e-mail traffic jammed the system, causing miscommunication and delays until the system was reprogrammed.

Although recovery activities were terminated with the restoration of normal flight operations about 48 hours after landfall, some recovery activities continue at EWR more than two years after Hurricane Sandy. Saltwater flooding of electrical and lighting systems created latent damage from corrosion; inspection, testing, and replacement of cables and connectors were still continuing in late 2014. Freshwater flooding from Hurricane Irene did not have this effect.

Figure 18 shows the milestones in the recovery at EWR.

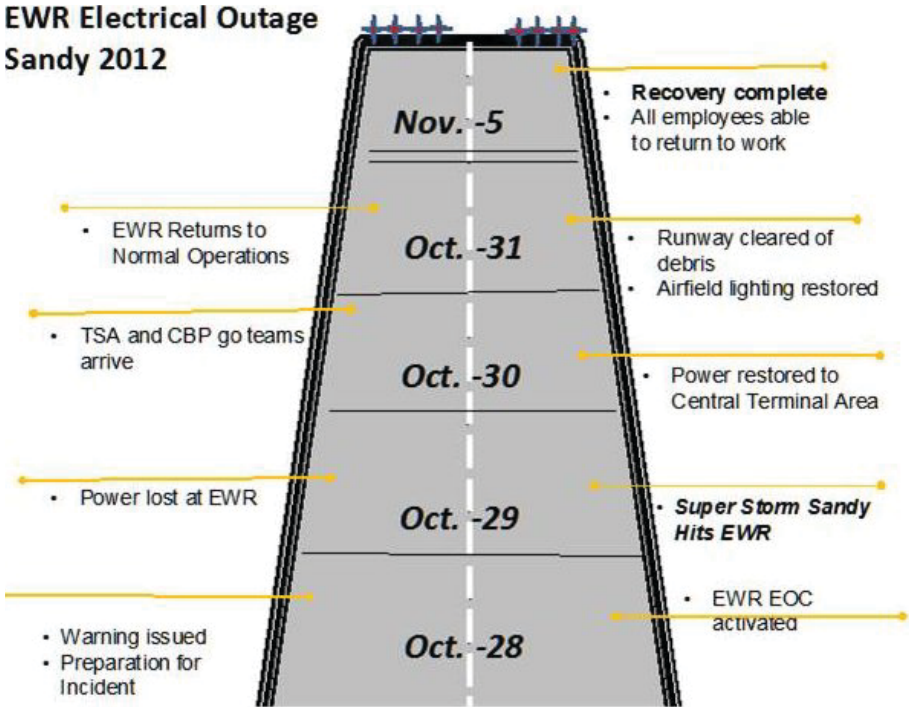

FIGURE 18 Timeline for EWR recovery.

Common Incident Objectives

- Protect life and safety of passengers and employees.
- Care for customers.
- Protect property.
- Coordinate effectively with PANY&NJ senior managers and EOC.
- Coordinate with electric utility.
- Coordinate effectively with city of Newark for pump station operation.
- Communicate effectively both internally and externally.
- Restore normal operations as soon as possible.

Lessons Learned

Command and Control

At both the airport level and at the corporate level, the Port Authority found it highly effective to have the right people at the table. For example, EWR included electric utilities representatives in the airport EOC and in planning for forecast disasters. In the future, EWR would consider including an electrical utility representative in the UC. NIMS and ICS were found to be effective for guiding recovery operations.

In Sandy, the Port Authority found that its on-airport EOCs worked well not only to coordinate response but also to coordinate recovery. The airport EOC will be kept active to manage and direct recovery as long as recovery activities are multidimensional and complex.

In the case of a multi-airport system with airport EOCs and a central corporate EOC, appropriate staff in the central EOC can assist, advise, facilitate, coordinate, mobilize resources, and prioritize, thereby helping the airport EOCs and recovery.

Communications

Communicating clearly, simply, and accurately is essential for effective recovery operations, which highlights the importance of a comprehensive crisis communications plan (CCCP). In the particular case of EWR and the Port Authority, well-developed and practiced procedures for communications between the airport EOC and the corporate EOC was key. Redirecting political callers are to the corporate EOC's PIO is also important.

A contingency telecommuting plan, which can be part of the CCCP, is essential to ensuring that normal administration and planning continue during airport recovery. Making sure that employees working at home have full access to their e-mail inboxes, including the ability to clear them remotely, will avoid disruption of essential communications.

Logistics and Resource Management

It is important to ensure that enough auxiliary power can be generated to provide for the operation of people movers, escalators, elevators, and baggage handling systems if the airport is to be able to handle at least some terminal operations in the earliest stages of recovery. Documentation of the system's capabilities and what it means to each phase of the airport's recovery should be accessible by the entire airport community. Also with regard to electrical power, the airport should be established as a Tier 1 priority for electric service and service restoration (the same level as hospitals).

As soon as extreme weather is forecast, maintenance and operations staff members should begin to check equipment and prepare emergency generators. Preparatory actions include fueling vehicles and performing preventive maintenance and relocating vehicles to high ground or higher levels of

parking structures to avoid their being flooded. A sufficient stock of consumable resources should be on hand, and with adequate backup.

Each airport in a multi-airport system can request an inventory of assets the other airports have, and the system can have a plan for sharing assets during recovery.

Highway and mass transit disruptions and gridlock (hampering transportation of employees, passenger access, logistics, etc.) can affect the airport's ability to recover. It is important that the airport anticipate and plan for such surface disruptions.

During recovery from a major regional disaster, the airport should anticipate competition for critical services and delays in getting contractors. The airport can benefit by pre-arranging (pre-contracting) for debris removal and disposal services and by planning escort procedures and assignments for the contractors. The airport can establish contingency contracts for electrical inspectors and electrical contractors including airfield lighting and ATC systems. Airport-qualified electrical inspectors and contractors can be hard to find, so they need to be identified, contacted, and contracted with as part of preparedness.

The airport can anticipate the discovery of delayed latent damage to electrical and lighting systems from saltwater flooding. This means that recovery may last as long as one or two years as the latent problems become acute, so the airport should be prepared to replace all cables, connectors, and controls that have been exposed to salt.

Advance coordination with the FAA can ensure that sufficient repair parts are on hand for navigational aids (NAVAIDS).

Response and recovery plans should include an alternative aircraft fueling plan using auxiliary power and tanker trucks. A review of the airport's fuel capacity and storage needs will reveal if expansion is needed in case airport operations resume before it gets access to fuel resupply. Contingency contracts for fuel supplies can be arranged as part of preparedness.

Planning

Nothing trumps great preparation, and great preparation means having invited the right people to participate. This includes stakeholders, vendors, outside experts, and mutual aid partners among others. A pre-landfall meeting with the airport's construction, facilities, maintenance, mechanical, and electrical staff to discuss preparation for and recovery from severe weather incidents was highly productive.

Lessons learned from other types of disruptive events can be applied to the current incident. However, even similar events (e.g., flooding from Hurricanes Irene and Sandy) can unfold very differently with different consequences.

Since flood control pumps are so critical at EWR, a recovery plan including detailed instructions and sequences for reenergizing pumps will optimize protection of the airport's infrastructure and speed the recovery. EWR needs to work closely with the city, if city-owned flood control devices (gates, pumps) are essential to protect the airport; or an outside agency such as the U.S. Army Corps of Engineers for flood control.

A plan to shut down airfield lighting in advance of flooding can avoid short-circuiting, protecting lighting speeds recovery.

To minimize the possibility of dangerous projectiles during high winds, the AEP needs to have explicit instructions with priorities for tying down or securing loose debris and equipment in order to limit damage. The sooner equipment and infrastructure can be secured, the better.

Designating in-house staff as go teams for various specific damage or risk scenarios, or assisting during an emergency with customer or employee care, etc., can speed both response and recovery.

It is not adequate only to evaluate the best sheltering-in-place locations for various scenarios; it is essential to have a workable plan for relocating passengers and employees (airport and TSA) to those locations.

It is absolutely key to keep contact lists updated.

As part of the planning process, the airport should consider the need for formal agreements with business partners and whether those agreements include specific roles and responsibilities in the recovery phase.

Customer Service

In addition to providing secure locations for sheltering in place and the means to move passengers to them, the airport needs to provide cots and supplies for stranded passengers.

Care for Employees

From the recovery from Sandy, EWR learned important lessons for employee care:

- Provide fuel for employees to commute.
- Be sensitive to personal losses of employees and give them time to deal with family matters by rotating schedules wisely.
- Institute 12-hour shifts with at-airport berthing and messing for duration of response and recovery. Anticipate effects of gridlock and fuel issues.
- Coordinate with airport hotel for housing for essential managers and employees during recovery; make sure hotel has adequate emergency generator capacity to stay open.

Leadership

Airport recovery is an important symbol of return to normalcy for the community. Effective and prompt recovery builds goodwill and community support. Effective airport leadership includes encouraging ingenuity, resourcefulness, and creativity. Fostering such traits pays great dividends when novel situations arise that are not covered by plans or prior arrangements. As already noted, it is essential to have the right people sitting at the table. Political and economic issues can delay application of lessons learned, especially if non-airport owners or agencies are involved.

Overtime

Overtime typically becomes a major issue after recovery or even during it, so an airport should have an overtime budget ("discretionary overtime budget" at the Port Authority) in reserve for emergency management. Overtime charged to separate codes and identified as an emergency expense allows precise and complete documentation in case FEMA or insurance reimbursement is available.

The Airport as Refuge and Aid Station

The airport needs to be prepared for citizens (non-employees, non-passengers, non-tenants) to come to the airport to request aid, fuel, or shelter, and have plans and policies in place for crowd control and provision of assistance.

Evaluation—Closing the Loop

After dealing with two hurricanes in two years, EWR made changes to its after-action review process and how it uses the results from it. Its recommendations include:

- Focus priorities in the AAR to protect assets and prevent damage.
- Allow time for applying lessons learned for needs assessment, design, and procurement.
- Revise risk and hazard assessments as part of the AAR.
- Use training, drills, exercises, and events of the same type or other types to test revisions to the AEP, the CCCP, and other policies and procedures.

Summary

Lessons learned from Hurricane Irene in 2011 aided in Newark Liberty International Airport's recovery from Hurricane Sandy, although not all revised procedures had been fully implemented. Recovery at the airport was complicated by external factors, for example, gridlock and fuel shortages that complicated workers' commutes to work. Focused contingency planning and workarounds allowed flights to resume fewer than 48 hours after Sandy's landfall. EWR's EOC coordinated recovery efforts with PANY&NJ's central EOC, and the consistent application of NIMS and ICS worked well. The single most important element of recovery was restoration of electrical power and provision of emergency power from generators. The ATC tower operations, evacuation of the terminals, and operation of the tied gate and pump station all depended on the availability of sufficient emergency power.

CHAPTER THREE

FINDINGS

THE MEANING OF "AIRPORT CLOSED" AND "AIRPORT OPEN"

Interviewees repeated used such phrases as "the airport was closed" or "the airport reopened," most often in the context of aircraft operations. While some smaller airports may actually close down entirely, larger airports may claim that they never "close," or only close particular areas, because they consider the airport to be far more than just a place where aircraft take off and land. Even when aircraft are no longer taxiing or in flight, other activities—concessions, aircraft services, airport maintenance, vehicular traffic control, and airport administration—will continue to function, perhaps even at a greater than normal pace. This is why many larger airports object when the media, airlines, FAA, law enforcement, or others state that the airport is closed.

Unscheduled airport closures are generally triggered by either safety or security related incidents. Airport operators, the TSA, and the FAA function collaboratively and respectfully of each other's responsibilities and jurisdiction to respond, assess, and mitigate the associated risks. The airport certificate holder or operator is solely responsible for the partial or total closing and reopening of the airport.

This said, the FAA has ultimate control and authority over the National Airspace System which when shut down, as on 9/11, will essentially halt all landings and takeoffs from U.S. airports. From a national airspace or FAA air traffic perspective, an airport runway or taxiway is closed only when a recognized representative of the certificate holder or airport operator issues a verbal order or a written NOTAM.

The TSA has the authority to stop air travel or require that an area be rescreened for security purposes when it is deemed that a significant threat exists. The TSA may exercise this authority working in conjunction with the FAA and airports, as on 9/11; or in the case of a localized threat, through regulatory authority over the airport.

FAA 14 CFR Part 139 prescribes the rules governing the certification and operation of air carrier airports. Part 139 requires certificated commercial airports to develop an Airport Certification Manual describing how the airport will manage non-standard conditions including emergencies. The FAA has also issued hundreds of airport 150 series Advisory Circulars which further describe the standards for the safe operations of airports. These standards become regulatory through grant assurances, which apply to most airports including GA airports.

FAA 49 CFR Part 1542 requires airports to develop an Airport Security Program (ASP) that defines standards for the secure operations of the airport; in the ASP, the airport operator commits to maintaining the prescribed security standards and to taking corrective action when necessary to ensure those standards. Aviation security (AVSEC) protocols, up to and including the closure of the airport to aircraft operations until such time as security can be restored to the prescribed standard, are defined and agreed to within the airport's ASP.

The TSA may trigger AVSEC procedures when it deems that a security threat warrants such action. It is then up to the airport operator and its response partners to put the measures in place or to take the necessary corrective action before air traffic can resume.

Although the decision to open, close, or reopen an airport begins and ends with the airport operator or certificate holder, they must take into account binding agreements and approvals that have been incorporated in the airport's ASP and ACM. They also must ensure that agencies having an interest

or legal jurisdiction, such as FAA, TSA, CBP, FBI, and CDC, are respected, involved, and informed throughout the decision processes leading to recovery.

A MAJOR CULTURE SHIFT HAS OCCURRED

In the 37 interviews and particularly in the four case examples, the authors found that airports appear increasingly willing to share details, results, and lessons learned with their stakeholders, communities, peer airports, the media, and the public. One possible explanation is that such transparency is aimed at increasing the preparedness and resiliency of individual airports and of the aviation industry as a whole. This cultural shift seem likely to be at least partially the result of the environment of information exchange and mutual respect created by ACRP publications and panels, the airport disaster operations groups (SEADOG and WESTDOG), the ARFF Working Group, and the AAAE Emergency Management Conferences. At the request of San Francisco International and Los Angeles International airports, ACI-NA facilitated peer airport visits and conferences after those airports' major incidents in 2013. An airport emergency management community has emerged over the past three years, which has brought closer ties among airports. The cultural change seems to be the fruit of this emerging community and of senior management that appreciates and supports it.

EFFECTIVE MANAGEMENT PRACTICES AND LESSONS LEARNED

The interview data were qualitatively analyzed first by incident type and then by themes or broad categories. Based upon the results of this analysis, effective practices were grouped under the following eight broad categories (Figure 19) that are germane to an all-hazard approach to recovery at an airport after an emergency or disaster:

- Advance planning and preparation
- Command and control
- Mutual aid
- Comprehensive crisis communications
- Operations and logistics
- Employee care
- Customer care
- Assessment, revision and validation of changes.

FIGURE 19 Categories of effective practices.

When used in this report, the term "effective" means that most or all of the airports reported that a practice had improved or would have improved recovery.

Effective management practices compiled from the airports in the study are summarized in this chapter to provide guidelines airports can follow when planning, executing, training for, drilling for, and assessing the effectiveness of their recovery efforts. In each category, practices are presented in terms of which of the four incident types they fit: aircraft accidents, natural disasters, criminal acts, or systems failures. This grouping is different from the categories in a typical ICS structure and has been chosen to represent the main temporal or functional clusters of activities reported at an airport during recovery.

Advance Planning and Preparation

When it comes to recovery, all the airports share a number of practices that contribute to success and are committed to continually improving these practices. Advance planning and preparation involves stakeholders and encompasses planning, training, preparing facilities and equipment, ensuring the availability of critical supplies and services, and making financial and accounting arrangements. In addition, for incidents involving aircraft accidents, part of the planning process is preparing to work with and anticipating the requirements of NTSB and other investigators.

Planning

The most effective practice is to have a recovery plan accompanying each response plan. Response and recovery plans can be all-hazards or there can be separate plans for each hazard; both approaches were seen among the 37 airports. Where the recovery plan is inserted into airport plans is a matter of local choice and does not appear to affect the usefulness of the plan or the quality of its outcomes. Recovery plans were variously seen as:

- part of airport emergency plan (AEP),
- part of the airport's continuity of business plan (COB or BCP),
- part of the continuity of operations plan (COP),
- a stand-alone all-hazards recovery document,
- a series of recovery plans for specific types of incidents,
- a series of response and recovery plans for specific types of incidents, or
- some combination thereof.

The recovery plan works most effectively when linked by reference to the other documents, and complementarity helps avoid confusion and unnecessary delays.

Recovery plans using an all-hazards approach appear to be more robust and satisfactory to airports than recovery plans based on a single incident type or subtype. In any case, the recovery plan works more effectively when based on facts along with realistic risk and hazard analyses. Geo-based risk analysis is helpful for planning safe storage of essential equipment for recovery. Plans would consider the effects of off-airport systems failures and the possibility of cascading systems failures.

Involvement of all stakeholders in the development and review of a recovery plan improves the quality of the plan and its usability. This is the "Whole Community Approach" to emergency management" (FEMA 2011b). Furthermore, it creates buy-in for the plan and builds relationships that make complex recovery actions more likely to succeed (see also Smith 2014).

Leases and contracts can be implemented to require airlines, tenants, and concessionaires to have local recovery plans compatible with the airport's plan, and to spell out obligations, roles, and responsibilities of these entities during recovery.

If a recovery plan does not include procedures to ensure that members of ICS structure, including IC or UC members, or other key employees or mutual aid partners can access the areas where they

are needed, delays in establishing the on-scene command post or even activating the airport EOC can result.

Training

A unifying tenet at most of the airports was that effective training on NIMS and ICS is essential for airport employees, key airline employees, key tenants, and mutual aid partners. Periodic refresher training ensures preparedness. The airports reported that holding an annual briefing on recovery plan and procedures was beneficial for airport employees, airlines, tenants, concessionaires, and mutual aid partners.

Effective recovery may require special planning for how to:

- get employees to work (dealing with gridlock, fuel shortages, mass transit disruptions, routes, vehicles, staging plan, etc.);
- accommodate citizens (non-passengers, non-employees at airport) who come to the airport for shelter and aid;
- control access to the airport during recovery;
- work with airport-to-airport mutual aid groups (i.e., SEADOG and WESTDOG); and
- work with NTSB or other investigators if a crash or criminal act is involved. NTSB training courses and workshops are particularly valuable for this eventuality.

Training for rare occurrences tests the limits of the recovery plan and the skills of personnel. It also encourages creativity, which is important when an incident develops in an unexpected manner, systems fail, or equipment is not available or breaks down, and flexibility and innovative problem solving are needed.

Initial and recurring training on web-based coordination systems used for emergencies and in airport EOCs is essential. Several airports reported issues and delays caused by trying to use unfamiliar systems. If such web-based systems go unused for months or years between emergencies, vital personnel, including mutual aid partners, may forget how to use them (IEM Inc. et al. 2013).

Preparing Systems, Facilities, and Equipment

Every airport found it important to have backup plans in place for all critical systems, procedures, equipment, and personnel. Backup approaches include procuring and maintaining equipment such as emergency generators, but also include developing alternate procedures and workarounds.

Testing all systems critical for recovery—communications, alternative communications, notification, and web-based coordination systems—prevents delays or other problems with recovery.

Arranging to Obtain Critical Supplies and Services

A major element of success in recovery is to pre-arrange access to services, spare parts, airport NAVAIDs, and consumable resources. The FAA can help an airport identify sources of backup or replacement airport NAVAIDs systems and parts. It is prudent to negotiate contracts for specialized services in advance (e.g., aviation law, public relations, debris removal and disposal, airfield lighting electricians, or electrical inspectors). It is also advisable that airports know where to obtain specialized services and equipment, for example, cranes and other equipment for recovering aircraft wreckage.

A relationship with one of the airport-to-airport mutual aid programs such as SEADOG and WESTDOG can be leveraged not just to obtain assistance from experts at other airports but also to facilitate the loan of long lead-time repair parts (IEM Inc. et al. 2012).

Financial and Accounting Arrangements

Airports that made preparations for recovery in their business procedures, finances, and accounting systems reported satisfactory outcomes. Such preparations typically included:

- Budgeting for contingencies to cover response and recovery in emergencies and minor disasters;
- Establishing adequate cost and expense record-keeping systems to support eventual reimbursement or insurance claims, ideally integrated into a web-based coordination system;
- Establishing a system for tracking personnel and equipment for possible reimbursement or insurance claims;
- Reserving sufficient cash to run the airport for four to six days (when a forecast allows) in case bank services are unavailable during response and recovery;
- Pre-authorizing overtime for recovery activities; and
- Pre-authorizing purchasing of supplies and services likely to be required for recovery (e.g., modular buildings).

Command and Control

Overwhelmingly, the airports surveyed indicated one of the top effective practices was the creation of a Unified Command (UC). A UC can be conducted both in the field and in the airport EOC. Generally a UC consists of the ICS and NIMS responders, as well as representatives from stakeholders in airport-critical lines of business (maintenance, IT, parking, tenants, airlines, etc.), along with TSA, FBI, CBP, FAA, FBOs, utility companies, etc.

Exercises ideally involve all groups that may be part of the UC during a critical situation where compliance with NIMS/ICS is required. A common theme in many airport interviews was that ICS, EOCs, and UC uphold the principles of standardization and collaboration to ensure effective communications among all responders and external agencies and help coordinate efforts of individual agencies (Stambaugh et al. 2014).

The ICS is comprised of five major functional areas: command, operations, planning, logistics, and finance/administration. A sixth functional area, intelligence/investigations, may also be established if required (Deal et al. 2006).

A number of airports identified planning section responsibilities as an area needing improvement and additional training. The planning section plays a critical role during the recovery phase. This section maintains information and intelligence on the current and forecast situation, as well as the status of resources assigned to the incident. It also prepares and documents the IAP and maps, gathers, and disseminates information and intelligence critical to the incident.

It is important that the planning section of the ICS structure be familiar with the recovery plans in place and utilize them during the incident. Both response and recovery plans should be proactive, not just reactive. Ideally, the planning section would be planning for recovery from the beginning of the response phase, and planning would continue for later stages of recovery during each current stage.

The EOC planning section must prepare for impacts to the airport's various systems, knowing that those impacts will change as recovery progresses. The section must effectively manage human resources to provide adequate rest and shift rotations of available staff to ensure prompt and continued recovery. Event management technology platforms can aid in the organization and communication of recovery staffing schedules. Accurate real-time record-keeping and documentation such as report forms, checklists, and data collection are critical for seeking future possible reimbursement. Good record-keeping and documentation can prevent troubles when critical incidents occur. The worst time to discover that the out-of-date toothpaste in customer care kits has turned to powder is during distribution.

Airports also asserted the absolute importance of ongoing training for ICS, airport EOC and UC roles, responsibilities, and procedures. All airport department heads and key personnel and their backups would benefit from training in airport EOC functions. This became quite clear from the smaller airports interviewed, as they simply ran out of personnel; they indicated that some transient volunteers did not apply ICS as proficiently as locally trained members, creating minor barriers in the airport EOC.

Airports also reported that training employees for dual roles, for example, training maintenance personnel for crowd management during repopulation after evacuation, was the highest and most effective use of available personnel. It is important that stakeholders be educated as to their roles within UC, clearly understand these processes, and know how and when to interact.

Mutual Aid

Several airports identified instances where recovery was expedited by mutual aid partners. Airports leverage a majority of their mutual aid from agencies in the surrounding areas; but interviewees frequently referred to the benefit of establishing an airport-to-airport mutual aid consortium. Several pointed to the value of belonging to SEADOG and WESTDOG, two widely known airport Disaster Operations Groups (DOGs).

Along with the airport-to-airport mutual aid groups, it is also very important to establish mutual aid within an airport's own system of airports, as well as with neighboring airports. For example, Colorado has a highly specialized airport-to-airport/airport-to-community mutual aid program, the Colorado Aviation Recovery Support Team (CARST), which provides mentoring, support, and guidance to assist in an airport or community recovery from an aviation incident (*ACRP Report 73*—IEM Inc. et al. 2012). Another identified effective practice was to establish a contractual relationship or mutual aid pact with necessary systems vendors and contractors needed immediately following an emergency.

One airport in this study has an Airport Community Emergency Response Team (A-CERT) (Griffith et al. 2014). Another airport developed something analogous to an A-CERT immediately after the incident studied in this report, and numerous other airports reported that they are exploring A-CERTs.

Local volunteer groups, such as the Citizen Corps, can provide NIMS-certified volunteers familiar with ICS environments who can provide substantial support during the recovery process. Using volunteers would require developing a plan for escorting un-badged helpers.

The language of tenant contracts and agreements is a critical element of preparation for recovery efforts. Many airports formulate emergency support language into their agreements with airport-based contacts, agencies, and tenants. These agreements can include support for areas such as incident reporting and cleanup criteria, and delineate required tenant participation in emergency training and exercises.

Airports also stressed the importance of formal agreements for services such as aircraft recovery and removal contractors, debris removal contractors, and HAZMAT companies. If possible, contract-based assistance would be exercised before any actual incident. Agreements with companies or other entities such as the military or FBO groups that have appropriate and sufficient equipment to recover damaged aircraft would be established. Ideally, these agreements ensure that the airport will exercise the highest priority access to such specialized equipment and manpower.

Airports are advised to prepare and familiarize partners with routes, escort procedures, credentialing, and other access details and limitations. It is essential that the airport clearly designate staging and marshaling areas and ensure that their mutual aid partners are familiar with their locations and access procedures. One airport emphasized that to be effective, these agreements must extend beyond paper; in an emergency, they depend on well-developed relationships with local and regional partners. Both

formal meetings and informal gatherings build trust, enhance communication, and foster commitment to common goals (Smith 2014).

Comprehensive Crisis Communications

The majority of airports surveyed indicated they have a communications plan as part of their AEP. However, they report that the plans often lack depth and clarity, especially concerning emerging technologies such as social media, websites, cell phone failures, control of PA systems, and internal and external mass communications during an emergency. Several airports have added additional public relations staff to attend to the complex environment of modern communications. A number of airports encountered issues with their emergency communication capabilities during incidents, and are currently developing and revising crisis communications plans separate from their AEP. A stand-alone communications plan can be updated rapidly in a changing media and communication environment. The *ACRP Report 65: IROPS Guidebook* (Mead and Hunt and Risk Solutions International 2012) provides checklists to help create communication plans for irregular operations at the airport.

Airports also emphasized that it is necessary to act in concert with other responding agencies and "speak with one voice" when making statements concerning emergencies. Difficulties with messaging and media relations frequently arise in AARs.

Consistent and accurate communication of facts before, during, and after an event facilitates effective recovery. The role of the airport's PIO during disasters must be clearly understood. Lack of message discipline can quickly complicate recovery efforts, confuse and frustrate stakeholders, and result in the loss of public confidence. A few airports indicated they now have contractual agreements with public relations firms to assist in time of crisis, as they do not have adequately trained staff and/or they are required to reserve airport staff for in-house matters during a crisis. As events unfold, it is important that airports ensure that their PIO is working through the multi-agency Joint Information Center (JIC); involved agencies should avoid making statements outside of the JIC. Several airports recommended the PIO courses provided by NTSB as particularly useful.

Communication issues were a constant topic of concern throughout the interviews, and airports are very aware of the benefits of a CCCP for both internal and external communications. Technologies that develop and disseminate a COP of an event can help maintain consistency of critical information and greatly enhance communication and information sharing between EOCs, UC teams, field command posts and other critical stakeholders. COP technologies require user training and periodic refresher courses for all levels of airport staff, airlines, tenants, and mutual aid partners. Many COP technologies provide functionalities such as real-time information sharing, event management and documentation, resource tracking, and asset management. Data collection and documentation from COP technologies can support AARs as well as post-event training. *ACRP Report 94* provides more information on web-based emergency management systems (IEM et al. 2013).

A Wireless Emergency Alert system quickly reaches all cellular phones within a predefined area with critical life safety information. Other systems to explore include social media, websites, reverse 911 message systems, etc., can all be adapted to improve ADA compliance.

Airports realize the necessity for effective and immediate communication with the public within their facilities during natural disasters. Timely and effective public notification can be a challenge for airports when PA systems are compromised or are zoned in a manner that fails to reach certain areas. To avoid negative consequences during an incident, technology-based announcement and warning systems require regular maintenance and testing.

Social media can be a valuable and effective communication and assessment tool before, during, and after a natural disaster or emergency, if Internet access is intact. To prevent the spread of misinformation, most airports assign an individual to monitor social media for public comments about an event. Technology systems are available that provide mass filtering and search capabilities to

gather and survey public comments and communications regarding a disaster; this information helps airports better understand public needs and perspectives.

While some airports report real success in their ability to utilize social media during an incident or event, others report a need to incorporate or improve procedures and policies regarding social media in their CCCP. Many of the small GA, reliever, and non-hub primary airports strongly advocated outsourcing media relations, public relations, and social media management to a public relations firm, an aviation law firm, or both. If an airport does not have a trained PIO on staff or an aviation-savvy PIO available from a sponsor or sister agency, an outside agency can help prevent misstatements and misunderstandings that might result in long-term damage to an airport's reputation and economics.

Overwhelmingly, airports continue to struggle with the ability to maintain interoperable radio communications. All of the airports stressed the absolute necessity of interoperable radio systems within and among the airport, the city or county EOC, and mutual aid partners in every phase of an emergency event. Several also noted that airlines' station managers, major airport tenants, and contractors would benefit from being included in the interoperable communications system.

In general, airports understand that they cannot assume they can solely rely on cell phones, landlines, or the Internet during an emergency or disaster, as these systems easily fail during extreme events. Many airports stress the importance of establishing independent back-up communications systems.

A common theme throughout the interviews was that systems often fail during emergencies. System failures can be idiosyncratic, or, as many airports report, they are often a byproduct of a larger incident, most often a weather event or natural disaster. While many weather threats are forecast in advance, severity and damage is an unknown until the event has subsided. Good forecasting gives an airport a window of opportunity to ready the facility; however, system failures outside the airports, such as banking, can seriously hamper recovery if airports do not have a predetermined amount of cash in reserve.

Aircraft accidents and criminal acts are much less predictable, making the planning and training phase more essential as the event plays out in real time. Many airports reported they were continually amazed by the number of functions at an airport that are controlled electronically, from doors to escalators to ticketing; losing power and/or connectivity means these systems are useless, and sometimes even present a hazard. It is a sound practice to inventory all electrical systems at the airport and determine backup systems or plans in the event of system failure.

Employees tend to use only systems that are familiar. Airport employees who rarely use emergency systems are not comfortable with them and as a result may not use them during the height of an emergency. Airports with emergency management-specific systems found that their employees were either unable or reluctant to utilize them; this universal observation calls for evaluating systems for user-friendliness as well as regular use and enhanced training to improve proficiency in an emergency.

As previously indicated, some airports have technology systems specifically designed to drive EOC functions and/or share a COP during events or emergencies. Many airports stressed the importance and value of these systems for overall record-keeping, asset and resource management, and of sharing a COP with involved stakeholders.

Operations and Logistics

Response and recovery almost always require cooperation. Airports realize that operations throughout all phases of an emergency or natural disaster involve a variety of responding agencies and businesses, often among several jurisdictions. It is important that all participants be well versed in the guiding principles of NIMS, ICS, and UC, and possibly the National Response Framework. All

operation groups responding to an airport event must understand and practice the principles of ICS throughout the response and recovery phases. Nearly all of the airports surveyed hold ongoing ICS and NIMS training for their personnel. Even smaller airports (non-Part 139) found ways through their jurisdictions to receive training in NIMS and ICS, leading to stronger cohesion among all responding groups and greater flexibility when managing the event or incident.

NIMS and ICS training standardizes approaches to organization and communication; this facilitates effective communication among all responders and external agencies and helps coordinate efforts of diverse individual agencies (Stambaugh et al. 2014).

NIMS and ICS designate a single centralized IC or UC to manage all responding operational groups. A typical response begins with an IC but shifts to a UC if the response becomes complex. However, many airports report that they initiate the UC command structure from the start, as recovery operations at airports are typically complex immediately. In cases where a UC was in place at the beginning of recovery, command often shifted to an IC, usually an airport department head, as the situation became more manageable.

Several of the incidents reviewed involved a phased approach to recovery wherein normal operations were restored to individual portions of the airport sequentially over time. These types of responses can quickly complicate the planning and communication efforts involved. Several airports reported practicing a "warm start" for their recovery efforts, planning the details of recovery from the very beginning of the response phase, as described in the LAX case example. In these cases, despite the prolonged investigation phase, the warm start enabled the airport to develop and activate a detailed, focused, and highly organized recovery, saving time and money. Multiple airports urged their peers to pre-plan recovery strategies, and when disaster strikes to start planning the specifics of recovery as early in the response phase as possible.

As related to recovery, many airports indicated a need for specialized response and inspection teams for evaluating and addressing structural and environmental compliance issues. They advocate activating internal go teams to inspect the airport's infrastructure and assess damage, capacity, and environmental issues following an incident. Airports could benefit from developing incident type-specific inspection plans, assignments, and priorities for inspections. Some airports within the FAA Southern Region report that their Regional Office of Certification Inspectors has a checklist they utilize to assess hurricane damage.

Inspection teams should be established before events when staffing allows, and made familiar with Building Inspection Code Enforcement (BICE). Electrical inspectors qualified to inspect airfield systems (e.g., lighting) can be pre-contracted to guarantee rapid response when needed. Airports may want to include engineers as an integral part of the inspection teams as well; this practice will assist return to normal operations as well as uncover long-term issues that will of necessity be identified and addressed following recovery. All critical areas would have pre-designated inspection teams to rapidly assess safety, functionality, and repair requirements. The teams, their use, and their procedures would to be drilled with the airport.

Effective practices call for communication and planning with the airport's certification inspector. To achieve a phased recovery, airports often are required to obtain waivers for operation from the FAA; it is best that communication with the airport's certification inspector regarding these and other procedures take place well ahead of a forecast weather event.

Employee Care

Respected, supported, and properly trained employees ensure an effective recovery. At all times, but especially during a recovery, it is important that airports manage human resources effectively to ensure an uninterrupted, continuous effort. It is prudent to anticipate shortages or procurement issues and be prepared to provide basic employee requirement such as shelter, food, rest, comfort, and supervision.

Emergencies and accidents generally bring trauma, suffering, and loss. Most airports surveyed identified a stress debriefing as a critical piece of airport recovery, as unprocessed trauma can lead to problems down the road. Individual and small group counseling is often made available during the recovery process and is especially warranted at airports that experience an aircraft accident or criminal act. Previous research favors the use of a facilitator with aviation incident experience (Kenville et al. 2009).

Several issues emerged regarding planning, training and assessing employee care prior to an emergency. A plan would be in place to rotate employees for each operational period, as people require rest even when commitment and adrenaline levels are high. Event management technology platforms can simplify and expedite organization and communication of recovery staffing schedules.

Most of the airports reported conducting critical incident stress debriefings for employees, tenants, and stakeholders during their final phases of recovery. Separate from the AAR meeting, these stress debriefings make mental health trauma specialists available to employees to help them process the event in their own ways. Most found it beneficial to employ someone outside the organization with aviation experience. They emphasized the benefits of addressing sensitive issues in small peer groups rather than a single large meeting.

A number of interviews pointed to the importance for providing training for both emergency and non-emergency personnel to determine and improve their competence in certain areas. Other airports noted in their AARs that employee depth of knowledge and expertise, and scheduled rotation of personnel working on recovery events required proactive management. A repeated theme was the need for further cross-training of personnel to qualify them to serve in multiple backup and relief roles. Training critical airport personnel on NTSB site documentation can facilitate efficient runway re-openings.

In the case of natural disasters, personnel may want respite care to attend to their own homes and family members. Several airports reported assisting staff with cleaning debris and storing belongings; this type of respite ensures they can return to their roles rested and without distraction. Recovery efforts can be bolstered by training employees for dual roles; for example, maintenance personnel can be trained to assist in crowd management during repopulation after an evacuation.

Customer Care

The safety, care, and comfort of customers was an overriding theme in all 37 interviews. Most airports pride themselves on providing high quality customer service; in a crisis, however, customer service is put to the ultimate test. Many airports assume that in the event of a disaster, airlines will meet the needs of the family and friends of victims, as required by the Aviation Disaster Family Assistance Act of 1996. However, some interviewees indicated that this was not always the case in actual crises. Airports cannot assume that the airlines will be able to meet the immediate requirements of family and friends of customers at their airport, and many larger commercial airports have experienced situations that necessitated the activation of an airport response plan for family assistance functions following an air disaster. Many airports are now considering developing their own specific family assistance plans. The need for family support is most acute when very few airline employees are on site or when airline customer services at the airport are outsourced to third parties.

Three airports that experienced general aviation accidents said they were poorly prepared to deal with the family assistance portion of the recovery process. Often the local FBO is not connected with the aircraft in question, and therefore has no responsibility to assist the airport. Airports would be wise to develop plans for assisting the family and friends of the victims throughout the recovery phase.

Interviewees also recommended that airports be prepared to manage and care for the public within their facilities when events occur. Many airports reported having a “Stranded Passenger Plan” to

guide the process of providing service to travelers in need. Several airports noted that their IROPS plans provided a good basis for this.

Assessment, Revision, and Validation

All 37 airports perform aggressive after-action reviews following every incident, including recovery. In the AARs, the airports review actions, outcomes, and consequences to see what worked and what needs improvement, and incorporates the results into revised AEPs, recovery plans, etc. The resulting plans and changed procedures are then typically tested using tabletop exercises (TTX), drills, and full-scale exercises; and eventually the revised plans and procedures become the basis of updated training requirements and lesson plans.

Several airports achieved considerable success using an outside facilitator to help develop AARs; others are considering using an outside contractor to facilitate exercises and plan review processes. Airports found that a critical outside post-event review of their actions led to more substantive lessons learned that then were built back into their AEPs, response plans, and recovery plans.

Most of the interviewees advocated taking an all-hazards approach when developing emergency plans, especially when building plans for their facilities. *ACRP Report 112* (Griffith et al. 2014) provides a guidebook and templates for the development of comprehensive Terminal Incident Response Plans (TIRPs) that cover events such as evacuation, shelter-in-place procedures, and repopulation for a variety of incidents that disrupt normal operations in airport passenger terminals: snowstorms, hurricanes, tornadoes, earthquakes, structural fires, electrical outages, bomb threats, security breaches, and active shooter incidents. The approach in *ACRP Report 112* can be used for recovery planning for the entire airport, not just terminals.

A comprehensive TIRP plan addresses the following areas:

- Care of stranded passengers during recovery, as airlines may be overwhelmed;
- Specific recovery plans for terminals, both airside and landside, including people movers and utility services;
- Repopulation as a specific recovery activity that is typically very different from evacuation or sheltering-in-place; and
- Information technologies systems restart issues and procedures.

It is generally recognized that effective emergency plans must be tested, tried out, and revised regularly. Past emergency event scenarios can provide effective training and exercise topics. Most airports surveyed hold regularly scheduled TTXs, and many do extra TTXs to test changed plans, procedures, or new mutual aid relationships.

Plan continuity between agencies and businesses expedites efficient and effective recovery. Airports identified a need to test plans for consistency with other agencies having overlapping jurisdictions. Each federal agency has its own plans which could be shared, revised, and blended to ensure consistency during each of the four phases of ICS. To maintain preparedness, airports are advised to anticipate the demands and expectations of outside groups and individuals such as the FAA, the TSA, the airport's Certification Inspector and Federal Security Director, as well as Customs and Border Protection and other federal agencies. Airline and tenant recovery plans must also match the airport's plan. Annual disaster briefings provide a venue for airlines and tenants to evaluate and share plans for consistency with the airport's recovery plan. Regular trainings with stakeholder groups and other agencies also provide a venue to coordinate and collaborate on specific plans.

Airports realize the importance of multi-dimensional plans that help them anticipate the unavailability of one or more identified support providers; effective plans are built in overlapping layers. Such multi-dimensional recovery plans are linked to the airports' core capabilities and mobilization of resources.

EVALUATING AND MEASURING THE EFFECTIVENESS OF RECOVERY PLANS AND ACTIONS

Assessment metrics are defined as a set of prescribed measurements used to determine successful performance and/or establish benchmarks with relation to other airports. Reliable data are essential to effective metrics, but in the often chaotic context of emergency response and recovery, it can be challenging to obtain them, much less compare them over time or to another organization. *ACRP Report 19A* (Hazel et al. 2011) describes 23 functional areas (e.g., ARFF and risk management) that can be assessed using airport performance indicators. Five performance indicators are used to track staffing levels, costs, and response times. In the ARFF area, quantitative indicators are based on financial issues, and do not necessarily assess the airport's performance in responding to the incident. The ACRP report identifies two safety/risk management metrics, but they pertain to employee accidents and runway incursions, both unlikely to be major factors in recovery operations.

An emerging tool that has the potential to facilitate the evaluation of recovery efforts as well as response is software that collates and displays a COP. Such a system can give at-a-glance awareness to ICs and UCs as well as to senior policy groups, multi-agency coordination centers, and JICs. Systems that generate and store COPs are invaluable tools for AARs, and many of the interviewed airports urged their expanded use.

The lack of performance metrics and assessment methods appears to result from the difficulty in determining, rating, and ranking an airport's performance with respect to a large-scale emergency response and recovery. Airports in this study develop strong after-action reports, but those reports are largely qualitative and narrative in nature and are primarily used to develop lessons learned in the field for incorporation into updated plans and future training exercises. While identifying lessons learned is an important aspect of continuous improvement, they can very easily be idiosyncratic and particular to the airport, and may not be applicable to all airports.

Surveyed airports suggested that the main metric for the effectiveness of a recovery was duration; that is, a speedy recovery is a successful recovery. This oversimplifies and even undermines a more balanced assessment of "success." None of the airports reported using metrics for preparedness.

Each incident is affected by unique factors (e.g., Newark Liberty's challenges with pumps and utility companies), and many factors that influence recovery phase are outside airport control, such as social media activity. Further study is needed to determine exactly how to quantify and report on airport recovery efforts using generally accepted performance measures.

EXISTING ISSUES

Architecture of Unified Command at Airports

Each airport interviewed indicated that it would benefit from a UC and an EOC. There is a related awareness that post-emergency response and recovery would be facilitated by the involvement of airport administration, operation, maintenance, and other specialized personnel, as well as key mutual aid partners and utility companies, in the airport EOC and ICS structure. Consequently, airports would be prudent to consider inviting a wide range of players to participate in planning, training, drilling, and exercising for the execution of the EOC.

Until FAA Advisory Circular 150/5200-31C required AEPs to incorporate all elements of NIMS and ICS, including the training and mutual aid aspects, most airports paid relatively little attention to the mechanics of NIMS and ICS implementation. At many of the airports surveyed, understanding and applying the concept of the UC—that is, command and control through a committee—continues to be a work in progress. Airports where police, ARFF, and airport operations staff work closely together on a regular or day-to-day basis appear to have a much better understanding of NIMS and ICS.

However, a UC is not a typical command structure for police and fire response on the streets, and therefore tends not to be applied in the early response phases at airports, where the IC roles are

generally organized around police or ARFF. These types of airports typically conduct emergency response using the same narrow ICS structure with little or no support other than that provided from the core first responder agencies of police, fire, and airport operations.

Consequently, UCs are very rarely employed for response and recovery and are used at only a few of the airports surveyed. Since the final extended deadline for approval of NIMS-compliant AEPs in 2012, most of the 37 airports have been grappling with how to implement UCs. In the interviews, a majority of the airports indicated a lingering uncertainty about how to leverage the greatest effectiveness from applying the UC concept in an ICS and NIMS environment, especially during recovery. Even fewer airports understood how, under NIMS guidelines, the UC is expected to change size and composition to reflect fluctuating needs during evolution of the incident from response to recovery.

Extent of Commitment to NIMS and ICS in Recovery

The interviews revealed widespread general awareness of the importance of NIMS and ICS training; however, many airports still appear to lack a solid working knowledge of NIMS and ICS principles as they pertain to regulatory compliance and actual application in emergencies. All 37 airports appear fully committed to NIMS and ICS in the planning process for the response phase. Application of NIMS and ICS during planning for recovery is, however, far more uneven.

Extent of Commitment to EOC in Recovery

Many of the airports in the study do not have their own EOCs. This is true not only of most GA and reliever airports but also of many small and even medium-size Part 139 airports, which rely on their local law enforcement agencies. The airports without EOCs may use ICS without an EOC, or use their city's or county's EOC, or implement IC without any EOC.

Airports with their own EOCs appear to have a much better understanding of the concept of UC. This may be true because the basic concept of an EOC is to provide support to the IC and the ICP as well as to manage overall impacts. This concept is the same within a multi-agency coordination center environment, where all agencies and experts involved support the IC in the development of a comprehensive IAP. For most of the incidents studied, the IC was a field command post. In a few cases where the event was either forecast or more airport-wide, the EOC served as the ICP. In even fewer cases, the IC function initiated in a field command post and was later transferred to the EOC during the recovery phase. This appeared to be the most effective strategy for recovery because these EOCs functioned as UC by including multiple agencies and area experts.

Airports also found that having access to a back-up EOC is very important. The back-up can be a second site on-airport, an off-site facility belonging to a partner agency, or a mobile command post. Over half the airports reported having mobile command posts or access to ones. Training and practice using the back-up EOCs is essential.

Integration of Mutual Aid and Other Partners in Airport EOC, NIMS, and ICS During Recovery

Since airport recovery is typically a complex array of actions requiring expert coordination, it appears to be most effective to establish the UC in the airport EOC and organize the EOC following ICS structure. In cases where such UC/EOC structures were used, airports reported that involving critical lines of airport business into the recovery management process yielded positive outcomes, as it allowed their specific requirements and issues to be addressed and incorporated into the overall recovery plan or IAP. DFW calls this UC/EOC structure a "hybrid" EOC. In such cases, involvement of partners still falls within accepted NIMS principles. The area of ambiguity or interest to explore here is how smaller airports can most effectively establish EOCs or avail themselves of the advantages of having an EOC without having one at the airport.

Status of Comprehensive Crisis Communications Planning and Implementation

While all certified airports meet the FAR Part 139 requirement, nearly all airports interviewed indicated that, in reviewing what went wrong and what went right during response and recovery, they found communications planning and implementation called for improvement. Many airports are in the process of developing CCCPs, and inquired if any were available. Several airports indicated they prefer their communications plans to stand apart from their AEP for the flexibility to incorporate the frequent rate of changes in theory, technology, social media, personnel, etc.

Many airports also indicated they added public information/communications specialists to their staff to help develop and implement crisis communications plans as well as handle the avalanche of requests for information that follow emergencies. A few airports indicated they contracted services or called on their governance body for permanent assistance. The demand to increase communications capability during and after disasters was a major lesson learned in nearly every after-action review in this study.

Metrics and Other Methods for Evaluating Recovery Plans and Procedures

Assessment metrics determine whether recovery plans and procedures are effective in real-world practice, being used either to determine benchmarks internally or to facilitate external comparisons. They provide a feedback loop that drives continuous improvement. Most airports surveyed rely on AARs, typically written narratives generated collaboratively by the parties involved, possibly with consultants. A COP system that logs data can be used to develop metrics for recovery.

None of the airports indicated that it used any sort of metric routinely, as in a conventional quantitative assessment. If indeed airports determine that they want and are required to quantitatively measure the level of success of response and recovery, then a universally acceptable metric will have to be developed. As stakeholders discuss areas for improvement during an after-action report, it is easy to say that response and recovery efforts were sufficient or insufficient; however, currently no hard data exists that describes, defines, and measures optimal situations. Moreover, there is no generally accepted definition of "success of recovery."

Performance measurement may include such processes as how long each group or department takes for recovery of their responsibilities. When all such measurements are assembled for each system that needs to be reactivated, this is the metric for overall recovery of the airport. Resource allocation and measure of success are different for different parts of the operation of an airport. Pending the development of recovery metrics (see "Suggestions for Further Research" in chapter four), the development and sharing of clear and true information, including COPs, and pinpointing what is needed for the process may be sufficient for planning.

INTRODUCTION TO THE LIST OF AIRPORT EMERGENCY POST-EVENT RECOVERY PRACTICES

Findings from the airport interviews and case examples were described, analyzed, evaluated, and filtered for effectiveness, desirability, or both; then organized into eight categories. The primary test of effectiveness is efficacy, that is, "this worked well;" and the primary test for desirability is the existence of current plans for improving preparedness as revealed in practice.

Data collected were amassed from some of the most current airport emergencies ranging in scope from small and easily addressed to very large, all-encompassing, exhaustive events. Regardless of the magnitude of the incident or the size of the airport, every interviewee had useful points to share with the airport community.

The list (Appendix A) is intended to provide a user-friendly "grab-and-go" type of document. It is not a rigid guide; rather, it provides a starting point that an airport can use to develop new recovery plans and procedures, evaluate existing plans and procedures, or guide a gap analysis of the airport's preparedness in terms of its ability to recover well. For example, listed practices include large items such as relationship-building, being proactive rather than reactive, and always having a recovery plan to accompany each response plan; and detailed items such as providing psychological support for employees after an incident.

CHAPTER FOUR

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Analysis of the data in this report yielded the following major conclusions:

1. There has been a major cultural shift among airports. In the interviews and documents, airports appear much more willing to share their detailed after-action review results and lessons learned.
2. Greater clarity is required in statements referring to an airport's being "closed" or "open," and greater control is necessary over who and how such statements are made.
3. The keys to a successful recovery are awareness, flexibility, and planning.
4. Relationships—among airport departments, between airports and their mutual aid partners, and between airports and other stakeholders—are essential to effective recovery, and relationships can be built in advance with a purpose, which is effective response and recovery.
5. Risk-based and fact-based advance planning support successful recovery.
6. The National Incident Management System (NIMS) and Incident Command System (ICS) provide sound guidelines for airport response and recovery efforts.
7. Airports require, and are requesting, more training on NIMS, ICS, and Unified Command (UC).
8. A UC, typically inside the airport Emergency Operations Center (EOC) if the airport has one, is the most effective means of command and control of recovery activities, at least during the early complex stages.
9. Airports that have and use comprehensive crisis communications plans find them indispensable during both response and recovery, and incorporate real-world experience into their plans. Airports without such plans want to develop them.
10. The speed of an airport's return to normal operations is a key aspect of the perceived level of success of a recovery. There is no industry-wide accepted definition of a successful recovery and no metrics currently exist to quantify success in recovery.
11. The perceived level of success or failure of an airport's recovery impacts the airport's public image and standing in the community.

Further research is suggested in 11 areas, listed in descending order of importance:

- Comprehensive crisis communications planning and implementation
- Airport family assistance planning
- Further development of common operating picture systems, especially as applicable to recovery and after-action reviews
- Use of and commitment to NIMS and ICS in recovery efforts
- Commitment to use of airport EOC in recovery efforts, including ways to improve integration of other partners in the EOC, NIMS, and ICS during recovery
- EOCs or EOC alternatives for resource-constrained airports
- Collection of data on specific elements, processes, stages, and phases of recovery, and associated terminology and concepts
- A complementary study that integrates lessons learned from this report, but focuses on airports that primarily serve cargo or are major cargo hubs
- Creation of a template for recovery plans, with the template scalable to serve airports of all types and sizes
- Airport-specific NIMS and ICS forms and checklists to guide recovery efforts
- Metrics and other methods for self-evaluating recovery procedures and plans, ideally associated with a template for recovery plans.

GLOSSARY

Advisory Circular—Instructions from the FAA on how to comply with federal aviation laws and regulations.

After-action review—A review, usually internal, conducted after response and recovery from an incident are complete, for the purpose of evaluating performance and fine-tuning plans and procedures for future incidents.

Air operations area—Any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft.

Air traffic control—The process by which aircraft are safely separated in the sky as they fly and at the airports where they land and take off.

Air traffic control tower—A tower at an airfield from which air traffic is controlled by radio and observed physically and by radar.

Aircraft Rescue and Fire Fighting—Specialized fire fighters, rescuers, procedures, and equipment to deal with aircraft accidents at an airport.

Airport Community Emergency Response Team—A Community Emergency Response Team (see entry below) that is specially trained to assist in defined functions at the airport to which it is attached.

Airport emergency plan—A comprehensive plan for dealing with all hazards reasonably expected to affect a given airport, required for all Part 139 airports and recommended for all other airports.

Airport-to-airport mutual aid—A voluntary program that coordinates airports to provide assistance in the form of skilled airport workers, equipment, and supplies to an airport that has been impacted by a natural disaster and that requests aid.

All-hazards—An adjective describing the full range of potential threats—natural and man-made disasters, pandemics, industrial accidents, etc.

Bench depth—Extent to which trained and qualified persons are available for shift rotations, as in a command post or emergency operations center; may include external partners as well as own staff.

Business continuity planning—Process of developing advance arrangements and procedures that enable an organization to respond to an event in such a manner that critical business functions continue with planned levels of interruption or essential change.

Catastrophe—A disaster that creates needs that exceed all ability to respond.

Colorado Aviation Response Support Team—A voluntary airport-to-airport mutual aid group in Colorado where airport managers who have experienced crashes and recovery assist airports or communities impacted by a crash.

Command and control—The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of goals and objectives.

Common operating picture—A common operating picture is an online graphic representation of an event, scene, location, or situation that can enhance coordination and collaboration and increase efficiency among all stakeholders during emergency responses and recovery operations as well as day-to-day operations. Geographic information systems, sensors, cameras, and wireless devices can be integrated into it.

Community Emergency Response Team—A key component of Citizen Corps, this program trains citizens to be better prepared to respond to emergency situations in their communities. When emergencies occur, team members can provide critical support to first responders, provide immediate assistance to victims, and organize volunteers at a disaster site.

Continuity of business practices—Practices that provide focus and guidance for the decisions and actions necessary for a business to prevent, mitigate, prepare for, respond to, resume, recover, restore, and transition from a disruptive event in a manner consistent with its strategic objectives.

Continuity of operations—An effort within an organization to ensure that its primary mission-essential functions continue during a wide range of emergencies, including localized acts of nature, accidents, and technological or attack-related emergencies.

Critical Incident Stress Debriefing—A specific, seven-phase, small group, supportive crisis intervention process that is one of the many crisis intervention techniques included under the umbrella of a Critical Incident Stress Management program.

Critical Incident Stress Management—An integrated program to anticipate, prevent, reduce, and otherwise address mental and emotional consequences from a traumatic incident.

Departmental operations center—The operations center that supervises normal operations, emergency operations, or both for a department of a larger organization.

Disaster—An occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, multiple injuries, and/or deaths.

Disaster operations group—A voluntary group of airports that provide coordinated assistance in the form of skilled airport workers, equipment, and supplies to an airport that has been impacted by a natural disaster and that requests aid. SEADOG and WESTDOG are the two disaster operations. groups formed thus far in the U.S.

Drill—A coordinated, supervised activity usually used to test a single specific operation or function in a single agency.

Emergency—Any occasion or instance that warrants action to save lives and protect property, public health, and safety.

Emergency management—The coordination and integration of all activities necessary to build, sustain, and improve the capabilities to prepare for, respond to, recover from, or mitigate threatened or actual disasters or emergencies, regardless of cause.

Emergency operations center (EOC)—A protected site from which emergency officials coordinate, monitor, and direct response activities during an emergency.

Exercise—A planned, staged implementation of the critical incident plan to evaluate processes that work and identify those needing improvement.

Full recovery—The stage at which the prescribed safety and security standards have been regained and the airport's capacity for aircraft operations has been restored to the level that existed before the incident.

General aviation airport—An airport that does not meet the criteria for classification as a commercial service airport may be included in the NPIAS as a general aviation airport if it accounts for enough activity (having usually at least 10 locally-based aircraft) and is at least 20 miles from the nearest NPIAS airport.

Human resources—The personnel of a business or organization, especially when regarded as a significant asset; also the department of a business or organization that deals with the hiring, administration, and training of personnel.

Incident—An occurrence or event, natural or manmade, that requires a response to protect life or property.

Incident action plan—An organized course of events that addresses all phases of incident control within a specified time. An incident action plan is necessary to effect successful outcomes in any situation, especially emergency operations, in a timely manner.

Incident command post—The physical location of the Incident Commander.

Incident Command System—A standardized organizational structure used to command, control, and coordinate the use of resources and personnel that have responded to the scene of an emergency.

Incident Commander—The individual responsible for all incident activities, including development of strategies and tactics and the ordering and release of resources.

Incident Management Team—An Incident Commander and the appropriate command and general staff personnel assigned to an incident; the level of training and experience of team members, coupled with the identified formal response requirements and responsibilities of the team, are factors in determining its "type," or level.

Interoperability—The ability of systems, personnel, and equipment to provide and receive functionality, data, information, and/or services to and from other systems, personnel, and equipment, between both public and private agencies, departments, and other organizations, in a manner enabling them to operate effectively together.

Irregular operations—Those actions taken to adjust for and recover from the impacts of disrupted airline schedules such as aircraft accidents, security incidents, crew absences, mechanical failures, and severe weather.

Large hub airport—An airport with at least 1% of total U.S. passenger enplanements.

Mass care—Actions taken to protect evacuees and other disaster victims from the effects of a disaster.

Medium-hub airport—An airport with between 0.25 percent and 1% of total U.S. passenger enplanements.

Mutual aid—Reciprocal assistance by emergency services under a predetermined plan.

Mutual aid agreement—A voluntary, non-contractual arrangement to provide emergency or disaster assistance between two or more entities. It typically does not involve payment, reimbursement, liability, or mandatory responses.

National Incident Management System (NIMS)—A systematic, proactive approach guiding government agencies at all levels, the private sector, and nongovernmental organizations to prepare for, prevent, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity, in order to reduce the loss of life and property and reduce harm to the environment.

National Plan of Integrated Airport Systems (NPIAS)—A national airport plan prepared by the FAA in accordance with Section 47103 of Title 49 of the United States Code; NPIAS includes primary and commercial service airports and selected general aviation airports as well as all general aviation airports designated as reliever airports by the FAA.

Navigation aid—Any visual or electronic device airborne or on the surface which provides point-to-point guidance information or position data to aircraft in flight.

Non-hub primary airport—An airport that enplanes less than 0.05% of all commercial passenger enplanements but has more than 10,000 annual enplanements.

Notice to Airmen—A notice or advisory distributed by means of telecommunication containing information concerning the establishment, conditions, or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to personnel and systems concerned with flight operations.

Operations and maintenance—All the services required to assure that the built environment will perform the functions for which a facility was designed and constructed.

Part 139 airport—An airport that serves scheduled and unscheduled air carrier aircraft with more than 30 seats, serves scheduled air carrier operations in aircraft with more than nine seats but less than 31 seats, and is required by the FAA Administrator to have a certificate for operation.

Phased recovery—Recovery that involves resuming some types of operations or operations at part of a facility.

Primary airport—Public airports receiving scheduled passenger service and having more than 10,000 annual passenger enplanements.

Public information officer—The person responsible for communicating with the public, media, and/or coordinating with other agencies, as necessary, with incident-related information requirements.

Reliever airports—A high-capacity general aviation airport in a major metropolitan area; such airports must have 100 or more based aircraft or 25,000 annual itinerant operations; the FAA officially designates reliever airports.

Risk analysis—The systematic objective examination or reexamination of the risks and hazards that may affect a facility, program, operation, or procedure.

Safety management system—The formal, top-down business approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures.

Small hub airport—An airport with 0.05% to 0.25% of total U.S. passenger enplanements.

Southeast Airports Disaster Operations Group (SEADOG)—The airport-to-airport mutual aid group made up of airports generally in the area from Washington, D.C., to Texas. It sends qualified volunteers to fill needs as requested by airports impacted by natural disasters.

Stafford Act—The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288) as amended is the statutory authority for most federal disaster response activities, including reimbursement, as they pertain to FEMA and FEMA programs.

Tabletop exercise—An activity that involves key personnel discussing simulated scenarios in an informal setting. This type of exercise can be used to assess plans, policies, and procedures; or to assess the systems needed to guide the prevention of, response to, and recovery from a defined

incident. Tabletop exercises are typically aimed at facilitating understanding of concepts, identifying strengths and shortfalls, and generating positive changes in attitude. Participants are encouraged to discuss issues in depth and develop solutions through slow-paced problem solving as opposed to the rapid, spontaneous decision-making that occurs under actual or simulated emergency conditions.

Terminal incident response plan—A detailed plan to guide the evacuation or sheltering-in-place of customers, other responses, and repopulation in an airport terminal consequent to a disruptive incident.

Unified Command—The Unified Command organization operating within NIMS consists of the Incident Commanders from the various jurisdictions or organizations operating together to form a single command structure.

Warm start—Planning and preparation for the next phase (e.g., recovery) that begins while the preceding phase (e.g., response) is still underway.

Western Airports Disaster Operations Group (WESTDOG)—The airport-to-airport mutual aid group made up of airports generally in the area from Denver west to the Pacific. It sends qualified volunteers to fill needs as requested by airports impacted by natural disasters.

Whole Community Approach—A means by which residents, emergency management practitioners, organizational and community leaders, and government officials can collectively understand and assess the needs of their respective communities and determine the most effective ways to organize and strengthen their assets, capacities, and interests. By doing so, a more effective path to societal security and resilience is built. In a sense, "whole community" is a philosophical approach to thinking about conducting emergency management.

ACRONYMS AND ABBREVIATIONS

9/11	September 11, 2001
A-CERT	Airport Community Emergency Response Team
AAR	After-action review
AEP	Airport emergency plan
AOA	Air operations area
API	Airport Performance Indicator
ARCC	Airport Response Coordination Center (LAX-specific term)
ASP	Airport security program
ATC	Air traffic control
ATCT	Air traffic control tower
AVSEC	Aviation Security
BCP	Business continuity planning
CBP	U.S. Customs and Border Protection
CERT	Community Emergency Response Team
COB	Continuity of business
DFW	Dallas/Fort Worth International Airport
DOC	Departmental operations center
DOG	Disaster operations group
EMP	Emergency Management Plan
EOC	Emergency operations center
FSD	Federal Security Director
GA	General aviation
IAP	Incident action plan
IC	Incident commander
ICP	Incident command post
ICS	Incident Command System
IMT	Incident Management Team
IROPS	Irregular operations
JIC	Joint information center
LAFD	Los Angeles Fire Department
LAPD	Los Angeles Police Department
LAWA	Los Angeles World Airports
LAWAPD	LAWA Police Department
LAX	Los Angeles International Airport
LGA	LaGuardia Airport
NAS	National Airspace System
NAVAID	Navigation aid
NOTAM	Notice to Airmen
PA	Public address
PANY&NJ	Port Authority of New York & New Jersey
PIO	Public information officer
SEADOG	Southeast Airports Disaster Operations Group
SFO	San Francisco International Airport
SMS	Safety management system
TIRP	Terminal incident response plan or planning
TTX	Table top exercise
TXDOT	Texas Department of Transportation
UC	Unified command
WESTDOG	Western Airports Disaster Operations Group

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APPENDIX A

List of Airport Emergency Post-Event Recovery Practices

The airports in this study reported the practices and policies in this list as being effective or desirable, or both, during recovery after an emergency or disaster. Not all of the practices and policies will apply at every airport, but every airport can profitably consider them to determine what it needs in its recovery plan, for preparedness, and for enhanced resiliency. The list organizes the practices into eight categories (Figure A1).

One of the further research needs identified by this study is the development of a template for recovery plans for airports of all types of sizes. Pending development of such a template, the items in sections I through VIII of the following list can be used as a table of contents for a comprehensive airport recovery plan. Not every item will apply at an airport, so the lists are best viewed as a series of delete options.

FIGURE A1 Categories of effective practices.

Part I. ADVANCE PLANNING AND PREPARATION		
Effective Practice	**Does It Apply?**	**Done**
Relationships built among airport departments and with mutual aid partners and other stakeholders in advance, and built to make recovery more effective		
Focus placed on the fundamental skills, principles, procedures, and organization for emergency management		
A recovery plan, which can be in AEP, in COB, in CBP, in COOP, as a stand-alone document, or a combination of these		
A recovery plan always paired with each response plan		
Measures taken to ensure that everyone understands the meaning of terms used in plans		
Planning Section head and back-up trained in and given tools for recovery planning		
Recovery planning initiated during response phase		
Planning Section planning for future recovery steps throughout recovery		
All-hazards (aircraft accidents, natural disasters, system failures, criminal acts) approach used for recovery planning		
Recovery plans based on realistic risk and hazard analyses		
Provisions included in recovery plans so that members of ICS structure, including IC or UC members, can reach their designated work space (i.e., mitigation of delays in establishing on-scene command post)		
Ensuring that airport employees, key airline employees, key tenants, and mutual aid partners have NIMS and ICS training, including periodic refresher training		
Factoring the effects of off-airport systems failures in recovery plans		
Including training for rare occurrences		
Holding annual briefings on recovery plans and procedures for airport employees, airlines, tenants, concessionaires, and mutual aid partners		
Involving all stakeholders in development and review of recovery plan		
Making sure local recovery plans of airlines, tenants, and concessionaires are compatible with the airport's plan		
Establishing alternative measures for getting employees to work (planning for gridlock, fuel shortages, mass transit disruptions, routes, vehicles, staging plan).		
Including back-up plans for all critical systems, procedures, equipment, and personnel		
Pre-arranging access to spare parts, NAVAIDS, and consumable resources		
Pre-arranging contracts for specialized services (e.g., debris removal and disposal, airfield lighting electricians, electrical inspectors)		

Pre-arranging contracts for outside consultants (e.g., aviation law, PR, media relations)		
Providing initial and recurring training on web-based coordination systems used for emergencies and in EOCs, and including mutual aid partners in training		
Testing all systems that are critical for recovery (e.g., communications, alternative communications, notification, web-based coordination systems)		
Establishing a relationship with one of the airport-to-airport mutual aid programs (SEADOG and WESTDOG)		
Censuring that cost and expense record-keeping systems are adequate to support eventual reimbursement or insurance claims, ideally integrated into web-based coordination system		
Integrating a system for tracking personnel and equipment for possible reimbursement or insurance claims		
Ensuring that recovery fully complementary with separate BCP or COB plan when plans are separate		
Keeping sufficient cash on hand to run airport for 4-6 days (when a forecast allows) in case banks and ATMs are unavailable during response and recovery		
Pre-authorizing overtime funding for recovery activities		
Pre-authorizing purchasing and procurement of supplies and services likely to be needed for recovery (e.g., modular buildings)		
Including plans for controlling access to airport during recovery		
Including plans for dealing with citizens (non-passengers, non-employees at airport) who come to airport for shelter and aid during recovery		
Using NTSB-provided training courses		
Maintaining a list of sources of specialized equipment and services (e.g., aircraft wreckage recovery cranes)		

Source: Smith, Kenville, and Sawyer data.

Part II. COMMAND AND CONTROL		
Effective Practice	**Does It Apply?**	**Done**
Using NIMS and ICS to guide recovery at least until the activities become simpler and longer-term so that EOC and UC or IC is no longer needed		
Pre-determining the location for an airport EOC		
Providing back-up EOC capability (back-up on-site, back-up off-site, use of partner's EOC off-site, mobile EOC, mobile command post)		
Understanding by everyone of the Unified Command concept and how the UC evolves as recovery evolves		
Including all pertinent airport departments and partners in airport EOC (a "hybrid" EOC as described in Case Example 2 in chapter two)		
Including utility company representative(s) in the airport EOC and when appropriate, the UC		
Maintain message discipline ("Speak with one voice.")		
Conducting command and control exercises jointly with partners		
Cross-trained personnel for roles in UC, EOC, and ICS structure		

Source: Smith, Kenville, and Sawyer data.

Part III. MUTUAL AID		
Effective Practice	**Does It Apply?**	**Done**
Establishing and sustaining relationships with mutual aid partners, including federal, state and local agencies		
Establishing mutual aid agreements with local partners, preferably in the form of written agreements		
Writting mutual aid roles and responsibilities into recovery plan, either directly or by reference to AEP or mutual aid agreements		
Practicing with airport-to-airport mutual aid programs (SEADOG and WESTDOG)		
Leveraging capabilities and resources of a multi-airport system (if any) (e.g., PANY&NJ, LAWA, Houston Airport System, Metropolitan Airports Commission (Minneapolis/St. Paul et al.), Metropolitan Washington (D.C.) Airports Authority		
Including recovery roles and responsibilities in contracts and leases with tenants and concessionaires		
Planning for volunteer assistance during recovery operations, and specifying positions and tasks that volunteers can fulfill		
Providing orientation and training for volunteers		
Considering an Airport Community Response Team (A-CERT) and implementing one if desired		
Identifying and involving stakeholders (e.g., airlines, tenants, concessionaires, FAA, TSA, utility companies)		
Holding a stakeholder meeting at least annually to review recovery plans, roles, and responsibilities		

Source: Smith, Kenville, and Sawyer data.

Part IV. COMPREHENSIVE CRISIS COMMUNICATIONS		
Effective Practice	**Does It Apply?**	**Done**
Having a comprehensive crisis communications plan in place to guide internal and external communications (content, procedures, and systems), including social media		
Identifying, procuring, testing, and exercising alternative communications systems to use when primary systems fail		
Cross-referencing comprehensive crisis communications plan placed in AEP or as standalone plan in AEP and BCP/COB plan		
Have a trained PIO on the airport staff or have access to a trained PIO whom the airport has taught about the special features of airports		
Strongly emphasizing the role of the PIO and its critical importance under NIMS and ICS as well as in message discipline		
Building realistic communications tests and failures into drills and exercises		
Included the PIO in all training, drills, and exercises for emergency response and recovery, including EOC training		
Establishing rules for the control and use of PA system during recovery		
Establishing testing procedures and intervals for PA and other notification systems		
Ensuring the ability to take control of flight information display systems and baggage handling systems		
Procuring movable visual warning or crowd management devices (e.g., digital signs) with guidance for their use		
Procuring internal communications systems that will work if phones, cell phones, internet, and electricity fail		
Using notification systems		
Use of the WEA (Wireless Emergency Alert) System		
Maintaining contact lists with procedures for timely and accurate updates		
Establishing a mobile phone application for the airport that includes information on emergency response and recovery status		
Procuring a Common Operating Picture (COP) capability, along with procedures for its use and dissemination		
Specifiying and documenting relationships and contact points with telecommunications and utility companies for communications and repairs		
Involving airlines, tenants, and concessionaires in development of a comprehensive crisis communications plan and training them on its application and use		
Ensuring that local communications plans of airlines, tenants, and concessionaires are compatible with the airport's plan		
Establishing goals, policies, and procedures for the use of social media during recovery to disseminate and gather information		

Source: Smith, Kenville, and Sawyer data.

Part V. OPERATIONS AND LOGISTICS		
Effective Practice	**Does It Apply?**	**Done**
Always considering the concept of phased recovery		
Begin a warm start preparations for recovery during response phase		
Providing clear information and warnings when the airport is closed (for non-towered airports: UNICOM message and temporary Xs on runways)		
Including damage assessments, guided by detailed plans and priorities, in recovery plans		
Using maintenance and engineering staff (or consultants) for inspections		
Using building inspection and code enforcement (BICE) teams for inspections		
Providing airport-oriented training for inspectors from mutual aid partners		
Paying attention to environmental concerns to avoid safety issues, environmental contamination, and delays in recovery from belated requests for clean-up or remediation		
Ensuring that sufficient fuel supplies are on hand for the duration of recovery		
Fueling and servicing all vehicles in anticipation of emergencies whenever possible		
Pre-arranging for FBO assistance with fuel		
Preparing a storage plan for vehicles and equipment to minimize risk of damage		
Ensuring that emergency generator power is adequate for airfield lighting and avionics		
Developing a Memorandum of Understanding/Memorandum of Agreement with FAA to have emergency power back-up, or a cost reimbursement provision for the airport to procure, maintain and store the generator when not in use		
Ensuring adequate emergency generator power for ATC tower		
Ensuring adequate emergency generator power for communications systems including alternatives and back-up systems		
Ensuring adequate emergency generator power for terminals at least sufficient to sustain evacuation or sheltering-in-place		
Providing and annually testing start-up methods for systems that have computer or electronic controls		
Measuring and testing capabilities of common use systems and their capabilities in workarounds if there is a partial system failure (e.g., baggage handling, security screening)		
Understanding procedures and capabilities of FAA inspectors as related to recovery, inspections, and reopening the airport		
Developing a format for information about status of recovery that matches needs of FAA inspectors		

Preserving site and evidence for NTSB, FBI, or other investigators		
Documenting site of accident or damage to assist work of NTSB or other investigators (e.g., photographs, videos, site maps)		
Providing reminders to investigators (and in case of an aircraft accident, the airlines) to help them understand the urgency for reopening the airport		
Providing special credentialing for essential ICS personnel to enter controlled areas to perform their duties for IC or UC		
Establishing a credentialing policy and process for persons needing temporary access to assist with recovery		
Establishing and following pre-authorization insurance and claims procedures		
Pre-authorizing personnel to approve overtime and emergency purchases and limits		
Performing effective hotwash		
Performing effective after-action review		

Source: Smith, Kenville, and Sawyer data.

Part VI. EMPLOYEE CARE		
Effective Practice	**Does It Apply?**	**Done**
Considering needs of employees who may have personal losses or emotional/psychological problems related to the event		
Cross-training for multiple roles and flexibility during recovery		
Including rotation and rest plan in recovery plan		
Creating internal employee assistance teams in advance and using them		
Arranging housing and messing for essential employees during recovery at hotel at airport or nearby		
Providing Critical Incident Stress Debriefings (CISD) and counseling		
Considering provision of on-site mental health assistance for employees		
Making options available for follow-up care for employees		

Source: Smith, Kenville, and Sawyer data.

Part VII. CUSTOMER CARE		
Effective Practice	**Does It Apply?**	**Done**
Having a Terminal Incident Response Plan in place to guide evacuation, sheltering-in-place, and repopulation, and having it continue through both response and recovery phases		
Establishing a Family Assistance Plan that continues through recovery		
Including a continuing recovery phase in Survivor Support Plan (e.g., housing)		
Having a transportation plan for passengers while the airport is closed		
Cooperating with hotels to create and implement a housing plan for passengers while the airport is closed		
Incorporating passenger and survivor communications in the comprehensive crisis communications plan		

Source: Smith, Kenville, and Sawyer data.

Part VIII. EVALUATION, REVISION, AND VALIDATION		
Effective Practice	**Does It Apply?**	**Done**
Storing common operating picture (COP) images and data for after-action review		
Practicing continuous improvement		
Extending drills and exercises to include aspects of recovery wherever possible and appropriate		
Performing aggressive and honest hotwashes after recovery phases and after training, drills, and exercises that address recovery		
Not considering the incident closed until hotwash has been completed		
Compiling a single after-action review (AAR), especially if multiple agencies are involved in the recovery		
Performing aggressive and honest AAR after recovery and after training, drills, and exercises that address recovery		
Including mutual aid partners, airlines, tenants, concessionaires & other key stakeholders in AAR		
Considering use of an outside consultant to facilitate or conduct AAR, if appropriate		
Inviting peer airports to participate in AAR		
Using metrics to evaluate effectiveness of specific recovery techniques		
Basing new training, drills, and exercises on past incidents at the airport or at other airports		
Sharing lessons learned with other airports		

Source: Smith, Kenville, and Sawyer data.

APPENDIX B

Participating Airports

Airport	Code	NPIAS	City	State	FAA Reg.	FAA Passenger Enplanements CY 2013	Total Operations CY 2013	Acreage
Aspen/Pitkin County Airport	ASE	NH-P	Aspen	CO	NM	206,686	35,328	573
Blue Grass Airport	LEX	SH	Lexington	KY	SO	539,238	64,720	911
Blue Ridge Regional Airport	MTV	GA	Martinsville	VA	EA	0	24,090*	270
Bob Hope Airport	BUR	MH	Burbank	CA	WP	1,918,011	131,122	610
Boise International Airport	BOI	SH	Boise	ID	NM	1,313,741	114,556	5,000
Boston Logan International Airport	BOS	LH	Boston	MA	NE	14,810,153	366,485	2,384
Buffalo–Niagara International Airport	BUF	MH	Buffalo	NY	EA	2,567,594	125,160	1,000
Centennial Airport	APA	R	Denver	CO	NM	0	168,352	1,400
Dallas–Fort Worth International Airport	DFW	LH	DFW Airport	TX	SW	29,038,128	678,059	17,207
Denver International Airport	DEN	LH	Denver	CO	NM	25,496,885	586,860	34,560
George Bush Intercontinental/Houston Airport	IAH	LH	Houston	TX	SW	18,592,840	505,143	11,251
Gulfport–Biloxi International Airport	GPT	SH	Gulfport	MS	SO	369,597	51,561	1,400
Jacksonville International Airport	JAX	MH	Jacksonville	FL	SO	2,549,070	90,149	7,911
John F. Kennedy International Airport	JFK	LH	New York	NY	EA	25,036,358	411,776	5,200
Joplin Regional Airport	JLN	NH-P	Joplin	MO	CE	23,329	26,763	970
LaGuardia Airport	LGA	LH	New York	NY	EA	13,372,269	375,420	680
Lambert–St. Louis International Airport	STL	MH	St. Louis	MO	CE	6,216,104	188,734	3,970
Los Angeles International Airport	LAX	LH	Los Angeles	CA	WP	32,425,892	614,917	640
Louis Armstrong New Orleans International Airport	MSY	MH	New Orleans	LA	SW	4,576,539	127,753	1,500

Airport	Code	NPIAS	City	State	FAA Reg.	FAA Passenger Enplanements CY 2013	Total Operations CY 2013	Acreage
Memphis International Airport	MEM	MH	Memphis	TN	SO	2,301,003	234,278	3,900
Minneapolis–St. Paul International Airport	MSP	LH	Minneapolis	MN	GL	16,280,835	431,573	2,930
Newark Liberty International Airport	EWR	LH	Newark	NJ	EA	17,546,506	419,850	2,027
North Little Rock Municipal Airport	ORK	GA	North Little Rock	AR	SW	0	32,120*	621
Orlando International Airport	MCO	LH	Orlando	FL	SO	16,884,524	298,552	13,302
Owatonna Degner Regional Airport	OWA	GA	Owatonna	MN	GL	0	29,930*	260
Page Municipal Airport	PGA	NH-P	Page	AZ	WP	26,998	48,910*	555
Phoenix Deer Valley Airport	DVT	R	Phoenix	AZ	WP	0	354,995	914
Rocky Mountain Metropolitan Airport	BJC	R	Denver	CO	NM	0	114,617	1,700
Saint Paul Holan Field Downtown Airport	STP	R	St. Paul	MN	GL	0	68,160	540
San Francisco International Airport	SFO	LH	San Francisco	CA	WP	21,704,626	420,915	5,207
Santa Paula Airport	SZP	GA	Santa Paula	CA	WP	0	97,090	51
Savannah-Hilton Head International Airport	SAV	SH	Savannah	GA	SO	798,376	84,921	3,650
Sloulin Field International Airport	ISN	NH-P	Williston	ND	GL	96,086	143,070*	740
Soldotna Airport	SXQ	GA	Alaska	AK	AL	0	14,965*	426
Washington Dulles International Airport	IAD	LH	Dulles	VA	EA	10,570,993	334,452	12,000
Yampa Valley Airport	HDN	NH-P	Hayden	CO	NM	91,823	9,490*	671
Yuma International Airport	NYL	NH-P	Yuma	AZ	WP	78,395	183,595*	3,100

Sources: FAA (2014); www.airnav.com; www.city-data.com/airports.
*Estimated operations/year computed as www.airnav.com daily operations x 365.

APPENDIX C

Questionnaire Used to Guide Interviews

QUESTIONS FOR AIRPORTS

Date of interview | Interviewer(s)

Name of airport | 3-letter airport code

Primary interviewee

Job title or descriptor

Interviewee's e-mail

Interviewee's phone

Other persons in interview and titles:

Statement of Purpose: The objective of this synthesis is to find what policies and practices have been effective in the recovery of airports from disruptions caused by emergency events including aircraft accidents, natural disasters, and manmade incidents (e.g. shootings, hostage situations, security breaches, industrial accidents, systems failures, and fires). The target audience for the results is airports of all types and sizes, their sponsors/owners, and the airports' partners in emergency preparedness and recovery.

1) Has your airport experienced any emergency incidents requiring recovery? If yes, please provide the details. [Details should include type of event, impacts, recovery timeline, organizational/ management structure in place or put in place to manage the emergency.] If you have had more than one incident, please address them.
2) What recovery processes or procedures were used?
3) Which were more effective and which were less effective? In your answer, please address the following topics (as well as any others that were important in your situation).
   a. Care of employees, tenants, traveling public and stakeholders
   b. Minimizing disruption of facilities
   c. Common objectives throughout the incident management process
   d. Integrated training and exercises, multi-agency collaboration, and after-action analysis
   e. Communications (internal and external)
   f. Other topics specific to your airport and incident.
4) Please comment on the mutual aid agreements that you have in place and how and if they were used.
5) What "common objectives" were identified during your recovery process? Which were determined to be more essential?
   a. Care of employees, tenants, traveling public and stakeholders
   b. Minimizing disruption of facilities
   c. Common objectives throughout the incident management process
   d. Integrated training and exercises, multi-agency collaboration, and after-action analysis
   e. Communications (internal and external)
   f. Other topics specific to your airport and incident.
6) How do you set the priorities for restoration and recovery?
7) What happens if the disaster is multi-dimensional?
8) What challenges and barriers to restoration and recovery were identified and when? How were they overcome?
9) What lessons were learned from the experience? What if any changes resulted? (Examples: Integrated into training and exercises, multi-agency collaboration, and after-action analysis, etc.)
10) In addition to operational, safety, security, and maintenance issues and lessons learned, what did your airport learn about the economic, social, political, and legal aspects of recovery? What lessons did you learn? What actions have you taken to prepare your sponsor/owner or other stakeholders for preparedness measures needed to apply your lessons learned about airport recovery after disruptive incidents?
11) Do you have any quantitative or qualitative measures of recovery time, costs, cost savings, or effectiveness? Do you have any event documentation that measures recovery time, costs, cost savings, or effectiveness? If yes, would you share these reports?

12) Have you had an opportunity to test the lessons learned or changes? How?
    a. TTX
    b. Annual reviews
    c. Triennial
    d. Actual incident of same type
    e. Incidents of other types
    f. Specialized team training somewhere such as TEEX or Huntsville.
13) Is there any comment, suggestion, criticism, or addition, either about the topic of this study or about this survey, you wish to add?
14) What documents can you share for us to include in the analysis of this synthesis and perhaps reproduce if your airport is chosen as a case example?
15) Do you have photographs or other visuals/graphics that you can share?

Thank you.

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
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
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
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