# APPENDIX D AIRPORT SURVEY METHODS AND RESULTS

## D.1.1 Approach

*Survey Development*

The project team developed the survey with the intention of gathering information about the types of weather events experienced by airports, what kind of damage was associated with those events, and how the airports prepared for, responded to, and recovered from those events. To meet this purpose, the project team developed a series of 18 questions covering these topics. The ACRP Topic Panel and subject matter experts in disaster risk management and airport operations helped to refine the research instrument. The research team revised the survey following these reviews.

The project team developed and tested the survey questions for comparisons across a range of airport locations, sizes, and potential impacts. In addition to requesting basic information such as FAA airport codes, airport size, and general types of operation, the questions solicited information to better understand weather events and their related impacts on operations, infrastructure, and human resources. In particular, the survey featured matrices to rate the level of impact of a certain weather stressor to a specific piece of infrastructure or operation (i.e., hail impacts on aircraft, taxiways and runways, lightning impacts on aircraft, taxiways and runways, etc.). Because airport operational components and weather events that airports experience vary, the survey balanced depth of information with breadth of weather stressors, impacts, and airport planning and response mechanisms.

During development of the survey, it became clear that airport operators can have differing opinions on which weather reach the "significant" threshold. To ensure that respondents held a common understanding of significance, the survey began with a detailed definition, as shown below:

*"Significant" weather is defined as an event that has the potential to disrupt flight operations for an extended period and has the ability to directly injure people or damage airport infrastructure/equipment. Events could include:*

*Extreme Temperatures (hot or cold)*

*Extreme Precipitation*

- *Heavy rainfall*
- *Snowfall requiring more than 2 hours to clear runways*
- *Ice storm*
- *Severe hail (e.g., resulting in body injury or equipment/infrastructure damage)*
- *Severe drought*

*Major Storms*

- *Tropical storm or hurricane*
- *Tornado within 10 miles of airport or occurring within same county*
- *Lightning that damages runway*
- *Flash flooding*
- *High winds disrupting operations*
- *Tsunamis*

*Visibility Reduction (e.g., below ¼ mile for over an hour)*

- *Fog*
- *Wildfires*
- *Volcanic eruptions*
- *Dust storms*

*Distribution to Airports*

With support from the American Association of Airport Executives (AAAE) and Airports Council International (ACI) – North America, the Airport Cooperative Research Program (ACRP) Significant Weather Impact Survey was distributed to 148 airports in the United States and 19 in Canada. The project team selected these airports based on their available contact information and participation in various regional and national conferences related to airport sustainability. Additionally, the airports reflected a range of sizes and geographies to capture different kinds of weather events and impacts to airports. The team developed and distributed the survey using Survey Monkey. Invitations to the survey explained the purpose of the ACRP study and the value of

airport representatives' participation in it. Automated emails with the link to the survey were sent to the US-based airports, while Canadian Airports Council individually sent the survey invitations to Canadian airports. The project team then sent four follow-up emails to unresponsive invitees, and sent personal email message to a dozen large hub airports, in order to reach ACRP's goal of 75 respondents. By the close of the survey, a total of 67 airports responded to the survey, distributed across the Canada and the United States (as shown in Figure D-1 below).

### D.1.2 Findings

*Survey Responses*

The survey received a total of 70 responses, six of which were from three airports reporting twice. The responses from these airport representatives were combined in order to create one response per airport. The following sections provide a summary of the survey findings, discuss the results of each question in the survey, and provide accompanying summary tables and graphs.

**Figure D-1. Distribution of Airport Survey Responses (n = 67)**


*Summary of Findings*

The following sections feature brief discussions of each question or group of questions from the survey, as well as figures summarizing survey responses.

**Questions 1–6: Understanding the participant demographic**

The first six questions of the survey seek to identify the participating airports, their location, size, and other characteristics of the respondent. As seen in Figure D-2, the 67 responding airports were a broad representation of sizes ranging from less than 10,000 through more than five million annual enplanements. Only two of the 67 respondents did not provide scheduled commercial air service. Airport tenants largely include fuel station operators, commercial airlines, fixed-based operators (FBO), public agencies, freight or distribution, and others (Figure D-3). Airports also noted aviation businesses, national defense organizations (i.e., Air National Guard), and customer services, such as rental car facilities, hotels, commercial office space, and tourist attractions. Two-thirds of respondents had an airside operations role

at their airport. Other notable roles included executive leadership (39.1%), emergency management (36.2%), public safety and security (33.3%), and ground operations (30.4%).[6]

**Figure D-2. Number of Annual Enplanements Handled by Responding Airports**

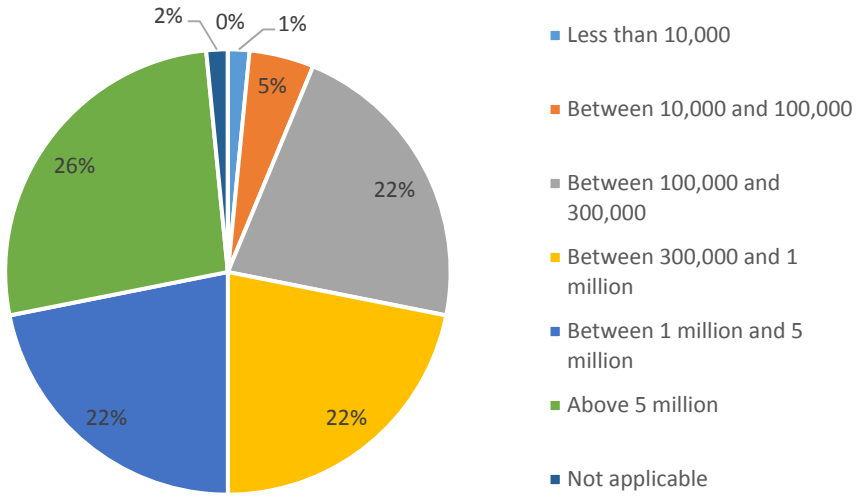
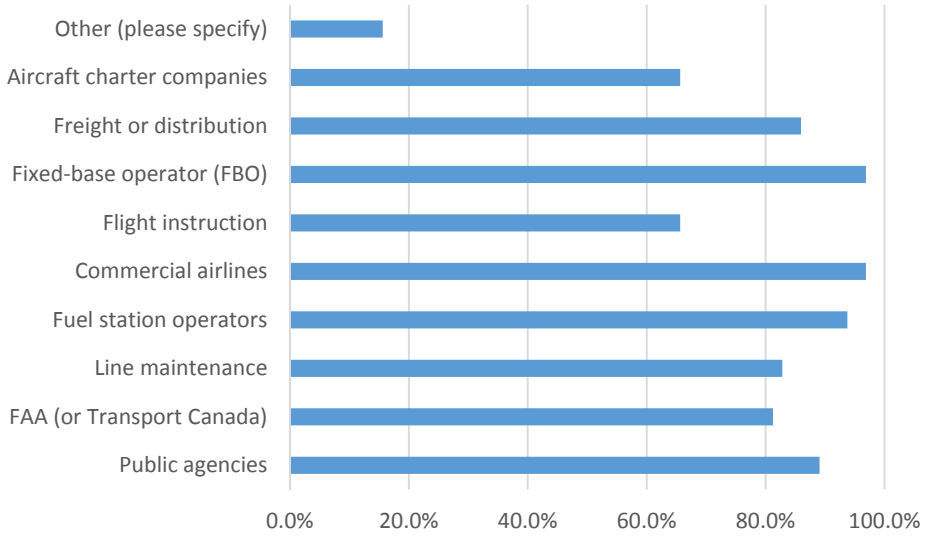



**Figure D-3. Tenants within Responding Airports**



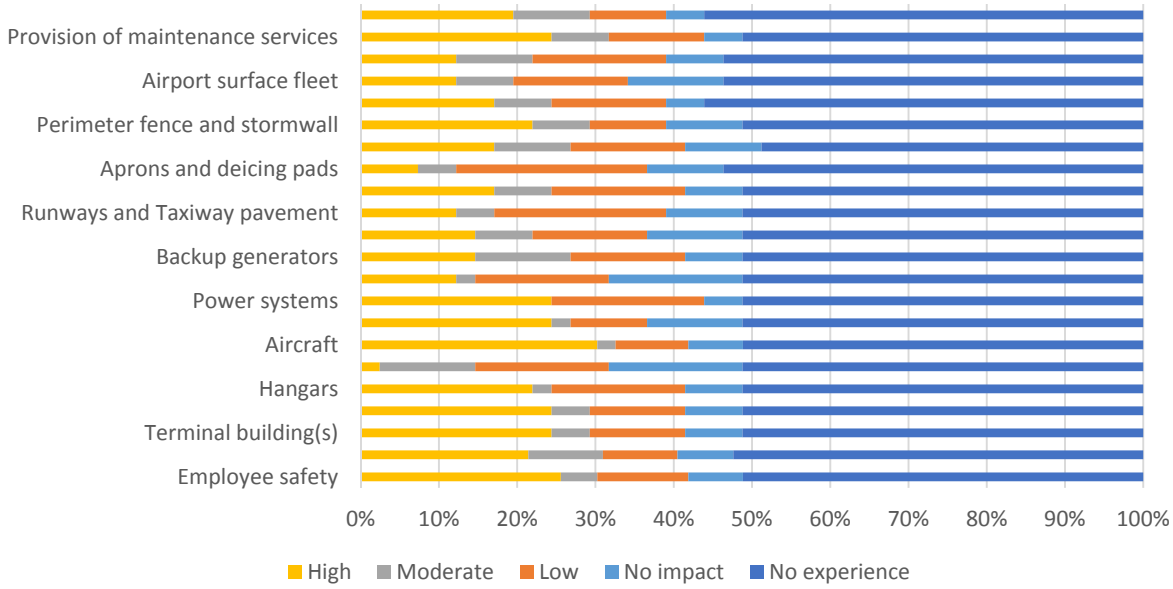

**Questions 7–9: Understanding potential weather impacts at airports**

Questions seven through nine sought to measure the impacts of various weather events on different pieces of infrastructure and operations at airports. There were a maximum of 58, 43, and 41 responses for questions seven, eight, and nine, respectively.

[6] Note: Percentages add up to more than 100%, as many respondents reported serving in multiple roles.

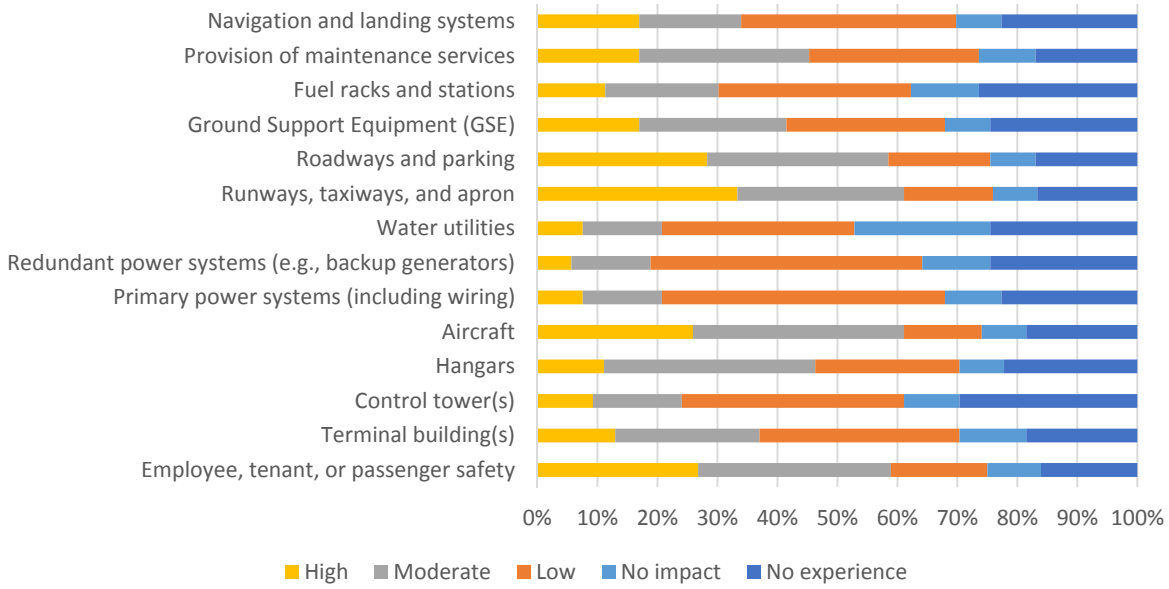
Overall, respondents noted that events that tend to be lower in frequency, such as tornadoes and hurricanes and tropical storms, create the greatest impact to the airports. As shown in Figure D-4, hurricanes and tropical storms on average were not experienced by more than 50% of respondents. However, more than 51% of respondents who reported experiencing these events noted moderate or high impacts to airport infrastructure and operations, most notably employee safety, passenger/tenant safety, terminal buildings, control towers, hangars, aircraft, jet-bridges and passenger stairways, power systems, and maintenance services.

**Figure D-4. Potential Impact of Hurricanes and Tropical Storms on Airport Infrastructure and Operations**




Rain, snow, and ice events were reported to be experienced more often, though impacts largely were low or moderate. However, these stressors were reported to be moderate to severe against employee and tenant safety, aircraft, runways and taxiways, and roads and other paved surfaces (Figure D-5). Hail, on the other hand, was largely reported to have a low impact on airport assets and operations. Hail's one major impact was on aircraft, with 55% of respondents assigning moderate or severe impacts.

**Figure D-5. Potential Impact of Snow on Airport Infrastructure and Operations**



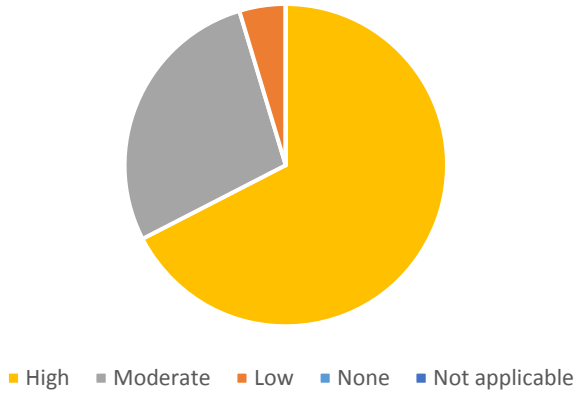

While the above events generated consistent impact trends across airport assets, heavy winds and thunderstorms and lightning produced more varied impact ratings. Heavy winds were most frequently experienced but were generally reported to have a low or nonexistent impact. Exceptions of this include moderate and high impacts on employee safety (65.1%) and aircraft (82.5%). Similarly, thunderstorms and lightning were reported to have moderate and high impacts on employee safety (74.4%) and aircraft (62.5%) in addition to power systems (64.3%).

In question nine, dust storms, fog, volcanic eruptions, and wildfires were reported to pose few moderate to high impacts to airports, with the exception of fog extending delays to flight operations (62.5%) and suspending ground operations (43.6%).

**Question 10: Understanding potential weather impacts at airports**

As shown in Figure D-6, airports largely reported that they had a good understanding of specific infrastructure and operational vulnerabilities to types of weather, with 68.2% reporting a high understanding and 27.3% reporting a moderate understanding (44 respondents reporting).

**Figure D-6. Self-reported Understanding of Airport Vulnerabilities to Weather Events**



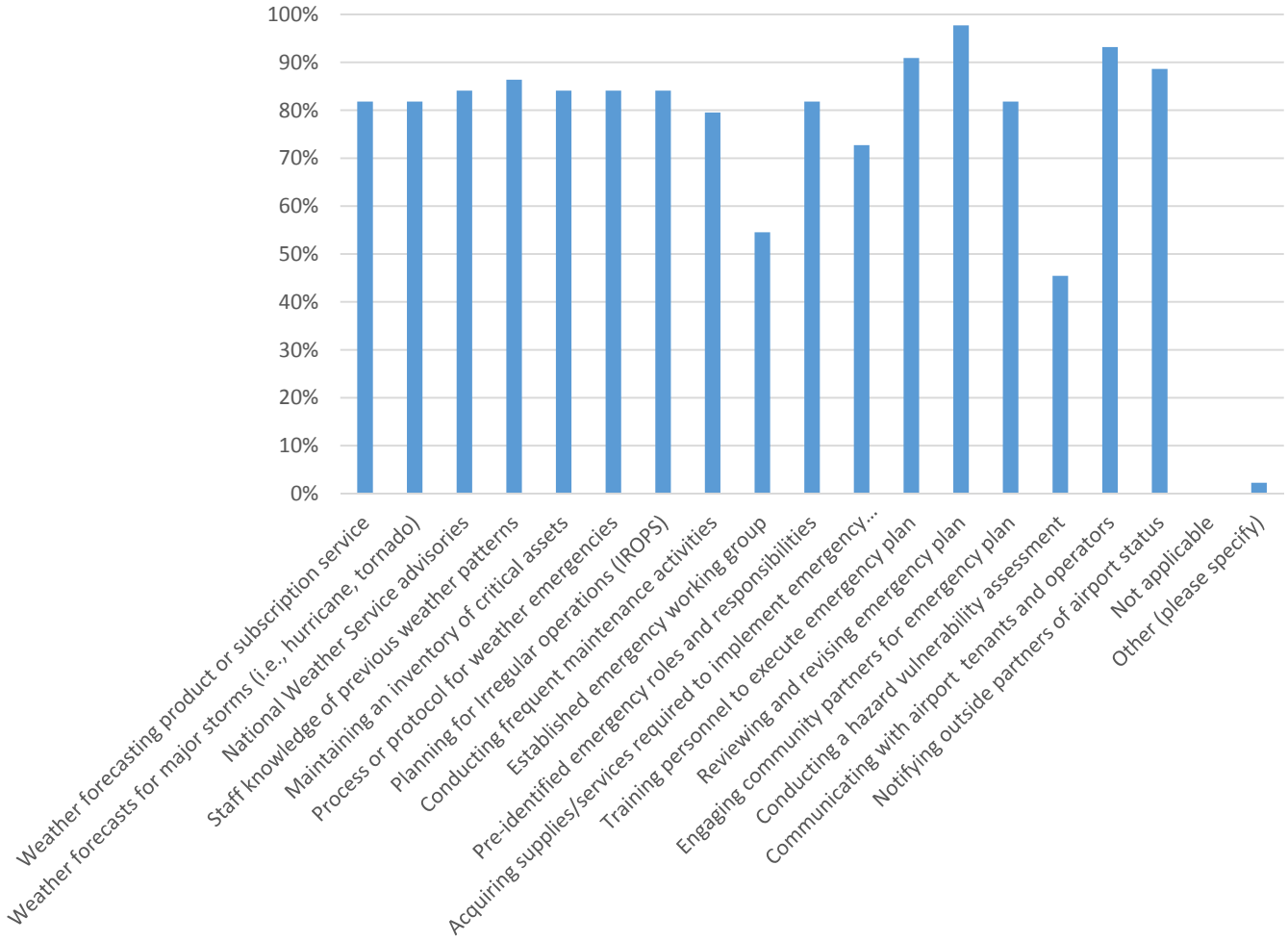

**Question 11: Airport preparedness for significant weather**

Of the 44 respondents to Question 11, six stated that they could respond to the "worst case" scenarios. Four of these airports handle more than five million enplanements each year, with the other two reporting between one and five million enplanements. On the other end of the spectrum, of the 13 airports reporting that they could only respond to typical weather events in their area, only two handled more than five million enplanements per year, with the majority handling between 100,000 and one million.

**Question 12: Preparing for significant weather**

Forty-four airports responded to Question 12, and they reported participating in many of the provided weather planning and preparation activities, most notably reviewing and revising emergency plans, communicating with airport tenants and operators, training personnel to execute emergency plans, and notifying outside partners of airport status (Figure D-7). The two least frequent responses were conducting a hazard vulnerability assessment and establishing an emergency working group. One respondent added that its operations, police, and aircraft rescue and firefighting offices were staffed 24 hours per day, 365 days of the year, which enhances the airport's ability to respond to events.

**Figure D-7. Percent of Respondents Reporting Use of Weather Preparation Activities**



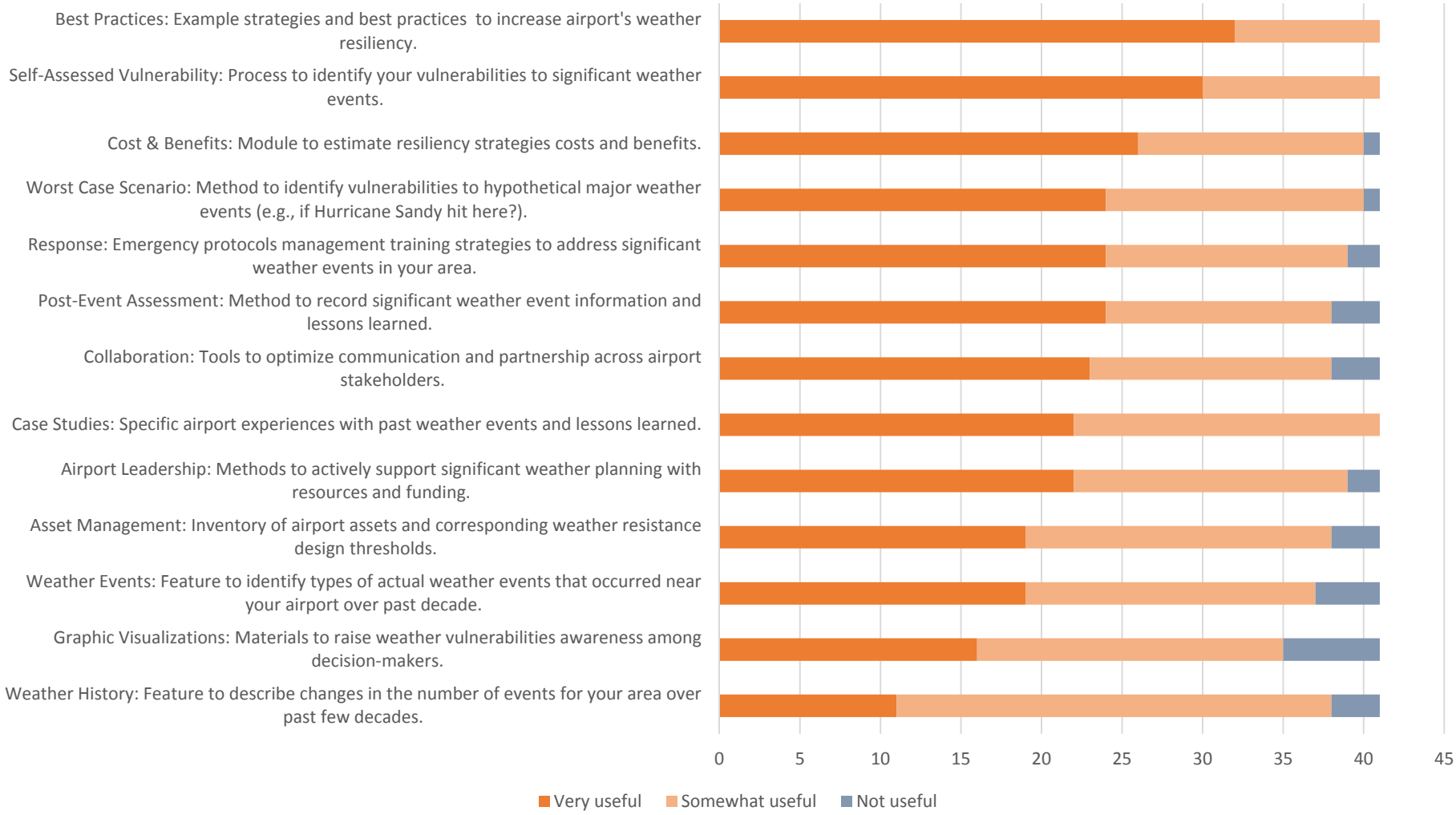

**Question 13: Preparing for significant weather**

Question 13 asked about resource gaps for airports' significant weather planning. The open-ended question received 45 responses, many of which highlighted the need for additional funding and personnel to effectively respond to weather events. Respondents also indicated the need for better training. In addition, a number of the respondents pointed out the challenge of preparing for unpredictable weather patterns that pose major impacts on their assets and operations. For example, airports in the southern United States may only encounter severe snow and ice storms once every five years, but must actively maintain snow removal equipment and trained personnel on an ongoing basis. Similarly, another airport that has not experienced a hurricane in more than 40 years has not direct experience to draw from and is reliant on the experiences of other airports.

**Question 14: Elements of the ACRP Toolkit**

Forty-two respondents rated the usefulness of various elements that could be included in the ACRP significant weather planning toolkit. While all of the elements were largely found to be either somewhat useful or very useful by respondents, best practices on increasing an airport's resiliency, case studies on specific airport experiences with past weather events, and a process to identify vulnerabilities to significant weather events were each found to be at least somewhat useful or very useful. Figure D-8 below shows how other potential elements of the toolkit were rated.

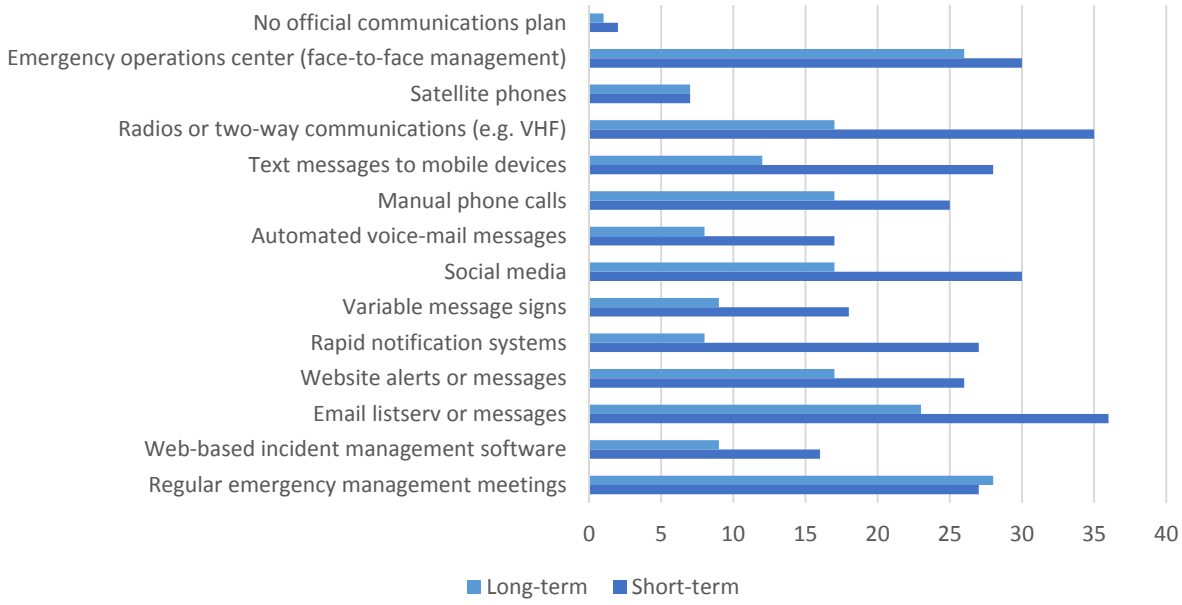
**Figure D-8. Respondent Ratings of Potential ACRP Significant Weather Planning Toolkit Features**



**Question 15: Short-term and long-term communication methods**

Responding airports used several communication methods outlined in Question 15, including regular emergency management meetings, email listservs or messages, social media, emergency operations centers, radios, and other modes of communication (Figure D-9). Some communication tools are generally geared more towards short-term (incident) use than long-term (daily routine) use, as outlined in Figure D-9. For example, rapid notification systems are reported as available for short-term communications by 27 of the 43 respondents to Question 15. Only eight airports noted their use in long-term communications. This likely reflects the greater value of rapid notification systems in significant weather response. Regular emergency management meetings, emails listservs or messages, website alerts, and emergency operations centers (face-to-face management) are used about as much for long-term planning as they are used for short-term planning. Two of 43 answering respondents noted that they did not have either a short-term or long-term communications plan.

**Figure D-9. Short-Term and Long-Term Communication Methods Used by Responding Airports**

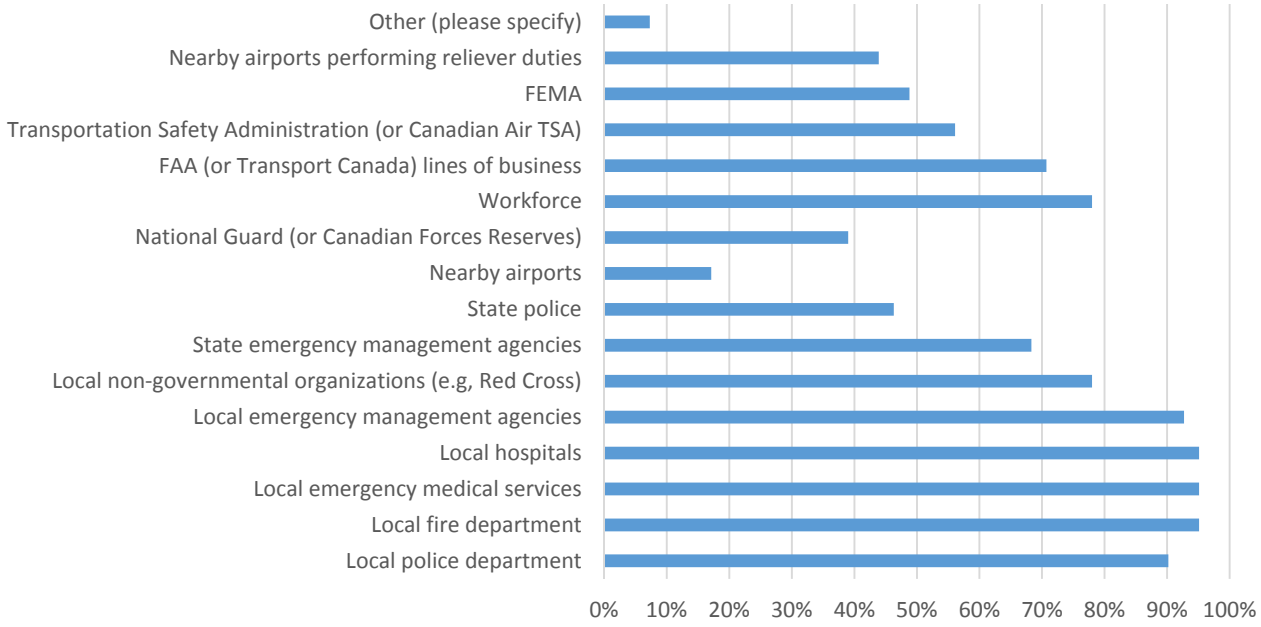



**Question 16: External partners for emergency response**

As shown in Figure D-10, respondents identified local police departments, fire departments, emergency medical services, hospitals, and emergency management agencies as frequently utilized external partners in their emergency response. Meanwhile, fewer of the 42 respondents identified the Federal Emergency Management Agency, the National Guard, and state police as partners. While only 17% identified actual nearby airports as partners, nearly 43% identified reliever duties performed by nearby airports, suggesting that an airport's ability to take in additional aircraft is often more useful than providing other potential services.

Those who did not identify the local police department as an emergency response partner were larger airports that handle at least one million enplanements per year. However, larger airports have Transportation Safety Administration and other security forces who perform the same role as police at smaller airports.

**Figure D-10. External Partners Used by Airports to Support Emergency Response**




**Question 17: Most valuable resources for recovering from significant weather**

Having a solid communications strategy and trained staff to implement a planned and organized response to a weather event has a noteworthy impact on an airport's response to an event. Respondents reported that planning ahead for events, having established communication systems, and maintaining a trained workforce are the most important elements in recovering from a significant weather event (Figure D-11). Furthermore, operations guidelines and organization of resources (in addition to their availability) were often cited as useful. Respondents less frequently identified the National Guard, border protection and transportation safety agencies, and state police as useful.

**Figure D-11. Most Valuable Resources for Recovering From Significant Weather (% of Respondents)**


**Question 18: Additional comments**

Survey participants were asked to provide any additional thoughts about significant weather impacts. Two airports had substantive comments. One of these two respondent mentioned that the survey provided ideas to consider for future use, and the other respondent stated the need to consider how federal agencies and airports work together when US-based airports are receiving flights from foreign countries that have been significantly impacted by weather events.

### *Findings by Airport Size*

Responding airports reported handling a variety of enplanements per year, and the size of an airport's operations can shed insight into the impacts it faces from significant weather. This section briefly summarizes findings from identified impacts across the different sizes of airports, which are outlined in Table D-1.

**Table D-1. Number of Responding Airports According to Airport Size**

| Number of Annual Enplanements Handled | Number of Responding Airports |
|---|---|
| Less than 10,000 | 1 |
| Between 10,000 and 100,000 | 3 |
| Between 100,000 and 300,000 | 15 |
| Between 300,000 and 1 million | 15 |
| Between 1 million and 5 million | 13 |
| Above 5 million | 18 |
| Not Applicable | 1 |

Generally, airports of different sizes experienced similar kinds and extents of impacts from significant weather events, and the geographic location of the airport was more of a determining factor of the most impactful events (see the next section, "*Findings by Region*"). That said, the size of an airport's operation appeared to influence its ability to respond to weather events.

For example, for airports of all sizes, snow and/or ice were consistently identified as significantly impactful weather events. For airports with more than one million annual enplanements that experience snow or ice events, 66% identified snow and ice as moderate or high impacts on airside and landside paved surfaces. Airports with 100,000 to one million annual enplanements identified snow and ice as a high or moderate impacts on paved surfaces 78% of the time. For smaller airports with fewer than 100,000 annual enplanements, 100% rated high or moderate impacts to paved surfaces due to snow and ice events. These findings suggest that the size of an airport's operations may play a role in the operational impact of snow and ice events, which is also supported by findings from Question 11 of this survey. However, this finding could be further investigated with a larger dataset to increase the representational sample size and statistical significance.

### *Findings by Region*

Airports were also grouped into the regions in Table D-2 in order to determine identified impacts across regions. Generally, snow and ice events were identified as having high or moderate impacts on paved surfaces across all regions, though southern regions noted these types of events less frequency. High wind events such as hurricanes, tornadoes, and sometimes thunderstorms were identified as having high or moderate impacts on assets supporting airport operations, such as employee safety, ground support equipment, and buildings. However, these types of events generally had little or no impact on underground infrastructure (i.e., building foundations or underground wiring). The following subsections provide brief findings for each region.

**Table D-2. Number of Responding Airports within US regions and Canada**

| Region | Number of Responding Airports |
|---|---|
| Canada | 9 |
| Northeast | 4 |
| Southeast | 14 |
| Rocky Mountain/Central | 19 |
| Pacific Northwest | 12 |
| Southwest | 10 |

**Canada** – Snow and ice events are noted as high or moderate impacts for several areas of Canadian airports, particularly those related surface operations, such as runways, taxiways, and aprons, employee safety, aircraft, roadways and parking, and navigation and landing systems. Thunderstorms and heavy winds are noted to have largely moderate impacts to employee safety, aircraft, and power supply systems, and some surface airside and landside operations. Tornadoes, drought, hurricanes, and coastal storms are typically not experienced by the responding airports.

**Northeast** – Similar to Canadian respondents, responding airports from the Northeast US noted significant impacts from snow and ice events, particularly on human safety and operations on paved surfaces. Hurricanes, thunderstorms, and tornadoes are also noted to have high impacts on human safety, though have more of an impact on assets operations-focused assets, such as ground support equipment, energy supply systems, navigation and landing systems, airside lighting, and provision of maintenance services.

**Rocky Mountain/Central** – Snow and ice events again were identified as having high impacts on aircraft, employee safety, and surface assets and operations. Hail was also noted to have significant impacts

on similar assets and operations. While some respondents did not experience tornadoes, those that did reported mostly high or moderate impacts to all areas of airport operations. Respondents generally reported extreme cold to have greater impacts than extreme heat throughout the airport.

**Southeast** – In the Southeast US, heavy winds, tornadoes, thunderstorms, and hurricanes are the most commonly identified weather events to have high impacts at airports, affecting control towers, hangars, aircraft, navigation and landing systems, and other assets critical to airside operations. Among these stressors, tornadoes are most consistently rated as having a high impact. In addition, while some Southeast airports report not experiencing ice events. The same group of airports that report ice events rate it largely as moderate or high impact for operations related to employee safety and paved surfaces.

**Pacific Northwest** – Unlike other regions of this study, airports in the Pacific Northwest consistently identified heavy rain as a notable impact on airside and landside paved surfaces, redundant power systems, aircraft, buildings, and employee safety. Because this category included airports in Hawaii and northern and southern parts of the Pacific coast, respondents in this category provided a range of responses on weather impacts. Therefore, snow, ice, and hail events are identified by some respondents to have moderate or high impacts, while other respondents cite no impact or experience.

**Southwest** – Unlike other regions in the United States and Canada, extreme heat is a major concern for employee safety, with six out of 10 noting a high impact and one indicating moderate impact. Generally, assets that involve energy usage or human health and safety, such as the provision of maintenance services and terminal buildings and control towers, are noted as being moderately-to-highly impacted by extreme heat. For paved surfaces like roadways, runways, taxiways, and aprons, ice is noted has a moderate or high stressor, even though ice events are not as frequently experienced in the southeast region as they are in other regions of North America. Finally, heavy winds and tornadoes were indicated to impact some maintenance and group support activities but have less of an effect on airside pavement, lighting, and other energy and water infrastructure.

### D.1.3 Exposure Impact on Airports

*Approach*

In the second stage of the analysis, the project team used the survey results in comparison with the historical exposure data gathered for the maps to provide a first-order analysis of the breadth and severity of impacts linked to each significant weather event type. This analysis is intended to investigate which event types have:

- the greatest overall impact on airports
- a wide-range of impacts on airports
- large variation in impacts across airports
- the greatest impacts on different airport functional areas

Once the maps were developed, the project team cross-walked the exposure to events as measured in the NOAA Storm Events Database with the sensitivity to the events as indicated by airport survey respondents. For each of the 67 U.S. airports that completed the survey, the project team used the airport's zip code to identify its county and determine the historical frequency of the various weather event types in that county. The survey of results is for a limited sampling of all airports in the United States and hence, may not be fully representative of all airports in the nation. However, the results provide an indication of general trends in airport stakeholder concerns and may reveal interesting relationships between levels of exposure and sensitivity.

The survey results provided a qualitative rating of the impact of each significant weather event type on the airport. Each respondent rated the impact of each event type to various components of the airport as either "no experience," "no impact," "low impact," "moderate impact," or "high impact." This question was asked of various specific components of the airport (e.g., runways vs. control towers), but for the purposes of this analysis, the team categorized each component into one of four primary airport functional areas: landside operations, airside operations, administration, and maintenance. Table D-3 shows how each survey question aligns with each of the four functional areas.

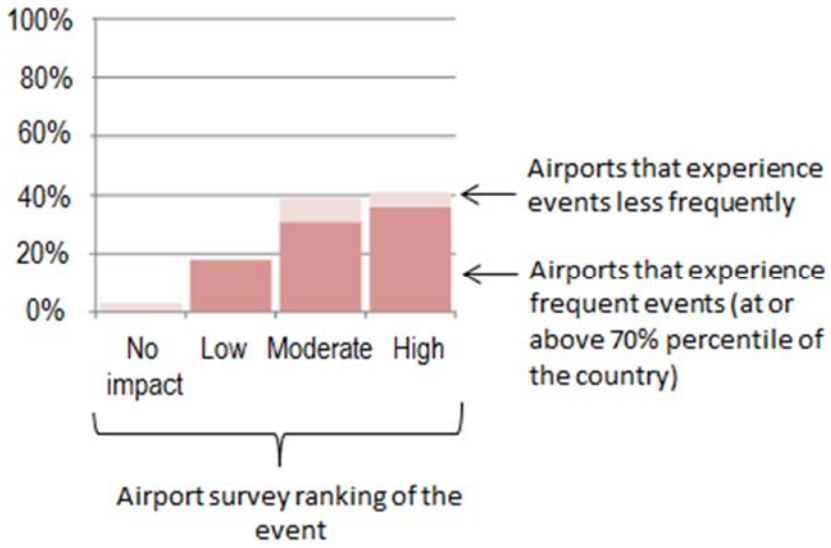
**Table D-3. Airport Components Aligned with Four of the Six Functional Areas Proposed for Toolkit**

| Landside Operations | Airside Operations | Administration | Maintenance |
|---|---|---|---|
| • Backup generators<br>• Building Foundations<br>• Drainage systems<br>• Fire detection<br>• Power Systems<br>• Primary power systems (including wiring)<br>• Redundant power systems (e.g., backup generators)<br>• Roadways and parking<br>• Suspension of ground operations<br>• Terminal buildings<br>• Utility wiring (underground)<br>• Water utilities | • Aircraft<br>• Aircraft body<br>• Aircraft engines<br>• Airport surface fleet<br>• Aprons and deicing pads<br>• Backup generators<br>• Building foundations<br>• Control tower(s)<br>• Drainage systems<br>• Extended delay to flight operations<br>• Fire detection<br>• Fuel racks and stations<br>• Ground support equipment (GSE)<br>• Hangars<br>• Jet-bridges and passenger stairways<br>• Navigation and landing systems<br>• Power systems<br>• Primary power systems (including wiring)<br>• Redundant power systems (e.g., backup generators)<br>• Runway/ taxiway pavement<br>• Runways, taxiways, and apron<br>• Suspension of ground operations<br>• Terminal building(s)<br>• Utility wiring (underground)<br>• Water utilities | • Employee health<br>• Employee safety<br>• Employee, tenant, or passenger safety | • Aprons and deicing pads<br>• Fuel racks and stations<br>• Heating, ventilation and air conditioning systems<br>• Provision of maintenance services |

Within each airport functional area, components may experience different levels of impact from a weather event type. For example, within Landside Operations, backup generators might experience a different level of impact from snow events than roadways. In the subsequent results, the team chose to use the impact level corresponding to highest impact level associated with any components within that functional area. The highest impact was chosen, opposed to the average, to ensure the worst impacts are captured.

The team developed a series of bar-charts for each airport functional area to assess how the frequency of exposure to a significant weather event may affect the level of associated impacts. For example, Figure D-12 shows the percentage of airports surveyed that said flooding had no, low, moderate, or high impact on landside operations. For each of these ratings, the bars are broken into two groups: the airports located in counties that experience flooding *frequently* (in the top 70$^{th}$ percentile of counties for flood frequency) and airports that are located in counties that experience flooding *less frequently* (at or below the 70$^{th}$ percentile nationwide). These groupings allow one to see how the frequency of exposure to a significant weather event may affect the level of associated impacts on airports.

**Figure D-12. Flooding Impacts to Landside Operations – Example Bar Chart Comparing Known Frequency of Event with Airport-Reported Impacts**




*Findings*

As expected, and helpful in "ground-truthing" the results, airports that are located in areas that have not experienced an event according to the NOAA Storm Events Database also did not report having experienced the event. However, there were a few instances where airports that reported "no experience" with a specific significant weather event were located in counties in which the NOAA storm events database suggests an event has occurred within the past 18 years. This are several possible explanations: limitation in the institutional knowledge going back 18 years, the event occurred in a different area of the county and did not affect the airport, the event was not large enough to impact the airport and thereby wasn't remembered, or the stakeholder filling out the airport survey was not familiar with the event had a different definition in mind for describing the significant weather.

Figure D-13 and Figure D-14 show how airport-reported impacts from the survey align with historical event frequency. These figures show impacts from tornadoes and hurricanes to landside operations, airside operations, airport administration, and maintenance. Both event types were generally rated as having "moderate" or "high" impacts when they occur, regardless of how often the airport experienced the event. Of all event types, ice events appear to show the greatest gains from experience—that is, airports who experience icing frequently report significantly lower impacts from icing that airports that do not experience it frequently.

**Figure D-13. Percent of Airports Surveyed who Report Impacts from Tornadoes, by Frequency of Event**

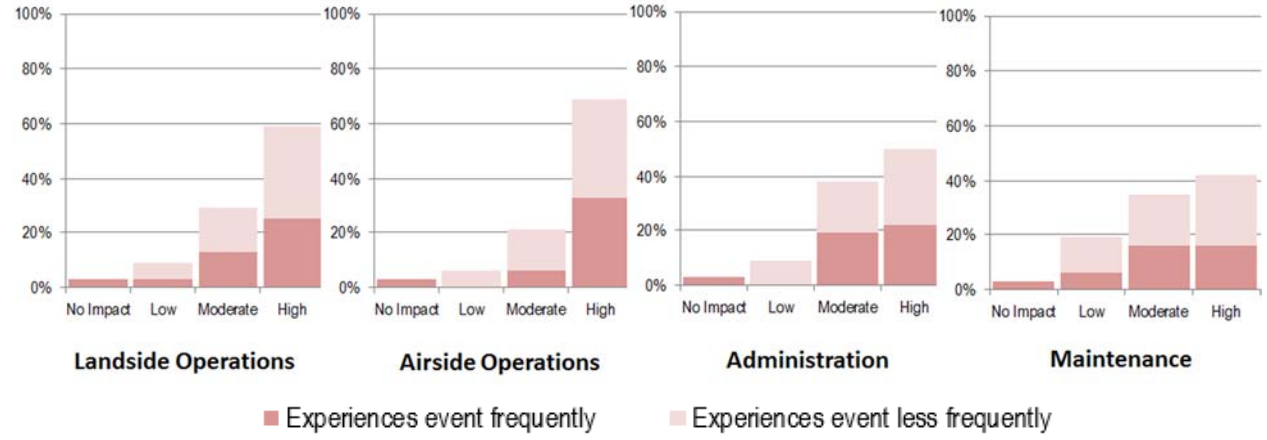
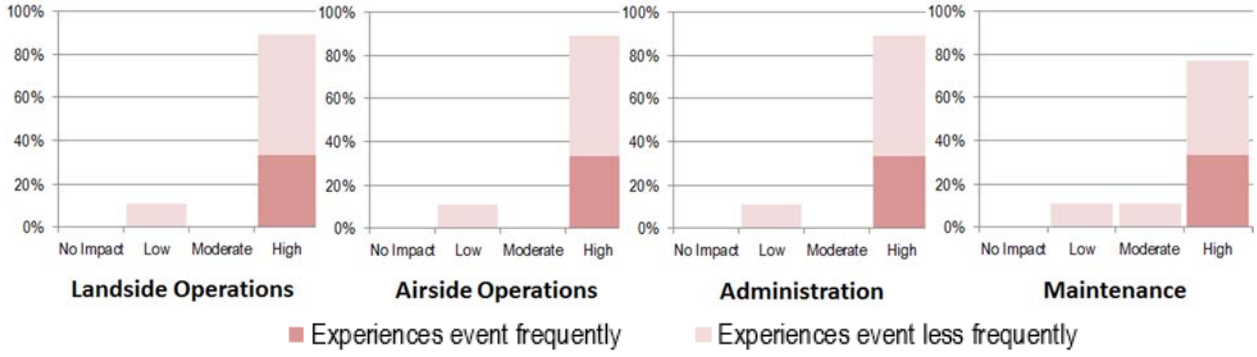



**Figure D-14. Percent of Airports Surveyed who Report Impacts from Hurricanes, by Frequency of Event**




Next, the project team considered the scope, variation, and vulnerability of the airports to significant weather events. For each airport functional area, the team assigned an overall impact rating based on how the majority of survey respondents assigned the rating. For example, more than 50% of airports surveyed ranked hurricanes as causing a "high" impact across all airport functional areas (see Figure D-12). In fact, many event types consistently ranked at a "high" to "medium/high" impact on airports across airport functional areas, including hurricanes, tornadoes, ice events, lightning, and snow events. Other event types were rated from "no impact" to "medium/high" impact depending on the functional area. Airside operations appear to be most sensitive to almost all of the event types, followed by landside operations.

Figure D-15 also suggests how difficult it is for airports to develop best practices for dealing with events. If an event occurs with frequency but the impact of the event is ranked “medium” to “high,” this suggests that it is challenging to cope when the event occurs and likely only reactionary practices are in effect (e.g., lightning). Those events that occur with regularity but have a low impact either do not cause notable disruptions or the airports are better able to prepare.

**Figure D-15. Airport Reported Event Impacts (by functional area) vs. Frequency of Events**

Table D-4 quantifies which events were identified to have the greatest impact on airports based on the percentage of airports that rated the impacts as "moderate" and "high," regardless of the frequency of the event. These results show that airside operations is the most sensitive of the functional areas and maintenance is the least sensitive. The most severe events that impact airports include hurricanes, tornadoes, and ice.

**Table D-4. Percent of Airports Surveyed that Rank Events as Having "Moderate" to "High" Impact to Airport Functional Areas**

| | Landside Operations | Airside Operations | Administration | Maintenance |
|---|---|---|---|---|
| Extreme cold | 54% | 54% | 43% | 37% |
| Flooding | 72% | 55% | 40% | 33% |
| Hail | 43% | 63% | 42% | 38% |
| Heat | 48% | 45% | 56% | 44% |
| Heavy precipitation | 70% | 60% | 40% | 33% |
| Heavy wind | 42% | 85% | 85% | 42% |
| Hurricane | 89% | 89% | 89% | 88% |
| Ice | 82% | 89% | 86% | 66% |
| Lightning | 74% | 80% | 79% | 53% |
| Poor visibility | 37% | 69% | 54% | 12% |
| Snow | 69% | 78% | 63% | 51% |
| Tornado | 88% | 90% | 88% | 77% |

Next, the team explored whether airports that rated an event as a "moderate" to "high" impact were more likely to be an airport that experiences these events infrequently, which would suggest that airports that deal with the event more frequently have developed best practices to deal with the event. **Table** provides the percentage of airports that rated an impact as "moderate" or "high" and experience the impact infrequently. For example, 46% of airports surveyed experience extreme cold less frequently than other airports and rank extreme cold as having a "moderate" or "high" impact on landside operations. As shown in Table D-5, many events are just challenging to deal with regardless of the frequency of exposure (as indicated by the green shading where airports that experience the event more frequently tend to rank the impact as "moderate" or "high"). An ice event, however, does seem to be more problematic for airports unaccustomed to these events. The other events which may have some useful best practices from airports that experience these events more frequently include heat, hurricanes, and tornadoes.

**Table D-5. Percent of Airports Surveyed that Experience Weather Event Types Less Frequently and Rank These Events as Having "Moderate" to "High" Impact to Airport Functional Areas**

| | Landside Operations | Airside Operations | Administration | Maintenance |
|---|---|---|---|---|
| Extreme cold | 46% | 46% | 35% | 41% |
| Flooding | 47% | 45% | 50% | 45% |
| Hail | 44% | 33% | 38% | 37% |
| Heat | 60% | 56% | 64% | 61% |
| Heavy precipitation | 43% | 47% | 30% | 27% |
| Heavy wind | 50% | 33% | 33% | 50% |
| Hurricane | 63% | 63% | 63% | 63% |
| Ice | 74% | 76% | 72% | 73% |
| Lightning | 18% | 16% | 14% | 11% |
| Poor visibility | 68% | 55% | 43% | 33% |
| Snow | 43% | 46% | 40% | 53% |
| Tornado | 57% | 57% | 53% | 58% |