Proposed Statement of Work
Aspen/Pitkin County Airport Winds Project

Larry Cornman and Arnaud Dumont
NSF NCAR Research Applications Laboratory
August 5, 2024

From the Aspen/Pitkin County Airport FlightOps Safety Task Force's Spring 2023 report, "Initial Report and Recommendations of the Aspen/Pitkin County Airport FlightOps Safety Task Force," their stated mission is: "to maximize safety and reduce aviation accidents and incidents at the Aspen/Pitkin County Airport (ASE) and associated airspace". The purpose of this project is for the National Science Foundation's National Center for Atmospheric Research, Research Application Laboratory (NSF NCAR/RAL) to provide technical support to the sponsors to help address these concerns. NSF NCAR/RAL has the technical expertise and experience in providing practical solutions to a wide variety of aviation hazard scenarios. Specific to this project, we have a proven track record of investigating airport wind, wind shear, and turbulence problems due to complex terrain and convection, as well as devising, developing, and deploying user-centric information and warning systems.

This project is considered as a first step in providing solutions for the ASE wind hazard problems. It would be unrealistic to propose a solution without understanding the meteorological and operational aspect which have contributed to past incidents. To produce actionable recommendations, NSF NCAR/RAL intends to investigate the meteorological conditions – specifically wind regimes and terrain interaction – that result in the hazardous wind conditions. Due to the limited nature of this first phase, we plan on performing this investigation via a case study approach – as opposed to a more comprehensive climatological study. The cases will be selected via a combination of archived pilot reports of hazardous winds encountered along the runway, final approach, and during departure, ASE ASOS data, and, as available, known accident/incident scenarios. To support the case studies, data from the NOAA High-Resolution Rapid Refresh (HRRR) model archives will be used. These data are available at a 3-km spatial and hourly resolution. Another set of supporting data will be lightning data, to help ascertain whether convection was present. These data sets will then be used to generate an understanding of the general, and to some extent, local meteorological conditions associated with known wind-impact scenarios. An adjunct to the case study analyses will be assessing the application of Automatic Dependent Surveillance (ADS-B Out) reports. These reports can provide high-resolution observations of aircraft motion, without the need to install additional instrumentation on-board. NSF NCAR/RAL has been sponsored by the FAA to develop turbulence detection algorithms from these data. That effort has been focused on enroute turbulence detection from Part 121 aircraft, but there is a strong interest and intention by the FAA to also consider GA and Part 135 aircraft. Another potential source of turbulence reports is data from ForeFlight. NSF NCAR/RAL is in the process of pursuing this possibility with the company.

Given a better understanding of the meteorological regimes associated with wind hazards in the vicinity of the airport, NSF NCAR/RAL will then investigate potential operational solutions. Three potential approaches come to mind: (1) a "wind information" system, which provides sensor data from which users can make operational decisions. This type of system doesn't not "interpret" the weather for users, but just provides the data from which the users would make those decisions. (2) A "warning system" which provides users with actionable warnings (e.g., wind shear or turbulence) specific to a given runway

operation. Such a warning system could come in three sub-types, (a) a *diagnostic* system that uses sensor information along with "look-up tables" that have been pre-computed to connect sensor measurements to wind hazards. An example of this type is the JAWS system in Juneau, AK, developed by NSF NCAR/RAL, which uses anemometers and wind profilers along with regression algorithms; (b) a *detection* system that uses sensor information to sense hazardous wind shear conditions, e.g. from complex terrain effects and thunderstorm outflows, and compute appropriate warning information. Examples of this type are the FAA's LLWAS (anemometer network) and TDWR (Doppler radar) systems, or a Doppler lidar approach – such as used in Hong Kong; and (c) a *hybrid detection-diagnostic* system. The rationale behind such an approach is that each separate system has strengths and weaknesses, and a combined system can leverage those aspects to produce more comprehensive and accurate results. The purpose of this task is to investigate which of these options might be best suited to the wind hazard situation at and around ASE, from a scientific and engineering perspective.

NSF NCAR/RAL will provide a report detailing the results of the efforts described above. A set of recommended follow-on activities will be provided. These activities could include further meteorological analysis (e.g. a more comprehensive climatology), fine-scale numerical wind modeling, more case studies, and/or further data collection exercises. Furthermore, the recommendations will include guidance on viable approaches for operational implementation of wind information and/or wind hazard warning systems. It is anticipated that a follow-on effort, targeted at Aspen Airport's prioritized hazard mitigation strategy, will be necessary to further refine the solution and implement an operational system. Throughout the project, NSF NCAR/RAL will ensure that communication between the parties is maintained via telecons, status briefings, etc. NSF NCAR/RAL will also work with the sponsor to investigate and participate in developing funding opportunities for follow-on efforts.

An optional task of installing temporary wind sensors around the airport, and performing data analysis on those data, is also included. This additional effort was not considered as part of the original set of tasks but is incorporated as we feel that it could be highly beneficial, and that it addresses a recommendation from Section (2B) of the Task Force report, "At a minimum, additional exploratory wind sensors should be installed as soon as possible to help us understand the conditions throughout the length of the runway even if these reports are not yet integrated into FAA displays and procedures." This deployment also fits very well within the context of Tasks 1 and 2 described above. NSF NCAR/RAL has an in-house capability to deploy self-contained, all-weather, research-quality anemometers. We envision three possible locations, one at the north end of the runway (perhaps coincident with the existing ASOS site), one at the south end, and one at the radar site on top of Shale Bluffs. Data will be collected at a minimum of one sample per second, transferred to, and archived at NSF NCAR in near real time. NSF NCAR will work with local entities to site and deploy the sensors, and then operate, collect, and perform an analysis of the data.

Task 1. ASE wind/turbulence case studies

The goal of this task is to get a better understanding of the wind regimes that can result in hazardous flying conditions along the arrival and departure paths at ASE. The approach is to perform case studies driven by pilot reports of wind, wind shear, and/or turbulence for flights into and out of ASE. In parallel to the case studies, we will also hold discussions with a variety of airport users (e.g., pilots and ATC personnel) to augment our knowledge base with anecdotal information regarding the perceived wind-related issues. These additional data could influence the focus of our study and the follow-on recommendations report. Finally, we will investigate previous NTSB accident/incident cases and if the appropriate data is available, perform case studies similar to those discussed above.

Specific Tasks:

1. Hold discussions with ASE users.
2. Review past accident/incident scenarios.
3. Collect and analyze case study data, using:
    a. Archived pilot reports of hazards encountered during take-off and landing
    b. ASE ASOS winds
    c. HRRR model synoptic data
    d. ADS-B flight data
    e. ForeFlight wind/turbulence data (TBD)

Task 2. Investigate potential short-term and longer-term solutions

The intent of this task is to consider practical, tangible, and specific steps forward. This task will build on the case study task described above and consider sensor types appropriate for ASE (given expected weather scenarios), sensor locations, deployment costs, and user aspects (e.g., displays and information content). The outcome of this task will be recommendations as to potential solutions for the ASE wind hazards.

Specific Tasks:

1. Investigate sensor systems (e.g., on-airport and off-airport anemometers, Doppler lidars, Doppler radars, Doppler wind profilers).
2. Describe a notional "Wind information" system (e.g., display of sensor data – *no interpretation* – just QC).
3. Describe a notional "Warning" system (actionable, user-friendly information. Could be graphical display).
4. Present user aspects for consideration (e.g., information content, useability, access, information display, communications, airline/FAA rules).

Task 3. Report and Project Management

Specific Tasks:

1. Summarize/describe work performed in tasks listed above.
2. Produce a report including recommendations regarding next steps.
3. Coordinate with the sponsor, provide briefings, and participate in telecons, as needed.

Optional Task. Deploy temporary anemometers

1. Consider 3 sites (e.g., N-end runway, S-end runway, radar ridge site above Shale Bluffs)
2. Fall/Winter data collection. (TBD)
3. Perform initial data analyses.

Budget

The following are rough order of magnitude numbers. Complete budget details will be included in any response to an RFP.
Task 1: $50K
Task 2: $25K
Task 3: $25K
Optional Task: $25K