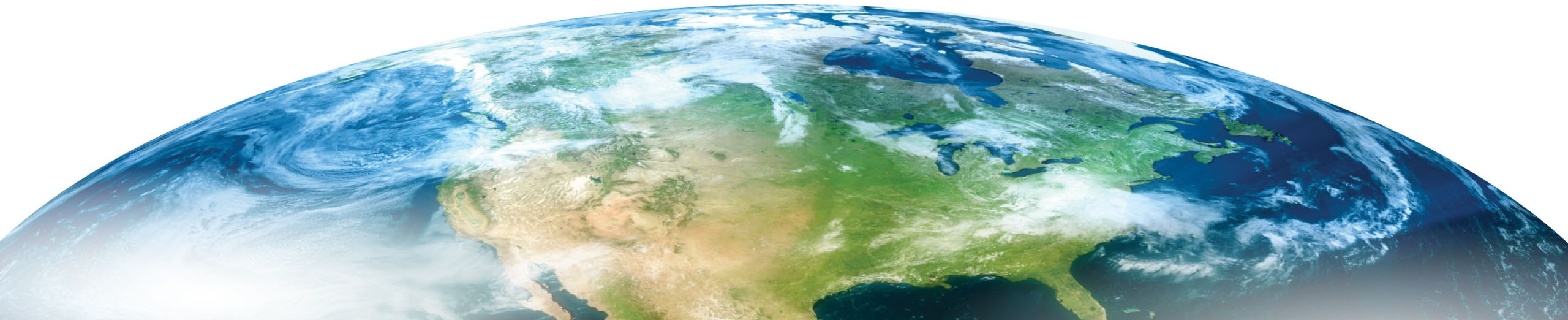




Next**GEN**

Visibility Estimation Through Image Analytics User Assessment Results

Presented to: Jenny Colavito
By: FAA AWDE Services, ANG-C63
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Introduction

This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.



Introduction

- The weather cameras have provided additional observations and are used routinely by pilots, dispatchers, meteorologists, and FAA Flight Service Specialist*.
- However, current camera limitations include limited to no use during nighttime conditions and the need for human interpretation of conditions presented on the cameras which adds to user workload and typically can not be done en route.
- To address these shortfalls, the FAA Aviation Weather Division (ANG-C61) funded the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) to develop the Visibility Estimation through Image Analytics (VEIA) algorithm.
- The VEIA algorithm is intended to supplement visibility observations currently used in Alaska and may help improve safety by providing greater situation awareness.
- The VEIA algorithm is still in the research and development phase.
- The FAA Aviation Weather Demonstration and Evaluation (AWDE) Services Team was tasked to conduct a virtual 4-6 week evaluation focused on determining the usability and suitability of VEIA.

*Due delays in Labor Relation coordination, FAA FSS were not able to participate during the assessment period. Coordination is in progress and data collection will begin as soon as coordination is complete.

Objectives

- Determine the suitability of VEIA.
 - Is VEIA available when needed?
 - Does VEIA provide the information necessary to support decision-making?
- Determine the usability of VEIA.
 - Is VEIA easy to use?
 - Is information easy to find?

User Assessment Approach

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Approach

- All participants were provided training detailing assessment objectives, participant expectations, VEIA background information, VEIA capabilities and contact information for AWDE personnel.
- All participants were asked to use VEIA as supplemental visibility information.
- All participants were asked to participate in at least two virtual meetings to provide feedback on the use of VEIA.
- Structured interviews were conducted virtually, one-on-one, with the exception of the Alaska Aviation Weather Unit (AAWU) Meteorologists, one group of dispatchers, and one group of Part 135 pilots, each group had multiple participants attend the two interviews.
- During the interviews, participants were asked to describe how VEIA was used during the assessment period.
- Participants were invited to share screen shots and supplemental information during and after interviews.

Approach

- During the interviews, the AWDE Team collected data using questions which:
 - Allowed participants to provide comments regarding the use of VEIA for decision-making.
 - Focused on information used to support decisions, utility of visibility information, and any additional information participants would want included in the VEIA capability.
- After completion of the structured interview sessions, participants were emailed a link to a Google Form Questionnaire to complete.
 - 5-point Likert scale rating was used (5-Strongly Agree, 4-Agree, 3-Neither Agree/Disagree, 2-Disagree, and 1-Strongly Disagree).
 - Space for additional comments was provided.

Participant Summary

# of Participants	User Group	Primary Geographic Region	Flight Hour Range
5	Part 135 Pilot	Interior Alaska, South Central, West Yukon Valley, Aleutians, South East Alaska, Juneau	1500-30,000
5	GA Pilot	Interior Alaska, South Central, West Yukon Valley, Anchorage Area	10- 4000
2	Part 121 Dispatcher	All of Alaska, Arctic Slope, North Slope, Upper Yukon, Koyukuk	N/A
1	Part 121/Part 135 Dispatcher	Alaska Statewide, Aleutians, SW Delta, Bristol Bay	N/A
7	Part 135 Dispatcher	Alaska Statewide, Western, Arm of Alaska, Bristol Bay, Delta, Kenai Area	N/A
2	AAWU Meteorologists	Anchorage Flight Information Region, All of Alaska and beyond	N/A
1	CWSU Meteorologists	Colorado	N/A
1	Testbed Meteorologist	All of Alaska	N/A
1	Alaska Regional Headquarters Meteorologist	All of Alaska	N/A
7	NWS WFO Meteorologists	South East Alaska, Panhandle, Northern Alaska, Central Alaska and Western Alaska	N/A
32	Total		

Results

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Questionnaire Results

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VEIA Questionnaire Results

Question <small>(Strongly Agree=5, Agree=4, Neither Agree nor Disagree=3, Disagree=2, Strongly Disagree=1)</small>	Part 121/135 Dispatchers <small>(N=3) Mean</small>	GA Pilots <small>(N=6) Mean</small>	Meteorologists <small>(N=7) Mean</small>	Overall <small>(N=16) Mean</small>
1. The information VEIA provides is easy to use.	4.7	4.2	4.6	4.4
2. VEIA provides visibility information in a timely manner to support identifying safe and efficient routes.	4.0	3.7	4.3	4.0
3. VEIA information would improve situational awareness of visibility along a route.	4.7	4.2	4.3	4.3
4. VEIA information is available when needed.	4.3	3.7	4.6	4.2
5. Information is easy to find when using VEIA.	4.3	4.2	4.3	4.3

The GA pilots rated having information in a timely manner and data availability as “Neither Agree/Disagree” due to slow data upload rates and site reliability issues. The AWDE evaluators did notify participants the site was being hosted on test platform with limited processing speed and capabilities and users may experience down times or delay in information.

VEIA Questionnaire Results

Question <small>(Strongly Agree=5, Agree=4, Neither Agree nor Disagree=3, Disagree=2, Strongly Disagree=1)</small>	Part 121/135 Dispatchers <small>(N=3) Mean</small>	GA Pilots <small>(N=6) Mean</small>	Meteorologists <small>(N=7) Mean</small>	Overall <small>(N=16) Mean</small>
6. VEIA would help me in decision-making	4.7	4.0	4.6	4.4
7. VEIA is easy to use in my operational environment.	4.7	3.5	4.6	4.2
8. I would use VEIA as a supplemental product to aid in decision-making.	4.7	4.3	4.9	4.6
9. I have more confidence in my decision-making when using VEIA.	4.3	3.8	4.3	4.1
10. It is not an issue when the time on the VEIA Trend graph doesn't match-up with other observations. (i.e. VEIA Trend graph provides up to 1830z of information while the METAR provides up to 2020z of information.	3.3	3.7	3.7	3.6

GA pilots rated VEIA's ease of use as "Neither Agree/Disagree" due to the need for a mobile friendly interface allowing use anywhere. GA pilots rated having more confidence in decision-making when using VEIA as "Neither Agree/Disagree" due to the conservative estimates provided when there are low cloud ceilings at a site.

On average, all participant groups provided a rating of "Neither Agree/Disagree" for the **timing** of VEIA issued observations not matching up with other issued observations. Participants didn't have a preference if the VEIA times and observation times matched or didn't match.

Structured Interview Question Results

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Question 1

Did you access and use the weather cameras prior to this assessment? If so, how often do you use the cameras? If not, why? Having access to VEIA, do you think your use of the cameras has increased, decreased, or stayed the same?

- All participants used the weather cameras multiple times a day to assess weather conditions.
 - GA and Part 135 pilots access the weather cameras prior to each flight.
 - Part 121 and Part 135 dispatchers viewed the weather cameras prior to dispatching a flight and while flights are en route.
 - Meteorologists access the weather cameras multiple times per shift to assess weather conditions to update forecasts and issue advisories.
- Participants indicated VEIA did not increase the use of weather cameras since the weather cameras are already a main source of weather information.

Question 1 (Continued)

Does VEIA decrease/increase the amount of time needed to assess visibility conditions?

- Participants stated the time needed to assess visibility conditions stayed the same or decreased due to using VEIA.
 - Participants who indicated no change in their assessment time stated VEIA information would be used in addition to other source of visibility information.
 - Participants who indicated their assessment time would decrease stated the numerical visibility value along with the trend information reduced the time needed to loop through the weather camera images.

Question 2

What decisions are you making when using the VEIA information? Does VEIA provide information needed to support decision-making?

- VEIA assisted pilots and dispatchers in assessing weather conditions at a location to determine if the visibility allowed for operations to proceed.
- Pilots and dispatchers noted VEIA visibility information aided the following decisions:
 - Make go-no-go decisions
 - Identify alternate landing locations
 - Determine visibility through mountain passes, choke points and in coves
 - Identify the routing for tours (i.e. if stops could be made, if visibility is degrading and tour route required modification)
- Meteorologists noted VEIA visibility information aided the following decisions:
 - Determine flight category (Visual Flight Rules (VFR), Marginal VFR, Instrument Flight Rules (IFR), Limited IFR)
 - Write Terminal Aerodrome Forecasts (TAFs)
 - Verify inconsistent data from other sources such as village agents, mesonet, Aviation Routine Weather Report (METAR)

Question 2 (Continued)

What information are you using? What information are you not using? (e.g., Station, Visibility (Miles), Trending data).

- All participants stated the VEIA visibility estimate was useful and provided a numerical value easily validated using the weather camera images, METAR observations, and other visibility observations.
- The Trend information was used by participants to provide a quick glance view indicating the weather was improving or degrading.
- Overall, participants did not have a preference for the textual output vs the trend graph, both were used consistently.
- Due to the limited weather observations available in Alaska, all participants stated VEIA visibility information was useful and would be used consistently as supplemental visibility information.

Question 3

When are you making these decisions (e.g., departure, en route, the day before, a few hours prior to departure?)

- **All Pilots:**
 - VEIA was consistently used within a hour of departure time to assess current visibility conditions. As departure time approached, VEIA aided in making final go-no-go decisions and helped identify alternate landing locations.
- **Part 121/135 Dispatchers:**
 - Dispatchers started using VEIA information 24 hours prior to a scheduled flight, specifically, visibility trend information.
 - Dispatchers stated VEIA was used 0-2 hours prior to an estimated time of departure (ETD) to assess the visibility trends for preparing a pilot briefing.
 - Final go-no-go decisions, based on supplemental VEIA visibility estimates, were made when a pilot contacts dispatch 30 minutes prior to flight.
 - Dispatchers track flights en route and provide pilots the most current visibility conditions.
- **Meteorologists:**
 - VEIA was used several times during a shift to assess current visibility conditions.
 - VEIA was used obtain visibility information to aid in determining the need to update TAFs or flight categories and create/update warnings such as AIRMETs and SIGMETs.

Question 4

How often did you use the VEIA information?

- All Pilots: VEIA was consistently used within a hour of departure time to assess the most current visibility conditions.
- Part 121/135 Dispatchers: VEIA was consistently used to provide visibility updates to the pilots while en route.
- Meteorologists: VEIA was used several times during an approximate 8 hour shift to verify and update flight categories, advisories, and forecasts.

Question 4 (Continued)

What other products did you use when using VEIA (e.g., METAR)?

Other Products Used (In alphabetical order for each group)		
Dispatchers	Pilots	Meteorologists
AAWU and NWS Forecasts	AAWU Synopsis Charts	BUFKIT Soundings
Area forecasts	Area forecasts	METARs /Weather Observations
Foreflight	Foreflight	Models Guidance
METARs, TAFs, PIREPs	METARs, TAFs, PIREPs,	PIREPS
Weather Cameras	Skyvector.com	Satellites
Weather Observers/Village Agents	Weather Cameras	Weather Cameras
Windy	Weather Observers/Village Agents	
	Windy	

Question 4 (Continued)

Why did you use other products to assess conditions?

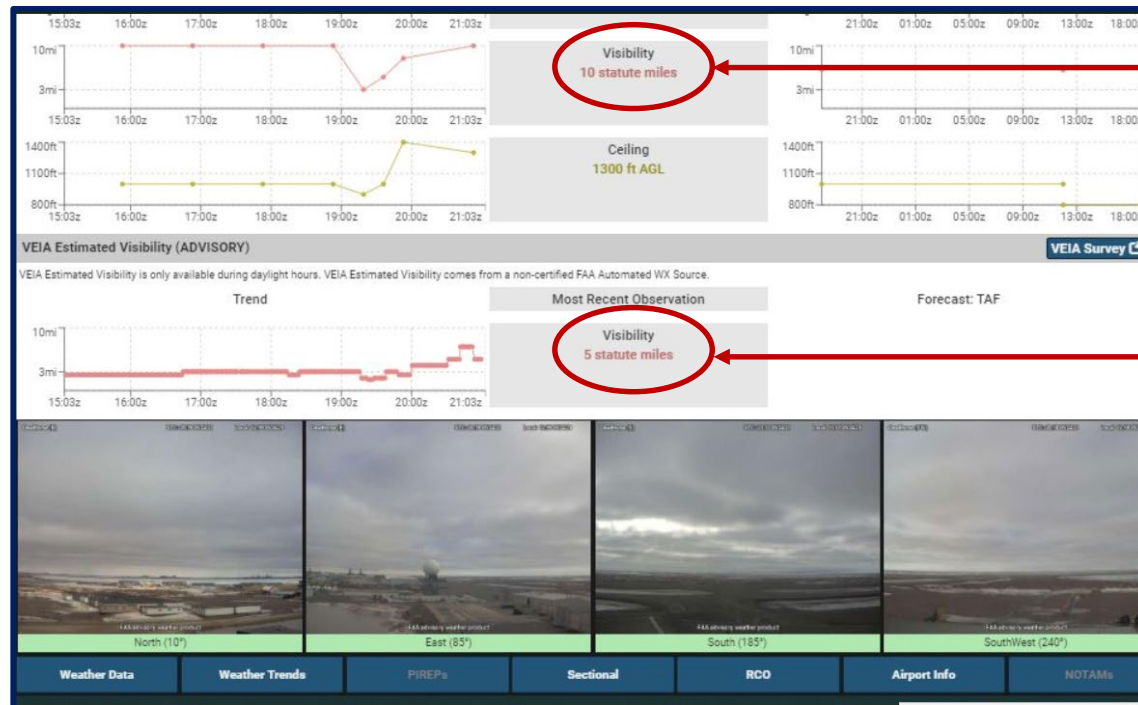
- Pilots and Dispatchers:
 - Access multiple weather sources to increase confidence in decision-making.
 - Using the weather camera data, VEIA, and other observations provides the capability to reach a concurrence, between pilots and dispatchers, to make go-no-go decisions.
- Meteorologists:
 - Utilizing multiple weather sources increase confidence when issuing warnings and updating forecasts.
 - Use many products to assess visibility conditions, based on knowledge of the products biases and weaknesses, depending on location and conditions, different products are more reliable. However, having the weather cameras provides a reliable source of visibility conditions.
 - Use weather cameras to visually see current conditions and visually confirm which observation is most reliable.

Question 4 (Continued)

If the information between the products was different, what source was more reliable?
Why?

If discrepancies are noticed in products, all participants stated the weather camera images are used to visually assess the current conditions.

Example of METAR and VEIA Estimated Visibility providing different information



METAR Visibility is 10 miles

VEIA Visibility is 5 miles

Participants use the Weather Camera images to validate visibility.

Question 5

Does VEIA give you more confidence in both making decisions and assessing the weather camera images? If so, why? If not, why?

- All Participants:
 - VEIA visibility provided more confidence in assessing weather camera images when the VEIA visibility matched what was determined by visual assessment.
 - If VEIA did not match the visual assessment of weather cameras, participants would have less confidence in the VEIA estimate and rely on weather camera images.
- Meteorologists:
 - VEIA would increase confidence in decisions by providing a visibility number and trend information which reduces subjectivity in assessing weather camera images.
 - Meteorologists need to validate the VEIA data to assess the performance and determine limitations where VEIA tends to produce a conservative visibility estimate such as during ground fog and blizzards and low ceiling.
 - By providing a quick glance view of the trend in visibility, VEIA would help forecasters focus on areas of decreasing or low visibility.

Question 6

Are there specific locations that VEIA provides more benefit to than others?

- All Participants:
 - Any location without METARs or good visibility markers.
 - Through the mountain passes especially in choke points.
- Pilots and Dispatchers:
 - Coastal locations where there is low level fog and the weather changes rapidly.
 - Weather Camera locations without a good clear day reference, such as Sister's Island.
 - Landing strips near mining camps and oil fields without observations.
 - Areas with IFR approach without observations to comply with the FAA Reauthorization Act of 2018, Section 322 which “permits an air carrier operation to operate to a destination with a published approach in a noncontiguous State under instrument flight rules and conduct an instrument approach without a destination METAR if a current Area Forecast, supplemented by noncertified local weather observations is available, and an alternate airport that has a weather report is specified”.*
 - Villages where a human observer is the only source of visibility to reduce the subjectivity due to human biases.

*H.R.302 - 115th Congress (2017-2018): FAA Reauthorization Act of 2018. (2018, October 5). <https://www.congress.gov/bill/115th-congress/house-bill/302>

Question 6

Are there specific locations that VEIA provides more benefit to than others?

- Meteorologists:
 - Locations with varying elevations.
 - Outside the airport area, closer to the community, for public warnings.
 - Areas with shallow fog since the camera are more elevated than the sensor on the runway.
 - Sea plane bases and locations near coves where sea planes land.
 - Across the highways in Alaska, specifically north of Fairbanks to provide more visibility information.

Question 7

Are there any suggested improvements to the VEIA information provided or the display of the information?

- Overall, participants who used the Weather Data* tab would prefer the most recent VEIA visibility listed at the top of the list to reduce the time needed to view recent visibility information.
- For a quick view, display the current VEIA visibility and a trend indicator on the FAA Weather Camera map to allow a quick glance of current visibility over a large area and indicate areas where the visibility is degrading.
- Participants stated a need for sector/quadrant visibility in addition to the prevailing visibility which would allow for flights to depart if the visibility is acceptable in the direction of travel.
- Participants stated a need for trending and confidence information in the VEIA estimate to aid in validating information.
- Pilots requested the ability to access the FAA Weather Camera site and VEIA from a mobile device.
- Meteorologists would like to access VEIA data in a downloadable option such as a comma separated format to integrate into other tools.

*Weather Data is a selectable tab on the FAA Weather Camera website.

Additional Comments

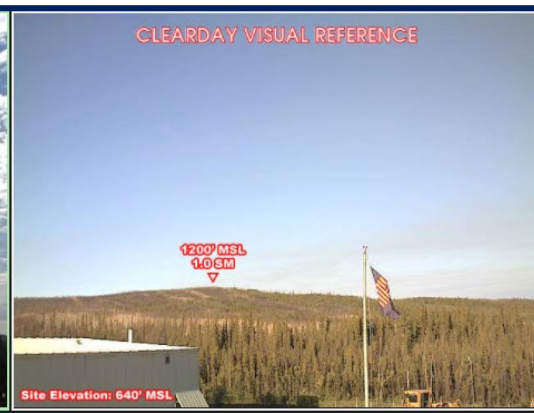
- VEIA provides a conservative estimate when the sun is below the horizon.
- VEIA assessment of shallow fog, ground blizzards, and low cloud ceiling is conservative.
- Additional reference points within 3 miles are needed at many camera locations (i.e. Kodiak) to help improve VEIA verification. The lack of close landmarks in the clear day image makes it difficult to estimate the camera images accurately at lower visibility levels.

Additional Comments

Clear day image should match orientation and zoom levels for the FAA Weather Camera image to more easily validate VEIA visibility estimates.

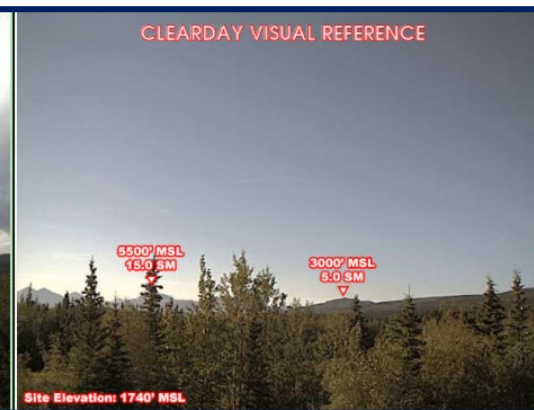
The Yukon River Bridge Camera and McKinley Park South Camera Images and the Clear Day Images, at the sites, are at different zoom levels and at different reference points.

Yukon River Bridge
Weather Camera Image



Clear Day Image

McKinley Park South
Weather Camera Image



Clear Day Image

Conclusions

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Objective 1: Determine the Suitability of VEIA

- VEIA visibility information would increase safety for all users by providing visibility estimates to support decision-making in locations without observations and also provide supplemental visibility information in locations with observations.
- The VEIA visibility estimate and trend data provides pilots and dispatchers the information necessary to support go-no-go decisions and plan routes.
- Although participants were told VEIA was hosted on a site with limited processing speed and capabilities, participants stated the VEIA FAA camera site was not available at times, when needed, or took too long to upload all necessary information.
- Due to limited computer availability at airplane hangers, developing a mobile friendly interface would provide VEIA more access to VEIA information.

Objective 2: Determine the Usability of VEIA

- The VEIA estimated value and 6-hour trend information provided quick and easy access to visibility information needed by pilots, dispatchers and meteorologists to assess current visibility at departure location, along the route, and at the destination.
- Participants stated reversing the order of the data listed on the Weather Data tab would provide a quick view of the current visibility and prevent the time needed to scroll to the bottom of the list. Participants stated when seeing the word “Missing” in the list, initial thoughts were there was no data and VEIA was not providing a visibility estimate. Participants did not realize the data was at the bottom of the screen.
- For ease of use, placing a color coded indicator or the current VEIA visibility on the FAA Weather Camera home page would make the information easier to use and find.