National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Revise Processes, Procedures, and Reporting Capabilities for Automated Weather Systems

Accident Numbers:	WPR19FA084/DCA18MM028
Operator:	Private Pilot/Ride the Ducks Branson
Locations:	Near Ely, Nevada/Table Rock Lake, near Branson, Missouri
Date:	February 15, 2019/July 19, 2018

The National Transportation Safety Board (NTSB) is providing the following information to urge the National Weather Service (NWS) and the Federal Aviation Administration (FAA) to take action on the safety recommendations in this report. In the interest of transportation safety, the recommendations address various concerns with malfunctioning automated surface observing systems (ASOS) and automated weather observing systems (AWOS), as well as their respective reporting capabilities, which can result in erroneous weather information being provided to the transportation community.[1]

These recommendations derive from the NTSB's investigation of a fatal accident involving a privately operated Cirrus SR22 that crashed while maneuvering at low altitude near Ely, Nevada, on February 15, 2019, as well as our investigation of the sinking of the amphibious passenger vessel *Stretch Duck 7* on July 19, 2018, near Branson, Missouri. The NTSB is issuing two new safety recommendations to the NWS and two new recommendations to the FAA to address identified safety issues.

Background and Analysis

Definitions and Procedures Concerning Erroneous ASOS Sensor Reporting

On February 15, 2019, about 1730 Pacific standard time, a Cirrus SR22, N917SR, was destroyed when it impacted terrain about 3.4 nautical miles (nm) north-northeast of Ely Airport (ELY), Ely, Nevada, while the pilot was maneuvering at low altitude in an attempt to locate the airport. The private pilot and passenger received fatal injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight. The pilot, who was not instrument rated, departed from Craig-Moffat Airport, Craig, Colorado, about 1430, under visual flight rules (VFR) en route to the destination airport (Twin Falls Regional Airport [TWF], Twin Falls, Idaho).[2]

[1] The FAA's Pilot/Controller Glossary defines AWOS and ASOS as "automated weather sensor platforms that collect weather data at airports and disseminate the weather information via radio and/or landline." Generally, the NWS monitors and maintains ASOSs, and the FAA does the same for AWOSs.

[2] More information about this accident, NTSB case number WPR19FA084, is available by accessing the NTSB's aviation accident database.

According to data provided by the FAA, the pilot contacted air traffic control (ATC) about 1438 and requested VFR flight-following services to TWF. The airplane proceeded west, then southwest, at an altitude of about 17,500 ft mean sea level, and the pilot reported to the controller that he planned to turn north upon reaching Salt Lake City, Utah. About 1451, after discussing with the pilot his intent to deviate around weather by continuing southwest, the controller suggested that the pilot proceed direct to ELY, which was about 154 nm west-southwest of the airplane's location, before continuing to TWF. About this time, the ELY ASOS reported visibility of 10 statute miles (sm), a broken cloud layer at 5,000 ft, and overcast clouds at 6,500 ft.[3] The pilot replied that he "hadn't planned to go as far west as Ely but if that's what I have to do I can."

The pilot proceeded toward ELY, descending to about 10,400 ft msl stating, "yeah, I'm trying to stay under the deck here." Radar contact was lost about 1634 as the airplane descended over mountainous terrain. About 1637, around 75 miles east of ELY, the pilot stated his intention to divert and land at ELY. The controller stated that he would keep looking for the airplane on radar and provided the ELY altimeter setting, which the pilot acknowledged. Radio communication between the controller and pilot was lost after this transmission, but another pilot operating in the area established contact with the accident pilot and relayed that radar service was terminated. The relay pilot reported that the accident pilot acknowledged the instructions; there was no further communication between the accident pilot and the controller, and radar contact was not reestablished.

During the accident airplane's descent to ELY, about 1724, the airport's ASOS reported 9 sm visibility and light snow even though a snowstorm was in progress at the airport. Several ground witnesses later reported heavy snowfall with visibility 1/4 to 1/2 mile around this time. After the pilot performed a go-around because he was unable to see the runway to land, the airplane impacted upsloping mountainous terrain in a relatively level attitude. A postaccident examination of the airframe and engine revealed no mechanical anomalies that would have precluded normal operation.

Our evaluation of the weather conditions at the time of the accident found that ASOS visibility reporting at ELY had, at times under various weather conditions, not been accurate for weeks before the accident and had been a concern for pilots operating at the airport.[4] On January 21, 2019, the ASOS Operations and Monitoring Center submitted a maintenance ticket concerning visibility reporting to the office responsible for maintaining the ELY ASOS (the NWS weather forecast office in Elko, Nevada, [LKN]). In response, a technician remotely checked the reporting logs for the ELY ASOS and, not seeing any sensor failure flags in the system's monitoring data, cleared the reporting errors.[5]

According to LKN maintenance personnel, remotely checking reported equipment problems was customary to determine whether a site visit was necessary. In this case, after clearing the reporting errors, the technician determined that the reported problem was not associated with

[3] Although it is possible visibility was as good as reported at this time (snow began to fall at ELY about 1702), it is not possible to determine remotely whether this report was accurate.

[4] Maintenance log entries for the ELY ASOS indicate recurring maintenance reports and actions concerning erroneous visibility reporting since December 2018.

[5] The reporting errors were related to ceiling, freezing rain, and visibility reporting.

a hardware issue and that a site visit was not necessary; no further discussion or action concerning the ELY ASOS visibility sensor occurred from that time until February 5, when LKN received a priority 1 ticket about unreliable wind and visibility reporting.[6]

In a postaccident interview, the LKN electronic systems analyst who handled the February 5 maintenance ticket stated that, although he saw nothing wrong with the system after checking it remotely, he ordered a replacement transmitter for the visibility sensor (on February 11) based on comments from meteorologists at LKN.[7] One day after receiving the replacement part, the day of the accident, LKN maintenance personnel attempted to reach the ELY ASOS but could not reach the site due to weather (likely the same weather system that affected the accident flight). LKN maintenance personnel attempted a second time to install the replacement part for the ELY ASOS on February 20 but found that the wrong part had been ordered; an order for the correct part was then placed. The ELY ASOS visibility sensor was finally repaired on February 27—37 days after the first maintenance ticket reporting the visibility issue was submitted—and the ticket was closed.

According to the NWS, erroneous ASOS visibility reporting also affects the reporting of snowfall intensity, as well as the issuance of special surface weather observations (or SPECIs), which are "particularly sensitive to…visibility and sky condition reports."[8, 9] Therefore, as a result of the erroneous visibility report of 9 sm on the day of the accident, the ELY ASOS reported light snow within the 15-minute period before and after the accident and did not produce or disseminate SPECIs during the 30 minutes before the accident, which it likely would have if its visibility sensor were reading correctly. Although new observations are available every minute from the ELY ASOS via VHF broadcasts and telephone, they are not available longline.[10] To remain aware of

[6] According to guidance in NWS Instruction 30-2111, which addresses ASOS maintenance requirements and responsibilities, priority 1 items are defined as safety-related failures that include visibility sensors; the maximum outage time indicated for priority 1 items is 24 hours at class 1 airports and 36 hours at class 2 airports, such as ELY.

[7] The electronic systems analyst's conversation with meteorologists was not part of a formal process; rather, it was a casual conversation during which meteorologists brought up possible issues with the visibility sensor, which prompted the analyst to order a new sensor.

[8] According to the NWS, snow intensity reported in ASOS observations is a function of the ASOS visibility measurement. An ASOS checks snow intensity against the observed visibility and adjusts the observed snow intensity measurement as necessary to comply with reporting standards contained in *Federal Meteorological Handbook No. 1*. Also, because of its effect on snow intensity reporting, an erroneous visibility measurement can affect deice holdover times, some of which are based on snowfall intensity.

[9] Important for many users, including pilots who receive weather information from facilities such as ATC and flight service, SPECIs provide critical updates when certain weather changes are observed at an airport between scheduled aviation routine weather reports (METAR). A SPECI contains all the data elements found in a METAR, along with additional plain language information that elaborates on the data in the report.

[10] Longline dissemination refers to weather observations made available in near-real time to national databases and made accessible globally to the general public from a large number of vendors. Public accessibility does not include observations from a reporting station's VHF or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the global general public has access to surface weather observations, particularly outside of the aviation community.

conditions at an airport, users who are not listening to the ASOS via VHF or telephone must usually rely on globally available SPECIs (and aviation routine weather reports known as METARs).[11]

The NTSB notes that although the terms "outage" and "failure" are used frequently in NWS Instruction (NWSI) 30-2111 (which outlines ASOS maintenance requirements and responsibilities), neither term is specifically defined. This documentation also lacks explicit instructions concerning maintenance actions in response to ASOS sensor reporting that is presumed to be erroneous but is not generating failure flags in the system's monitoring data, as was the case with the ELY ASOS during the weeks before the accident.

Postaccident interviews with various NWS staff found that, as addressed in NWSI 30-2111, an ASOS outage or failure is generally understood to mean that a sensor or component has stopped providing data. At ELY, the malfunctioning visibility sensor continued to provide (erroneous) data. Although NWS maintenance personnel pursued an examination of the reported issue, they initially relied on failure flags, which did not indicate a stoppage of data—that is, an outage as NWS management understood the term. Further, because personnel believed they initially responded appropriately to the failure flags by clearing them remotely, they did not attempt to resolve the issue within the "maximum outage time" associated with a priority 1 maintenance ticket (36 hours). Given the nature of the problem and the noted lack of clarity in NWS guidance, the NTSB's investigation found that it was unclear whether the maximum outage time applied.

The NTSB is concerned that the lack of clarity in NWSI 30-2111 resulted in an ambiguous understanding about the nature of the issue reported in the February 5 (priority 1) maintenance ticket and the urgency with which it should be handled, as well as the imprecision of the maintenance actions taken. The prompt resolution of erroneously reporting ASOS sensors is critical to aviation safety. Roughly 900 ASOSs are in use across the National Airspace System (NAS) and are installed at almost all major airports; therefore, the effects of delayed or ineffective maintenance of ASOSs potentially impact a large number of NAS users.

The NTSB concludes that the lack of clarity in NWSI 30-2111 concerning the terms "outage" and "failure" and specific maintenance actions to address erroneous sensor reporting that does not produce flags in the system's monitoring data undermines guidance intended to support timely ASOS maintenance and can negatively impact safety if users are provided erroneous weather information. Therefore, the NTSB recommends that the NWS revise NWSI 30-2111 to clearly define "outage," "failure," and similar terms regarding individual ASOS sensor and component performance and to include explicit maintenance actions intended to mitigate presumed erroneous ASOS sensor reporting that does not generate failure flags in maintenance monitoring data.

The NTSB also notes that report processing for the ELY ASOS's visibility sensor was not turned off until the second maintenance trip to ELY on February 20. NWSI 30-2112, which outlines reporting and communications requirements concerning system and equipment outages, does not currently contain procedures or provide authority to NWS operational staff, such as

[11] In the case of this accident, the pilot had access to equipment capable of receiving updated SPECIs and METARs but postaccident damage precluded determining whether it was used for that purpose during the accident flight.

forecasters, to turn off report processing in cases where an ASOS sensor is believed to be reporting erroneously but does not generate failure flags in the monitoring data. For ASOS sites that do not have weather observers augmenting the observations, such as at ELY, NWS maintenance staff have the primary authority to turn off ASOS report processing for a sensor when it is known to be performing poorly. However, NWS maintenance staff are not operational meteorologists, and they generally only respond to technical failures that appear in the ASOS's maintenance information rather than compare a sensor's output against what would be expected meteorologically.

Postaccident communications with NWS employees found the widely held view that providing no data is preferred to providing bad data. The NTSB therefore believes that when an ASOS sensor is suspected of reporting erroneously, it is necessary to decide whether to allow that sensor to report possibly bad data or to prevent its output by disabling report processing, which would cause the ASOS to report the data as "missing." Once the report processing for the ELY ASOS visibility sensor was called into question, a procedure that instructed NWS operational staff to perform such an evaluation may have resulted in the sensor's report processing being turned off sooner and may have prevented the accident pilot from considering ELY as an appropriate destination. The lack of a procedure to address this aspect of a malfunctioning sensor resulted in the ELY ASOS's continued production of erroneous visibility reports over a 15-day period (from the day the first replacement part was ordered) that included the day of the accident.

The NTSB concludes that operational staff at NWS weather forecast offices are in a unique position to question the validity of ASOS data during operations and should have the authority to turn off report processing for ASOS sensors that they determine are not performing optimally. Therefore, the NTSB recommends that the NWS revise NWSI 30-2112 to provide operational (forecasting) staff at weather forecast offices the authority to determine whether report processing for an ASOS sensor at an unattended site (or other site not currently being appropriately augmented) should be turned off immediately if the sensor is believed to be reporting erroneously but does not yield flags in its maintenance monitoring data and to include clear instructions for performing this task.

Consistent Criteria for Issuing ASOS- and AWOS-Related NOTAMs

According to criteria provided in FAA Order 7930.2S, "Notices to Airmen (NOTAM)," the conditions for issuing a NOTAM on a malfunctioning ASOS are different than the criteria for issuing a NOTAM on a malfunctioning AWOS. While Order 7930.2S stipulates that NOTAMs should be issued for an AWOS when a sensor is reporting erroneous information, the order specifies that NOTAM information on an ASOS can only be accepted from an NWS weather forecast office when at least one of the following conditions is reported:

1. The entire ASOS observation is missing and no backup observation is available for longline dissemination.
2. The altimeter setting is missing and is not backed−up.
3. The date/time group is erroneous and has not been corrected.

NWSI 10-1305, which provides observational quality control procedures for NWS personnel, repeats these criteria. Under these guidelines, a NOTAM cannot be issued if an ASOS sensor, by itself, is reporting erroneously, such as occurred at ELY about the time of the accident.

Order 7930.2S states that the NOTAM criteria for ASOS- and AWOS-related issues are different because the NWS monitors and maintains ASOSs, and the FAA does the same for AWOSs. When the NTSB asked the FAA to expand on this rationale, the FAA responded that the "NWS determines the criteria for ASOS system availability" but provided no further substantive information. The NTSB continues to question why NOTAMs for an ASOS with an erroneously reporting sensor cannot be issued but can be issued for the same type of AWOS error.

ASOSs provide critical safety information to pilots, both preflight and en route. Pilots have no way to know that NWS staff or FAA personnel believe an ASOS is potentially reporting erroneous information unless they or someone else in contact with pilots encounter unreported weather conditions in an affected area, at which time it may be too late to change course. When deciding whether to proceed to a specific airport or to divert to an alternate airport, pilots require the most timely and accurate weather information available. NOTAMs provide pilots with very important information on the performance of systems they rely upon for safe operation. The criteria for issuing ASOS-related NOTAMs should be consistent with those governing the issuance of AWOS-related NOTAMs, regardless of who is responsible for monitoring and maintaining these systems.

In addition, NTSB notes that while the first criterion in FAA Order 7930.2S for issuing an ASOS-related NOTAM (when "the entire ASOS observation is missing and no backup observation is available for longline dissemination") is appropriate, it is incomplete. This criterion should also include instances when an ASOS is not able to disseminate its observations via VHF, which can also impact aviation safety.

The NTSB concludes that it is critical to safety of flight for NOTAMs to be issued in instances when ASOSs are providing inaccurate or unreliable sensor information or are not broadcasting over VHF so pilots can make informed decisions preflight and en route. Therefore, the NTSB recommends that the FAA revise Order 7930.2S to make the standards for issuing NOTAMs as they relate to ASOSs consistent with the NOTAM issuance standards for AWOS, including criteria addressing inaccurate or unreliable ASOS sensor information and VHF outages.

AWOS Clock Errors and Effect on Dissemination of Weather Observations

On July 19, 2018, about 1908 central daylight time, the *Stretch Duck 7*, a 33-ft-long, modified World War II-era amphibious passenger vessel operated by Ride The Ducks Branson, sank during a storm with high wind that developed rapidly on Table Rock Lake near Branson, Missouri. Of the 31 occupants aboard, 17 died. The NWS had issued a severe thunderstorm warning for the area (effective immediately until 1930) advising of wind gusts of 60 mph about a minute before the *Stretch Duck 7* departed the boarding facility.[12] The captain had also been

[12] For more information on this accident, see *Sinking of Amphibious Passenger Vessel Stretch Duck 7, Table Rock Lake, near Branson, Missouri, July 19, 2018*. Marine Accident Report NTSB/MAR-20/01. Washington, DC.

monitoring weather radar before passengers began boarding and stated after the accident that he had "noticed there was some weather coming in."[13]

About 1827, the operations supervisor advised the captain and driver to complete the lake portion of the tour before the land tour, which normally occurred first, due to the approaching weather. About 5 minutes after the vessel entered the water at 1855, the leading edge of the storm front (later determined to be a "derecho") passed through the area generating strong wind and waves reportedly 3- to 5-feet high; the highest wind gust was recorded at 73 mph.[14] The *Stretch Duck 7*'s captain attempted to reach shore, but the vessel began taking on water and sank about 250 ft away from the tour's exit ramp. Several first responders, along with the crewmembers and passengers aboard a paddle boat moored nearby, rescued and triaged 14 passengers, 7 of whom were transported to local hospitals.

During its lifespan, the derecho was observed by ground-based weather radars, and its associated surface wind magnitudes were monitored by ground-based automated weather systems such as AWOS and ASOS. The systems closest to the accident location (in the direction from which the storm approached) were an ASOS at Springfield-Branson National Airport (SGF), about 46 miles north, and an AWOS at Branson West Municipal Airport (FWB), which was about 9 miles north-northwest.[15]

Weather radar imagery identified an "outflow boundary," which can introduce strong and/or shifting wind at the surface, slightly ahead of the heavy rainfall region of the derecho; the outflow boundary led the advancement of the derecho to the south-southeast both preceding and during the accident time.[16] The following figure presents a weather radar image of the derecho at 1851, just after its outflow boundary passed over FWB.

[13] The captain did not specify the weather observations system that he used to follow weather developments.

[14] A derecho is generally considered to be a widespread, long-lasting windstorm that is associated with a continuous band of rapidly moving showers or intense thunderstorms. It is characterized by wind damage extending more than 250 miles and by a rapid increase of wind gusts of at least 58 mph (about 50 knots) along most of its length, as well as several separated gusts of 75 mph (about 65 knots) or greater. See Stephen F.Corfidi, Michael C. Coniglio, Ariel E. Cohen, and Corey M. Mead, "A Proposed Revision to the Definition of 'Derecho'," *Bulletin of the American Meteorological Society* (June 2016).

[15] The AWOS at FWB supplied weather data to the web-based application of the weather information service to which Ride The Ducks Branson subscribed.

[16] An outflow boundary is a surface boundary formed by the horizontal spreading of thunderstorm-cooled air.

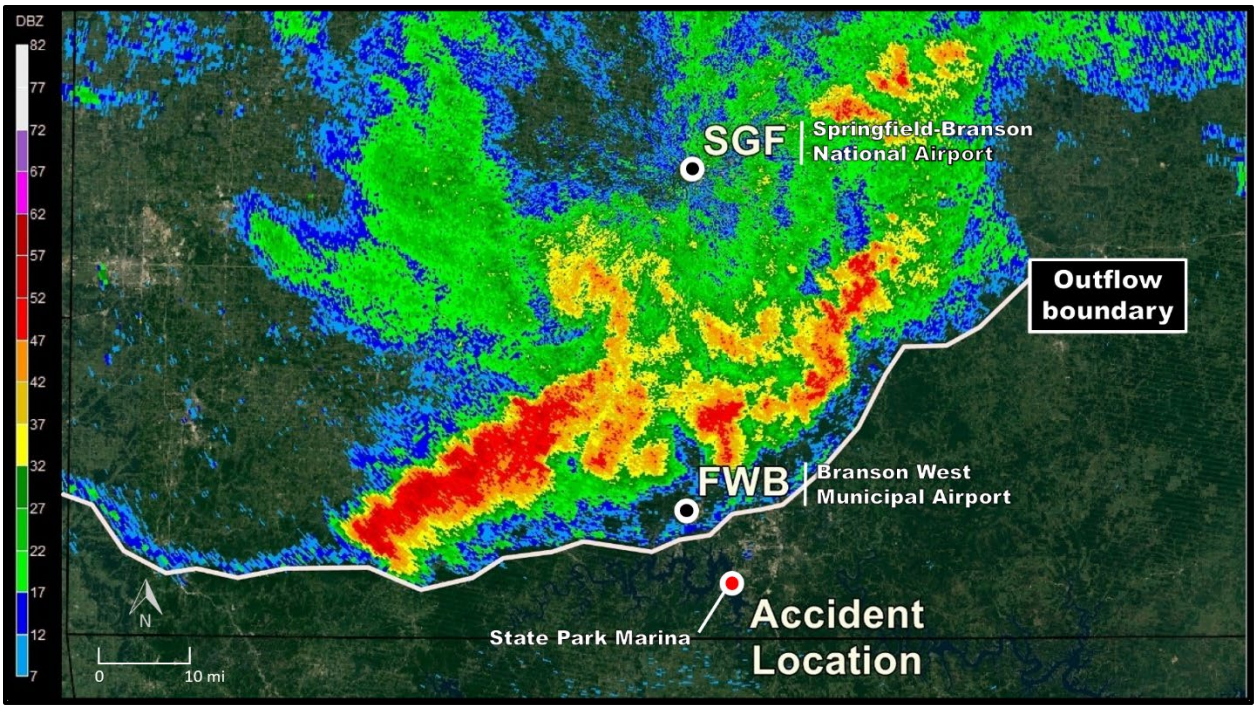

Figure. Weather radar image at 1851.

Normally, the FWB AWOS records observations every minute and disseminates longline weather observations every 20 minutes, timestamped at 15, 35, and 55 minutes past each hour. At 1815, the FWB AWOS reported a calm wind. At 1855, it reported an average wind of 31 mph with gusts to 52 mph. The scheduled observation at 1835 was missing.[17]

One-minute observations retrieved from the AWOS at FWB (see the following table) showed wind gusts greater than 40 mph were first recorded at 1841, when the AWOS logged a gust of 43 mph.[18] At 1844, it recorded an increase in the wind gust to 56 mph. However, weather radar data, which are synchronized with GPS time, suggested the wind gust speed would have likely increased at FWB closer to 1850, about 5 to 10 minutes *after* the 1-minute observations from the FWB AWOS indicated. The NTSB's investigation and the FWB AWOS technician estimated that the FWB AWOS clock was slow by about 7, 8, or 9 minutes during the day of the accident; the exact time lag relative to GPS time could not be determined.

[17] During a postaccident interview, the FWB AWOS technician stated the following concerning the missing observation: "the [:35 report was] not received by the [dissemination] ingest system from the site. The system uses a cellular modem. I suspect but cannot prove that either the cell site dropped the link during the storm or that there was a quick power glitch that reset the cellular device but did not affect the AWOS."

[18] (a) These FWB AWOS observations were not publicly disseminated longline but may have been available in real time via VHF and/or telephone. (b) Wind direction is referenced to true north.

Table. FWB AWOS Weather Observations (in mph)

Time	1838	1839	1840	1841	1842	1843	1844	1845	1846	1847	1848
Wind direction	020	010	360	360	010	360	360	360	350	340	340
Average speed	5	9	15	26	31	29	35	36	29	31	31
Gust speed	–	–	25	43	43	43	56	56	56	56	56

Time	1849	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859
Wind direction	350	340	350	340	330	340	350	350	360	350	350
Average speed	29	29	23	21	24	29	31	31	31	32	30
Gust speed	56	56	56	56	56	56	52	46	46	46	46

According to a representative of the weather information service used by Ride the Ducks Branson, at the time of the accident, employees at the operator had chosen to receive numerous e-mail alerts via the service's web-based application, including when an average wind speed greater than 30 mph was observed by surface weather stations within 20 miles of State Park Marina, which was located about 0.75 mile southeast of the ramp where the *Stretch Duck 7* entered the lake.[19] The first publicly disseminated longline observation from FWB around the accident time that reported an average wind speed greater than 30 mph was timestamped at 1855.[20] However, because the FWB AWOS clock was 7, 8, or 9 minutes slow, this weather observation was actually taken at FWB and disseminated longline sometime between 1902 and 1904 (GPS time). This FWB observation appeared in the weather information service's alerting system sometime after 1906:44 but before 1910:51 on the day of the accident. The service's records indicate an e-mail alert for an average wind magnitude greater than 30 mph was sent to Ride The Ducks Branson personnel at 1910, about the time of the sinking.

According to the FWB AWOS technician, due to an issue with clock drift on certain AWOS systems, resetting the clock on these systems is a regular maintenance item. In providing guidance on system maintenance for non-federal installations, FAA Advisory Circular (AC) 150/5220-16E, "Automated Weather Observing Systems (AWOS) for Non-Federal Applications," recommends (among nine listed tasks) checking the system time and resetting it as needed tri-annually (or every 4 months).[21]

The FWB AWOS manufacturer's (All Weather Inc.) maintenance manual does not include information on tri-annual maintenance; instead, it indicates, "check system clock; adjust if error >1 minute" in the AWOS "Monthly Technical Performance Record." This manual advises that the

[19] The application offered subscribers the option to receive e-mail alerts about weather events based on user-established criteria.

[20] FWB was the only surface weather station monitored by the weather information service between the accident location and the oncoming derecho to the north and northwest that would have prompted an e-mail alert for a wind speed with this criterion.

[21] For more information, see section 4.4 ("Maintenance Checks and Schedules") of the AC, dated March 10, 2017.

clock on the AWOS model that was installed at FWB (the 900 series) should be checked and adjusted as needed once per month.[22] According to the manufacturer's chief technology officer, a failure of the clock and power supply problems (including "brownouts") can cause clock drift.

In a postaccident response to the NTSB's request for clarification concerning AWOS clock drift, the FAA noted that manufacturer-prescribed checks are acceptable as long as they continue to meet the tri-annual criteria in AC 150/5220-16E. Regarding the clock drift in some AWOSs, the FAA stated the following:

> The clock function should be accurate to within 15 seconds each month (or within 45 seconds during maintenance checks and annual inspections) when compared to an official time source…. For those type-certified, commissioned systems whose output is provided to the national weather network, i.e., AWOS III or IV only, AWOS clock errors in excess of 5 minutes may result in rejection of all data sent to the national weather network. …This time check and possible rejection is performed by WMSCR [weather message switching center replacement].

However, follow-up correspondence from the FAA noted that "there is no automated procedure in place that WMSCR uses to reject a METAR from a non-[federal] AWOS (or from any source) if the timestamp error is in excess of 5 minutes… .WMSCR's criteria for rejecting METARs is if the time of the observation is more than one hour different than the current time."[23] According to logs provided to the NTSB that documented the status of clock drift affecting 97 AWOSs in the United States at a particular instant in early 2019, 17 of those systems (about 18%) exhibited a time error of 10 or more minutes, with 3 systems exhibiting a time error of more than 20 minutes. The specific reasons for the errors observed in these logs are unknown. The FAA stated that the agency had "no way of determining" how fast AWOS clocks may drift for federal and non-federal AWOS systems.

The FWB AWOS technician believed that the last clock adjustment for the FWB AWOS was about 1 month before the *Stretch Duck 7* accident. It is not known whether the time lag of 7, 8, or 9 minutes that occurred on the day of the sinking was due to clock drift, an AWOS system failure, or a combination of the two. Although the NTSB found that, on the day of the accident, the NWS accurately forecasted and issued timely notifications of a severe thunderstorm that would impact the accident location and this issue was not a factor in the accident, we are concerned that

[22] According to All Weather Inc.'s chief technology officer, the company's 900 series AWOS is outfitted with one clock that controls the timestamping of observations as well as when observations are disseminated. He stated that although this AWOS model was engineered to meet FAA accuracy requirements, it is susceptible to clock drift. In extreme cases, clock drift has amounted to hours. A newer AWOS model by the manufacturer has an integrated GPS that keeps the clock synchronized with GPS time and thus prevents the clock drift issue that affects the 900 series.

[23] Taken and disseminated at preset times, METARs may be prepared by AWOS systems (with or without augmentation) or by certified weather observers.

AWOS clock drift represents a potential safety issue in that it can negatively affect transportation operators' situation awareness and decision-making.[24]

Accurate weather information is vital support for safety-related decision-making in all modes of transportation. Because weather conditions at the surface can change rapidly, weather reports from locations such as airports (where almost all ASOSs are located) that provide the public with up-to-date surface conditions in real time must be accurate minute to minute. When internal system clocks and timestamps are incorrect, ASOS (and AWOS) observations may reflect current conditions but suggest those phenomena happened in the past, or, more dangerously, reports of current conditions may be significantly delayed into the future. In aviation, for example, this can result in users who are monitoring ASOS and AWOS longline reports being unable to achieve appropriate situation awareness of hazards such as wind shifts, onset of freezing precipitation, restrictions to visibility, and convective weather.

The NTSB concludes that maintenance procedures aimed at mitigating internal clock drift on some models of non-federal AWOS have been ineffective and that the continued erroneous timestamping of AWOS observations and, thus, obsolete longline dissemination of AWOS weather observations, does not support transportation operators in maintaining situation awareness. Therefore, the NTSB recommends that the FAA establish maintenance standards to eliminate erroneous timestamping and related delayed longline dissemination of weather observations due to excessive internal clock drift and system events from affected AWOS models. Although the NTSB is concerned that the FAA only rejects a METAR if the observation from a nonfederal AWOS has a timestamp that is in error by greater than 1 hour, we believe that addressing the issue of clock drift would alleviate this concern because erroneous timestamping would be eliminated.

Recommendations

To the National Weather Service

> Revise National Weather Service Instruction 30-2111 to clearly define "outage," "failure," and similar terms regarding individual automated surface observing system (ASOS) sensor and component performance and to include explicit maintenance actions intended to mitigate presumed erroneous ASOS sensor reporting that does not generate failure flags in maintenance monitoring data. (A-21-1)

> Revise National Weather Service Instruction 30-2112 to provide operational (forecasting) staff at weather forecast offices the authority to determine whether report processing for an automated surface observing system sensor at an unattended site (or other site not currently being appropriately augmented) should be turned off immediately if the sensor is believed to be reporting erroneously but

[24] The NTSB's investigation found that, in addition to the NWS severe thunderstorm warning, other opportunities were available for Ride the Ducks to recognize the risk that the approaching storm posed to its duck boats and passengers. The NTSB determined that the probable cause of this accident was, in part, the operator's "continued operation of waterborne tours after a severe thunderstorm warning was issued for Table Rock Lake, exposing the vessel to a derecho, which resulted in waves flooding through a non-weathertight air intake hatch on the bow."

does not yield flags in its maintenance monitoring data and to include clear instructions for performing this task. (A-21-2)

To the Federal Aviation Administration

Revise Federal Aviation Administration Order 7930.2S to make the standards for issuing notices to airmen (NOTAM) as they relate to automated surface observing systems (ASOS) consistent with the NOTAM issuance standards for automated weather observing systems, including criteria addressing inaccurate or unreliable ASOS sensor information and VHF outages. (A-21-3)

Establish maintenance standards to eliminate erroneous timestamping and related delayed longline dissemination of weather observations due to excessive internal clock drift and system events from affected automated weather observing system models. (A-21-4)

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