ASOS Wind Sensor Logistics Replacement Data Evaluation Final Report

As of: 12/13/17

Executive Summary

The manufacturer of the ASOS Ice Free Wind Sensor (IFWS), the Vaisala 425NWS, announced in 2016 that 425NWS repair parts were no longer available, rendering the sensor obsolete. Vaisala offered the WMT702 as a logistics replacement. Limited testing was performed on the WMT702 at the Sterling Field Support Center (SFSC) in lieu of a formal System Test (ST) and an in-depth data evaluation was conducted at twelve operational ASOS sites in lieu of a formal Operational Test & Evaluation (OT&E). The objectives of the evaluation were to evaluate the installation of the sensor, the integrity of the wind data, the representativeness of the wind data as well as the performance of WMT702-equipped ASOS. The twelve sites are a mix of nine 24-hour Limited Aviation Weather Reporting Stations (LAWRS) with backup wind equipment and three non-airport locations.

The ASOS Wind Sensor Logistics Replacement Data Evaluation demonstrated that ASOS is properly processing the wind data from the WMT702 and is properly formatting wind reports. The evaluation also demonstrated that the installation of the WMT 702 had no effect on the frequency of warm starts or sensor response time-outs, and that the wind data from the WMT702 is comparably representative to that from the 425NWS. The evaluation also shows that the occurrence of missing winds increases, on average, by 34% with the WMT702. Most of this increase was due to increased rejection of 5-second sample data by the low wind speed-invalid peak check portion of the ASOS IFWS Quality Control (QC) Algorithm.

Based on the findings of this evaluation, it is recommended that the WMT702 be deployed as-needed across the ASOS network, but deployment should be deferred as long as possible across the Intermountain West, the southwestern U.S. and coastal southern Alaska where the IFWS QC Algorithm already rejects 1%+ of the 5-second sample data. At locations with unique wind regimes or unorthodox wind sensor configurations, the WMT702 should not be installed if it can be avoided. If the ACU-DCP re-host is significantly delayed, or if other operational demands require the development of an interim software load, then RC #14962 ("*Change the IFWS QC Algorithm Invalid Peak Wind Criteria at Low Wind Speeds from 6 knots to 13 knots"*) must be included in the interim software load. Within a few years following initial deployment, a WMT702-specific QC algorithm should be developed.

1.0 Overview

The Vaisala 425NWS sonic anemometer was deployed across the ASOS Network as a replacement for the original Belfort cup and vane style anemometer in the mid-2000s, and was expected to be in service through the early 2020s. However, critical repair parts are no longer available and the 425NWS is unsupportable. Vaisala has offered the WMT702 as a logistics replacement to the 425NWS. The WMT702 has an ASOS mode, which allows it to integrate with ASOS in the same manner as the 425NWS. Additionally, the WMT700 series anemometer is the current operational wind sensor on the FAA's AWOS Network.

Limited testing was performed at the Sterling Field Support Center (SFSC) during the first half of 2017 in lieu of a formal System Test (ST). This testing included wind tunnel testing, environmental chamber testing and testing on an ASOS in the SFSC Testbed. Based on this testing, it was determined that the risk of fielding the WMT702 sensor is low and that the WMT702 is a viable alternative. Please see Appendix A for more details on the results of the SFSC testing.

Due to the impending depletion of stock and resultant inability of ASOS to provide wind measurements following sensor failure, time was not available to conduct a formal ST and Operational Test and Evaluation (OT&E). Pursuant to an approved Request for Change (RC #15561), an in-depth data evaluation was conducted at twelve operational ASOS sites in lieu of a formal Operational Test & Evaluation (OT&E). The objectives of the evaluation were to evaluate: the installation of the sensor, the integrity of the wind data, the performance of the sensor, the performance of ASOS when equipped with the sensor, and the representativeness of the wind data. The sites where the evaluation was conducted were selected based on limitation of impact to airport operations, climate regime and proximity to the WFO. Site selection was fully coordinated with the tri-agencies. The twelve selected sites are a mix of nine 24-hour Limited Aviation Weather Reporting Stations (LAWRS) with backup wind equipment and three non-airport locations.

2.0 Scope and Objectives

WMT702 wind sensors were installed at the following twelve locations during August 2017: KAGC, KACY, KNAK, KDPA, KPIA, KSGF, KCQC, KFTW, KBOI, KGTF, KTUS and PATO. The 425NWS wind sensors were removed from these locations and sent back to the National Logistics Support Center (NLSC). This data evaluation was authorized by the ASOS Configuration Control Board (ACCB) on July 20, 2017 with the approval of RC #15561. The results of the evaluation are summarized in this report in accordance with the required implementation activity documented in Part C of approved RC #15561.

The objectives of the evaluation are to evaluate: the installation of the WMT702, the integrity of the wind data, the performance of the sensor, the performance of ASOS when equipped with the sensor, and the representativeness of the wind data as determined by air traffic controllers. In order to evaluate the installation of the sensor, feedback from the technician regarding the installation of the WMT702 was assessed. Analysis of the wind reports in the METAR/SPECI observations, 5-minute observations, daily summary messages and of the 5-second sample wind data was conducted to verify the integrity of the data. System Log (SYSLOG) and sensor diagnostic data were analyzed to ascertain sensor performance, as well as the performance of ASOS as a whole when equipped with the WMT702. EDITLOG data at the nine staffed sites has been analyzed to check for changes in representativeness of the wind data.

3.0 Methodology

3.1 425NWS Wind Data Collection from Twelve Sites

Sixty days of SYSLOG and EDITLOG data was collected from the sites prior to installation of the WMT702. This data was used to compare with data collected following the installation in order to evaluate changes in wind sensor performance, system performance and representativeness of wind reports.

3.2 WMT702 Wind Data Collection from Twelve Sites

OBS (METARs and SPECIs), 5MIN (5-minute observations), IFW5SEC (5-second wind sample data), IFWWT (1-minute sensor diagnostic data), Daily Summary Messages (DSM) and SYSLOG (System Log data) was collected from each of the twelve sites for a period of sixty days following the installation of the WMT702. EDITLOG data was also collected from the nine staffed sites as well sites for a period of sixty days following the installation of the WMT702. This data was used to compare with data collected prior the installation in order to evaluate changes in wind sensor performance, system performance and representativeness of wind reports. This data was also used to verify the integrity of the wind data from the sensor and the ability of ASOS to properly process the data in the wind reporting algorithms.

3.3 Evaluation of Data Collected from the Twelve Sites

The objectives of the evaluation were to evaluate: the installation of the WMT702, the integrity of the wind data, the performance of the sensor, the performance of ASOS when equipped with the sensor, and the representativeness of the wind data as determined by air traffic controllers. The following sections describe the evaluation methodology used to meet each stated objective.

3.3.1 WMT702 Installation Evaluation Methodology

In order to evaluate the installation of the sensor, feedback from NWS technicians regarding the installation of the WMT702 was assessed. Feedback from the technicians regarding the installation kit, the installation instructions and any other aspect of the installation was documented, adjudicated and used to update the installation instructions given in Modification Note #105.

3.3.2 Wind Data Integrity Evaluation Methodology

In order to evaluate the integrity of the data, observational and 5-second sample data was analyzed. The 5-second sample data was analyzed to verify that the samples are being received and formatted properly. 5-minute Observations, METARs, SPECIs, and DSMs were evaluated to verify that the wind data is being formatted properly and that the wind reports generated by ASOS are correct for the given 5-second sample input data. From each of the twelve sites, ten 5-minute Observation, METAR and/or SPECI wind reports were evaluated to verify that the correct wind report was being generated by ASOS for the given sensor input. These included at least one peak wind remark (wind speed exceeding 25 knots during the past hour), at least three reports with reportable gusts (G), one variable wind report (average wind speed exceeding six knots winds varying by 60° or more), at least one light and variable wind report (average wind speed of six knots or less winds varying by 60° or more) and at least one "00000KT" wind report (average wind speed of less than three knots) from each site. For each of the twelve sites, three daily summary messages were also evaluated to verify that the correct daily wind summary report was being generated by ASOS for the given sensor input.

3.3.3 WMT702 Performance Evaluation Methodology

In order to evaluate the performance of the sensor, 1-minute diagnostic data was collected and analyzed. The diagnostic data was evaluated to determine if it is in the correct format and for the occurrence of failures, faults and errors.

3.3.4 WMT702 Equipped ASOS Performance Evaluation Methodology

In order to evaluate the performance of ASOS equipped with the WMT702 wind sensor, SYSLOG data was analyzed. The number of warm starts (SYSLOG code #0140) and sensor response time outs (SYSLOG code #1785), the occurrence and duration of wind data outages (SYSLOG codes #1790 and #1791), and the number of 5-second wind samples rejected by the IFWS QC Algorithm (SYSLOG code #1798) during the sixty days following the installation of the WMT702 was compared with the those from sixty days prior to WMT702 installation.

3.3.5 Wind Data Representativeness Evaluation Methodology

In order to evaluate the representativeness of the wind data, EDITLOG data was analyzed from the nine staffed 24-hour LAWRS ASOS locations. The number of edits and the magnitude of the changes made in the edits by the LAWRS observers during the sixty days following the installation of the WMT702 were compared with those made during the sixty days prior to WMT702 installation.

4.0 Results

4.1 WMT702 Installation Evaluation Results

The following feedback was received from NWS technicians regarding the installation of the WMT702. The installation instructions provided in Modification Note #105 have been updated to incorporate this feedback and modifications to the WMT702 installation kit have been made.

Site	Technician Feedback on Installation
KCQC	"Install of WMT700 Wind Sensor complete for site CQC. It took a little longer than expected to install it. Many issues with the procedure. Would like to talk about it sometime. CQC is an SCA site so we had to add to the procedure. Data is coming in and no alarms."
KNAK	"The NAK ASOS MOD is completed. There were no issues. The paperwork for the mod was fine. The only thing that I might recommend adding is to the same section as the Control + J command. I would add a comment to make sure that the Caps Lock is on before entering the WA, WS, WF, WD, and WT commands. The program will not recognize them in lower case. We started the mod at about 10:40am and left the site at 1:30pm. So the mod only took a little less than 3 hours to complete."
KTUS	The sensor is installed & working at this time. Found that changing the Procomm transfer protocol setting from Zmodem to ASCII I could talk to the sensor with the laptop. After connecting back to the Fiber Optic Modem, the ASOS was still not polling the wind sensor. We replaced the Fiber Optic Modem & it's working now.

Table 1

4.2 Wind Data Integrity Evaluation Results

As shown in Table 2 below, the 5-second sample data and 1-minute diagnostic data have been analyzed and found to be properly produced by the sensor and properly formatted by ASOS at all twelve locations. Ten wind reports from a mix of METARs, SPECIs and 5-Minute Observations were evaluated from each location under a variety of wind conditions. In addition, three daily summary reports were evaluated for each location. It was found that the wind reports in all instances were correct and as expected for the given sensor input. Thus, ASOS is properly processing the WMT702 wind data through the wind algorithms and is properly formatting the resultant wind reports in the observations and reports.

Site	5-sec (IFW5SEC) Correct?	1-min (IFWWT) Correct?	PK Wind Remark Correct (1 req'd)	G-reports Correct (3 req'd)	Var Wind Correct (1 req'd)	VRB Correct (1 req'd)	Calm report Correct (1 req'd)	Other Wind Reports	Wind reports correct (10 req'd)	Correct DSM (3 req'd)
KAGC	YES	YES	1	3	1	1	1	3	10	3
KACY	YES	YES	1	3	1	1	1	3	10	3
KNAK	YES	YES	1	3	1	1	1	3	10	3
KDPA	YES	YES	1	3	1	1	1	3	10	3
KPIA	YES	YES	1	3	1	1	1	3	10	3
KSGF	YES	YES	1	3	1	1	1	3	10	3
KCQC	YES	YES	3	3	1	1	1	1	10	3
KFTW	YES	YES	1	3	1	1	1	3	10	3
KTUS	YES	YES	1	3	1	2	1	2	10	3
KBOI	YES	YES	1	3	1	1	1	2	10	3
KGTF	YES	YES	1	3	1	1	1	3	10	3
PATO	YES	YES	1	4	1	1	1	2	10	3

Table 2

4.3 WMT702 Performance Evaluation Results

In order to evaluate the performance of the sensor, 1-minute diagnostic data was collected and analyzed from the twelve sites. The diagnostic data was evaluated to determine if it is in the correct format and for the occurrence of failures, faults and errors. As indicated in the previous section, the 1-minute diagnostic data is being properly received, formatted and processed by ASOS.

It was noticed shortly after installation that there are sporadic instances where the winds go missing as a result of data coming from the sensor with a sensor status of "F". This was associated with the heaters coming on, even when the temperatures were well above freezing. An example of this occurred at KSGF on 8/29 around the 18Z hourly observation. At 17:48 UTC, the 5-second sample data indicated a heater flag “H” in the sensor status followed by complete sensor failure. The next 1-minute diagnostic data sample (17:49) shows an increase of bad 1-second samples by 12, path failures and a thermistor temperature which has risen by 15°C from 26°C to 41°C. A minute later (17:50), the thermistor temperature increases to 53°C and stays in the 53°C to 56°C range for the next 37 minutes before gradually settling back down to ambient. The METAR shows an ambient temperature of 25°C. During the first 24 minutes of this high thermistor temperature episode, the 5-second samples show the winds going "in and out", with multiple F/H sensor status samples interspersed with “P”. This caused the winds to go missing. The 1-minute diagnostic data samples showed occasional path failures and an increase in the number of 1-second samples. During the last 13 minutes of the episode, the wind sensor status remained at "P" with no issues. Please see Appendix B for a compilation of the WA and WT data from this episode. This same phenomenon was observed at KCQC, KGTF and KTUS as well.

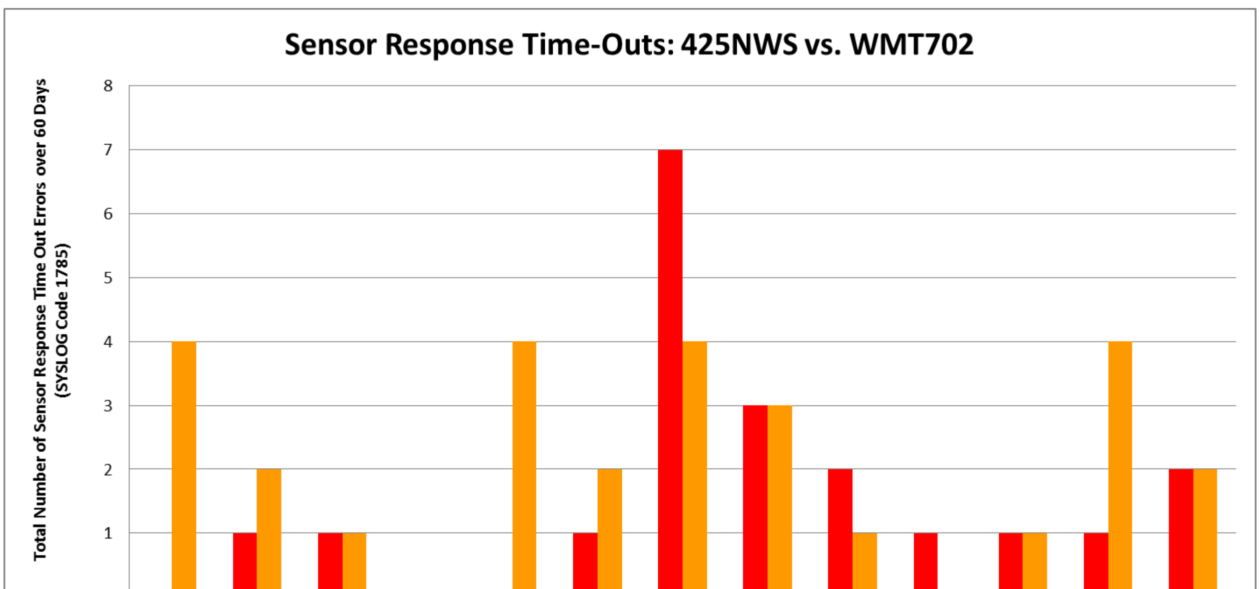
Further investigation by SFSC, NLSC and the NWS Training center revealed that when the WMT702 detects a path failure, the heaters will turn on, irrespective of the temperature. This seems to be an effort to clear a blockage due to icing, even though there are other causes to path blockage than ice such as birds. Thus, the sensor outage is due to the presence of a blockage as opposed to the heaters themselves or some other hardware failure and does not represent a problem since the winds would (and should) be missing when there is a blockage.

4.4 WMT702 Equipped ASOS Performance Evaluation Results

In order to evaluate the performance of ASOS when equipped with the WMT702 wind sensor, SYSLOG data was analyzed. The number of warm starts (SYSLOG code #0140) and sensor response time outs (SYSLOG code #1785), the occurrence and duration of wind data outages (SYSLOG codes #1790 and #1791), and the number of 5-second wind samples rejected by the IFWS QC Algorithm (SYSLOG code #1798) during the sixty days following the installation of the WMT702 was compared with the those from sixty days prior to the WMT702 installation.

4.4.1 Sensor Response Time-Out Error Evaluation

Many factors affect the occurrence of sensor response time-outs. These include, but are not limited to, ACU-DCP communications interruptions, power issues, sensor issues, software errors, data corruption and ACU-DCP hardware problems. A change of one of the ASOS's sensors can have an impact on the occurrence of sensor response time-outs. While a myriad or factors can and do determine the occurrence of sensor response time-outs at a site, it is possible to determine what affect a sensor change will have on the occurrence of these errors if the analysis is done over a sufficient period of time for numerous sites. When a sensor response time-out for the wind sensor occurs, ASOS will record it in the SYSLOG with a code 1785, along with the date and time.



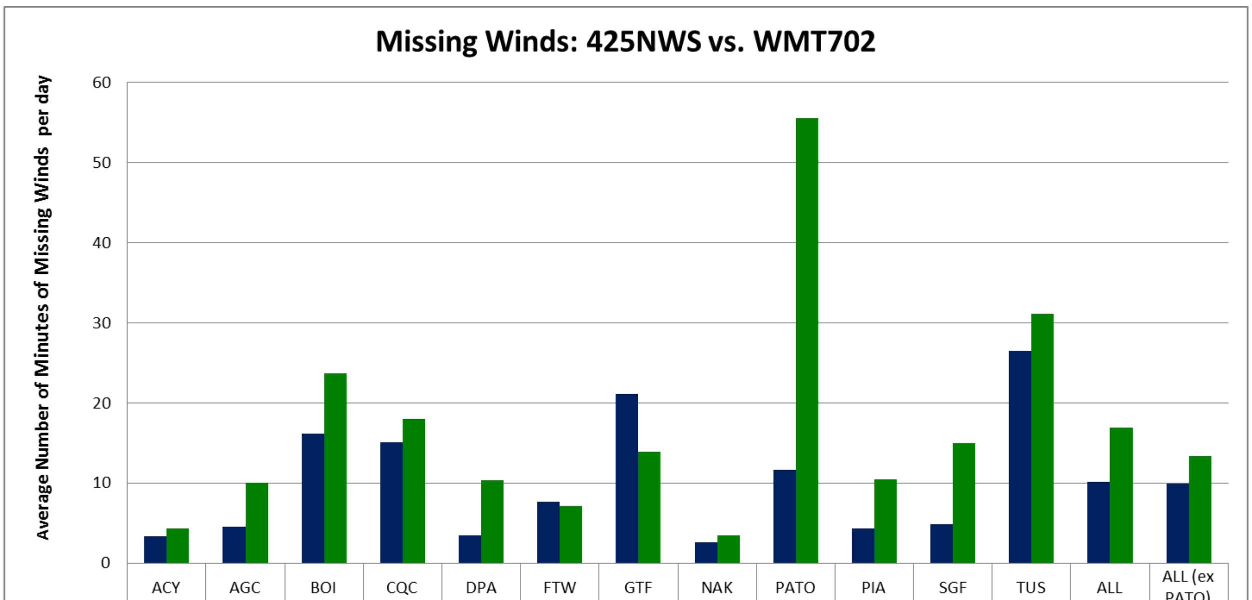
	ACY	AGC	BOI	CQC	DPA	FTW	GTF	NAK	PATO	PIA	SGF	TUS	ALL
425NWS	0	1	1	0	0	1	7	3	2	1	1	1	2
WMT702	4	2	1	0	4	2	4	3	1	0	1	4	2

Figure 1

In order to determine what affect, if any, the installation of the WMT702 will have on the occurrence of sensor response time-out errors, the occurrence of these errors was recorded for 60 days with the 425NWS installed at the twelve evaluation sites and was compared with 60 days of data with the WMT702 installed. None of the sites was plagued with a high number of sensor response time-out errors. The number of errors increased slightly at five sites with the WMT702 installed, while the number decreased at three sites, and was unchanged at four of the evaluation sites. The average number of sensor response time-out errors over 60 days was the same, two, irrespective of which wind sensor was installed. Thus, the installation of the WMT702 had no systematic effect on the occurrence of sensor response time-out errors. Please refer to Appendix C for the detailed site-by-site tabulation of the data collected over the course of the evaluation.

4.4.2 Evaluation of the Impact of the WMT702 on Missing Winds

In order to determine the potential effects of installing the WMT702, the impact on wind data availability was evaluated. The occurrence of missing winds, irrespective of cause, was analyzed for a sixty-day period with the WMT702 as the wind sensor and compared with missing winds observed during a sixty-day period with the 425NWS installed. The 425NWS evaluation period was generally late May through late July, 2017. The WMT702 evaluation period was generally August through October, 2017.

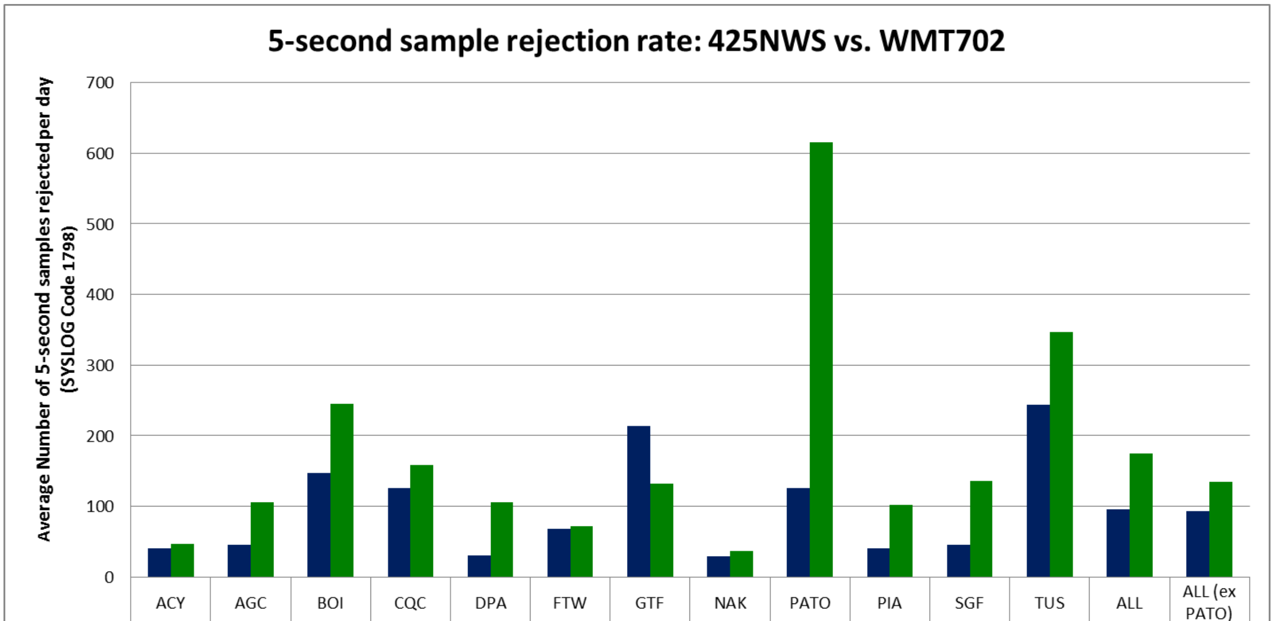


	ACY	AGC	BOI	CQC	DPA	FTW	GTF	NAK	PATO	PIA	SGF	TUS	ALL	ALL (ex PATO)
425NWS	3.367	4.533	16.167	15.1	3.433	7.7	21.133	2.667	11.633	4.333	4.9	26.5	10.122	9.985
WMT702	4.3	10.017	23.75	18.033	10.367	7.133	13.933	3.5	55.517	10.5	14.95	31.1	16.925	13.417

Figure 2

It was found that, on average, the winds were missing for 10.1 minutes per day at the twelve evaluation sites when the 425NWS was the operational wind sensor. With the WMT702 as the operational wind sensor, this amount increased by about 6.8 minutes, or 67%, to 16.9 minutes per day.

Ten out of the twelve evaluation sites observed an increase in missing winds. These increases ranged from 15% to 205%. At two of the twelve sites, the amount of missing winds actually decreased by 7 to 34% with the WMT 702. The occurrence of missing winds at Portage, AK (PATO) increased quite dramatically from about 11.6 minutes per day with the NWS 425 to over 55 minutes per day with the WMT 702, an increase of 377%. This resulted in PATO being an outlier in the observational sample. When the data from PATO is not included, the winds went missing for an average of 10.0 minutes per day at the evaluation sites when the 425NWS was the operational wind sensor. When the operational wind sensor is changed to the WMT702, this amount increased by about 3.4 minutes, or 34%, to 13.4 minutes per day. For detailed site-by-site data, please refer to Appendix C.



	ACY	AGC	BOI	CQC	DPA	FTW	GTF	NAK	PATO	PIA	SGF	TUS	ALL	ALL (ex PATO)
425NWS	40.6	45.6	146.8	125.4	31.1	68.5	214.2	29.7	125.4	40.9	45.2	243.7	96.4	93.8
WMT702	47.4	106.2	244.7	158.3	105.3	72.3	132.7	36.3	616.1	101.7	136.3	347.1	175.4	135.3

Figure 3

The causes for the missing winds included occasional communications intereutions, power issues, path blockages (most likely casued by roosting birds) and other wind data that was rejected by the IFWS QC Algorithm.

The QC Algorithm evaluates each 5-second sample from the IFWS against ten criteria. Samples failing to meet any of the ten criteria are flagged with a numeric error code ranging from 1 to 10, bracketed in the 14-hour archive and are <u>NOT</u> used in the wind algorithms. The wind algorithms consider flagged samples as missing. If seven or more 5-second samples are missing in a two minute period, then the wind report in the obsevation will go missing. The ten criteria used by the IFWS QC Algorithm are listed below, along with the corrosponding error code.

Code	**Error**
1	**Sensor did not respond when polled by ASOS**
2	**Wind Speed out of range (less than 0 or more than 165)**
3	**Averaging Times wrong (Average = 5 seconds, Peak = 3 seconds)**
4	**P/F Flag is set to "F" (Fail)**
5	**5-second average speed exceeds 3-second peak speed by 1 or more knots**
6	**5-sec avg < 12 knots AND 3-sec peak > 30 knots**
7	**5-sec avg speed >= 12 knots AND |avg direction – peak direction| exceeds 30º**
8	**Signal Quality is less than 79**
9	**5-sec ave >= 12 AND 3-sec peak is greater than 2.5 times the 2 min avg wind speed**
10	**The 2 min avg =< 6 kts AND 3-sec peak > 6 AND 3-sec peak is greater than 2.5 times the 2 min avg wind speed**

The number of samples rejected by the algorithm per day generally increased where the occurance of missing winds increased. On average, the number of 5-second samples rejected per day was 96.4 at the twelve evaluation sites when the 425NWS was the operational wind sensor. When the WMT 702 was the operational wind sensor, this number increased by 82% to 175.4. When the data from PATO is not included, the average number of wind samples rejected per day is 93.8 when the 425NWS is the operational wind sensor. This increases by 44% to 135.3 when the WMT702 is the operational wind sensor.

Most of the increases in wind sample rejection were the result of an increase in the number of samples failing the so-called low wind speed-invalid peak check. These samples are given an error code of 10 as seen in this sample from KTUS:

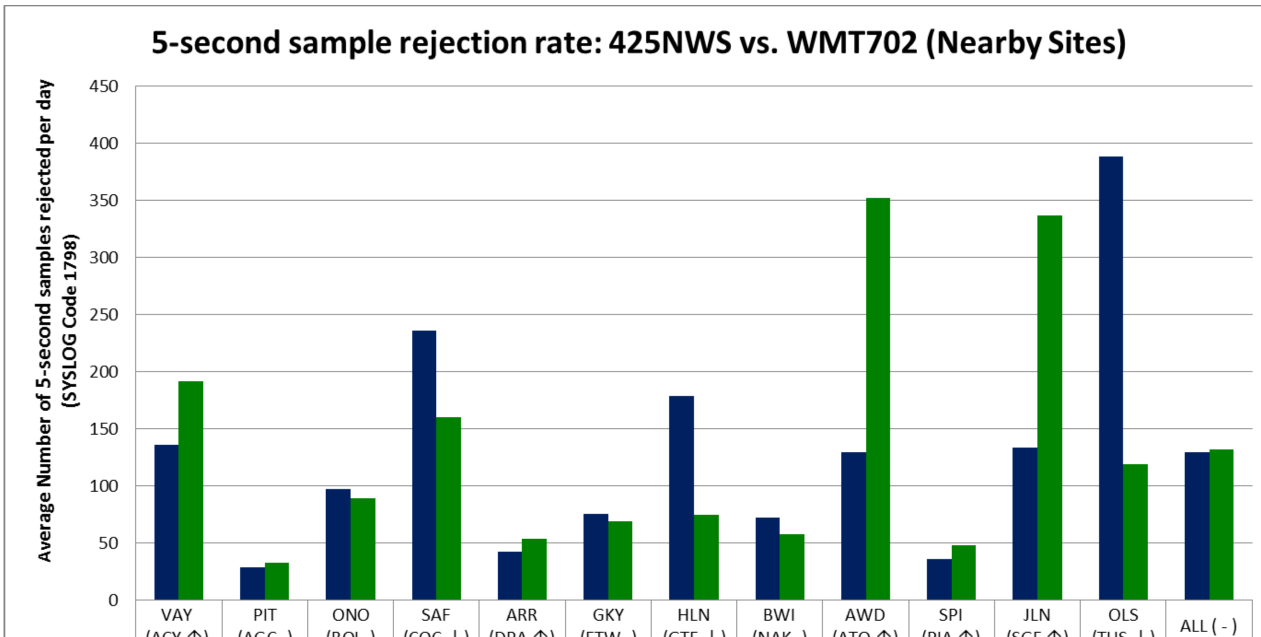
[0817	**214700**	**10**	**P**	**005**	**003**	**345**	**11.2**	**347**	**13.3**	**99]**
[0817	**214705**	**10**	**P**	**005**	**003**	**305**	**10.8**	**290**	**13.2**	**99]**

This part of the the algorithm was implemented to address the issue of erroneous wind gusts generated during periods of light winds when small birds would roost on the sensor head. The low wind speed-invalid peak check has been found to be a little bit too tight, and tends to reject some good data as well as data contaminated by small birds. An RC was approved (RC #14962, "*Change the IFWS QC Algorithm Invalid Peak Wind Criteria at Low Wind Speeds from 6 knots to 13 knots"*) in February of 2016 that will improve the low wind speed-invalid peak check. The improvement is expected to reduce the occurance of missining winds caused by good data rejection by the IFWS QC Algorithm by 89% will be implemented with the ACU-DCP re-host software. The conditions which contribute to the highest occurance of the low wind speed-invalid peak check rejecting meteorologically sound data occurs when the winds either rapidly increase from low speeds (six knots or less) or when the winds are generally light but fluctuate rapidly, characterized by gusts in the six to 12 knot range. The meteorological conditions associated with these wind regimes include the breaking of a surface-based inversion (re-coupling of the atmosphere, typically in the mid-morning hours) and, most frquently, a well-mixed atmosphre with a weak surface pressure gradient.

The WMT700 Series Test Memo indicates that the WMT702 is more stable than the legacy 425NWS wind sensor and the WMT702 may be better able to respond to the higher frequency fluctuations in the wind observed with these wind regimes. While this will result in more accurate wind reports, it also is a contributor to the increase in good data being rejected bythe IFWS QC algorithm. The implemntation of RC #14962 will reduce these effects significantly. Ideally, a QC algorithm specifically designed for the WMT702 will eventually be developed and implemented.

As previously mentioned, missing winds have numerous causes. Some of these causes have a seasonal component to them. For example, bird migration and feeding patterns can result in more bird-interference issues during some times of the year or under certain meteorological conditions. Additionally, the meteorlogical conditions condusive to the wind regimes which increase the good wind data rejection rate by the IFWS QC Algorithm may occur more frequently at some times of the year or with certain large-scale meteorological patterns (such as near the center of a high pressure area). One of the objectives of the evaluation is to evaluate changes in the performance of ASOS when equipped with the WMT702. Therefore, this seasonal impact will be estimated in order to ascertain the effect that seasonal variations in the environment had on the increase in missing winds.

In order to estimate this, SYSLOG data was analyzed from sites within 100 miles of the twelve data evaluation sites. The assumption is that since the sites are nearby, they are should experience similar seasonal changes. Since the wind sensor was not changed at these sites and the dates analyzed are the same as the dates analyzed for the evaluation, the changes in wind data rejection rates between the 425NWS and WMT702 periods at the nearby sites would be mainly due to environmental changes and should be similar to that component of the change in missing winds seen at the evaluation sites.



	VAY (ACY ↑)	PIT (AGC -)	ONO (BOI -)	SAF (CQC ↓)	ARR (DPA ↑)	GKY (FTW -)	HLN (GTF ↓)	BWI (NAK -)	AWD (ATO ↑)	SPI (PIA ↑)	JLN (SGF ↑)	OLS (TUS ↓)	ALL (-)
425NWS	136.1	28.3	96.7	235.6	42.1	75.4	178.5	72.1	129.1	35.6	133.3	388.2	129.3
WMT702	191.7	32.5	89	160.3	53.4	68.6	74.2	57.8	352.4	47.7	336.8	118.6	131.9

Figure 4

As can be seen in Figure 4, there was an increase in wind data rejection during the WMT702 evaluation period at sites in the Midwest and in southern Alaska. For example, Seward, AK (PAWD, about 50 miles southeast of PATO) experienced a 173% increase in the number of 5-second samples rejected by the algorithm (PATO experienced a 391% increase). Thus, the increase in missing winds at KDPA, KPIA, KSGF and PATO was likely due, in part, to seasonal changes in environmental conditions. Conversely, Figure 4 shows a decrease in wind data rejection across the western CONUS. At KTUS and KCQC, the seasonal changes in environmental conditions have likely acted to reduce the occurrence of missing winds. KTUS and KCQC experienced a 15% and 19% increase in missing winds, respectively. If the effects due to seasonal changes in environmental conditions were removed, KTUS and KCQC would have likely experienced larger increases in missing winds. Missing winds actually decreased at KGTF by 34%, however the amount of rejected wind data decreased by 58% over the same period at nearby KHLN (located about 70 miles southwest). Thus, the decrease in missing winds at KGTF seems to have been primarily due to seasonal changes in environmental conditions.

In the eastern CONUS, seasonal changes in environmental conditions appear to be small and likely did not have an impact on the missing winds. KVAY (about 40 miles northwest of KACY) shows a fairly large increase in rejected wind data during the WMT702 evaluation period; however this increase was mainly due to an extended hardware failure on 9/21/17. The seasonal changes in environmental conditions at KGKY (20 miles southeast of KFTW) and at KONO (about 50 miles northwest of KBOI) were also small.

The average number of samples rejected per day for all sites was 129.3 during the 425NWS period. The average number of samples rejected per day for all sites was nearly unchanged for the WMT702 period at 131.9. Therefore, seasonal changes in environmental conditions did not appear to have an effect on the overall increase in missing winds, but had significant regional effects. The seasonal changes in environmental conditions contributed to the increase in missing winds observed in the Midwest and Alaska, and likely countered the increase in missing winds across the arid portions of the southwestern CONUS.

The Evaluation of the Impact of the WMT702 on Missing Winds shows that the occurrence of missing winds increases with the installation of the WMT702, and this increase is on average about 34%. The change in missing winds can be affected by the time of year, geographical location and local siting of the sensor. For detailed site-by-site data, please refer to Appendix C.

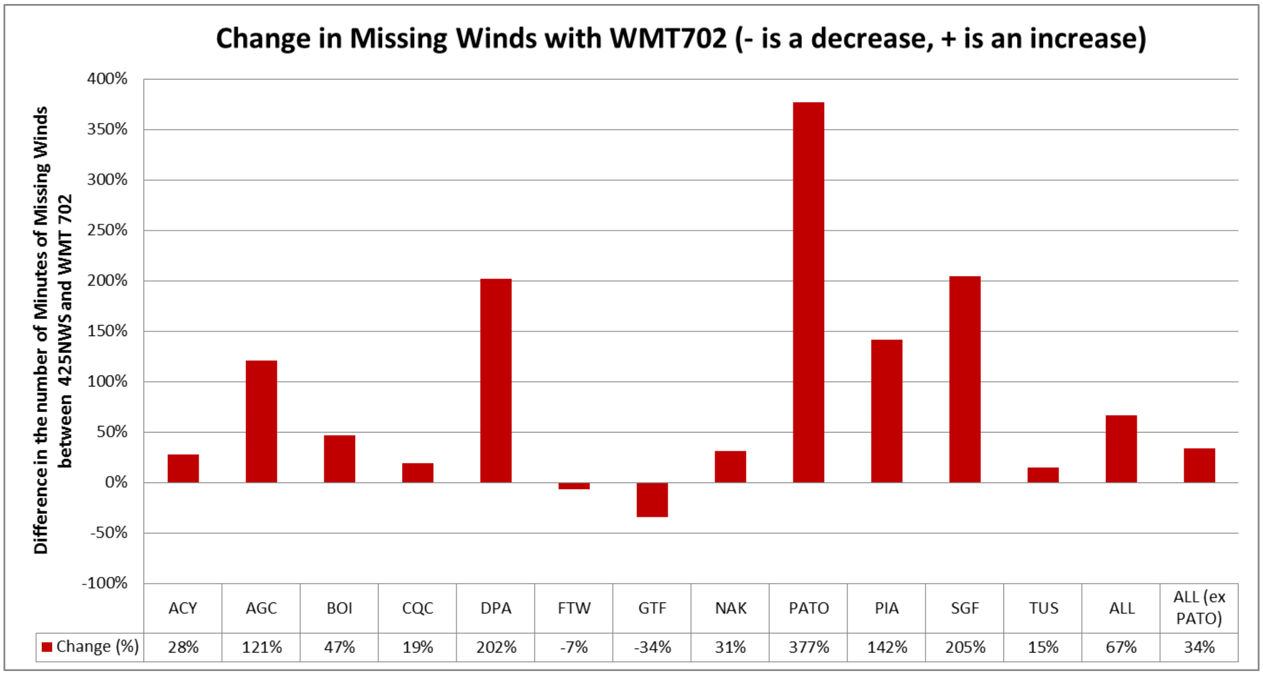
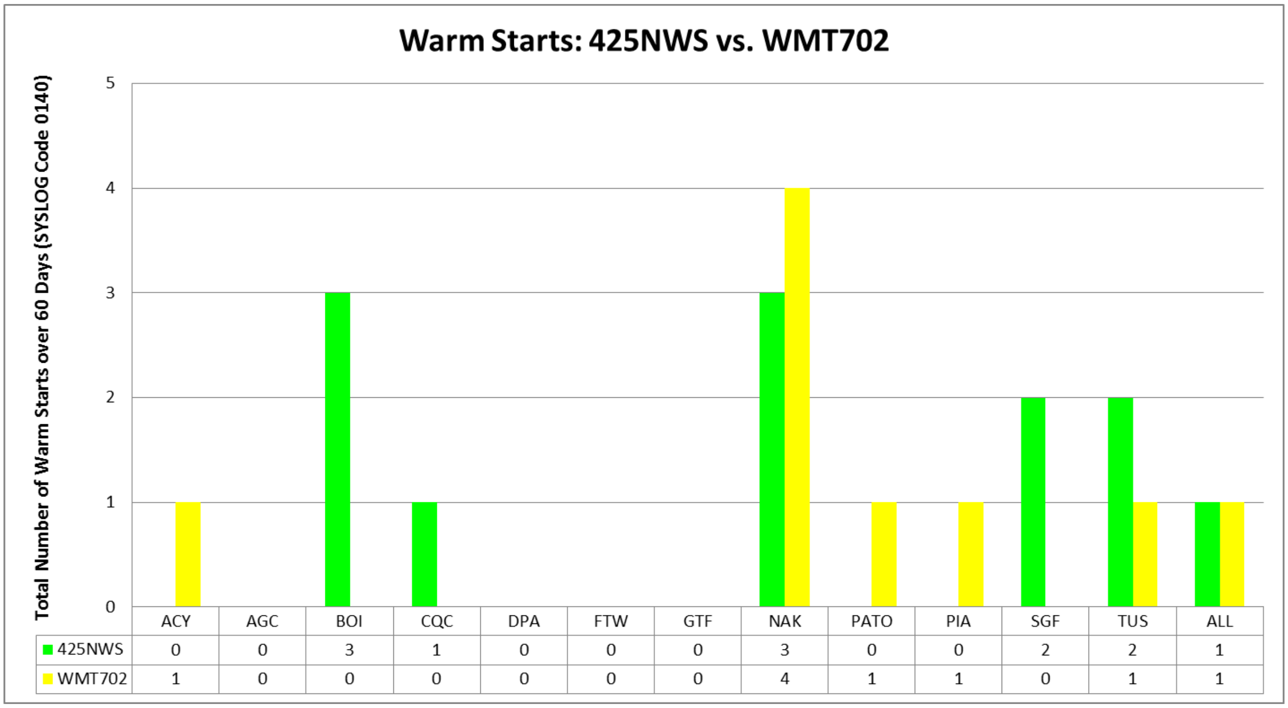


Figure 5

4.4.3 Evaluation of the Impact on the Occurrence of Warm Starts

As with sensor response time-out errors, many factors affect the occurrence of so-called ACU warm starts. These include, but are not limited to, power issues, sensor issues, software errors, telecommunications issues and ACU-DCP hardware problems. As with sensor response time-out errors, a change of one of the system's sensors can affect the frequency of warm starts. As with sensor response time-out errors, it is possible to determine what effect a sensor change will have on the frequency of warm starts if the analysis is done over a sufficient period of time and for numerous sites. When an ACU warm start occurs, ASOS will record it in the SYSLOG with a code 0140, along with the date and time.

In order to determine what effect, if any, the installation of the WMT702 will have on the frequency of warm starts; their occurrence was recorded for 60 days with the 425NWS as the operational wind sensor at the twelve evaluation sites and was compared with 60 days of data with the WMT702 as the operational wind sensor. This is analogous to the evaluation done on the occurrence of sensor response time-out errors. None of the sites experienced a particularly high number of warm starts. There were slightly more warm starts experienced at four of the evaluation sites with the WMT702, while the number decreased at four of the evaluation sites and was unchanged at the remaining four sites. It is worth noting that the magnitudes of the changes were small, with none experiencing a change in the number of warm starts exceeding two. The average number of warm starts over 60 days was the same, one, irrespective of which wind sensor was installed. Thus, the installation of the WMT702 had no systematic effect on the frequency of ACU warm starts. Please refer to Appendix C for a detailed site-by-site tabulation of the data collected over the course of the evaluation.



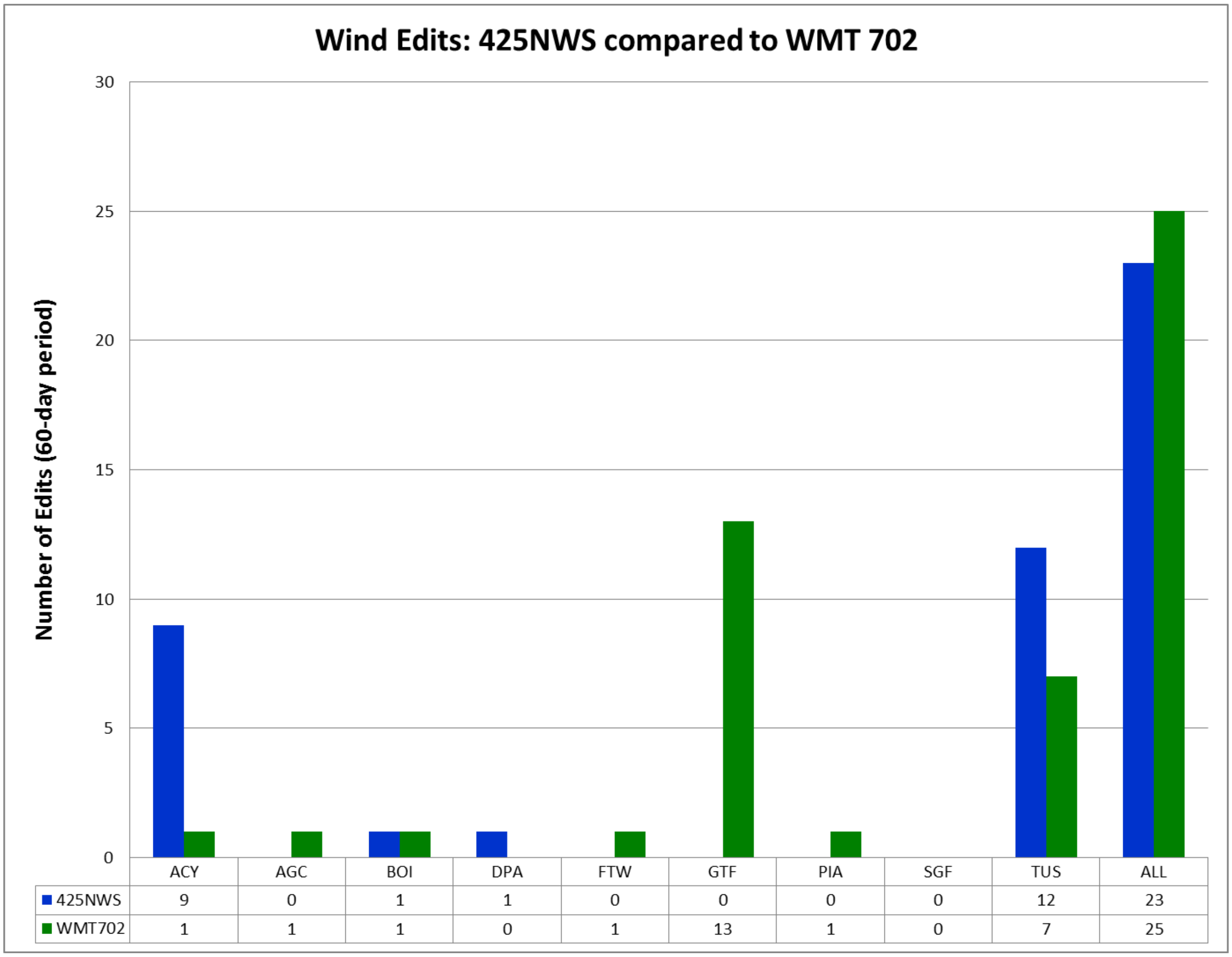
	ACY	AGC	BOI	CQC	DPA	FTW	GTF	NAK	PATO	PIA	SGF	TUS	ALL
425NWS	0	0	3	1	0	0	0	3	0	0	2	2	1
WMT702	1	0	0	0	0	0	0	4	1	1	0	1	1

Figure 6

4.5 Wind Data Representativeness Evaluation Results

In order to evaluate the representativeness of the wind data, EDITLOG data was analyzed from the nine staffed 24-hour LAWRS. The number of edits and the magnitude of the changes made by the LAWRS observers during the sixty days following the installation of the WMT702 were compared with those made during the sixty days prior to the installation.

In general, the amount of editing at the nine sites evaluated changed little with the installation of the WMT702. There were a total of 23 edits made over the sixty day evaluation period with the 425NWS compared to a total of 25 edits made over the sixty day evaluation period with the WMT702. At most of the sites, the amount of editing was unchanged. There was either one edit or no editing at all over both sensors' evaluation period at six of the nine sites.



	ACY	AGC	BOI	DPA	FTW	GTF	PIA	SGF	TUS	ALL
425NWS	9	0	1	1	0	0	0	0	12	23
WMT702	1	1	1	0	1	13	1	0	7	25

Figure 7

At KACY and at KTUS, there was more editing done on the 425NWS wind data than on the WMT702 wind data. At KGTF, however, there was a marked increase in editing of the WMT702 wind data. There were no edits made to the 425NWS wind data compared with 13 made to the WMT702 wind data. For detailed site-by-site data, please refer to Appendix D.

The magnitudes of the edits were also evaluated. Edits were separated into three categories: minor edits (those edits that resulted in a change in wind speed of less than 5 knots and a change in direction of 10° or less), major edits (those edits that resulted in a change in wind speed of more than 10 knots or a change in wind direction of more than 50°) and moderate edits (those edits that resulted in a change in wind speed of 5 to 10 knots or a change in wind direction of 20° to 50°, and did not meet major edit criteria).

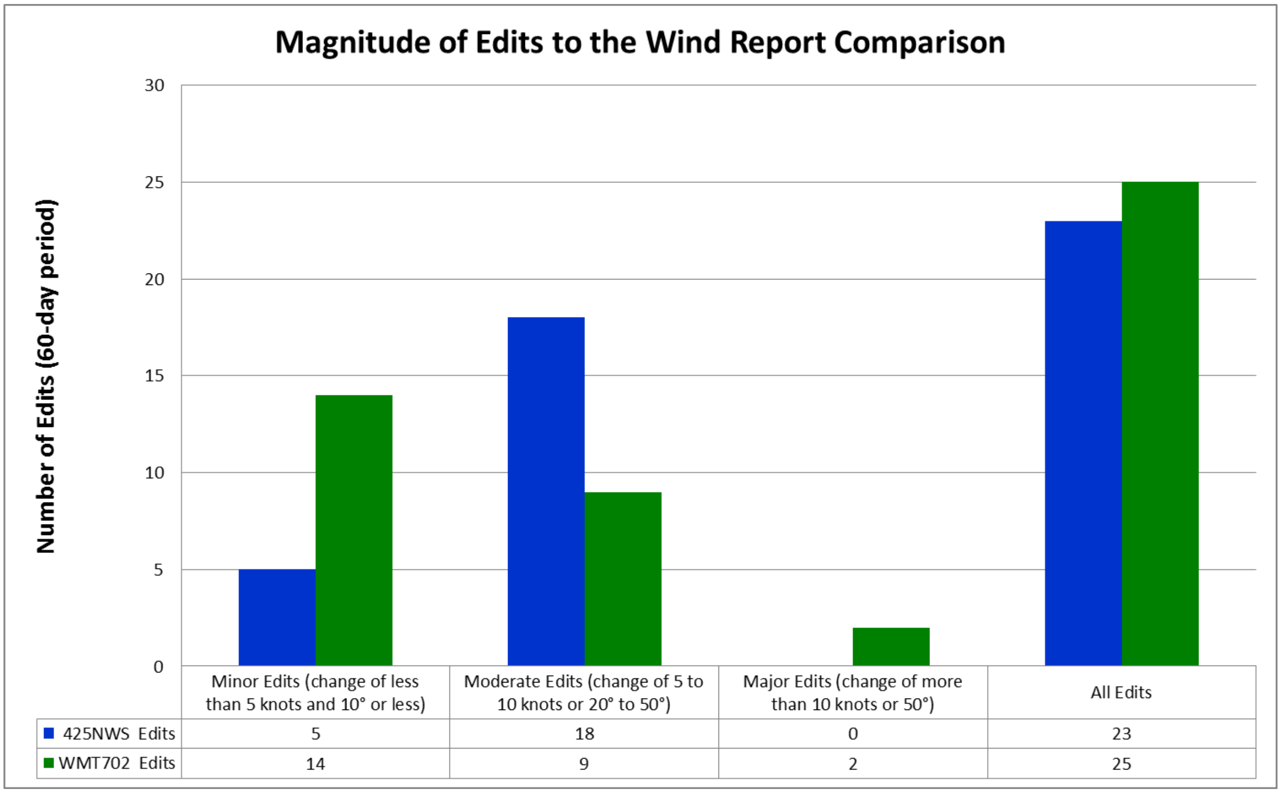


Figure 8

While the total number of edits was about the same for both sensors, the number of minor edits increased by nearly three-fold with the WMT702, and the only two major edits of the evaluation occurred at KGTF while equipped with the WMT702. Conversely, the number of moderate edits was decreased by half with the WMT702. For detailed site-by-site data, please refer to Appendix D.

The amount of editing overall was very similar, with a total of 23 edits made to the 425NWS data compared with 25 edits made to the WMT702 data. There was little if any change in the amount of editing at six of the nine evaluation sites. The amount of editing decreased markedly at two locations following installation of the WMT702, and increased markedly at one. Thus, overall wind data from the WMT702 is comparably representative to that from the 425NWS. However, at some locations, the WMT702 may be more or less representative than the 425NWS.

4.6 Caveat Emptor: Data Evaluation Limitations

The following are the limitations of the ASOS Wind Sensor Logistics Replacement Data Evaluation:

- The evaluation does not compare co-located 425NWS/WMT702 data.

- Parameters being evaluated are often affected by other factors. Power issues, radio interference, wildlife interference, time of year, meteorological pattern and any changes in observational staff will all affect the parameters being evaluated.

5.0 Conclusions

There were five main conclusions drawn from the ASOS Wind Sensor Logistics Replacement Data Evaluation. They are as follows:

1. ASOS is properly processing the wind data from the WMT702 through the wind algorithms and is properly formatting the resultant wind reports in the observations and reports.

2. When the WMT702 detects a path failure, the heaters will turn on and the wind data goes missing. Since the data outage is due to the presence of a blockage as opposed to the heaters themselves, this does not represent a problem since the winds would (and should) be missing when there is a blockage.

3. The occurrence of missing winds increases by 34% with the installation of the WMT702. Most of this increase is due to increased rejection of 5-second sample data by the low wind speed-invalid peak check of the IFWS QC Algorithm. Implementation of RC #14962 will greatly reduce these missing winds. Eventual implementation of a QC Algorithm specifically designed for the WMT702 would be ideal.

4. The installation of the WMT702 had no systematic effect on the frequency of ACU warm starts or sensor response time-outs.

5. In general, the wind observations derived from the WMT702 are comparably representative to those from the 425NWS. At some locations, the WMT702 may be more or less representative than the 425NWS.

6.0 Recommendations

The ASOS Wind Sensor Logistics Replacement Data Evaluation demonstrated that ASOS properly processes WMT702 data, the data are comparably representative to that from the legacy sensor and that the installation of the WMT702 does not adversely affect the operation of ASOS. However, the IFWS QC Algorithm designed for the 425NWS rejects a higher amount of good wind data samples from the WMT702. This results in a 34% increase in the occurrence of missing winds on average.

As a result of the five conclusions drawn from the ASOS Wind Sensor Logistics Replacement Data Evaluation, the following is recommended:

1. Deploy the WMT702 as-needed across the network. However, deployment should be deferred as long as possible across the Intermountain West, the arid areas of the southwestern U.S. and coastal southern Alaska where the IFWS QC Algorithm already rejects 1% or more of the 5-second sample data. At locations with unique wind regimes or unorthodox wind sensor configurations, such as Portage, AK and Central Park, NY, the WMT702 should probably not be installed at all if it can be avoided.

2. If the ACU-DCP re-host is significantly delayed or if other operational demands require the development of an interim software load, then RC #14962 ("*Change the IFWS QC Algorithm Invalid Peak Wind Criteria at Low Wind Speeds from 6 knots to 13 knots*") must be included in the interim software load.

3. Within a few years following initial deployment, a WMT702-specific QC algorithm should be developed.

NOTE: These recommendations are made without regard to any acquisition constraints, procurement constraints or contract constraints and are based purely on the results of the ASOS Wind Sensor Logistics Replacement Data Evaluation.

Acronyms

425NWS	Vaisala Model 425NWS ultrasonic anemometer
ACCB	ASOS Configuration Control Board
ACU	Acquisition Control Unit
ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
DCP	Data Collection Package
DSM	Daily Summary Message
FAA	Federal Aviation Administration
IFWS	Ice Free Wind Sensor
LAWRS	Limited Aviation Weather Reporting Stations
NLSC	National Logistics Support Center
NWS	National Weather Service
OT&E	Operational Test and Evaluation
PM	Program Manager
POC	Point of Contact
QC	Quality Control
RC	Request for Change
SFSC	Sterling Field Support Center
ST	System Test
SYSLOG	ASOS System Log
WFO	Weather Forecast Office
WMT702	Vaisala Model WMT702 ultrasonic anemometer

Site ID List			
Evaluation Sites		**Nearby Sites**	
Site ID	**Site Name**	**Site ID**	**Site Name**
KACY	Atlantic City, NJ	KVAY	Mt. Holly, NJ
KAGC	Alleghany County, PA	KPIT	Pittsburgh, PA
KBOI	Boise, ID	KONO	Ontario, OR
KCQC	Clines Corners, NM	KSAF	Santa Fe, NM
KDPA	DuPage, IL	KARR	Aroura, IL
KFTW	Fort Worth, TX	KGKY	Arlington, TX
KGTF	Great Falls, MT	KHLN	Helena, MT
KNAK	Annapolis, MD (Naval Academy)	KBWI	Baltimore-Washington Int’l Airport
KPIA	Peoria, IL	KSPI	Springfield, IL
KSGF	Springfield, MO	KJLN	Joplin, MO
KTUS	Tucson, AZ	KOLS	Nogales, AZ
PATO	Portage Glacier, AK	PAWD	Seward, AK

Appendix A: WMT700 Series Test Memo

Introduction

The 425NWS ultrasonic wind sensor is the standard wind sensor at all Automated Surface Observing System (ASOS) sites. The sensor manufacturer has informed the National Weather Service (NWS) that the sensor is no longer being produced and will not be supported. According to the NWS National Reconditioning Center (NRC), the current stock of 425NWS sensors will likely be depleted by the summer of 2017.

Therefore, the ASOS program requested that OBS33 assess a candidate ice-free wind sensor from Vaisala Inc, the WINDCAP® Ultrasonic Wind Sensor WMT700 series, as a replacement for the 425NWS.

Test Configuration

Testing took place at the Sterling Field Support Center (SFSC) from September 2016 through April 2017. Initially, Vaisala lent the NWS eleven WMT703 sensors (nine with full heating (transducers, arms, body) and two with no heating) for testing and the FAA lent the NWS one WMT702. The major difference between the WMT703 and WMT702 is the maximum wind speed at which the sensor is guaranteed to perform accurately. When the NWS decided to focus on the WMT702 (maximum wind speed of 65 m/s or 126 kts), Vaisala lent the NWS two WMT702 sensors with just transducer and arm heating.

All sensors were run through the wind tunnel. Two sensors were also run through environmental tests in one of SFSC’s environmental chambers, and a sensor was installed on a test ASOS at SFSC to test its ability to be installed on an ASOS with no changes to software.

Wind Tunnel

Wind tunnel testing consisted of running sensors through a full 360 degrees at 13, 22, 40, 70 and 125 knots. All sensors met the specification in the wind tunnel and actually appeared to be more stable than the 425NWS. Two sensors were also tested with an NWS bird deterrent installed. Both sensors passed every point at all wind speeds except for 125kts. According to specification NWS-F510-SP1000, the sensors have to meet the accuracy specification 97.5% of the time. At 125 kts, one sensor met the specification 97.3% of the time and the other sensor met it 95.9% of the time. This performance is similar to that of the 425NWS with the bird deterrent installed.

Chamber Test

<u>Environmental Tests</u>

Two sensors were installed in one of the walk-in environmental chambers at the SFSC. They were subjected to nine different environmental profiles: High Temperature Soak, High Temperature Cycle, High Temperature Shock, Summer Cycle, Low Temperature Soak, Low Temperature Cycle, Low Temperature Shock, Winter Cycle, and High Humidity. Theses profiles are standard environmental profiles used for all ASOS testing.

The sensors had no performance issues during all of the profiles except for the low temperature soak. Both sensors that were in the chamber were rated for performance to -55 °C (-67 °F). One sensor went missing not long after the chamber reached -40 °F and one went missing around -60 °F. They started reporting again when the temperature rose above -40 °F and -60 °F, respectively.

Spray Test

One sensor was subjected to freezing spray in the environmental chamber to test the effectiveness of the heaters. This was done with a sensor that had heating on arms, transducers, and body. Ice melted around the transducers and arms and did not interfere with the sensor operation. Testing of a sensor with just transducer and arm heating has not been completed because of scheduling issues with the chamber and the late date that SFSC received a sensor with that type of heating.

Field Test with ST2

A WMT702 sensor was installed on the SFSC SCA with the new power supply plate and firmware version 2.12. It powered on and ASOS was able to communicate with it. A check of the SYSLOGs doesn’t show any glaring issues with the sensor being connected to the ASOS.

Conclusion

Based on limited testing at the SFSC, the risk of fielding the WMT702 sensor is low. Because of the dire need for a stop-gap to the alternative of having a loss of wind data critical to the national air space, the WMT702 is a viable alternative.

Appendix B: WMT 702 WA/WT data from KSGF missing wind episode (August 29, 2017)

METAR KSGF 291752Z 10SM FEW036 SCT045 **25**/16 A3007 RMK AO2 SLP173 **T02500161** 10250 20144 50000

0829 174624 1
WTP21.0P12.P0.0P+25P22.0P5.00P10.0-03000P99P99P99P99P99P99

0829 174724 1
WTP21.0P12.P0.0P+26P22.0P5.00P10.0-03000P99P99P99P99P99P99

DATE	UTC	ERRCD	SENSRSTAT	AVG.PARAMS		5-SEC		3-SEC		SIG.QUAL
0829	174725	0	P	005	003	016	3.7	010	4.5	99
0829	174730	0	P	005	003	005	4.2	002	5.4	99
0829	174735	0	P	005	003	004	3.8	004	4.6	99
0829	174740	0	P	005	003	008	4.3	005	4.8	99
0829	174745	0	P	005	003	356	4.3	357	4.7	99
0829	174750	0	P	005	003	004	3.8	017	4.1	99
0829	174755	0	P	005	003	014	2.8	008	3.6	99
0829	174800	0	P	005	003	004	3.5	001	4.5	99
0829	174805	0	P	005	003	008	4.1	007	4.7	99
0829	174810	0	P	005	003	007	3.5	002	4.2	99
0829	174815	0	P	005	003	014	3.2	021	3.7	99
0829	174820	0	H	005	003	010	2.7	023	3.7	99

0829 174824 1
WTP21.0P12.P0.0P+26P22.0P5.00P10.0-03000P99P99P99P99P99P99

0829	174825	0	H	005	003	359	2.9	359	2.9	85
[0829	174830	2	F	005	003	999	999.9	999	999.9	00]
[0829	174835	2	F	005	003	999	999.9	999	999.9	00]
[0829	174840	2	F	005	003	999	999.9	999	999.9	00]
[0829	174845	2	F	005	003	999	999.9	999	999.9	00]
[0829	174850	2	F	005	003	999	999.9	999	999.9	00]
[0829	174855	2	F	005	003	999	999.9	999	999.9	00]
[0829	174900	2	F	005	003	999	999.9	999	999.9	00]
[0829	174905	2	F	005	003	999	999.9	999	999.9	00]
[0829	174910	2	F	005	003	999	999.9	999	999.9	00]
[0829	174915	2	F	005	003	999	999.9	999	999.9	00]
[0829	174920	2	F	005	003	999	999.9	999	999.9	00]

0829 174924 1
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[0829	174925	4	F	005	003	065	6.8	065	7.5	59]
[0829	174930	11	H	005	003	067	6.9	071	7.8	99]
[0829	174935	11	H	005	003	054	6.7	064	7.1	99]
[0829	174940	4	F	005	003	064	7.0	064	7.0	04]
[0829	174945	11	P	005	003	071	5.5	070	5.7	85]
[0829	174950	11	P	005	003	030	4.1	068	5.5	99]
[0829	174955	11	P	005	003	071	5.1	069	5.4	99]
[0829	175000	11	P	005	003	053	4.3	074	5.1	99]
[0829	175005	4	F	005	003	069	5.1	069	5.1	75]
[0829	175010	4	F	005	003	090	5.0	090	5.5	39]
[0829	175015	11	P	005	003	091	4.5	086	5.3	99]
[0829	175020	11	H	005	003	085	4.7	080	5.4	99]

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[0829	175030	11	P	005	003	096	3.9	108	5.1	99]
[0829	175035	11	P	005	003	093	4.8	096	5.9	99]
[0829	175040	11	P	005	003	087	3.5	090	4.2	99]
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[0829	175050	11	H	005	003	041	5.2	074	7.0	99]
[0829	175055	11	H	005	003	065	6.1	062	7.3	99]
[0829	175100	11	P	005	003	054	6.0	059	7.0	99]
[0829	175105	11	H	005	003	061	4.7	081	5.2	99]
[0829	175110	11	H	005	003	079	4.5	073	5.3	99]
[0829	175115	12	H	005	003	069	4.3	066	6.6	99]
[0829	175120	12	P	005	003	078	6.7	078	7.1	99]

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[0829	175150	12	H	005	003	085	5.5	084	6.2	99]
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[0829 175220 4 F 005 003 073 4.3 073 4.3 39]

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[0829 175235 4 F 005 003 082 3.4 082 4.0 59]

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[0829 175250 12 P 005 003 064 4.4 063 5.0 99]

[0829 175255 12 P 005 003 068 3.8 063 4.5 99]

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[0829 175305 12 P 005 003 042 3.3 046 4.5 99]

[0829 175310 12 P 005 003 011 2.8 356 3.8 99]

[0829 175315 12 P 005 003 359 3.6 008 4.7 99]

[0829 175320 12 P 005 003 345 3.4 336 4.8 99]

0829 175324 1
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[0829 175335 12 P 005 003 350 5.2 358 6.2 99]

[0829 175340 12 P 005 003 355 5.3 003 6.2 99]

[0829 175345 12 P 005 003 002 4.9 005 5.3 99]

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[0829 175355 12 P 005 003 345 3.7 354 4.6 99]

[0829 175400 12 P 005 003 347 3.0 346 3.4 99]

[0829 175405 12 P 005 003 357 3.0 011 3.3 99]

0829 175410 0 P 005 003 008 3.2 013 3.7 99

0829 175415 0 P 005 003 015 3.2 021 3.6 99

0829 175420 0 P 005 003 022 2.5 019 3.1 99

0829 175424 1
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0829 175425 0 P 005 003 037 3.1 041 4.1 99

0829 175430 0 P 005 003 045 3.3 042 4.6 99

0829	175435	0	P	005	003	029	4.0	031	5.0	99
0829	175440	0	P	005	003	039	4.4	039	5.5	99
0829	175445	0	P	005	003	024	4.3	029	6.6	99
0829	175450	0	P	005	003	023	6.8	033	9.0	99
0829	175455	0	H	005	003	024	4.8	019	5.8	99
0829	175500	0	P	005	003	028	7.6	021	9.2	99
0829	175505	0	P	005	003	025	7.7	016	8.7	99
0829	175510	0	P	005	003	023	8.1	015	9.8	99
0829	175515	0	P	005	003	023	7.0	026	7.5	99
0829	175520	0	P	005	003	030	7.3	033	8.2	99

0829 175524 1
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0829	175525	0	P	005	003	023	7.4	017	8.9	99
0829	175530	0	P	005	003	036	8.8	034	10.9	99
0829	175535	0	P	005	003	038	9.8	044	10.5	99
0829	175540	0	P	005	003	033	8.6	035	9.5	99
0829	175545	0	P	005	003	033	8.8	033	9.4	99
0829	175550	0	P	005	003	025	9.7	019	11.4	99
0829	175555	0	P	005	003	019	10.0	018	11.3	99
0829	175600	0	P	005	003	017	9.5	015	10.3	99
0829	175605	0	P	005	003	013	9.6	015	10.6	99
0829	175610	0	P	005	003	017	8.9	013	10.7	99
0829	175615	0	P	005	003	019	7.8	022	8.3	99
0829	175620	0	P	005	003	018	7.6	020	8.2	99

0829 175624 1
WTP21.0P12.P0.0P+52P22.0P5.00P10.0-03064P99P99P99P99P99P99

0829	175625	0	P	005	003	019	8.4	021	9.3	99
0829	175630	0	P	005	003	019	8.4	023	9.2	99
0829	175635	0	P	005	003	026	9.8	026	10.7	99
0829	175640	0	P	005	003	028	9.6	026	10.1	99
0829	175645	0	P	005	003	029	9.5	030	9.8	99
0829	175650	0	P	005	003	024	9.3	021	9.7	99
0829	175655	0	P	005	003	022	9.7	022	10.0	99
0829	175700	0	P	005	003	021	9.3	020	9.6	99
0829	175705	0	P	005	003	023	8.5	021	9.0	99
0829	175710	0	P	005	003	021	7.6	019	8.1	99
0829	175715	0	P	005	003	028	7.6	027	8.2	99

0829	175720	0	P	005	003	029	7.7	022	10.4	99

0829 175724 1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03064P99P99P99P99P99P99

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0829	175735	0	P	005	003	030	6.9	030	7.7	99
0829	175740	0	P	005	003	033	7.0	033	7.5	99
0829	175745	0	P	005	003	036	6.2	036	6.3	99
0829	175750	0	P	005	003	033	5.0	034	6.0	99
0829	175755	0	P	005	003	031	4.1	034	5.1	99
0829	175800	0	P	005	003	031	4.4	030	5.9	99
0829	175805	0	P	005	003	037	6.0	034	6.5	99
0829	175810	0	P	005	003	042	4.4	030	7.7	99
0829	175815	0	P	005	003	020	5.4	032	8.0	99

0829 175824 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03064P99P99P99P99P99P99

0829	175820	0	P	005	003	029	6.1	031	9.2	99
0829	175825	0	P	005	003	031	8.7	032	10.1	99
0829	175830	0	P	005	003	034	8.9	034	10.0	99
0829	175835	0	P	005	003	030	9.0	032	9.9	99
0829	175840	0	P	005	003	024	8.1	020	10.2	99
0829	175845	0	P	005	003	028	7.9	025	8.4	99
0829	175850	0	P	005	003	028	7.7	029	8.7	99
0829	175855	0	P	005	003	027	8.3	029	8.8	99
0829	175900	0	P	005	003	023	7.8	027	8.5	99
0829	175905	0	H	005	003	030	5.9	034	6.2	99
[0829	175910	4	F	005	003	029	5.9	029	5.9	09]
[0829	175915	4	F	005	003	047	6.7	047	6.7	04]
0829	175920	0	H	005	003	045	6.4	043	7.0	99

0829 175924 1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03064P99P99P99P99P99P99

[0829	175925	4	F	005	003	047	6.3	045	6.3	25]
0829	175930	0	H	005	003	045	6.2	042	7.3	99
0829	175935	0	P	005	003	025	4.2	035	5.8	99
0829	175940	0	P	005	003	023	4.1	031	5.8	99
0829	175945	0	H	005	003	020	5.0	000	5.7	99

0829	175950	0	H	005	003	013	5.6	011	8.2	99
0829	175955	0	H	005	003	354	6.1	002	7.0	90
[0829	180000	2	F	005	003	999	999.9	999	999.9	00]
[0829	180005	2	F	005	003	999	999.9	999	999.9	00]
0829	180010	0	H	005	003	018	11.5	019	12.9	85
0829	180015	0	H	005	003	019	9.7	010	10.4	99
0829	180020	0	H	005	003	027	9.6	029	9.9	99

0829 180024 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03068P99P99P99P99P99P99

[0829	180025	4	F	005	003	029	9.9	029	9.9	25]
0829	180030	0	H	005	003	027	6.9	028	7.8	99
[0829	180035	4	F	005	003	026	6.9	026	6.9	29]
[0829	180040	4	F	005	003	024	7.4	016	9.1	79]
[0829	180045	11	H	005	003	018	7.8	018	7.8	85]
[0829	180050	2	F	005	003	999	999.9	999	999.9	00]
[0829	180055	2	F	005	003	999	999.9	999	999.9	00]
[0829	180100	2	F	005	003	999	999.9	999	999.9	00]
[0829	180105	4	F	005	003	037	7.2	034	7.8	65]
[0829	180110	11	P	005	003	029	5.4	033	6.8	99]
[0829	180115	11	P	005	003	017	7.8	008	9.2	99]
[0829	180120	11	P	005	003	003	7.5	011	8.8	99]

0829 180124 1
WTP21.0P12.P0.0P+52P22.0P5.00P10.0-03075P99P99P60P99P99P99

[0829	180125	11	H	005	003	006	7.9	012	8.5	99]
[0829	180130	4	F	005	003	006	7.9	006	7.9	09]
[0829	180135	2	F	005	003	999	999.9	999	999.9	00]
[0829	180140	2	F	005	003	999	999.9	999	999.9	00]
[0829	180145	2	F	005	003	999	999.9	999	999.9	00]
[0829	180150	4	F	005	003	010	8.5	012	9.2	65]
[0829	180155	11	P	005	003	012	8.2	016	8.9	99]
[0829	180200	11	P	005	003	017	8.8	017	9.4	99]
[0829	180205	11	P	005	003	015	8.8	017	9.1	99]
[0829	180210	11	P	005	003	013	8.4	014	8.8	99]
[0829	180215	11	H	005	003	016	8.3	018	8.8	99]
[0829	180220	4	F	005	003	014	8.5	014	8.5	25]

0829 180224 1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03098P99P99P99P99P99P99

[0829 180225 2 F 005 003 999 999.9 999 999.9 00]

[0829 180230 2 F 005 003 999 999.9 999 999.9 00]

[0829 180235 2 F 005 003 999 999.9 999 999.9 00]

[0829 180240 11 H 005 003 008 8.5 009 8.8 99]

[0829 180245 11 P 005 003 007 7.9 008 8.1 99]

[0829 180250 11 H 005 003 008 7.1 008 7.6 99]

[0829 180255 4 F 005 003 008 7.0 008 7.0 50]

[0829 180300 2 F 005 003 999 999.9 999 999.9 00]

[0829 180305 2 F 005 003 999 999.9 999 999.9 00]

[0829 180310 2 F 005 003 999 999.9 999 999.9 00]

[0829 180315 11 H 005 003 004 5.8 004 7.5 99]

[0829 180320 11 H 005 003 013 6.7 022 8.5 99]

0829 180324 1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03118P99P99P64P99P99P99

[0829 180325 11 P 005 003 016 7.3 025 8.3 99]

[0829 180330 11 P 005 003 001 5.5 016 7.6 99]

[0829 180335 11 H 005 003 355 5.3 354 7.4 99]

[0829 180340 4 F 005 003 355 4.9 355 4.9 45]

[0829 180345 2 F 005 003 999 999.9 999 999.9 00]

[0829 180350 4 F 005 003 354 7.2 354 8.5 79]

[0829 180355 11 P 005 003 356 7.8 356 8.5 99]

[0829 180400 11 P 005 003 352 7.2 353 7.5 99]

[0829 180405 11 P 005 003 353 7.6 352 8.5 99]

[0829 180410 11 P 005 003 351 6.5 352 7.7 99]

[0829 180415 11 P 005 003 352 6.1 352 7.0 99]

[0829 180420 11 P 005 003 351 5.9 352 6.6 99]

0829 180424 1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03131P99P99F00F00P99P99

[0829 180425 11 P 005 003 350 6.1 347 6.6 99]

[0829 180430 11 H 005 003 355 5.3 356 6.0 99]

[0829 180435 4 F 005 003 355 4.8 355 4.8 39]

[0829 180440 2 F 005 003 999 999.9 999 999.9 00]

[0829 180445 2 F 005 003 999 999.9 999 999.9 00]

[0829 180450 2 F 005 003 999 999.9 999 999.9 00]

[0829 180455 2 F 005 003 999 999.9 999 999.9 00]

[0829	180500	2	F	005	003	999	999.9	999	999.9	00]
[0829	180505	2	F	005	003	999	999.9	999	999.9	00]
[0829	180510	2	F	005	003	999	999.9	999	999.9	00]
[0829	180515	2	F	005	003	999	999.9	999	999.9	00]
[0829	180520	2	F	005	003	999	999.9	999	999.9	00]

0829 180524 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03139P99P99F21F07P99P99

[0829	180525	2	F	005	003	999	999.9	999	999.9	00]
[0829	180530	2	F	005	003	999	999.9	999	999.9	00]
[0829	180535	4	F	005	003	033	6.5	030	7.3	55]
[0829	180540	11	P	005	003	032	5.6	030	6.7	99]
[0829	180545	11	P	005	003	025	4.5	031	6.0	99]
[0829	180550	11	H	005	003	018	4.2	016	4.5	99]
[0829	180555	11	H	005	003	017	3.8	017	4.0	99]
[0829	180600	4	F	005	003	016	4.0	016	4.0	29]
[0829	180605	2	F	005	003	999	999.9	999	999.9	00]
[0829	180610	2	F	005	003	999	999.9	999	999.9	00]
[0829	180615	2	F	005	003	999	999.9	999	999.9	00]
[0829	180620	2	F	005	003	999	999.9	999	999.9	00]

0829 180624 1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03190P99P99P99P99P99P99

[0829	180625	2	F	005	003	999	999.9	999	999.9	00]
[0829	180630	4	F	005	003	016	3.2	015	4.0	39]
[0829	180635	11	H	005	003	017	3.5	019	3.7	90]
[0829	180640	11	P	005	003	012	2.6	020	4.5	99]
[0829	180645	11	P	005	003	009	2.1	004	2.4	99]
[0829	180650	11	H	005	003	023	2.3	028	3.2	99]
[0829	180655	4	F	005	003	034	3.0	034	3.0	75]
[0829	180700	2	F	005	003	999	999.9	999	999.9	00]
[0829	180705	2	F	005	003	999	999.9	999	999.9	00]
[0829	180710	2	F	005	003	999	999.9	999	999.9	00]
[0829	180715	2	F	005	003	999	999.9	999	999.9	00]
[0829	180720	2	F	005	003	999	999.9	999	999.9	00]

0829 180724 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03217P99P99P99P99P99P99

[0829	180725	2	F	005	003	999	999.9	999	999.9	00]
[0829	180730	2	F	005	003	999	999.9	999	999.9	00]

[0829	180735	2	F	005	003	999	999.9	999	999.9	00]
[0829	180740	2	F	005	003	999	999.9	999	999.9	00]
[0829	180745	2	F	005	003	999	999.9	999	999.9	00]
[0829	180750	2	F	005	003	999	999.9	999	999.9	00]
[0829	180755	2	F	005	003	999	999.9	999	999.9	00]
[0829	180800	2	F	005	003	999	999.9	999	999.9	00]
[0829	180805	2	F	005	003	999	999.9	999	999.9	00]
[0829	180810	2	F	005	003	999	999.9	999	999.9	00]
[0829	180815	2	F	005	003	999	999.9	999	999.9	00]
[0829	180820	2	F	005	003	999	999.9	999	999.9	00]

0829 180824 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03260P99P99F35F50P99P99

[0829	180825	2	F	005	003	999	999.9	999	999.9	00]
[0829	180830	2	F	005	003	999	999.9	999	999.9	00]
[0829	180835	2	F	005	003	999	999.9	999	999.9	00]
[0829	180840	11	H	005	003	073	4.2	068	5.1	99]
[0829	180845	4	F	005	003	068	5.1	068	5.1	35]
[0829	180850	2	F	005	003	999	999.9	999	999.9	00]
[0829	180855	4	F	005	003	050	5.2	051	5.5	14]
[0829	180900	11	H	005	003	053	5.8	053	5.8	85]
[0829	180905	2	F	005	003	999	999.9	999	999.9	00]
[0829	180910	2	F	005	003	999	999.9	999	999.9	00]
[0829	180915	4	F	005	003	038	5.2	062	7.1	65]
[0829	180920	11	P	005	003	067	6.4	073	7.4	99]

0829 180924 1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03314P99P99P64F10P99P99

[0829	180925	11	P	005	003	053	5.9	078	7.1	99]
[0829	180930	11	P	005	003	045	5.0	070	6.1	99]
[0829	180935	11	P	005	003	037	5.9	067	8.3	99]
[0829	180940	11	P	005	003	066	6.9	068	7.8	99]
[0829	180945	11	P	005	003	036	5.8	072	7.6	99]
[0829	180950	11	P	005	003	025	4.7	075	6.5	99]
[0829	180955	11	P	005	003	027	4.9	074	6.7	99]
[0829	181000	11	P	005	003	052	5.8	056	7.3	99]
[0829	181005	11	P	005	003	036	4.0	069	5.3	99]
[0829	181010	11	P	005	003	065	5.0	062	5.9	99]
[0829	181015	11	P	005	003	017	3.4	066	4.6	99]

[0829 181020 11 P 005 003 025 3.7 069 5.2 99]

0829 181024 1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03329P99P99P99P99P99P99

[0829 181025 11 P 005 003 052 4.3 065 5.2 99]

[0829 181030 11 P 005 003 066 4.5 061 5.4 99]

[0829 181035 11 P 005 003 045 4.3 073 5.5 99]

[0829 181040 12 P 005 003 061 5.6 076 6.3 99]

[0829 181045 12 H 005 003 074 4.9 074 5.2 99]

[0829 181050 4 F 005 003 070 4.7 071 5.1 70]

[0829 181055 12 P 005 003 002 3.7 059 5.7 99]

[0829 181100 12 P 005 003 050 4.5 065 5.7 99]

[0829 181105 12 H 005 003 063 4.8 058 6.1 99]

[0829 181110 4 F 005 003 063 5.8 063 5.8 75]

[0829 181115 2 F 005 003 999 999.9 999 999.9 00]

[0829 181120 4 F 005 003 052 4.5 064 4.9 35]

0829 181124 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03329P99P99P99F00P99P99

[0829 181125 12 H 005 003 025 2.6 066 3.9 99]

[0829 181130 4 F 005 003 348 2.4 050 5.0 59]

[0829 181135 12 P 005 003 043 3.6 052 4.8 99]

[0829 181140 12 P 005 003 058 3.2 035 4.0 99]

[0829 181145 12 P 005 003 052 2.9 054 4.2 99]

[0829 181150 12 P 005 003 031 1.9 034 2.6 99]

[0829 181155 12 P 005 003 022 1.9 030 2.7 99]

[0829 181200 12 P 005 003 025 1.8 032 2.2 99]

[0829 181205 12 H 005 003 019 2.0 025 4.5 99]

[0829 181210 4 F 005 003 019 1.9 019 1.9 29]

[0829 181215 4 F 005 003 010 0.8 007 1.3 65]

[0829 181220 11 P 005 003 357 1.2 349 1.6 99]

0829 181224 1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03333P99P99P99P99P99P99

[0829 181225 11 H 005 003 337 0.9 331 1.3 99]

[0829 181230 4 F 005 003 338 0.7 338 0.7 45]

[0829 181235 4 F 005 003 332 0.7 341 1.1 59]

[0829 181240 4 F 005 003 018 0.8 102 1.4 59]

[0829 181245 11 P 005 003 226 1.0 238 1.3 99]

[0829 181250 11 P 005 003 180 0.9 193 1.6 99]

[0829 181255 11 P 005 003 331 1.0 309 1.5 99]

[0829 181300 11 P 005 003 268 0.6 346 1.0 99]

[0829 181305 11 P 005 003 154 0.6 101 1.3 99]

[0829 181310 11 P 005 003 163 1.4 118 2.1 99]

[0829 181315 11 P 005 003 196 1.3 207 2.1 99]

[0829 181320 11 P 005 003 167 1.2 137 1.7 99]

0829 181324 1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03334P99P99P99P99P99P99

[0829 181325 12 P 005 003 168 1.3 140 2.0 99]

[0829 181330 12 P 005 003 151 2.3 130 3.2 99]

[0829 181335 12 P 005 003 131 2.8 123 3.1 99]

[0829 181340 12 P 005 003 143 2.9 138 3.6 99]

[0829 181345 12 P 005 003 141 2.4 131 2.8 99]

[0829 181350 12 P 005 003 127 2.4 130 3.2 99]

[0829 181355 12 P 005 003 142 2.5 157 2.9 99]

[0829 181400 12 P 005 003 154 2.5 153 2.7 99]

[0829 181405 12 P 005 003 151 2.4 142 2.6 99]

[0829 181410 12 P 005 003 159 2.3 143 2.7 99]

[0829 181415 12 P 005 003 127 1.0 112 1.7 99]

[0829 181420 12 P 005 003 123 1.6 101 2.2 99]

0829 181424 1 WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03334P99P99P99P99P99P99

[0829 181425 12 P 005 003 156 2.3 158 3.0 99]

[0829 181430 12 P 005 003 179 2.3 185 2.9 99]

[0829 181435 12 P 005 003 176 1.6 169 2.3 99]

[0829 181440 12 P 005 003 164 2.2 153 3.1 99]

[0829 181445 12 P 005 003 154 2.7 167 3.6 99]

[0829 181450 12 P 005 003 171 3.0 168 3.9 99]

0829 181455 0 P 005 003 174 2.7 168 3.0 99

0829 181500 0 P 005 003 171 2.8 170 3.1 99

0829 181524 1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03334P99P99P99P99P99P99

0829 181624 1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03334P99P99P99P99P99P99

0829 181724 1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03334P99P99P99P99P99P99

0829 181824 1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03334P99P99P99P99P99P99

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 0829  181924  1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182024  1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03334P99P99P99P99P99P99


 0829  182124  1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182224  1
WTP21.0P12.P0.0P+54P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182324  1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182424  1
WTP21.0P12.P0.0P+55P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182524  1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182624  1
WTP21.0P12.P0.0P+53P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182724  1
WTP21.0P12.P0.0P+56P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182824  1
WTP21.0P12.P0.0P+49P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  182924  1
WTP21.0P12.P0.0P+41P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  183024  1
WTP21.0P12.P0.0P+36P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  183124  1
WTP21.0P12.P0.0P+31P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  183224  1
WTP21.0P12.P0.0P+29P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  183324  1
WTP21.0P12.P0.0P+28P22.0P5.00P10.0-03334P99P99P99P99P99P99

 0829  183424  1
WTP21.0P12.P0.0P+26P22.0P5.00P10.0-03334P99P99P99P99P99P99
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Appendix C: Sensor Performance

Site: All	425NWS			WMT702			Comparison
	Total Number	Total Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	18	720	0.025	26	720	0.036	+0.011 (+44%)
Number of Inoperative Sensor Episodes (1791)	1264	720	1.756	2173	720	3.018	+1.262 (+72%)
Minutes Wind Sensor is Inopertaive	7288	720	10.122	12186	720	16.925	+6.803 (+67%)
Samples Rejected by QC (1798)	69412	720	96.4	126259	720	175.4	+79.0 (+82%)
Warm Starts (0140)	11	720	0.015	8	720	0.011	-0.004 (-27%)

Site: All (ex. PATO)	425NWS			WMT702			Comparison
	Total Number	Total Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	16	660	0.024	25	660	0.038	+0.014 (+58%)
Number of Inoperative Sensor Episodes (1791)	1145	660	1.735	1480	660	2.242	+0.507 (+29%)
Minutes Wind Sensor is Inopertaive	6590	660	9.985	8855	660	13.417	+3.432 (+34%)
Samples Rejected by QC (1798)	61889	660	93.8	89295	660	135.3	+41.5 (+44%)
Warm Starts (0140)	11	660	0.017	7	660	0.011	-0.006 (-35%)

Site: KAGC	425NWS (5/28 – 7/26/2017)			WMT702 (8/18 – 10/16/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	2	60	0.034	+0.017
Number of Inoperative Sensor Episodes (1791)	51	60	0.850	119	60	1.983	+1.133
Minutes Wind Sensor is Inopertaive	272	60	4.533	601	60	10.017	+5.484
Samples Rejected by QC (1798)	2733	60	45.6	6369	60	106.2	+60.6
Warm Starts (0140)	0	60	0	0	60	0	0

Site: KACY	425NWS (5/28 – 7/26/2017)			WMT702 (8/16 – 10/14/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	0	60	0	4	60	0.067	+0.067
Number of Inoperative Sensor Episodes (1791)	34	60	0.567	38	60	0.633	+0.066
Minutes Wind Sensor is Inopertaive	202	60	3.367	258	60	4.300	+0.933
Samples Rejected by QC (1798)	2435	60	40.6	2845	60	47.4	+6.8
Warm Starts (0140)	0	60	0	1	60	0.017	+0.017

Site: KNAK	425NWS (5/12 – 6/5/17 & 6/22 – 7/26/2017)			WMT702 (8/15 – 10/13/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	3	60	0.050	3	60	0.050	0
Number of Inoperative Sensor Episodes (1791)	29	60	0.483	39	60	0.650	+0.167
Minutes Wind Sensor is Inopertaive	160	60	2.667	210	60	3.500	+0.833
Samples Rejected by QC (1798)	1784	60	29.7	2178	60	36.3	+6.6
Warm Starts (0140)	3	60	0.05	4	60	0.067	+0.017

Site: KPIA	425NWS (5/28 – 7/26/2017)			WMT702 (8/16 – 10/14/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	0	60	0	-0.017
Number of Inoperative Sensor Episodes (1791)	45	60	0.750	123	60	2.050	+1.300
Minutes Wind Sensor is Inopertaive	260	60	4.333	630	60	10.500	+6.167
Samples Rejected by QC (1798)	2453	60	40.9	6104	60	101.7	+60.8
Warm Starts (0140)	0	60	0	1	60	0.017	+0.017

Site: KDPA	425NWS (5/28 – 7/26/2017)			WMT702 (8/9 – 10/7/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	0	60	0	4	60	0.067	+0.067
Number of Inoperative Sensor Episodes (1791)	38	60	0.633	86	60	1.433	+0.800
Minutes Wind Sensor is Inopertaive	206	60	3.433	622	60	10.367	+6.934
Samples Rejected by QC (1798)	1863	60	31.1	6315	60	105.3	+74.2
Warm Starts (0140)	0	60	0	0	60	0	0

Site: KSGF	425NWS (5/28 – 7/26/2017)			WMT702 (8/2 – 10/1/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	1	60	0.017	0
Number of Inoperative Sensor Episodes (1791)	54	60	0.900	145	60	2.417	+1.517
Minutes Wind Sensor is Inopertaive	294	60	4.900	897	60	14.950	+10.050
Samples Rejected by QC (1798)	2713	60	45.2	8176	60	136.3	+91.1
Warm Starts (0140)	2	60	0.033	0	60	0	-0.033

Site: KCQC	425NWS (5/15 – 6/5/17 & 6/22 – 7/29/2017)			WMT702 (8/4 – 10/2/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	0	60	0	0	60	0	0
Number of Inoperative Sensor Episodes (1791)	163	60	2.717	190	60	3.167	+0.450
Minutes Wind Sensor is Inopertaive	906	60	15.100	1082	60	18.033	+2.933
Samples Rejected by QC (1798)	7522	60	125.4	9495	60	158.3	+32.9
Warm Starts (0140)	1	60	0.017	0	60	0	-0.017

Site: KFTW	425NWS (5/27 – 7/25/2017)			WMT702 (8/25 – 10/23/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	2	60	0.033	+0.016
Number of Inoperative Sensor Episodes (1791)	83	60	1.383	77	60	1.283	-0.100
Minutes Wind Sensor is Inopertaive	462	60	7.700	428	60	7.133	-0.567
Samples Rejected by QC (1798)	4107	60	68.5	4340	60	72.3	+3.8
Warm Starts (0140)	0	60	0	0	60	0	0

Site: KTUS	425NWS (5/28 – 7/26/2017)			WMT702 (8/25 – 10/23/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	4	60	0.067	+0.050
Number of Inoperative Sensor Episodes (1791)	308	60	5.133	332	60	5.533	+0.400
Minutes Wind Sensor is Inopertaive	1590	60	26.500	1866	60	31.100	+4.600
Samples Rejected by QC (1798)	14621	60	243.7	20827	60	347.1	+103.4
Warm Starts (0140)	2	60	0.033	1	60	0.017	-0.016

Site: KGTF	425NWS (5/28 – 7/26/2017)			WMT702 (8/12 – 10/10/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	7	60	0.117	4	60	0.067	-0.050
Number of Inoperative Sensor Episodes (1791)	172	60	2.867	148	60	2.467	-0.400
Minutes Wind Sensor is Inopertaive	1268	60	21.133	836	60	13.933	-7.200
Samples Rejected by QC (1798)	12849	60	214.2	7964	60	132.7	-81.5
Warm Starts (0140)	0	60	0	0	60	0	0

Site: KBOI	425NWS (5/28 – 7/26/2017)			WMT702 (8/9 – 10/7/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	1	60	0.017	1	60	0.017	0
Number of Inoperative Sensor Episodes (1791)	168	60	2.800	183	60	3.050	+0.250
Minutes Wind Sensor is Inopertaive	970	60	16.167	1425	60	23.750	+7.583
Samples Rejected by QC (1798)	8809	60	146.8	14682	60	244.7	+97.9
Warm Starts (0140)	3	60	0.050	0	60	0	-0.050

Site: PATO	425NWS (4/7 – 6/5/2017)			WMT702 (8/17 – 10/15/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Sensor Response Timeouts (1785)	2	60	0.033	1	60	0.017	-0.016
Number of Inoperative Sensor Episodes (1791)	119	60	1.983	693	60	11.550	+9.567
Minutes Wind Sensor is Inopertaive	698	60	11.633	3331	60	55.517	+43.884
Samples Rejected by QC (1798)	7523	60	125.4	36964	60	616.1	+490.7
Warm Starts (0140)	0	60	0	1	60	0.017	+0.017

Appendix D: Data Representativeness

Site: ALL	425NWS			WMT702			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	23	540	0.043	25	540	0.046	+.003 (+7%)
Minor Edits (changes of less than 5 knots and 10 degrees or less)	5	540	0.009	14	540	0.026	+0.017 (+189%)
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	18	540	0.034	9	540	0.017	-0.017 (-50%)
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	540	0	2	540	0.004	+0.004

Site: KAGC	425NWS (5/28 – 7/26/2017)			WMT702 (8/18 – 10/16/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	0	60	0	1	60	0.017	+0.017
Minor Edits (changes of less than 5 knots and 10 degrees or less)	0	60	0	1	60	0.017	+0.017
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	0	60	0	0	60	0	0
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	60	0	0	60	0	0

Site: KACY	425NWS (5/28 – 7/26/2017)			WMT702 (8/16 – 10/14/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	9	60	0.15	1	60	0.017	-0.133
Minor Edits (changes of less than 5 knots and 10 degrees or less)	0	60	0	0	60	0	0
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	9	60	0.15	1	60	0.017	-0.133
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	60	0	0	60	0	0

Site: KPIA	425NWS (5/28 – 7/26/2017)			WMT702 (8/16 – 10/14/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	0	60	0	1	60	0.017	+0.017
Minor Edits (changes of less than 5 knots and 10 degrees or less)	0	60	0	1	60	0.017	+0.017
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	0	60	0	0	60	0	0
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	60	0	0	60	0	0

Site: KDPA	425NWS (5/28 – 7/26/2017)			WMT702 (8/9 – 10/7/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	**1**	**60**	**0.017**	**0**	**60**	**0**	**-0.017**
Minor Edits (changes of less than 5 knots and 10 degrees or less)	**0**	**60**	**0**	**0**	**60**	**0**	**0**
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	**1**	**60**	**0.017**	**0**	**60**	**0**	**-0.017**
Major Edits (changes of more than 10 knots or more than 50 degrees)	**0**	**60**	**0**	**0**	**60**	**0**	**0**

Site: KSGF	425NWS (5/28 – 7/26/2017)			WMT702 (8/2 – 10/1/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	**0**	**60**	**0**	**0**	**60**	**0**	**0**
Minor Edits (changes of less than 5 knots and 10 degrees or less)	**0**	**60**	**0**	**0**	**60**	**0**	**0**
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	**0**	**60**	**0**	**0**	**60**	**0**	**0**
Major Edits (changes of more than 10 knots or more than 50 degrees)	**0**	**60**	**0**	**0**	**60**	**0**	**0**

Site: KFTW	425NWS (5/28 – 7/26/2017)			WMT702 (8/25 – 10/23/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	**0**	**60**	**0**	**1**	**60**	**0.017**	**+0.017**
Minor Edits (changes of less than 5 knots and 10 degrees or less)	**0**	**60**	**0**	**0**	**60**	**0**	**0**
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	**0**	**60**	**0**	**1**	**60**	**0.017**	**+0.017**
Major Edits (changes of more than 10 knots or more than 50 degrees)	**0**	**60**	**0**	**0**	**60**	**0**	**0**

Site: KTUS	425NWS (5/28 – 7/26/2017)			WMT702 (8/25 – 10/18/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	**12**	**60**	**0.2**	**7**	**60**	**0.117**	**-0.083**
Minor Edits (changes of less than 5 knots and 10 degrees or less)	**4**	**60**	**0.07**	**4**	**60**	**0.07**	**0**
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	**8**	**60**	**0.13**	**3**	**60**	**0.05**	**-0.080**
Major Edits (changes of more than 10 knots or more than 50 degrees)	**0**	**60**	**0**	**0**	**60**	**0**	**0**

Site: KBOI	425NWS (5/28 – 7/26/2017)			WMT702 (8/9 – 10/7/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	1	60	0.017	1	60	0.017	0
Minor Edits (changes of less than 5 knots and 10 degrees or less)	1	60	0.017	1	60	0.017	0
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	0	60	0	0	60	0	0
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	60	0	0	60	0	0

Site: KGTF	425NWS (5/28 – 7/26/2017)			WMT702 (8/12 – 10/10/2017)			Comparison
	Total Number	Days Evaluated	Number per day	Total Number	Days Evaluated	Number per day	[WMT702 per day] – [425NWS per day]
Wind Edits	0	60	0	13	60	0.217	+0.217
Minor Edits (changes of less than 5 knots and 10 degrees or less)	0	60	0	7	60	0.117	+0.117
Moderate Edits (changes of 5 to 10 knots or 20 to 50 degrees)	0	60	0	4	60	0.067	+0.067
Major Edits (changes of more than 10 knots or more than 50 degrees)	0	60	0	2	60	0.033	+0.033