OPERATIONAL TEST AND EVALUATION (OT&E) FINAL REPORT

For

Automated Surface Observing System (ASOS) CL31 Ceilometer Replacement

And

ASOS Acquisition Control Unit Version 2.79Y with **Data Collection Platform V2.0 Erasable Programmable Read Only Memory**

September 2010

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service/Office of Operational Systems
Field Systems Operations Center/Test and Evaluation Branch

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WFO TBA – D. Sobien

Executive Summary

This test report contains the test and evaluation results from the Operational Test & Evaluation (OT&E) for the Vaisala replacement ceilometer (CL31) on the Automated Surface Observing System (ASOS) using the Acquisition Control Unit (ACU) Version (V) 2.79Y and Data Collection Platform (DCP) V2.0. The report includes the test objectives and criteria, Test Trouble Reports (TTRs), test results, and recommendations.

The OT&E started on January 27, 2010. The OT&E was performed at 41 ASOS sites representing a diverse set of ASOS hardware configurations and ASOS regions. Full test data collection at 41 sites ended on May 04, 2010. System Maintenance Logs (SYSLOG) continued being collected until August 17, 2010, at four sites to monitor the sensor response timeout behavior at these sites (LCH, TPA, TUS, and RKP).

During the OT&E the CL31 ceilometer was configured as the operational sensor at 38 sites. At FAI (Fairbanks, AK), the existing CT12K ceilometer was used as Official sensor and the CL31 the Test sensor. At ITO (Hilo, HI), AMA (Armarillo, TX), and at NWSTC (Kansas City, MO) the CT12K was available as Test sensor. Attachment 1 lists all the sites participants. Data from the 6 U.S. Navy ASOS sites and one NWS site, Williston (ISN), ND were also collected since June 2010 to provide additional data to support the MCE2a study. In this study the ASOS outputs were compared to Observer Editing. Attachment 2 lists these ASOS sites. An additional 30 FAA-sponsored sites will be used in the MCE2b study in which inter-comparisons at dual sited locations and EDITLOG evaluations at single sensor sites will be performed. The purpose of the studies was to validate that there will be no degradation of service with the implementation of the CL31 and V2.79Y.

All TTR's found during OT&E were adjudicated and resolved.

The OT&E successfully concluded on August 17, 2010. The voting of the TRG members on whether to move to resume national deployment of the CL31 with V2.79Y ASOS ACU firmware will not be conducted until the completion of the MCE2a and MCE2b studies.

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Acronyms

ACU	Acquisition Control Unit
AOMC	ASOS Operations Monitoring Center
ASOS	Automated Surface Observing System
ATRB	ASOS Test Review Board
CL31	Vaisala CL31 Replacement Ceilometer
CT12K	Current Vaisala 12K Ceilometer
DCP	Data Collection Platform
FAA	Federal Aviation Administration
Mod Notes	NWS Engineering Modification Notes
NCAR	National Center for Atmospheric Research
NOAA	National Oceanic and Atmospheric Administration
NRC	National Reconditioning Center
NWS	National Weather Service
NWSTC	National Weather Service Training Center
OT&E	Operational Test and Evaluation
OOS	Office of Operational Systems
OPS24	Office of Operational Systems, Test & Evaluation Branch
OST	Office of Science and Technology
PROM	Programmable Read Only Memory (chips)
SCA	Single Cabinet Assembly
SFSC	Sterling Field Support Center
SPAWARSYSCEN	U.S. Navy Space and Naval Warfare Systems Center
SRT	Sensor Response Timeout
ST	System Test
TRG	Test Review Group
TTR	Test Trouble Report
USAF	United States Air Force
WFO	Weather Forecast Office
WSH	National Weather Service Headquarters

1.0 Introduction

This test report contains the test and evaluation results from Operational Test & Evaluation (OT&E) for the Vaisala replacement ceilometer (CL31) on the Automated Surface Observing System (ASOS) using the Acquisition Control Unit (ACU) V2.79Y and Data Collection Platform (DCP) V2.0 Boot PROM.

The software version 2.79Y is based on the V2.79X (03/23/09) and contains a fix for a critical error found in V2.79X. Briefly, the error occurs when the CL31 ceilometer detects multiple cloud layers, the ASOS algorithm processes the highest layer that is passed to it when it should process the lowest layer (OTR#1093). As a result only the highest cloud layer is reported. This was corrected in software version 2.79Y and was successfully checked out at the WSH and at SFSC prior to being operationally tested at 41 selected sites (Attachment 1).

The OT&E started on January 27, 2010, and concluded on August 17, 2010. Weekly Test Review Group (TRG) meetings were held via teleconference with the TRG members during the OT&E, and the detailed minutes and other supporting documentation from each TRG meeting were recorded and are available on the OPS24 website:

http://www.nws.noaa.gov/ops2/ops24/documents/asos_ceilometer.htm

2.0 Purpose

The purpose of the OT&E was to confirm the validity of the fix for OTR#1093 in operational use at selected ASOS locations, and to ensure the ASOS system stability is maintained and the existing ASOS functions are not negatively affected by the new changes.

3.0 OT&E Objectives

The OT&E objectives were to validate:

1. The ACU software bug (OTR#1093), which only processes and passes the highest cloud layer, has been fixed.

2. The ASOS ACU V2.79Y firmware does not negatively affect ASOS operational systems.

3. After a successful OT&E, the software will be recommended for operational use when resuming the CL31 deployment at the OT&E wrap-up meeting.

The MCE2a and MCE2b test objectives are to validate:

1. The CL31 and 2.79Y software are meeting service requirements for aviation, weather and water forecasting, and general information about the state of cloud ceilings.

2. Data are representative of meteorological/cloud conditions.

4.0 OT&E Accomplishments

The OT&E was conducted as planned. OT&E objectives 1 and 2 were met. Test objective 3 will depend on the outcomes of the MCE2a & MCE2b studies. The results demonstrated that the ACU software bug, which only processed and passed the highest cloud layer, was successfully fixed in V2.79Y (See MCE2a & MCE2b Report) and that the V2.79Y did not negatively affect ASOS operational systems.

4.1 OT&E Test Conduct

The test software version 2.79Y was installed at 41 sites (40 operational sites and one test site at the NWSTC). These sites were proposed by the weather service regions to represent a variety of hardware configurations and climatic regions. The OT&E started in January 27, 2010 and officially ended on August 17, 2010 to allow for adequate data collection and analysis. ASOS system maintenance logs (SYSLOG) and other pertinent logs were collected and analyzed.

In parallel with the OT&E a second meteorological comparison evaluation study (MCE2a & MCE2b) was conducted between the CL31, CT12K and human observer to validate that there would be no degradation of service with the implementation of the CL31 and V2.79Y. The purpose of the Meteorological Comparison Evaluation is to assess the functional comparability of the ASOS algorithm output from the CL31 and CT12K ceilometers in weather conditions critical for aviation and weather forecasting as compared to the human observer. The NWS wants to ensure the replacement CL31 produces ASOS algorithm-generated cloud reports that are meteorologically representative. The MCE2a & MCE2b data is being collected from ISN (Williston, ND), 6 US-Navy and Marine Corp sites (Attachment2), and 30 FAA-sponsored sites. Results of the MCE2a & MCE2b are presented in a separate report.

4.2 Test Trouble Reports

Three Test Trouble Reports (TTRs) were generated during OT&E and adjudicated in the following way before the end of the OT&E:

4.2.1. False Ceilings being reported at EET (Alabaster, AL)

On April 6, 2010, under clear skies (see 1602Z satellite picture), the ASOS at Alabaster, AL (located in central Alabama, about 30 miles south of Birmingham) reported false ceilings (see below METARs) for two consecutive hours. This is one day after false ceilings were reported for approximately 5 hours on the afternoon of 4/5/10 (Attachment 3). The incorrect reporting was

probably due to excessive pollens at the sensor or the sensor itself was faulty.

-The Electronics Technician at the site used one of the three complete units there awaiting installation to swap out the existing unit. After this, the meteorologists thought the sky reports have been accurate. It was also noted that the amount of pollens was not as heavy as during the previous week. The original unit was returned to NRC for testing.

- Don Zabel of NRC tested the whole unit with a Termination Hood installed. It ran 3 days with out reporting any clouds, as designed.

4.2.2 Incorrect calculation of site elevation (TTR#246)

This problem is about the V2.79Y reporting unrepresentative cloud heights based on the real CL31 input values observed at SFSC. Subsequently Hak Kim (NWS/OPS23) found out that the ASOS version V2.79Y (began with version 2.79S) is not updating the difference between ceilometer elevation and field elevation for the CL31 sensor when the CL31 sensor elevation is changed. It waits until one of the following actions to update the difference: cold start, AOMC download, deconfigure and reconfigure the CL31 sensor, or field elevation change in site physical page. In other words, if a technician changes the CL31 sensor elevation alone or later than the field elevation, the difference value is not computed and algorithm uses the old difference value. However CT-12K sensor does not have the same problem. A Test Trouble Report (TTR#246) was written for this problem and it will be changed to an Operational Trouble Report (OTR).

- There is a workaround with two means of implementation. One, the AOMC manually performed the specific steps (provided by Hak Kim), to have the ASOS software recognize any changes in the CL31 sensor elevation. Chris Stark reported the AOMC has completed this procedure for all the sites with CL31. Two, the ASOS maintenance Branch (OPS12) would issue a Maintenance Note directing the local electronics technician perform these same steps when and if the CL31 elevation is changed due to sensor relocation. A permanent fix will be provided in software load V3.05.

4.2.3 Erroneous Layers Stabilization (OTR#1099)

Several sites observed discrepancy between ASOS and human Ceiling Balloon observation on the “one-minute SKY data” during MCE2 activity. A software bug was found in the Sky stabilization algorithm. This bug can cause the ASOS observation to be off up to 199ft. This bug has existed in many software loads prior to V2.79Y. This problem is related to a similar problem found and documented in a Request for Change (RC) in 2002 (WSH Tracking Number AA713). This RC fix will be implemented in V3.05 and will correct this OTR as well.

4.2.4 ACU Firmware Crash (OTR#1096)

An ACU firmware problem that causes inadvertent warm starts if a command sequence is added at the ACU UPS screen or the DCP UPS screen was found. That is, unintentionally entering the command sequence “Zero” “Zero” then “BACK” at the ACU UPS screen will cause the system to warm start. Unintentionally entering the command sequence “Zero” “Zero” then “BACK” and then

"EXIT" at the DCP UPS screen will also cause the system to warm start.

This problem affects all sites with a UPS installed in the ACU and use software loads 2.79D to 2.79Y. This problem will be fixed in a future revision of the ACU software. Currently there is ASOS Maintenance Note #87 to advise the field technicians not to type the above command sequences.

4.2.5 CL31 Sensor Response Timeouts

Description of the Issue

An issue that came up during the OT&E of the ACU V2.79Y software is the significant occurrences of sensor response timeouts (SRT) of the CL31 at selected sites. This has been a long standing problem and was reported in the previous OT&E in 2009 (TTR#216). These sensor response timeout errors will generate a maintenance flag ($). This maintenance flag if generated unnecessarily (i.e., no missing of erroneous data) will cause additional work load for the AOMC and/or field technicians to clear the $. This SRT issue was again discussed at the ACM on June 15, 2010. It was agreed that a plan needs to be written and executed to resolve the SRT issue at the "problem" sites. The plan will be written in accordance with coordinated direction from the ACM members. The goal of the plan is to reduce the number of unnecessary "$" to a minimum.

It was recommended in the 2009 OT&E report that the NWS (NRC, OST31, OPS12, and OPS23) would conduct a follow on action plan to investigate this problem. OPS24 has put together a team to investigate this problem with the first meeting held on April 21, 2010 at the WSH to discuss ways to address the problem and develop a plan to mitigate the issue.

Analysis of the Problem

OPS24 has performed extensive data analysis from the data collected during the current OT&E (Appendix 1). The SRTs were divided into two categories:

1) "Random" SRTs for which there is no obvious causes and
2) "Deterministic" SRTs due to known causes such as power failures, DCP resets, etc.

For comparison, results from the baseline data collected in 2009 are also presented. At that time the selected sites were using V2.79D and the CT12K ceilometer; CL31 was not used. Because of the differences in the selected sites and the number or operational days in the two data sets, the results were **normalized per site per day**. The data set from the current OT&E consists of 3285 operational days from 38 sites, from 01/28/2010 to 04/28/2010. The baseline data set consisted of 1524 operational days from 21 sites from 02/18/2009/ to 05/07/2009.

The results show that with respect to random SRTs, the normalized average per site per day for the current V2.79Y and CL31 is similar to that of the V2.79D and CT12K that occurred before. The CL31 actually seems to do better than the CT12K (0.092 SRTs per site per day vs. 0.195).

The results also show that the "deterministic" SRTs will occur when there are ACU/DCP Communications (Comm) failures, DCP Reset, or power outages. During these events, data will be missing from all affected sensors. Depending on the duration of these events, automated OBS can be missing as well. The "random" SRTs generally generate a single missing data point and will not materially affect the availability of the OBS.

Options Offered

Several options were proposed during the ACM meetings as follows:

1. Find an optimal configuration for the DCP/Comm/ACU to mitigate unnecessary maintenance flags ($).

2. Change the sensor baud rate for the CL31 ceilometer from 9600 to 2400 to stabilize the ACU to DCP communications. Select one of the OT&E sites which exhibit mostly CL31 sensor response timeout only and keep everything intact but replace the CL31 with CT-12K (with baud rate of 2400) to study the baud rate sensitivity to sensor response timeout error.

3. Generate "$" based on Data Quality Errors rather than Sensor Response Timeout. This option will require a software change in the ASO ACU.

4. On-site debugging: John Monte's suggestion is to package a laptop computer with the Prism+ software development environment and the ASOS Version 2.79Y software along with whatever emulation capability is required to debug DCP firmware, and send this equipment to one of the sites experiencing the CL31 sensor response timeouts frequently along with whatever software engineering staff and Prism Communications staff deem would be necessary to debug the problem in the field exactly as was done to resolve the ADAS problem experienced at Vero Beach. At the same time, a temporary patch could be made to the ACU firmware to set the CL31 serial baud rate to 2400 baud in order to assess the efficacy of this change.

5. Dave Eckberg (SAIC) proposed setting up the ASOS Sensor Simulator (ASENSE) computer out at the RF linked DCP and use the computer to simulate the sensors on the DCP suite. Basically, we would disconnect the existing DCP sensor suite from the DCP SIO DB9 connectors and place the simulated sensor data computer in direct communication with the DCP thus testing the ACU/DCP RF link processing of the ASOS system for any data drop out or data corruption issues.

Resolution of the Sensor Response Timeout Problem

Based on the results from the four worst sites (LCH, RKP, TPA, TUS) which exhibited both a high number of random SRTs and deterministic Comm failures, it was recommended a special team with expertise in Comm issues be sent to one or more of these sites to diagnose the deterministic Comm problem being experienced at these sites (Option 4, above). The problem with the "random" SRT can be minimized or mitigated as proposed in Option 3.

However, the field technicians took the initiative to investigate the Comm issues themselves. As a result, the number of Comm failures and SRTs at these sites have been significantly reduced.

There has not been any ACU/DCP Comm failure or SRT from TPA since 06/23/10, after the site has replaced the Motorola radios having frequency of 410.950MHz with the Motorola radios having frequency of 410.075MHz.

There has not been any ACU/DCP COMMS failure or SRT from TUS since 06/14/10, after the site technician (Terry Bohannon) did a lot of troubleshooting on the ASOS comms problem and ended up replacing many parts, including the DCP power relays, and also switched to the Yagi style antennas.

There have been infrequent ACU/DCP Comm failures and SRTs at LCH, after the site technician changed the PHASE I RADIO to PHASE II RADIO in the REVUE/CONFIG/DEFIN field on 07/15/10. Other actions by the technicians might not have been recorded.

There have been infrequent ACU/DCP Comm failures and SRTs at RKP since 07/01/10.

Scott Birch (WRH) requested PHX (Phoenix, AZ) to be added to the list of OTE sites on 06/30/10 because this site, using V2.79Y and CL31, also exhibited many SRTs. There have been infrequent ACU/DCP comm failures and SRTs since the technician at PHX changed the antenna location at the DCP and an antenna type at the ACU (OMNI to Directional with Horizontal polarization) on 07/21/10.

4.3 Lessons Learned

During the OT&E there were a few "lessons learned" that are summarized here:

- Improvement to the design of datasets so that problems in the ASOS algorithm can be found early on during Factory Acceptance Test and System Test.
- As was demonstrated at TPA, TUS, LCH, and PHX, proper configuration and maintenance of the hardware must be performed prior to installation of a new ACU software load. This way it will be easier to ascertain the performance of the new software.

5.0 Conclusions and Recommendations

The OTR#1093 was successfully fixed and the V2.79Y has been stable and operational at 38 sites since the beginning of February. No new critical problem was found at any of these sites. If the results of the MCE2a & MCE2b Study indicate that the ASOS cloud reports are meteorologically representative then it is recommended this V2.79Y software be used to resume the CL31 deployment and to replace V2.79X at the sites which currently use it.

A major concern was the presence of many SRTs at a few sites such as TPA, TUS, LCH, and PHX. However, these sites also have had many ACU/DCP Comm failures prior to the deployment of V2.79Y. After the ACU/DCP Comm was improved at these sites, the SRTs were vastly reduced. The WRH has replaced all the radio omni-directional antennae to horizontally-polarized antennae at their sites and recommended that any site which suffers ACU/DCP Comm failures should try this approach.

ATTACHMENT 1 - List of OT&E Sites

Regions	**Site names**	**V2.79Y Installation Dates**	**Notes**
Eastern	CMH - Columbus, OH	01/28/10	
Eastern	BTV – South Burlington, VT	01/29/10	
Eastern	ROA – Roanoke, VA	01/27/10	
Eastern	LYH – Lynchburg, VA	02/01/10	
Eastern	EWN – New Bern, NC	01/28/10	
Eastern	CAR – Caribou, ME	01/27/10	
Eastern	BLF – Bluefield, WV	02/01/10	
Western	VNY – Van Nuys, CA	02/03/10	
Western	DVT – Phoenix, AZ	01/28/10	
Western	SDL – Scottsdale, AZ	02/02/10	
Western	TUS – Tucson, AZ	02/02/10	
Western	OKB – Oceanside, CA	01/27/10	
Western	DAG – Daggett, CA	01/27/10	
Western	SAD – Safford, AZ	01/29/10	
Western	HIO – Portland, OR	01/28/10	
Western	PHX – Phoenix, AZ	06/30/10	
Central	JKL – Jackson, KY	01/28/10	
Central	BIS – Bismarck, ND	01/27/10	
Central	CYS – Cheyenne, WY	01/29/10	
Central	ISN – Williston, ND	03/08/10	
Pacific	ITO – Hilo, HI	01/27/10	CL31 Official, CT-12K Test
Pacific	KOA – Kailua-Kona, HI	01/27/10	
Southern	TPA – Tampa, FL	01/28/10	
Southern	TUL – Tulsa, OK	02/01/10	
Southern	FMY – Ft. Meyers, FL	01/27/10	
Southern	LCH – Lake Charles, LA	01/27/10	
Southern	EET – Alabaster, Al	01/27/10	
Southern	BVO – Bartlesville, OK	01/27/10	
Southern	BGD – Borger, TX	01/27/10	
Southern	CNM – Carlsbad, NM	01/27/10	
Southern	COT – Cotulla, TX	01/28/10	

Southern	GOK – Guthrie, OK	02/01/10	
Southern	RKP – Rockport, TX	01/29/10	
Southern	CKV – Clarksville, TN	01/28/10	
Southern	AMA – Amarillo, TX	01/27/10	CL31 Official, CT-12K Test
Southern	MLB – Melbourne, FL	01/28/10	
Southern	DHT – Dalhart, TX	02/13/10	
Southern	GUY – Guymon, OK	03/01/10	
Southern	FST – Fort Stockton, TX	06/11/10	
Alaska	FAI – FairBanks , AK	03/18/10	**CT-12K Official**, CL31 Test
NWSTC	NWSTC – Kansas City, MO	03/17/10	CL31 Official, CT-12K Test

ATTACHMENT 2 - List of US-Navy and Marine Corp MCE2a Sites

Using V2.79D and CT12K as Official Ceilometer, CL31 as Stand-alone test sensors

ASOS Locations	**Site names**	**Notes**
NAS Norfolk, VA	KNGU	
NAS Jacksonville, FL	KNIP	
NAS North Island	KNZY	
NAS Whidbey Island	KNUW	
MCAS Cherry Point	KNKT	
	KNIS	
MCAS Miramar	KNKX	

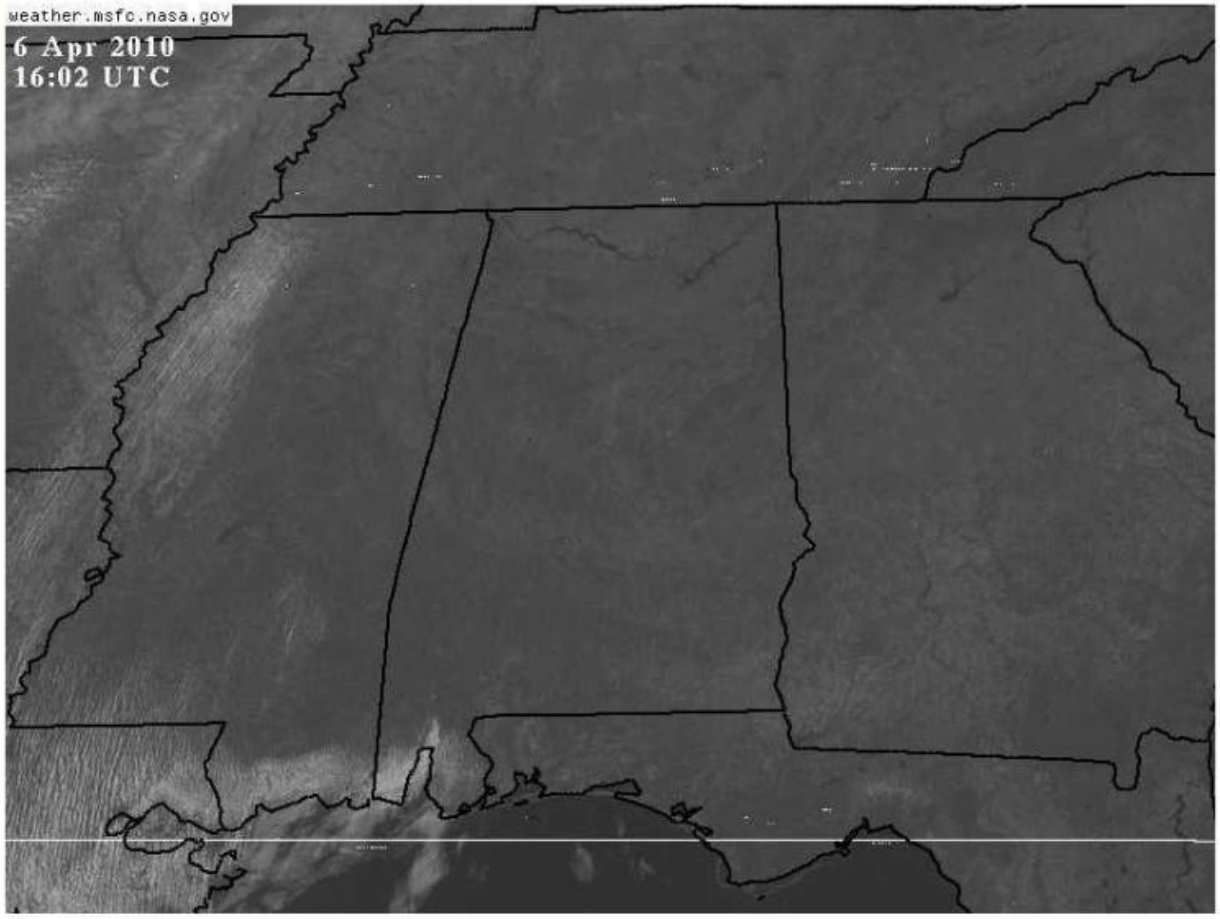
ATTACHMENT 3 - CL31 TROUBLE TICKET
FALSE CEILINGS BEING REPORTED at ALABASTER, AL

(Courtesy Victor Murphy, SRH)

This morning, under clear skies (see 1602Z satellite picture), the ASOS at Alabaster, AL (located in central Alabama, about 30 miles south of Birmingham) reported false ceilings (see below METARs) for two consecutive hours. This is one day after false ceilings were reported for approximately 5 hours on the afternoon of 4/5/10 (see below METARs underneath the satellite pictures). The site is running the V2.79Y software with the CL31.

At the suggestion of John Monte of NWSH, a new measuring unit was ordered today. Until this arrives, the report processing for the ceilometers will be disabled.

METAR KEET 061453Z AUTO 18008KT 9SM 23/13 A3012 RMK AO2 SLP194 T02280128
SPECI KEET 061521Z AUTO 21009KT 10SM **BKN018** 23/12 A3012 RMK AO2
METAR KEET 061553Z AUTO 19008KT 10SM **OVC022** 25/12 A3011 RMK AO2 SLP191 T02500122



04/05/10 13:53:26 METAR KEET 051953Z AUTO 18009G14KT 150V220 10SM **OVC031** 29/09 A3016 RMK AO2 SLP207 T02890089

04/05/10 14:53:26 METAR KEET 052053Z AUTO 00000KT 10SM **BKN037** 29/07 A3014 RMK AO2 SLP201 T02940067 56024

04/05/10 15:53:26 METAR KEET 052153Z AUTO 20008KT 10SM **SCT037** 29/05 A3013 RMK AO2 SLP197 T02890050

04/05/10 16:53:26 METAR KEET 052253Z AUTO 21006KT 10SM **BKN037** 28/07 A3012 RMK AO2 SLP194 T02830067

04/05/10 17:53:26 METAR KEET 052353Z AUTO 20003KT 10SM **OVC033** 27/07 A3012 RMK AO2 SLP194 T02670072 10300 20256 56008

ATTACHMENT 4 - TRG and ATRB members

TRG Members

Name/Organization	Function	Vote
Khien Nguyen (W/OPS24)	Test Review Group Chair	
Khien Nguyen (W/OPS24)	Test Director	
Greg Dalyai (W/OPS12)	Maintenance Branch	
Bing Huang (ATO-T)	FAA Focal Point	
Tim Rutkoswki (W/ER41)	Eastern Region ASOS Focal Point	
Lewis Harrington (W/SR41)	Southern Region ASOS Focal Point	
Bob Brashears (W/CR43)	Central Region ASOS Focal Point	
Son Nguyen (W/WR4)	Western Region ASOS Focal Point	
Angel Corona (W/AR4)	Alaska Region ASOS Focal Point	
John Bush (W/PR1)	Pacific Region ASOS Focal Point	
Christopher Kornkven (WFO MKE)	NWS Employee Organization Focal Point	
Kevin Conaty (W/CIO12)	AOMC	
Jim McNitt (W/OPS22)	ISSO (ASOS)	

ATRB Members

Name/Organization	Function	Vote
Jae Lee (W/OPS24)	ATRB Chair/Primary	
Joseph Fiore (W/OPS24)	DOC/NWS Secretariat/Alternate Chair/Primary	
Khien Nguyen (W/OPS24)	DOC/NWS Secretariat Alternate	
Dave Mannarano (W/OPS22)	DOC Primary	

Tom Townsend (W/CR1)	DOC Alternate	
Bing Huang (FAA- ATO-T)	FAA Primary	
Tuyen Kieu (FAA–ATO-W)	FAA Alternate	
William Lawrence (USAF contractor HQ AFWA/A8PA)	USAF Primary	
Todd Allen (USAF YE-3)	USAF Alternate	
Gerald “Wayne” Knight (SPAWARSYSCEN)	US Navy Primary	
Ronald Heatherdale (SPAWARSYSCEN)	US Navy Alternate	
Roy Rasmussen (NCAR)	NCAR Primary	
Scott Landolt (NCAR)	NCAR Alternate	

APPENDIX 1

ASOS SENSOR RESPONSE TIMEOUT(SRT) ANALYSIS

Description of the Issue

An issue that came up during the OT&E of the ACU V2.79Y software is the significant occurrences of sensor response timeouts (SRT) of the CL31 at selected sites. This has been a long standing problem and was reported in the previous OT&E in 2009 (TTR#216). These sensor response timeout errors will generate a maintenance flag ($). This maintenance flag if generated unnecessarily (i.e., no missing of erroneous data) will cause additional work load for the AOMC and/or field technicians to clear the $. This SRT issue was again discussed at the ACM on June 15, 2010. It was agreed that a plan needs to be written and executed to resolve the SRT issue at the "problem" sites. The plan will be written in accordance with coordinated direction from the ACM members. The goal of the plan is to reduce the number of unnecessary "$" to a minimum.

It was recommended in the 2009 OT&E report that the NWS (NRC, OST31, OPS12, and OPS23) would conduct a follow on action plan to investigate this problem. OPS24 has put together a team to investigate this problem with the first meeting held on April 21, 2010 at the WSH to discuss ways to address the problem and develop a plan to mitigate the issue.

Analysis of the Problem

OPS24 has performed extensive data analysis from the data collected during the current OT&E. The results are presented in this report. For comparison, results from the baseline data collected in 2009 are also presented. At that time the selected sites were using V2.79D and the CT12K ceilometer; CL31 was not used. Because of the differences in the selected sites and the number or operational days in the two data sets, the results were **normalized per site per day**. The data set from the current OT&E consists of 3285 operational days from 38 sites, from 01/28/2010 to 04/28/2010. The baseline data set consisted of 1524 operational days from 21 sites from 02/18/2009/ to 05/07/2009.

Results of the analysis are tabulated in the attached tables. SRTs were divided into two categories:

3) "Random" SRTs for which there is no obvious causes and
4) "Deterministic" SRTs due to known causes such as power failures, DCP resets, etc.

Data Analysis of Random SRTs

Table 1 presents the summary results for the "Random" SRTs only*. **The overall results show that with respect to random SRTs, the normalized average per site per day for the current V2.79Y and CL31 (Col. C) is similar to that of the V2.79D and CT12K (Col. E) that occurred before.** The CL31 actually seems to do better than the CT12K (0.092 SRTs per site per day vs. 0.195).

Note 1: Averaged Occurrences (per site per day) of 38 Sites during the current 2010 OT&E in a total of 3285 operational days (from 01/28/2010 to 04/28/2010) (See column C)

Note 2: Averaged Occurrences (per site per day) of 21 baseline sites prior to 2009 OT&E in a total of 1524 operational days (from 02/18/2009 to 05/07/2009) (See column E)

Table 1 – SUMMARY RESULTS – Random SRTs

A	B	C	D	E
SENSORS / SYSTEMS	ACU V2.79Y Total SRT Occurrences	**ACU V2.79Y Normalized Averaged** (See **Note 1**)	ACU V2.79D Total SRT Occurrences	**ACU V2.79D Normalized Averaged** (See **Note 2**)
CEILOMETERS	303	**0.092**	297	**0.195**
VISIBILITY	173	**0.053**	74	**0.049**
WIND	159	**0.048**	42	**0.027**
LEDWI	74	**0.022**	51	**0.034**
TEMP/DEW	54	**0.016**	32	**0.021**
HO83	16	**0.005**	12	**0.008**
DTS1	58	**0.018**	19	**0.012**
AWPAG	210	**0.064**	100	**0.066**
THUNDERSTORM	0	**0**	3	**0.002**
OVERALL		**0.318**		**0.414**

* Note, these results do not include Deterministic SRTs.

Note 3: See Table 2 for detail site specific breakdown for random STRs.

Table 2 presents the results for only the "Random" SRTs from the OT&E data set (38 sites in 2010, using V2.79Y and CL31 Ceilometers). Four sites (LCH, RKP, TPA, TUS) exhibited unusually high numbers of SRTs compared with the rest. Among these four sites, TPA and TUS also exhibited high number of deterministic COMM Failure instances (See Table 4).
* Note the remarkable decreasing of STRs for these sites (BIS, CAR, GUY) using CL31 and V2.79Y (See Table 3).

Table 2 – RANDOM SRTs from Current OT&E Data

	Number of random SRT Occurrences								
Sites	**CL31**	**VIS**	**WIND**	**LEDWI**	**TD**	**HO83**	**DTS1**	**AWP-PAG**	**TS**
AMA	16	8	3	1	0	0	1	1	0
BGD	5	12	7	6	3	3	5	0	0
BIS*	0	4	1	2	0	4	9	2	0
BLF	0	3	3	1	1	0	0	4	0
BVO	2	5	4	2	0	3	4	0	0
CAR*	1	1	1	1	0	0	0	79	0
CKV	0	1	0	0	0	0	0	0	0
CMH	1	13	1	1	2	0	0	3	0
CNM	1	3	3	1	1	0	1	0	0
COT	0	0	0	10	1	0	0	0	0
CYS	0	2	12	1	1	0	0	31	0
DAG	1	11	0	1	1	0	2	0	0
DHT	0	6	4	1	2	0	0	0	0
DVT	2	2	3	0	1	0	0	0	0
EET	4	3	2	3	1	0	0	0	0
EWN	2	0	6	0	0	0	0	0	0
FAI	0	0	0	0	13	0	9	26	0

FMY	8	2	0	0	7	4	4	0	0
GOK	3	6	0	1	3	0	1	0	0
GUY*	0	1	4	5	1	0	0	1	0
HIO	1	3	0	1	0	0	0	0	0
ISN	3	8	0	2	0	0	1	3	0
ITO	1	0	0	0	3	0	5	5	0
JKL	2	3	1	1	0	0	0	0	0
KOA	0	0	0	0	0	0	0	0	0
LCH	**83**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**
LYH	0	0	0	0	0	0	0	2	0
MLB	0	5	3	2	0	0	1	0	0
NWSTC	0	10	0	0	1	0	0	0	0
OKB	0	21	1	1	2	0	1	0	0
RKP	**59**	**0**	**0**	**3**	**0**	**0**	**1**	**0**	**0**
ROA	2	3	0	1	0	0	0	4	0
SAD	0	5	0	0	0	0	0	0	0
SDL	0	0	5	1	1	0	0	0	0
TPA	**49**	**10**	**1**	**0**	**2**	**0**	**1**	**8**	**0**
TUL	0	14	4	3	0	1	1	2	0
TUS	**57**	**5**	**88**	**12**	**7**	**0**	**11**	**39**	**0**
VNY	0	3	2	1	0	1	0	0	0
Total	**303**	**173**	**159**	**74**	**54**	**16**	**58**	**210**	**0**

Table 3 presents the results for only the "Random" SRTs from the baseline data set (21 sites in 2009, using V2.79D and CT-12K ceilometers). ANJ exhibited a very high number of SRT at the time, using CT12K. Now with CL31 installed it has not exhibited any SRT for several months.

Table 3 – RANDOM SRTs from Baseline Data

	Number of random SRT Occurrences								
Sites	CT-12K	VIS	WIND	LEDWI	TD	HO83	DTS1	AWP-PAG	TS
ABR	3	6	1	4	0	1	0	9	0
ANJ	**126**	**1**	**1**	**7**	**0**	**4**	**4**	**8**	**0**
BIS*	**24**	**0**	**1**	**2**	**0**	**1**	**2**	**18**	**0**
BTV	0	0	1	2	0	0	1	3	0
CAR*	**14**	**2**	**0**	**2**	**0**	**0**	**0**	**2**	**2**
CMA	2	2	1	7	5	0	6	1	0
CMH	3	16	1	7	3	0	0	9	0
CYS	7	1	4	0	0	0	0	16	0
DDC	**27**	**3**	**2**	**3**	**15**	**0**	**1**	**2**	**0**
FAI	3	22	3	1	2	0	1	0	0
GDP	1	0	8	1	1	0	0	1	0
GEG	6	2	1	1	0	0	0	1	0
GUY*	**73**	**0**	**1**	**9**	**0**	**0**	**0**	**2**	**0**
HIO	1	5	1	1	0	0	0	0	0
ITO	0	0	4	0	6	0	0	16	0
JKL	1	3	1	1	0	0	0	0	0
NBC	0	0	2	0	0	0	3	0	1
OKC	0	6	1	2	0	1	0	3	0
OXR	2	2	1	1	0	1	1	0	0
PHX	0	0	0	0	0	0	0	9	0

ROA	4	3	7	1	0	4	0	0	0
Total	**297**	**74**	**42**	**52**	**32**	**12**	**19**	**100**	**3**

* Note the remarkable decreasing of STRs for these sites (BIS, CAR, GUY) using CL31 and V2.79Y (See Table 2).

Data Analyses of Deterministic Results

Table 4 presents the results for the "Deterministic" SRTs only from the OT&E data set (38 sites in 2010). It does not contain "Random" STRs. These STRs happened right after the occurrence of an ACU/DCP Comm failure, a DCP reset, or an ACU warm-start. Thus, these SRTs are thought to be related to these events.

Table 4 – DETERMINISTIC SRTs from Current OT&E Data

	Number of deterministic SRT Occurrences											
Sites	**CL31**	**VIS**	**WIND**	**LED-WI**	**TD**	**HO83**	**DTS1**	**AWP-PAG**	**TS**	**DCP Resets**	**WARM Starts**	**COMM Failures**
AMA	0	0	0	0	0	0	0	0	0	0	2	
BGD	5	5	5	5	5	0	5	0	0	6	5	2
BIS	0	0	0	1	0	1	1	0	0	1	0	1
BLF	1	1	1	1	1	0	0	1	1	1	0	1
BVO	1	1	1	1	0	0	1	0	0	1	3	0
CAR	3	3	3	3	3	0	3	3	0	4	3	4
CKV	2	2	2	2	2	0	2	0	0	2	0	0
CMH	7	7	3	3	3	0	3	3	0	6	2	7
CNM	3	3	3	3	3	0	3	0	0	2	6	3
COT	0	0	0	0	0	0	0	0	0	0	15	0
CYS	2	2	2	2	2	0	2	2	0	2	6	3
DAG	3	3	3	3	3	0	3	0	0	3	35	3
DHT	2	2	1	2	1	0	2	0	0	3	1	3
DVT	2	1	0	1	0	0	1	0	0	1	0	6
EET	4	4	4	4	4	0	4	0	0	4	1	0
EWN	0	0	0	0	0	0	0	0	0	1	1	1
FAI	0	2	2	2	2	0	2	2	0	4	4	2
FMY	2	2	2	2	0	2	2	2	0	4	3	3
GOK	4	4	3	4	3	0	4	0	0	4	4	0
GUY	0	0	0	5	0	0	0	0	0	0	4	1
HIO	1	1	1	1	0	1	1	0	0	1	2	1
ISN	0	1	0	1	1	0	1	0	0	0	3	0
ITO	0	0	0	0	0	0	0	0	0	0	1	0
JKL	1	1	1	1	1	0	1	1	0	1	0	1
KOA	14	15	14	15	14	0	15	0	0	12	1	16
LCH	**6**	**6**	**6**	**6**	**6**	**0**	**6**	**6**	**0**	**6**	**1**	**9**
LYH	0	0	0	0	0	0	0	0	0	0	0	0
MLB	0	0	0	0	0	2	0	0	0	0	0	4
NWSTC	0	0	0	0	0	0	0	0	0	0	0	0
OKB	1	1	1	1	1	0	1	0	0	1	1	0
RKP	**2**	**2**	**1**	**2**	**1**	**0**	**2**	**0**	**0**	**2**	**5**	**0**
ROA	2	1	0	1	0	2	1	0	0	1	3	0
SAD	2	2	2	2	2	0	2	0	0	2	2	0
SDL	0	0	0	0	0	0	0	0	0	0	0	0
TPA	**72**	**74**	**47**	**48**	**47**	**0**	**48**	**49**	**0**	**77**	**13**	**94**
TUL	2	2	2	2	0	2	2	2	0	2	3	2

TUS	**27**	**18**	**19**	**21**	**19**	**0**	**17**	**16**	**0**	**21**	**5**	**31**
VNY	2	2	2	2	0	2	2	0	0	2	0	2
Total	**173**	**168**	**131**	**147**	**124**	**12**	**137**	**87**	**1**	**177**	**135**	**200**

Table 5 presents all "deterministic" SRTs from TPA during COMM Failures. Normally during these events, when a comms failure occurs, a DCP reset will follow, causing sensor response timeout for all sensors. Additional details are provided in the Appendix 1-A concerning comms issues

Table 5 – DETERMINISTIC SRTs from TPA

* Note: Only DCP2 reset occurred

ANALYSIS OF SRTs DUE TO COMM FAILURES AT TPA
WITH CL31 CEILOMETER INSTALLED
From 01/28/2010 to 04/28/2010

Using ACU Software V2.79Y

	CL31	VIS	WIND	LEDWI	TEMP/ DEW	DTS1	PRECIP ACCUM	DCP RESET	WARM START	COMM FAILED
TPA012910	1	1	1	1	1	1	1	1		1
TPA013010	1	1	1	1	1	1	1	1		1
TPA013110	1	1	1	1	1	1	1	1		1
TPA020110	1	1	1	1	1	1	1	1		1
TPA020310	1	1	1	1	1	1	1	1		1
TPA020410	1	1	1	1	1	1	1	1		1
TPA020510	1	1	1	1	1	1	1	1		1
TPA020710	3	3	3	3	3	3	3	3		3
TPA020810	1	1	1	1	1	1	1	1		3
TPA020910										1
TPA021010										2
TPA021110										1
TPA021310	3	3	3	3	3	3	3	4		4
TPA021410	3	3	3	3	3	3	3	3		4
TPA021510		1	1	1	1	1	1	1		1
TPA021610										1
TPA021710	2	2	2	2	2	2	2	2		2
TPA021810	1	1	1	1	1	1	1	1		1
TPA021910	1	1	1	1	1	1	1		1	1
TPA022010	3	3	3	3	3	3	3	3	1	4
TPA022110	2	2	2	2	2	2	2	3		3
TPA022210	3	3	3	3	3	3	3	4		6
TPA022410	4	4	4	4	4	4	4	5	5	5
TPA022510	2	2	2	2	2	2	2	2		3
TPA022610	3	3	3	3	3	3	3	3	2	3
TPA022710	1	1	1	1	1	1	1	1		1
TPA022810										1
TPA030110	2	2	2	2	2	2	2	2		3
TPA030310	2	2					2	3	2	3

TPA030410	2	1	1	1	1	1	1	2		2
TPA030510	1	2						1		1
TPA030910	1	2						1		1
TPA031010	2	2	2	2	2	2	2	2		2
TPA031110										
TPA031210										
TPA031510	1	1						1*		1
TPA031610	1	1						1*		1
TPA031710	2	2						2*		2
TPA032010	1	1						1*		1
TPA032110										
TPA032210	2	2						2*		
TPA032510	1	1						1*		1
TPA032710	2	2						2*		4
TPA032810	1	1						1*		1
TPA032910										
TPA033010	1	1								1
TPA033110	2	2						2*		2
TPA040110	2	2	1	1	1	1	1	2		2
TPA040210	1	1						1*		1
TPA040310	1	1						1*		1
TPA040410	1	1						1*		1
TPA040510										1
TPA041010	2	2						2*		2
TPA041210										
TPA041410	2	2	1	1	1	1	1	2	1	2
TPA041710				1		1		1		1
TPA041810									1	
TPA041910										
TPA042110										
TPA042210										
TPA042610										
TPA042610										
TPA042810										
Total	**72**	**74**	**47**	**48**	**47**	**48**	**49**	**77**	**13**	**94**

Assessment of the Results

The results show that the "deterministic" SRTs will occur when there are COMM failures or power outages. During these events, data will be missing from all affected sensors. Depending on the duration of these events, automated OBS can be missing as well. The "random" SRTs generally generate a single missing data point and will not materially affect the availability of the OBS.

Options Offered

Several options were proposed during the meetings as follows:

1. Find an optimal configuration for the DCP/Comm/ACU to mitigate unnecessary maintenance flags ($).

2. Change the sensor baud rate for the CL31 ceilometer from 9600 to 2400 to stabilize the ACU to DCP communications. Select one of the OT&E sites which exhibit mostly CL31 sensor response timeout only and keep everything intact but replace the CL31 with CT-12K (with baud rate of 2400) to study the baud rate sensitivity to

sensor response timeout error.

3. Generate "$" based on Data Quality Errors rather than Sensor Response Timeout. This option will require a software change in the ASO ACU.

4. On-site debugging: John Monte's suggestion is to package a laptop computer with the Prism+ software development environment and the ASOS Version 2.79Y software along with whatever emulation capability is required to debug DCP firmware, and send this equipment to one of the sites experiencing the CL31 sensor response timeouts frequently along with whatever software engineering staff and Prism Communications staff deem would be necessary to debug the problem in the field exactly as was done to resolve the ADAS problem experienced at Vero Beach. At the same time, a temporary patch could be made to the ACU firmware to set the CL31 serial baud rate to 2400 baud in order to assess the efficacy of this change.

5. Dave Eckberg (SAIC) proposed setting up the ASOS Sensor Simulator (ASENSE) computer out at the RF linked DCP and use the computer to simulate the sensors on the DCP suite. Basically, we would disconnect the existing DCP sensor suite from the DCP SIO DB9 connectors and place the simulated sensor data computer in direct communication with the DCP thus testing the ACU/DCP RF link processing of the ASOS system for any data drop out or data corruption issues.

RECOMMENDATIONS

Based on the results from the four worst sites (LCH, RKP, TPA, TUS) which exhibited both a high number of random SRTs and deterministic COMM failures, it is recommended a special team with expertise in COMM issues be sent to one or more of these sites to diagnose the deterministic COMM problem being experienced at these sites (Option 4, above). The problem with the "random" SRT can be minimized or mitigated as proposed in Option 3.

Appendix 1-A

Table A-1 – EXAMPLE OF DATA STREAM DURING COMM FAILURES

This table presents a snapshot of the data stream for CL31 during a comm. failure. Normally during these events, a comm. failure will generate SRTs for affected sensors. If a DCP reset occurs, data from all affected sensors will be temporarily missing. If there are enough missing data, the OBSs will be missing for affected sensors also.

EXAMPLE OF CL31 DATA SRTEAM DURING ACU/DCP COMMS FAILURES	
From TPA (Tampa, FL) on 04/14/10	
1432; P1 03010 ///// ///// 0000 0000 C020; P0 ///// ///// ///// 0000 0000 C020	
1433; P0 ///// ///// ///// 0000 0000 8020; P0 ///// ///// ///// 0000 0000 8020	
1434; P0 ///// ///// ///// 0000 0000 8020; P0 ///// ///// ///// 0000 0000 8020	**ACU/DCP COMMS FAILED**
1435; P0 ///// ///// ///// 0000 0000 8020; M	
1436; M; M	**Causes Missing(M) CL31 data**
1437; M; M	**and other sensors data**
1438; M; M	
1439; M; M	**Leads to Missing OBS**
1440; M; M	Required Observer Augmentation (See Table A-2 below)

1441; M; M	
1442; M; M	
1443; M; M	
1444; M; M	
1445; M; M	
1446; M; M	
1447; M; M	
1448; M; M	
1449; M; M	
1450; M; M	
1451; M; M	
1452; M; M	
1453; M; M	
1454; M; M	
1455; M; M	
1456; M; M	
1457; M; M	
1458; M; M	
1459; M; M	
1500; M; M	
1501; M; M	
1502; M; M	
1503; M; M	
1504; M; M	
1505; M; M	
1506; M; M	
1507; M; M	
1508; M; M	
1509; M; M	
1510; M; M	
1511; M; M	
1512; M; M	
1513; M; M	
1514; M; M	
1515; M; M	
1516; M; M	
1517; M; M	
1518; M; M	
1519; M; M	
1520; M; M	
1521; M; M	
1522; M; M	
1523; M; M	
1524; M; M	
1525; M; M	
1526; M; M	DCP1 RESET TO BOOT PROM
1527; P0 ///// ///// ///// 0000 0000 0020; M	RADIO COMMS HARD FAILURE
1528; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	

1529; P0 ///// ///// ///// 0000 0000 0020; M	Intermittent Data Missing
1530; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	For CL31 and Other Sensors
1531; P0 ///// ///// ///// 0000 0000 0020; M	
1532; P0 ///// ///// ///// 0000 0000 0020; M	
1533; P0 ///// ///// ///// 0000 0000 0020; M	
1534; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	
1535; P0 ///// ///// ///// 0000 0000 0020; M	
1536; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	
1537; P0 ///// ///// ///// 0000 0000 0020; M	
1538; P0 ///// ///// ///// 0000 0000 0020; M	ACU WARMSTART
1539; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 C020	
1540; P1 04050 ///// ///// 0000 0000 C020; P1 03860 ///// ///// 0000 0000 C020	
1541; P1 04350 ///// ///// 0000 0000 C020; P1 03990 ///// ///// 0000 0000 C020	
1542; P1 04020 ///// ///// 0000 0000 C020; P1 04190 ///// ///// 0000 0000 C020	
1543; P1 04180 ///// ///// 0000 0000 C020; P1 04020 ///// ///// 0000 0000 8020	
1544; P1 03830 ///// ///// 0000 0000 8020; P1 03730 ///// ///// 0000 0000 8020	
1545; P1 03830 ///// ///// 0000 0000 8020; P1 03830 ///// ///// 0000 0000 8020	
1546; P1 03920 ///// ///// 0000 0000 0020; P1 03990 ///// ///// 0000 0000 0020	
1548; P1 04090 ///// ///// 0000 0000 0020; M	**Single Missing Data**
1549; P0 ///// ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	**will not lead to Missing OBS**
1550; P1 04280 ///// ///// 0000 0000 0020; P0 ///// ///// ///// 0000 0000 0020	
1551; P1 04250 ///// ///// 0000 0000 0020; P1 04220 ///// ///// 0000 0000 0020	

Table A-2 – EXAMPLE OF EDITLOG DURING COMM FAILURES
From TPA (Tampa, FL) on 04/14/10

Note: Time is Local (5 hours behind Zulu Time in Table A-1)

```
04/14/10 08:49:52 EDITED SKY PREV SCT130 BKN250 AUTO CLR NEW FEW150 BKN250
04/14/10 09:48:07 AUTO REM FOR PRECIP TURNED OFF
04/14/10 09:48:09 EDITED SKY PREV FEW150 BKN250 AUTO MM NEW SCT044 BKN250
04/14/10 09:49:40 EDITED WND AUTO M  /M EDIT 070/18G23
04/14/10 09:50:49 EDITED DEW AUTO MC/MF EDIT 15.6C/60F
04/14/10 10:43:48 EDITED SFC VIS AUTO M EDIT 10SM
04/14/10 10:47:07 RESET SKY AUTO MM EDIT SCT048 BKN250
04/14/10 10:50:58 EDITED SKY PREV SCT048 BKN250 AUTO MM NEW SCT044 BKN250
```