2010 National Atmospheric Deposition Program Site Survey Program Annual Report

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List of Acronyms and Abbreviations

ACM	Aerochem Metrics
AIRMoN	Atmospheric Integrated Research Monitoring Network
AMNet	Atmospheric Mercury Network
CAL	Central Analytical Laboratory
CASTNET	Clean Air Status and Trends Network
DVM	Digital multi-meters
DQI	Data Quality Indicator
EEMS	Environmental, Engineering & Measurement Services, Inc.
EPA	U.S. Environmental Protection Agency
FSSD	Field Site Survey Database
HAL	Hg (Mercury) Analytical Laboratory
MDN	Mercury Deposition Network
NADP	National Atmospheric Deposition Program
NIST	National Institute of Standards and Technology
NOS	Network Operations Subcommittee
NTN	National Trends Network
PDA	Personal Digital Assistant
PO	Program Office
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QR	quality rating
SOP	Standard Operating Procedures
WAAS	Wide Area Augmentation System

Executive Summary

Under US EPA contract number EPW-07061, Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations, Environmental, Engineering & Measurement Services, Inc. (EEMS) has initiated an independent evaluation and assessment site survey program for the purpose of maintaining the quality assurance of the networks of the National Atmospheric Deposition Program (NADP). The NADP is a cooperative, multi-agency organization, which measures precipitation chemistry and estimates atmospheric wet deposition for various pollutant ions and mercury. The four inter-related NADP networks are, the National Trends Network (NTN), the Atmospheric Integrated Research Monitoring Network (AIRMoN), the Mercury Deposition Network (MDN), and the Atmospheric Mercury Network (AMNet). The AMNet was approved and accepted into the NADP in October of 2009 and surveys of those sites have not been performed yet. EPA has provided long-standing support for the operation of NADP including operational support for four US Forest Service monitoring sites, and recurring funding for the chemical analysis and coordination for several wet deposition sites, in addition to the support for the survey and quality assurance programs of the NADP atmospheric deposition networks.

To understand the impact of emissions reductions on the environment, scientists and policy makers use data collected from long-term national monitoring networks such as the Clean Air Status and Trends Network (CASTNET) and the NADP to quantify changes in pollutant deposition. These networks are complementary in many ways and provide information on a variety of indicators necessary for tracking temporal and spatial trends in regional air quality and atmospheric deposition.

Work performed under this contract includes the survey of sites associated with the NADP. Site surveys include:

- Evaluation of site operator proficiency and technique.
- Reinforcement of NADP protocols and training.
- Maintenance, evaluation, and quality assurance assessment of site instruments.
- Updates to the graphical representation of the site instruments with respect to each other and the site surroundings.

Site surveys afford the necessary checks and balances for site operations and serve to independently validate data provided by the sites in the network.

The results of those surveys performed during the reporting period are presented in this report.

1.0 Introduction / Background

The National Atmospheric Deposition Program (NADP) Site Survey Program is an independent and unbiased Quality Assurance (QA) program of systems and performance surveys to assess and document the conditions and operations of the collective sites of the NADP. The conditions and operations pertain to the siting, sample collection and handling, equipment operation and maintenance, recordkeeping, reports, and field laboratory procedures.

Ongoing QA programs are an essential part of, and add credence to, any long-term monitoring network. The external evaluations provided by this program verify, and support, the established procedures and criteria of the NADP and its networks, and ensure they are maintained. The site survey program provides a higher level of confidence in the data reported by the NADP.

Quality assurance and quality control (QC) activities for these networks improve overall data quality and ensure field measurements remain accurate and precise. Stringent QA and QC are essential for obtaining unbiased and representative atmospheric deposition measurements and for maintaining the integrity of the sample during collection, handling, and analysis. These activities strengthen the reliability and overall quality of the data the agency uses for policy decisions and for measures of accountability.

Essentially, NADP site surveys are accomplished by visiting each site, observing the site operator while performing the routine site activities, providing technical and training support, checking the operation of the site instrumentation, performing routine repairs and maintenance, and reporting the results. More details of the activities are provided in the following key tasks.

1. Scheduling sites to be surveyed. This task is coordinated with the EPA Project Officer, the NADP Program Office, network liaisons, site operators, supervisors, and sponsors. Approximately 90 NADP sites (co-located are not considered separated sites) are scheduled for surveys during each contract period. The schedule is developed based on the elapsed time since the previous site survey (longest time between visits first), inclusion of sites that have not been surveyed, and consideration for efficient and cost effective travel.

2. Preparing for field site surveys. During survey preparation, available site data are compiled and reviewed creating the site file. The necessary materials and standards for each site survey are checked and shipped if necessary. The site operators scheduled for surveys are contacted to finalize the survey arrangements.

3. Performing site surveys. During each site survey a comprehensive qualitative and quantitative assessment is performed. The site assessment consists of:

- Verifying site contact information.
- Verifying the NADP collector location using a WAAS GPS.
- Qualitatively evaluating the site regarding the current NADP siting criteria that can be found at http://nadp.isws.illinois.edu/.
- Qualitatively assessing the site surroundings regarding obstructions which could impact data collection and quality. Documenting the site surroundings with at least 8 digital photographs taken in the cardinal directions of N, NE, E, SE, S, SW, W, and NW. The photographs should be taken within 5 -10 meters of the NADP collector with the direction referenced.
- Qualitatively assessing the instruments and equipment with regard to function, maintenance, and condition. Documenting equipment malfunctions and signs of wear on the survey forms and with photographs as necessary.
- Qualitatively evaluating the site personnel regarding the methods and procedures used for sample handling, field analytical analysis (AIRMoN), calibrations, cleaning, maintenance, recordkeeping, reporting, and material storage. Reviewing on-site documentation (raingage charts, logs, forms) for legibility, accuracy and completeness. Confirming that the current versions of NADP manuals/documentation are present.
- Quantitatively assessing the accuracy of the NADP instrumentation responses to QA standards. These include standard weights for raingage tests and mass determinations, and analytical standards for pH and conductivity meter and cell tests (AIRMoN sites only).
- Verifying, or creating the site plan view. (The site plan view identifies all equipment and major features within a 30 meter radius.)
- Recording all data on the hard copy forms provided in the site file. Printing additional forms from the database if required in order to record all data. Comparing the observations to the pre-populated values, verifying and correcting any discrepancies, and confirming with the site personnel as needed.

4. Performing minor repairs, maintenance, adjustments, and guidance. With the consent of the site personnel and the approval of the appropriate liaison
    - Perform any necessary minor repair, maintenance, adjustment, and calibration to restore proper function in accordance with the Network Operations Subcommittee (NOS) procedures. These tasks can include leveling and stabilizing the instrument, and correcting the orientation. Record all actions on the appropriate survey form.
    - Provide technical assistance, instruction, and training regarding the maintenance of the site and equipment, sample collection and handling, and site operation procedures, consistent with the NADP Quality Assurance Project Plan (QAPP), and SOP specific to the network.

5. Transferring observations from survey forms to survey database. Enter the survey information obtained in the steps above into the survey database and review for significant differences using the automated verification feature, and entry/exit rules.

6. Conducting an exit interview with the site personnel. This task includes the preparation and delivery of an exit/spot report summarizing any equipment deficiencies or failures, survey results, activities, adjustments, and any aspects that are, or could potentially affect data quality. The report is provided to the site operator, supervisor, NADP QA Manager, and the EPA Project Officer. The report is then included in the site file with the appropriate document control number.

7. Providing a Site Performance Survey Report, with the survey data set. The final site survey data set is considered to be the final site survey report. The data set is delivered to the NADP QA Manager and the EPA Project Officer each month and contains data obtained during site surveys conducted the previous month. The data set for each site consists of:
    - Survey results that have been subjected to duplicate entry and internal QA review.
    - Edited and scanned site plan view (or site sketch).
    - Digital photographs.
    - Scanned raingage chart.
    - Any additional pertinent supporting information.

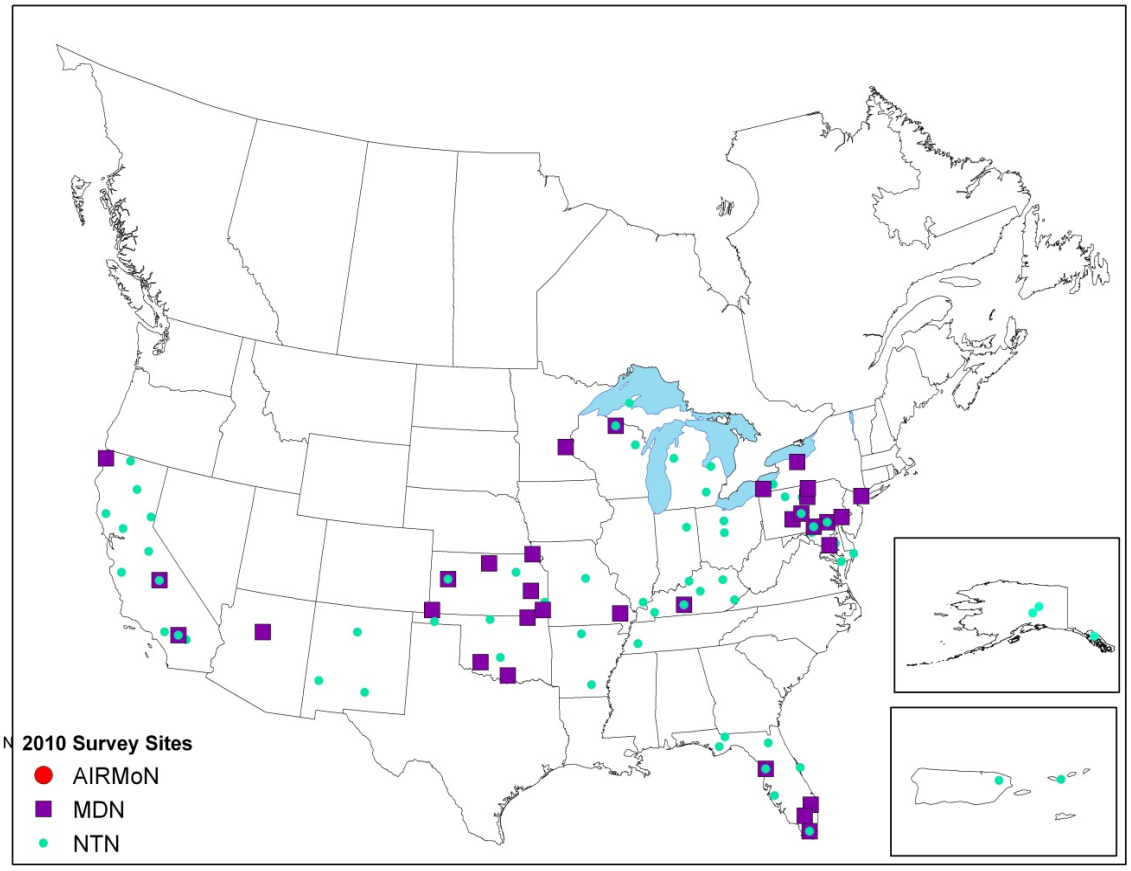
2.0 Status of Sites Surveyed

2.1 Sites Surveyed

This annual report includes site surveys performed from January through December of 2010. This annual report covers portions of two contract periods which begin and end in June of each year.

A total of 95 NADP sites (this number includes co-located sites) were surveyed during the period covered by this report at 85 distinct locations. These include 32 MDN sites, 63 NTN sites. Figure 2-1 is a map of the locations of the sites visited during 2010. Table 2-1 is a list of the sites surveyed and includes the network, site name, survey date, and equipment found.

Figure 2-1 Site Survey Locations in 2010



Source – NADP Program Office

2.2 General Status of Sites Surveyed

Overall the sites surveyed during the reporting period were found in good condition and collecting data that meet NADP quality objectives. Of the 85 precipitation gages surveyed (co-located sites use the same gage), 47 were Belfort mechanical raingages. Due to the age of the Belfort gages, most were found to have some operational issues. Most problems were minor and were corrected during the site survey. Survey data continues to indicate that the gages require attention and it is likely that the mechanical gages have reached, or in some cases exceeded, their useful life-expectancy. Replacing Belfort gages with electronic gages has led to improved network operation. Altogether 38 electronic gages were surveyed[1], with only a few minor problems observed with those gages. One of the electronic gages (KY03) was not challenged with calibration weights because communication with the datalogger could not be established. This problem is discussed in further detail in Section 5.0 of this report.

Of the 95 sites surveyed (collectors), 12 sites operated N-CON collectors. The 83 other collectors were AerocChem Metrics (ACM) type and manufactured by either AeroChem Metrics or Loda Electronics Company.

Forty-eight sites visited operate various types of backup gages. The site survey only takes into account the siting criteria of the backup gage and not the performance of the gage itself.

The qualitative evaluation of the site personnel with respect to their ability to follow NADP protocols and operate the site instrumentation, found the overwhelming majority of them to be capable, knowledgeable, and committed to maintaining quality throughout the sample and data collection process. They demonstrated both enthusiasm and conscientiousness concerning the operation of their sites by their willingness to receive instruction from the survey team regarding improvements to their sample handling technique and equipment maintenance.

However operators at three sites, PA30-MDN, AK01-NTN, and KY03-NTN were in need of additional instruction with regard to sample handling technique. Training and instructions were provided during the surveys at those sites.

Specific survey findings that impact, or could impact data quality, are discussed in Section 3.0.

2.3 Equipment Encountered During the Site Surveys

The list of sites surveyed during 2010 and the equipment found at the sites is shown in Table 2.1.

[1] CA99 has two electronic gages, the primary which was challenged and the backup which was not.

Table 2-1. Sites Surveyed from January through December 2010 and Equipment Found at the Sites

Site ID	Site Name	Network	Survey Date	Collector Type	Raingage Type	Backup Raingage Type
AK01	Poker Creek	NTN	6/7/2010	ACM-type	Electronic	N/A
AK02	Juneau	NTN	6/10/2010	ACM-type	Electronic	N/A
AK03	Denali National Park-Mt. McKinley	NTN	6/7/2010	ACM-type	Electronic	Belfort
AR02	Warren 2WSW	NTN	9/27/2010	ACM-type	Belfort	N/A
AR16	Buffalo National River-Buffalo Point	NTN	9/28/2010	ACM-type	Electronic	N/A
AZ02	Sycamore Canyon	MDN	4/27/2010	ACM-type	Belfort	N/A
CA20	Yurok Tribe-Requa	MDN	5/17/2010	ACM-type	Belfort	N/A
CA42	Tanbark Flat	NTN	5/11/2010	ACM-type	Belfort	Tipping Bucket
CA45	Hopland	NTN	5/14/2010	ACM-type	Belfort	N/A
CA50	Sagehen Creek	NTN	5/19/2010	ACM-type	Belfort	Other
CA66	Pinnacles National Monument-Bear Valley	NTN	5/25/2010	ACM-type	Belfort	Tipping Bucket
CA67	Joshua Tree National Park-Black Rock	NTN	5/6/2010	ACM-type	Electronic	Tipping Bucket
CA75	Sequoia National Park-Giant Forest	MDN/NTN	5/24/2010	ACM-type	Electronic	Belfort
CA76	Montague	NTN	5/18/2010	ACM-type	Belfort	N/A
CA88	Davis	NTN	5/19/2010	ACM-type	Belfort	Tipping Bucket
CA94	Converse Flats	MDN/NTN	5/8/2010	ACM-type	Electronic	Tipping Bucket
CA96	Lassen Volcanic National Park-Manzanita Lake	NTN	5/18/2010	ACM-type	Electronic	N/A
CA99	Yosemite National Park-Hodgdon Meadow	NTN	5/20/2010	ACM-type	Electronic	Ott
FL03	Bradford Forest	NTN	1/22/2010	ACM-type	Belfort	Stick
FL05	Chassahowitzka National Wildlife Refuge	MDN/NTN	1/25/2010	ACM-type	Belfort	Belfort

Table 2-1. Sites Surveyed from January through December 2010 and Equipment Found at the Sites (continued)

Site ID	Site Name	Network	Survey Date	Collector Type	Raingage Type	Backup Raingage Type
FL11	Everglades National Park-Research Center	MDN/NTN	2/9/2010	ACM-type	Electronic	Tipping Bucket
FL14	Quincy	NTN	1/28/2010	ACM-type	Belfort	Stick
FL23	Sumatra	NTN	2/22/2010	ACM-type	Electronic	Tipping Bucket
FL34	Everglades Nutrient Removal Project	MDN	2/2/2010	ACM-type	Belfort	Other
FL41	Verna Well Field	NTN	1/26/2010	ACM-type	Belfort	Stick
FL97	Everglades-Western Broward County	MDN	2/2/2010	ACM-type	Belfort	Other
FL99	Kennedy Space Center	NTN	1/27/2010	ACM-type	Belfort	N/A
IL63	Dixon Springs Agricultural Center	NTN	4/13/2010	ACM-type	Belfort	N/A
IN20	Roush Lake	NTN	7/15/2010	ACM-type	Belfort	Stick
KS03	Reserve	MDN	10/21/2010	N-CON	Electronic	Tipping Bucket
KS04	West Mineral	MDN	10/18/2010	N-CON	Electronic	N/A
KS05	Coffey County Lake	MDN	10/18/2010	N-CON	Electronic	N/A
KS07	Farlington Fish Hatchery	NTN	10/18/2010	ACM-type	Belfort	Stick
KS24	Glen Elder State Park	MDN	10/19/2010	N-CON	Electronic	N/A
KS31	Konza Prairie	NTN	10/20/2010	ACM-type	Electronic	Belfort
KS32	Lake Scott State Park	MDN/NTN	7/16/2010	N-CON	Belfort	Stick
KS99	Cimarron Nat. Grassland	MDN	7/26/2010	N-CON	Electronic	N/A
KY03	Mackville	NTN	4/26/2010	ACM-type	Electronic	Tipping Bucket
KY10	Mammoth Cave National Park-Houchin Meadow	MDN/NTN	4/27/2010	ACM-type	Electronic	Belfort
KY19	Seneca Park	NTN	6/2/2010	ACM-type	Belfort	N/A

Table 2-1. Sites Surveyed from January through December 2010 and Equipment Found at the Sites (continued)

Site ID	Site Name	Network	Survey Date	Collector Type	Raingage Type	Backup Raingage Type
KY22	Lilley Cornett Woods	NTN	5/10/2010	ACM-type	Belfort	N/A
KY35	Clark State Fish Hatchery	NTN	4/26/2010	ACM-type	Belfort	N/A
KY99	Mulberry Flat	NTN	4/28/2010	ACM-type	Electronic	N/A
MD00	Smithsonian Environmental Research Center	MDN	10/26/2010	ACM-type	Electronic	Tipping Bucket
MD07	Catoctin Mountain Park	NTN	10/18/2010	ACM-type	Belfort	N/A
MD13	UM Wye Center	NTN	3/31/2010	ACM-type	Electronic	Belfort
MD15	Smith Island	NTN	4/9/2010	ACM-type	Belfort	Other
MD18	Assateague Island National Seashore-Woodcock	NTN	3/31/2010	ACM-type	Electronic	Tipping Bucket
MI51	Unionville	NTN	7/8/2010	ACM-type	Electronic	Tipping Bucket
MI52	Ann Arbor	NTN	7/20/2010	ACM-type	Electronic	Tipping Bucket
MI53	Wellston	NTN	7/12/2010	ACM-type	Electronic	Stick
MI99	Chassell	NTN	8/3/2010	ACM-type	Belfort	Other
MN98	Blaine	MDN	8/4/2010	ACM-type	Electronic	N/A
MO03	Ashland Wildlife Area	NTN	4/13/2010	ACM-type	Belfort	N/A
MO05	University Forest	NTN	4/15/2010	ACM-type	Belfort	N/A
MO46	Mingo National Wildlife Refuge	MDN	4/14/2010	ACM-type	Belfort	N/A
NM01	Gila Cliff Dwellings National Monument	NTN	8/26/2010	ACM-type	Belfort	N/A
NM07	Bandelier National Monument	NTN	8/27/2010	ACM-type	Belfort	N/A
NM08	Mayhill	NTN	8/24/2010	ACM-type	Belfort	N/A
NY06	Bronx	MDN	10/19/2010	N-CON	Electronic	N/A

Table 2-1. Sites Surveyed from January through December 2010 and Equipment Found at the Sites (continued)

Site ID	Site Name	Network	Survey Date	Collector Type	Raingage Type	Backup Raingage Type
NY10	Chautauqua	NTN	10/12/2010	ACM-type	Belfort	N/A
NY43	Rochester	MDN	11/2/2010	N-CON	Electronic	Tipping Bucket
OH15	Lykens	NTN	7/17/2010	ACM-type	Electronic	Tipping Bucket
OH17	Delaware	NTN	5/9/2010	ACM-type	Electronic	N/A
OK00	Salt Plains National Wildlife Refuge	NTN	9/2/2010	ACM-type	Belfort	N/A
OK04	Lake Murray	MDN	8/31/2010	N-CON	Electronic	N/A
OK06	Wichita Mountains NWR	MDN	8/31/2010	N-CON	Electronic	N/A
OK17	Kessler Farm Field Laboratory	NTN	9/2/2010	ACM-type	Belfort	N/A
OK29	Goodwell Research Station	NTN	8/30/2010	ACM-type	Belfort	Tipping Bucket
OK31	Copan	MDN	9/1/2010	N-CON	Electronic	N/A
PA00	Arendtsville	MDN/NTN	11/19/2010	ACM-type	Electronic	Tipping Bucket
PA13	Allegheny Portage Railroad National Historic Site	MDN	7/19/2010	ACM-type	Belfort	Stick
PA18	Young Woman's Creek	NTN	7/27/2010	ACM-type	Belfort	Stick
PA29	Kane Experimental Forest	NTN	10/11/2010	ACM-type	Electronic	Tipping Bucket
PA30	Erie	MDN	10/13/2010	ACM-type	Belfort	Stick
PA42	Leading Ridge	MDN/NTN	11/22/2010	ACM-type	Belfort	Stick
PA47	Millersville	MDN/NTN	7/27/2010	ACM-type	Belfort	Stick
PA52	Little Pine State Park	MDN	7/20/2010	N-CON	Belfort	Stick
PA60	Valley Forge	MDN	7/18/2010	ACM-type	Belfort	Stick
PA90	Hills Creek State Park	MDN	7/20/2010	ACM-type	Belfort	Stick

Table 2-1. Sites Surveyed from January through December 2010 and Equipment Found at the Sites (continued)

Site ID	Site Name	Network	Survey Date	Collector Type	Raingage Type	Backup Raingage Type
PR20	El Verde	NTN	2/26/2010	ACM-type	Belfort	Tipping Bucket
TN14	Hatchie National Wildlife Refuge	NTN	6/1/2010	ACM-type	Electronic	N/A
VI01	Virgin Islands National Park-Lind Point	NTN	3/2/2010	ACM-type	Electronic	Belfort
WI25	Suring	NTN	8/2/2010	ACM-type	Belfort	N/A
WI36	Trout Lake	MDN/NTN	8/2/2010	ACM-type	Belfort	Tipping Bucket

3.0 Specific Problems Encountered and Frequency

Each site survey consists of assessing, and entering into a database, information as it relates to NADP siting criteria, performance and condition of the equipment found (collector and primary gage), status of supplies, site operator's performance, and other general information relating to the site.

The questionnaire used during the performance survey of a typical NTN and MDN site (i.e., Belfort raingage, ACM-type collector and no backup raingage) contains 221 and 226 (not including memo fields) required entries, respectively (this includes 50 entry fields for the Belfort calibration and eight entry fields for the NTN scale challenge).

3.1 Findings Likely to Impact Data Quality

The assessments considered by EEMS to have the most impact on data quality can be categorized by four elements and are listed in terms of relative importance as:

- Sample handling
- Collector operation
- Compliance with siting criteria rules and guidelines, and
- Raingage performance.

Of the 95 sites included in this report, 44 collectors (28 NTN ACM-type, 5 MDN ACM-type, and 11 N-CON) were in accordance with all collector assessments, 13 Belfort gages, and 26 electronic gages were in accordance with all raingage assessments, and 14 sites (4 MDN and 10 NTN) conformed to all siting criteria rules and guidelines. With the exception of three sites (PA30, AK01, KY03) all sites were found to maintain sample media quality; however gloves were not consistently used by all operators. The proper protocol regarding glove use was stressed during the survey visits.

Of the 5 assessments concerning NTN collectors, one was found compliant at all 63 NTN sites. Of the 12 assessments regarding MDN collectors, 5 were found to be in conformity at the 20 sites with ACM-type collectors. Of the eight assessments regarding the N-CON collector, seven were found to be in conformity at the 12 sites with N-CON collectors.

Of the 24 siting criteria assessments found to most impact data quality, five were found to be in conformity at all NTN sites and two were found to be in conformity at all MDN sites. Of the 4 assessments for the electronic gage, two were found in conformity for all gages. As was the case during the previous reporting period, one assessment for Belfort gages (turn over) has the highest incidence of failures.

Appendix A contains the complete list of current survey assessments that EEMS considers could directly impact data quality. The remainder of this section and the following tables focus on the survey data that describes only the assessments that ***did not*** meet NADP criteria during this reporting period.

Tables 3-1 and 3-2 present the non-compliant survey data for the different networks and sites. EEMS cannot report with any level of confidence that siting or operation for the entire NADP has improved or declined during the period of site survey performance since this would require multiple visits for every site in the program. However, Table 3-1 does include a comparison of the results of each assessment conducted in 2010 to the results observed during the previous reporting period. As stated, the same sites were not visited so data presented cannot be interpreted as improvement or decline for the overall program, individual network, or site. This data is presented as general information and not to be used as an indication of trends.

However, if areas of operation are improved network or program wide, it would be expected that those improvements would be reflected within individual assessments. For example, if it was determined that the lid liners currently used throughout the networks were degrading sooner than the scheduled six month replacement interval and the PO revised the replacement protocol to be three months, then it would be expected that a corresponding positive change in lid liner condition would be observed regardless of the site visited.

Summarizing this information in the tables below also allows any high number of observed assessment failures to be quickly and easily identified.

Table 3-1. Percent of Non-compliant Findings - MDN

Siting and Performance Checks	Number of Assessments	Found Non-Compliant	Percent (%) Non-Compliant	Change from Previous Report
Sample Handling				
Is sampling media quality maintained?	32	1	3.1	+
Siting Criteria Assessments				
Is the orifice of the collector +/- .3 m of raingage (elevation)	32	6	18.8	-
30 degree rule for buildings met (raingage)	32	0	0.0	No change
No objects > 1 m height inside 5 m radius (raingage)	32	16	50.0	-
No fences > 1 m height inside 2 m radius (raingage)	32	5	15.6	-
No vegetation height > 0.6 m within 5 m radius (raingage)	32	5	15.6	-
Collector and sensor oriented properly	32	2	6.3	-
45 degree rule met (collector)	32	3	9.4	+
30 degree rule for trees met (collector)	32	11	34.4	-
30 degree rule for buildings met (collector)	32	0	0.0	No change

Table 3-1. Percent of Non-compliant Findings - MDN (continued)

Siting and Performance Checks	Number of Assessments	Found Non-Compliant	Percent (%) Non-Compliant	Change from Pervious Report
No objects > 1 m height within 5 m radius (collector)	32	16	50.0	-
No fences > 1 m height inside 5 m radius (collector)	32	7	21.9	-
No vegetation height > 0.6 m within 5 m radius (collector)	32	6	18.8	-
No treated lumber inside 5 m radius (collector)	32	3	9.4	-
No galvanized metal inside 5 m radius collector (MDN)	32	9	28.1	-
No pastures and ag. activity within 20 m radius	30	4	13.3	-
No herbicides and fertilizers used within 20 m radius	30	1	3.3	-
Roads meet NADP siting criteria	32	1	3.1	+
Waterways meet NADP siting criteria	32	1	3.1	-
Airports meet NADP siting criteria	32	1	3.1	-
Combustion sources meet NADP siting criteria (MDN only)	32	0	0.0	+
Parking lots and maintenance areas meet NADP siting criteria	32	1	3.1	+
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria	32	0	0.0	No change
Metalworking operations meet NADP siting criteria (MDN only)	32	0	0.0	No change
ACM-type Collector Assessments				
Dry side bucket is clean	19	1	5.3	+
Does lid seal properly	20	1	5.0	-
Lid liner in good condition	20	0	0.0	+
Fan in good condition	20	1	5.0	-
Cooling fan thermostat in good condition	20	0	0.0	No change
Heater in good condition	16	0	0.0	+
Heater thermostat in good condition	19	0	0.0	No change
Has flush wall filter mount been installed	20	5	25.0	-
Filter in good condition	15	1	6.7	-
Max / min thermometer within acceptable limits	20	2	10.0	-
ACM sensor operates properly	20	2	10.0	-
Motor-box operates within acceptable limits	20	0	0.0	+
N-CON Collector Assessments				
N-CON fan in good condition	12	0	0.0	No change
N-CON cooling fan thermostat in good condition	12	0	0.0	No change
N-CON heater in good condition	12	0	0.0	No change
N-CON heater thermostat in good condition	12	0	0.0	No change
N-CON max / min thermometer in acceptable limits	11	1	9.1	-
N-CON sensor respond to a 20-second mist of water	11	0	0.0	No change
N-CON lid seal in good condition	12	0	0.0	No change
N-CON lid liner in good condition	12	0	0.0	No change

Table 3-1. Percent of Non-compliant Findings - MDN (continued)

Siting and Performance Checks	Number of Assessments	Found Non-Compliant	Percent (%) Non-Compliant	Change from Pervious Report
Belfort Raingage Assessments				
Was the 'as found' turn over set properly *	15	12	80.0	+
Electronic Gage Assessments				
Raingage operates properly (electronic gage)	17	1	5.9	-
Does datalogger receive event signals form all collectors (electronic gage)	17	2	11.8	-
Does optical sensor respond to "blocking" of light beam (electronic gage)	17	0	0.0	No change
Does optical sensor respond to mist of water (electronic gage)	17	0	0.0	No change

Table 3-2. Percent of Non-compliant Findings - NTN

Siting and Performance Checks	Number of Assessments	Found Non-Compliant	Percent (%) Non-Compliant	Change from Pervious Report
Sample Handling				
Is sampling media quality maintained?	63	2	3.2	-
Siting Criteria Assessments				
Is the orifice of the collector +/- .3 m of raingage (elevation)	63	8	12.7	-
30 degree rule for buildings met (raingage)	63	0	0.0	No change
No objects > 1 m height inside 5 m radius (raingage)	63	18	28.6	-
No fences > 1 m height inside 2 m radius (raingage)	63	5	7.9	+
No vegetation height > 0.6 m within 5 m radius (raingage)	63	12	19.0	-
Collector and sensor oriented properly	63	3	4.8	-
45 degree rule met (collector)	63	10	15.9	-
30 degree rule for trees met (collector)	63	27	42.9	-
30 degree rule for buildings met (collector)	63	1	1.6	-
No objects > 1 m height within 5 m radius (collector)	63	19	30.2	-
No fences > 1 m height inside 5 m radius (collector)	63	4	6.3	+
No vegetation height > 0.6 m within 5 m radius (collector)	63	13	20.6	-
No treated lumber inside 5 m radius (collector)	63	3	4.8	+
No pastures and ag. activity within 20 m radius	63	3	4.8	+
No herbicides and fertilizers used within 20 m radius	63	5	7.9	-
Roads meet NADP siting criteria	63	0	0.0	+
Waterways meet NADP siting criteria	63	0	0.0	No change
Airports meet NADP siting criteria	63	0	0.0	No change
Animal operations meet NADP siting criteria (NTN and AIRMoN)	63	0	0.0	+
Parking lots and maintenance areas meet NADP siting criteria	63	3	4.8	-
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria	63	1	1.6	-

Table 3-2. Percent of Non-compliant Findings - NTN (continued)

Siting and Performance Checks	Number of Assessments	Found Non-Compliant	Percent (%) Non-Compliant	Change from Pervious Report
ACM-type Collector Assessments				
Dry side bucket is clean	63	10	15.9	+
Does lid seal properly	63	0	0.0	No change
Lid liner in good condition	63	1	1.6	+
ACM sensor operates properly	63	4	6.3	+
Motor-box operates within acceptable limits	63	3	4.8	-
Belfort Raingage Assessments				
Was the 'as found' turn over set properly	37	20	54.1	+
Electronic Gage Assessments				
Raingage operates properly (electronic gage)	24	0	0.0	+
Does datalogger receive event signals form all collectors (electronic gage)	23	2	8.7	-
Does optical sensor respond to "blocking" of light beam (electronic gage)	23	0	0.0	No change
Does optical sensor respond to mist of water (electronic gage)	24	0	0.0	No change

***** *The assessment with the highest percentage of failures is the Belfort gage turnover setting. In order to better understand the problems noted with the Belfort raingages some additional description of the gage is necessary. The gage is a dual-traverse mechanical weighing precipitation gage designed to measure the amount of precipitation which falls during a seven day period. The precipitation is captured through an eight inch opening and funneled into a bucket. The bucket rests on a mechanical scale that moves an ink pen as weight (precipitation) is added to the bucket. The pen trace is recorded on a paper chart attached to a rotating drum which completes one rotation during a seven day period. The chart is marked both vertically and horizontally so both time and precipitation can be determined from the pen trace.*

The bottom of the chart begins at zero precipitation and the top of the chart corresponds to six inches of precipitation. The dual-traverse gage is designed to measure from zero to twelve inches of precipitation. This is accomplished by the first, or upward traverse of the pen from zero to six inches, and then as additional weight is added to the bucket the pen "turns over" and begins a second or downward traverse from six to twelve inches of precipitation. Proper function of the gage requires that the pen moves within ± 0.10 inches of the distance corresponding to the weight of the precipitation amount and that it turns over at the top of the chart.

Tables 1 through 3 in Appendix B present EEMS's findings regarding the assessments of siting criteria, raingage and collector condition, and site operator proficiency (assessed as "sampling media quality maintained") which are considered to be the areas that may most impact data quality. As described in survey task #3, the assessment of site operator proficiency includes the qualitative evaluation of the site personnel regarding the methods and procedures used for sample handling, recordkeeping, reporting, equipment cleaning, maintenance, and material storage.

Additionally, on-site documentation (raingage charts, logs, forms) was also assessed for legibility, accuracy and completeness.

The data indicate that most of the non-compliant findings are related to objects within the 5 meter radius of the raingage and/or collector. The other most prevalent issues are the calibration and turn over adjustment of the Belfort gage.

Table 3-4 lists the sites surveyed that have seen changes since the last survey (i.e., to the question "No significant changes to local site conditions within 500 meters of the collector since previous survey" the response was "NO"). However, these changes may or may not have contributed to siting criteria compliance. The effects of the changes are captured in the current siting criteria results presented in the previous tables.

Table 3-3. Sites with Changes Since Last Survey (not including e-gage installation)

Station ID	Network
AK02	NTN
AR16	NTN
CA67	NTN
FL34	MDN
FL97	MDN

Station ID	Network
KS03	MDN
KS04	MDN
KS24	MDN
KS31	NTN

Station ID	Network
MI52	NTN
NY06	MDN
OH17	NTN
PA52	MDN

3.2 Survey Results for Sites with Second Survey Visits

A small set of sites (21) have been visited twice for surveys. EEMS does not consider this number of sites to be sufficient for trend analysis. Also since the survey visits were conducted at least two years apart, some issues found during the first survey visit may have been corrected and then reoccurred as an issue prior to the second visit. However, data are presented here as a general representation of the sites that attempted to improve items that were brought to the attention of the operators and supervisors during the first survey.

Identified items at about 13 sites were observed to have improved between survey visits. About the same number of sites were observed to have items identified to be acceptable during the first survey visit, and then were not acceptable at the time of the second visit. In a few cases the same site had both improved and worsened conditions.

Nearly all of the items observed that were either corrected or worsened were siting criteria issues. These included objects within 5 meters of the gage or collector, fences too near gages or collectors, trees and vegetation too tall near the gage or collector and orifice heights not within 0.3 meters for the collector and gage. Data indicate that in most cases at sites where it was possible; attempts were made to improve siting criteria issues. One site (NY10) made 6 corrections of issues reported after the first survey visit.

It is also important to note that all equipment operational problems that were reported following the first survey visit were corrected prior to the second visit. These items include sensors and motor-boxes not functioning properly, min/max thermometers not within acceptance limits, Belfort gage turnover adjustments, and dry-side bucket cleaning or replacement issues. As is expected some of these same items were found deficient during the second survey visit that were operating properly during the first visit.

In general review of data from repeat survey visits indicates that there is no noticeable change to site operation or data quality. The Program Office should consider some type of recognition for site operators and supervisors that make an effort to improve site conditions with respect to siting criteria.

3.3 Findings Related to the Wind Shield at Site Surveyed

Data provided by the NADP PO indicate that raingages located at elevations greater than 1000 meters are required to have a wind shield installed, as well as at sites where more than 20 percent of the annual precipitation is frozen. Table 3-5 presents the assessments of wind shields at the sites surveyed during the period covered by this annual report. Fourteen of the 23 sites identified as requiring windshields were found to have shields installed. This represents approximately 70% compliance and a significant improvement above the approximately 30% compliance that was observed during the previous reporting period.

Table 3-4. Status of Surveyed Sites Requiring Raingage Shields

Site ID	Network	Condition	Site ID	Network	Condition
AK02	NTN	Installed	MI99	NTN	Not Present
AR02	NTN	Not Present	MN98	MDN	Installed
AZ02	MDN	Not Present	NY06	MDN	Installed
CA50	NTN	Installed	NY43	MDN	Installed
CA75	MDN/NTN	Not Present	OH17	NTN	Not Present
CA76	NTN	Installed	OK04	MDN	Installed
CA96	NTN	Installed	OK06	MDN	Installed
CA99	NTN	Installed	OK31	MDN	Installed
KS24	MDN	Not Present	TN14	NTN	Not Present
KS99	MDN	Installed	WI25	NTN	Not Present
MI51	NTN	Installed	WI36	MDN/NTN	Not Present
MI53	NTN	Installed			

4.0 Field Site Survey Results

This section summarizes the quantifiable survey data relating to raingage accuracy tests and sensor heater performance.

4.1 Belfort Raingage Accuracy

Figure 4.1 presents the "as found" Belfort raingage accuracy results for 47 Belfort raingages encountered during the period covered by this report. At co-located sites the same gage measures precipitation data for more than one network (i.e. MDN and NTN). Data presented here represents precipitation data as a whole, and is not related to any one network of NADP.

Overall program-wide Belfort raingage accuracy was found to be very good with a slope of approximately 98% and a correlation of 0.9792. A relatively few number of sites were not performing well and are easily identifiable in Figure 4-1.

Figure 4-1. As Found Belfort Accuracy Results - 47 Gages

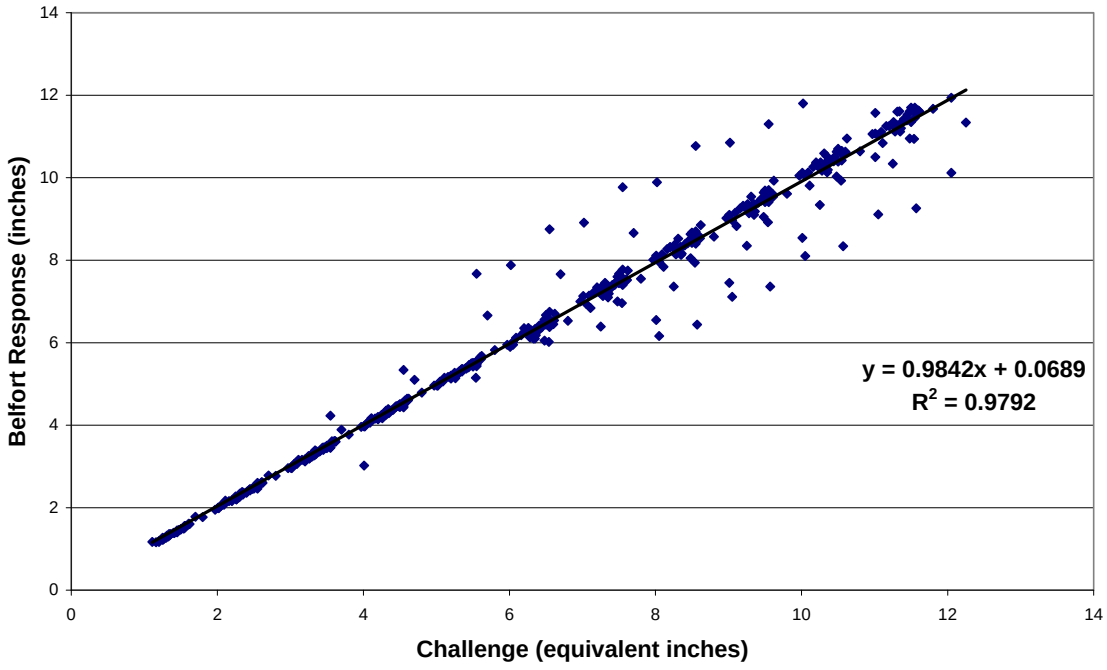
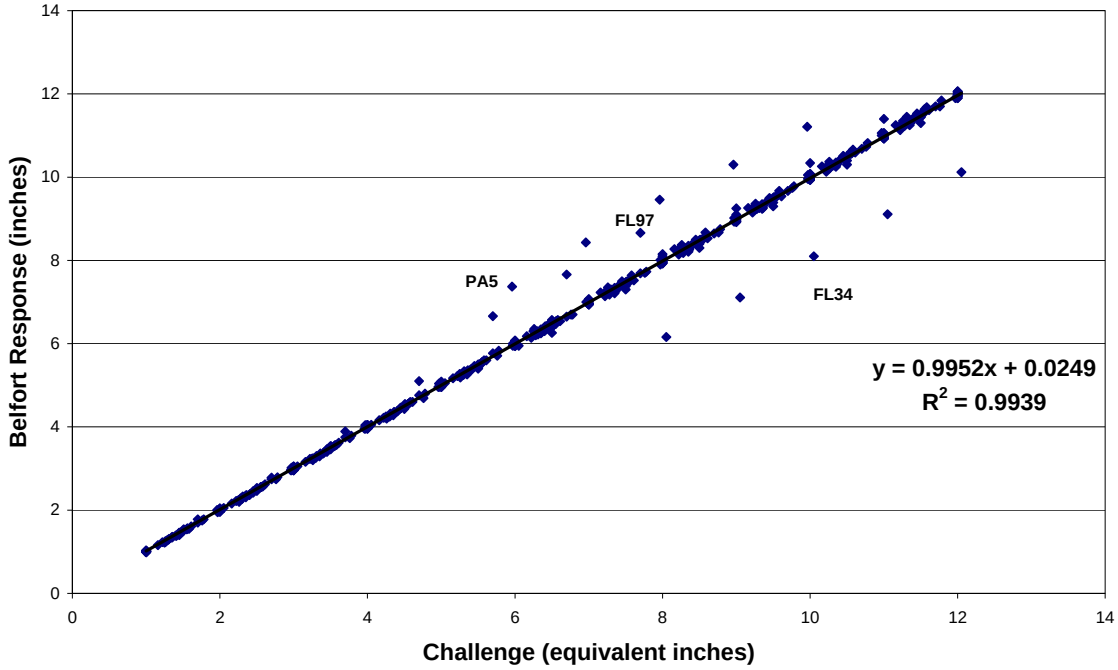


Figure 4-2 presents the "as left" Belfort raingage accuracy results for all gages encountered following any adjustments or improvements to the operation. Adjustments include leveling, cleaning, adjusting linkage, and calibration. Overall program-wide accuracy was improved as the results indicate with a slope of approximately 99.5 % and a correlation of 0.9939, however there were still some gages that could not be adjusted to within the tolerance of 0.10 inch throughout the entire range of 0-12 inches. The three sites that were not able to be adjusted to within acceptable limits were PA52, FL34, and FL97. All three gages were due to be replaced with electronic gages shortly after the survey visits.

Figure 4-2. As Left Belfort Accuracy - 47 Gages



4.2 Belfort Calibration Results

Of the 47 Belfort gages encountered, 31 gages required some type of adjustment. Only data from Belfort gages that were adjusted during the survey are presented in this subsection. Gages that were already within tolerance or could not be adjusted[2] to within tolerance are not included. Figure 4-3 presents the "unadjusted" calibration results and Figure 4-4 presents the results after adjustments and calibration. There is a noticeable decrease in accuracy observed in points above six inches in Figure 4-3. This is mostly attributed to improper gage turnover which was discussed in Section 3.0 and will be addressed again in Section 6.0 of this report.

[2] One gage could not be adjusted to within tolerance.

Figure 4-3. As Found Belfort Accuracy - 31 Adjusted Gages

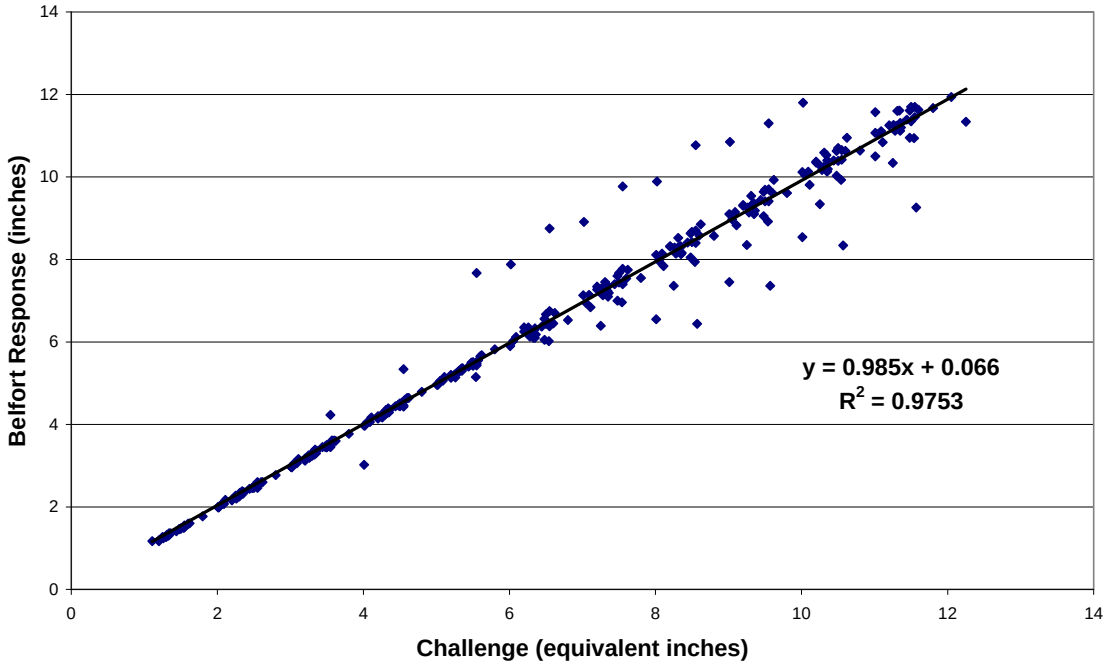
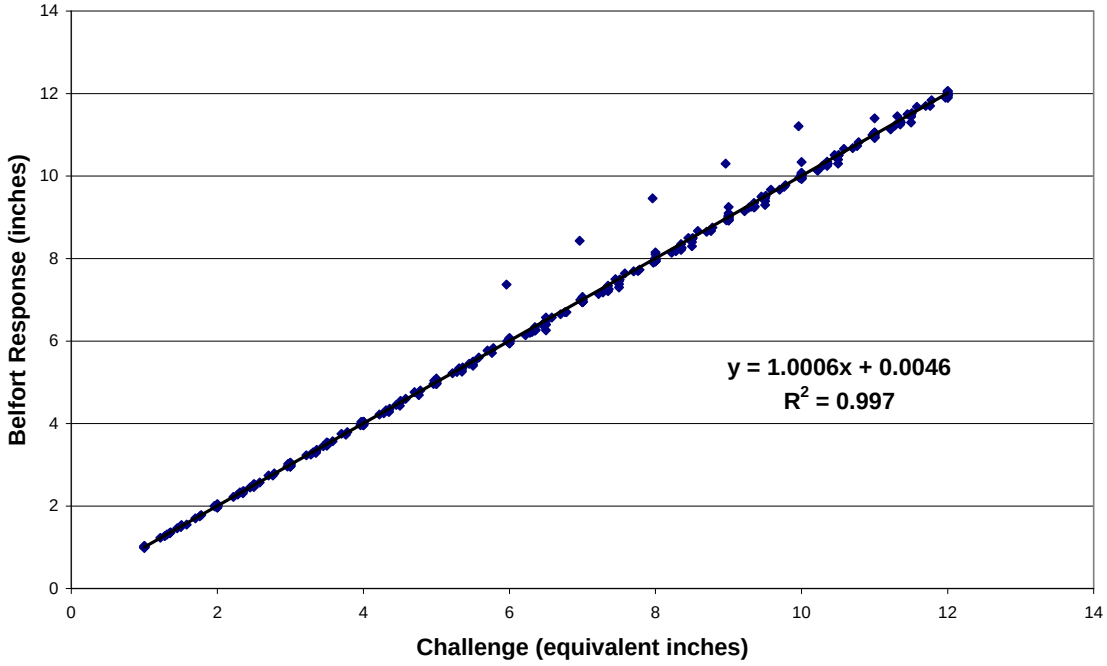


Figure 4-4. As Left Belfort Accuracy - 31 Adjusted Gages

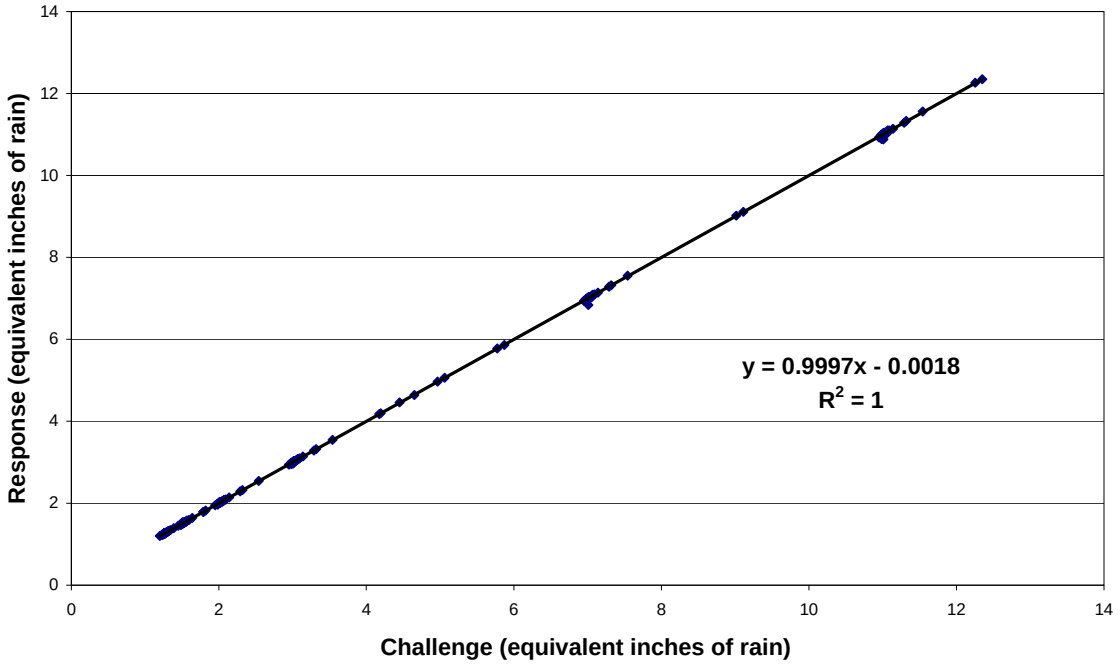


4.3 Electronic Gage Accuracy

The results of the accuracy tests for the 37 electronic raingages (KY03 was not challenged due to communication problem with the DAS) challenged during the period covered by this report are presented in Figure 4-5. As clearly indicated the gages report the weight of the standards added very accurately for the entire span. No problems were encountered and no adjustments were required for the electronic gages. The only notable problem with the electronic gage operation is related to the Personal Digital Assistant (PDA) and the required interfacing software. This is discussed further in Section 5.0.

Although not clearly seen in Figure 4-5, one electronic gage at site MD00 was not within acceptance limits when tested during the survey. The CAL was notified during the survey visit to determine what further action would be required to adjust the gage.

Figure 4-5. As Found Electronic Gage Accuracy - 37 Gages



4.4 Sensor Heater Tests

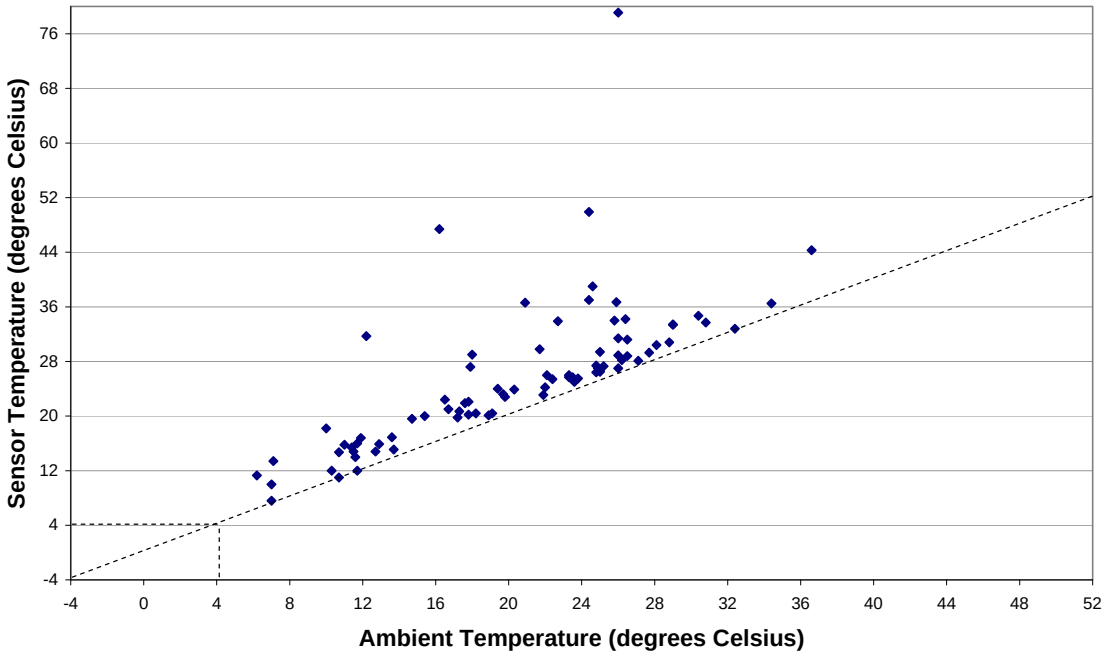
The ACM type collectors used throughout the networks of the NADP utilize a contact grid sensor. When precipitation bridges the gap between the grid and the sensor plate the sensor is "activated" and the collector opens. In order to optimize that operation the sensor is heated at a low level when the ambient temperature is below 4˚C during dry conditions. This provides enough heat to melt frozen precipitation and bridge the gap quickly when a snow or ice event

occurs. The manufacturer states that when the ambient temperature is above 4˚C and the conditions are dry, the sensor is not heated.

When the sensor is activated the sensor is heated at a high level to evaporate the precipitation from the grid surface quickly when the event ends. The intent is to minimize the time the collector is open with no precipitation occurring and to maximize the precipitation catch. The nominal temperature range of an activated sensor is approximately 60˚C within 10 minutes of activation.

The inactive sensor temperature tests are conducted using a thermocouple with the sensor shaded immediately after measuring the ambient temperature with the same device. The thin thermocouple is placed directly on the sensor plate between the sensor grids without making contact with the grid. The test results are presented in Figure 4-6.

Figure 4-6. Inactivated Sensor Temperature

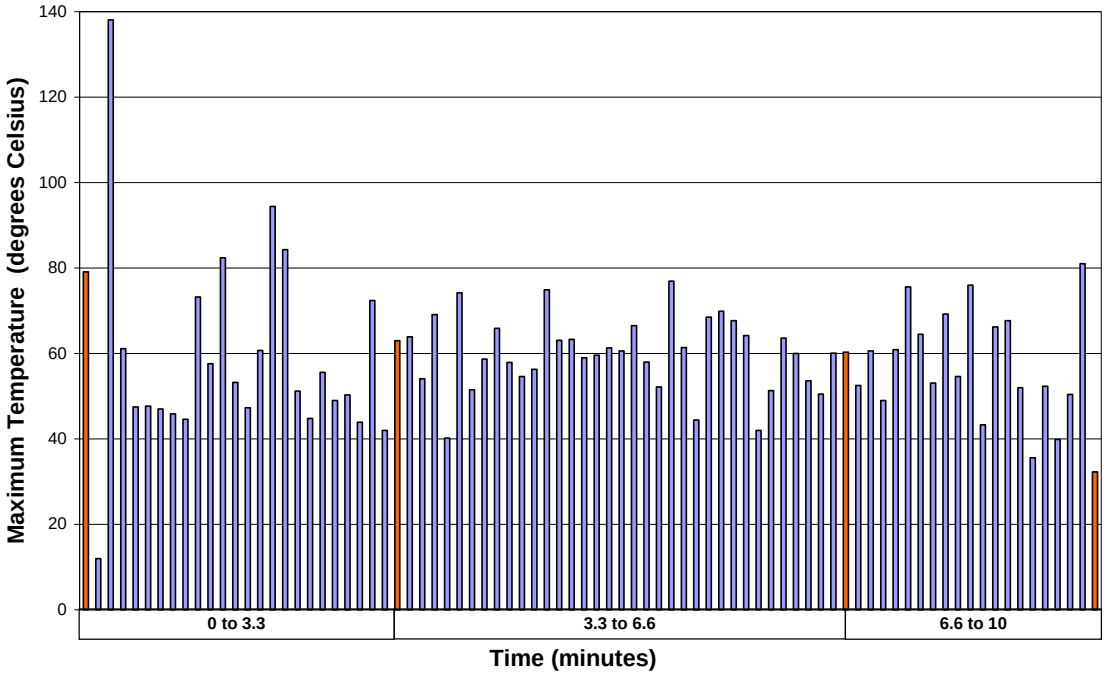


It appears that data from this year might reflect more careful methods applied by the field technicians. Most of the sensors were found just a few degrees above ambient temperature. Since the measurement is made after shading the sensor and measuring the ambient temperature, a difference of just a few degrees seems reasonable since it would take some time for the sensor to cool after absorbing heat prior to shading. By comparing this graph to that of last year, less scatter and more points just above and parallel to the line can be observed.

Figure 4-7 presents the maximum temperature reached by each sensor when activated, and the time required for each sensor to reach that temperature. There seems to be considerable variability between sensors for maximum temperature, but nearly all sensors are generally around 60˚C prior to 10 minutes of activation.

As indicated in the figure, one sensor reached a temperature of nearly 140 degrees with the first minute of activation. The sensor was in operation at site CA20-MDN and was flagged as not operating properly and a replacement sensor was requested.

Figure 4-7. Activated Sensor Temperature and Elapsed Time



It was determined from these two sensor tests that three sensors were not functioning properly. One sensor (CA20-MDN) reached nearly 140 degrees within the first minute and it was also hot when not activated. Another heater was always on (MO46-MDN) and the temperature was constantly nearly 80 degrees. A third sensor heater (PA42-NTN) did not function at all when activated and remained at ambient temperature. Replacements for all of these sensors were requested. Two other sites had sensors that were warm when not active, but both were tested when the ambient temperature was high, and it may have required more time for the sensors to cool to ambient conditions. Therefore replacements for these were not requested.

5.0 Recommendations to the NADP Program Office

The following subsections provide recommendations that, in the opinion of EEMS, would help to improve the operation of the sites and quality of data collected by the NADP.

In an attempt to quantify the NADP QA program's effectiveness, EEMS added a quality indicator to Tables 3-1, 3-2, and 3-3 in order to assess whether there are positive or negative changes in some individual assessments each year. Each of the non-compliant assessments that are identified to have a possible impact on data quality is compared to the non-compliant assessments from the previous reporting period to determine if there has been a change. Since the number of sites or distribution of networks visited is not the same each year this data cannot be used to determine trends.

One critical area that showed a positive change at the sites visited during this reporting period was the condition of the lid seal and liner. This is an issue that appeared to need improvement when reviewing data observed during the last reporting period. It is unknown whether the CAL stressed the importance of a proper lid liner and seal or if the weather conditions were less severe during this period at the sites visited. Since a poor lid seal or lid liner can cause a highly adverse impact on data quality due to possible sample contamination or evaporation, the quality of both should continue to be stressed as a high priority for site operators.

As surveys are completed and the survey database is populated, tracking of site conditions and improvements will be captured and reported on the three-year site survey rotation schedule. This should provide data as to specific improvements at individual sites.

5.1 Documentation

Although most sites surveyed have been operating for a very long time, and most site operators are experienced and knowledgeable of the procedures and duties they are required to perform, some of the documentation of those procedures is outdated. It is important to modify and update site operation reference documentation and distribute that documentation to the operators, supervisors, and data users. EEMS is aware that this process has been ongoing at the NADP Program Office and updated manuals and procedures are made available on the NADP website as they are completed and approved. A link to the site is provided here:
http://nadp.isws.illinois.edu/

This is an improvement over the distribution of hardcopy documents that have been produced in the past. The NADP website is a valuable tool for providing both data and documentation for data users, but it is sometimes not utilized by site operation personnel. Changes to procedures that are distributed via direct mailing to operators, and are intended to append or replace pages in

the current documentation are not always retained on-site. Some site operators suggested that revised operations manuals be distributed, and subsequent revisions and updates be supplied and tracked electronically. This may be accomplished using a registration and download process through the current website.

5.2 Equipment and Procedures

The following subsections pertain to problems observed with equipment and suggestions for improvement to equipment and procedures used to collect NADP data.

5.2.1 Belfort Raingage

As indicated in both the 2008 and 2009 reports, analysis of the survey data obtained from the sites surveyed during this reporting period also suggests that an additional raingage operation and maintenance procedure may benefit data quality. As was the case with the sites encountered during the previous periods, the most common problems observed with the Belfort raingages include improper turnover adjustment and dirty linkage. Dirty linkage causes sticky or poor pen response to changes in weight. However, as the mechanical gages are replaced with electronic gages the problems will be less significant.

Measured precipitation is affected by incorrect pen turnover when large amounts of precipitation occur during the sample period, or when the gage is winterized which raises the pen baseline and allows precipitation to accumulate for multiple weeks. Both cases are more likely to cause the pen to turnover and begin the downward transverse. In most cases where the gage turnover was an issue, a minor adjustment corrected the second transverse (six to twelve inch) response.

Two solutions that could be easily implemented and could help to eliminate inaccuracies in precipitation measurement due to turnover problems are:

- Reduce the amount of antifreeze used during the winter and have the site operator empty the bucket and replace the antifreeze more frequently during the winter to avoid reaching the second transverse.
- Have the site operator check and adjust the turnover on a regular schedule.

The first suggestion may not be practical at all site locations due to both the amount of precipitation that falls during one week and the logistics involved with winterization of the gage.

The second solution requires removing the gage cover and making an adjustment to a linkage. There is always a potential for undesired results when adjustments are made to the mechanical linkage of the gage, therefore training should be provided and proper care should be exercised if implementing this approach. It has been our experience however, that the turnover adjustment is

relatively straightforward and easily accomplished. Most site operators would be able to perform this adjustment with proper instruction received during the annual training classes provided by the Central Analytical Laboratory (CAL) and the Mercury Analytical Laboratory (HAL) and/or on site training provided during the site surveys.

It is further suggested that if the second approach (check and adjust the turnover) is to be performed, it should be done during good weather just prior to winterizing the gage.

The second problem affecting the gages surveyed was the accumulation of dirt on the internal moving linkages. In most cases cleaning the linkages restored proper function of the gage. Therefore it is suggested that the site operators be instructed to clean the gages at least once per year. The best time to clean the gage would vary from site to site based on the local weather patterns. For example, gages in the southwest should be cleaned following the spring windstorms when they are likely to receive the most wind-blown dust. This would also ensure that they are clean and working properly prior to the season most likely for precipitation to occur.

It would also be advisable to clean the gage when performing the turnover adjustment, and check the turnover when cleaning the gage, since both procedures require removing the gage cover.

5.2.2 ACM Type Collector

Problems with the following items were frequently noted with the ACM type collectors during the surveys:

Chimney Caulking for MDN Collectors

In a number of cases water appears to seep between the funnel and chimney. This is especially prevalent during events with high winds. This has the potential to cause confusion regarding the source of the liquid in the over-flow container and possibly the Quality Rating (QR) code of the sample.

Many of the MDN sites also have chimney insulation that is showing signs of severe deterioration. It may be necessary to implement a procedure and schedule for insulation replacement for ACM MDN collectors. A photo of a chimney that requires replacement insulation is included in Figure 5-1.

Figure 5-1. – ACM MDN Chimney Insulation

MDN Dry Side Bucket Protocol

For the most part dry side buckets at MDN sites were found to be in good condition given that a new bag is installed every week. However, there were some exceptions and some site operators were unsure of the procedure to get a replacement dry side bucket. It would be constructive to clarify the procedure for dry side bucket replacement and cleaning.

Sensor Temperature

Improvement was observed regarding site operators testing the sensor heater before activating the motor-box (see Section 4.0). EEMS continues to review the proper operation of the sensors and stresses the importance of testing the sensors each week.

Collector Arms During Cold Season

Some site operators report malfunction of the motor-box due to the arms freezing in one position. This has been an ongoing problem throughout the history of the NADP. EEMS is aware that the Program Office is investigating some options for improvement to the collector to help minimize the problem. Many of the upgrade bushing kits have been installed by operators and field technicians. Hopefully improved collector operation will be observed in the network.

At least one site was operating a collector with deteriorated boot covers for the collector arms. This was reported during the survey and a replacement set was requested. Due to the expense of the current approved boots it is suggested that efforts continue to identify other acceptable materials for boot covers. A photograph of a deteriorated boot cover is included in Figure 5-2 below.

Figure 5-2. – ACM MDN Boot Cover for Collector Arm

Lid Liner Replacement Protocol

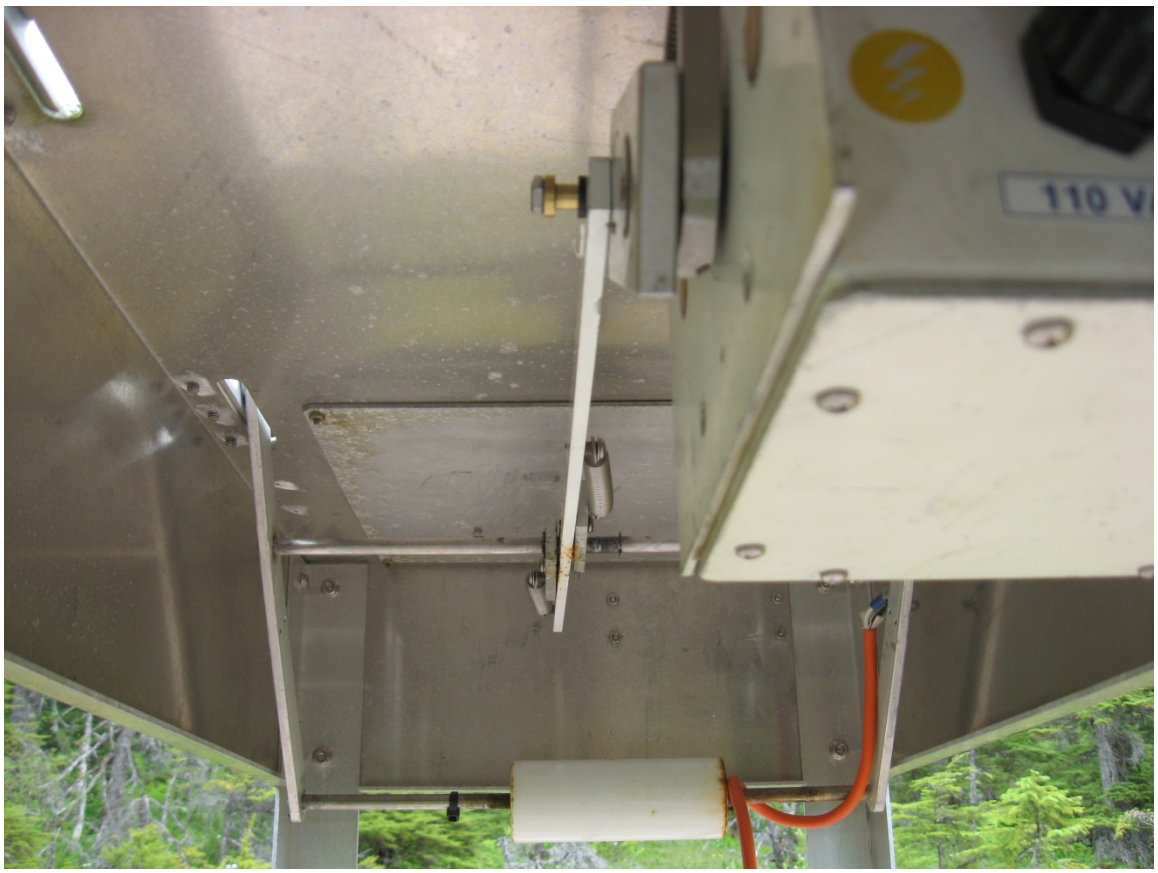
EEMS noticed an improvement regarding the lid liner replacement protocol. Most site operators are now aware of the scheduled replacement of the lid liners. It is still helpful to remind site operators of the minimum required replacement schedule and procedures, and reinforce the requirement for the liner to be replaced whenever needed due to damage from birds or other animals.

Motor-Box Linkage Assembly

A few sites had motor-box linkage assemblies that were not installed correctly causing the linkage arm to be misaligned with the motor-box arm. This can cause added stress on the motor-box and reduced force on the collector arms. It is most likely that these were the result of incorrect installation following a motor-box replacement. It may be necessary to review the

documentation for that procedure to be sure it is clear as to how to reattach the linkage after installing a motor-box. A photo of a misaligned linkage is included in Figure 5-3 below.

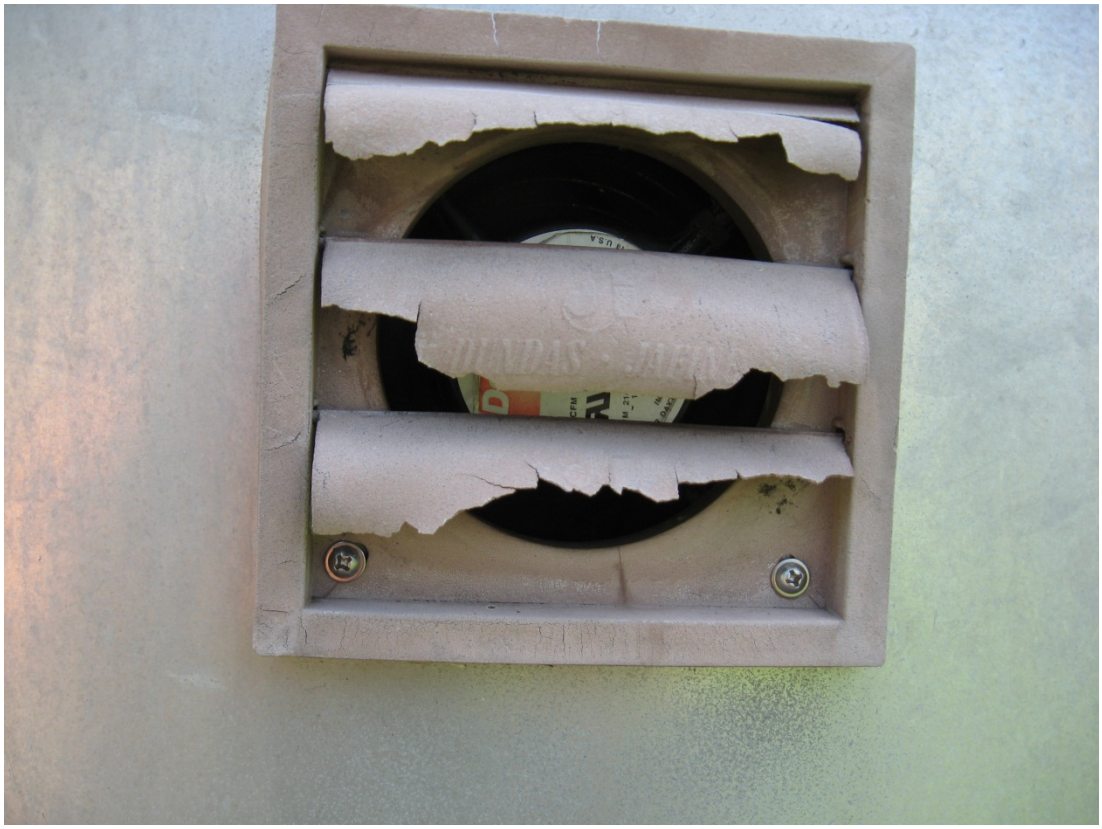
Figure 5-3. – ACM Motor-Box Linkage Misaligned



MDN Cooling Fan Louvers

Some of the older ACM MDN collector fan louvers are beginning to deteriorate. It may be necessary to implement an inspection and replacement schedule for the louvers. A photograph is included in Figure 5-4 below.

Figure 5-4. – ACM MDN Cooling Fan Louver



5.2.3 Electronic Gage and PDA

The introduction of the electronic raingages into the network is a great improvement. All of the site operators where they have been installed are very glad to be operating them. However there is still some room for improvement with their operation.

PDA Software Versions and Procedures

EEMS is aware that software development and testing requires time. Also the introduction of new electronic devices including PDA sometimes renders the older models obsolete. As the program moves to the digital world these challenges are evident. Improvement in the areas of software development and documentation has been observed during the surveys that took place during this year. Effort should stay focused as continued changes occur going forward.

It is suggested that the PDA documentation include detailed references to the various versions of both hardware and software. An effort should be made to standardize the software as much as possible. If need be this should include specific versions of software for specific hardware. This information can be used to evaluate if the appropriate combination and latest version is available at each site. This evaluation can become part of the site survey assessment.

Comparison of Electronic Gage Measurements to Mechanical Gage Measurements

Although the electronic gages encountered proved to be very accurate balances and were able to report the weight of the standards accurately, there are still some questions regarding their comparability to the mechanical gages used historically. The electronic gages most widely in use rely on the combination of a load cell for weighing and optical sensors to determine precipitation events. Unlike the mechanical gage, the datalogger inside the electronic gage is programmed to determine if the change in weight of the collection bucket is due to precipitation.

EEMS believes that this difference is being investigated by the Program Office to quantify the collection efficiency of the electronic gages compared to the mechanical gages.

Sensor Response Tests

In addition to comparison of gage catch tests, comparisons of the various collector sensors operating in the network should be more thoroughly evaluated. Ideally any approved sensor should respond identically in terms of responding to all types of precipitation events. Currently this is not the case. More testing should be conducted with goal to both qualify and quantify the operation of all types of approved sensors (optical and mechanical).

Electronic Gage Installations

It was observed that some of the electronic gage installations were not performed according to the guidelines and rules provided by the NADP. Photographs are included in Figures 5-5 and 5-6 below.

Figure 5-5. – Objects Within 5 Meters

Figure 5-6. Objects Within 5 Meters

EEMS recommends that when site upgrades are planned, such as the installation of new electronic gages, that care should be exercised to improve the site conditions with respect to siting criteria issues and instrument operation. It may be necessary to review the rules and guidelines with the installer prior to the installation to ensure compliance.

Whenever EEMS observes gage installations that can be improved the site operator, supervisor, and network liaison is advised. It is suggested that during the next site survey (if not sooner) that installation issues be addressed and corrected if possible.

6.0 Field Laboratory Survey Results

The field site survey results have been presented and discussed in other sections of this report. Current field laboratory procedures are limited to sample weighing and decanting at NTN sites. AIRMoN sites still require pH and conductivity measurements. This section will focus on weighing, decanting the NTN samples. Since no AIRMoN sites were visited this year, results of the weighing, decanting, pH and conductivity measurements of AIRMoN samples are not included.

All site operators were observed to be proficient with sample weighing and decanting procedures. During the surveys, training procedures were reinforced regarding not mixing the sample prior to decanting. One suggestion that may be of value would be to move the field lab as close to the sample site as possible to help eliminate sample loss or mixing while transporting the sample to the lab. This is most practical at sites co-located with CASTNET sites, since there is usually space available for the lab equipment.

Sample Weighing

Some site scales used for sample weighing require attention. Although very accurate and easy to use, electronic scales require routine and regular maintenance. This is usually provided by a service contractor that visits the lab and certifies the scale. Scales that are determined to be functioning poorly during the site surveys should be identified as action items and require some follow-up from the CAL. This could include replacing the scale with a surplus instrument. Table 6-1 presents results for the scales surveyed when challenged with four standard Belfort weights (from approximately 830g to 3400g). An average error of 0.5% or more was used as the accuracy tolerance. Only one scale was found to be outside this accuracy tolerance.

Table 6-1. Average Percent Difference for Site Scales

Site Id	Network	Average % Difference	Site Id	Network	Average % Difference	Site Id	Network	Average % Difference
AK01	NTN	-0.01%	FL41	NTN	0.06%	MO03	NTN	-0.03%
AK02	NTN	-0.09%	FL99	NTN	-0.01%	MO05	NTN	-0.53%
AK03	NTN	-0.02%	IL63	NTN	-0.02%	NM01	NTN	-0.08%
AR02	NTN	0.00%	IN20	NTN	0.03%	NM07	NTN	-0.05%
AR16	NTN	0.05%	KS07	NTN	0.07%	NM08	NTN	0.03%
CA42	NTN	-0.08%	KS31	NTN	0.02%	NY10	NTN	0.06%
CA45	NTN	0.03%	KS32	NTN	0.18%	OH15	NTN	-0.05%
CA50	NTN	-0.14%	KY03	NTN	0.05%	OH17	NTN	-0.18%
CA66	NTN	-0.01%	KY10	NTN	0.11%	OK00	NTN	0.00%
CA67	NTN	0.15%	KY19	NTN	-0.21%	OK17	NTN	0.44%
CA75	NTN	0.11%	KY22	NTN	0.14%	OK29	NTN	0.10%
CA76	NTN	-0.03%	KY35	NTN	-0.04%	PA00	NTN	0.16%

Table 6-1. Average Percent Difference for Site Scales (continued)

Site Id	Network	Average % Difference
CA88	NTN	0.03%
CA94	NTN	-0.11%
CA96	NTN	0.04%
CA99	NTN	-0.02%
FL03	NTN	0.45%
FL05	NTN	0.05%
FL11	NTN	-0.02%
FL14	NTN	0.18%
FL23	NTN	-0.25%

Site Id	Network	Average % Difference
KY99	NTN	0.04%
MD07	NTN	-0.24%
MD13	NTN	0.00%
MD15	NTN	-0.08%
MD18	NTN	0.02%
MI51	NTN	0.01%
MI52	NTN	-0.19%
MI53	NTN	-0.13%
MI99	NTN	0.06%

Site Id	Network	Average % Difference
PA18	NTN	-0.11%
PA29	NTN	0.13%
PA42	NTN	0.00%
PA47	NTN	0.07%
PR20	NTN	0.04%
TN14	NTN	-0.03%
VI01	NTN	0.01%
WI25	NTN	0.04%
WI36	NTN	-0.03%

7.0 Data Quality Information

Several procedures are in place to help ensure survey data quality. Foremost, a comprehensive QAPP has been developed prior to collecting survey data. Field survey team training has been provided to ensure consistency of methods. Duplicate entry of survey data has been implemented to help detect and correct typographic errors. Ongoing review of results for accuracy and consistency is provided by the EEMS' QA Manager, who is not involved with the field data collection.

7.1 Quality Assurance Project Plan

Improvement to procedures for collecting survey data, recording data in the survey database and reporting survey results are an ongoing process. As improvements are identified, suggested changes are submitted for approval by the EPA Project Officer, and the NADP QA Manager. Once the suggested changes are approved the Site Survey QAPP and associated SOPs can be updated.

During the reporting period changes to the site survey questionnaire were planned that include the design and implementation of a new relational database to enable more efficient data collection and reporting. The design was planned and changes to the existing questionnaire were discussed and approved by the Program Office and EPA. The new database is expected to be operational in June of 2011. The database upgrade will require a corresponding update of the QAPP.

The expected date for the completion of the QAPP revision 01 is October 2011. This revision will include updated data entry screens and site data reporting, filing, and archiving procedures. This revision will include data entry screens and site reporting, filing and archiving procedures.

7.2 Field Team Training and Internal QA Audits

Initial survey team training took place while performing two surveys in Indiana in December 2007. Survey team members routinely share experiences through regular communication which helps to clarify questions that may arise the first time a problem is encountered. This is an ongoing process that will continue, thereby expanding the knowledge base of the team and maintaining consistency of methods.

Internal QA Audits and Site Operator Reviews

In August 2009, EEMS' QA Manager attended site surveys at the three network sites of IL11 to observe the performance of the three survey teams. This was the second internal QA audit of the site survey teams. An internal QA audit report of the survey was distributed to the appropriate

interested parties by the QA Manager following the visit. Due to schedule conflicts no internal QA audits were conducted in 2010.

Beginning with the first site survey performed in calendar year 2009 (FL32), the EEMS QA Manager is providing site operators with a form for them to evaluate the performance of the field technician completing the site survey. These forms are provided with a self addressed stamped envelope in order to make it easier for the site operator to respond. The QA Manager is using the information gathered to provide reports to management and suggestions for improvements of techniques and procedures for the field technicians. The information is also provided to the NADP QA Manager and the EPA Project Officer.

Training Class Attendance

In order to keep up with changes to the NADP procedures and protocols EEMS survey team members and the EEMS QA Manager have attended the semiannual site operator training classes provided by the Mercury Analytical Laboratory (HAL), Central Analytical Laboratory (CAL), and Program Office in conjunction with the NADP spring and fall meetings. This provides EEMS with a means to stay current with procedures and changes to site equipment. It also allows EEMS to provide the Program Office with feedback and suggestions to improve the site operator training classes.

7.3 Duplicate Data Entry

A routine procedure utilized as part of the QA program for survey data, is duplicate data entry. Field personnel enter survey data results into the Field Site Survey Database (FSSD) after completing the survey. An initial spot report is generated using this raw data. After completing three surveys, the database is sent electronically to the EEMS office. The original hardcopy field forms are sent to the EEMS office via FedEx.

Upon receipt of the field forms, a second set of data tables are populated independently using the original hardcopy forms. The QA Manager then compares the two sets of tables. Discrepancies are identified and investigated to determine the intended entry. In some cases this requires contacting the field personnel to verify or confirm a result. If necessary, after the QA process and acceptance by the QA Manager, a revised spot report is generated from the set of tables populated at the office. This preserves the original set of tables populated in the field, and provides review, tracking, and edit documentation for the survey results and reports.

Once data have been approved by the QA Manager, appropriate tables are generated and sent to the NADP QA Manager and to the EPA Project Officer. It is EEMS' goal to forward this information on a monthly basis, however there are times when data verification may take longer than expected.

It is anticipated that upon completion of the new survey information database the process will be more streamline and require less time to complete and delivery survey data.

7.4 Identifiable Areas Improvement to the Survey Program

As with all programs, continuous efforts are underway within the survey program to provide improvements to techniques and procedures in an attempt to deliver useful and meaningful information to the EPA and NADP. Those efforts have been described in the previous sections. As a direct result, the improvements summarized in the following subsections are being implemented.

7.4.1 Site Survey Questionnaire

Despite considerable effort on the part of both EEMS and the NADP PO, some of the questions contained in the Site Survey Questionnaire remain ambiguous. This has led to some survey field personnel interpreting some questions one way, while another team member might interpret the same question differently. Additionally, some survey questions are redundant or impossible to answer accurately during the field site survey. As cases are discovered during review of the survey reports, additional clarification is requested from the NADP QA Manager regarding the intent of the question. This information is then shared with the survey team members to eliminate confusion and maintain consistency. Subsequent versions of the questionnaire and database have been designed as described briefly in previous sections of this report. It is anticipated that changes to the questionnaire will be much easier to implement with the revised database.

Prior to the 2008 fall NADP meeting, EEMS prepared a list of items from the site survey questionnaire that can cause confusion or be misinterpreted during surveys. This list was discussed with the NADP QA Manager and the EPA Project Officer. Some of these items required further definition and refinement; others were candidates for removal from the questionnaire. Changes were approved by the NADP QA Manager, and by the EPA Project Officer. EEMS is finalizing these changes which will be included in the new version of the data-collection database. The approved changes can be found in Appendix C of this report. This is an ongoing process and a meeting is held each spring to discuss further refinement of the survey questionnaire.

Refinement and improvement to the information collected during a site survey will continue. It is expected that feedback regarding the survey data will be provided on an annual basis from the NADP PO and other data users so that EEMS can continue to collect data that are meaningful and useful to the NADP.

7.4.2 Internal QA

This section summarizes the results of EEMS' internal QA processes.

Site File Review

The internal review and audit process performed by the EEMS QA Manager (as described in previous sections) has identified some problems with the files received from the site survey teams. The problems were generally a result of poor recordkeeping on the part of the survey team. Issues included illegible or incomplete field form entries, incomplete equipment forms, site sketches not notated, inconsistent file naming, and delays in providing survey information. The issues were addressed by providing a corrective action memo to the survey team members. Subsequent survey files and reports have improved considerably. Files and reports will continue to be reviewed and monitored to improve consistency and quality.

Results of Duplicate Data Entry Process and Site File Review

When a discrepancy is identified by the EEMS QA Manager during review of the duplicate data entry, a code is assigned to the record to indicate if the error was the result of a typo by field personnel or QA personnel. If an error in the original entry is identified and not the result of a typo the record is also coded. The results of the QA coding are presented in Table 7-1.

The data indicates that of the 45,714 entries that are compared (minus memo fields, site ID, and Network) the entry error rate is less than 0.6%. The field entry errors are approximately twice as high as the duplicate entry errors. This represents an improvement over last year's dataset which indicated that field entry error was approximately 5 times higher than the duplicate entry. Of the 22,857 data points, 252 edits were made by the QA Manager as a result of errors other than an entry error. These errors included missing values from hardcopy forms, responses of "none" rather than "not applicable" (or similar), and data format discrepancies. The survey database is currently being revised to help eliminate these types of errors.

Table 7-1. 2010 Internal QA Results

	Field Entry	Duplicate QA Entry	Total Entries
Total Number of Entries Compared	22,857	22,857	45,714
Initial Field Entry Errors	171		
Duplicate QA Entry Errors		84	
Percent Errors	0.75%	0.37%	
Total Entry Errors	255		
Total Percent Errors	0.56%		
Total Edits	507		
Other Than Entry Edits	252		
Total Percent Other Edits	0.55%		

Internal Survey Audits

No internal survey audits were conducted in 2010.

7.5 Survey Equipment Certification

The instruments used by the survey team are maintained and certified by the EEMS QA Manager. Most undergo annual certification by various sources. Digital multi-meters (DVM) are certified National Institute of Standards and Technology (NIST) traceable by the manufacturer. The DVMs are used to measure temperature with a thermocouple input which is certified with a NIST traceable thermometer.

The weights used to challenge the weighing raingages and site scales are certified annually on a NIST traceable electronic scale at the EEMS facility in Gainesville, FL.

The compass used to determine the azimuth of objects near the collector is certified as NIST traceable annually by a third party.

All certification documentation is provided in Appendix D.

APPENDIX A

Assessments Determined to Impact Data Quality

Assessments Determined to Impact Data Quality

Field Entry	NTN	MDN	AIRMON
Is sampling media quality maintained?	✓	✓	✓
Are samples stored and shipped properly	N/A	N/A	✓
Is the orifice of the collector +/- .3 m of raingage (elevation)	✓	✓	✓
30 degree rule for buildings met (raingage)	✓	✓	✓
No objects > 1 m height inside 5 m radius (raingage)	✓	✓	✓
No fences > 1 m height inside 2 m radius (raingage)	✓	✓	✓
No vegetation height > 0.6 m within 5 m radius (raingage)	✓	✓	✓
Does NADP require a raingage wind shield at this site	✓	✓	✓
If raingage wind shield present, is it installed correctly	✓	✓	✓
Collector and sensor oriented properly	✓	✓	✓
45 degree rule met (collector)	✓	✓	✓
30 degree rule for trees met (collector)	✓	✓	✓
30 degree rule for buildings met (collector)	✓	✓	✓
No objects > 1 m height within 5 m radius (collector)	✓	✓	✓
No fences > 1 m height inside 5 m radius (collector)	✓	✓	✓
No vegetation height > 0.6 m within 5 m radius (collector)	✓	✓	✓
No treated lumber inside 5 m radius (collector)	✓	✓	✓
No galvanized metal inside 5 m radius collector (MDN)	N/A	✓	N/A
No pastures and ag. activity within 20 m radius	✓	✓	✓
No herbicides and fertilizers used within 20 m radius	✓	✓	✓
Roads meet NADP siting criteria	✓	✓	✓
Waterways meet NADP siting criteria	✓	✓	✓
Airports meet NADP siting criteria	✓	✓	✓
Animal operations meet NADP siting criteria (NTN and AIRMoN)	✓	N/A	✓
Combustion sources meet NADP siting criteria (MDN only)	N/A	✓	N/A
Parking lots and maintenance areas meet NADP siting criteria	✓	✓	✓
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria	✓	✓	✓
Metalworking operations meet NADP siting criteria (MDN only)	N/A	✓	N/A
Dry side bucket is clean	✓	✓	✓
Does lid seal properly	✓	✓	✓
Lid liner in good condition	✓	✓	✓
Fan in good condition	N/A	✓	N/A
Cooling fan thermostat in good condition	N/A	✓	N/A
Heater in good condition	N/A	✓	N/A
Heater thermostat in good condition	N/A	✓	N/A
Has flush wall filter mount been installed	N/A	✓	N/A
Filter in good condition	N/A	✓	N/A
Max / min thermometer in acceptable limits	N/A	✓	N/A
ACM sensor operates properly	✓	✓	✓
Motorbox operates within acceptable limits	✓	✓	✓
N-CON fan in good condition	N/A	✓	N/A

Field Entry	NTN	MDN	AIRMON
N-CON cooling fan thermostat in good condition	N/A	✓	N/A
N-CON heater in good condition	N/A	✓	N/A
N-CON heater thermostat in good condition	N/A	✓	N/A
N-CON max / min thermometer in acceptable limits	N/A	✓	N/A
N-CON sensor responds to a 20-second mist of water	N/A	✓	N/A
N-CON lid seal in good condition	N/A	✓	N/A
N-CON lid liner in good condition	N/A	✓	N/A
Was the 'as found' turn over set properly (Belfort gage)	✓	✓	N/A
Raingage operates properly (electronic gage)	✓	✓	N/A
Does datalogger receive event signals form all collectors (electronic gage)	✓	✓	N/A
Does optical sensor respond to "blocking" of light beam (electronic gage)	✓	✓	N/A
Does optical sensor respond to mist of water (electronic gage)	✓	✓	N/A
Does the stick measure within tolerances (.01") (NWS stick gage)	N/A	N/A	✓

N/A = Not applicable

APPENDIX B

Findings Most Likely to Impact Data Quality

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 1 of 6)

	AK01	AK02	AK03	AR02	AR16	CA42	CA45	CA50	CA66	CA67
Is sampling media quality maintained	X									
Is the orifice of the collector +/- .3 m of rain gage						X				
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage			X				X			X
No fences > 1 m height inside 2 m radius, rain gage							X			
No vegetation height > 0.6 m within 5 m radius, rain gage	X		X			X		X		X
Collector and sensor oriented properly		X								
45 degree rule met, collector								X		X
30 degree rule for trees met, collector		X	X		X	X	X	X		
30 degree rule for buildings met, collector										
No objects > 1 m height within 5 m radius, collector						X	X			X
No fences > 1 m height inside 5 m radius, collector							X			
No vegetation height > 0.6 m within 5 m radius, collector	X					X				X
No treated lumber inside 5 m radius, collector		X								
No pastures and agricultural activity within 20 m radius collector										
No herbicides and fertilizers within 20 m radius collector				X			X			
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria										
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria										
Dry side bucket clean										
Does lid seal properly										
Lid liner in good condition										
ACM Sensor operates properly		U to T								
Motorbox operates within acceptable limits	X	X								
Turn over set properly	N/A	N/A	N/A	X	N/A	X				N/A
Rain gage operates properly	U to T			N/A		N/A	N/A	N/A	N/A	
Does datalogger receive event signals from all collectors	U to T	U to T		N/A		N/A	N/A	N/A	N/A	
Does optical sensor respond to "blocking" of light beam	U to T			N/A		N/A	N/A	N/A	N/A	
Does optical sensor respond to mist of water	U to T			N/A		N/A	N/A	N/A	N/A	

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 2 of 7)

	CA75	CA76	CA88	CA94	CA96	CA99	FL03	FL05	FL11	FL14
Is sampling media quality maintained										
Is the orifice of the collector +/- .3 m of rain gage								X		
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage				X						
No fences > 1 m height inside 2 m radius, rain gage										
No vegetation height > 0.6 m within 5 m radius, rain gage										
Collector and sensor oriented properly										
45 degree rule met, collector	X									
30 degree rule for trees met, collector	X			X		X	X			X
30 degree rule for buildings met, collector										
No objects > 1 m height within 5 m radius, collector	X			X						
No fences > 1 m height inside 5 m radius, collector										
No vegetation height > 0.6 m within 5 m radius, collector				X		X				
No treated lumber inside 5 m radius, collector										
No pastures and agricultural activity within 20 m radius collector										
No herbicides and fertilizers within 20 m radius collector										
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria										
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria										
Dry side bucket clean							X			
Does lid seal properly										
Lid liner in good condition										
ACM Sensor operates properly										
Motorbox operates within acceptable limits										
Turn over set properly	N/A		X	N/A	N/A	N/A		X	N/A	
Rain gage operates properly		N/A	N/A				N/A	N/A		N/A
Does datalogger receive event signals from all collectors		N/A	N/A				N/A	N/A		N/A
Does optical sensor respond to "blocking" of light beam		N/A	N/A				N/A	N/A		N/A
Does optical sensor respond to mist of water		N/A	N/A				N/A	N/A		N/A

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 3 of 7)

	FL23	FL41	FL99	IL63	IN20	KS07	KS31	KS32	KY03	KY10
Is sampling media quality maintained									X	
Is the orifice of the collector +/- .3 m of rain gage	X								X	
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage	X						X			
No fences > 1 m height inside 2 m radius, rain gage							X			
No vegetation height > 0.6 m within 5 m radius, rain gage	X	X						X		
Collector and sensor oriented properly										
45 degree rule met, collector	X	X								
30 degree rule for trees met, collector	X	X								
30 degree rule for buildings met, collector										
No objects > 1 m height within 5 m radius, collector	X					X			X	X
No fences > 1 m height inside 5 m radius, collector										
No vegetation height > 0.6 m within 5 m radius, collector	X							X		
No treated lumber inside 5 m radius, collector	X									
No pastures and agricultural activity within 20 m radius collector				X						X
No herbicides and fertilizers within 20 m radius collector										
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria			X							
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria										
Dry side bucket clean									X	
Does lid seal properly										
Lid liner in good condition	X									
ACM Sensor operates properly										
Motorbox operates within acceptable limits										
Turn over set properly	N/A	X	X	X		X	N/A	X	N/A	N/A
Rain gage operates properly		N/A	N/A	N/A	N/A	N/A		N/A	U to T	
Does datalogger receive event signals from all collectors		N/A	N/A	N/A	N/A	N/A	X	N/A	U to T	
Does optical sensor respond to "blocking" of light beam		N/A	N/A	N/A	N/A	N/A	N/A	N/A	U to T	
Does optical sensor respond to mist of water		N/A	N/A	N/A	N/A	N/A	N/A	N/A	U to T	

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 4 of 7)

	KY19	KY22	KY35	KY99	MD07	MD13	MD15	MD18	MI51	MI52
Is sampling media quality maintained										
Is the orifice of the collector +/- .3 m of rain gage						X		X		
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage								X	X	X
No fences > 1 m height inside 2 m radius, rain gage		X								
No vegetation height > 0.6 m within 5 m radius, rain gage										X
Collector and sensor oriented properly										
45 degree rule met, collector		X								X
30 degree rule for trees met, collector		X	X		X					
30 degree rule for buildings met, collector										
No objects > 1 m height within 5 m radius, collector		X	X			X				
No fences > 1 m height inside 5 m radius, collector		X								X
No vegetation height > 0.6 m within 5 m radius, collector									X	X
No treated lumber inside 5 m radius, collector						X				
No pastures and agricultural activity within 20 m radius collector										
No herbicides and fertilizers within 20 m radius collector	X									
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria						X				
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria										
Dry side bucket clean	X	X	X							X
Does lid seal properly										
Lid liner in good condition										
ACM Sensor operates properly								X		
Motorbox operates within acceptable limits					X					
Turn over set properly	X	X		N/A		N/A	X	N/A	N/A	N/A
Rain gage operates properly	N/A	N/A	N/A		N/A		N/A			
Does datalogger receive event signals from all collectors	N/A	N/A	N/A		N/A		N/A			
Does optical sensor respond to "blocking" of light beam	N/A	N/A	N/A		N/A		N/A			
Does optical sensor respond to mist of water	N/A	N/A	N/A		N/A		N/A			

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 5 of 7)

	MI53	MI99	MO03	MO05	NM01	NM07	NM08	NY10	OH15	OH17
Is sampling media quality maintained										
Is the orifice of the collector +/- .3 m of rain gage			X							
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage	X			X			X	X	X	X
No fences > 1 m height inside 2 m radius, rain gage							X	X		
No vegetation height > 0.6 m within 5 m radius, rain gage	X			X						
Collector and sensor oriented properly									X	
45 degree rule met, collector							X		X	
30 degree rule for trees met, collector	X		X	X			X	X		X
30 degree rule for buildings met, collector										
No objects > 1 m height within 5 m radius, collector	X			X			X		X	
No fences > 1 m height inside 5 m radius, collector							X			
No vegetation height > 0.6 m within 5 m radius, collector	X			X	X					
No treated lumber inside 5 m radius, collector										
No pastures and agricultural activity within 20 m radius collector										
No herbicides and fertilizers within 20 m radius collector										
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria										
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria	X									
Dry side bucket clean									X	
Does lid seal properly										
Lid liner in good condition										
ACM Sensor operates properly			X							X
Motorbox operates within acceptable limits										
Turn over set properly	N/A		X		X	X	X		N/A	N/A
Rain gage operates properly		N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Does datalogger receive event signals from all collectors		N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Does optical sensor respond to "blocking" of light beam		N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Does optical sensor respond to mist of water		N/A	N/A	N/A	N/A	N/A	N/A	N/A		

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 6 of 7)

	OK00	OK17	OK29	PA00	PA18	PA29	PA42	PA47	PR20	TN14
Is sampling media quality maintained										
Is the orifice of the collector +/- .3 m of rain gage								X		
30 degree rule for buildings met, rain gage										
No objects > 1 m height inside 5 m radius, rain gage							X		X	
No fences > 1 m height inside 2 m radius, rain gage										
No vegetation height > 0.6 m within 5 m radius, rain gage										
Collector and sensor oriented properly										X
45 degree rule met, collector										
30 degree rule for trees met, collector		X			X		X			X
30 degree rule for buildings met, collector		X								
No objects > 1 m height within 5 m radius, collector						X			X	
No fences > 1 m height inside 5 m radius, collector										
No vegetation height > 0.6 m within 5 m radius, collector										
No treated lumber inside 5 m radius, collector										
No pastures and agricultural activity within 20 m radius collector				X						
No herbicides and fertilizers within 20 m radius collector				X						X
Roads meet NADP siting criteria										
Waterways meet NADP siting criteria										
Airports meet NADP siting criteria										
Animal operations meet NADP siting criteria										
Parking lots and maintenance areas meet NADP siting criteria										
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria										
Dry side bucket clean		X			X		X	U to T		
Does lid seal properly										
Lid liner in good condition										
ACM Sensor operates properly							X			
Motorbox operates within acceptable limits										
Turn over set properly				N/A	X	N/A	X			N/A
Rain gage operates properly	N/A	N/A	N/A		N/A		N/A	N/A	N/A	
Does datalogger receive event signals from all collectors	N/A	N/A	N/A	X	N/A		N/A	N/A	N/A	
Does optical sensor respond to "blocking" of light beam	N/A	N/A	N/A		N/A		N/A	N/A	N/A	N/A
Does optical sensor respond to mist of water	N/A	N/A	N/A		N/A		N/A	N/A	N/A	N/A

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 1. Findings Most Likely to Impact Data Quality - NTN Sites (page 7 of 7)

	VI01	WI25	WI36
Is sampling media quality maintained			
Is the orifice of the collector +/- .3 m of rain gage			
30 degree rule for buildings met, rain gage			
No objects > 1 m height inside 5 m radius, rain gage	X		
No fences > 1 m height inside 2 m radius, rain gage			
No vegetation height > 0.6 m within 5 m radius, rain gage	X		
Collector and sensor oriented properly			
45 degree rule met, collector	X		
30 degree rule for trees met, collector		X	
30 degree rule for buildings met, collector			
No objects > 1 m height within 5 m radius, collector	X		
No fences > 1 m height inside 5 m radius, collector			
No vegetation height > 0.6 m within 5 m radius, collector	X		
No treated lumber inside 5 m radius, collector			
No pastures and agricultural activity within 20 m radius collector			
No herbicides and fertilizers within 20 m radius collector			
Roads meet NADP siting criteria			
Waterways meet NADP siting criteria			
Airports meet NADP siting criteria			
Animal operations meet NADP siting criteria			
Parking lots and maintenance areas meet NADP siting criteria	X		
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria			
Dry side bucket clean			
Does lid seal properly			
Lid liner in good condition			
ACM Sensor operates properly			
Motorbox operates within acceptable limits			
Turn over set properly	N/A	X	X
Rain gage operates properly		N/A	N/A
Does datalogger receive event signals from all collectors		N/A	N/A
Does optical sensor respond to "blocking" of light beam		N/A	N/A
Does optical sensor respond to mist of water		N/A	N/A

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 2-A. Findings Most Likely to Impact Data Quality - MDN Sites with ACM Collector (page 1 of 2)

	AZ02	CA20	CA75	CA94	FL05	FL11	FL34	FL97	KY10	MD00	MN98
Is sampling media quality maintained											
Is the orifice of the collector +/- .3 m of rain gage					X			X			
30 degree rule for buildings met, rain gage											
No objects > 1 m height inside 5 m radius, rain gage	X			X						X	X
No fences > 1 m height inside 2 m radius, rain gage											
No vegetation height > 0.6 m within 5 m radius, rain gage		X									
Collector and sensor oriented properly								X			
45 degree rule met, collector			X								
30 degree rule for trees met, collector	X	X	X	X							
30 degree rule for buildings met, collector											
No objects > 1 m height within 5 m radius, collector	X		X	X						X	X
No fences > 1 m height inside 5 m radius, collector	X										X
No vegetation height > 0.6 m within 5 m radius, collector		X	X	X							
No treated lumber inside 5 m radius, collector											X
No galvanized metal inside 5 m radius collector	X						X			X	X
No pastures and agricultural activity within 20 m radius collector	N/A			N/A					X		
No herbicides and fertilizers within 20 m radius collector	N/A			N/A							
Roads meet NADP siting criteria											
Waterways meet NADP siting criteria											
Airports meet NADP siting criteria											X
Combustion sources meet NADP siting criteria											
Parking lots and maintenance areas meet NADP siting criteria											
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria											
Metalworking operations meet NADP siting criteria											
Dry side bucket clean											
Does lid seal properly											
Lid liner in good condition											
Fan in good condition											
Cooling fan thermostat in good condition											
Heater in good condition						N/A	N/A	N/A			
Heater thermostat in good condition						N/A					
Has flush wall filter mount been installed			X								
Filter in good condition	U to T		N/A								
Max / min thermometer in acceptable limits			X								
ACM Sensor operates properly		X									
Motorbox operates within acceptable limits											
Turn over set properly	X	X	N/A	N/A	X	N/A	X	X	N/A	N/A	N/A
Rain gage operates properly	N/A	N/A			N/A		N/A	N/A		X	
Does datalogger receive event signals from all collectors	N/A	N/A			N/A		N/A	N/A		X	
Does optical sensor respond to "blocking" of light beam	N/A	N/A			N/A		N/A	N/A			
Does optical sensor respond to mist of water	N/A	N/A			N/A		N/A	N/A			

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 2-A. Findings Most Likely to Impact Data Quality - MDN Sites with ACM Collector (page 2 of 2)

	MO46	PA00	PA13	PA30	PA42	PA47	PA60	PA90	WI36
Is sampling media quality maintained				X					
Is the orifice of the collector +/- .3 m of rain gage	X					X	X		
30 degree rule for buildings met, rain gage									
No objects > 1 m height inside 5 m radius, rain gage			X	X	X		X	X	
No fences > 1 m height inside 2 m radius, rain gage							X		
No vegetation height > 0.6 m within 5 m radius, rain gage				X				X	
Collector and sensor oriented properly									
45 degree rule met, collector								X	
30 degree rule for trees met, collector			X	X	X		X	X	
30 degree rule for buildings met, collector									
No objects > 1 m height within 5 m radius, collector				X	X		X	X	
No fences > 1 m height inside 5 m radius, collector							X		
No vegetation height > 0.6 m within 5 m radius, collector									
No treated lumber inside 5 m radius, collector	X								
No galvanized metal inside 5 m radius collector									
No pastures and agricultural activity within 20 m radius collector		X							
No herbicides and fertilizers within 20 m radius collector		X							
Roads meet NADP siting criteria									
Waterways meet NADP siting criteria				X					
Airports meet NADP siting criteria									
Combustion sources meet NADP siting criteria									
Parking lots and maintenance areas meet NADP siting criteria	X								
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria									
Metalworking operations meet NADP siting criteria									
Dry side bucket clean				X					N/A
Does lid seal properly							X		
Lid liner in good condition									
Fan in good condition	X								
Cooling fan thermostat in good condition									
Heater in good condition						U to T			
Heater thermostat in good condition									
Has flush wall filter mount been installed			X	X	X	X			
Filter in good condition	X		N/A	N/A	N/A	N/A			
Max / min thermometer in acceptable limits							X		
ACM Sensor operates properly	X								
Motorbox operates within acceptable limits									
Turn over set properly		N/A		X	X		X	X	X
Rain gage operates properly	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Does datalogger receive event signals from all collectors	N/A	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Does optical sensor respond to "blocking" of light beam	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Does optical sensor respond to mist of water	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

Table 2-B. Findings Most Likely to Impact Data Quality - MDN Sites with N-CON Collector

	KS03	KS04	KS05	KS24	KS32	KS99	NY06	NY43	OK04	OK06	OK31	PA52
Is sampling media quality maintained												
Is the orifice of the collector +/- .3 m of rain gage								X				
30 degree rule for buildings met, rain gage												
No objects > 1 m height inside 5 m radius, rain gage			X				X	X	X	X	X	X
No fences > 1 m height inside 2 m radius, rain gage								X	X	X	X	
No vegetation height > 0.6 m within 5 m radius, rain gage			X		X							
Collector and sensor oriented properly							X					
45 degree rule met, collector								X				
30 degree rule for trees met, collector			X					X				
30 degree rule for buildings met, collector												
No objects > 1 m height within 5 m radius, collector			X				X	X	X	X	X	X
No fences > 1 m height inside 5 m radius, collector								X	X	X	X	
No vegetation height > 0.6 m within 5 m radius, collector			X		X							X
No treated lumber inside 5 m radius, collector			X									
No galvanized metal inside 5 m radius collector					X		X		X	X	X	
No pastures and agricultural activity within 20 m radius collector				X							X	
No herbicides and fertilizers within 20 m radius collector												
Roads meet NADP siting criteria				X								
Waterways meet NADP siting criteria												
Airports meet NADP siting criteria												
Combustion sources meet NADP siting criteria												
Parking lots and maintenance areas meet NADP siting criteria												
Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria												
Metalworking operations meet NADP siting criteria												
Turn over set properly	N/A	N/A	N/A	N/A	X	N/A	N/A	N/A	N/A	N/A	N/A	X
Rain gage operates properly					N/A							N/A
Does datalogger receive event signals from all collectors					N/A							N/A
Does optical sensor respond to "blocking" of light beam					N/A							N/A
Does optical sensor respond to mist of water					N/A							N/A
Lid seal in good condition												
Lid liner in good condition												
Fan in good condition												
Cooling fan thermostat in good condition												
Heater in good condition					U to T							
Heater thermostat in good condition					U to T							
Max / min thermometer in acceptable limits									X			
Does sensor respond to a 20-second mist of water												

X Indicates found non-compliant

U to T Indicates "Unable to Test"

N/A Indicates " Not Applicable"

APPENDIX C

Suggested Modifications to the Site Survey Questionnaire

Table of Questions Requiring Revision and Action Taken

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Site Information		
Non-NADP precipitation chemistry	Clarify - only if not removed from NTN sample?	Delete question (same as question in Field Lab Form)
Date of rescheduled survey	Would like to remove question. Rescheduled survey would have a survey date, canceled survey will not be submitted	Delete question (new survey date will be survey date)
Operator is competent	We recommend removing both of these questions and creating one that asks "recommend operator attend NADP training class". If assessment indicates that the operator would benefit from additional training, question will be asked positively: Example: "Has site operator attended training? Would site operator like to attend training?"	Replace both of these questions with new question "Site operator not recommended or interested in attending training course"
No CAL/HAL follow-up needed with operator on technique		
Does operator check sensor heater before and after collector opening?	We recommend changing to after activating. Site operator does not say... Cannot tell by touch if heated by sun, or even warm. Could be applied for winter.	No change - stress the need for testing. Sensor should not be heating at temps above 40.
→	We want to add Site Supervisor to EEMS db →	Add new field to database: Site Supervisor contact name
→	We want to add Site Supervisor information to EEMS db →	Add new fields to database: Site Supervisor phone number, email address

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Siting Criteria		
No significant changes to local site conditions within 500 meters of the collector since previous survey	Is equipment relocation or replacement considered a significant change? How far does it have to move before it is significant?	Only means new buildings, clear cutting, new agriculture activity, items not on site sketch
Site Type	Suggest that we delete from EEMS db. We would need to research to answer accurately. Currently based on census information	Data would remain pre-populated. Change the available response to "agree" "not certain" "undesignated"
Raingage mounting	Minimum height for "stand-on" platform? (NY67, NY98)	No minimum height - if you can stand on it, it is a platform
Raingage ground cover, 30 m radius	Do platforms count as natural?	Consider features not identified in site sketch. Site should represent surroundings (no over mowing)
No objects > 1 m height inside 5 m radius (raingage)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of gage**.**
No fences > 1 m height inside 2 m radius (raingage)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of gage.
No vegetation height > 0.6 m within 5 m radius (raingage)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of gage.
Collector mounting	Minimum height for "stand-on" platform? (NY67, NY98)	No minimum height - if you can stand on it, it is a platform

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Collector ground cover, 30 m radius	Do platforms count as natural?	Consider features not identified in site sketch. Site should represent surroundings (no over mowing)
No objects > 1 m height within 5 m radius (collector)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of collector legs.
No fences > 1 m height inside 5 m radius (collector)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of collector legs.
No vegetation height > 0.6 m within 5 m radius (collector)	Criteria says from the base of collector... ?	Greater than 1 meter height starting from bottom of collector legs.
No treated lumber inside 5 m radius (collector)	Is old treated wood allowed? Do posts under decks count?	Include any, without regard to age. Elaborate in comments section
No galvanized metal inside 5 m radius collector (MDN)	How much?	Include comments as to type and how much. Elaborate in comments section.
ACM Collector		
Were the correct fuses found	We have found collectors labeled with 1 amp and 1/2 amp. We will make sure the fuse matches the collector. Where not labeled, we will assume 1/2 amp?	Mark checking with Tim to determine fuse preference - we will label motorboxes if miss-labeled
Order replacement ACM battery	Who provides batteries? Collectors and gages?	Response intended for site supervisors, no change
Dry side bucket is clean	Clarify - just the rim?	Still assess condition and replacement procedures for both NTN and MDN

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Overflow bucket in good condition	We would like to discuss the purpose of the question and overflow bucket and causes of leaks. Also inlet heater	Provided input to Bob and Gerard regarding source of leaks
Max / min thermometer in acceptable limits	What is acceptable limit... 5 degrees?	Five degrees C is acceptable
Dry side bag installed correctly	About things in the bucket to hold the bag down	Okay to add things to hold bag down - Adding following question
→	Add new question? →	"Is quantity of liquid in dry side bag assessed and reported?"
Hight of both dry and wet bucket holders	Currently in inches	Request change to cm
Correct sensor grid type	We recommend changing question to number of grids present... Some sites use more sensitive grid to improve collection.	Changing the response field to number of grids with acceptable answers, 7 and 11
Does sensor respond to a drop of water	Would like to clarify question to "one drop of water"	Change question to "one" instead of "a". A "no" response would also mean sensor <u>does not</u> operate properly.
Temperature of sensor inactivated (deg. C)	Still need clarification about sensor "warming"	Sensor is not supposed to warm when inactive and above 40 C
Maximum temperature = <10 minutes (deg. C)	Not having trouble with measurements, but we suggest not insulating the sensor during test to make it more "real-world"	Do not insulate the sensor during test

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Motorbox operates within acceptable limits	Is there another quantitative test other than 2 weights?	2 weights is the only test
N-CON Collector		
Were the correct fuses found?	N-CON manual has fuse listed as 10 and 7	Discussed with Jack - 10 amp is preferred - he will make sure they are labeled - we will also label in field
Max / min thermometer in acceptable limits	What is acceptable limit... 5 degrees?	Five degrees C is acceptable
Temperature of enclosure	Currently reported in degrees F	Request change to C
Belfort		
Order replacement pen nibs	Can they use felt pens?	Add felt tip pens to supply list (well pens are $60 each! - suggest operator try cleaning before ordering)
Field Lab		
Does site conduct field chemistry	Question similar to # 12 on Site Information. Removed from NTN sample?	Only "yes" if removed from NTN sample - new procedure - pour 75 ml into NTN bottle and seal - use bucket for other
Measured conductivity of audit sample	Is there a criterion?	Discussed with Jane - not as tight as lab tolerance - send remaining audit sample back to Jane

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
Measured pH of audit sample	Is there a criterion?	Discussed with Jane - not as tight as lab tolerance - send remaining audit sample back to Jane
Temperature of blank bottles in refrigerator	Is there a criterion? Degrees C or F	Modify question: Temperature of blank bottles and samples in refrigerator (C) Should be 4 degrees C
Supplies		
Sample mailers on hand Black Box w/blue tape	No one uses black box mailers... Is this question needed?	Remove question
Temperature blank bottles on hand	Are blanks sent with each sample mailing and should they have a supply of "blank bottles"	Remove question - same as #18 above
Order gloves	Clarify - specific from each lab?	MDN (gloves from HAL) must be used for MDN procedures - CAL gloves should be used for NTN and AIRMoN
Stick Gage		
1.21 Inch Calibration Check - PASSED	We would like to calculate challenge depths based on the actual diameters these could be different for each gage and entered like Belfort calibration or balance calibration	New question - adding 500 ml to tube and calculating challenge depth - reporting standard and response: 500 ml test challenge

Table of Questions Requiring Revision and Action Taken *(continued)*

Question as it Currently Exists in Questionnaire	Issues with the questions	Decision Made, Possible Solution or Clarification
2.43 Inch Calibration Check - PASSED		New question - adding 1000 ml to tube and calculating challenge depth - reporting standard and response: 1000 ml test challenge
→	Would like to add question regarding diameter of funnel →	New question : Diameter of funnel
→	Would like to add question regarding diameter tube →	New question: Diameter of tube
Backup Gage		
No objects > 1 m height inside 5 m radius (backup raingage)	Same as siting criteria questions	Greater than 1 meter height starting from bottom of gage.
No fences > 1 m height inside 2 m radius (backup raingage)	Same as siting criteria questions	Greater than 1 meter height starting from bottom of gage.
No vegetation height > 0.6 m within 5 m radius (backup raingage)	Same as siting criteria questions	Greater than 1 meter height starting from bottom of gage.

APPENDIX D

Transfer Standard Instrument Certifications

Certificate of Calibration

Customer: EE & MS
1950 NW 39TH PLACE
GAINESVILLE, FL 32605
352-317-2463

P.O. Number: HOLD

ID Number: 01310

Description:	MULTIMETER	Calibration Date:	12/17/2010
Manufacturer:	FLUKE	Calibration Due:	12/17/2011
Model Number:	187	Procedure:	TMI-M-DMM Rev: 7/1/2008
Serial Number:	86590148	Temperature:	73 °F
Technician:	JIM HYATT	Humidity:	32 % RH
		As Found Condition:	**IN TOLERANCE**
On-Site Calibration: ☐		**Calibration Results:**	**IN TOLERANCE**

Comments:

Limiting Attribute:

This instrument has been calibrated using standards traceable to the National Institute of Standards and Technology, derived from natural physical constants, ratio measurements or compared to consensus standards. Unless otherwise noted, the method of calibration is direct comparison to a known standard.

Reported uncertainties and "test uncertainty ratios" (TUR's) are expressed as expanded uncertainty values at approximately 95% confidence level using a coverage factor of K-2. A TUR of 4:1 is routinely observed between the accuracy of the reference standard and the tolerance of the UUT unless otherwise noted on the certificate. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System complies with the requirements of ISO 9001, ANSI/NCSL Z540-1, 10 CFR 50 Appendix B and 10 CFR Part 21.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

TONY ROGERS, BRANCH MANAGER

JACK SHULER, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Serial Number	Cal Due
7040208	FLUKE	5520A	7040208	4/14/2011

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
Phone: 813-978-3054 Fax 813-978-3758
www.tmicalibration.com

ISO 9001:2008
ANSI/NCSL Z540-1-1994

INSTRUMENT DATA SHEET

Asset Number: 01310 Customer: EE & MS
Date Tested: 12/17/2010

Parameter Tested	Nominal Value	Tolerance	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
DC Voltage Calibration							
mV Range	45.000mV	±(0.1% + 20 dgts)	44.935	45.065	45.009mV	Pass	As Found
	450.00mV	±(0.03% + 2 dgts)	449.84	450.16	450.02mV	Pass	As Found
	900.0mV	±(0.025% + 5 dgts)	899.3	900.7	900.1mV	Pass	As Found
	2100.0mV	±(0.025% + 5 dgts)	2099.0	2101.0	2100.1mV	Pass	As Found
	2700.0mV	±(0.025% + 5 dgts)	2698.8	2701.2	2700.2mV	Pass	As Found
	-2700.0mV	±(0.025% + 5 dgts)	-2701.2	-2698.8	-2700.0mV	Pass	As Found
V Range	4.5000V	±(0.025% + 10 dgts)	4.4979	4.5021	4.5003 V	Pass	As Found
	45.000V	±(0.03% + 3 dgts)	44.983	45.017	45.002 V	Pass	As Found
	450.00V	±(0.1% + 2 dgts)	449.53	450.47	450.01 V	Pass	As Found
	900.0V	±(0.1% + 2 dgts)	898.9	901.1	900.0 V	Pass	As Found
AC Voltage Calibration							
mV Range	45mV@40Hz	±(2% + 80 dgts)	44.020	45.980	45.032mV	Pass	As Found
	45mV@9kHz	±(5% + 40 dgts)	42.710	47.290	43.594mV	Pass	As Found
	45mV@19kHz	±(5.5% + 40 dgts)	42.485	47.515	43.419mV	Pass	As Found
	43mV@100kHz	±(15% + 40 dgts)	36.510	49.490	41.032mV	Pass	As Found
	450mV@40Hz	±(1% + 80 dgts)	440.20	459.80	450.43mV	Pass	As Found
	450mV@9kHz	±(5% + 40 dgts)	427.10	472.90	434.85mV	Pass	As Found
	450mV@19kHz	±(5.5% + 40 dgts)	424.85	475.15	433.71mV	Pass	As Found
	450mV@100kHz	±(8% + 40 dgts)	413.60	486.40	431.90mV	Pass	As Found
	2700mV@40Hz	±(2% + 80 dgts)	2638.0	2762.0	2691.1mV	Pass	As Found
	2700mV@9kHz	±(0.4% + 40 dgts)	2685.2	2714.8	2699.2mV	Pass	As Found
	2700mV@19kHz	±(1.5% + 40 dgts)	2655.5	2744.5	2694.4mV	Pass	As Found
	2700mV@100kHz	±(8% + 40 dgts)	2480.0	2920.0	2740.9mV	Pass	As Found
V Range	4.5V@40Hz	±(2% + 80 dgts)	4.4020	4.5980	4.4941 V	Pass	As Found
	4.5V@9kHz	±(0.4% + 40 dgts)	4.4780	4.5220	4.4997 V	Pass	As Found
	4.5V@19kHz	±(1.5% + 40 dgts)	4.4285	4.5715	4.4944 V	Pass	As Found
	4.5V@100kHz	±(8% + 40 dgts)	4.1360	4.8640	4.4315 V	Pass	As Found
	45V@400Hz	±(0.4% + 40 dgts)	44.780	45.220	45.025 V	Pass	As Found
	45V@9kHz	±(0.4% + 40 dgts)	44.780	45.220	45.078 V	Pass	As Found
	45V@19kHz	±(1.5% + 40 dgts)	44.285	45.715	45.243 V	Pass	As Found
	45V@100kHz	±(8% + 40 dgts)	41.360	48.640	44.970 V	Pass	As Found
	450V@400Hz	±(0.4% + 40 dgts)	447.80	452.20	450.30 V	Pass	As Found
	450V@9kHz	±(0.4% + 40 dgts)	447.80	452.20	450.98 V	Pass	As Found
	900V@400Hz	±(0.4% + 40 dgts)	892.4	907.6	900.1 V	Pass	As Found
	900V@9kHz	±(0.4% + 40 dgts)	892.4	907.6	902.3 V	Pass	As Found
dBV	0.7943V@1kHz	±0.10	-2.10	-1.90	-1.98 dB	Pass	As Found
	1V@1kHz	±0.10	-0.1	0.1	0.01 dB	Pass	As Found
	316.228V@1kHz	±0.10	49.90	50.10	50.00 dB	Pass	As Found

INSTRUMENT DATA SHEET

Parameter Tested	Nominal Value		Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
Resistance Calibration					(Ω)		
	190.00Ω	±(0.05% + 10 dgts)	189.80	190.20	190.16	Pass	As Found
	1.9000KΩ	±(0.05% + 2 dgts)	1.8988	1.9012	1.9002k	Pass	As Found
	19.000KΩ	±(0.05% + 2 dgts)	19.988	19.012	19.000k	Pass	As Found
	190.00KΩ	±(0.05% + 2 dgts)	189.88	190.12	190.02k	Pass	As Found
	1.9000MΩ	±(0.15% + 4 dgts)	1.8967	1.9033	1.9006M	Pass	As Found
	19.000MΩ	±(1% + 4 dgts)	18.806	19.194	19.012M	Pass	As Found
	100.0MΩ	±(3% + 2 dgts)	89.9	110.2	99.8M	Pass	As Found
nS (100Mohms)	10nS	±(1% + 10 dgts)	9.80	10.20	10.02nS	Pass	As Found
Capacitance Calibration					(F)		
	9.00nF	±(1% + 5 dgts)	8.86	9.14	9.04n	Pass	As Found
	90.0nF	±(1% + 5 dgts)	88.6	91.4	90.1n	Pass	As Found
	0.900µF	±(1% + 5 dgts)	0.886	0.914	0.900µ	Pass	As Found
	1.40µF	±(1% + 5 dgts)	1.34	1.46	1.40µ	Pass	As Found
Temperature					(°C)		
	0°C	±(1%rdg + 1°C)	-1.0	-1.0	0.02	Pass	As Found
	350°C	±(1%rdg + 1°C)	345.5	354.5	351.2	Pass	As Found
DC Current Calibration					(A)		
uA	450.00	±(0.25% + 20 dgts)	448.67	451.33	450.13µ	Pass	As Found
	4500.0	±(0.25% + 2 dgts)	4488.5	4511.5	4500.4µ	Pass	As Found
mA	45.000	±(0.15% + 10 dgts)	44.922	45.078	45.040m	Pass	As Found
	360.00	±(0.15% + 2 dgts)	359.44	360.56	360.25m	Pass	As Found
A	4.5	±(0.5% + 10 dgts)	4.4765	4.5235	4.5024	Pass	As Found
	9	±(0.5% + 2 dgts)	8.953	9.047	9.004	Pass	As Found
AC Current Calibration					(A)		
uA@400Hz	450.00	±(0.75% + 20 dgts)	446.42	453.58	450.35µ	Pass	As Found
	4500.0	±(0.75% + 5 dgts)	4465.7	4534.3	4503.3µ	Pass	As Found
mA@400Hz	45.000	±(0.75% + 20 dgts)	44.642	45.358	45.046m	Pass	As Found
	360.00	±(0.75% + 5 dgts)	357.25	362.75	360.44m	Pass	As Found
A@400Hz	4.5000	±(1.5% + 20 dgts)	4.4305	4.5695	4.5037	Pass	As Found
	9.000	±(1.5% + 5 dgts)	8.860	9.140	9.008	Pass	As Found
Frequency Calibration					(Hz)		
Hz	450.00 Hz	±(0.005% + 1 dgts)	449.97	450.03	450.01	Pass	As Found
kHz	4.5000 KHz	±(0.005% + 1 dgts)	4.4997	4.5003	4.5001k	Pass	As Found
	45.000 KHz	±(0.005% + 1 dgts)	44.997	45.003	45.001k	Pass	As Found

Certificate Number
A840844

Certificate of Calibration

Customer: EE & MS
1950 NW 39TH PLACE
GAINESVILLE, FL 32605
352-317-2463

P.O. Number: HOLD

ID Number: 01311

Description:	MULTIMETER	Calibration Date:	12/17/2010
Manufacturer:	FLUKE	Calibration Due:	12/17/2011
Model Number:	287	Procedure:	TMI-M-DMM Rev: 7/1/2008
Serial Number:	95740135	Temperature:	73 °F
Technician:	JIM HYATT	Humidity:	32 % RH
		As Found Condition:	**IN TOLERANCE**
On-Site Calibration: ☐		**Calibration Results:**	**IN TOLERANCE**
Comments:			

Limiting Attribute:

This instrument has been calibrated using standards traceable to the National Institute of Standards and Technology, derived from natural physical constants, ratio measurements or compared to consensus standards. Unless otherwise noted, the method of calibration is direct comparison to a known standard.

Reported uncertainties and "test uncertainty ratios" (TUR's) are expressed as expanded uncertainty values at approximately 95% confidence level using a coverage factor of K-2. A TUR of 4:1 is routinely observed between the accuracy of the reference standard and the tolerance of the UUT unless otherwise noted on the certificate. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System complies with the requirements of ISO 9001, ANSI/NCSL Z540-1, 10 CFR 50 Appendix B and 10 CFR Part 21.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

TONY ROGERS, BRANCH MANAGER

JACK SHULER, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Serial Number	Cal Due
7040208	FLUKE	5520A	7040208	4/14/2011

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
Phone: 813-978-3054 Fax 813-978-3758
www.tmicalibration.com

ISO 9001:2008
ANSI/NCSL Z540-1-1994

INSTRUMENT DATA SHEET

Asset Number: 01311 Customer: EE & MS
Date Tested: 12/17/2010

Parameter Tested	Nominal Value	Tolerance	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
DC Voltage							
50m Volt range	45mV		44.957	45.043	45.001mV	Pass	As Found
500m Volt range	450mV		449.87	450.13	449.98mV	Pass	As Found
5 Volt range	1.5V		1.4994	1.5006	1.5000 V	Pass	As Found
	3.5V		3.4989	3.5011	3.4999 V	Pass	As Found
	4.5V		4.4987	4.5013	4.4999 V	Pass	As Found
50 Volt range	45V		44.987	45.013	44.998 V	Pass	As Found
500 Volt Range	450V		449.84	450.16	449.98 V	Pass	As Found
1000 Volt range	900V		899.5	900.5	900.0 V	Pass	As Found
AC Voltage					(V)		
50m Volt Range	45/20 Hz		44.265	45.735	44.921m	Pass	As Found
	45/65 Hz		44.840	45.160	45.020m	Pass	As Found
	45/10k Hz		44.795	45.205	44.998m	Pass	As Found
	45/20k Hz		44.645	45.355	44.904m	Pass	As Found
	45/65k Hz		43.385	46.615	43.773m	Pass	As Found
	45/100k Hz		42.260	47.740	42.284m	Pass	As Found
500m Volt range	450/20 Hz		442.65	457.35	448.79m	Pass	As Found
	450/65 Hz		448.40	451.60	449.80m	Pass	As Found
	450/10k Hz		447.95	452.05	450.90m	Pass	As Found
	450/20k Hz		446.45	453.55	451.27m	Pass	As Found
	450/100k Hz		433.85	466.15	455.70m	Pass	As Found
5 Volt range	4.5/20 Hz		4.4265	4.5735	4.5346	Pass	As Found
	4.5/65 Hz		4.4840	4.5160	4.5072	Pass	As Found
	4.5/10k Hz		4.4705	4.5295	4.5182	Pass	As Found
	4.5/20k Hz		4.4285	4.5715	4.5329	Pass	As Found
	4.5/65k Hz		4.3385	4.6615	4.5771	Pass	As Found
	4.5/100k Hz		4.2260	4.7740	4.6127	Pass	As Found
50 Volt range	45/65 Hz		44.840	45.160	45.042	Pass	As Found
	45/10k Hz		44.795	45.205	45.079	Pass	As Found
	45/20k Hz		44.645	45.355	45.125	Pass	As Found
	45/100k Hz		43.385	46.615	45.165	Pass	As Found
500 Volt range	450/65 Hz		448.40	451.60	450.20	Pass	As Found
	450/10k Hz		447.95	452.05	450.35	Pass	As Found
1000 Volt range	900/65 Hz		894.8	905.2	900.1	Pass	As Found
	900/10k Hz		893.9	906.1	901.9	Pass	As Found

INSTRUMENT DATA SHEET

Parameter Tested	Nominal Value	Tolerance	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
					(A)		
DC Current	450uA		449.46	450.54	450.00µ	Pass	As Found
	4500uA		4496.4	4503.6	4500.0µ	Pass	As Found
	45mA		44.967	45.033	45.000m	Pass	As Found
	360mA		359.44	360.56	360.00m	Pass	As Found
	4.5A		4.4855	4.5145	4.5000	Pass	As Found
	9A		8.971	9.029	9.000	Pass	As Found
					(A)		
AC Current	450uA/40 Hz		445.30	454.70	452.11µ	Pass	As Found
	450uA/5k Hz		447.10	452.90	449.84µ	Pass	As Found
	4500uA/400 Hz		4472.5	4527.5	4501.9µ	Pass	As Found
	4500uA/5k Hz		4472.0	4528.0	4500.3µ	Pass	As Found
	360mA/40 Hz		356.35	363.65	360.06m	Pass	As Found
	360mA/5k Hz		354.50	365.50	360.1m	Pass	As Found
	9A/40 Hz		8.860	9.140	8.993	Pass	As Found
	9A/5k Hz		8.720	9.280	8.981	Pass	As Found
Resistance					(Hz)		
50	45		44.912	45.088	45.004	Pass	As Found
500	450		449.67	450.33	450.02	Pass	As Found
5k	4.5K		4.4975	4.5025	4.502k	Pass	As Found
50k	45k		44.975	45.025	45.002	Pass	As Found
500k	450k		449.75	450.25	450.01	Pass	As Found
5M	4.5M		4.4928	4.5072	4.5010M	Pass	As Found
Capacitance					(F)		
10n	0.009u		8.86	9.14	9.03n	Pass	As Found
100n	0.09u		88.6	91.4	89.8n	Pass	As Found
1u	0.9u		0.886	0.914	0.899µ	Pass	As Found
10u	9u		8.86	9.14	8.99µ	Pass	As Found
100u	90u		88.6	91.4	89.9µ	Pass	As Found
1000u	900u		886	914	899µ	Pass	As Found
10m	9m		8.86	9.14	9.00m	Pass	As Found
100m	90m		86.2	93.8	89.1m	Pass	As Found

Certificate of Calibration

Customer: EE & MS
1950 NW 39TH PLACE
GAINESVILLE, FL 32605
352-317-2463

P.O. Number: HOLD

ID Number: 01312

Description:	MULTIMETER	Calibration Date:	12/17/2010
Manufacturer:	FLUKE	Calibration Due:	12/17/2011
Model Number:	287	Procedure:	TMI-M-DMM Rev: 7/1/2008
Serial Number:	95740243	Temperature:	73 °F
Technician:	JIM HYATT	Humidity:	32 % RH
		As Found Condition:	**IN TOLERANCE**
On-Site Calibration: ☐		**Calibration Results:**	**IN TOLERANCE**

Comments:

Limiting Attribute:

This instrument has been calibrated using standards traceable to the National Institute of Standards and Technology, derived from natural physical constants, ratio measurements or compared to consensus standards. Unless otherwise noted, the method of calibration is direct comparison to a known standard.

Reported uncertainties and "test uncertainty ratios" (TUR's) are expressed as expanded uncertainty values at approximately 95% confidence level using a coverage factor of K-2. A TUR of 4:1 is routinely observed between the accuracy of the reference standard and the tolerance of the UUT unless otherwise noted on the certificate. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System complies with the requirements of ISO 9001, ANSI/NCSL Z540-1, 10 CFR 50 Appendix B and 10 CFR Part 21.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

TONY ROGERS, BRANCH MANAGER

JACK SHULER, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Serial Number	Cal Due
7040208	FLUKE	5520A	7040208	4/14/2011

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
Phone: 813-978-3054 Fax 813-978-3758
www.tmicalibration.com

ISO 9001:2008
ANSI/NCSL Z540-1-1994

INSTRUMENT DATA SHEET

Asset Number: 01312 Customer: EE & MS
Date Tested: 12/17/2010

Parameter Tested	Nominal Value	Tolerance	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
DC Voltage							
50m Volt range	45mV		44.957	45.043	45.020mV	Pass	As Found
500m Volt range	450mV		449.87	450.13	450.01mV	Pass	As Found
5 Volt range	1.5V		1.4994	1.5006	1.5000 V	Pass	As Found
	3.5V		3.4989	3.5011	3.5000 V	Pass	As Found
	4.5V		4.4987	4.5013	4.4999 V	Pass	As Found
50 Volt range	45V		44.987	45.013	44.999 V	Pass	As Found
500 Volt Range	450V		449.84	450.16	449.98 V	Pass	As Found
1000 Volt range	900V		899.5	900.5	900.0 V	Pass	As Found
AC Voltage					(V)		
50m Volt Range	45/20 Hz		44.265	45.735	44.908m	Pass	As Found
	45/65 Hz		44.840	45.160	45.004m	Pass	As Found
	45/10k Hz		44.795	45.205	44.992m	Pass	As Found
	45/20k Hz		44.645	45.355	44.924m	Pass	As Found
	45/65k Hz		43.385	46.615	43.986m	Pass	As Found
	45/100k Hz		42.260	47.740	42.767m	Pass	As Found
500m Volt range	450/20 Hz		442.65	457.35	448.80m	Pass	As Found
	450/65 Hz		448.40	451.60	449.75m	Pass	As Found
	450/10k Hz		447.95	452.05	450.90m	Pass	As Found
	450/20k Hz		446.45	453.55	451.27m	Pass	As Found
	450/100k Hz		433.85	466.15	455.70m	Pass	As Found
5 Volt range	4.5/20 Hz		4.4265	4.5735	4.5346	Pass	As Found
	4.5/65 Hz		4.4840	4.5160	4.5072	Pass	As Found
	4.5/10k Hz		4.4705	4.5295	4.5182	Pass	As Found
	4.5/20k Hz		4.4285	4.5715	4.5329	Pass	As Found
	4.5/65k Hz		4.3385	4.6615	4.5771	Pass	As Found
	4.5/100k Hz		4.2260	4.7740	4.6127	Pass	As Found
50 Volt range	45/65 Hz		44.840	45.160	45.042	Pass	As Found
	45/10k Hz		44.795	45.205	45.079	Pass	As Found
	45/20k Hz		44.645	45.355	45.125	Pass	As Found
	45/100k Hz		43.385	46.615	45.165	Pass	As Found
500 Volt range	450/65 Hz		448.40	451.60	450.20	Pass	As Found
	450/10k Hz		447.95	452.05	450.35	Pass	As Found
1000 Volt range	900/65 Hz		894.8	905.2	900.1	Pass	As Found
	900/10k Hz		893.9	906.1	901.9	Pass	As Found

INSTRUMENT DATA SHEET

Parameter Tested	Nominal Value	Tolerance	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
					(A)		
DC Current	450uA		449.46	450.54	450.00µ	Pass	As Found
	4500uA		4496.4	4503.6	4500.0µ	Pass	As Found
	45mA		44.967	45.033	45.000m	Pass	As Found
	360mA		359.44	360.56	360.00m	Pass	As Found
	4.5A		4.4855	4.5145	4.5000	Pass	As Found
	9A		8.971	9.029	9.000	Pass	As Found
					(A)		
AC Current	450uA/40 Hz		445.30	454.70	452.11µ	Pass	As Found
	450uA/5k Hz		447.10	452.90	449.84µ	Pass	As Found
	4500uA/400 Hz		4472.5	4527.5	4501.9µ	Pass	As Found
	4500uA/5k Hz		4472.0	4528.0	4500.3µ	Pass	As Found
	360mA/40 Hz		356.35	363.65	360.06m	Pass	As Found
	360mA/5k Hz		354.50	365.50	360.1m	Pass	As Found
	9A/40 Hz		8.860	9.140	8.993	Pass	As Found
	9A/5k Hz		8.720	9.280	8.981	Pass	As Found
Resistance					(Hz)		
50	45		44.912	45.088	45.004	Pass	As Found
500	450		449.67	450.33	450.02	Pass	As Found
5k	4.5K		4.4975	4.5025	4.502k	Pass	As Found
50k	45k		44.975	45.025	45.002	Pass	As Found
500k	450k		449.75	450.25	450.01	Pass	As Found
5M	4.5M		4.4928	4.5072	4.5010M	Pass	As Found
Capacitance					(F)		
10n	0.009u		8.86	9.14	9.03n	Pass	As Found
100n	0.09u		88.6	91.4	89.8n	Pass	As Found
1u	0.9u		0.886	0.914	0.899µ	Pass	As Found
10u	9u		8.86	9.14	8.99µ	Pass	As Found
100u	90u		88.6	91.4	89.9µ	Pass	As Found
1000u	900u		886	914	899µ	Pass	As Found
10m	9m		8.86	9.14	9.00m	Pass	As Found
100m	90m		86.2	93.8	89.1m	Pass	As Found

Certificate Number
A845488

Certificate of Calibration

Customer: EE & MS
1950 NW 39TH PLACE
GAINESVILLE, FL 32605
352-317-2463

P.O. Number: HOLD

ID Number: 01231

Description:	TEMPERATURE PROBE	Calibration Date:	12/29/2010
Manufacturer:	UNKNOWN	Calibration Due:	12/29/2011
Model Number:	SP034-39	Procedure:	TMI-M-THERMOMETER Rev: 6/30/1998
Serial Number:	01H0060	Temperature:	68.6 °F
Technician:	RYAN FILSON	Humidity:	31 % RH
		As Found Condition:	**IN TOLERANCE**
On-Site Calibration: ☐		**Calibration Results:**	**IN TOLERANCE**

Comments:

Limiting Attribute:

This instrument has been calibrated using standards traceable to the National Institute of Standards and Technology, derived from natural physical constants, ratio measurements or compared to consensus standards. Unless otherwise noted, the method of calibration is direct comparison to a known standard.

Reported uncertainties and "test uncertainty ratios" (TUR's) are expressed as expanded uncertainty values at approximately 95% confidence level using a coverage factor of K-2. A TUR of 4:1 is routinely observed between the accuracy of the reference standard and the tolerance of the UUT unless otherwise noted on the certificate. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System complies with the requirements of ISO 9001, ANSI/NCSL Z540-1, 10 CFR 50 Appendix B and 10 CFR Part 21.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

MILT MOSHER, BRANCH MANAGER

JACK SHULER, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Serial Number	Cal Due
ATL254	HART SCIENTIFIC	1502A	A33140	7/15/2012
ATL255	HART SCIENTIFIC	5626	0662	7/15/2012
ATL259	HART SCIENTIFIC	9103-A	A21317	11/8/2012

TMI Technical Maintenance, Inc.
3000 NORTHWOODS PKWY STE 270, NORCROSS, GA 30071
Phone: 770-409-8348 Fax 770-409-8349
www.tmicalibration.com

ISO 9001:2008
ANSI/NCSL Z540-1-1994

Certificate Number
A845481

Certificate of Calibration

Customer: EE & MS
1950 NW 39TH PLACE
GAINESVILLE, FL 32605
352-317-2463

P.O. Number: HOLD

ID Number: 01230

Description:	TEMPERATURE INDICATOR	Calibration Date:	12/29/2010
Manufacturer:	EUTECHNICS	Calibration Due:	12/29/2011
Model Number:	4600-1.2.5	Procedure:	TMI-M-THERMOMETER Rev: 6/30/1998
Serial Number:	01D102193	Temperature:	68.6 °F
Technician:	RYAN FILSON	Humidity:	31 % RH
		As Found Condition:	**IN TOLERANCE**
On-Site Calibration: ☐		**Calibration Results:**	**IN TOLERANCE**

Comments:

Limiting Attribute:

This instrument has been calibrated using standards traceable to the National Institute of Standards and Technology, derived from natural physical constants, ratio measurements or compared to consensus standards. Unless otherwise noted, the method of calibration is direct comparison to a known standard.

Reported uncertainties and "test uncertainty ratios" (TUR's) are expressed as expanded uncertainty values at approximately 95% confidence level using a coverage factor of K-2. A TUR of 4:1 is routinely observed between the accuracy of the reference standard and the tolerance of the UUT unless otherwise noted on the certificate. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System complies with the requirements of ISO 9001, ANSI/NCSL Z540-1, 10 CFR 50 Appendix B and 10 CFR Part 21.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

MILT MOSHER, BRANCH MANAGER

JACK SHULER, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Serial Number	Cal Due
ATL254	HART SCIENTIFIC	1502A	A33140	7/15/2012
ATL255	HART SCIENTIFIC	5626	0662	7/15/2012
ATL259	HART SCIENTIFIC	9103-A	A21317	11/8/2012

TMI Technical Maintenance, Inc.
3000 NORTHWOODS PKWY STE 270, NORCROSS, GA 30071
Phone: 770-409-8348 Fax 770-409-8349
www.tmicalibration.com

ISO 9001:2008
ANSI/NCSL Z540-1-1994

INSTRUMENT DATA SHEET

Serial/Asset Number: 01D102193/01230 Customer: EE & MS
Date Tested: 12/29/10 Certificate: A845481

Parameter Tested	Nominal Value In °C	Tolerance ±.13 °C	Lower Limit	Upper Limit	As Found	Pass/Fail	As Left
Temperature Accuracy							
	0.026	0.130	-0.104	0.156	0.03	PASS	AS FOUND
	9.975	0.130	9.845	10.105	9.98	PASS	AS FOUND
	19.942	0.130	19.812	20.072	19.94	PASS	AS FOUND
	30.005	0.130	29.875	30.135	29.98	PASS	AS FOUND
	39.955	0.130	39.825	40.085	39.90	PASS	AS FOUND
	49.941	0.130	49.811	50.071	49.86	PASS	AS FOUND

Weight / Balance Calibration Log

SEG

Date	Balance SN#	Weight SN#	Cal Type	Std. (g)	Act. (g)	Calibrator	Notes
1/2/2011	8028481064	26677	Bal Init	0.00	0.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1500.00	1500.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1000.00	1000.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	500.00	499.96	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	200.00	199.97	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	100.00	99.99	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	50.00	50.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	20.00	20.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	10.00	10.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	5.00	5.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	2.00	2.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1.00	1.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	0.00	0.00	CKH	Initial Balance Check
1/2/2011	8028481064	2-0	Audit		1000.04	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-1			824.12	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-2			823.36	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-3			825.11	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-4			823.70	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-5			823.76	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-6			824.44	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-7			824.87	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-8			824.71	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-9			824.18	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-10			823.74	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-11			823.91	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	2-12			823.38	CKH	Weight Set #2 Belfort
1/2/2011	8028481064	26677	Bal Post	0.00	0.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1500.00	1500.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1000.00	1000.02	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	500.00	499.99	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	200.00	199.98	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	100.00	99.98	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	50.00	49.99	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	20.00	20.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	10.00	10.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	5.00	4.99	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	2.00	2.01	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1.00	1.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	0.00	0.00	CKH	Post Balance Check

Set #2 assigned to Sandy

Calibrator Signature: _____ Date: 1/2/2011

Reviewer Signature: _____ Date: _____

Weight / Balance Calibration Log

EOH

Date	Balance SN#	Weight SN#	Cal Type	Std. (g)	Act. (g)	Calibrator	Notes
1/2/2011	8028481064	26677	Bal Init	0.00	0.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1500.00	1500.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1000.00	1000.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	500.00	499.98	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	200.00	199.97	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	100.00	99.99	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	50.00	49.99	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	20.00	20.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	10.00	10.01	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	5.00	5.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	2.00	2.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	1.00	1.00	CKH	Initial Balance Check
1/2/2011	8028481064	26677	Bal Init	0.00	0.00	CKH	Initial Balance Check
1/2/2011	8028481064	3-10	Audit		1000.87	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-1			823.12	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-2			823.04	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-3			824.44	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-4			824.14	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-5			824.49	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-6			822.47	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-7			823.72	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-8			823.31	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-9			822.93	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-10			823.42	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-11			823.73	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	3-12			823.68	CKH	Weight Set #3 Belfort
1/2/2011	8028481064	E1-1			207.70	CKH	Electronic Cal Weights
1/2/2011	8028481064	E1-2			206.53	CKH	Electronic Cal Weights
1/2/2011	8028481064	E1-3			204.61	CKH	Electronic Cal Weights
1/2/2011	8028481064	E1-4			204.29	CKH	Electronic Cal Weights
1/2/2011	8028481064	26677	Bal Post	0.00	0.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1500.00	1500.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1000.00	1000.02	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	500.00	499.96	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	200.00	199.97	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	100.00	99.98	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	50.00	50.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	20.00	20.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	10.00	9.99	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	5.00	5.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	2.00	2.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	1.00	1.00	CKH	Post Balance Check
1/2/2011	8028481064	26677	Bal Post	0.00	0.00	CKH	Post Balance Check

Set #3 assigned to Eric

Calibrator Signature: _____ Date: 1/2/2011

Reviewer Signature: _____ Date: _____

Warren-Knight Instrument Company
2045 Bennett Road
Philadelphia, PA 19116
Phone: 215-464-9300; Fax: 215-464-9303
Web: http://www.warrenind.com

CERTIFICATION OF CALIBRATION AND CONFORMANCE

We hereby certify that the equipment below has been manufactured and/or inspected by standards traceable to NIST. Calibration of the specified instrument has been performed in compliance with ANSI Z540-1 requirements. It is warranted that the equipment has been calibrated to be in full conformance with the drawings and specifications of the instrument. Calibration tests were performed on the material specified below and were in accordance with all applicable quality assurance requirements with data on file at our facility.

Customer Name:	EE & MS
Purchase Order #:	EOH
Instrument:	S-25 Tracon Surveying Compass
Serial Number:	190037 FEMS # 01265
Quantity:	1
Calibration Due:	1/2012

John Noga

John Noga, Quality Control

January 4, 2011

Measurement Standards:
Theodolite: Wild T-3 S/N 18801/CAL 5/14/97 NIST# 738/229329-83 738/223398
Optical Wedge: K&E 71-7020 S/N 5167/CAL 4/19/01 NIST# 731/244084-89

Warren-Knight Instrument Company
2045 Bennett Road
Philadelphia, PA 19116
Phone: 215-464-9300; Fax: 215-464-9303
Web: http://www.warrenind.com

CERTIFICATION OF CALIBRATION AND CONFORMANCE

We hereby certify that the equipment below has been manufactured and/or inspected by standards traceable to NIST. Calibration of the specified instrument has been performed in compliance with ANSI Z540-1 requirements. It is warranted that the equipment has been calibrated to be in full conformance with the drawings and specifications of the instrument. Calibration tests were performed on the material specified below and were in accordance with all applicable quality assurance requirements with data on file at our facility.

Customer Name:	EE & MS
Purchase Order #:	SDossett
Instrument:	S-25 Tracon Surveying Compass
Serial Number:	192034 EEMS # 01270
Quantity:	1
Calibration Due:	1/2012

John Noga, Quality Control

January 4, 2011

Measurement Standards:
Theodolite: Wild T-3 S/N 18801/CAL 5/14/97 NIST# 738/229329-83 738/223398
Optical Wedge: K&E 71-7020 S/N 5167/CAL 4/19/01 NIST# 731/244084-89

Warren-Knight Instrument Company
2045 Bennett Road
Philadelphia, PA 19116
Phone: 215-464-9300; Fax: 215-464-9303
Web: http://www.warrenind.com

CERTIFICATION OF CALIBRATION AND CONFORMANCE

We hereby certify that the equipment below has been manufactured and/or inspected by standards traceable to NIST. Calibration of the specified instrument has been performed in compliance with ANSI Z540-1 requirements. It is warranted that the equipment has been calibrated to be in full conformance with the drawings and specifications of the instrument. Calibration tests were performed on the material specified below and were in accordance with all applicable quality assurance requirements with data on file at our facility.

Customer Name:	EE & MS
Purchase Order #:	
Instrument:	S-25 Tracon Surveying Compass
Serial Number:	191832 SEG EEMS # 01272
Quantity:	1
Calibration Due:	1/2012

John Noga, Quality Control

January 4, 2011

Measurement Standards:
Theodolite: Wild T-3 S/N 18801/CAL 5/14/97 NIST# 738/229329-83 738/223398
Optical Wedge: K&E 71-7020 S/N 5167/CAL 4/19/01 NIST# 731/244084-89

Certificate No.: 161603-066-121809

Mettler Toledo
Service Business Unit Laboratory
1900 Polaris Parkway
Columbus, OH 43240
1-800-METTLER

METTLER TOLEDO

ISO 9001 : 2000 Registered

Basic Test Confirmation

Customer

Company:	Illinois State Water Survey		
Address:	2204 Griffith Drive		
City:	Champaign	*State/Province:*	Illinois
Zip/Postal:	61820		

Procedure Statement: The device referenced in this document has been metrologically tested in accordance with METTLER TOLEDO Work Instruction VW0152A. All translations into other languages are based on the referenced work instruction, which is in English.
This certificate refers to: As Found and As Left

Test Date:	18-Dec-2009	*Next Cal. Due Date:*	31-Dec-2010
Service Technician:	Warren Lemke	*Signature:*	Warren A. Lemke

Reference Weights

Traceability of Test Equipment: All weights used for metrological testing are traceable to national or international standards. The weights were calibrated and certified by an accredited calibration laboratory.

Weight Set 1

Weight Set No.:	201	*Date of Issue:*	26-Feb-2008
Calibration Due Date:	28-Feb-2010	*NIST Traceability No.*	822/269558-04/MT000603
Class:	F1		

Weight Set 2

Weight Set No.:	442	*Date of Issue:*	25-Mar-2009
Calibration Due Date:	31-Mar-2010	*NIST Traceability No.*	MT5061
Class:	E2		

List of Devices Tested

Manufacturer	*Model*	*Serial No.*	*Ecc*	*Lin*	*Hys*	*Weight Set*	*Ref. Wt. Span*	*AS FOUND*	*AS LEFT*
Denver	P-4002D	P4K2D128001	✔	✔	✔	201	4000.0 g	4001.1 g	4000.0 g
Denver	P-4002D	P4K2D044007	✔	✔	✔	201	4000.0 g	3999.6 g	4000.0 g
Sartorius	IB12EDE-P00	50511901	✔	✔	✔	201	12000.0 g	11999.2 g	12000.2 g
Mettler Toledo	XP8002S	1127021794	✔	✔	✔	201	8000.00 g	7999.91 g	8000.00 g

Remarks

None.