APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

1.0 QUALITY ASSURANCE PROJECT PLAN (QAPP)

A quality assurance project plan (QAPP) is an integral part of the implementation of the Sampling and Analysis Plan (SAP). It specifies the data quality and quantity requirements needed as well as the procedures that will be used to collect, analyze, and report those data. The goal of SAP/QAPP is to collect representative samples which yield results that meet the projects data quality objectives and needs. The goal of quality assurance (QA) and quality control (QC) is to limit errors and bias in sampling and analysis process through an integrated implementation of management, assessment and control measures, thus facilitating the generation of data that is useful for decision making.

The QAPP can include one or more of the following:

- project management, organization and project personnel responsibilities;
- sampling, analysis, and measurement procedures;
- instrument calibration procedures;
- procedures for recording, reducing, validating, and reporting data;
- procedures for performing quality assurance verification and internal quality control checks;
- preventive maintenance schedules;
- specific routine procedures to evaluate;
- precision, accuracy, and completeness;
- steps for addressing deviations from plans and appropriate corrective actions; and
- information on appropriate staff training.

1.1 Project Management

Project organization, roles and responsibilities, training, record keeping, and documentation are discussed in the subsections that follow.

1.1.1 Project Organization Roles

- Project Manager and Technical Lead,
- Quality Assurance/Quality Control (QA/QC) Manager,
- Hydrogeologist/Hydrogeologist,
- Field Operations Manager,
- Soil Scientist,
- Field Engineer,
- Radiation Safety Officer,
- Health and Safety Coordinator,

- Field Crew

1.1.2 Responsibilities

A generalized description of the roles and responsibilities of the staff supporting the implementation on the Plan is as follows:

Project Manage and Technical Lead – provides project oversight, communicate with clients and regulatory representative/personnel, evaluate employee experience by certifying individuals qualified to work at the site and manage personnel.

QA/QC Manager – provides technical review of report(s) including QA/QC of technical data and verify data usability,

Hydrologist/Hydrogeologist –review surface water data and develop sampling plan, coordinate sampling and field activities, communicate with analytical laboratories, evaluate data usability and quality, analyze and interpret data, prepare report(s),

Soil Scientist – provides site materials characterization oversight (including sample plan development for soil characterization, vegetation densities and inventory, and habitat identification), communicate with analytical laboratories, evaluate data usability, data quality, analyze and interpret data, prepare report(s).

Field Operations Manager and Engineer – direct field activities and field sampling procedures, verify sample handling and field measurement procedures follow the SAP, report on status of field activities.

Health and Safety Coordinator – review, approve and implement Health and Safety Plan,

Radiation Safety Officer– provides oversight of field radiological survey, provide radiation safety and survey equipment training,

Field Sampling Crew – conduct field sampling and measurement activities in accordance with approved SAP and implement proper sampling and sample handling procedures.

1.2 Training Requirements

1.2.1 Health and Safety Training

It is recommended that personnel who work on-site have one or more forms of health and safety training. This may include formal Occupational Safety and Health Administration (OSHA) or Mine Safety and Health Administration training as defined in Title 29 of the Code of Federal Regulations (CFR) Part 1910.120(e) and Title 30 CFR Part 46, respectively. Additional training may include: three (3) days of actual on-site field experience under the supervision of a trained and experienced field supervisor; ten (10) hours OSHA construction worker training and radiation safety training. Field personnel who directly supervise employees will go over the health and safety program requirements, training requirements, PPE requirements, and appropriate health-hazard monitoring procedures and techniques. Site-specific training covers the following areas:

- Names of personnel and alternates responsible for health and safety at the site;
- Health and safety hazards that may be present on site;
- Selection of the appropriate personal protection levels;
- Correct use of PPE;
- Work practices to minimize risks from hazards;
- Safe use of equipment on site; and
- The contents of the site-specific health and safety plan.

1.3 Documentation and Records

Documentation is critical for evaluating the success of any environmental data collection activity. The following section discusses the requirements for documenting field activities. Field personnel would use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook would list the contract name and number, the project number, the site name, and the names of subcontractors, the client, and the project manager. At a minimum, the following information would be recorded in the field logbook:

- Names and affiliations of all on-site personnel or visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Sample locations, types, depths, GPS coordinates, and identifiers;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and their resolution;
- Discussions of deviations from the QAPP or other governing documents; and
- Descriptions of all photographs taken.

1.4 Data Acquisition

This section describes the requirements for the following:

- Sampling Design and Data Collection
- Field Activities
- Sample Handling and Custody
- Analytical Methods
- Quality Control Sampling
- Equipment Testing, Inspection, and Maintenance
- Instrument Calibration Procedures
- Inspection and Acceptance Requirements for Supplies and Consumables
- Management of Work Plan Deviations

1.4.1 Sample Design and Data Collection

The sampling design is described in detail in the previous Section entitled "Sampling and Analysis Plan". Global Positioning System (GPS) data will be collected using a Geoexplorer II (Trimble ®) or equivalent and maintained in a database specified for the site. In addition, to logging the data on the GPS unit, GPS coordinates, date, time, and other relevant information (e.g. sample ID, type, etc) will be hand recorded in hard-bound field notebooks or worksheets.

1.4.2 Sampling Method Requirements

Sampling techniques including standard methods, sampling containers and preservation are described in the Section entitled "Sampling and Analysis Plan."

1.4.3 Sample Handling and Custody Requirements

The following subsections describe sample handling procedures, including sample identification, labeling, documentation, Chain of Custody (COC), and shipping.

1.4.3.1 Sample Identification

Each sample collected during site assessment activities will be identified using a unique sample identification (ID) number and cross-referenced to the description of the sample type (water, soil, sediment, waste, etc.), sample collection location and the depth of sample collection in the field notes. The sample ID would be recorded on the COC forms. Field duplicates for aqueous samples would be collected at a frequency of 10 percent for individual sampling events. The duplicate sample would be given an ID similar to the one for the normal sample but with a distinct extension. This way, the sample association would be blind to the laboratory. The association between normal and duplicate sample would be noted in the log book and/or sampling forms.

1.4.3.2 Sample Labels

Labels would be affixed to each sample container. The label would be completed with the following information written in indelible ink:

- Project name and location
- Sample identification number
- Date and time of sample collection
- Preservative used (if any)
- Sample collector's initials
- Analysis required
- And refrigerated (if necessary) by placing on ice in a cooler.

1.4.3.3 Sample Documentation

Documentation during sampling is essential to promote proper sample identification. Field personnel would adhere to the following general guidelines for maintaining field documentation:

- Documentation would be completed in permanent black or blue ink.
- All entries would be legible.
- Errors would be corrected by crossing out the entry with a single line and then dating and initialing the lineout.
- Any serialized documents would be maintained and referenced in the site logbook.
- Unused portions of pages would be crossed out, and each page would be signed and dated.

1.4.3.4 Chain of Custody (COC)

Field personnel would use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. COC procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The COC form would be used to document all samples collected and the analyses requested. Information that the field personnel would record on the COC form includes:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of sample (laboratory name)

- Sample ID
- Date and time of collection
- Number and type of containers filled
- Analyses requested
- Preservatives used (if applicable)
- Filtering (if applicable)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Airbill number (if applicable) or courier information
- Project contact and phone number

Unused lines on the COC form would be crossed out and field personnel would sign COC forms and the airbill number would be recorded. It is expected that samples would be hand-carried to a local analytical laboratory for analysis. In the eventuality that samples would be shipped by courier or air carrier, the COC form would be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills would serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the COC form and the airbill would be retained and filed by field personnel before the containers are shipped.

The laboratory sample custodian would receive all incoming samples, sign the accompanying COC forms, and retain copies of the forms as permanent records. The laboratory sample custodian would record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample IDs, and any unique laboratory identification numbers for the samples. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory would provide a secure storage area for all samples. Access to this area would be restricted to authorized personnel. The custodian would ensure that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, would be properly stored and maintained prior to analysis.

1.4.3.5 Analytical Methods

Analytical methods for the project are specified in Tables A-1, A-2 and A-3.

1.4.3.6 Quality Control Sampling

The subsections below specify QA/QC protocols for field and laboratory samples. Duplicate samples would be collected during the investigation at a frequency of 10% the total number of samples collected.

1.4.3.7 Instrument/Equipment Testing, Inspection and Maintenance

All equipment used during the site assessment would be properly tested, inspected, maintained, and calibrated. Samples collected during this investigation would be analyzed only by laboratory equipment. The laboratory's QA plan and written operating procedures describing specific testing, inspection, maintenance, and calibration procedures for equipment would be followed. Operation of the GPS unit and subsequent differential data corrections will be performed in accordance with the operator's manual. Daily GPS checks will include battery life, position dilution of precision, known point and data acquisition checks. Daily quality control checks for gamma survey meters will include battery life, high voltage and threshold, background, and known radioactive source checks.

1.4.3.8 Field Instrument Calibration Procedures

All field equipment utilized for this project (ie: water quality meters, soil pH kit, etc.) would be calibrated regularly according to the associated manufacturer's Operation Manuals. Gamma survey meters employed will be calibrated by the manufacturer. The minimum detectable activity (MDA) level will be defined for all gamma survey meters using the calculations suggested in the literature NUREG-1507 and NUREG/CR-5849 Section 5. Additionally, the meters will be tested periodically at the Calibration Pad facility outside of Grants, NM and in accordance with the literature (Leino, et al., 1994; George, et al., 1985).

1.4.3.9 Inspection and Acceptance Requirements for Supplies and Consumables

The field operations manager has the primary responsibility for identifying the types and quantities of supplies and consumables needed to complete the project and is responsible for identifying acceptance criteria for these items.

Supplies and consumables can be received either at the office or at the work site. When supplies are received at an office, the project manager or field personnel would sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies would be noted on the packing slip and purchase order and the item would then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. When supplies are received, the project manager or field personnel would inspect all items against the acceptance criteria. Any deficiencies or problems would be noted in the field logbook, and deficient items would be returned for immediate replacement.

With respect to surface water samples, the analytical laboratory would provide certified clean containers for all analyses.

1.4.4 Plan Deviations

Minor deviations, including field instrument malfunction (pH meter, etc.) would be addressed by field crew and the project manager using professional judgment. Any deviation from the SAP would be detailed in the field notebook and included in the final report to the client and regulatory agency representative. Any deviation considered significant would be addressed by the field crew, project manager, the client and the regulatory representative. A consensus on correcting the deviation would be achieved prior to executing any work plan changes. If a situation arises that requires work plan deviation and attempts to contact the client and regulatory representative are unsuccessful and the need for a decision is time critical, the project manager would use professional judgment to adjust work plan specifications as needed.

1.5 Data Validation and Usability

This section describes the procedures that are planned to review and evaluate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet the data quality objectives.

1.5.1 Data Review, Validation and Verification Requirements

For this project, 100 percent of the laboratory results will be reviewed. No validation will be performed outside of those performed by the certified analytical laboratory. Data will be reviewed for holding times, handling and preservation procedures, chain of custody, acceptance within control limits, and to ensure data meet method control limits for project goals.

1.5.2 Data Evaluation and Usability

Laboratory personnel would verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any non-conformances to the requirements of the analytical method. Laboratory personnel would make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification would be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation would be clearly identified in the case narrative section of the analytical data package.

All laboratory and previously collected data would be reviewed to ensure usability. The data evaluation strategy would determine if the analytical results are within the QC limits set for the project and data usability would be assessed. Specifically, sample analytical methods, handling requirements, holding times, duplicate results, and QC control limits would be reviewed.

1.5.3 Data Management

Field data would be recorded in logbooks and/or field forms and scanned copies would be included in the appendices of the Baseline Data Report. Analytical data would be received in electronic form and would be summarized, tabulated, analyzed, and provided in the body of the report. The original laboratory data would also be provided in the appendices. As appropriate, some data would be presented graphically. Environmental data collection will undergo an appropriate level of assessment and audit activities. Any problems encountered during an assessment of field investigation or laboratory activities would require appropriate corrective action to ensure that the problems are resolved.

1.6 Reporting

Quarterly progress reports will be prepared summarizing the results of the field investigation activities and monitoring results for the duration of the field investigation. The outcome of this investigation would be documented in a final baseline data report. This report would include a description of all field operations, any deviations from the original SAP, a review of previously collected data and data limitations, all raw and processed analytical data collected during this investigation, as well as graphical representations of all spatial data. The report would also include other related supporting information and recommendations for subsequent data collection if data gaps are identified upon completion of the current investigation.

TABLE A-1
ANALYTICAL METHODS FOR RADIONUCLIDE CHEMISTRY OF SOILS AND SEDIMENT

Radionuclide Analyte	Analytical Method Hot Digest*	Detection Limit
Uranium, total-238	EPA 6020, ICP-MS	0.01 mg kg^{-1}
Radium 226	EPA 903.1	0.5 pCi g^{-1}
Radium 228	EPA 9320	3.0 pCi g^{-1}
Thorium, total-232	EPA 6020, ICP-MS	0.1 mg kg^{-1}
Gross alpha/beta	EPA 9310	4.0 pCi g^{-1}

* Extraction = US EPA Method 3050B (hot acid digestion for soils, wastes and sediments).

TABLE A-2
ANALYTICAL METHODS FOR CHEMICAL AND PHYSICAL CHARACTERIZATION OF SOILS, SEDIMENTS AND OTHER MATERIALS

Analysis	Source-Method
Saturated Paste pH	SLS, 1954 - Method 2 and 21a
Electrical Conductivity	SLS, 1954 - Method 3a and 4b
Saturation percentage	SLS, 1954 - Method 27a
$CaCO_3$ equivalent percent (lime)	SLS, 1954- Method 23c
Particle Size Distribution	Gee and Bauder (1986)
Rock Fragments	Dry sieve/gravimetric
Total Sulfur and Sulfur Forms, ABA	Sobek et al., 1978
Neutralization Potential	Sobek et al., 1978
SPLP extracted metals (As, Ba, Cu, Co, Mn, Se, U)	EPA Method 1312.
Selenium (hot water soluble)	Agron. 9 - Method 80/3.2.1
Boron (hot water soluble)	Agron. 9 -Method 75-4

TABLE A-3
ANALYTICAL METHODS FOR CHEMICAL ANALYSES OF WATER SAMPLES

Analyte	Standard Methods	Detection Limits (mg/L)
Alkalinity	EPA 310	10.0
Aluminum	EPA 200.8	0.1
Antimony	EPA 200.8	0.003
Arsenic	EPA 200.8	0.005
Barium	EPA 200.8	0.1
Boron	EPA 200.7	0.1
Cadmium	EPA 200.7	0.001
Calcium	I-3485	1.0
Chloride	EPA 300	1.0
Chromium	EPA 200.8	0.01
Cobalt	EPA 200.8	0.01
Copper	EPA 200.8	0.01
Cyanide	ASTM D2036	0.005
Fluoride	EPA 300.0	0.1
Gross Alpha	EPA 900.0	1.0 pCi/L
Gross Beta	EPA	2.0 piC/L
Iron	EPA 6010	0.03
Lead	EPA 200.8	0.002
Magnesium	EPA 6010C	1.0
Manganese	EPA 200.8	0.01
Mercury	EPA 200.8	0.0001
Molybdenum	EPA 200.8	0.005
Nickel	EPA 200.8	0.01
Nitrate, as N	EPA 300.0	0.05
Nitrite, as N	EPA 300.0	0.05
Nitrate+Nitrite	EPA 300.0	0.01

Analyte	Standard Methods	Detection Limits (mg/L)
Potassium	I-3631	1.0
Radium-226 + 228	EPA 904.0	1.0 pCi/L
Radon-222	ASTM D5072-92	100.0 pCi/L
Selenium	EPA 200.8	0.005
Silicon	EPA 6010C	0.1
Sodium	EPA 6010C	1.0
Sulfate	EPA 300	1.0
TDS	EPA 160.1	10.0
Uranium	EPA 200.8	0.0003
Vanadium	EPA 200.8	0.1
Zinc	EPA 6010C	0.01
Ph	EPA 150.1	0.1

APPENDIX B

SIPHON SURFACE WATER SAMPLER

USGS
science for a changing world

Comparison of Water-Quality Samples Collected by Siphon Samplers and Automatic Samplers in Wisconsin

Introduction

In small streams, flow and water-quality concentrations often change quickly in response to meteorological events. Hydrologists, field technicians, or locally hired stream observers involved in water-data collection are often unable to reach streams quickly enough to observe or measure these rapid changes. Therefore, in hydrologic studies designed to describe changes in water quality, a combination of manual and automated sampling methods have commonly been used-manual methods when flow is relatively stable and automated methods when flow is rapidly changing. Automated sampling, which makes use of equipment programmed to collect samples in response to changes in stage and flow of a stream, has been shown to he an effective method of sampling to describe the rapid changes in water quality (Graczyk and others, 1993). Because of the high cost of automated sampling, however, especially for studies examining a large number of sites, alternative methods have been considered for collecting samples during rapidly changing stream conditions. One such method employs the siphon sampler (fig. 1), also referred to as the "single-stage sampler." Siphon samplers are inexpensive to build (about $25-$50 per sampler), operate, and maintain, so they are cost effective to use at a large number of sites. Their ability to collect samples representing the average quality of water passing though the entire cross section of a stream, however, has not been fully demonstrated for many types of stream sites.

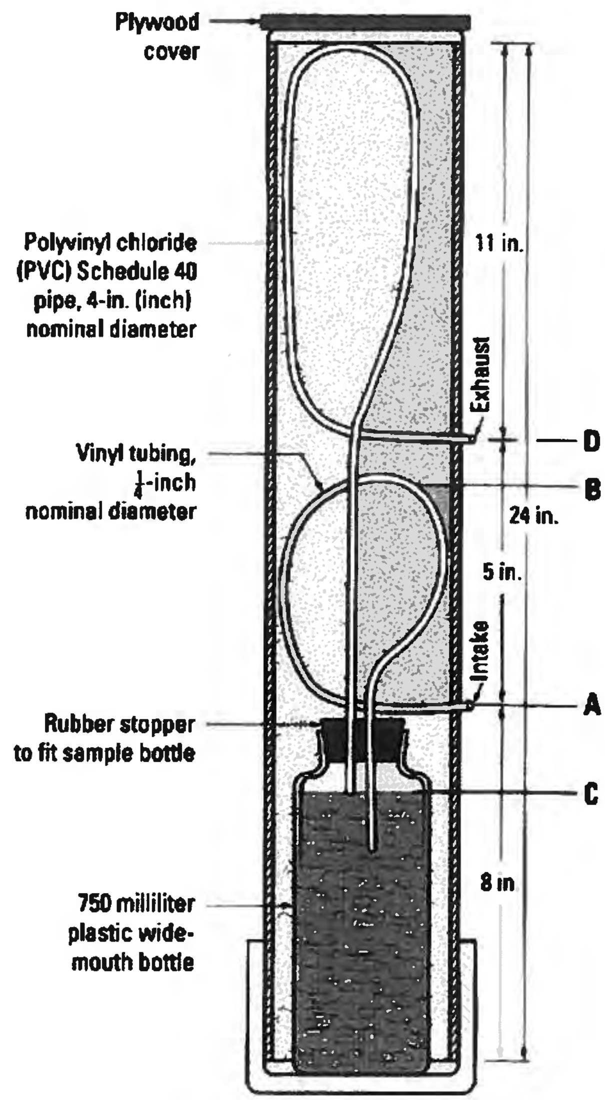


Figure 1. Typical siphon sampler.

The Inter-Agency Committee on Water Resources, Subcommittee on Sedimentation

(ICWR-SS) developed and tested siphon samplers under laboratory conditions and concluded that siphon samplers are able to collect a sample representative of near-surface water quality during rising stages. ICWR-SS (1961) developed several models of samplers to collect representative samples for distinct ranges of stream velocity, water-surface surge, water temperature, and sediment size. The study concluded that siphon samplers are useful when sediment concentrations near the water surface are of value and sampling by other, possibly more accurate methods is not practical or feasible. Edwards and Glysson (1988) outlined some of the limitations of siphon samplers. The primary limitation was that, because samples are collected near the water surface at one point in the stream, adjustments may be needed to describe the vertical and horizontal distributions in water quality, especially if the stream transports large sand-size particles. This is also a limitation for automatic samplers because automatic samplers collect a sample at a fixed horizontal and vertical location in the stream cross section.

The U.S. Geological Survey (USGS) and Wisconsin Department of Natural Resources (WDNR) are currently monitoring the water quality of several streams with a combination of manual and automated sampling methods. Future studies are aimed at describing changes in water quality at many sites; therefore, siphon samplers are being considered as a means to augment manual sampling and minimize sampling costs. Siphon samplers have had limited use in Wisconsin but have not been thoroughly tested to determine their ability to collect representative samples in Wisconsin streams. This fact sheet describes how successfully siphon samplers can be used to collect representative samples at selected stream sites in Wisconsin. Concentrations of suspended sediment, total phosphorus, and ammonia nitrogen in samples collected by siphon samplers in three streams in southwestern Wisconsin are compared with those collected with the more thoroughly investigated stage-change-activated automated samplers (Krug and Goddard, 1986).

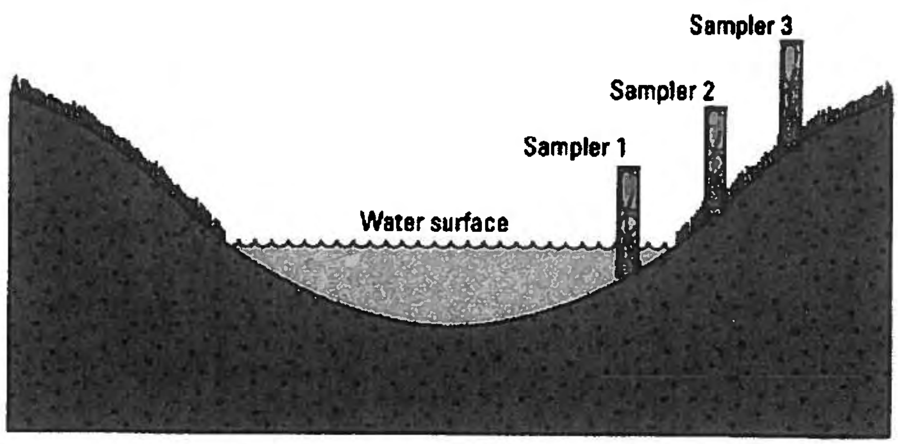


Figure 2. Typical stream-site installation of siphon samplers.

Siphon-Sampler Design and Operation

The design of the siphon sampler used in this study is similar to that described by the ICWR-SS (1961) and by Edwards and Glysson (1988) and shown in figure 1. The operation of a siphon sampler during an event with increased stage and flow is simple. As the stream stage rises to the elevation of the intake level A (fig. 1), water enters the 1/4-inch-diameter plastic tube. As the stream continues to rise, water continues to move up the intake tube until the stream and the water in the tube reach level B. When the water levels rise past level B, a siphon is created and the sample bottle starts to fill. The sample bottle fills rapidly because the flow rate is driven by the hydraulic head, which is approximately the height difference between the stream stage (level B) and the discharge end of the intake tube (level C). As the water level in the sample bottle reaches the bottom end of the exhaust port (level C), filling is substantially completed; however, a small amount of additional water, equal to the water volume in the exhaust tube between levels C and D, enters the bottle after the water level rises past level C. After the stream stage reaches level D, an airlock is established in the loop of the exhaust tube, which precludes further filling of the bottle. Changes in the water level after this point do not significantly affect the contents in the bottle. After the event, the bottles are collected and the contents analyzed. Siphon samplers are unrefrigerated; therefore, analytical results may have to be qualified for certain constituents that are unstable at temperatures above about 40 Celsius. Several samplers can be installed at different levels at each site to collect samples throughout the anticipated range in water levels (fig. 2).

Table 1. Comparison of water-quality data from siphon samplers with those from automated (ISCO) samplers. [Statistics are based on 47paired samples for total phosphorus and ammonia nitrogen and 41 paired samples for suspended sediment]

	Concentration, in milligrams per liter					Difference in concentration (Siphon – ISCO), in milligrams per liter (and percent)				
Constituent and method	Minimum	Maximum	Standard deviation	Mean	Median	Maximum negative difference	Maximum positive difference	Standard deviation	Mean difference	Median difference
Total phosphorus										
Siphon sampler	0.10	4.16	0.73	0.60	0.41	-2.16	1.08	0.43	-0.05 (-23%)	-0.03 (-7%)
ISCO sampler	0.13	3.58	0.73	0.65	0.41					
Ammonia nitrogen										
Siphon sampler	0.02	4.15	0.67	0.39	0.22	-2.09	1.49	0.43	-0.07 (-7%)	-0.02 (-8%)
ISCO sampler	0.05	3.25	0.68	0.46	0.22					
Suspended sediment										
Siphon sampler	12	995	193	155	75	-291	617	133	14 (-41%)	5 (4%)
ISCO sampler	23	512	120	141	95					

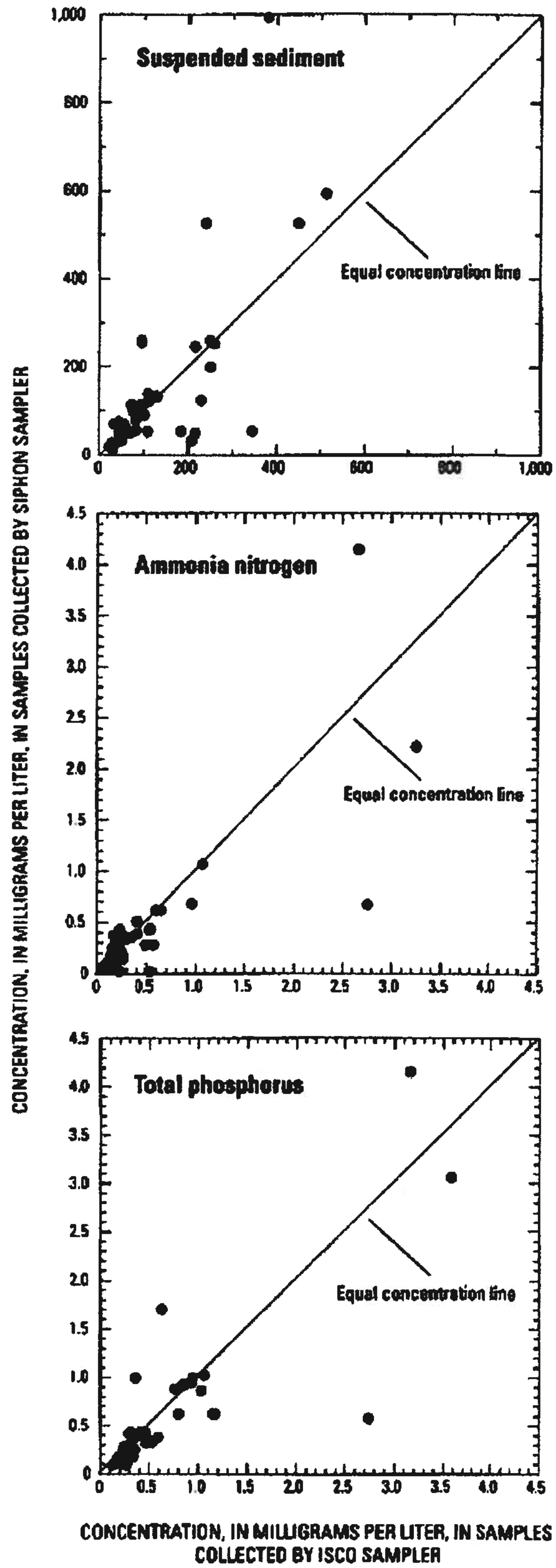
Sampling Sites

Siphon samplers were installed at three sites near USGS offices in Middleton, Wis.: North Fork of Pheasant Branch Creek (North Fork) and Pheasant Branch Creek at Highway 12 (Pheasant Branch), which are perennial streams; and South Fork of Pheasant Branch Creek (South Fork), an ephemeral stream. A USGS streamflow-gaging station was operational at each site, along with an automated water-quality sampler (ISCO) programmed to collect samples during runoff events. The drainage area above the North Fork site, 9.8 mi^2 (square miles), is primarily agricultural, whereas the drainage area above the South Fork site (5.7 mi^2) is predominantly urban. The drainage area above Pheasant Branch (18.3 mi^2), which is downstream from both the North and South Forks, encom-passes

Figure 3. Concentrations of suspended sediment and chemical constituents in samples collected by the siphon sampler and ISCO sampler.

both agriculture and urban development. Historical data from samples collected at Pheasant Branch indicate that most suspended-sediment particles were silt- and clay-sized (particles<0.062 millimeters).

At each site, siphon samplers were installed at three distinct elevations to sample different stages and times during an episode of increasing streamflow (fig. 2). The samplers were placed so that the first sample would be collected when the water stage rose approximately 0.2 feet. The second sample would be collected approximately 0.3-0.5 feet above where the first sample was collected, and the third sample would be collected 0.4-0.6 feet above where the second was collected. A fence post was driven into the stream bottom, and each siphon sampler was attached to the post by a large hose clamp. The intake nozzles of the samplers were oriented perpendicular to the direction of streamflow to minimize the likelihood of the nozzles being clogged with sediment or debris. The automated ISCO samplers at each site were programmed to collect discrete samples at the stages and times similar to those for the siphon samplers.



Samples were removed from both the automated refrigerated samplers and siphon samplers as soon as possible after each runoff event and preserved by either chilling (for suspended-sediment analyses) or chilling and acidifying (for total phosphorus and ammonia nitrogen analyses). After sample removal, each sampler was cleaned by flushing the intakes with streamwater and distilled water. Suspended-sediment analyses were done by the USGS sediment laboratory in Iowa City, Iowa, and total phosphorus and ammonia nitrogen analyses were done by the Wisconsin State Laboratory of Hygiene in Madison, Wis. All samples were analyzed by use of standard methods (American Public Health Association, 1995; Guy, 1969).

Water-Quality Comparison

Pairs of samples (IS CO and siphon) were collected from the three sites over a range of flows and water-quality conditions and were aggregated into one data set for the statistical analyses. Forty-seven pairs of samples were analyzed for total phosphorus and ammonia nitrogen and 41 pairs for suspended sediment. As is evident from table 1, constituent concentrations in the paired samples were similar, but the ranges in values were slightly smaller in the samples collected with the ISCO samplers than in those collected with the siphon samplers.

No systematic biases are evident in the distribution of data points about the 1:1 line (the line of equal concentrations) in the graphs shown in figure 3. The mean concentrations of the total phosphorus and ammonia nitrogen in the 47 sample pairs were within 0.07 mg/L (milligrams per liter) of each other, although the mean percentage difference for total phosphorus was almost 23 percent. The mean concentrations of suspended sediment were within 14 mg/L of each other, with a mean percentage difference of 41 percent. Differences between medians were even smaller. The median total phosphorus and ammonia nitrogen concentrations were identical, with the median percentage difference about 8 percent. The median difference in suspended-sediment concentrations was 5 mg/L and the median percentage difference was 4 percent.

A nonparametric Wilcoxon signed-rank test (Conover, 1980) applied to the data indicated no statistically significant differences in the constituent concentrations between the samples collected by the two types of samplers. The null hypotheses of the tests performed were that there were no differences between the constituent concentrations using either sampler. At the 5-percent significance level ($P < 0.05$), there were no statistically significant differences found in concentrations between the sampling methods for any of the constituents. Therefore the null hypotheses were not rejected.

In general, the constituent concentrations of samples collected with automated samplers (ISCO) have been shown to be similar to those of manually collected, cross-section-ally integrated water-quality samples (Krug and Goddard, 1986). Therefore, the similarity found in the means and medians for each of the three water-quality constituents indicates that siphon samplers also collect representative water samples over the range of sampled flow conditions for the type of streams examined. It follows that samples collected with siphon samplers typically should have about the same accuracy (bias) as automated samplers; however, individual measurements may be less precise (as seen in the variance around the 1:1 lines in fig. 3). Part of the scatter around the 1:1 line of equal concentrations may have resulted from the pair of samples not being collected exactly at the same time and, therefore, may have been samples of water of different concentrations. Additional work is needed to determine if this variability between data sets is caused by sampler performance or by slight differences in sample-collection timing.

* Use of trade names in this report is for identification purposes only and does not constitute endorsement by the US Geological Survey.

Conclusions

Siphon samplers are low-cost alternatives to automatic samplers that have been traditionally used to collect representative water-quality samples. Siphon samplers can be used to augment manual sampling of "flashy" streams and remote streams by collecting samples during rapidly increasing stream stage-a generally impractical condition to be sampled adequately with a manual sampling program. Siphon samplers would also be a cost-effective alternative to automatic samplers if samples need to be collected at numerous sites. Siphon samplers do not collect water samples when the stream stage is decreasing; therefore, manual samples still need to be collected during this period. Decreases in stage, however, are generally more protracted than increases in stage and commonly can be manually sampled by a field person dispatched at the beginning of the event. Additional studies may help to determine the reason for the variability between individual constituent concentrations of samples collected with an automated sampler and the siphon sampler as demonstrated by the scatter around the 1:1 lines in figure 3.

Authors: David J. Graczyk, Dale M. Robertson,
Layout and illustrations: Michelle Greenwood and Aaron Konkol

References

American Public Health Association, 1995, Standard methods for examination of water and wastewater (19th ed.): Washington, D.C. variously paged.

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Graczyk, D.J., Walker, J.F., Greb, S.R., and Owens, D.W., 1993, Evaluation of non-point contamination, Wisconsin-Selected data for 1992 water year: US Geological Survey Open-File Report 93-630, 48 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U. S. Geological Survey Techniques of Water-Resources Investigations; book 5. chap. Cl, 58 p.

Krug, W. R., and Goddard, G. L., 1986, Effects of urbanization on streamflow, sediment loads, and chemical morphology in Pheasant Branch Basin near Middleton, Wisconsin: US Geological Survey Water-Resources Investigations Report 85-4068, 82 p.

Information

For information on USGS programs in Wisconsin, contact:

District Chief William J. Rose and Jeffrey J. Steuer
US Geological Survey
8505 Research Way
Middleton, WI 53562
(608) 828-9901
http://wi.water.usgs.gov/

USGS Fact Sheet FS-067-00
July 2000

US Department of the Interior
US Geological Survey

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APPENDIX C

QUALITY ASSURANCE PERFORMANCE AUDIT OF METEOROLOCIAL TOWER

QUALITY ASSURANCE PERFORMANCE AUDIT OF METEOROLOGICAL TOWER HOMESTAKE MINING COMPANY GRANTS, NEW MEXICO MAY 2008

Prepared for:

Homestake Mining Company
Grants Project
P.O. Box 98
Grants, New Mexico 87020-0011

By

Meteorological Solutions Inc.
Project No. 05080728

August 2008

Meteorological Solutions Inc.

QUALITY ASSURANCE PERFORMANCE AUDIT
OF METEOROLOGICAL TOWER
BARRICK/HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO
MAY 2008

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Appendix

QUALITY ASSURANCE PERFORMANCE AUDIT
OF METEOROLOGICAL TOWER
BARRICK/HOMESTAKE MINING COMPANY
GRANTS, NEW MEXICO
MAY 2008
MSI Project No. 05080728

1.0 INTRODUCTION

On May 28, 2008, MSI conducted quality assurance performance audits of instrumentation on a meteorological tower owned and operated by Barrick/Homestake Mining Company in Grants, New Mexico to meet US EPA Prevention of Significant Deterioration (PSD) quality assurance requirements. This report summarizes the performance audit activities conducted during that site visit.

Meteorological instrument performance audits at Barrick/Homestakes' meteorological monitoring station was conducted in accordance with the following guidelines:

- EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), 1987; and
- Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, March 2008.

2.0 PERFORMANCE AUDIT EQUIPMENT

The following MSI reference standard instruments, presented in Table 2-1 were used to conduct sensor performance audits.

Table 2-1

MSI Quality Assurance Performance Audit Equipment

Parameter	Audit Reference Equipment	Serial Number
Wind Direction	Brunton 5008 Pocket Transit Met One Model 040 Direction Template Waters Torque Watch 366-1M	5060803362 NA 3950
Wind Speed	RM Young Model 18811 Anemometer Drive Waters Torque Watch 366-3M	CA01889 3618
Temperature	Brooklyn Digital Model 6661	C404690
Precipitation	Pyrex 100 ml graduated cylinder Kimax 50 ml graduated cylinder	3024 NA
Relative Humidity	Vaisala Model HMP45AC	W1630084
Barometric Pressure	Vaisala PTB101B	A1950021
Solar Radiation	LiCor Model 200x	PY56373

NA = Not Available.

Copies of the audit equipment certifications are presented in Appendix A.

3.0 SENSOR PERFORMANCE AUDITS

This section describes the meteorological instrument performance checks conducted by MSI at the Barrick/Homestake Mining Company, Grants, New Mexico meteorological monitoring station.

3.1 Description of Meteorological Station

Barrick/Homestake's meteorological station is located approximately at:

Latitude: 35° 14' N

Longitude: 107° 51' W

The station is equipped to measure horizontal wind speed and wind direction at 10 meters, temperature at 9.5 meters, solar radiation at 2 meters, relative humidity at 9.4 meters, precipitation at 0.4 meters, and barometric pressure at 8.8 meters. Table 3-1 lists the meteorological sensors installed at the meteorological station. Figure 3.1 presents a photograph of the meteorological station.

Table 3-1
Homestake Mining Meteorological Station Sensors

Parameter	Meteorological Equipment	Serial Number
Wind Direction	Qualimetrics Model 2020	2881
Wind Speed	Qualimetrics Model 2030	NA
Temperature	Vaisala Model HMP45AC	NA
Precipitation	Weathertronics Model 6011	374
Relative Humidity	Vaisala Model HMP45AC Vaisala Model HMP45AC	NA[1] C5110079 [2]
Barometric Pressure	Weathertronics	7112
Solar Radiation	LiCor 200X	PY31168

1 - As found

2 - Replacement sensor

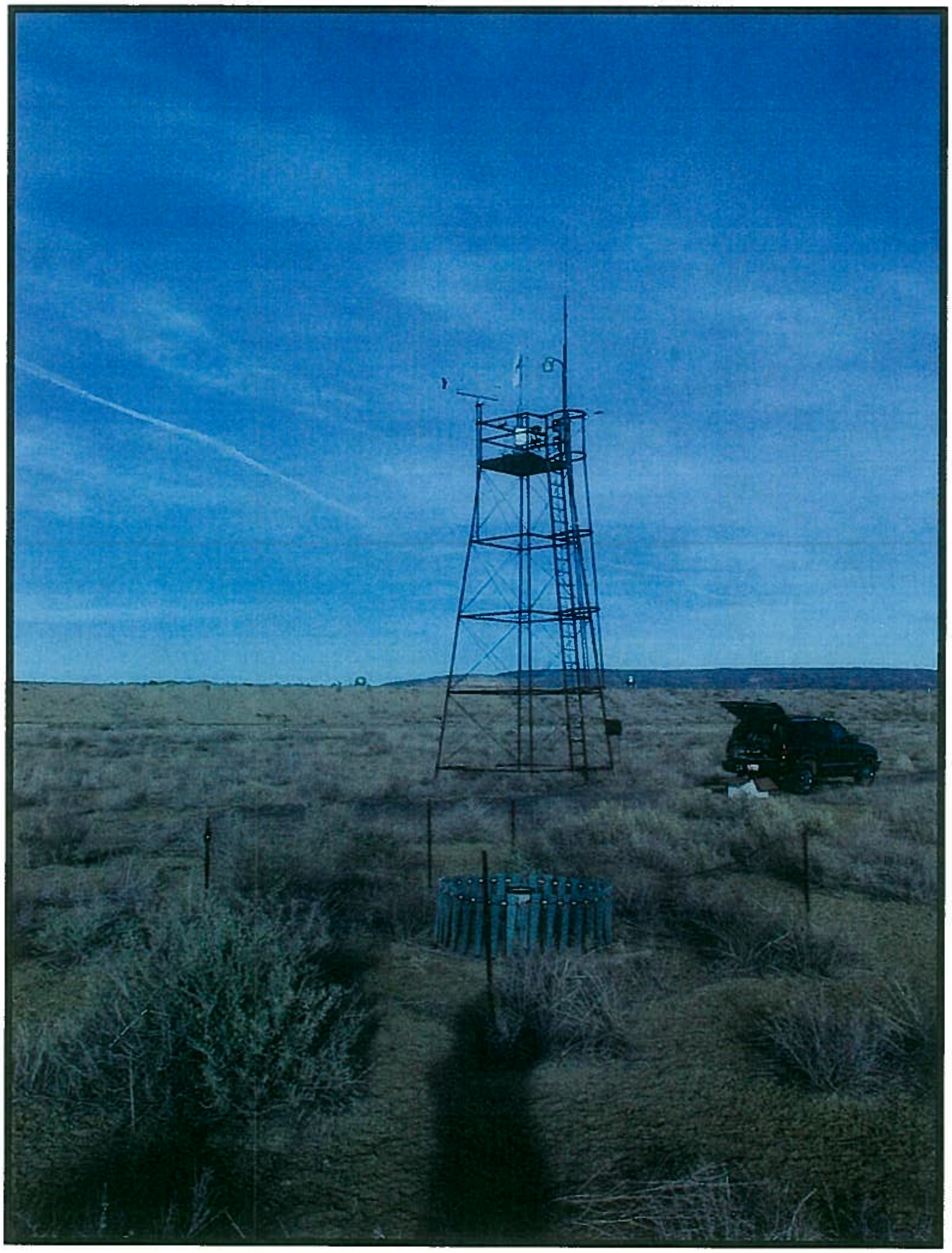

Figure 3.1 Photograph of Meteorological Monitoring Station

3.2 Performance Audit Methods

This section describes the audit methods used to verify the performance of the meteorological equipment. A summary of the audit methods and the acceptable tolerances for each method is presented in Table 3-2.

Table 3-2
Performance Audit Methods and Acceptable Tolerances

Parameter	Audit Method	Acceptable Tolerances
Wind Direction	Orientation plus Linearity Starting Threshold	±5° <0.5 m/s
Wind Speed	Synchronous Motor Starting Threshold	±0.25 m/s @ <5 m/s or ±5% @ >5 m/s <0.5 m/s
Temperature	Reference Thermometer Comparison	±1.0°C
Relative Humidity	Collocated Reference Comparison	±10%
Solar Radiation	Certified Reference Collocation	±5%
Barometric Pressure	Collocated Reference Comparison	±3 mbar
Precipitation	Calibrated Volumetric Addition	±10%

3.2.1 Wind Direction

The orientation of the wind direction sensor was checked using a professional magnetic compass. The compass was set using a magnetic declination of 10 degrees east of north.

In addition, the wind direction sensor linearity was verified by checking the sensor output at 90 degree increments throughout the entire 0 to 360 degree range in both clockwise and counterclockwise directions. The sensor starting torques were determined by measuring shaft rotational torque.

3.2.2 Wind Speed

The performance of the wind speed sensor was verified by applying known revolutions per minute using a variable speed motor drive. The shaft of the synchronous motor was attached to the bearing shaft of the anemometer with the cups removed. Synchronous motor speeds were translated into calculated wind speeds in miles per hour using manufacturer's specifications. Sensor responses were compared to the calculated wind speeds. Wind speed sensor shaft rotational torques were measured with a torque gauge to evaluate starting threshold.

3.2.3 Temperature

The calibration of the temperature sensor was verified by direct comparison of the sensor outputs to a collocated calibrated reference standard thermometer at ambient temperature.

3.2.4 Relative Humidity

The relative humidity sensor was checked by collocating a certified reference sensor with the station sensor.

3.2.5 Solar Radiation

The solar radiation pyranometer outputs were verified by collocation of a calibrated pyranometer adjacent to the system sensor. The MSI reference pyranometer was interfaced to a Campbell datalogger for signal processing and averaging. A 4-hour period was recorded and the readings from the reference pyranometer were compared directly to the site's pyranometer readings.

3.2.6 Barometric Pressure

The barometric pressure sensor was audited by collocating a calibrated reference barometer and comparing outputs with sensor outputs recorded on the data acquisition system.

3.2.7 Precipitation

Precipitation sensor outputs were audited using a standard graduated volumetric cylinder and syringe to add water to the gauge to simulate rainfall. The volume of water required to produce ten tips was recorded for each of the three runs. This volume was compared with the calculated calibration value and the amount of precipitation recorded by the data acquisition systems.

4.0 PERFORMANCE AUDIT RESULTS

The following sections present the quality assurance performance audit results for the meteorological sensors located at Barrick/Homestake's meteorological monitoring site. Performance audits of the meteorological sensors were conducted on May 28, 2008.

4.1 Wind Direction

As found, the wind direction sensor orientation checks indicated that the cross arm alignment was 270 degrees in reference to true west. When the wind vane was positioned parallel to the cross arm at 90 and 270 degrees, the sensor output was 400 and 120 degrees, respectively. The wind direction sensor orientation was not within the acceptable tolerance of ±5 degrees. Sensor linearity, when checked at 90 degree increments over the entire 0 to 360 degree range both clockwise and counterclockwise, was within 536 degrees. The wind direction sensor orientation plus linearity was not within the recommended tolerance of ±5 degrees. Sensor shaft rotational torque was <4.0 gram-centimeters (gm-cm) clockwise and counterclockwise. The rotational torque was within the starting threshold of ≤0.5 meters per second (m/s). Further investigation revealed that the datalogger did not have the correct programming for this wind sensor. The correct program was uploaded, the bearings were replaced and the wind direction sensor was re-audited.

After program upload and bearing replacement, the orientation checks indicated that the cross arm alignment was 270 degrees in reference to true west. When the wind vane was positioned parallel to the cross arm at 90 and 270 degrees, the sensor output was 90 and 269 degrees, respectively. Sensor linearity, when checked at 90 degree increments over the entire 0 to 360 degree range both clockwise and counterclockwise, was within 2.8 degrees. The wind direction sensor orientation plus linearity was within the recommended tolerance of ±5 degrees. Sensor shaft rotational torque was <3.0 gm-cm clockwise and counterclockwise. The rotational torque was within the starting threshold of ≤0.5 m/s.

4.2 Wind Speed

The wind speed sensor responses were checked over the range of 0 to 100 miles per hour (mph). As found, the shaft rotational torque was 1.2 gm-cm clockwise and counterclockwise translating to a starting threshold greater than 0.5 mps. Sensor response to anemometer drive inputs was unexpectedly an order of magnitude too high. Investigation revealed incorrect datalogger programming for this sensor.

The correct program was uploaded to the datalogger and sensor bearings were changed. Following bearing replacement and program change, the wind speed sensor was re-audited. The shaft rotational torque was less than 0.1 gm-cm clockwise and counterclockwise translating to a starting threshold less than 0.5 m/s. Sensor responses were nearly identical with the rpm audit input references that were checked.

4.3 Temperature

A certified digital thermometer was collocated with the station sensor simultaneously at ambient temperature for intercomparison. The temperature sensor output was within 0.7°C of the reference standard which exceeds the acceptable tolerance of ±0.5°C.

The temperature sensor was replaced and was re-audited. The digital reference thermometer was collocated with the station sensor at ambient temperature for intercomparison. The temperature sensor output was within an absolute average of 0.3°C of the reference standard which is within the acceptable tolerance of ±0.5°C.

4.4 Precipitation

Three runs of ten tips indicated that the precipitation gauge required an average of 3 percent more water to produce ten tips than the amounts recorded by the data acquisition system. The gauge output is within the ±10.0 percent tolerance.

4.5 Relative Humidity

A reference standard relative humidity sensor was collocated with the station sensor at ambient conditions for intercomparison. Sensor output was within 0.1 percent of the reference standard which is within the acceptable tolerance of ±10.0 percent.

The relative humidity sensor was replaced and re-audited. Sensor output was within an absolute average of 0.25 percent of the reference standard which is within the acceptable tolerance of ±10.0 percent.

4.6 Barometric Pressure

A certified reference barometer was used for intercomparison with the sensor at ambient conditions in inches of mercury (in. Hg). The audit input and responses were then converted to millibars (mb) from in. Hg. The sensor was found to be an average of 15.5 mb different than the reference standard which exceeds the allowable tolerance of ±3 mb.

4.7 Solar Radiation

A calibrated reference pyranometer was collocated with the station sensor for approximately 4 hours. Instantaneous manual readings taken at 6 different times during this period showed an average difference of 1.8 percent. Hourly averages during this period showed an average difference of 2.3%. This is within the recommended ±5 percent tolerance.

An intercomparison plot showing one-hour reference standard data versus one-hour Homestake data is shown in Figure 4.1. Figure 4.2 presents the linear regression results of the hourly paired solar radiation values. Tabular Data from the Homestake sensor and the MSI reference standard during the audit period are presented in Table 4-1.

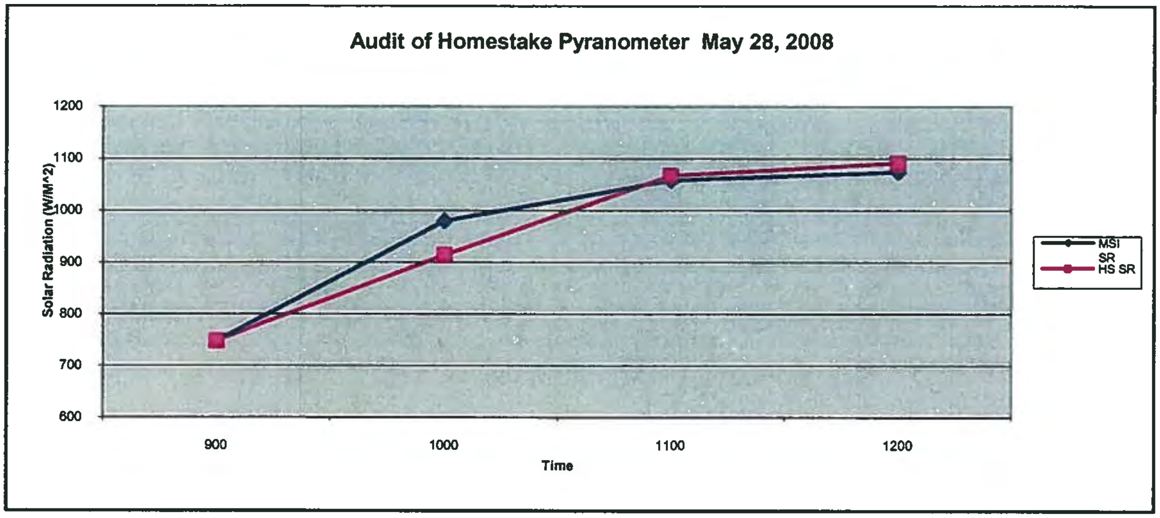

Figure 4.1 Intercomparison Plot - MSI Reference Standard Versus Homestake Mining Company's Solar Radiation Sensor

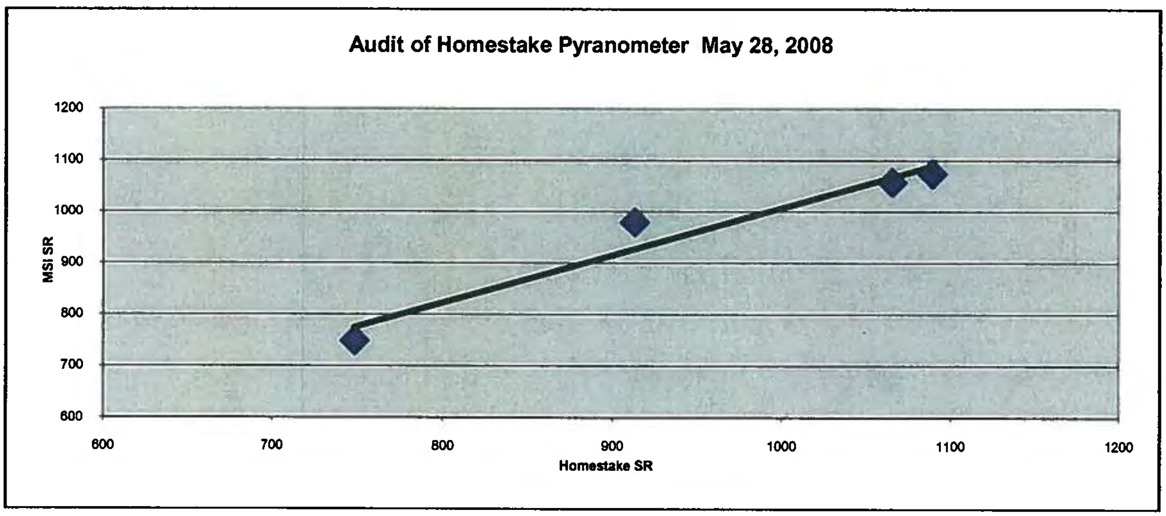

Figure 4.2 Linear Regression Results of Paired Solar Radiation Values

Table 4-1

Tabular Data from Homestake Mining Company's Solar Radiation Sensor and MSI Reference Standard

Time	MSI Pyranometer Watts/m^2	Homestake Pyranometer Watts/m^2	Percent Difference
900	748	748	0.0
1000	979	913	-6.7
1100	1057	1065	0.8
1200	1073	1089	1.5
Percent Difference = 2.3			

Copies of the performance audit field data sheets for the meteorological station are found in Appendix B.

5.0 SUMMARY

On May 28, 2008, MSI conducted quality assurance performance audits of meteorological instrumentation at Homestake Mining's Grants, New Mexico meteorological station.

As found, wind sensor speed and direction outputs were nowhere near reference inputs. Further investigation revealed that an extended power outage on June 23, 2007 caused the datalogger to shut down completely since the backup battery was depleted. Once power was restored and the battery re-charged, the datalogger apparently automatically retrieved an older no longer used program resident in the attached storage module used for datalogger backup. It contained different wind sensor programming from what is currently used and caused wind sensor outputs to be incorrect. In addition, the wind speed sensor starting threshold exceeded recommended tolerances because of bad bearings. Once the proper datalogger program was installed and wind sensor bearings were replaced, wind sensor performance was within US EPA recommended specifications.

Temperature sensor checks indicated that the site sensor was reporting ambient temperatures slightly lower than the reference. This sensor was scheduled for replacement during this visit and audit checks on the replacement sensor showed agreement with the reference within recommended tolerance.

Barometric pressure sensor output, when checked against a certified reference was not within recommended tolerance. This sensor is no longer supported by the manufacturer due to its age. Barometric pressure data should be scrutinized and unreasonable values should be invalidated. MSI recommends replacement of the barometric pressure sensor.

Solar radiation, relative humidity, and precipitation sensors were all operating with recommended tolerances.

The wind, temperature, and barometric pressure sensors failed the May 28, 2008 audit. All other sensors at the meteorological site were found to be operating normally and reporting data accurately within manufacturer's recommended tolerances and EPA-approved quality assurance guidelines for meteorological measurements. Table 5-1 summarizes the results of this audit.

Table 5-1

Summary of May 28, 2008 Audit Results

Sensor Parameter	Result
Wind Direction	Fail
Wind Speed	Fail
Temperature	Fail
Precipitation	Pass
Relative Humidity	Pass
Barometric Pressure	Fail
Solar Radiation	Pass

Appendix A
Audit Equipment Certifications

THE BRUNTON COMPANY
Certificate Of Calibration

Equipment Owner: METEOROLOGICAL SOLUTIONS
Name: ______

Address: 2257 SOUTH 1100 EAST SUITE 203

City, State, Zip: SALT LAKE CITY UT 84106

Calibration traceable to the National Institute of Standards and Technology in accordance with Mil-STD-45662A has been accomplished on the instrument listed below by comparison with standards maintained by The Brunton Co. The accuracy and stability of all standards maintained by The Brunton Co. are traceable to national standards maintained by the National Institute of Standards and Technology in Washington, D.C. and Boulder, CO. Complete record of all work performed is maintained by The Brunton Co. and is available for inspection upon request.

This Unit has been calibrated to Lietz TM10E serial number 30937 traceable to N.B.S. no. 738 227675 this 29TH Day of APRIL 2008

DESCRIPTION: POCKET TRANSIT

PURCHASE ORDER: RA 123319

ORDER NUMBER: 1727835

LOT NUMBER: ______

MODEL NUMBER: 5006

SERIAL NUMBER: 5060863362

CALIBRATION DATE: 4-29-08

RECALIBRATION DUE DATE: 4-29-09

Signed: Linda Kenyon
QUALITY CONTROL MANAGER

Houston Precision, Inc.

Calibration Report

8729 Gulf Freeway
Houston, TX 77017-6504

Company:	Meteorological Solutions, Inc.	**Doc #:**	41467
Address:	2257 South 1100 East Suite 203 Salt Lake City, UT 84106	**Date:**	8/22/2007
		PO#:	CREDIT CARD
Contact:	Mike Peterson	**Page:**	1
Dept:	QC		
Gage:	366-1M Torque Watch	**Control:**	3950
Mfg:	Waters	**Model:**	366-1M Torque Watch
Location:		**Serial #:**	3950

Parameters:

Text:

Comments:

Calibration Completed by: Caltech
Original Certificate (attached) #: 5450

Reference HPI S/O # 15322

We certify the equipment used for this calibration is traceable to NIST through one or more of the following numbers:
Vendor Master:
Last / Next Cal Dates: -->

Gage Status: PASS **Next Calibration Due: 8/22/2008**

Certified By: Denice V. Mills Signature: Denice Mills

This certificate is not valid unless all 1 page(s) are present.
*Laboratory Environmental Conditions: Temperature: 68°F +/- 3.6°F and/or 20C +/- 2C, Relative Humidity: between 40% and 60%.
*Calibration measurements are performed in accordance with guidelines set forth in ANSI/NCSL Z540-1-1994 and Houston Precision's Quality manual.
*The measurement of uncertainity has not been taken into account when reporting readings "in" or "out of tolerance" on this calibration report.
*If additional information regarding this calibration is required, please contact this laboratory.
*All calibrations have been performed under the supervision and authority of Jacob Bradley , Lab Manager.
*Any number of factors may cause the subject of this calibration to drift out of calibration before the recommended interval has expired. HPI will not be held responsible for the calibration status of an item whose calibration interval exceeds the actual validity of the calibration.
*This Report shall not be reproduced expect in full, or with the expressed written permission of Houston Precision, Inc.
End of document.

Certificate of Calibration

The instrument listed below meets or exceeds published specifications and has been calibrated under controlled conditions and is traceable to the National Institute of Standards and Technology(N.I.S.T.), or to accepted intrinsic standards of measurement, or by the ratio type of self-calibration techniques. Cal-Tech Calibration conforms to the following. ISO/IEC 25/17025.

Customer: Houston Precision
Certificate Number: 5450
Instrument Make: Waters
Model: 366-1M
S/N: 3950
ID: n/a

Date: 8-22-07
Temp: 73 Deg F
Humidity: 43%
Rec. In Tol.
Due Date: 8-22-08

This report may not be reproduced, except in full without written permission from Cal-Tec Calibration.

Certification by:

Accuracy: +\- n/a

Comments:

Standards Used	**Model**	**Certification Number**	**Due Date**
Acculab	VIC-300	19453469	11-30-07
Troemner	Weight Set	822/266607-02	03-08

In.Oz. Range	**As Found**	**After Adjust**	**Final Reading**
3.01	3.00	none	3.00
6.02	6.01	none	6.01
12.0	12.0	none	12.0
18.0	18.0	none	18.0
21.0	21.1	none	21.1

Cal-Tech Calibration, Inc.
1314 FM 646 West /Ste. 15 / Dickinson, Texas 77539 /Phone 281-614-0050 / Fax 281-614-0046

Houston Precision, Inc.

Calibration Report

8729 Gulf Freeway
Houston, TX 77017-6504

Company:	Meteorological Solutions, Inc.	**Doc #:**	41468
Address:	2257 South 1100 East Suite 203 Salt Lake City, UT 84106	**Date:**	8/22/2007
		PO#:	CREDIT CARD
Contact:	Mike Peterson	**Page:**	1
Dept:	QC		
Gage:	366-3M Torque Watch	**Control:**	3618
Mfg:	Waters	**Model:**	366-3M Torque Watch
Location:		**Serial #:**	3618

Parameters:

Text:

Comments:

Calibration Completed by: Caltech
Original Certificate (attached) #: 5449

Reference HPI S/O # 15322

We certify the equipment used for this calibration is traceable to NIST through one or more of the following numbers:
Vendor Master:
Last / Next Cal Dates: ->

Gage Status: PASS **Next Calibration Due: 8/22/2008**

Certified By: Denice V. Mills Signature: Denice V. Mills

This certificate is not valid unless all 1 page(s) are present
*Laboratory Environmental Conditions: Temperature 68°F +/- 3.6°F and/or 20C +/- 2C, Relative Humidity: between 40% and 60%.
*Calibration measurements are performed in accordance with guidelines set forth in ANSI/NCSL Z540-1-1994 and Houston Precision's Quality manual.
*The measurement of uncertainity has not been taken into account when reporting readings "in" or "out of tolerance" on this calibration report.
*If additional information regarding this calibration is required, please contact this laboratory.
*All calibrations have been performed under the supervision and authority of Jacob Bradley , Lab Manager
*Any number of factors may cause the subject of this calibration to drift out of calibration before the recommended interval has expired.
HPI will not be held responsible for the calibration status of an item whose calibration interval exceeds the actual validity of the calibration.
*This Report shall not be reproduced expect in full, or with the expressed written permission of Houston Precision, Inc
End of document.

Certificate of Calibration

The instrument listed below meets or exceeds published specifications and has been calibrated under controlled conditions and is traceable to the National Institute of Standards and Technology(N.I.S.T.), or to accepted intrinsic standards of measurement, or by the ratio type of self-calibration techniques. Cal-Tech Calibration conforms to the following, ISO/IEC 25/17025.

Customer: Houston Precision
Certificate Number: 5449
Instrument Make: Waters
Model: 366-3M
S/N: 3618
ID: n/a

Date: 8-22-07
Temp: 73 Deg f
Humidity: 43%
Rec. In Tol.
Due Date: 8-22-08

This report may not be reproduced, except in full without written permission from Cal-Tec Calibration.

Certification by: ____________________

Accuracy: +\- n/a

Comments:

Standards Used	**Model**	**Certification Number**	**Due Date**
Acculab	VIC-300	19453469	11-30-07
Troemner	Weight Set	822/266607-02	03-08

In.Oz. Range	**As Found**	**After Adjust**	**Final Reading**
.40	.42	none	.42
.80	.81	none	.81
1.20	1.20	none	1.2
1.60	1.61	none	1.61
1.80	1.80	none	1.80

Cal-Tech Calibration, Inc.
1314 FM 646 West /Ste. 15 / Dickinson, Texas 77539 /Phone 281-614-0050 / Fax 281-614-0046

SIMCO electronics
6537 CECILIA CIRCLE
BLOOMINGTON, MN 55439

ACCREDITED CERT 1395.14

Certificate No. **3697178**

CERTIFICATE OF CALIBRATION FOR METEOROLOGICAL SOLUTIONS INC

Description: **BROOKLYN, 6661, Digital Thermometer/Probe**

Serial No: **CT071007015-TM9** Asset No: Simco ID: **43762-1**

Dept: **NONE** PO No: **1562**

Calibration Date: **11/08/07**	Calibration Interval: **12 Months**	Recall Date: **11/08/08**
Arrival Condition: **MEETS MANUFACTURER'S SPEC'S.**	Service: **CALIBRATED TO MFR SPEC,& CLEAN**	

Procedure: **NAV17-20ST-10 2/95**
Temperature: **69°F** Relative Humidity: **36%**

Standards Used:

Type	Simco ID	Due Date	Intvl Mos	Acc/Unc	Trace No.
Digital Thermometer	39051*130	12/29/08	24	TEMPERATURE	269872-04
RTD PROBE	39051*127	12/18/08	12	TEMP C	SEE FILE
RTD PROBE	39051*127	12/18/08	12	0to-197 +/-25mK	A4715016
RTD PROBE	39051*127	12/18/08	12	1to232 +/-30mK	A4715016
Liquid Bath	39051*460	06/12/08	12	TEMP STABILITY	
Liquid Bath	39051*460	06/12/08	12	+/-0.025 DEG C	CINA 31274

Detail Of Work Performed:
The Expanded Measurement Uncertainty listed on the data sheet applies only at the time of calibration and no allowance has been made for handling or time related effects.
Expanded uncertainty computed at 95% confidence level, coverage factor K = 2.
MEASUREMENT UNCERTAINTY: 0.03 DEG C

FULL SN IS CT071007015-TM99A-E, FOR
6661 BROOKLYN DIGITAL THERMOMETER.

Continued on next Page

SIMCO electronics

Certificate No. **3697178**

6537 CECILIA CIRCLE
BLOOMINGTON, MN 55439

A2LA ACCREDITED CERT. 1395.14

CERTIFICATE OF CALIBRATION
FOR
METEOROLOGICAL SOLUTIONS INC

Continued from Page 1

Parts Replaced:

EN22	9V BATTERY/NO CHARGE	(1)

Calibration Data:

Parameter	Nominal	Measured Before	Measured After	Tolerance
TEMPERATURE				
SYSTEM CAL				
METER/PROBE	-20.7 DEG C	-20.8	-20.8	+/-0.1 DEG C
METER/PROBE	-10.1 DEG C	-10.1	-10.1	+/-0.1 DEG C
METER/PROBE	0.0 DEG C	0.0	0.0	+/-0.1 DEG C
METER/PROBE	20.0 DEG C	20.0	20.0	+/-0.1 DEG C
METER/PROBE	40.0 DEG C	40.0	40.0	+/-0.1 DEG C

Work performed by:
Diane Carmon
Electronic Technician B (13192)

Reviewed by:
Ken Wyckoff
Electronic Tech Lead/ QA Rep

SIMCO Electronics' quality management system conforms to ISO 9001:2000, ISO/IEC 17025:2005, and ANSI/NCSL Z540-1-1994. All calibrations are performed using internationally recognized standards traceable to the International System of Units (SI Units). Traceability is achieved through calibrations by the National Institute of Standards and Technology (NIST), other National Measurement Institutes (NMIs'), or by using natural physical constants, intrinsic standards or ratio calibration techniques. Instruments are calibrated with a test accuracy ratio of 4:1 or greater, otherwise measurement uncertainty analysis and/or guard bands are applied during the measurement process. The information shown on this certificate applies only to the instrument identified above and may not be reproduced, except in full, without prior written consent from SIMCO Electronics. There is no implied warranty that the instrument will maintain its specified tolerances during the calibration interval due to possible drift, environment, or other factors beyond our control. This is an A2LA Accredited calibration.

Dated: **11/08/07**

Duplicate Certificate

Temperature Sensor Calibration Record

MSI

Meteorological Solutions Inc

Sensor Type: Brooklyn Digital with utility probe

Sensor ID: C404690

Sensor Range: -40.0 to +150.0 C

CALIBRATION:

Calibrated on 11/21/2007

Next calibration due 11/21/2008

Time: 9:45

Location: MSI Lab

Reference Device Brooklyn Digital with utility probe

Reference Device ID: CT071007015-TM9

Technician: Scott Adamson

Procedure:

Water baths used for temp medium. Each point stirred 3-5 minutes until stabil.

Values should be within +/- 0.5 degrees C.

Calibration Temperature Point	Calibration Reference Temperature (C) Tr	Observed Sensor Temperature (C) Ts	Difference in Degrees (C)	Percent Error (dT) [dT=((Ts-Tr)*100)/Tr]
1	47.80	47.70	-0.1	-0.21%
2	22.40	22.30	-0.1	-0.45%
3	0.00	0.00	0.0	0.00%

RELATIVE HUMIDITY SENSOR CALIBRATION RECORD

Sensor Manufacturer: VAISALA HMP45AC
Sensor ID: W1630084
Sensor Range: 0 - 100%
Calibrated on 12/31/07
Next calibration due 12/31/08
Time: 10:00 - 13:30
Location: MSI lab
Reference Device: Vaisala HMK 15 Salt Chambers
Reference Device ID: (LiCL C435) (MgCL12 C413) (NaCL C471)
Brooklyn digital thermometer s/n CT071007015-TM9
Technician: MRP
Comments Lab temperature = 24.3 C

Time From	Time To	Reference Salt Solution NaCL / LiCL	Reference Relative Humidity %	Observed Sensor Output	Difference
10.00	11.00	LiCL	11.3%	10.9%	0.4%
11:00	12.00	MgCL12	33.0%	31.1%	2.0%
12:00	13:00	NaCL	75.4%	74.6%	0.8%
			Reference Temperature	Sensor Response	Difference
13:00	13:30		24.3 C	24.3 C	0.0 C

Procedure.
Remove sensor cap and insert probe into salt chamber.
After one hour record value.
Record lab temperature and comparison with HMP sensor using reference thermometer.

VAISALA

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

FINAS
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

CERTIFICATE OF CALIBRATION no K008-Q02193

Customer VAISALA Oyj
PO Box 26
FI-00421 Helsinki, Finland

Item NaCl Saturated Salt Solutions

Manufacturer Vaisala Oyj

Model 19731HM

Batch NaClC471, 100 pcs

Description Sample calibration of 19731HM Saturated Salt Solutions.
From salt batch no NaClC471 six (6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more than 16 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on November 21, 2007 by Lasse Mäki.

Uncertainty The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

Results

Salt	1	2	3	4	5	6
Reference	75,4 %RH	75,4 %RH	75,4 %RH	75,4 %RH	75,4 %RH	75,4 %RH
Reading	75,5 %RH	75,5 %RH	75,6 %RH	75,4 %RH	75,4 %RH	75,5 %RH
Temperature	+ 23,0 °C	+ 23,0 °C	+ 23,0 °C	+ 23,0 °C	+ 23,0 °C	+ 23,0 °C
Correction	- 0,1 %RH	- 0,1 %RH	- 0,2 %RH	0,0 %RH	0,0 %RH	- 0,1 %RH
Uncertainty	± 0,4 %RH	± 0,4 %RH	± 0,4 %RH	± 0,4 %RH	± 0,4 %RH	± 0,4 %RH

All the measured values extended by the estimated uncertainty were within the specification (± 1,5 %RH) of the NaCl Saturated Salt Solutions 19731HM at the measurement temperature.

Conditions Temperature + 24,1 °C ± 0,3 °C
Humidity 36 %RH ± 3 %RH

Date November 21, 2007

Signature Lasse Mäki
Calibration Engineer

Page 1 (1)

Documents attached -

Checked by:

Vaisala Oyj, PO Box 26, FI-00421 Helsinki, Finland
Telephone +358 9 894 91 • Fax +358 9 8949 2227
Email MeasStdLab@vaisala.com • www.vaisala.com
Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

VAISALA

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

FINAS
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

CERTIFICATE OF CALIBRATION no K008-Q01988

Customer VAISALA Oyj
PO Box 26
FI-00421 Helsinki, Finland

Item MgCl2 Saturated Salt Solutions

Manufacturer Vaisala Oyj

Model 19730HM

Batch MgCl2C413, 100 pcs

Description Sample calibration of 19730HM Saturated Salt Solutions.
From salt batch no MgCl2C413 six (6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more than 16 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on October 18, 2007 by Lasse Mäki.

Uncertainty The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

Results

Salt	1	2	3	4	5	6
Reference	32,9 %RH	32,9 %RH	32,9 %RH	32,9 %RH	32,9 %RH	32,9 %RH
Reading	32,9 %RH	32,9 %RH	32,8 %RH	32,9 %RH	32,9 %RH	32,9 %RH
Temperature	+ 22,9 °C	+ 22,9 °C	+ 22,9 °C	+ 22,9 °C	+ 22,9 °C	+ 22,9 °C
Correction	0,0 %RH	0,0 %RH	+ 0,1 %RH	0,0 %RH	0,0 %RH	0,0 %RH
Uncertainty	± 0,5 %RH	± 0,5 %RH	± 0,5 %RH	± 0,5 %RH	± 0,5 %RH	± 0,5 %RH

All the measured values extended by the estimated uncertainty were within the specification (± 1,2 %RH) of the MgCl2 Saturated Salt Solutions 19730HM at the measurement temperature.

Conditions Temperature + 23,4 °C ± 0,3 °C
Humidity 40 %RH ± 3 %RH

Date October 18, 2007

Signature [signature]
Lasse Maki
Calibration Engineer

Page 1 (1)

Documents attached -

Checked by: HTD

Vaisala Oyj, PO Box 26, FI-00421 Helsinki, Finland
Telephone +358 9 894 91 • Fax +358 9 8949 2227
Email MeasStdLab@vaisala.com • www.vaisala.com
Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

VAISALA

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

FINAS
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

CERTIFICATE OF CALIBRATION no K008-Q02049

Customer	VAISALA Oyj PO Box 26 FI-00421 Helsinki, Finland
Item	LiCl Saturated Salt Solutions
Manufacturer	Vaisala Oyj
Model	19729HM
Batch	LiClC435, 156 pcs

Description

Sample calibration of 19729HM Saturated Salt Solutions.
From salt batch no LiClC435 six (6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more then 48 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on November 1, 2007 by Heli Tonteri.

Uncertainty

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

Results

Salt	1	2	3	4	5	6
Reference	11,3 %RH	11,3 %RH	11,3 %RH	11,3 %RH	11,3 %RH	11,3 %RH
Reading	11,2 %RH	11,1 %RH	11,2 %RH	11,3 %RH	11,3 %RH	11,3 %RH
Temperature	+ 23,0 °C	+ 23,1 °C	+ 23,1 °C	+ 23,0 °C	+ 23,0 °C	+ 23,0 °C
Correction	+ 0,1 %RH	+ 0,2 %RH	+ 0,1 %RH	0,0 %RH	0,0 %RH	0,0 %RH
Uncertainty	± 0,7 %RH	± 0,7 %RH	± 0,7 %RH	± 0,7 %RH	± 0,7 %RH	± 0,7 %RH

All the measured values extended by the estimated uncertainty were within the specification (± 1,3 %RH) of the LiCl Saturated Salt Solutions 19729HM at the measurement temperature.

Conditions

Temperature + 23,5 °C ± 0,3 °C
Humidity 40 %RH ± 3 %RH

Date November 1, 2007

Signature [signature]
Heli Tonteri
Calibration Engineer

Page 1 (1)

Documents attached -

Checked by: [signature]

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Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

PRESSURE Calibration Record	MSI

2257 S 1100 E
Suite 203
SLC UT 84106
Meteorological Solutions Inc.
P 801 474 3826 F 801.474.0706

Start Date 12/7/2007
Sensor Type Vaisala PTB101B
Sensor ID A1950021
Next calibration due 12/7/2008

Reference Device Novalynx Digital Barometer (MSI REF)
Reference Device ID 930690-Y4
Location MSI Lab
Comments Lab Temp checked with Brooklyn Digital Thermometer s/n CT071007015-TM9
Technician Scott Adamson

Procedure:
Three readings taken side by side with MSI reference in ambient conditions. Then averaged.

Date	Time	Lab Temp C	Reference inches Hg	Pressure Sensor inches Hg	Diff mb
12/7/07	1355	24	853.5	853.6	0.10
12/7/07	1423	23.2	853.5	853.6	0.10
12/7/07	1550	23.4	854.3	854.50	0.20
Average		23.5	853.77	853.90	0.13

Calibration Critieria = +/- 3 mb

Adjustment required ? No

Kipp & Zonen

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Bohemia, New York 11716
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E kipp.usa@kippzonen.com

CALIBRATION CERTIFICATE
PYRANOMETER

PYRANOMETER MODEL : LI-COR LI-200

SERIAL NUMBER : PY56373

SENSITIVITY : 5.01 mV / 1KWm^{-2}
derived indoors at normal incidence
in accordance with ISO-9847 standard

CALIBRATION PROCEDURE : The indoor calibration procedure is based upon comparison to a LI-COR LI-200 calibration transfer reference pyranometer under a voltage stabilized artificial sun/lamp source (150W metal-halide gas discharge lamp). The lamp reflector and lens assembly under illumination conditions produces a vertical beam irradiance of approximately 575 Wm^2 at the pyranometer transfer reference and test pyranometer detector level. Both LI-COR LI-200 transfer reference and test pyranometer to be calibrated are illuminated simultaneously side-by-side for a period of 1-minute and the voltage output signals recorded. Both pyranometers are then shaded for 1-minute and the respective dark noise offset signals of each are either added or subtracted from the recorded illumination signals. The position of the pyranometers are then reversed 180° and the above process is repeated. A lamp stability check is conducted after the second lamp illumination cycle; if the lamp test is successful the sensitivity of the LI-COR LI-200 test pyranometer is calculated from the established ratio; test signal / mean reference signal. Because the LI-COR LI-200 transfer reference and test pyranometers are of identical model type, the indoors calibration condition in principle has no adverse bias on the sensitivity transfer from the reference pyranometer to the test pyranometer.

REFERENCE PYRANOMETER : LI-COR LI-200 S/N: PY55910

The above LI-COR LI-200 calibration transfer reference pyranometer has been calibrated outdoors in New York on Nov. 28, 2007 under clear sky conditions against a collocated Kipp & Zonen CM21 pyranometer. s/n 990631, in the horizontal global hemispheric mode.

The CM21 reference pyranometer was calibrated on June 8, 2007 outdoors by National Renewable Energy Laboratory, Golden CO, against a WRR traceable Primary Standard HF Cavity Radiometer via component summation technique (normal incidence SW direct + global SW diffuse). The derived sensitivity of the CM21 reference pyranometer is normalized for 45° direct beam response.

OTHER TEST EQUIPMENT : Keithley 2000 Multi-Meter, Calibrated: April 4, 2007

IN CHARGE OF TEST : Robert Dolce, Nov. 29, 2007, Bohemia, NY

Notice:
This calibration certificate is valid for one year upon customer receipt, or instrument deployment. Although the date of calibration and customer receipt/deployment date may differ, the instrument does not suffer from any sensitivity drift effect while packaged and shielded from solar or visible radiation; also refer to the 'non-stability' performance (max. sensitivity / year drift) in the radiometer specifications list.

YOUNG

CALIBRATION PROCEDURE
18801/18810 ANEMOMETER DRIVE

DWG: CP18801(A)
REV: C101107 PAGE: 2 of 3
BY: TJT DATE: 10/11/07
CHK. JC W.C. GAS-12

CERTIFICATE OF CALIBRATION AND TESTING

MODEL: **18801** (Comprised of Models 18820 Control Unit & 18830 Motor Assembly)
SERIAL NUMBER: CA01889

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor Rpm	Output Frequency Hz (1)	Calculated Rpm (2)	Indicated Rpm (3)
600	320	600	600
1200	640	1200	1200
2400	1280	2400	2400
4200	2240	4200	4200
6,000	3200	6000	6000
8,100	4320	8100	8100
9,900	5280	9900	9900
[X] Clockwise and Counterclockwise rotation verified			

(1) Measured at the optical encoder output.
(2) Frequency output produces 32 pulses per revolution of motor shaft.
(3) Indicated on the Control Unit LCD display.

* Indicates out of tolerance

[X] No Calibration Adjustments Required [ ] As Found [ ] As Left

Traceable frequency meter used in calibration Model: DP5740 SN: 4863

Date of inspection 16 JAN 2008
Inspection Interval One Year

Tested By EC

Appendix B
Performance Audit Field Data Sheets

HORIZONTAL WIND DIRECTION AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 0845 DAS
Stop Time: 1530 DAS

Sensor Mfg: Qualimetrics
Serial No.: 2881
Crossarm Alignment: 270/90
Site Declination (degrees): 10°
Last Calibration Date:

WD Sensor Model: 2020
WD Sensor Ht (m): 10 (33')
WD Sensor Range 0-: 360 degrees
Vane parallel to crossarm=: 400/120
WD Shaft Rotational Torque: <4 gm-ccm
Starting Threshold: NA

AUDIT INPUT (deg)	(deg)	CLOCKWISE DAS RESPONSE DAS (v)	DAS (deg)	DIFF (deg)	COUNTERCLOCKWISE DAS RESPONSE DAS (v)	DAS (deg)	DIFF (deg)
North	0/360		536.0	536.0		533.0	533.0
East	90/450		117.0	27.0		118.0	28.0
South	180/540		255.0	75.0		255	75.0
West	270		397.0	127.0		395.0	125.0

Audit Criteria:
Alignment with true North: ± 5 degrees
Linearity Test: ± 3 degrees
Starting Threshold: <= .5 m/s

WD Audit Device: Met One
WD Audit Model: 040 Template
WD Audit Serial #: NA

Comments:
Brunton 5008 Pocket Transit # 5060803362
Waters Torque 366-1M #3950

Audited By: W. Hauze

HORIZONTAL WIND DIRECTION AUDIT SHEET

After Datalogger Programming Change and Bearing Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator	Homestake Mining	Date	5/28/2008
Site Name	Grants, New Mexico	Stn ID	
Project	AQ07-28	Client	Homestake Mining

Start Time: 0845 DAS
Stop Time: 1530 DAS

Sensor Mfg	Qualimetrics	WD Sensor Model	2020
Serial No.	2881	WD Sensor Ht (m)	10 (33')
Crossarm Alignment	270/90	WD Sensor Range 0-	360 degrees
Site Declination (degrees)	10°	Vane parallel to crossarm=	90/269
Last Calibration Date		WD Shaft Rotational Torque	<3 gm-cm
		Starting Threshold	NA

AUDIT INPUT (deg)	AUDIT INPUT (deg)	CLOCKWISE DAS RESPONSE DAS (v)	CLOCKWISE DAS (deg)	CLOCKWISE DIFF (deg)	COUNTERCLOCKWISE DAS RESPONSE DAS (v)	COUNTERCLOCKWISE DAS (deg)	COUNTERCLOCKWISE DIFF (deg)
North	0/360		0.2	0.2		0.2	0.2
East	90/450		87.2	-2.8		87.5	-2.5
South	180/540		177.5	-2.5		178.2	-1.8
West	270		271.0	1.0		269.0	-1.0

Audit Criteria:
Alignment with true North: ± 5 degrees
Linearity Test: ± 3 degrees
Starting Threshold: <= .5 m/s

WD Audit Device: Met One
WD Audit Model: 040 Template
WD Audit Serial #: NA

Comments: Brunton 5008 Pocket Transit # 5060803362
Waters Torque 366-1M #3950
New bearings installed.
Datalogger programming change due to power failure June 23, 2007.

Audited By: W. Hauze

HORIZONTAL WIND SPEED AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining

Start Time: 0845 DAS
Stop Time: 1530 DAS

Sensor Mfg: Qualimetrics
Serial No.: Not readable
Last Calibration Date:

WS Sensor Model: 2030
WS Sensor Ht (m): 10 (33')
WS Range 0- 100 mph

WS Shaft Rotational Torque: 1.2 gm-cm
Sensor Starting Threshold: >0.5 m/s

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(rpm)	(mph)	DAS (v)	DAS (mph)	DIFF (mph)	DAS (v)	DAS (mps)	DIFF (mps)
0.0	0.0		0.0	0.0			
300	15.9		227	211.1			
600	31.1		450	418.9			
900	46.2		675	628.8			
1500	76.5		1125	1048.5			
1800	91.65		1345	1253.4			

Audit Criteria: ± 0.25 m/s when wind speed <= 5 m/s
± 5% when ws >5 m/s

WS Audit Device: R M Young
WS Audit Model: 18811
WS Audit SER #: CA01889

Comments: Waters Torque 366-3M #3618
Incorrect datalogger program

Audited By: W. Hauze

HORIZONTAL WIND SPEED AUDIT SHEET

After Datalogger Programming Change and Bearing Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Start Time: 0845 DAS
Stn ID:
Stop Time: 1530 DAS
Client: Homestake Mining

Sensor Mfg: Qualimetrics
Serial No.: Not readable
Last Calibration Date:

WS Sensor Model: 2030
WS Sensor Ht (m): 10 (33')
WS Range 0-: 100 mph

WS Shaft Rotational Torque: <0.1 gm-cm
Sensor Starting Threshold: <0.5 m/s

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(rpm)	(mph)	DAS (v)	DAS (mph)	DIFF (mph)	DAS (v)	DAS (mps)	DIFF (mps)
0.0	0.0		0.0	0.0			
300	5.8		5.89	0.09			
600	15.9		15.9	0.0			
900	31.1		31.1	0.0			
1200	46.2		46.2	0.0			
1500	76.5		76.5	0.0			
1800	91.65		91.65	0.0			

Audit Criteria: ± 0.25 m/s when wind speed <= 5 m/s
± 5% when ws >5 m/s

WS Audit Device: R M Young
WS Audit Model: 18811
WS Audit SER #: CA01889

Comments: Waters Torque 366-3M #3618
New bearings installed. Correct datalogger program uploaded.

Audited By: W. Hauze

BAROMETRIC PRESSURE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008 Start Time: 1147 DAS
Stn ID: Stop Time: 1445 DAS
Client: Homestake Mining

Sensor Mfg: Weathertronics
Serial No.: 7112
Recording Resolution:

Sensor Ht (m): 8.8 (29')

Last Calibration Date: 12/7/2007

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
Time	(in. Hg)	DAS (v)	DAS (in. Hg)	% DIFF	DAS (v)	DAS (in. Hg)	% DIFF
1147	23.63		23.46	-0.72			
1340	23.58		22.85	-3.10			
1401	23.57		22.85	-3.05			
1445	23.56		23.35	-0.89			
			Abs. Avg. =	1.94			

Audit Criteria: 3 mbar

Gauge Audit Device: Vaisala
Gauge Audit Model: PTB101B
Gauge Audit SER #: A1950021

Comments: Sensor failed audit.

Audited By: W. Hauze

BAROMETRIC PRESSURE AUDIT SHEET

As Found Millibar Conversion

2257 S 1100 E
Suite 203
SLC, UT 84106

MSI
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining

Site Name: Grants, New Mexico

Project: AQ07-28

Date: 5/28/2008

Stn ID:

Client: Homestake Mining

Start Time: 1147 DAS

Stop Time: 1445 DAS

Sensor Mfg: Weathertronics

Serial No.: 7112

Recording Resolution:

Sensor Ht (m): 8.8 (29')

Last Calibration Date: 12/7/2007

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
Time	(mb)	DAS (v)	DAS (mb)	DIFF (mb)	DAS (v)	DAS (mb)	DIFF (mb)
1147	800.2		794.4	5.80			
1340	798.5		773.8	24.70			
1401	798.2		773.8	24.40			
1445	797.8		790.7	7.10			
			Abs. Avg. =	15.5			

Audit Criteria: ± 3 mb

Gauge Audit Device: Vaisala

Gauge Audit Model: PTB101B

Gauge Audit SER #: A1950021

Comments: Sensor failed audit.

Audited By: W. Hauze

RELATIVE HUMIDITY AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106
MSI
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 9/26/2007
Start Time: 15:09
Stn ID:
Stop Time: 17:05
Client: Homestake Mining

Sensor Mfg: Vaisala
Sensor Model: HMP45AC
Serial No.: NA
Range: 0-100%

Sensor Ht. (m): 9.4 (31' AGL)

Last Calibration Date:

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
DAS (Time)	(%)	DAS (v)	DAS (%)	DIFF (%)	DAS (v)	DAS (%)	DIFF (%)
925	39.3		39.1	-0.2			
1145	22.2		22.2	0.0			
1341	9.3		9.3	0.0			

Audit Criteria: ± 10% RH

Rel. Humidity Audit Device: Vaisala
Rel. Humidity Audit Model: HMP45AC
Rel. Humidity Audit SER #: W1630084

Comments:

Audited By: W. Hauze

RELATIVE HUMIDITY AUDIT SHEET

After Sensor Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 9/26/2007
Start Time: 15:09
Stn ID:
Stop Time: 17:05
Client: Homestake Mining

Sensor Mfg: Vaisala
Sensor Model: HMP45AC
Serial No.: C5110079
Range: 0-100%

Sensor Ht. (m): 9.4 (31' AGL)

Last Calibration Date:

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
DAS (Time)	(%)	DAS (v)	DAS (%)	DIFF (%)	DAS (v)	DAS (%)	DIFF (%)
1402	7.4		7.7	0.3			
1443	6.3		6.5	0.2			
Audit Criteri: ± 7% RH							

Rel. Humidity Audit Device: Vaisala
Rel. Humidity Audit Model: HMP45AC
Rel. Humidity Audit SER #: W1630084

Comments: New sensor installed; Vaisala C5110079.

Audited By: W. Hauze

SOLAR RADIATION AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining

Start Time: 0925 DAS
Stop Time: 1440 DAS

Sensor Mfg: Li-Cor
Serial No.: PY31168
Range: 0-1400 watts/m^2

Sensor Model: LI200X
Sensor Ht. (m): 2 (6.56')

Last Calibration Date: 5/16/2007

AUDIT INPUT			DAS RESPONSE (watts/m^2)			DAS RESPONSE (watts/m^2)	
Time	(watts/m^2)	(Ly/min)	(volts)	(watts/m^2)	(diff %)	(watts/m^2)	(diff)
935	894			928	3.8%		
957	948			978	3.2%		
1146	1106			1126	1.8%		
1342	1042			1050	0.8%		
1400	1005			1012	0.7%		
1440	915			919.5	0.5%		
					1.8%		

Audit Criteri: ± 5%

Solar Radiation Audit Device: Li Cor
Solar Radiation Audit Model: Li200x
Solar Radiation Audit SER #: PY56373

Comments:

Audited By: W. Hauze

PRECIPITATION GAUGE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining

Start Time: 1410 DAS
Stop Time: 1445 DAS

Sensor Mfg: Weathertronics
Serial No.: 374
Recording Resolution: 1 TIP = 0.01 in

Sensor Model: 6011
Sensor Ht (m): 0.43 (17"AGL)
Gauge Range 0 -: unlimited

Last Calibration Date:

Funnel size (cm): 20 cm

AUDIT INPUT (in.)	PRIMARY DAS RESPONSE DAS (v)	DAS (in.)	% DIFF	BACKUP DAS RESPONSE DAS (v)	DAS (in.)	% DIFF
80 ml		0.1				
85 ml		0.1				
82 ml		0.1				
Ave. = 82.3 ml = 0.1031		0.1	-3.0			

Audit Criteria: ± 10% of input

Gauge Audit Device: Pyrex
Gauge Audit Model: 100 ml grad cyl
Gauge Audit SER #: 3024

Comments: Kimax 50 ml grad cyl

Audited By: W. Hauze

TEMPERATURE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1143 DAS
Stop Time: 1441 DAS

Sensor Mfg: Vaisala
Serial No.: NA
Range: -40 to 60 °C

Sensor Model: HMP45AC
Sensor Ht (m): 9.5 (31.17")

Last Calibration Date:

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(Time)	(°C)	DAS (v)	DAS (°C)	DIFF (°C)	DAS (v)	DAS (°C)	DIFF (°C)
1143	23.9		23.2	0.7			
Audit Criteria: ± 0.5 °C							

Temperature Audit Device: Brooklyn
Temperature Audit Model: 6661
Temperature Audit SER #: C404690

Comments:

Audited By: W. Hauze

TEMPERATURE AUDIT SHEET

After Sensor Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1143 DAS
Stop Time: 1441 DAS

Sensor Mfg: Vaisala
Serial No.: C5110079
Range: -40 to 60 °C

Sensor Model: HMP45AC
Sensor Ht (m): 9.5 (31.17")

Last Calibration Date:

AUDIT INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(Time)	(°C)	DAS (v)	DAS (°C)	DIFF (°C)	DAS (v)	DAS (°C)	DIFF (°C)
1408	27.8		27.4	-0.4			
1441	28.8		28.6	-0.2			
			Absolute Avg.	0.3			

Audit Criteria: ± 0.5 °C

Temperature Audit Device: Brooklyn
Temperature Audit Model: Digital 6661
Temperature Audit SER #: C404690

Comments: New temperature sensor installed; Vaisala C5110079

Audited By: W. Hauze