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# Project Summary

# Quality Assurance Audits of the EPA State-Operated Precipitation Collection Network

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**Networks that collect and quantify the constituents of precipitation in the United States have increased in number and size in recent years. Eleven states presently participate in the EPA-sponsored State-Operated Precipitation Network that collects weekly samples at 27 locations. As networks have grown, so have the development and application of quality assurance considerations to ensure that accurate, precise, complete, and representative data are obtained.**

**Quality assurance protocols for system and performance audits of the State-Operated Network (SON) of wet deposition collection sites are outlined. The protocols address site characteristics, training, precipitation collection and measurement equipment, sample retrieval and handling, system audits, and the use of simulated precipitation test solutions in performance audits. Results from quality assurance studies by Research Triangle Institute in 1985 and 1986 of the 27-site SON sites and recommendations for corrective action are given.**

***This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

## Introduction

In response to the need for data to determine the extent and nature of acidic precipitation, wet deposition collection networks in the United States have grown in number and size in the last decade. As the networks have grown, so has the development of protocols and procedures for external quality assurance. Benefits of quality assurance studies of networks include assuring that established protocols for siting, sample collection, and analysis are being followed; identifing non-complying equipment to be fixed and operators who need further training; providing a means of documenting the data base with respect to accuracy, precision, completeness, and representativeness; and allowing the data quality of several networks to be compared in a systematic way.

The 27-site SON has been in place since 1982. The full report describes quality assurance procedures established for this network and gives results of 1985 and 1986 site visits. Recommendations for improvement are also given. The procedures are similar to those developed and applied earlier by two other networks: the Utility Acid Precipitation Study Program, (UAPSP), that collects on a daily basis[1] and the National Atmospheric Deposition Program/National Trends Network, (NADP/NTN), that collects weekly samples [2].

## Procedures

Adherence to established siting guidelines is checked by comparing each site's installation and nearby surroundings to criteria given in urban- or regionally-sited station checklists designed expressly for the State-Operated Network. These checklists are given in the full report. Important criteria common to either type station are: (a) type and height of nearby groundcover; (b) distance of collector and

rain gauge from obstructions; (c) distance of the collector from sources of contamination and pollution; (d) proximity of human or animal activities to the collector; and (e) nearby land and water features.

During the visit the following system audit topics are reviewed: (a) sample collection equipment and procedures (including plastic bag bucket liners used in the SON); (b) site laboratory facilities and cleanliness; (c) analysis procedures; (d) communication and recordkeeping; and (e) quality control tests and corrective action procedures. Technical assistance is provided whenever an operator is uncertain of procedures or when equipment needs maintenance or calibration.

The accuracy of response of each site's collection and measurement devices is tested during the visit. The performance audit techniques and designated tolerances for the SON are described in Table 1.

## Results and Discussion

### *Siting Criteria Checks*

At least one variation from the designated siting criteria was found for most of the SON sites. Many were minor and should have negligible effect on the physical and chemical data base. The most important siting exceptions are noted below.

#### Collector/rain gauge obstructions

Several collectors and gauges were near enough to trees, towers, or other equipment such that the object projected onto the collector at greater than a 45 degree angle. Since the sample catch and chemistry could be affected by this, it was recommended that the samplers be slightly repositioned or that the obstructions be removed.

#### Proximity to sources

Several sites had sources nearby although the criterion for collector/source separation was minimally satisfied. Examples include asphalt plant, animal stockade, and salt water. It was recommended that data users be made aware of these facts and that the site be moved or the source removed if possible.

#### Collector and rain gauge positioning

Ideally the collector and rain gauge orifices should be at the same height above ground (~1 m) and be separated by at least 5 but no more than 30 m. Several sites had the collector and gauge positioned within 1 m of each other in the horizontal; others were separated by several meters in the vertical dimension. It was recommended that the rain gauges be repositioned and inoperative gauges be repaired or replaced.

### *System Audits*

System checks were made of the precipitation collector, the rain gauge, sample collection procedures, and the field laboratory. Results are noted below.

#### Precipitation collector

Eleven of 27 collectors were higher above ground than the prescribed one meter. This exception was due to placement on platforms or roofs to avoid snowpack, for security, and to avoid obstructions. The effect on the sample is thought to be minimal. Ten collectors were installed with the wet bucket facing N or E rather than the prescribed W. If rainstorms approach predominantly from the S or SW, the collector itself may influence the collection process. Eight collectors lacked the event marker capability. Knowing when and for how long the collector is open is an important quality control consideration. All but two sites had properly seating bucket covers. A dry-site bucket was missing at one site; another site had a deteriorated liner. Proper seating is necessary to keep out dust.

#### Rain gauge

Variations from the desired distance from the collector and height with respect to the collector were noted at about half of the sites. Six sites do not have record-

**Table 1.** *Audit Techniques and Tolerance Limits For Collection and Measurement Methods*

| *Measurement Device and Audit Observable* | *Audit Technique or Test* | *Expected Results* |
|---|---|---|
| *1. Recording Rain Gauge* | | |
| *- Accuracy of precipitation depth on gauge* | *- Use calibration weights simulating precipitation.* | *- Agreement within ± 0.10 inch of audit weight.* |
| *2. Precipitation Collector* | | |
| *- Lid liner-bucket-rim seal* | *- Determine lid drop distance (Bucket in - bucket out).* | *- Distance >3 mm.* |
| *- Sensor activation and heating* | *- Observe open/close cycle. Determine temperature with thermistor 5 min. after activation.* | *- Ambient temperature, prior to activation. Temperature of 50-70°C attained after activation.* |
| *3. Conductivity Meter* | | |
| *- Accuracy of response to simulatd precipitation samples* | *- Have operator determine conductivity of simulated sample.* | *- Agreement within ± 4 μS/cm.* |
| *- Deionized water quality* | *- Have operator determine.* | *- Conductivity <10 μS/cm.* |
| *4. pH Meter* | | |
| *- Accuracy of response to simulated precipitation samples* | *- Have operator determine pH of simulated precipitation sample.* | *- Agreement within ± 0.1 pH unit of established value.* |
| *5. Mass by Solution Balance* | | |
| *- Accuracy of response to calibrated weights* | *- Have operator determine mass of weights in the range 800 g to 3300 g.* | *- Agreement within ± 5 g of stated mass.* |

ing rain gauges; several sites had malfunctioning tipping bucket gauges.

### Same collection procedures

Proper sample collection procedures were followed in virtually all instances. It was noted that not all operators visually check the sample for contamination before returning it to the field laboratory. It was recommended that this be done; otherwise contaminants may dissolve and be unnoticeable later.

### Field laboratory

The field laboratories had adequate space, were clean, and temperature-controlled. Operators and analysts were trained and familiar with their duties. Variations in measurement technique were noted and discussed. It was recommended that smaller sample aliquots be used, that the network's central laboratory have first priority for samples, and that samples be shipped within three days of collection.

## *Performance Audits*

Performance evaluations were made of the rain gauge; the precipitation collector; and the pH meter, conductivity cell, and solution balance. Results are given in Table 2 and discussed briefly here.

### Rain gauge

All 13 weighing-type recording rain gauges agreed within 0.1 inch of the designated audit value over the range 0 to 5 inches. Eight of the 13 gauges were out of tolerance above 5 inches. However, this is a seldom-used range as the guage bucket is usually emptied before this depth is reached. Most of the gauges were recalibrated to meet specifications.

### Precipitation collector

All collectors operated when the sensor was activated. The lid-liner/bucket rim seal was adequate. Several problems were noted with sensor temperature range and control. If the sensor does not heat during and immediately following a rain, the collector's bucket cover will not close promptly and contamination of the sample by dust or debris may occur.

### Conductivity meter

Meter readings at 3 of 20 field laboratories varied by more than 4 $\mu$S/cm from the designated value of the audit solution. Results were quite acceptable otherwise. The quality of deionized water in use at the sites also met specifications.

### pH meter

Only 2 of 21 field laboratories had pH results that varied by more than 0.1 pH unit from the designated value. The average absolute variation was 0.054 pH unit.

### Mass

Sixteen of the 19 balances checked agreed within 1 g of the designated value at a loading of 1646 g. The worst case was a 10 g variation corresponding to 1.2 percent at an 823 g loading or 0.3 percent at a 3292 g loading.

## Conclusions

The EPA-sponsored SON is a weekly precipitation collection network of 27 sites located primarily in the eastern and southeastern United States. State agencies have provided personnel to service the sites and laboratories and to analyze and submit samples to a central laboratory for analysis. The site supervisors, operators, and analysts were familiar with their duties, handled the precipitation samples carefully, analyzed the samples accurately in most cases, and seemed genuinely interested in the network and the data.

Several of the sites should be improved upon in terms of siting and maintenance of sample collection and analysis equipment. Emphasis should be placed on proper placement and operation of precipitation collectors, installation and

**Table 2.** *Performance Audit Results: EPA State-Operated Network, 1985-1986*

| *Measurement Device Audited* | *Number Audited* | *Range of Response; Average Response* | *Comments* |
|---|---|---|---|
| *1. Rain Gauge* | | | |
| *- accuracy of precipitation depth* | *13* | *All within ± 0.1 inch from 0 to 5 inches.* | *Out-of-tolerance readings occurred on 8 of 13 but only at 6 inches or greater depth, a seldom-used range.* |
| *2. Precipitation Collector* | | | |
| *-lid liner/bucket rim seal* | *16* | *Range 7 to 33 mm; avg. 13.6 mm.* | *All met 3 mm criterion of acceptability.* |
| *- sensor activation and heating* | *27* | *All respond and open collector. Range 23 - 100°C; avg. 55°C.* | *Eight heated at all times. Six did not heat. Twenty-one heat; of these 10 attain temperature <50°C, three > 70°C.* |
| *3. Conductivity Meter* | | | |
| *- accuracy of response* | *20* | *0.3 to 5.80 $\mu$S/cm;[a] avg. 1.63 ± 1.76 $\mu$S/cm.* | *EPA performance audit sample; value is 20 or 24 $\mu$S/cm.* |
| *- deionized water quality* | *14* | *0.35 to 3.80 $\mu$S/cm; avg. 1.75 $\mu$S/cm.* | |
| *4. pH Meter* | | | |
| *- accuracy of response* | *21* | *0.01 to 0.18 pH unit;[a] avg. 0.054 ± 0.04 pH unit.* | EPA performance audit samples; designated value is 4.28 or 4.39 pH units. |
| *5. Solution Balance Mass* | | | |
| *- accuracy of response* | *19* | *16 of 19 agree within ± 1 g at 1646 g loading.* | 17 of 19 are accurate within *± 5 g over 823 to 3292 g range. All are within ± 10 g agreement.* |

[a] *Range of differences where difference = | (site value) - (designated value) |.*

proper operation of rain gauges, and standardization of field laboratory techniques.

## References


1. W. C. Eaton, K. A. Daum, E. D. Estes, and F. Smith, "Quality Assurance Results for the Utility Acid Precipitation Study Program (UAPSP), 1982 to 1984," Transactions: Quality Assurance in Air Pollution Measurements, APCA Publication TR-3, Pittsburgh, PA (1985), pp. 488-499.
2. D. S. Bigelow, "Quality Assurance Report; NADP/NTN Deposition Monitoring. Field Operations, July 1978 through December 1983." National Atmospheric Deposition Program, Coordinator's Office, NREL, Colorado State University, Fort Collins, CO, (August 1986).



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*The complete report entitled "Quality Assurance Audits of the EPA State-Operated Precipitation Collection Network," (Order No. PB 87-208 740/AS; Cost: $13.95, subject to change) will be available only from:*

*National Technical Information Service*
*5285 Port Royal Road*
*Springfield, VA 22161*
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