



Air Quality Monitoring Plan

Remedial Investigation/Feasibility Study Iron King Mine – Humboldt Smelter Superfund Site Dewey-Humboldt, Yavapai County, Arizona EPA Identification No. AZ0000309013

Remedial Action Contract 2 Full Service Contract: EP-W-06-004

Prepared for

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July 2008
Revision: 00
EA Project No. 14342.34



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LIST OF ACRONYMS AND ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
AOI	Area of Interest
AQM	Air quality monitoring
CVAA	Cold Vapor Atomic Absorption
COPC	Chemical of primary concern
DL	Detection limit
DQO	Data quality objective
EA	EA Engineering, Science, and Technology, Inc.
ERA	Ecological Risk Assessment
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
H ₀	Null hypothesis
H _a	Alternative hypothesis
HHRA	Human Health Risk Assessment
ICP	Inductively Coupled Plasma
Ironite	Ironite Products Company
LCS	Laboratory control sample
LD	Laboratory duplicate
lpm	Liters per minute
MDD	Minimum detectable difference
mm	Millimeter
NPL	National Priorities List
PM ₁₀	Particulate matter less than 10 microns
ppb	Parts per billion
PRP	Potentially responsible party
QAPP	Quality Assurance Project Plan
QC	Quality control
RI	Remedial Investigation
SOP	Standard operating procedure
TSP	Total Suspended Particulates
Site	Iron King Mine – Humboldt Smelter Superfund Site
WRS	Wilcoxon rank sum
µm	Micron

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc. (EA) has been authorized by the U.S. Environmental Protection Agency (EPA), under Remedial Action Contract No. EP-W-06-004, Task Order 0034-RICO-09MX, to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the Iron King Mine – Humboldt Smelter Superfund Site (Site). EA has prepared this Air Quality Monitoring Plan (AQMP) in accordance with: (1) specifications provided in the U.S. Environmental Protection Agency (EPA) Statement of Work (SOW), dated 3 March 2008 (EPA 2008); and (2) the EPA-approved EA Work Plan, dated 22 May 2008 (EA 2008).

The Site is located in Dewey-Humboldt, Yavapai County, Arizona (Figure 1). The Site is a combination of sources and releases from two separate facilities: the Iron King Mine property and the Humboldt Smelter property. A portion of the Town of Humboldt is situated between the mine and the smelter (Figure 2).

During the site visit that was conducted on 19 March 2008, the following Areas of Interest (AOI) were identified:

- Iron King Mine – The Iron King Mine Proper Area, Iron King Operations Area, Former Fertilizer Plant Area, and ancillary associated properties;
- Humboldt Smelter and ancillary associated properties;
- Off-site Soil in the vicinity of the Site;
- Waterways - Including the Chaparral Gulch, Galena Gulch, Aqua Fria River, and adjoining drainage channels and outfalls; and
- Ground Water - Shallow alluvial and deep bedrock ground water.

These five AOIs were combined into a single Operational Unit for the purpose of conducting the RI/FS because: (1) ore from the Iron King Mine may have been processed at Humboldt Smelter; (2) off-site migration of particulates from the Iron King Mine and Humboldt Smelter may have overlapping air-depositional areas; (3) mine tailings from the Iron King Mine may have migrated onto the Humboldt Smelter property via the Chaparral Gulch; (4) the Aqua Fria River and its contributing waterways (e.g., Chaparral Gulch and Galena Gulch) may have impacts from both the Iron King Mine and Humboldt Smelter; and (5) ground water may be impacted from both the Iron King Mine and Humboldt Smelter.

The Iron King Mine property, located west of Highway 69, occupies approximately 153 acres. The Iron King Mine property is bordered by Chaparral Gulch, to the north, Galena Gulch to the south, Highway 69 to the east, and undeveloped land to the west. The Iron King Mine was a periodically active gold, silver, copper, lead, and zinc mine from 1906 (when the mine produced fluxing ore for the Humboldt Smelter) until 1969. Ore from the Iron King Mine may have been processed at the Humboldt Smelter, which operated from the late 1800s until 1969.

The Humboldt Smelter property, located at the east end of Main Street, occupies approximately 189 acres. The smelter is situated less than 1-mile east of the Iron King Mine property. The Humboldt Smelter property is bordered by the Town of Humboldt to the west and north, the Agua Fria River to the east, and the Chaparral Gulch to the south.

The Iron King Mine property includes the following three subordinate properties:

- The Iron King Mine Proper Area, which consists of a large tailings pile and a plant area. In addition, there are 5 retention ponds or impoundments: Main Retention Pond, Pond 40-01A, Pond 40-02A, Pond 100-003F, and Pond 200-5S.
- The Iron King Operations Area, which historically contained at least 11 buildings, including the assay laboratory office, main office, change rooms, and the mechanical room. This property also contains multiple mine shafts, and the former Glory Hole; the latter of which has more recently been used as a landfill.
- The Former Fertilizer Plant Area includes several abandoned buildings, concrete pads, sumps, tanks, and an ore bin.

The Humboldt Smelter property consists of several abandoned buildings, a smelter stack, a tailings pile (763,000 square feet), a smelter ash pile (1,041,200 square feet), and a slag pile (456,000 square feet). On-site ponds, pits, and lagoons were reportedly used for the leaching of minerals from mined ore.

Chaparral Gulch, a natural drainage channel, flows from northwest to southeast along the border of the Iron King Mine property. The gulch crosses under Highway 69, passes through a residential area, and then enters the northeast boundary of the Humboldt Smelter property, flowing through the southwest corner. A tailings dam located on the smelter property within the Chaparral Gulch has retained tailings from both the Iron King Mine and Humboldt Smelter properties. The Chaparral Gulch flows into the Agua Fria River approximately ¼ mile downstream of the Chaparral Gulch dam. The Agua Fria River also flows from the north to the south along the eastern boundary of the Humboldt Smelter property.

Presently, the full extent of off-site soil contamination and possible ground water contamination has not been assessed. Arsenic and other metals have impacted off-site soil, sediments, surface water, and ground water at concentrations significantly above background levels.

Portions of this Site were regulated under the Arizona Department of Environmental Quality (ADEQ)'s Voluntary Remediation Program. In September 2007, EPA received a response from Arizona Governor Napolitano consenting to the placement of the Site on the National Priorities List (NPL). On 19 March 2008, EPA formally proposed the Site to the NPL.

1.1 Air Quality Monitoring Plan Objectives

The primary objectives of the RI/FS are to determine the nature and extent of contamination and to gather sufficient information so that the EPA can select a remedy that eliminates, reduces, or

controls risks to human health and the environment. The off-site migration of particulates from site soils is a primary migration pathway for the Iron King Mine and Humboldt Smelter AOIs. Therefore, the RI/FS field program has included ambient air sampling to evaluate this pathway from these potential sources.

1.2 Air Quality Monitoring Plan Goals

The goal of the Air Quality Monitoring program is determine potential source areas where airborne particulate material originates and quantify the off-site migration of air particulates. Data collected during the field investigation will include:

- Meteorological data to support the ambient air sampling program;
- Total suspended particulates (TSP) data, which may be useful for evaluating the off-site migration of airborne particulates, but may not be useful for the human health risk assessment because the coarse particle size of TSP is not respirable;
- Particulate matter less than 10 microns (PM₁₀) data, which is considered respirable and is directly applicable to human health exposure; and
- Inorganics data to evaluate analyte-specific human health exposure.

EPA guidance documents that were used to develop this plan include, but are not limited to:

- Air/Superfund National Technical Guidance Study Series: Volume I – Overview of Air Pathway Assessments for Superfund Sites (EPA, 1992a);
- Air/Superfund National Technical Guidance Study Series: Volume IV – Guidance for Ambient Air Monitoring at Superfund Sites (EPA, 1993);
- Design Considerations for Ambient Air Monitoring at Superfund Sites (EPA, 1992b); and
- Superfund Program Representative Sampling Guidance: Volume II – Air Short-term Monitoring (EPA, 1995).

1.3 Air Monitoring Program Design Considerations

EPA's *Air/Superfund National Technical Guidance Study Series: Volume IV – Guidance for Ambient Air Monitoring at Superfund Sites* (EPA, 1993) describes a general design for an air monitoring network used to assess off-site migration. The approach includes the measurement of target analytes concentrations at various locations around the Site.

Data will be collected at six locations upwind and downwind of the Site (Figure 3). The data will be compared to Residential and Industrial Air Regional Screening Levels for Chemical Contaminants at Superfund Sites (Oak Ridge National Laboratory [ORNL] 2008) to evaluate

human health exposure at downwind locations. The difference in concentrations measured upwind and downwind of the Site will represent the Site-related contribution to local air quality.

The factors that often dictate the air monitoring methodology include the list of target analytes, detection limits, temporal resolution, spatial resolution, and cost. Sampling duration and frequency depend upon the monitoring program goals and the relevant action levels. Because the air monitoring program will occur over a short-duration, six samplers will be deployed over a three-week period. Understanding wind patterns and other meteorological measurements is important for evaluating off-site migration of particulates and potentially exposed populations.

1.4 Air Monitoring Locations

Six TSP and six PM₁₀ samplers will be utilized over a three week period. Therefore, approximately 90 ambient air samples (of each type) will be available for evaluation (6 sample locations x 5 day per week x 3 weeks). EA will deploy one upwind and one downwind sampler of each type at the Iron King Mine property and the Humboldt Smelter property (Figure 3). Additionally, two samplers of each type will be placed in the town of Humboldt to evaluate human health exposure to air particulates from the Site.

The predominant wind direction is from the south-southwest (see Attachment A). The initial sample locations were selected to account for this variable. Nevertheless, sample locations may be adjusted as necessary based on the data collected from the meteorological station. To minimize disturbance to the community and also to minimize the risk of theft or vandalism, the air samplers will be deployed during daylight hours. It is anticipated that the samplers will be deployed for approximately 8 hours per day.

1.5 Summary of Air Monitoring Methods

There are three main monitoring methods that will be used in the AQM program: TSP samplers, PM₁₀ samplers, and meteorological monitoring equipment. The objectives for each of these monitoring methods are described below.

1.5.1 BGI PQ100

BGI PQ100 samplers will be used for the collection of PM₁₀ and TSP samples (followed by chemical analyses for metals). The air sampling equipment is further discussed in section 3.1.

1.5.2 Meteorological Monitoring Equipment

Meteorological data will be collected to evaluate the wind patterns. The primary parameters are wind speed, wind direction, and precipitation.

1.6 Air Sampling Frequencies and Duration

EPA's *Air/Superfund National Technical Guidance Study Series: Volume IV – Guidance for Ambient Air Monitoring at Superfund Sites* (EPA, 1993) provides recommendations on the frequency, duration, and type of air monitoring. The recommended frequency and duration of

data collection are dictated by the averaging period of the action level (e.g., acute, chronic, etc.). Generally, annual averages will result in average concentrations that reflect seasonal variations due to climate changes. This recommendation is also supported by the following EPA guidance:

- *A Preliminary Risk-based Screening Approach for Air Toxics Monitoring Data Sets* (EPA, 2006a);
- *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA, 1987);
- *Guidelines on Air Quality Modeling* (EPA, 2006b); and
- *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA, 2000a).

The Site is located in a mountainous region of Arizona and has an average high temperature of approximately 50-degrees Fahrenheit (F) in the winter and 90-degrees F in the summer. The wind direction tends to come from the south-southwest and is slightly calmer during the summer months (see Attachment A). Precipitation tends to fall during the monsoon season (i.e., July and August) and again during the winter (e.g., December). Because of this variation, there is a temporal aspect to exposure and migration of site contaminants. Exposure to site-related contaminants will tend to be greater during the summer when receptors are more active. Off-site migration of air-borne particulates may tend to be lower in the summer months, when average wind speeds are decreased. However, off-site migration of contaminated soil and water would likely be higher during the summer monsoon season. These temporal variances are considered minor and are not considered a significant source of uncertainty.

Given the nature and purpose of this Task Order, an abbreviated air monitoring program is considered appropriate. The results of this first air sampling event will assist EPA in evaluating the impact of the Iron King Mine and Humboldt Smelter on downwind receptors. After evaluation of the data, EPA may elect to conduct additional air monitoring studies at the Site as necessary.

2. DATA QUALITY OBJECTIVES

The following sections present the DQOs for this project. Much of the information used to develop DQOs was obtained from the SOW issued by the EPA (2008) and the EPA approved Work Plan (EA 2008). The CUS technical memorandum, which is presented in Appendix A, also forms the basis for the DQO assessment as it functions as the preliminary Conceptual Site Model (CSM). This DQO assessment follows EPA's 7-step DQO process (Table 2), which is outlined in *Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4)* (EPA 2006c) and *Systematic Planning: A Case Study for Hazardous Waste Site Investigations (QA/CS-1)* (EPA 2006d)

Additional information is referenced, as appropriate, in the following sections:

- Section 2.1.1 Purpose and Goal;
- Section 2.1.2 Step 1 – State the Problem;
- Section 2.1.3 Step 2 – Identify the Goal of the Study;
- Section 2.1.4 Step 3 – Identify Information Inputs;
- Section 2.1.5 Step 4 – Define the Boundaries of the Study;
- Section 2.1.6 Step 5 – Develop the Analytical Approach;
- Section 2.1.7 Step 6 – Specify the Performance or Acceptance Criteria; and
- Section 2.1.8 Step 7 – Develop the Plan for Obtaining Data.

2.1.1 Step 1 – State the Problem

The first step in any systematic planning process, and therefore the DQO process, is to define the problem that has initiated the study. As environmental problems are often complex combinations of technical, economic, social, and political issues, it is critical to the success of the process to separate each problem, define it completely, and express it in an uncomplicated format.

The most important activities in DQO Step 1 are as follows:

- Give a concise description of the problem;
- Identify leader and members of the planning team;
- Develop a CSM of the environmental hazard to be investigated; and
- Determine resources (i.e., budget, personnel, and schedule).

2.1.1.1 Problem Description

The soil at Iron King Mine and Humboldt Smelter has high concentrations of COPCs (primarily lead and arsenic) that may be being transported off-site via air particulate migration to the Off-site Soil AOI.

2.1.1.2 Planning Team Members and Stakeholders

A proven effective approach to formulating a problem and establishing a plan for obtaining information that is necessary to resolve the problem is to involve a team of experts and stakeholders that represent a diverse, multidisciplinary background. Such a team provides the ability to develop a concise description of complex problems, and multifaceted experience and awareness of potential data uses. Planning team members (including the leader) and stakeholders are presented below.

Planning Team Members

- Leah Butler, EPA TOM
- David Seter, EPA Alternate TOM
- Sophia Serda, EPA Human Health Risk Assessor

- Ned Black, EPA Ecological Risk Assessor
- Brian Stonebrink, ADEQ Project Manager

Stakeholders

- EPA Region 9 Superfund Division Management
- EPA Headquarters
- EPA's Lead Sites and Technical Review Workgroups
- United States Bureau of Land Management
- ADEQ Remediation Division
- Arizona Game and Fish Department
- Local residents.

If additional planning team members and/or stakeholders are identified as the RI progresses, they will be incorporated into the decision-making process as appropriate.

2.1.1.3 Conceptual Site Model

It is critical to carefully develop an accurate conceptual site model (CSM) of the environmental problem, as this model will serve as the basis for all subsequent inputs and decisions.

The soil at Iron King Mine and Humboldt Smelter has high concentrations of COPCs (primarily lead and arsenic) that may be being transported off-site via air particulate migration to the Off-site Soil AOI.

Historically, the Iron King Mine and Humboldt Smelter were used for mining related or other industrial activities. It is likely, that future reuse will remain commercial or industrial at these two AOIs. However, future reuse that would include construction worker, recreational, trespasser, or residential exposure is possible. The Off-site Soil AOI includes residential or commercial/industrial exposure as appropriate for the designated land use.

Ecological receptor exposure at the Iron King Mine and Humboldt Smelter is expected to be limited due to the lack of natural resources, habitat, and vegetation. The Galena and Chaparral Gulches provide a more suitable environment for ecological receptors, especially during periods when the gulches retain water. However, the most sensitive and valuable habitat is the Agua Fria River, which contains water throughout the year.

Additional details pertaining to the CSM are provided in the CUS Technical Memorandum presented in Appendix A, and are not repeated here for brevity.

2.1.1.4 Determine Resources

Resources should be identified by the planning team so that constraints (e.g., budget, time, etc.) associated with collecting/evaluating data can be anticipated during the Project Life Cycle. To assist in this evaluation, the DQO process (e.g., developing performance or acceptance criteria)

and the SAP (i.e., for collecting and analyzing samples, and interpreting and assessing the collected data) should be completed.

The EPA will perform a review of each required deliverable and provide comments as necessary. EPA will also solicit comments from other planning team members or stakeholders as appropriate. EPA anticipates that a RI/FS Report will be submitted to the EPA prior to 18 May 2009, which is 11 months after the Task Order approval date of 18 June 2008. Additional details pertaining to the schedule of events and deliverables necessary to meet this milestone are provided in the RI/FS Work Plan (EA 2008).

2.1.2 Step 2 – Identify the Goal of the Study

Step 2 of the DQO process involves identifying the key questions that the study attempts to address, along with alternative actions or outcomes that may result based on the answers to these key questions. These two items are combined to develop a decision statement, which is critical for defining decision performance criteria later in Step 6 of the DQO process.

The most important activities in DQO Step 2 are as follows:

- Identify principal study question(s).
- Consider alternative actions that can occur upon answering the question(s).
- Develop decision statement(s) and organize multiple decisions.

2.1.2.1 Principal Study Question

The principal study question(s) (PSQ) define the question(s) to be answered by the Human Health Risk Assessment (HHRA), Screening Level Ecological Risk Assessment (ERA); and RI. The PSQs are as follows:

What are the nature and extent of air contamination at the AOIs?

What are the migration pathways for these contaminants to be transported to other AOIs?

Are concentrations of AOI COPCs significantly greater than background?

What is the potential risk to human health and ecological receptors from exposure to Site related COPCs at the AOIs?

2.1.2.2 Alternative Actions

The alternative actions provide PSQ alternatives in the FS, as follows. Potential alternative actions, which will be evaluated in the FS, include, but are not limited to, the following:

- Remediate the source areas at Iron King Mine and Humboldt Smelter;
- Restrict access to the Iron King Mine or Humboldt Smelter properties to limit exposure;

- Mitigate the air and surface water migration pathways from the Iron King Mine and Humboldt Smelter;
- Remediate off-site soil areas impacted by other AOIs; and
- Address other migration/exposure pathways impacting receptors by employ engineering or institutional controls.

An Interim Measures Technical Memorandum, which addresses some potential alternative actions, is provided in Appendix B; details of that evaluation are not repeated here for brevity.

2.1.2.3 Decision Statement

For decision-making problems, the PSQs and alternative actions are combined to develop decision statements, which are critical for defining decision performance criteria later in DQO Step 6.

The decision statements are as follows:

Determine the nature and extent of air contamination at the AOIs.

Determine the migration pathways for these contaminants to be transported to other AOIs.

Determine whether the concentrations of AOI COPCs are significantly greater than background.

Determine if exposure to Site related COPCs at the AOIs pose a potential unacceptable risk to human health and ecological receptors.

2.1.3 Step 3 – Identify Information Inputs

Step 3 of the DQO process determines the types and sources of information needed to resolve: (1) the decision statement or produce the desired estimates; (2) whether new data collection is necessary; (3) the information basis the planning team will need for establishing appropriate analysis approaches and performance or acceptance criteria; and (4) whether appropriate sampling and analysis methodology exists to properly measure environmental characteristics for addressing the problem.

The most important activities in DQO Step 3 are as follows:

- Identify types and sources of information needed to resolve decisions or produce estimates;
- Identify the basis of information that will guide or support choices to be made in later steps of the DQO process; and

- Select appropriate sampling and analysis methods for generating the information.

The EPA RI/FS SOW (EPA 2008) and EPA approved Work Plan (EA 2008) sets forth the framework and requirements for this effort.

2.1.3.1 Necessary Information and Sources

A variety of sources and types of information form the basis for resolving the decision statements. The following information and sources are necessary to resolve this step of the DQO process.

The decision statements are supported by the following:

Determine the nature and extent of air contamination at the AOIs.

- Air data will be collected as noted in Section 1.

Determine the migration pathways for these contaminants to be transported to other AOIs.

- A weather station will be constructed at the Site to collect meteorological data for the evaluation of off-site migration of airborne particulates from the Iron King Mine and Humboldt Smelter to off-site soil.

Determine whether the concentrations of AOI COPCs are significantly greater than background.

- Air data will be collected to evaluate the potential anthropogenic and ambient contributions of contaminants above background.

Determine if exposure to Site related COPCs at the AOIs pose a potential unacceptable risk to human health and ecological receptors.

- A HHRA and Screening Level ERA will be conducted to evaluate potential unacceptable risk from off-site migration of air particulates.

2.1.3.2 Basis of Information

The basis of information, which will guide or support choices to be made in later steps of the DQO process.

The basis of information is supported by the following:

Determine the nature and extent of air contamination at the AOIs.

- During the RI field program, air data will be collected at six locations upwind and downwind of the Site (Figure 3).

Determine the migration pathways for these contaminants to be transported to other AOIs.

- The Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 1988) describes the process for evaluating migration pathways.

Determine whether the concentrations of AOI COPCs are significantly greater than background.

- Statistical approaches, including the background evaluation, will be consistent with EPA guidance, including, but not limited to: ProUCL 4.0 User Guide (Singh, Singh, and Maichle 2007); EPA Guidance for Comparing Background and Chemical Concentrations in soil for CERCLA Sites (EPA 2002a); and Role of Background in CERCLA Cleanup Program (EPA 2002b).

Determine if exposure to Site related COPCs at the AOIs pose a potential unacceptable risk to human health and ecological receptors.

- A HHRA will be conducted in accordance with the EPA's guidance which includes, but is not limited to: Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (EPA 1989); and Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (EPA 2002c).
- A Screening Level ERA will be conducted in accordance with the EPA's guidance which includes, but is not limited to: Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual (EPA 1997a); Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA 1997b, 1999); and other relevant EPA guidance.

To determine the nature and extent of contamination at the Site, a field investigation has been proposed to collect air data. Details pertaining to this effort are contained in Section 1.0 and will not be repeated here for brevity.

2.1.3.3 Sampling and Analysis Methods

A field investigation has been proposed to collect air data. Details pertaining to this effort are contained in Section 1.0 and will not be repeated here for brevity.

2.1.4 Step 4 – Define the Boundaries of the Study

In Step 4 of the DQO process, the target population of interest and spatial/temporal features pertinent for decision making should be identified. The most important activities in DQO Step 4 are as follows:

- Define the target population of interest.

- Specify temporal or spatial boundaries and other practical constraints associated with sample/data collection.

2.1.4.1 Target Population

The target population of interest are human health and ecological receptors near or in the vicinity of the Site that may be impacted by site-related impacts. These receptors are evaluated in a conceptual exposure pathway analysis in Appendix A. Details of this evaluation are not repeated here for brevity.

2.1.4.2 Temporal or Spatial Boundaries

The horizontal study boundary for the Site RI/FS includes five AOIs discussed in Section 1.1.2 (Figure 3):

- Iron King Mine – The Iron King Mine Proper Area, Iron King Operations Area, Former Fertilizer Plant Area, and ancillary associated properties;
- Humboldt Smelter and ancillary associated properties; and
- Off-site Soil in the vicinity of the Site.

This investigation will evaluate the three AOIs and any additional areas identified during this investigation, as appropriate. The Site is located in a mountainous region of Arizona and has an average high temperature of approximately 50-degrees Fahrenheit (F) in the winter and 90-degrees F in the summer. The wind direction tends to come from the south-southwest and is slightly calmer during the summer months. Precipitation tends to fall during the monsoon season (i.e., July and August) and again during the winter (e.g., December). Because of this variation, there is a temporal aspect to exposure and migration of site contaminants. Exposure to site-related contaminants will tend to be greater during the summer when receptors are more active. Off-site migration of air-borne particulates may tend to be lower in the summer months, when average wind speeds are decreased. However, off-site migration of contaminated soil and water would likely be higher during the summer monsoon season. These temporal variances are considered minor and are not considered a significant source of uncertainty.

2.1.5 Step 5 – Develop the Analytical Approach

Step 5 of the DQO process involves developing an analytic approach that will guide how to analyze the study results and draw conclusions from the data. It is the intention of this step to integrate the outputs from the previous four steps with the parameters developed in this step.

The most important activities in DQO Step 5 are as follows:

- Specify the appropriate population parameters for making decisions.

- Choose a workable action level and generate an “If ... then ... else” decision rule which involves it.

2.1.5.1 Population Parameters

The population parameter is defined as the value used in the decision statement to evaluate a decision point. The population parameter will be used as an exposure point concentration in the HHRA and Screening Level ERA. A population parameter will be determined for each chemical (e.g., arsenic); in each exposure area (e.g., Iron King Mine); for each sample group (e.g., air particulates). In this example, the population is arsenic in air samples from near the Iron King Mine. The population parameter for site comparisons will be the 95% Upper Confidence Limit of the Mean (95UCLM), which will be calculated using ProUCL version 4.0 (Singh, Singh, and Maichle 2007), or the maximum detected concentration if lower.

Background statistical evaluations will also be conducted. Two-population tests may be used to determine if an exposure area is significantly greater than background. Also, background level threshold values (BTV) may be used to evaluate some datasets (e.g., property specific off-site soils).

2.1.5.2 Action Level Decision Rule

The action levels for the Site will likely be either: (1) risk-based screening criteria developed during the HHRA or Screening Level ERA; or (2) site-specific background concentrations (i.e., BTVs). Site-specific background concentrations will be developed during the course of the investigation.

Residential and Industrial Air Regional Screening Levels for Chemical Contaminants at Superfund Sites (ORNL 2008) will be used to evaluate whether analytical data are of sufficient quality for risk assessment

The decision rule for the Site is as follows:

- If Site concentrations are not significantly greater than background and are less than risk based criteria, then the remedial actions are generally not recommended;
- Else, if Site concentrations are significantly greater than background or greater than risk based criteria, then a risk evaluation is generally recommended.

2.1.6 Step 6 – Specify the Performance or Acceptance Criteria

Step 6 of the DQO process specifies the tolerable limits on decision errors. Data are subject to various types of errors due (e.g., how samples were collected, how measurements were made, etc.). As a result, estimates or conclusions that are made from the collected data may deviate from what is actually true within the population. Therefore, there is a chance that an erroneous conclusion could be made or that the uncertainty in the estimates will exceed what is acceptable.

The performance or acceptance criteria for collected data will be derived to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels. Performance criteria and QA practices will guide the design of new data collection efforts. Acceptance criteria will guide the design of procedures to acquire and evaluate existing data.

The most important activities in DQO Step 6 are as follows:

- Recognizing the total study error and devising mitigation techniques to limit error.
- Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.

2.1.6.1 Total Study Error

Even though unbiased data collection methods may be used, the resulting data will still be subject to random and systematic errors at different stages of the collection process (e.g., from field sample collection to sample analysis). The combination of all these errors is called the “total study error” (or “total variability”) associated with the collected data. There can be many contributors to total study error, but there are typically two main components, sampling error and measurement error.

Sampling Error

Sampling error, sometimes called statistical sampling error, is influenced by the inherent variability of the population over space and time, the sample collection design, and the number of samples collected. It is usually impractical to measure the entire population space, and limited sampling may miss some features of the natural variation of the measurement of interest. Sampling design error occurs when the data collection design does not capture the complete variability within the population space, to the extent appropriate for making conclusions. Sampling error can lead to random error (i.e., random variability or imprecision) and systematic error (bias) in estimates of population parameters. In general, sampling error is much larger than measurement error and consequently needs a larger proportion of resources to control.

Measurement Error

Sometimes called physical sampling error, measurement error is influenced by imperfections in the measurement and analysis protocols. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission, and storage.

The potential for measurement error will be mitigated by using accurate measurement techniques. Sampling techniques were selected to limit the measurement error, including the following:

- Sample collection procedures, sample processing, and field sample analysis protocols are fairly standard. This will ensure that the methodology remains consistent and limits the potential for measurement error.
- Field teams will be trained and will perform specific tasks (e.g., sample collection or processing) throughout the field sampling effort to limit the potential for measurement error.
- Potential for measurement error in the sample analysis will be limited by the analysis of QC samples (e.g., duplicates).
- Data management procedures, which are outlined in the DMP (Appendix C of the SMP [EA 2008b]), will limit the potential for data reduction, transmission, and storage errors.

2.1.6.2 Statistical Hypothesis Testing and Decision Errors

Decision-making problems are often transformed into one or more statistical hypothesis tests that are applied to the collected data. Data analysts make assumptions on the underlying distribution of the parameters addressed by these hypothesis tests, in order to identify appropriate statistical procedures for performing the chosen statistical tests.

Due to the inherent uncertainty associated with the collected data, the results of statistical hypothesis tests cannot establish with certainty whether a given situation is true. There will be some likelihood that the outcome of the test will lead to an erroneous conclusion (i.e., a decision error).

When a decision needs to be made, there are typically two possible outcomes: either a given situation is true, or it is not. Although it is impossible to know whether an outcome is really true, data are collected and statistical hypothesis testing is performed to make an informed decision. In formulating the statistical hypothesis test, one of the two outcomes is labeled the “baseline condition” and is assumed to represent the *de facto*, true condition going into the test, and the other situation is labeled the “alternative condition.” The baseline condition is retained until the information (data) from the sample indicates that it is highly unlikely to be true.

The statistical theory behind hypothesis testing allows for defining the probability of making decision errors. However, by specifying the hypothesis testing procedures during the design phase of the project, the performance or acceptance criteria can be specified.

There are four possible outcomes of a statistical hypothesis test. Two of the four outcomes may lead to no decision error; there is no decision error when the results of the test lead to correctly adopting the true condition, whether it is the baseline or the alternative condition. The remaining two outcomes represent the two possible decision errors. The first is a false rejection decision error, which occurs when the data leads to decision that the baseline condition is false when, in reality, it is true. The second is a false acceptance decision error, which occurs when the data are insufficient to change the belief that the baseline condition is true when, in reality, it is false.

In the statistical language of hypothesis testing, the baseline condition is called the “null hypothesis” (H_0) and the alternative condition is called the “alternative hypothesis” (H_a). A false rejection decision error, or a Type I error, occurs when you reject the null hypothesis when it is actually true. The probability of this error occurring is called alpha (α) and is called the hypothesis test’s level of significance. A false acceptance decision error, or a Type II error, occurs when you fail to reject the null hypothesis when it is actually false. The probability that this error will occur is called beta (β). Frequently, a false rejection decision error is the more severe decision error, and therefore, criteria placed on an acceptable value of alpha (α) are typically more stringent than for beta (β). Statisticians call the probability of rejecting the null hypothesis when it is actually false the statistical power of the hypothesis test. Statistical power is a measure of how likely the collected data will allow you to make the correct conclusion that the alternative condition is true rather than the default baseline condition and is a key concept in determining DQOs for decision-making problems. Note that statistical power represents the probability of “true rejection” (i.e., the opposite of false acceptance) and, therefore, is equal to $1-\beta$.

Decision errors can never be totally eliminated when performing a statistical hypothesis test. However, the primary aim of this step is to arrive at the upper limits on the probabilities of each of these two types of decision errors that the planning team finds acceptable.

Background Evaluation

Inorganics in air will be subject to a background evaluation to determine whether Site concentrations are significantly greater than background. Two-population tests will be used to determine if the concentrations downwind are significantly greater than background. Because the Site is heavily impacted by inorganics (i.e., lead and arsenic), the null hypothesis is the mean concentration of a contaminant does exceed (i.e., is greater than or equal to) the mean background concentration and the alternative hypothesis is the mean concentration does not exceed the mean background concentration as follows:

$$H_0 = \text{Mean Air Analyte Concentration} \geq \text{Mean Air Analyte Background}$$

$$H_a = \text{Mean Air Analyte Concentration} < \text{Mean Air Analyte Background}$$

Also, BTVs may be used to evaluate the datasets if appropriate. The null hypothesis is the mean concentration of a contaminant does exceed (i.e., is greater than or equal to) the action level or background dataset and the alternative hypothesis is the mean concentration does not exceed the action level as follows:

$$H_0 = \text{Mean Air Analyte Concentration} \geq \text{Action Level}$$

$$H_a = \text{Mean Air Analyte Concentration} < \text{Action Level}$$

For the statistical evaluations conducted for the Site, the probability of a Type I error occurring will be established at 5 percent and a Type II error will be established at 10 percent.

The Type I error rate was set more conservatively because this type of error would result in finding the site uncontaminated when it actually was contaminated. Type I error is considered more serious than Type II error because it would leave contamination in place for continuing

exposure to receptors. By comparison, a higher Type II error rate of 10 percent was tolerable because this type of error would result in considering the site contaminated when it is actually not contaminated.

2.1.7 Step 7 – Develop the Plan for Obtaining Data

In the Steps 1 through 6 of the DQO process, performance or acceptance criteria were developed. The goal of Step 7 is to develop a resource-effective sampling design for collecting and measuring environmental samples, or for generating other types of information needed to address the PSQ. In addition, this sampling design will lead to data that will achieve the performance and acceptance criteria.

The most important activity in DQO Step 7 is as follows:

- Use the information from Steps 1 through 6 of the DQO process to identify a sampling and analysis design that will answer the PSQ and achieve the performance or acceptance criteria.

Normally, this step would require compiling a few different sampling and analysis designs, which could be evaluated to determine the best approach to answer the PSQ and achieve the performance or acceptance criteria. However, the sampling and analysis design was largely dictated by the SOW issued by EPA on 3 March 2008 (EPA 2008); the scoping meeting that was conducted on 10 March 2008; the site visit that was conducted on 19 March 2008; the negotiation meetings conducted on 12 and 14 May 2008; the comments received from EPA via e-mail dated 14 May 2008; the EPA-approved EA Work Plan dated 22 May 2008 (EA 2008a); and subsequent conference calls and E-mail correspondence. The sampling and analysis design is detailed throughout this document and will not be repeated here for brevity.

3. MONITORING EQUIPMENT

The following sections describe the AQM equipment for high volume air sampling, continuous particulate monitoring, and meteorological monitoring.

3.1 Air Sampling Equipment

The PQ100 is a battery operated mass flow controlled air sampler manufactured by BGI, Inc. for TSP and PM₁₀ measurements. This instrument is approved by the EPA under Federal Reference Method Number RFPS-1298-124, and is designated as a reference method for PM₁₀ air monitoring (CEPA 2003)

All system components are housed in an anodized aluminum case that supports a size selective vertically symmetric particulate inlet. During operation air is drawn by the pump through a filter (glass fiber for TSP and quartz fiber for metals and PM₁₀) and a flow mass sensor. This sensor allows the device to determine if the flow rate is correct. If the sensor determines that the flow rate is not correct, it will automatically adjust the pump speed to maintain the correct flow rate,

pressure, and temperature. All parameter information is stored by the device, and can be displayed on the screen or downloaded to a computer using manufacturer-supplied software (BGI 2008)

The PQ100 can be programmed to begin its sampling job at a specific user-defined date and time and run for a pre-determined time period. If a fault occurs that prevents normal operation, the device enters a shutdown mode until the problem is corrected, consuming no battery power. The PQ100 was designed to operate from 1.0 standard liter per minute (lpm) to 25.0 lpm and is not affected by changes in ambient temperature and barometric pressure. The flow rate precision is guaranteed to 2 percent of the calibration set point (BGI 2008).

Default values in this instrument have been selected to reflect EPA air sampling procedures (BGI 2008). When configured in accordance with the EPA manual reference method, RFPS-1298-124, the PQ100 is designated as a reference method for PM₁₀ monitoring. The PQ100 air sampler can be configured with different inlets to accommodate PM₁₀ or TSP sampling (CEPA 2003). For additional details on the PQ100 sampler, please see Attachment B for the PQ100 Air Sampler Instruction Manual.

3.2 Meteorological Monitoring Equipment

The exact meteorological station that will be used for this project has not yet been determined. However, at a minimum, the station will be capable of recording data for the following parameters: (1) time; (2) wind speed; (3) wind direction; and (4) precipitation.

4. SAMPLING SPECIFICATIONS

This section describes the EPA-approved specifications for air sampling and meteorological monitoring performed at the Site.

PM₁₀ sampling will be conducted in accordance with 40 CFR, Chapter I, Appendix J to Part 50, *Reference Method for the Determination of Particulate Matter as PM-10 in the Atmosphere* (EPA, 1998a). TSP sampling will be conducted in accordance with 40 CFR, Chapter I, Appendix B to Part 50, *Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)* (EPA, 1998b).

- **Air Sample Designation.** Air sample designation will include two fields that are separated by dashes; for example: AHS-01.
 - The first field, “AHS,” identifies the sample matrix as air near the Humboldt Smelter. Similarly, “AIK” is near the Iron King Mine.
 - The second field, “01,” represents the sample location identifier

5. ANALYTICAL PARAMETERS AND METHODS

This section describes analytical parameters and methods and sample holding times for high volume air sampling. The AQM program consists of gravimetric analysis of PM₁₀ and TSP filters and chemical analysis of 17 metals present on PM₁₀ filters shown below. EA will require analysis of air monitoring filters for PM₁₀, total particulates, and metals. The following is a list of the metals that are included: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, calcium, copper, iron, mercury, nickel, lead, silver, selenium, sodium, and zinc.

Table 1 summarizes the analytical methods, sample matrix, estimated number of samples, turnaround times, and sample holding times for ambient air sampling.

TABLE 1 ANALYTICAL METHODS

Parameter	Method	Sample Matrix	Estimated Number of Samples	TAT (days)	Holding Time ^a
Ambient Air Samples					
TAL metals (including Hg)	ICP 6010 and Hg by CVAA 7471	47 mm quartz fiber	Up to 90	14 days	180 days
PM ₁₀	Gravimetric Analysis, Inorganic Compendium Method IO-3.1, Section 5, (EPA/625/R-96/010a)	47 mm quartz fiber	Up to 90	14 days	180 days
TSP	Gravimetric Analysis, Inorganic Compendium Method IO-3.1, Section 5, (EPA/625/R-96/010a)	47 mm glass fiber	Up to 90	14 days	180 days
Notes:					
a Holding time is measured from the time of sample collection to the time of sample extraction and analysis.					
CVAA Cold vapor atomic absorption					
Hg Mercury					
ICP Inductively coupled plasma					
mm millimeter					
PM ₁₀ Particulate matter less than ten microns in size					
TAL Target analyte list					
TAT Turnaround time					
TSP Total suspended particulates					

Actual reporting limits achieved for samples from any given monitoring location during any given monitoring event will depend on the actual sample volume collected, which can vary.

6. QUALITY ASSURANCE PLAN

Quality assurance for the Site is described in the Sampling and Analysis Plan (SAP), which is the main document to this Appendix. The program incorporates the following items: standard operating procedures (SOPs), equipment calibration and maintenance, independent audit, field and laboratory quality control (QC) samples, data validation, corrective action, and data completeness.

6.1 Standard Operating Procedures

Calibration, operation, and maintenance of the air monitoring equipment will be conducted in accordance with the manufacturer recommendations. The SOP for calibration, operation, and maintenance of the PM₁₀ and TSP air sampling equipment is provided in Attachment B.

6.2 Equipment Calibration

Equipment calibration for the air samplers and meteorological station will be performed in accordance with manufacturer specifications and/or EPA guidance as described below.

6.2.1 Air Samplers

According to the manufacturer, the PQ100 samplers should not need calibration; however, EA will have calibration equipment at the site and will perform calibrations if necessary. Information regarding calibration by the manufacturer is provided below.

When using a specific filter and flow rate (i.e. 47 mm Teflon at 16.7 lpm this calibration will be maintained in memory indefinitely. However, calibration should be checked on a yearly basis. Assuming that a typical filter for a target was in place at the time of the calibration, the filter load is compensated for causing the pump to initialize to the proper speed. Once a target has been calibrated it should never have to be re-calibrated unless extreme conditions are expected (BGI 2008).

6.2.2 Meteorological Station

If recommended by the manufacturer, calibration of the meteorological station will be performed at the start of the AQM program.

6.3 Field and Laboratory QC Samples

Field and laboratory QC samples for the AQM program are specified in the SAP, which is the main document to this Appendix. Field QC samples consisting of co-located samples, filter blanks, and field blanks as described below.

For repeatability assessments, EA will co-locate samplers on a frequency rate of approximately one for every 20 samples (up to four total).

Analyses of filter blanks (a.k.a. trip blanks) are used to assess the contamination of samples from the native presence of target analytes in the filters used for air sample collection. A filter blank consists of a clean filter that is transported with associated primary samples, but is never taken out of its protective sleeve. A filter blank will be collected and analyzed for every 20 primary samples (i.e., 5 filter blank samples).

Analyses of field blanks are used to assess the contamination of samples during sample collection. A field blank consists of a clean filter that is placed onto the air sampler and then taken off without running the sampler. A field blank will be collected and analyzed for every 20 primary samples (i.e., 5 field blank samples). All field QC samples will be submitted to the laboratory without designating them as blanks to avoid bias. Field QC samples will be analyzed for the same parameters specified for the associated primary samples. Laboratory QC samples consist of method blanks, laboratory control samples, and laboratory duplicates samples as specified in the SAP, which is the main document to this Appendix.

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Figures

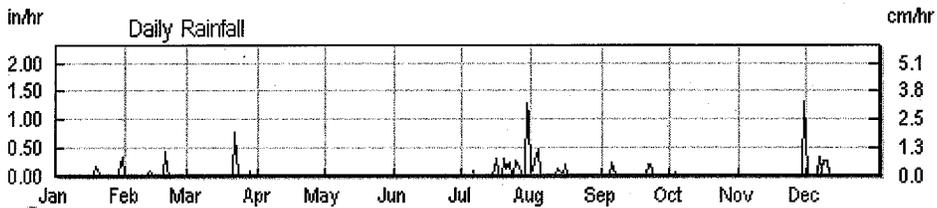
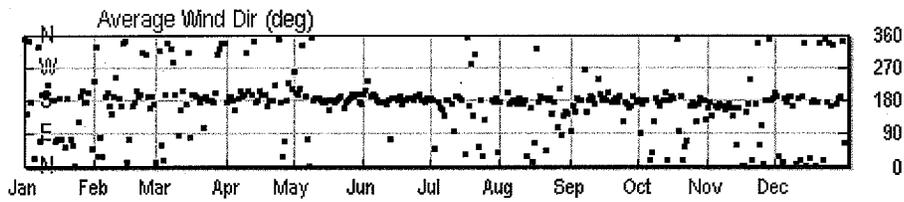
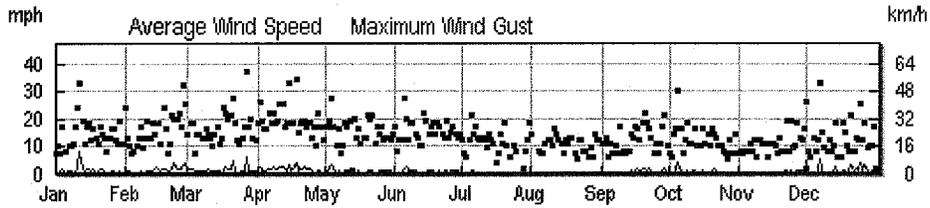
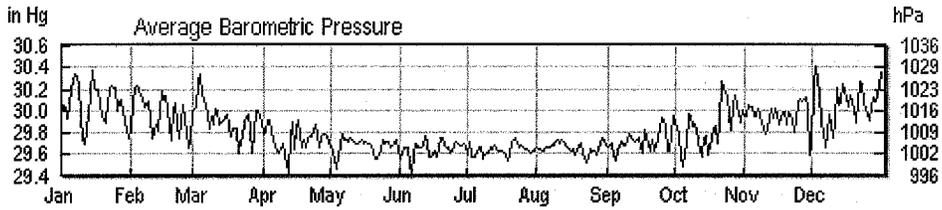
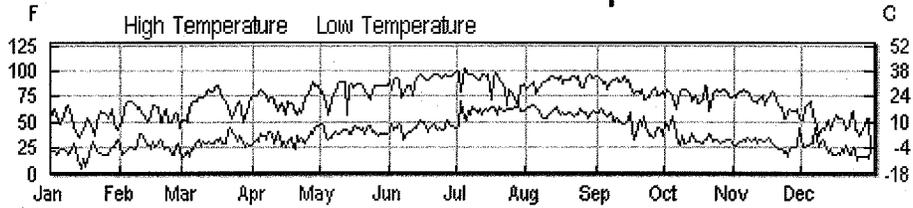


Attachment A

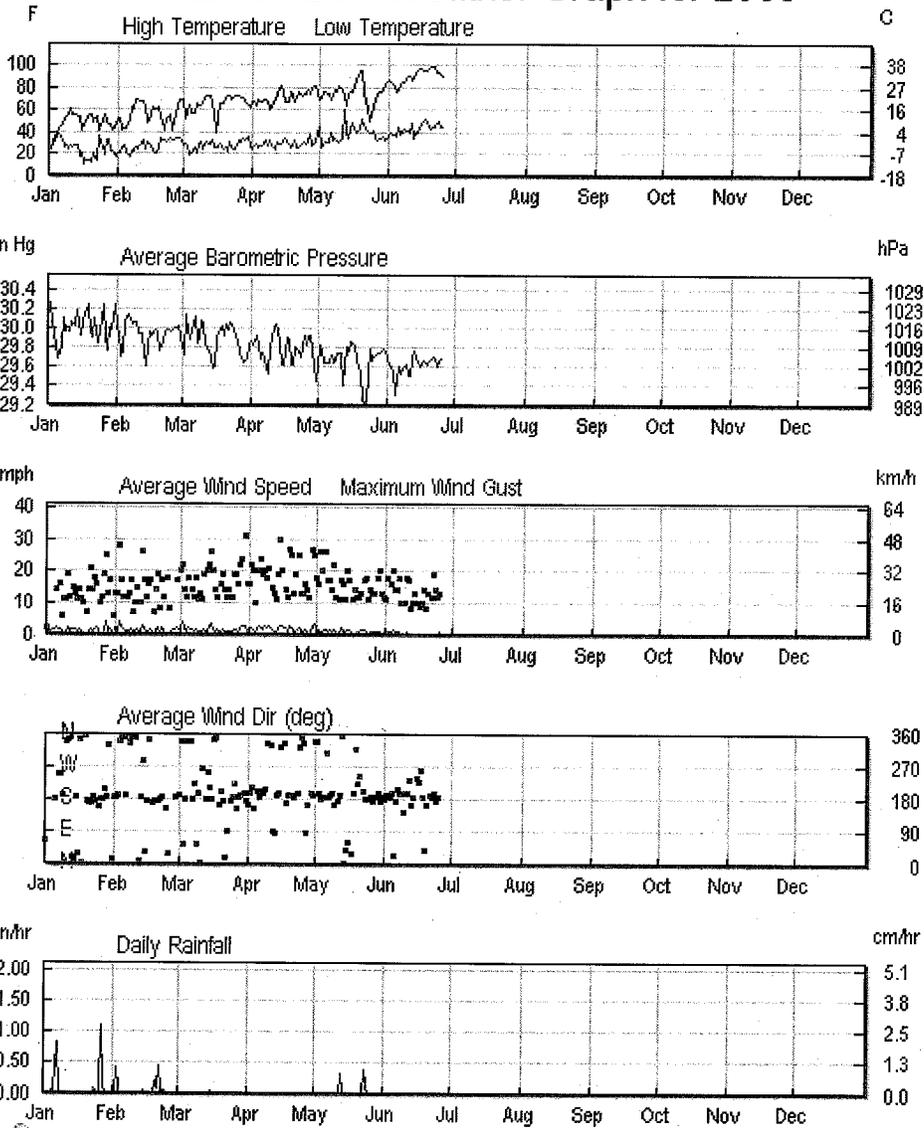
Historical Weather Data for Humboldt, Arizona



KAZHUMBO1 Weather Graph for 2007



KAZHUMBO1 Weather Graph for 2008



Attachment B

BGI PQ100 Air Sampler Instruction Manual



PQ100

Air Sampler

INSTRUCTION MANUAL

PM₁₀ REFERENCE SAMPLER

DESIGNATION NO. RFPS-1298-124

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PREFACE

The purpose of this manual is to provide complete operational, calibration and maintenance details for the BGI PQ100 air sampler. This instrument has been specifically designed to meet or exceed the operational requirements of a Reference Method sampling device under 40 CFR Part 50, Appendix J ("Reference Method For The Determination of Particulate Matter as PM-10 in the Atmosphere") and was designated a Federal Reference Method Sampler Number RFPS-1298-124 in December 1998.

SAFETY

The PQ100 should only be operated as described and for its intended use. Because the PQ100 runs primarily from battery power, all of the typical hazards associated with high voltages and internal A.C. wiring have been reduced or eliminated. Personal injury, damage to the instrument, or fire can occur if the following electrical precautions are not observed:

- Caution should always be given when attaching the A.C. mains power connection. Do not attempt to connect main power if the plug or wire are cracked or frayed.
- Do not attempt to connect main power if the power cord, leads, or outlet are wet. Do not immerse power cords in water or other liquids.
- Place power cords away from traffic and do not allow anything to rest on them during operation.
- Do not overload AC outlets.
- Do not attach improperly wired external batteries, solar panels or power sources.
- Do not open the control panel or handle any other of the electrical parts while power is applied to the PQ100. Always disconnect the power supply first.

In addition, personal injury or damage to the instrument could occur if the following precautions are not observed:

- Always operate the PQ100 in a normal, upright position. The legs should be bolted down to prevent tipping in conditions of high winds.
- Do not operate the PQ100 if any of the parts are defective, damaged, or missing.

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1.0 INTRODUCTION

The BGI PQ100 is an "Intelligent Air Pump" that can monitor its own airflow rate and thereby adjust the pump speed to compensate for changes in load pressure and/or other forces which would otherwise hamper the flow of air through a filter (or sample collector). The PQ100 can be programmed to begin its sampling job at a specific date and time and stop sampling after the user defined run time is depleted. A 24 character by 2 line Liquid Crystal Display provides the operator with a readout of flow rate, and other useful information.

Events such as the flow being restricted by blocking the inlet, batteries depleted (power failure), pump unable to regulate flow (excess resistance), etc. all force the pump into a shutdown mode which consumes no battery power until the problem causing the shutdown is corrected.

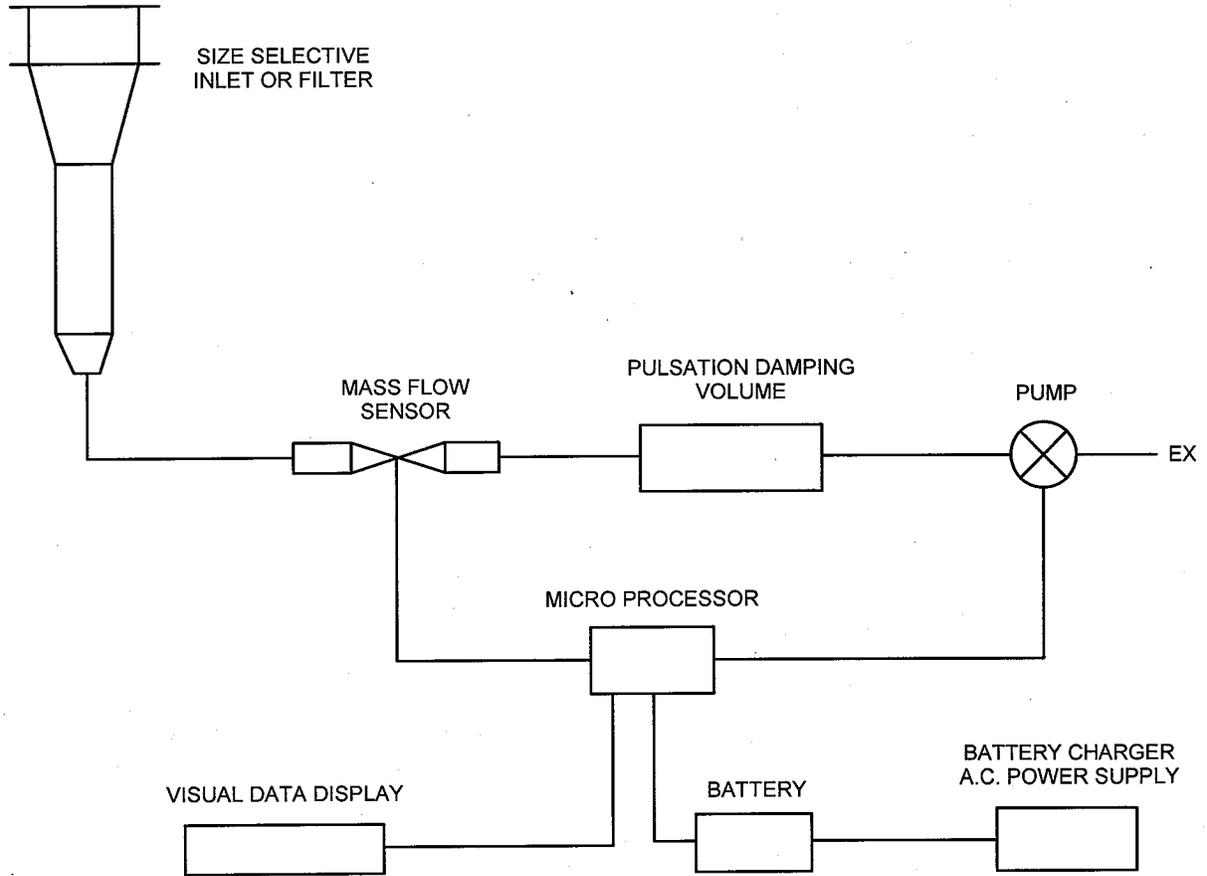
The PQ100 was designed to operate from 1 standard liter per minute (1000 cc per minute) to 25.0 standard liters per minute and is unaffected by changes in ambient temperature and barometric pressure. The flow rate precision is guaranteed 2% of the calibration set point. Standard conditions, for some forms of air sampling, being 20°C, 760 mm of Mercury barometric pressure.

Certain default values in this instrument have been selected to reflect EPA style air sampling procedures. The default "Run Time" is 24 hours. The default "Start Date and Time" is midnight tomorrow.

Principle of Operation

The operating principle of the PQ100 can be appreciated by referring to the block diagram below. Air is drawn by the pump through a size selective inlet device and/or filter. It then passes inside the instrument housing to a Mass Flow Sensor. The signal generated by the sensor is then routed to a microprocessor which determines if the flow is at the set value and adjusts the pump speed to maintain the correct flow rate. Because the flow sensor is extremely sensitive and all pumps produce pulsation to some degree, a pulsation damping volume has been introduced to control this effect. The microprocessor not only controls the flow rate accurately and precisely to the set point but also performs several other functions. These include turning the instrument on at a preselected time and running it for a selected interval. The flow is maintained by the processor to a designated pressure and temperature value. A pulse width modulated signal is configured and sent to the pump motor in a constantly updated manner based on signal information received from the Mass Flow Sensor. The microprocessor also stores all parametric information generated during the run period and configures it for presentation on the visual display and downloading to the software provided with the instrument.

The system is completed by its 12 volt battery and external battery charger/A.C. power supply. The power supply function permits operation if desired with no battery whatsoever.



SCHEMATIC DIAGRAM OF PQ 100 SYSTEM

1910

2.0 GETTING STARTED CHECKLIST

2.1 Included with the PQ100

1. PQ100 Main Unit
2. PQ101 Battery Charger (120 VAC or 240 VAC)
3. CQ2 PC Communication Adapter Cable
4. PC Software Diskettes - 3 1/2", 1.44K
5. PQMAN Manual
6. PQ102 Hose Adapter

2.2 Optional Accessories Available (See Section 5)

1. PQ103 Replacement Battery
2. CQ3 External Battery Adapter Cable
3. SSI-10 Size Selective Inlet (SSI) Kit
4. TP100R Dicot Inlet Rigid Tripod Assembly
5. F20 47mm Filter Holder for BGI16.7
6. F21 Filter Cassette (for use with F20 above)
7. TSP CAP Total Suspended Particulate Inlet

2.3 User Supplied Items

1. A DeltaCal, TetraCal (formally triCal) or Bubble Meter/Calibrator.
Note: Dry Calibrators and Rotameters are not recommended!
2. A length of rubber hose (about a half meter).
3. A Pinch Clamp or Valve (helpful but not required).
4. Ambient Temperature and Local Barometric Pressure Readings.
5. A Magnehelic Pressure Gauge (helpful but not required).
6. Filter Holder (F20) with Filter Cassettes (F21/2) to collect sample (also protects the PQ100 from damage).

Note: Permanent damage can occur if the PQ100 is operated without a filter in series with the Inlet. If the unit is operated without a SSI head with filter and holder, a suitable filter must be used to prevent damage to the pump and sensors.

3.0 HOW TO USE THE PQ100 IMMEDIATELY

3.1 What the Buttons do

- "ON/OFF" Turns the PQ100 On or Off.
- "RESET" Press after a sampling job to clear all the counters in preparation for the next sampling job.
- "RUN/STOP" Use when the PQ100 has been reset and programmed for another run and you now wish to start the pump.
- "+" Increase
- "-" Decrease
- "SETUP" Traveling from screen to screen and entering the information set on the screen.
- "ENTER" Accepts new setting within the screen.

3.2 Running the PQ100 at 16.7 Liters per Minute

1. Turn the PQ-100 on (Push the "ON/OFF" button). If a message is blinking on the display, press "ENTER" to proceed to the "MAIN IDLE DISPLAY".
2. Before you change any setups and to delete the last run push the "RESET" button. Screen display should be:

ET0000Min TS00.00M (Date)
Q(Flow)Lpm T(Time) Bty(Capacity)%

(Date) - today's date in military type notation; e.g., 01JAN= January 1st

(Flow) - the current flow rate selected to be regulated.

(Time) - military time; e.g., 13:08= 13 Hours 8 Minutes or 1:08 PM

(Capacity) - remaining charge in the internal battery.

3. Press "SETUP"
Screen reads; "Select FLOW RATE"

To change TARGET FLOW RATE;

- * Press ENTER (Whole number value will remain on constant while the tenths still blink); use "+" or "-" to increase or decrease until 16 is displayed.
- * Press ENTER (Tenths value will now remain constant while whole number blinks); use "+" or "-" to increase or decrease until .7 is displayed.

Note: If the flow rate displayed is followed by Lpm then the selected flow rate is calibrated and recalibration is not required. If CAL is displayed then calibration should be performed as described in section 7.0.

4. Press "SETUP"
Screen reads; "Set DATE and TIME"

To change the Date and Time;

- a. DAY: Press ENTER and change by pressing the + or - key. When the day is correct, press ENTER.
- b. MONTH: To change, press + or - key. When correct, press ENTER.
- c. YEAR: To change, press + or - key. When correct, press ENTER.
- d. TIME (hrs): To change, press + or - key. When correct, press ENTER.
- e. TIME (min): To change, press + or - key. When correct, press ENTER.

5. Press "SETUP"
Screen reads; "Set START DATE and TIME"

This determines when you wish to start a sample job. It always defaults to midnight the next day. Should you wish to change it;

- a. DAY: Press ENTER and change by pressing the + or - key. When the day is correct, press ENTER.
- b. MONTH: To change, press + or - key. When correct, press ENTER.
- c. YEAR: To change, press + or - key. When correct, press ENTER.
- d. TIME (hrs): To change, press + or - key. When correct, press ENTER.
- e. TIME (min): To change, press + or - key. When correct, press ENTER.
- f. (enable): This is to turn this function On or Off. If "Off" then a sample job (pump starts running) is initiated as soon as the "RUN/STOP" key is pressed from the "MAIN IDLE DISPLAY". If "On" then the sample job is initiated when the start date and time are achieved. SET THIS FUNCTION TO "OFF" IF YOU WISH TO START SAMPLING NOW. Change by pressing + or - key. When correct, press ENTER. FOR THE PURPOSE OF THIS TUTORIAL, SET TO "OFF".

6. Press "SETUP"
Screen reads; "Set RUN TIME"

This is for when you wish to set the length of time that the pump will run for. (Other than for 24 hrs). It always defaults to 24 hrs 0 min. To change;

- a. HOURS: Press ENTER and change by pressing the + or - key. When the hours are correct, press ENTER.
- b. MINUTES: To change, press + or - key. When correct, press ENTER.
- c. (enable): This is to turn this function On or Off. If "On" then the pump will run for the amount of time specified and then power itself off.
SET THIS FUNCTION TO "OFF" IF YOU WISH TO RUN UNTIL THE BATTERIES RUN DOWN. Change by pressing + or - key. When correct, press ENTER. FOR THE PURPOSE OF THIS TUTORIAL, SET TO "OFF".

7. Press "SETUP"
Screen returns to the "MAIN IDLE DISPLAY"

DO NOT PRESS THE RESET BUTTON AT THIS TIME AS THE START TIME AND RUN TIME WILL DEFAULT.

8. Press "RUN/STOP"
If the START TIME ENABLE is set to "OFF" then the pump will begin to run immediately and will run until one of the shutdown causes (explained in APPENDIX E) force the unit to terminate the sample job. During the initial time that the PQ100 requires to stabilize its flow rate, flow will be displayed as --.-Lpm. If the START TIME ENABLE is set to "ON" then the message "Alarm Triggered Run..." followed by "PQ100 Powering Down.." will appear briefly. The PQ100 is now waiting for the internal real time clock to achieve the designated start time and will then power itself on and begin the Air Sample Job.

3.3 Downloading (A Quick Start Overview)

1. Insert the "PQ" software diskette in the "A:" drive of your PC or notebook and type INSTALLC at the A:\> prompt. This will create a subdirectory on your hard drive called PQ and will copy all files from the floppy disk to this subdirectory. After the installation is complete, type PQ at the A:\> prompt to run the program (see section 8.0).

2. From the PQ MAIN MENU, select "b" to begin a job and answer the questions provided or simply press enter for each of the entries.
3. From the PQ MAIN MENU, select "I" to import (download) the data from the PQ100.
4. Connect the cable provided from your computer to the UTILITY ADAPTER port on the front of the PQ100. NOTE: THE PQ100 MUST BE AT THE "MAIN IDLE DISPLAY" FOR THE DOWNLOAD TO WORK.
5. When the download is complete you may then select "s" from the "PQ MAIN MENU" to view the file data.

4.0 SPECIFICATIONS

4.1 Flow Rate Precision, Accuracy and Pulsation

Flow Rate Selections: 1.0 to 25.0 Lpm in .1 Lpm increments

Flow Rate Accuracy: .5%
(When calibrated with a DeltaCal or TetraCal (formally tetraCal))

Flow Rate Precision: 2%

Pulsation for various applications as measured downstream from the filter:

Flow Rate	Media Type	Pulsation
-----	-----	-----
16.7 Lpm	47mm Quartz	4.56%
10.0 Lpm	47mm Quartz	3.84%
10.0 Lpm	47mm Teflo	7.38%
7.0 Lpm	47mm Quartz	5.06%
5.0 Lpm	47mm Quartz	6.13%
4.0 Lpm	47mm Quartz	7.94%
2.2 Lpm	37mm MCE w/BGI-4 Cyclone	4.70%

4.2 Run Times for Various Applications

Flow Rate	Media Type	Pressure Drop	Run Time
-----	-----	-----	-----
25.0 Lpm	47mm Teflo	28.0cm H2O	11.6 Hours
25.0 Lpm	47mm Fiberglass	37.0cm H2O	7.4 Hours
16.7 Lpm	47mm Teflo	10.8cm H2O	33.6 Hours
16.7 Lpm	47mm Fiberglass	25.4cm H2O	32.4 Hours
16.7 Lpm	47mm Quartz	33.0cm H2O	28.4 Hours
14.0 Lpm	37mm MCE .8	112.0cm H2O	13.0 Hours
12.0 Lpm	37mm MCE .8	94.0cm H2O	13.5 Hours
12.0 Lpm	25mm MCE .8	170.0cm H2O	11.6 Hours
10.0 Lpm	37mm MCE .8	66.0cm H2O	19.8 Hours
2.2 Lpm	37mm w/BGI-4 Cyclone	5.0cm H2O	67.0 Hours

4.3 Dimensions and Weights (PQ100 Main Unit Only)

Dimensions:

Height:	5.3" (13.46cm)
Width:	9.9" (25.15cm)
Depth:	9.7" (24.64cm)
Weight:	19 Lbs. (8.63Kg)

4.4 Electrical Specifications

Main Battery-	12V 12Ah Short Circuit Protected
Clock Battery-	3.6V Lithium Cell
Clock Battery Life-	2 Years
Motor Drive-	High Efficiency Pulse Width Modulator
Flow Rate Measurement-	Mass Flow Sensor
Serial Data Signals:	
	Outputs- 9V Nom.
	Inputs- 30V Max.
Charging System-	120VAC (60 Hz) or 240VAC (50 Hz)

Note: The PQ100 can run from the Charger.

4.5 Hardware Requirements for PQ Software

IBM XT, AT or 100% Compatible Clone
MS-DOS Operating System version 2.1 or greater
Minimum one 3.5, 5.25, Low or High Density Floppy Drive
COM1 or COM2 RS232 Serial Port for Downloading
(Not required for Correction Calculator)
Any Video Adapter Configuration
Hard Disk is preferred but not required

For Printouts: All printouts are directed to LPT1 as generic ASCII text with no special printer functions. This means that redirection can be accomplished using the MS-DOS function "MODE" and that any printer will work.

4.6 Dimensions, Weights and Flow Specifications for SSI

SSI-10 Inlet Kit (Including Rigid Tripod Assembly)

Flow Rate:	16.7 Lpm 5%
Weight:	16 Lbs. (7.3Kg)
Tripod Diameter Footprint:	51" (1.29M)
Tripod/Inlet Overall Height:	76" (1.93M)

5.0 ACCESSORIES

5.1 Cables

CQ2 Communication Adapter Cable	Connects the PQ100 to a computer for downloading
CQ4 External High Capacity Battery Cable	Use to connect the PQ100 to a large external battery, typically 80 Amp Hour for greater than 48 hour run time

5.2 Inlets, Adapters and Filter Holders

PQ102 Hose Adapter	For attachment of a rubber hose to the PQ100.
SSI-10 Inlet Kit	PM10 Size Selective Inlet for separation and collection of particles with an aerodynamic equivalent of 10 micrometers or less.
F20 47mm Filter Holder	Connects to Dicot Inlet and holds Filter Media, also used as TSP Inlet when used with TSP CAP.
F21/2 Filter Cassette (for use with F20 above)	Plastic Cassette containing a screen and filter media
TSP 100 Micrometer Inlet	(for use with F20 above)

5.3 Batteries and Chargers

PQ101 Battery Charger
Auxiliary Power Supply

Used to Recharge system batteries and to power the PQ100 for long run times when AC Power is available.

PQ103
Replacement Battery

5.4 Miscellaneous

TP100R
Rigid Tripod Assembly

Supports Dicot Inlet at EPA recommended height

6.0 OPERATION DETAILS

6.1 Basic Operation

To operate the PQ100 Air Sampler, press the Power "On/Off" pushbutton keyswitch. The unit will beep a few times and display;

BGI PQ100 Air Sampler

and briefly, the unit serial number and firmware revision;

SN:1234 Version 5.23

and then;

Initializing!

During the power-up sequence if it has been determined that the unit had previously shutdown due to one of the shutdown conditions, i.e. "Flow Rate Error", "Low Batteries", "Sample Run Completed" etc. the unit will then flash one of these messages at the display and requires that the user press the "Enter" key to continue on to the MAIN IDLE DISPLAY (See APPENDIX E for a description of all shutdown codes). If the unit was powered down normally, i.e. the power "On/Off" key was previously pressed while at the MAIN IDLE DISPLAY, then it will jump from the above initialization messages directly to the MAIN IDLE DISPLAY and will not display a flashing error message.

6.2 Main Idle Display

ET0000Min TS00.00M 28oct (or similar)
Q10.0 Lpm T01:00 Bty99%

Where;

ET is the Elapsed Time of the previous run in minutes.
TS is the Total Sample of the previous run in cubic meters.
Q is the selected TARGET flow rate in liters per minute.
Bty is the percentage of charge stored in the battery.
T is Time (24:00 hour system)
28oct is Day Month (year is displayed only on Setup and download).

For power conservation purposes, the PQ100 is equipped with an algorithm which detects inactivity. If the front panel pushbutton switches or the RS232 port are not used within 3 minutes the unit will power itself off.

6.3 What to Do Next

Pressing the "Setup" key steps through the various Menu Selections. Each of the selections are explained in detail, in the order they will be encountered, on the following pages.

6.4 Setting a New Target Flow Rate

From the "MAIN IDLE DISPLAY" press the "Setup" key once until the message below appears;

```
Select FLOW RATE  
Target Q... xx.yLpm
```

where;

```
xx = Liters per minute  
y = tenths of a Liter per minute
```

The target flow rate is that which the PQ100 will draw air through the inlet at when a run is initiated.

If the displayed flow rate is acceptable and you do not wish to change it, press the "Setup" key. This action will change nothing and will step the menu to the next selection. If a change is required, press the "Enter" key. You will notice that the whole number value (the value preceding the decimal point) will then remain on while the tenths value continues to flash. The value that remains on is the one that will change when the "+/-" keys are pressed. When the proper value has been reached, pressing the "Enter" key will then select the tenths value (the digit after the decimal point) for editing. After the values have been entered, pressing the "Setup" key will then store the new values in memory and step to the next menu selection.

6.5 Setting the Date and Time

From the "MAIN IDLE DISPLAY" press the "Setup" key twice until the message below appears;

```
Set DATE and TIME  
dd mmm yyyy hh:mm
```

where;

```
dd = day of the month  
mmm = month  
yyyy = year  
hh = hour (0-24, 24 hour system) mm = minutes (0-59)
```

The date and time are read from the real time clock just prior to entering this screen. This action copies the precise date and time data at that instant to temporary memory locations. Once the values have been established in these temporary locations they are then modifiable by the user and will then be flashing on the display.

If all is correct pressing the "Setup" key will change nothing and will step the menu to the next selection. If a change is required, press the "Enter" key. You will notice that the day will then remain on while the rest of the values continue flashing. The value that remains on is the one that will change when the "+/-" keys are pressed. When the proper value has been reached, pressing the "Enter" key will then select the next value for editing. After all the values have been entered, pressing the "Setup" key will then write the new values to the real time clock and step to the next menu selection.

Notes:

1. Seconds will always default to zero. Therefore, if you wish to synchronize the clock exactly, press the "Setup" key at zero seconds.
2. Once the Set Time menu selection is entered, the clock is not read again during this screen. Don't expect the date or time to change while this menu selection is engaged. However, the clock is not halted, and is still keeping time. If the "Enter" key is never pressed while this menu selection is being displayed no changes are made to the date or time even though the time does not appear to change.
3. Century will only change on 12/31/1999 at midnight. Century will then become 2000.

6.6 Setting the Start Date and Time

From the "MAIN IDLE DISPLAY" press the "Setup" key three times until the message below appears;

```
Set START DATE and TIME
dd mmm   hh:mm   eee
```

Where;

```
dd = day of the month
mmm = month
hh = hour (0-24, 24 hour system) mm = minutes (0-59)
eee = enable "On" or "Off"
```

Note: If "On" is enabled see the next section for further description of run procedure.

This sets the date and time that the sampler will begin running the pump. If all is acceptable pressing the "Setup" key will change nothing and will step the menu to the next selection. If a change is required, press the "Enter" key. You will notice that the day will then remain on while the rest of the values continue flashing. The value that remains on is the one that will change when the "+/-" keys are pressed. When the proper value has been reached, pressing the "Enter" key will then select the next value for editing. After all the values have been entered, pressing the "Setup" key will then write the new values to the real time clock alarm registers and step to the next menu selection. This function can be disabled. This means that if the Enable (eee) is set to "Off", the PQ100 will begin to run the pump immediately when the "Run/Stop" key is pressed from the "MAIN IDLE DISPLAY" regardless of the start time and date.

IF YOU SIMPLY WANT THE PUMP TO START RUNNING WHEN YOU PRESS THE "RUN/STOP" KEY, THE LOWER RIGHT OF THE DISPLAY SHOULD INDICATE OFF.

Note: When the reset key is pressed to clear the counters this setup will automatically default to Midnight (00:00) of the next day. If some other Date and Time are required you must reset the run first before using this menu selection (See Resetting the Counters).

RESET DOES NOT AFFECT THE ENABLE AND WILL REMAIN UNCHANGED!

6.7 Setting the Run Time

From the "MAIN IDLE DISPLAY" press the "Setup" key four times until the message below appears;

```
Set RUN TIME
Hours:hh Min:mm eee
```

Where;

```
hh = hour (0-99 hours)
mm = minutes (0-59)
eee = enable "On" or "Off"
```

This sets the length of time that the sampler will run the pump for. If the setting is acceptable, pressing the "Setup" key will change nothing and will step the menu to the next selection. If a change is required, press the "Enter" key. You will notice that the hours will then remain on while the other values continue flashing. The NON-FLASHING value will now change when the "+/-" keys are pressed. When the proper value has been achieved, pressing the "Enter" key will then select the next value for editing. After all the values have been entered, pressing the "Setup" key will then store the new values and step to the "MAIN IDLE DISPLAY".

This function can be disabled thereby allowing the pump to run until some other shutdown such as Low Batteries etc. if the Enable (eee) is off.

IF YOU SIMPLY WANT THE PUMP TO RUN UNTIL SOME OTHER CONDITION SUCH AS BATTERIES TOO LOW CAUSES A SHUTDOWN, THE LOWER RIGHT OF THE DISPLAY SHOULD INDICATE OFF.

Note: When the reset key is pressed to clear the counters this setup will automatically default to 24 Hours. If some other Run Time is required you must reset the run first before using this Mode (See Resetting the Counters).

RESET DOES NOT AFFECT THE ENABLE AND WILL REMAIN UNCHANGED!

Note: If START TIME was enabled, after RUN TIME screen, the unit will not step the screen to the "MAIN IDLE DISPLAY". Instead, the next screen that appears will state;

```
To initiate a run,
Press Run/Stop
```

At this time pressing "Run/Stop" will power the unit off and sampling will commence at the programmed run time. If you simply wish to go to the main idle screen (bypass this function) press "Setup". This will return you to the "MAIN IDLE DISPLAY". At this point you can also press "Run/Stop" to initiate the run.

6.8 Running the Pump

6.8.1 Start Time Disabled

To initiate a run, from the "MAIN IDLE DISPLAY", press the "Run/Stop" key. If the START ALARM is disabled (See setting the Start Time and Date) the pump will immediately begin running and the "Q" in the display window will start to flash. This indicates normal operation and the pump will run at the specified Flow Rate until a stop condition is encountered (i.e. Batteries depleted, excess Flow Restriction etc.). If "CAL" is displayed after the Flow Rate in the lower left corner of the display, this target is not calibrated and therefore the Flow Rate indicated is a coarse approximation and is somewhere 10% of that displayed. Use the Calibration Mode to set this to 2%.

During the initial time that the PQ100 requires to stabilize its flow rate, flow will be displayed as --.-Lpm.

6.8.2 Start Time Enabled

To initiate a run, from the "MAIN IDLE DISPLAY", press the "Run/Stop" key. If the Alarm values are correctly set and Enabled, the PQ100 will power itself off (or GO TO SLEEP) until the start date and time have been reached. When the Alarm triggers the PQ100 to "Wake-Up", after the Initialization and diagnostics, the pump will begin to run until a shutdown condition occurs.

6.8.3 Run Time

If the RUN TIME is Enabled ("On"), the pump will run until this shutdown condition occurs. Successful completion is indicated by the following message flashing on the screen when the unit is powered on;

SAMPLE RUN COMPLETED!
Key "Enter" to Continue!

6.8.4 Acoustic Phenomena at High Negative Pressure

When running the PQ100 at very high load pressures (i.e. 150 centimeters of water or better), a metal popping sound may be heard by the user. This is merely the internal pulsation dampner (Plenum) adjusting its chamber area. The PQ100 will alert you as to the nature of any problems via the shutdown messages as described in APPENDIX E.

6.9 Verifying the Flow Rate

To verify the Flow Rate while the Pump is running, a DeltaCal or TetraCal (formally triCal) is highly recommended for Calibration and Verification of the true Actual Flow Rate. Use section 8.7; Appendix A, Equation 2; or the "CORRECT" utility provided on floppy diskette to calculate the corrected flow rate as shown on the Calibration/Verification Standard.

If the flow rate is not within 2% of the "Corrected Flow Rate" a leak in the system is the probable cause and should be inspected.

More information on the DeltaCal or TetraCal (formally triCal) may be found at www.bgiusa.com/cal/index.htm

6.10 Resetting the Run

When a Run has been completed, and all the information from it either recorded or downloaded via the Communications Software, the "Reset" key can be pressed to clear all of the "Run-Time Variables". This action causes the "Elapsed Time" (ET) and the "Total Sample" (TS) to Clear (all zero's) and also causes the Start Time Alarm Clock to default to the next occurrence of Midnight (00:00) and the Run Time to 24 Hours. The Reset Function does not affect the Enables for the Start Time or Run Time. Also, all "Flow Calibrations" remain in memory.

NOTE: IF YOU SIMPLY WISH TO START A NEW RUN WITH NO CHANGES (DEFAULT START TIME, RUN TIME, AND CALIBRATION VALUES ARE ALL ACCEPTABLE) THEN THE ONLY ACTIONS NECESSARY AFTER RECORDING OR DOWNLOADING THE PREVIOUS RUN DATA IS TO PRESS THE "RESET" KEY (CLEARS ALL COUNTERS AND DEFAULTS THE RUN TIME AND START TIME) AND PRESS "RUN/STOP" FROM THE "MAIN IDLE DISPLAY". THIS WILL CAUSE THE PQ100 TO BEGIN A SAMPLING JOB IDENTICAL TO THE PREVIOUS JOB.

7.0 CALIBRATION

7.1 Entering and Using Calibration Mode

From the "MAIN IDLE DISPLAY" press the "Setup" key once until the message below appears;

Select FLOW RATE
Target Q... xx.yLpm

(See Section 6.4 to select a new target Flow Rate.)

From the "Select FLOW RATE" message screen you must press both the "Reset" key and the "Run/Stop" key simultaneously to enter the calibration mode and the message below will appear;

CALIBRATE Target=qq.qLpm

where;

qq.q = Target Flow Rate to be Calibrated

CAUTION: BE CAREFUL WHEN USING CALIBRATION MODE. IT IS NOT USED TO CHECK CALIBRATION FLOW RATE. INCORRECT USE CAN ERASE A PREVIOUSLY STORED CALIBRATION. IF YOU SIMPLY WISH TO CHECK THE FLOW RATE ACCURACY FOR THE SELECTED TARGET, GO TO THE MAIN IDLE DISPLAY AND PRESS "RUN/STOP". BE CERTAIN THAT THE START DATE ENABLE IS SET TO "OFF" (SECTION 6.9).

This mode is used to Calibrate the PQ100 at a target flow rate. It should be noted here that each individual target has it's own independent calibration storage area and is non-volatile. That means that each and every flow rate from 1.0 LPM to 25.0 LPM can have its own discrete tolerances without approximation and will remain programmed in the instrument even in the event of total battery discharge. Pump speed values are also stored with the calibration data.

Assuming that a typical filter for a target was in place at the time of the calibration, the filter load is compensated for causing the pump to initialize to the proper speed. Once a target has been calibrated it should never have to be re-calibrated unless extreme conditions are expected.

To use this mode, Press the "Run/Stop" key to turn on the pump (pump will start to draw at somewhere in the range of the target flowrate depending on the resistance presented by the filter and calibrating device) and the following message will appear;

Reference Q.. rr.r

Where;

rr.r is an approximate flow rate used only as a visual aid in finding the corrected flow on the calibration device. This value may indicate 5 to 15% error. Don't be concerned! This is for reference only!

Use the "+/-" keys to move the pump speed up or down until the calibration device indicates the "Corrected Flow Rate" value as determined by the Calibration Equations given on the following pages.

HOLDING DOWN THE "RESET" KEY WHILE PRESSING THE "+" OR "-" KEY WILL ALLOW FOR COARSE ADJUSTMENT OF THE PUMP SPEED. WHEN THE PUMP SPEED WILL SEEM TO GO NO HIGHER OR LOWER, THE UPPER AND LOWER LIMITS HAVE BEEN REACHED.

When a good stable reading has been achieved, pressing the "Enter" key will store both the "Actual Sensed Flow Rate" and the pump speed data into the table of non-volatile calibrations where they will remain as "Constants" until a change is required (Only under "Extreme Ambient Conditions" as it should be impervious to moderate changes) and will then exit the Setup menu and return to the "MAIN IDLE DISPLAY".

CALIBRATIONS ARE NOT AFFECTED UNTIL THE ENTER KEY IS PRESSED AND THE PUMP IS RUNNING.

7.2 Using a DeltaCal or TetraCal (formally triCal)

The use of a DeltaCal or TetraCal (formally triCal) is highly recommended for calibration of the PQ100. Connect either unit to the PQ100 just before the filter holder and read the actual flow on the display. More information on the DeltaCal or TetraCal (formally triCal) may be found at www.bgiusa.com/cal/index.htm

7.3 Using a Rotameter

Calibrating the PQ100 Air Sampler with a Rotameter is to be avoided for two reasons. The PQ100 is more accurate (.5% of the expected flow rate) than the typical rotameter (within 3% of Full Scale). Secondly, the rotameter, unlike the bubble meter, has a reference condition calibration and requires a correction for ambient conditions.

The procedure for using a rotameter is best illustrated by example.

Example 4:

Referring to the conditions cited in example 1 (Appendix A), the required set point is 9.74 Lpm. If a rotameter is used, they are typically calibrated at 760 millimeters of Mercury and 70 degrees Fahrenheit (21.11 degrees Celsius or 294.29 degrees Kelvin). The room conditions in Example 1 were 19 degrees Celsius and 765 millimeters of Mercury. The equation for the rotameter correction is;

$$QI = QT \left(\frac{PT}{PI} \times \frac{TI^{1/2}}{TT} \right) \quad \text{Equation \#4}$$

$$QI = 9.74 \left(\frac{760}{765} \times \frac{292.18^{1/2}}{294.93} \right) = 9.66 \text{ Lpm}$$

where;

- QT is the Rotameter Calibration Condition flow rate in Liters per minute (Lpm)
- QI is the calibrator reading (Lpm) at a given Time, Temperature and Barometric Pressure
- PT is the Rotameter Calibration Condition Barometric Pressure (760) in millimeters of mercury (mm of Hg)
- PI is the Indicated Barometric Pressure reading (mm of Hg.) at the time of the calibrator flow reading
- TT is the Rotameter Calibration Condition Temperature (21.11) in degrees Celsius.
- TI is the Indicated Temperature reading (degrees Celsius) at the time of the calibrator flow reading.

However, a 3% accurate rotameter, suitable for reading 10 Lpm, usually reads 2 to 20 Lpm. That means 9.66 Lpm could actually vary from 9.06 to 10.26 Lpm! Therefore, if a rotameter must be used with the PQ100, the corrections are pointless and a straight 10 Lpm read from the rotameter should be utilized. The accuracy of the PQ100 is now degraded to 5%.

7.4 Calibration Notes

1. After a Calibration has been entered, it should be "Run" 15 minutes or so for verification. If the measured flow appears to be offset, determine the amount of offset and jot this number down. Next, Re-enter the Calibration mode and this time, set the calibration high or low depending on the observed offset.
2. If the "Run/Stop" key is pressed to stop the pump for any reason during calibration, the Target location becomes Un-Calibrated. If the "Setup" key is then pressed to exit, the location remains Un-Calibrated.

THE ONLY WAY TO "ACCEPT" THE VALUE IS TO PRESS THE "ENTER" KEY WHILE THE PUMP IS RUNNING.

3. EACH TARGET FLOW RATE THAT IS TO BE USED SHOULD BE CALIBRATED WITH A FILTER WHOSE PRESSURE DROP IS SIMILAR TO THE TYPE ACTUALLY INTENDED FOR USE.

Failure to follow this procedure will result in an extended time period for the Flow Control System to Equilibrate (1-3 min.)

8.0 INSTALLATION AND USE OF THE PC SOFTWARE

8.1 Supported Hardware

Any IBM PC or compatible running MS-DOS 2.1 or higher with 1 floppy drive and at least 512K of memory. Any video adapter, Color or Monochrome, may be used. A hard drive is useful but not required. One serial communication port must also be available if you intend to use the communication software but is not required for the correction calculator program. For printouts, any printer attached to or redirected from LPT1 will work. All data sent to print are ASCII characters with no special printer functions called out.

8.2 Installation on a Hard Disk System

To install the software onto your C drive (typical installation), insert the supplied floppy disk into drive A of your PC, select drive A and run the "INSTALLC.bat" batch program. The installation utility will then create a subdirectory called "PQ" on the C drive and copy all files to it. Those wishing to install to another Drive such as D, E or F can use the "INSTALL.bat" batch program and specify the drive you want to install on as an argument, e.g., "INSTALL D:".

8.3 Advanced Installation

For those users who wish to install to other directories from any other floppy drive, the only file supplied on the disk of real importance is "PQ.EXE". You may create any directory you wish and copy this file to it. All files managed by PQ.EXE are, by default, placed in the directory where PQ.EXE resides unless full path names are specified.

8.4 Floppy Based Systems (No Hard Drive)

The Executable program supplied "PQ.EXE" can be run directly from either floppy drive by simply invoking the program from the drive prompt.

```
A:\>PQ
```

8.5 Program Overview

PQ.exe is a menu driven program that utilizes the serial communication port of the PC to download sample data from the PQ Series of Air Sampling Systems and to provide Data logging, Concentration Equations, export to Database, and Chain of Custody applications. PQ allows the user to communicate with the PQ100 Air Sampler and

downloads Run Data from the PQ100 to your PC. The data may then at a later time be appended with the measured final filter weight, printed and stored for later use.

The Correction Calculator is also available from the PQ Main Menu and allows the user to determine corrections for calibration and verification of flow rate.

8.6 Running the Program

From the MS-DOS prompt (typically "C:\PQ>") type;

PQ [ENTER]

if COM1 is to be used or,

PQ -2 [ENTER]

if COM2.

where;

[ENTER] is the enter key on the PC Keyboard

The "PQ" Main Menu will then be displayed.

Note: "Ctrl-C" refers to the simultaneous depression of two keys at once on the computer console. To produce a "Ctrl-C", press and hold down the "Ctrl" key on the keyboard. While this key is held down press the "C" key. This action will most always halt the program and return you to the MS-DOS prompt.

8.7 Correct Utility

CORRECT is a utility that will perform the calculations outlined in the CALIBRATION EQUATIONS. From the PQ Main Menu press "c". The resulting screen will present a message that describes this utilities function. You must have the present local barometric pressure reading and the ambient temperature reading of the calibration area. To correct to Engineering Standards answer "y" to the first two questions presented by the utility (See Appendix A for other than Engineering Standard Conditions). Then enter the "Target Flow Rate" in liters per minute. The target flow rate is that which the PQ100 is set to operate at. Then enter your barometric pressure and temperature readings. The results from the correction equations will then be displayed. The Corrected Flow Rate value is that which must be observed on the calibration standard (Bubble Meter) for the given target flow rate. A Printout can then be obtained for reference.

8.8 Beginning a Sample Job

To initiate a run and manage the data generated by the PQ100, a file must be opened at the beginning of a job to store site and other background data along with "Initial Filter Weight". Initial weight is used when the job is complete to determine delta weight (final weight, minus initial weight) and when combined with sample time is used to compute concentration.

From the PQ Main Menu press "b" to Begin a Job File for a Run. The resulting screen requires that you adopt a Job File naming convention.

- a. Default method By pressing enter at the prompt, a unique name will be given to the file based on today's date and run number.
- b. Custom method Type in anything you wish.

Once a file name has been entered, a number of other fields are presented such as Site Name, Station Code, Job Code, Operator, Filter Number, and Initial Filter Weight. You may press enter for each field which will leave it blank. The job file editor provides the means to enter the data later if you wish, however, it is recommended that the fields be filled when beginning the job to avoid confusion and to maintain chain of custody.

8.9 Downloading

When a sample job has been completed, the data pertaining to the run is stored in the PQ100 until it is reset by the user. Prior to resetting the PQ100 for its next run, the data should be downloaded using the PQ software to provide information such as run time, total sample accumulated, cause of the shutdown etc. All of this data is important in determining the particulate concentration and conditions during the prior run.

From the PQ Main Menu press "I" to import data from the PQ100. The resulting screen will prompt you for a file to append the download to. This should be the file that was begun in the previous step to insure file integrity. If you do not remember the name of the file, go back to the MAIN MENU and select "d" to view a directory of current files. If you try to select a file that was already appended with a download, the system will let you know. When the proper file has been selected you are ready to download.

THE CQ2 COMMUNICATION CABLE SHOULD NOW BE ATTACHED TO THE PQ100 AND TO THE PC "COM1" or "COM2" PORT. THE PQ100 MUST BE POWERED ON AND AT THE MAIN IDLE DISPLAY FOR THE DOWNLOAD TO WORK!

8.10 Adding the Final Filter Weight

Upon completion of the sample job, the final filter weight must be determined and this final weight entered in order to compute concentration. From the PQ Main Menu press "a" to Add the final filter weight. Again you are asked for the appropriate file name and again you must be careful to select the proper file. When the file is selected the resulting screen will show the initial weight, final weight, delta weight (difference) and standard concentration. All except for initial weight should display zero. When a final weight is entered, concentration is dynamically computed and displayed. This is to allow for re-entry of the final weight in case concentration computes unbelievable results indicating an error during entry. When the results are as expected press "n" for no new filter weight and the program will exit normally.

8.11 Data Displays

Showing the data on the screen is accomplished by pressing "s" at the MAIN MENU. You can alternately obtain a printout if a printer is attached to your computer. Simply press 'Y' when prompted with "Would you like a printout (y) or (n)?". If a printer is not attached pressing 'Y' will result in the DOS message;

"Write fault error writing device PRN" "Abort, Retry, Ignore, Fail?"

You must then press 'a' to abort and you will be sent back to the DOS prompt.

8.12 Managing Data Files

Job files can be easily erased when no longer required using the "e"rase function or can be "r"enamed to allow reuse of a particular Job File name while retaining the old data if required. All Job files from the PQ software have the extension ".run" and can be copied to floppy disk using standard MS-DOS functions for archive purposes.

8.13 Spreadsheet Support

Job Files can be exported to a coma delimited file called database.txt. This format is readable by most database programs allowing reports and graphs to be generated for presentation. This function is provided as a tool for users of database programs that are experienced enough with their database program to import from this type of file format.

From the PQ Main Menu press "x" to export the run data to a file. You will be prompted to enter a file name. After entering the file name you will be asked if this is a new database you are generating or appending an old one. If this is a new report that you are

generating based on a particular site etc. select "n"ew. If you want to add records to build a database, press "a"ppend.

This is used to combine a number of run files into a multi record database with each job file as a record. For a more detailed description of the use of this type of file refer to the users manual of your database program. If you do not already have a database program, Borland Paradox is recommended as it is the most user friendly and simplest to use.

9.0 A.C. POWER SUPPLY/CHARGER

The PQ100 should be Recharged before use to allow for the greatest available Run Time. Connect the Charger to the PQ100 Utility Adapter socket located on the front panel. Plug the Charger into an appropriate power source. **BE SURE TO CHECK CHARGER SPECIFICATIONS FOR CORRECT POWER SOURCE INPUT.**

Charging is activated only when AC power is actually applied to the charger. This allows the system to be used in a long run time application where the battery is to be used for power loss protection. While the Charger is engaged the PQ100 will display [DCin] in the lower right corner of the display.

When the battery has reached full charge (16 hours typically), the PQ100 will then display "Charged" in the lower right display.

THE PQ100 SHOULD ALWAYS BE CONNECTED TO THE CHARGER WHEN NOT IN USE! THIS WILL PROVIDE MAXIMUM RUN TIME WHENEVER NEEDED AND WILL NOT HARM THE INTERNAL BATTERY.

10.0 MAINTENANCE AND SERVICE

10.1 Replacement Component List

The following is a list of components for replacement and/or servicing the PQ100 and may be ordered from the factory (Refer to drawing figures 1 thru 7 for identification by Item#);

Item#	Fig.	PN	Description
1	5	SSI-10	Dicot Inlet
3	5	CT16.7	Coupler Tube - Old Model
4	5,4,8	A1752	Filter Holder Top
5	4,8	BUNA135	O-Rings
6	4,8	A1727-L27	Cassette Top - New Model
7	4,8	F1/U	Screen
8	4,8	A1729-L29	Cassette Bottom - New Model
9	5,4,8	B1425	Filter Holder Bottom
10	5	A1446	Holder Hose Adapter - Old Model
11	5,6	TP100	Tripod Assembly
11a	5,6	B1453	Leg Extensions - Old Model
69	5	P1001	Pull Pin
12	5	HS4	1 Meter of Rubber Hose - Old Model
13	5,6	CRPQ1	Cradle Assembly - Old Model
14	5,6,8	PQ100	Main Unit
15	8	B1475	TSP Inlet
16	8	A1474	TSP Cover
17	8	SC0100	#10-32x3/8" Flat Head Screw
18	1	PQ103	Main Battery
19a	1	SC0101	#6-32x1/4" Screw w/ washer
19b	1	WS0100	#6x.372 Flat Washer
20	1	B1412	Pulsation Dampner/Plenum
21	1	HS3	Hose
22	1	PM3026	Pump Assembly
23	1	B1413	Chassis
24	3	SC0107	#4-40 x 1/4" Phillips Pan Head Screws
25a	1	SC0103	#4-40x1 1/2" Pan Head Screws
25b	1	WS0101	#4x.372 Flat Washer
26	1	HS2	Hose
27	1	A1416	Sensor tube adapters

Item#	Fig.	PN	Description
28	1	Buna 113	O Rings
29	1	CB1	Clock Battery
30	1	MFS1	Mass Flow Sensor
31	1	HS1	Hose
32	1	PQFP	Front Panel Assembly
33	1	SC0104	#6-32 x 3/8" Flat Head Screws
71	1	BP001	Rubber Bumper
72	1	BATT.PCA	P.C. Ass'y, Battery
34	5	PQ102	Hose Adapter
35	2	B1292	Valve Upper Plate
36	2	B1293	Valve Lower Plate
37	2	A1288	Diaphragm Retainer
38	2	A1281	Diaphragm
39	2	A1289	Diaphragm Retainer Bushing
40	2	B1283	Pump Housing
41	2	A1287	Follower Yoke
42	2	DDRI-6632	Bearing \ as assembly only
43	2	A1294	Eccentric /
44	2	SC0105	Set Screw
45	2	SC0106	#2.5x8mm CheeseHead Screw
46	2	A1290	Motor Mount
47	2	PQMOTOR	Motor
48	2	BUNA010	O-Rings
49	2	A1402	Locating Pins
50	2	B1408	Valves
51	3	SC4014	#4-40x1/2" Phillips Pan Head
52	3	Nt3006	#4-40 Hex Nut w/ Captive Washer
53	3	SC2001	#4-40x3/8" Screw w/ Washer
54a	3	SC3014	#8-32 Phillips Pan Head
54b	3	LW4001	#8 Internal Tooth Lock Washer
55	3	SC3028	#10-32x1/2" Slotted
56	3	NT3027	7/16" Panel Nut
57	3	ICA001	Utility Connector/Cable Assembly
58	3	DSP001	Display Assembly
59	3	PQ100PC	P.C. Assembly
60	3	B1417	Front Panel
61	3	B1409	Graphic Faceplate
62	3	H9111B	Handle
63	3	A1419,A1420	Exhaust Port
64	3	A1418	Inlet Receptacle
65	3	CCC001	Cap and Chain

Item#	Fig.	PN	Description
66	3	A1483	Connector Gasket
67	3,5	BUNA116	O-Ring
86	2	SC1014	#8x1" Sheet Metal Screws
87	2	A1403	Inlet/Outlet Tube
88	2	SC1013	#8x1/2" Sheet Metal Screws
146	7	SC3030	#6-32 x 3/8" Philips pan head screw
147	7	1705-L5	10 micron inlet top
148	7	1709-L9	Spacer
149	7	1709-L8	Screen
150	7	1711-L11	10 micron inlet sub top
151	7	1712-L12	10 micron inlet body
152	7	Viton-036	O-ring
153	7	DI1013	10 micron inlet tube
154	7	SC3031	1/4 x 3/8 NPT adapter (Old Style)
155	7	SC3032	1/4 NPT nipple (Old Style)
156	7	JC3033	Jar top
157	7	SC3034	1/4 NPT plug (Old Style)
158	7	JR3035	Glass jar
159	7	Buna-026	O-ring
--	-	ICA002	Internal Battery Cable Assembly
--	-	ICA003	Flow Sensor Cable Assembly
164	7	SC3036	1/4" NPT Hex Nipple

10.2 Rebuilding the Pump after 5000 Hours

To determine "Pump Cumulative Time" you must use the PQ software to obtain a download from the PQ100 (See Section 8.9). Pump Cumulative time is the number of actual service hours of the dual diaphragm pump and is shown when either printing or screen viewing a download. When this time exceeds 5000 hours the pump should be rebuilt. The rebuild is a relatively easy task and requires the replacement of the diaphragms, valves, and bearing. A kit of parts is available from the factory and includes instructions. Service can also be performed by the factory.

Kit #	Description
X014	Pump Rebuild Kit (Includes valves, diaphragms and "o" rings)
X015	Advanced Pump Rebuild Kit (Includes X014 with bearing)
X016	Total Pump Rebuild Kit (Includes X014 with bearing and motor)
X017	Pump Diaphragms Only

10.3 Replacement of the Mass Flow Sensor

As each mass flow sensor is unique and will present variations in operation, all stored calibrations are obsolete when the sensor is replaced. Each flow sensor replacement kit contains an 8 pin DIP Integrated Circuit (I.C.) that must be replaced (socketed) on the main printed circuit board. This will clear all calibrations and will require that a new set of calibrations must be entered for the new sensor.

11.0 OPERATIONAL THEORY

When first powered on, the micro controller runs through some initialization and diagnostic routines. When completed, data stored as "Run-Time information" is then read from the non-volatile (EEPROM) memory device. Amongst this data is a single byte flag called the "shutdown code". If this code indicates that the system was shutdown normally (i.e. power-off button was pressed) it will proceed to the "IDLE MODE" display screen which contains all the pertinent run-time information such as Elapsed Time, Total Sample, Battery condition, last known Flow Rate when halted etc. If the shutdown code indicates that some other event has caused the system to power down such as Flow Restricted, Excess Flow Resistance, Batteries Too Low, Sample run time Completed, an appropriate message will be displayed to the operator indicating the cause of the stoppage and requires operator intervention to proceed to the "IDLE MODE" display. From the "IDLE MODE" display the active keys are "Reset" (all run parameters to their default conditions), "Run/Stop"- runs the pump at the last selected flow rate and continues the previously setup run (if a start time was programmed then the pump will not begin to run until the start time has been achieved), and "Setup" allows for programming the user definable run parameters such as target Flow Rate, Start time, Run time, Date & Time, and also provides a calibration mode. If Run/Stop is pressed at this time the pump will begin to run and attempt to match the target, pre-programmed Flow Rate.

12.0 WARRANTY INFORMATION

BGI Incorporated warrants equipment of its manufacture and bearing its nameplate to be free from defects in workmanship and material. We make no warranty, express or implied, except as set forth herein. BGI's liability under this warranty extends for a period of one (1) year from the date of BGI's shipment. It is expressly limited to repairing or replacing at the factory during this period and at BGI's option, any device or part which shall within one year of delivery to the original purchaser, be returned to the factory, transportation prepaid and which on examination shall in fact be proved defective.

BGI assumes no liability for consequential damages of any kind. The purchaser, by acceptance of this equipment, shall assume all liability for consequences of its misuse by the purchaser, his employees or others. This warranty will be void if the equipment is not handled, installed, or operated in accordance with our instructions. If damage occurs during transportation to the purchaser, BGI must be notified immediately upon arrival of the equipment. Return transportation charges are collect.

A defective part in the meaning of this warranty shall not, when such part is capable of being repaired or replaced, constitute a reason for considering the complete equipment defective. Acknowledgment and approval must be received from BGI prior to returning parts or equipment for credit. BGI Incorporated makes engineering changes and improvements from time to time on instruments of its manufacture. We are under no obligation to retrofit these improvements and/or changes into instruments which have already been purchased.

No representative of ours has the authority to change or modify this warranty in any respect.

APPENDIX A. CALIBRATION EQUATIONS

Because the PQ100 uses a "Through Stream" mass flow sensor, the mass flow is not affected by pressure and temperature. However, the velocity (flow rate) through a fixed area nozzle will vary with atmospheric conditions. When work is carried out in an area with conditions other than Engineering Standard Conditions the "Corrected Flow Rate" is that which is measured on the calibration device for these new conditions.

The following equations are used to determine the "Corrected Flow Rate" that should be set on the PQ100 for atmospheric conditions other than "Engineering Standard Conditions" of 20 degrees Celsius (293.18 degrees Kelvin) and 760 millimeters of Mercury. They are provided for users who do not have access to an IBM PC or Compatible and can not use the "CORRECT" utility provided on the floppy disk.

These equations and recommendations have been prepared for Investigators with an advanced understanding of atmospheric sampling procedures. It is not our intention to justify every equation and procedure set down below to the uninitiated. For this reason, the "Correct" program supplied with the instrument is highly recommended.

To set up a calibration on the PQ100 to "Engineering Standard Conditions" the following applies;

$$QI = QS \left(\frac{PS}{PI} \times \frac{TI}{TS} \right) \text{Equation \#1}$$

where;

- QS is the Standard Condition (PQ100 Target) flow rate in Liters per minute (Lpm)
- QI is the calibrator reading (Lpm) at a given Time, Temperature and Barometric Pressure
- PS is the Standard Condition Barometric Pressure (760) in millimeters of mercury (mm of Hg) (Equal to 1013.25 HectoPascals)
- PI is the Indicated Barometric Pressure reading (mm of Hg.) at the time of the calibrator flow reading
- TS is the Standard Condition Temperature (20) in degrees Celsius
- TI is the Indicated Temperature reading (degrees Celsius) at the time of the calibrator flow reading

Therefore, for Standard Conditions;

$$QI = QS \left(\frac{760}{PI} \times \frac{TI}{293.18} \right)$$

$$QI = 2.592 \quad QS \left(\frac{TI}{PI} \right) \text{ Equation \#2}$$

Example 1:

The instrument is being set up to run at 10 Lpm at Standard Conditions with a flow meter. The ambient conditions in the set up location are 19 degrees Celsius (292.18 degrees Kelvin) and 765 millimeters of Mercury.

Then;

$$QI = 2.592 \quad 10.0 \left(\frac{292.18}{765} \right) = 9.899 \text{ Liters per minute}$$

Therefore, if you set a Target Flow of 10.0 Lpm on the PQ100 and 9.90 Lpm on the flow meter, you will always be sampling at 10.0 Lpm to Standard Conditions regardless of changes in the weather (i.e. regardless of changes in air density). At a later date when you wish to check the calibration, Equation #2 still applies as in Example 2.

Example 2:

The instrument was set as detailed in Example 1. You are now out of doors at a sampling site. The conditions are TI = 27 degrees Celsius (300.18 degrees Kelvin) and PI = 750 millimeters of Mercury.

From Equation #2;

$$QI = 2.549 \quad 10.0 \left(\frac{300.18}{750} \right) = 10.37 \text{ Liters per minute}$$

Therefore, if the PQ100 reads 10.00 Lpm and the bubble meter reads 10.37 Lpm the PQ100 is still in calibration and is sampling 10.0 Lpm at Standard Conditions.

On July 18, 1997, U.S. EPA changed the regulations for the operation of mass flow controlled instruments (e.g., the PQ100). Previously, EPA specified a set of "EPA Standard Conditions", which were 25 degrees C and 760 mm of Hg.

Now, mass flow controlled instruments are to be run in "volumetric mode". The details of EPA's recommended calibration procedure may be found in general form 40 CFR Part 50, Appendix M, 8.2.4 July 18, 1997. When applying these instructions to the PQ100, the following steps are suggested:

1. Place a clean filter of the type to be used for the sampling in the PQ100 filter holder.
2. Remove the PM10 inlet and connect a bubble meter to the filter holder. BGI adaptor (P/N L-30) is convenient for this purpose.
3. Enter the calibration mode and adjust the flow up or down until the flow meter reads 16.67 LPM and lock the flow rate.
4. Record the barometric pressure and temperature at the time of calibration.
5. This procedure provides volumetric flow rate control as long as there are no shifts in temperature. EPA recommends the use of seasonal average values. In the case of the PQ100, this requires calibration for each season of intended use. Since it is not practical to be out of doors to perform the calibration, a facility has been provided in the calculation section of our software supplied with the PQ100.
6. In software, selection the correction calculator. Then select (C) "EPA volumetric or user defined conditions".

For T insert average seasonal local temperature
For P insert average seasonal local barometric pressure
For sample target flow rate enter 16.67 lpm
Enter Pstd at calibration location (local)
Enter Tstd at calibration location (local)

The program will return the flow rate which is to be observed on the flow meter in order to be running in the field at 16.67 lpm.

EPA regulations require that you calibrate at 3 flow rates. The other two flow rates selected are generally in the range of 15 lpm and 18.4 lpm ($\pm 10\%$). This procedure serves no particular purpose with the PQ100 which is microprocessor controlled. However, it is a statutory requirement and must be performed for concentration measurements to be compliant. An example of the calibration procedure is illustrative:

Tstd = 10°C, outdoor location, seasonal average

Pstd = 720 mm of Hg
Target flow rate = 16.67 lpm (desired volumetric flow at above conditions)
Tlab = 22°C (conditions in calibration location)
Plab = 760 mm of Hg

Corrected flow rate = 16.95 lpm (flow in calibration location)

In the event that a computer is unavailable, the above example may be calculated manually:

$$\text{Corrected Q} = Q_{\text{target}} \left(\frac{\text{Plab}}{\text{Pstd}} \times \frac{\text{Tstd}}{\text{Tlab}} \right)$$

APPENDIX B. TROUBLESHOOTING

- Problem:** Pressing the "Run/Stop" key causes the unit to shutdown.
Answer: This indicates that the PQ100 is now powered off and ready to begin a sample run at the designated Start Date and Time. It means that the enable for the Start Date and Time is set to "On" (See Section 6.1). Be sure that the Start Date and Time are set correctly.
- Problem:** The Actual Flow Rate is not what is indicated in the Display.
Answer: Variations in Atmospheric Conditions (B.P. and Temp.) will cause slight variations in flow as displayed on the Calibration Device however the PQ100 will be displaying "True Flow Rate". If large variations exist, or if the variation is different from that of the calculated "Corrected Flow Rate" as described in the Calibration Equations Section of this manual then, the unit requires service.
- Problem:** I hear a popping metal sound as the PQ100 load pressure increases.
Answer: When running the PQ100 at very high load pressures (i.e. 150 centimeters of water or better), a strange metal popping sound may be heard by the user. Do not be concerned! This is merely the internal pulsation dampner (Plenum) adjusting its chamber area. The PQ100 will alert you as to the nature of any problems via the shutdown messages as described in APPENDIX E.
- Problem:** The flow rate does not seem to hold when additional pressure is added to the load (usually tested using a pinch clamp).
Answer: This is usually caused by a leak somewhere between the PQ100 Inlet and the calibration measuring device. Make sure that the hose adapter is firmly tightened in the PQ100 inlet, check the inlet mechanism and filter holder. You can usually isolate the suspect device by starting at the PQ100 inlet and working your way out.

APPENDIX C. SYSTEM BATTERIES

MAIN INTERNAL BATTERY

If the Internal Battery should ever require replacement, use **ONLY** the proper BGI Battery (PQ103).

EXTERNAL BATTERY

The External Battery is used to provide double the Run Time Capacity of the PQ100.

CAUTION: REVERSAL OF THE BATTERY LEADS CAN CAUSE IRREPARABLE DAMAGE TO THE PQ100.

CLOCK BATTERY

The Real Time Clock/Calender is backed-up by a Lithium Cell that will require changing once every 2 years. It also provides power to the Alarm Clock wake-up circuit. The PQ100 will let you know when this battery requires changing by providing a warning just prior to shutdown or when powered on and must be acknowledged by the user. You can temporarily ignore the warnings but a replacement should be acquired from the factory immediately. If the battery is allowed to get too low (ignoring the warnings) you may not be able to power off the PQ100 (It will keep waking up after a shutdown).

IF "REPLACE CLOCK BATTERY" MESSAGE IS ENCOUNTERED YOU MUST REPLACE THE CLOCK BATTERY IMMEDIATELY FOR CONTINUED OPERATION. IGNORING THIS MESSAGE MAY PRODUCE ERRATIC OPERATION.

APPENDIX D. MILITARY TIME CHART

The following chart is supplied for users who are unfamiliar with a 24 hour Military type time system.

00:00	12:00 Midnight
01:00	1:00 AM
02:00	2:00 AM
03:00	3:00 AM
04:00	4:00 AM
05:00	5:00 AM
06:00	6:00 AM
07:00	7:00 AM
08:00	8:00 AM
09:00	9:00 AM
10:00	10:00 AM
11:00	11:00 AM
12:00	12:00 Noon
13:00	1:00 PM
14:00	2:00 PM
15:00	3:00 PM
16:00	4:00 PM
17:00	5:00 PM
18:00	6:00 PM
19:00	7:00 PM
20:00	8:00 PM
21:00	9:00 PM
22:00	10:00 PM
23:00	11:00 PM

APPENDIX E. SHUTDOWN MESSAGES

The following is a description of the various messages that can be displayed by the PQ100 or the PQ Software to indicate the reason for sample job termination or current status of the PQ100;

00 Download not yet Appended! PQ Software

* Indicates that a previously created job file has yet to receive a download from a PQ100 Sampler.

01 LOW BATTERY SHUTDOWN! PQ100
Low Batteries! PQ Software

* Indicates that the sample job was terminated when the battery power had been depleted and should now be recharged.

02 SAMPLE RUN COMPLETED! PQ100
Run Completed! PQ Software

* Indicates that the sample job was terminated when the RUN TIME had been depleted (See Section 6.7 or Section 6.8.3).

03,04 FLOW RESTRICTED! PQ100
Flow Restricted! PQ Software

* Indicates that the sample job was terminated due to a flow rate transient of 50% of the target flow rate and is usually caused by a kinked or broken hose, filter load removal etc.

During the initial time that the PQ100 requires to stabilize its flow rate, flow will be displayed as --.-Lpm. During this stabilization period, flow rate is allowed to vary more than 50% for a maximum of one minute. After one minute the flow is considered restricted causing the above shutdown. Once the flow rate has stabilized, the flow rate will appear and response to transients greater than 50% is instantaneous.

05 Counters Reset, Awaiting new Run! PQ Software

* Indicates that the PQ100 has been "Reset" and is now ready for a new sample job.

06 Powered Off Normally! PQ Software

* Indicates that the PQ100 had last been powered off by pressing the "ON/OFF" button. If you simply allow the PQ100 to power itself off (automatic after approximately 3 minutes of no user activity such as key presses or downloads) then the last Shutdown code is retained.

07 Waiting for Alarm Event! PQ Software

* Indicates that the PQ100 has been programmed to start a sampling job at some future time and is waiting for this occurrence.

08 MAXIMUM LOAD EXCEEDED! PQ100
Maximum Load Exceeded! PQ Software

* Indicates that the sample job was terminated because the PQ100 could not force the pump to run any faster to regulate flow rate. This can happen when a large load pressure is developed and the battery voltage drops. To eliminate this problem you can run from the charger, recharge the batteries or try a different filter media.

09 Run Terminated by Operator! PQ Software

* Indicates that the sample job was terminated when an operator has pressed the "RUN/STOP" button while a sample job was in progress.

10 RUN TIME EXCEEDED! PQ100

* Indicates that the PQ100 can not initiate a run as the RUN TIME (See Section 6.7) has not been reset.

11 REPLACE CLOCK BATTERY! PQ100

* Indicates that the internal clock battery now requires replacement (See Appendix C).

APPENDIX F. ASSEMBLING THE PQ167 PM10 AIR SAMPLING SYSTEM

Included with your PQ167 PM10 Air Sampler System are the following items (Item#'s are indicated on the appended drawings);

Item#	Qty..	PN	Description
-----	-----	----	-----
14	1	PQ100	Air Sampler Main Unit
*	1	PQ101	Battery Charger (specify 120 VAC or 240 VAC)
34	1	PQ102	Hose Adapter
*	1	CQ2	PC Communication Adapter Cable
*	1	PQMAN	Manual
12	1	HS4	1 Meter of Rubber Hose
11	1	TP100	Tripod Frame
*	3	B1453	Leg Extensions
13	1	CRPQ1	PQ Series Sampler Cradle
01	1	SSI-10	Inlet
2,3	1	JR3035	Water Jar w/ 2.5" Coupler
4,5,9,10	1	F20	Filter Holder (Requires F21/2 Cassette)
6,7,8	2	F21/2	47mm Filter Adapter Cassette w/Screen
*	1	QD3	3.5" PQ Software Diskette

FOR COMPLETE SYSTEM ASSEMBLY PLEASE REFER TO FIGURES 4, 5 AND 6.

APPENDIX G. ASSEMBLING THE BGITSP AIR SAMPLING SYSTEM

Included with your PQTSP Air Sampler System are the following items (Item#'s are indicated on the appended drawings);

Item#	Qty.	PN	Description
14	1	PQ100	Air Sampler Main Unit
*	1	PQ101	Battery Charger (specify 120 VAC or 240 VAC)
34	1	PQ102	Hose Adapter
*	1	CQ2	PC Communication Adapter Cable
*	1	PQMAN	Manual
4,5,9,10	1	F20	Filter Holder (Requires F21 Cassette)
6,7,8	2	F21/2	47mm Filter Adapter Cassette w/Screen
15,16,17	1	TSP	TSP Inlet Adapter Cap
*	1	QD3	3.5" PQ Software Diskette

FOR COMPLETE SYSTEM ASSEMBLY PLEASE REFER TO FIGURES 4, AND 8.

APPENDIX H. INSTALLING FILTER MEDIA

Referring to Figure 4, the filter media is placed on screen (7) and placed on the inner lip of cassette base (8). Cassette top (6) is then inserted into cassette base when pin of base is aligned with locating hole on cassette top. Holder base (9) and holder top (4) are supplied with O-Rings (5) already installed. Loaded cassette is then inserted into base (9) with the screen side down and holder top (4) is then screwed into base (9) firmly as to insure against leaks.

APPENDIX I. CONCENTRATION EQUATION

For reference, the following is the formula for Concentration used by the PQ Software;

$$\frac{\text{CONTAMINANT WEIGHT (mg) x 1000}}{\text{TOTAL SAMPLE VOLUME (m}^3\text{)}} = \text{CONCENTRATION } \left(\frac{\text{micrograms}}{\text{m}^3} \right)$$

Where;

- | | |
|-----------------------|---|
| (CONTAMINANT WEIGHT) | is the difference between initial filter weight and final filter weight |
| (TOTAL SAMPLE VOLUME) | is the Volume of air passed through the filter in cubic meters |
| (CONCENTRATION) | is the quantity of particulate matter in micrograms per cubic meter |

APPENDIX J. FLOW RATE STABILITY

EPA Regulations 40 CFR part 53.43 (July 1987) require measurement of flow rate stability during the testing of an instrument for reference or equivalency. This test is permanently incorporated into the PQ100 firmware. The flow rate through the instrument is measured and stored automatically while the run is in progress. The initial flow rate is measured one minute after the instrument has stabilized the flow rate (The flow rate is stable when the PQ100 visual display shows the actual flow rate instead of "Q--.-"). The flow rate is then sampled once every hour thereafter until the completion of the run with a maximum capability of 30 readings after the initial.

NOTE: THE RUN MUST BE CONTINUOUS IN ORDER FOR THE READINGS TO BE TRUE. IN OTHER WORDS, IF A RUN IS HALTED FOR ANY REASON THE PQ100 MUST BE RESET TO INSURE THAT THE READINGS ARE STORED IN THE PROPER SEQUENCE.

The Flow Rate Stability Report is generated after a run is completed and the data has been downloaded as previously described by the PQ Software. The report is shown as a second page after a run has been "Screened". The option of obtaining a printout is given for each screen after viewing the data.

The following is a description of the equations used to calculate flow rate stability as shown in the report;

$$\bar{F} = \frac{F(1) + F(2) + F(3) + \dots + F(n)}{n}$$

where;

\bar{F} = Average Flow Rate in Liters per Minute

n = Total number of readings taken

F(1) = Initial Flow Rate reading 1 minute after flow has stabilized

F(2) = Flow Rate 1 Hour after Initial Flow Rate reading

F(n) = Flow Rate (n-1) Hours after Initial reading

The first EPA indicator of flow rate stability is the percent of difference between average flow rate and initial flow rate.

$$= \frac{\bar{F} - F(1)}{F(1)} \times 100$$

where;

% difference between average and initial flow rate.

This may be a plus or minus value and may not exceed 5% (EPA).

The second EPA indicator of flow rate stability is the percent of difference between each hourly flow rate reading and the initial flow rate.

$$(t) = \frac{F(t) - F(1)}{F(1)}$$

where;

F(t) = hourly flow rate readings F(2), F(3), F(4) etc.

(t) = % difference between individual hourly readings and initial flow rate.

This may be a plus or minus value and no value may exceed 10%.

In reality all displayed values should be expected to be typically less than 1% and should not exceed 2%. Values more than 2% should be investigated. A blocked or restricted inlet, hose, etc. at precisely the time the PQ100 takes a reading internally should be suspected.

APPENDIX K. FIGURES

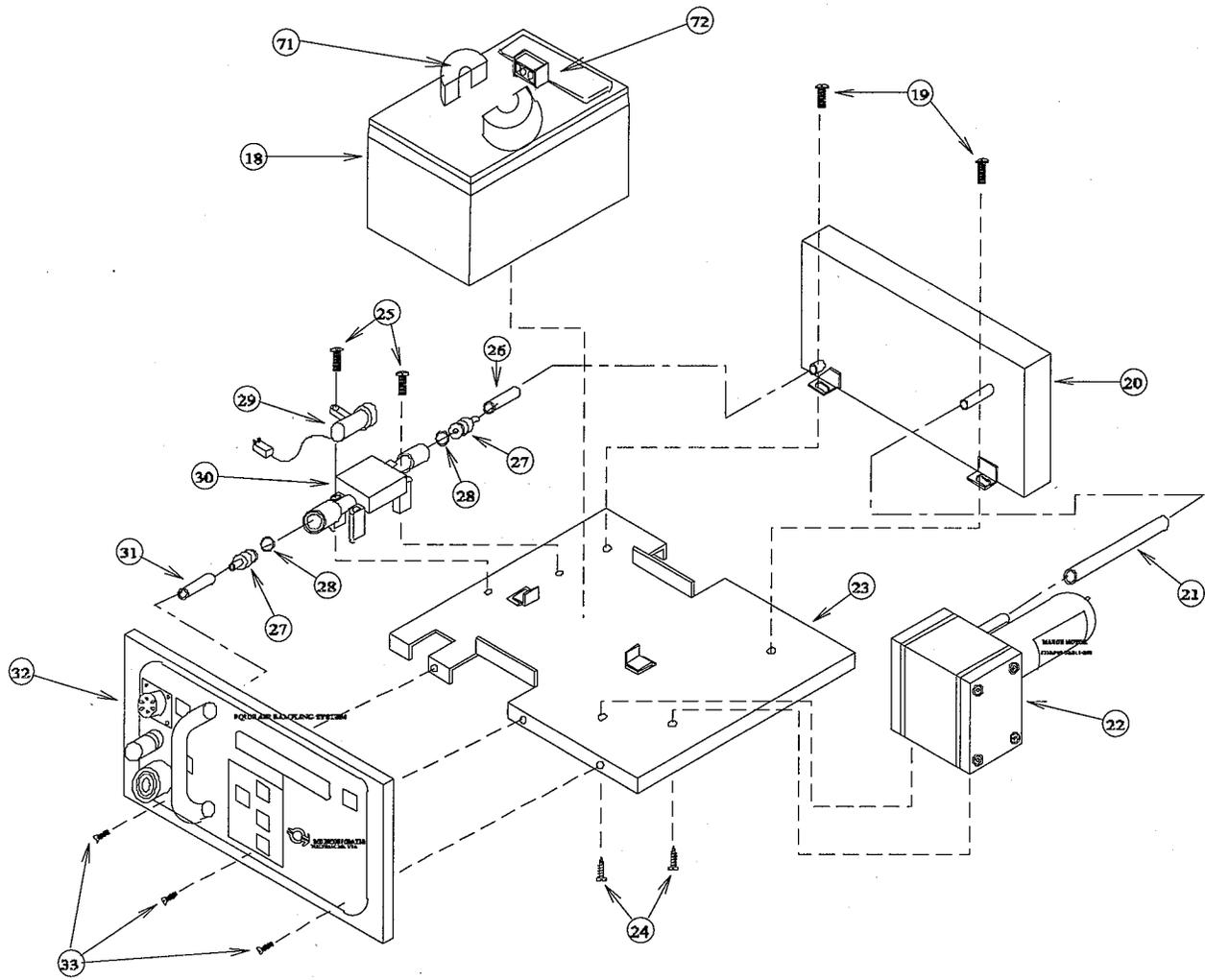
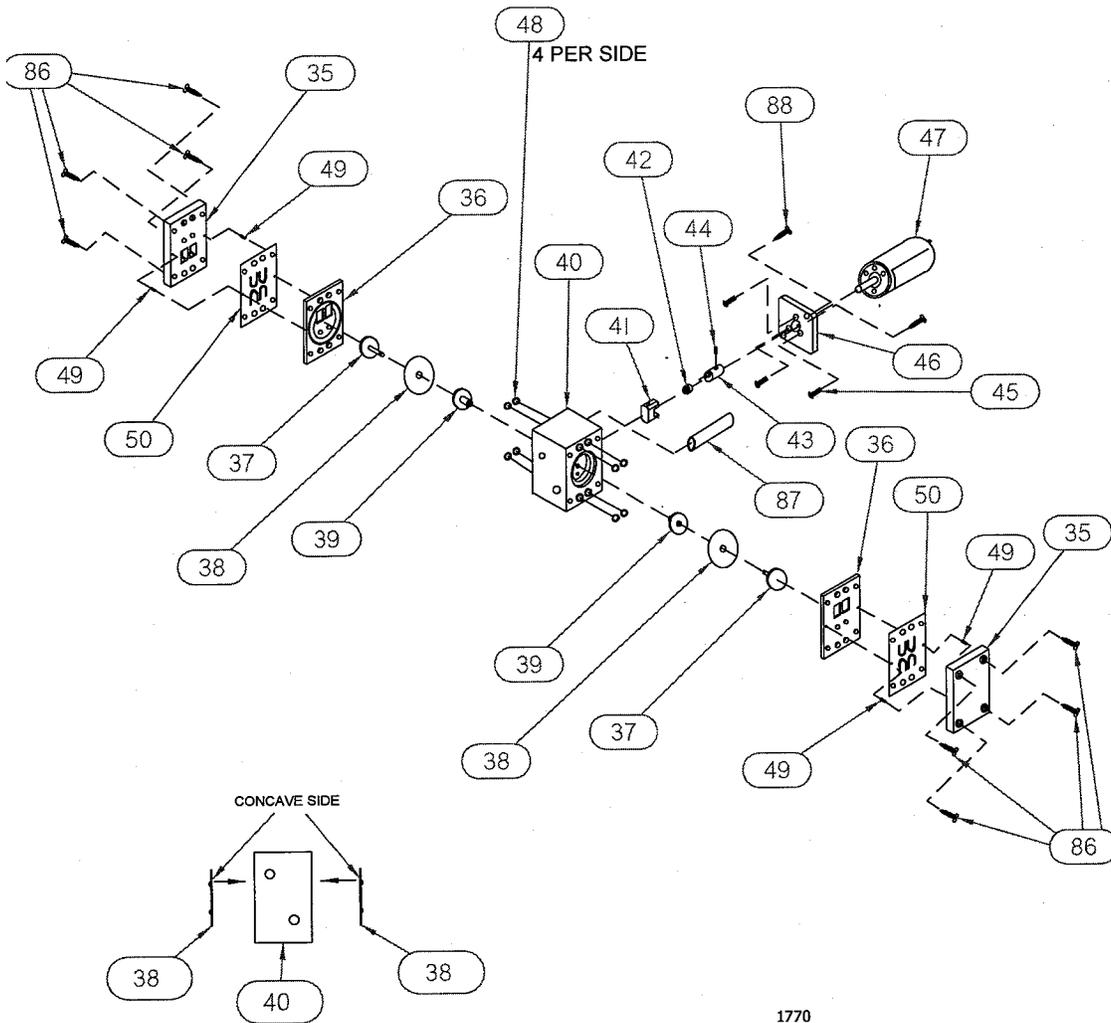


Figure 1. Exploded Assembly View



1770

Figure 2. Exploded View of Pump

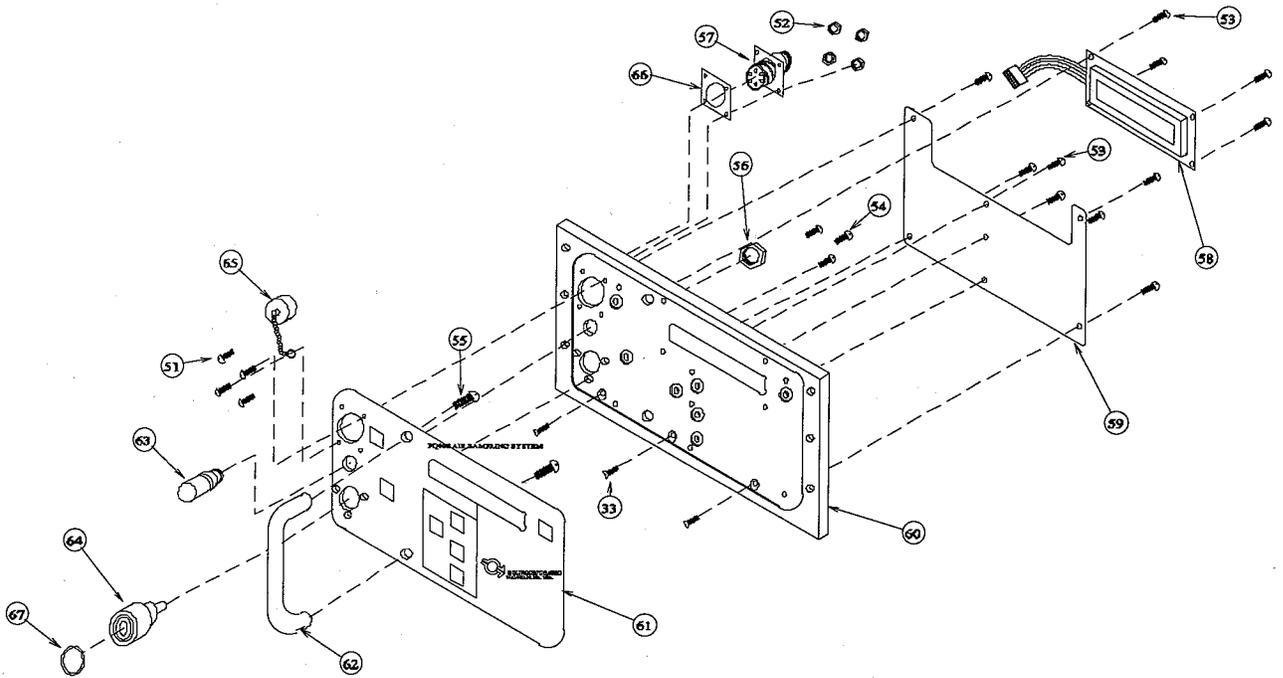
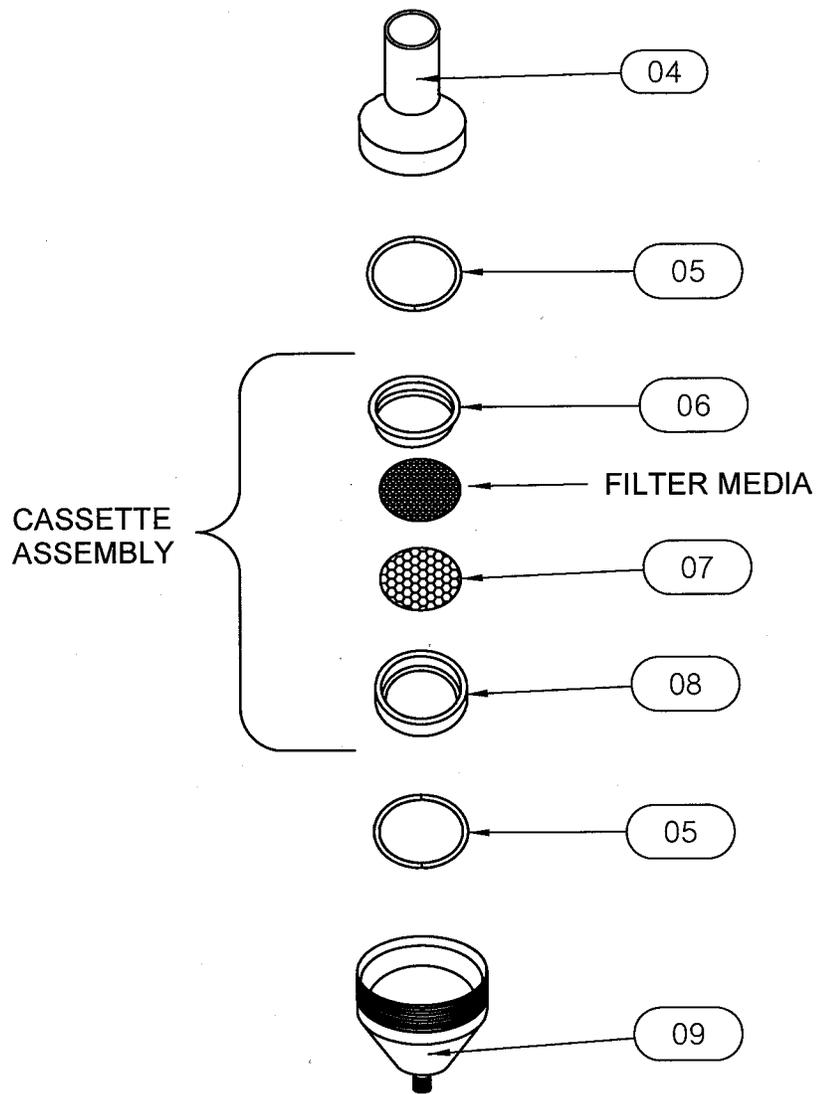


Figure 3. exploded View of Front of PQ100



2418

Figure 4. Exploded View of Filter Cassette and Filter Holder

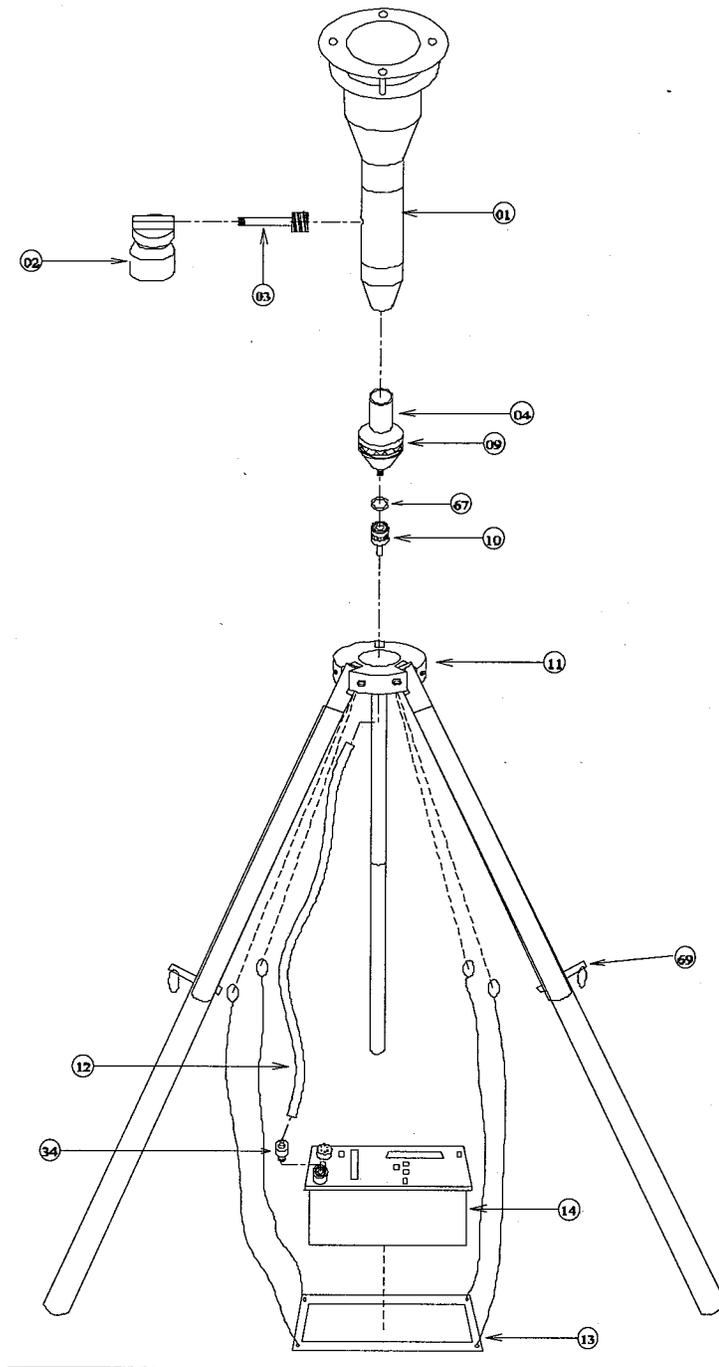


Figure 5. Exploded Assembly with Inlet and tripod

(January 2000: OBSOLETE> Parts subject to stock on hand. See Appendix O)

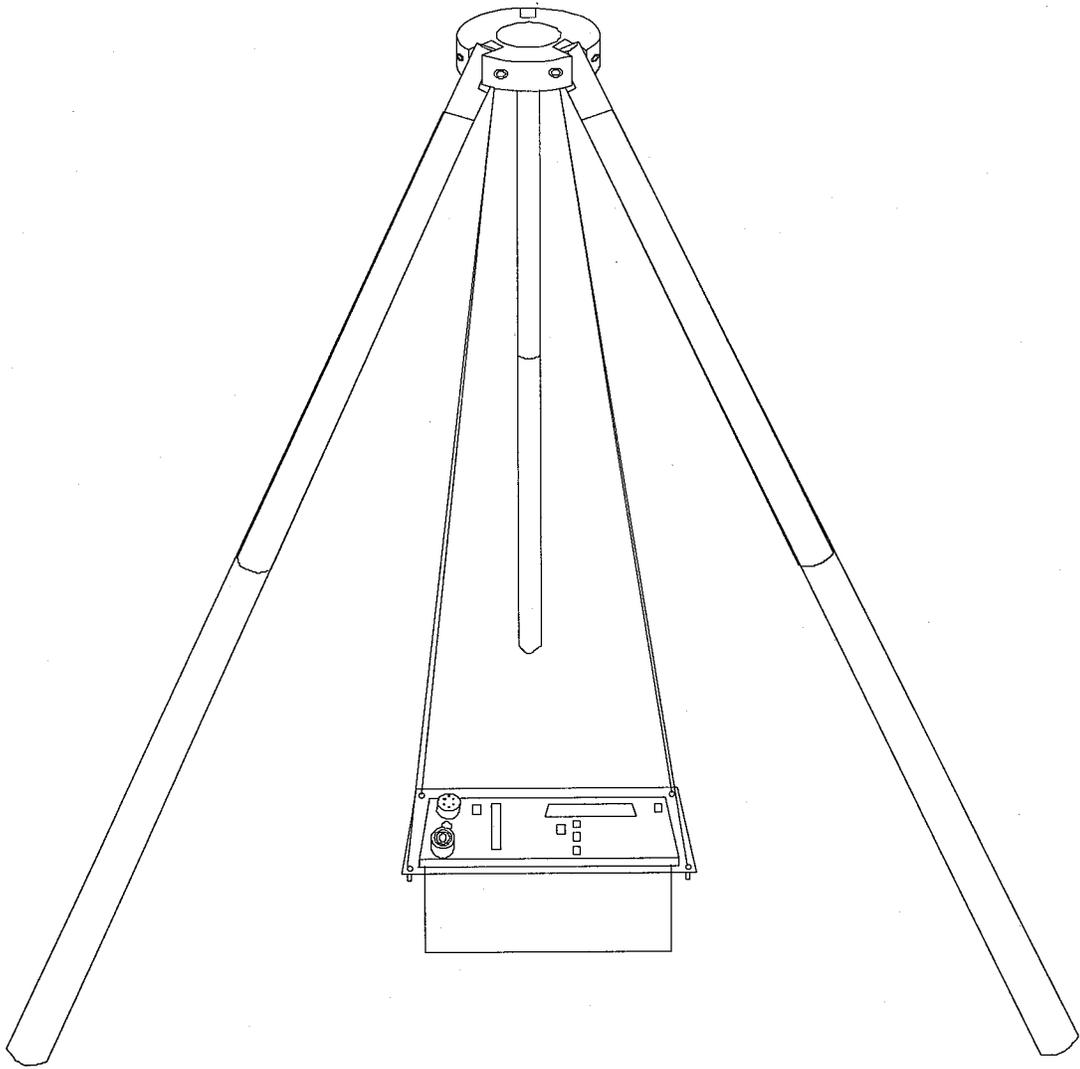


Figure 6. assembled PQ100 Tripod.

(January 2000: OBSOLETE> Parts subject to stock on hand. See Appendix O)

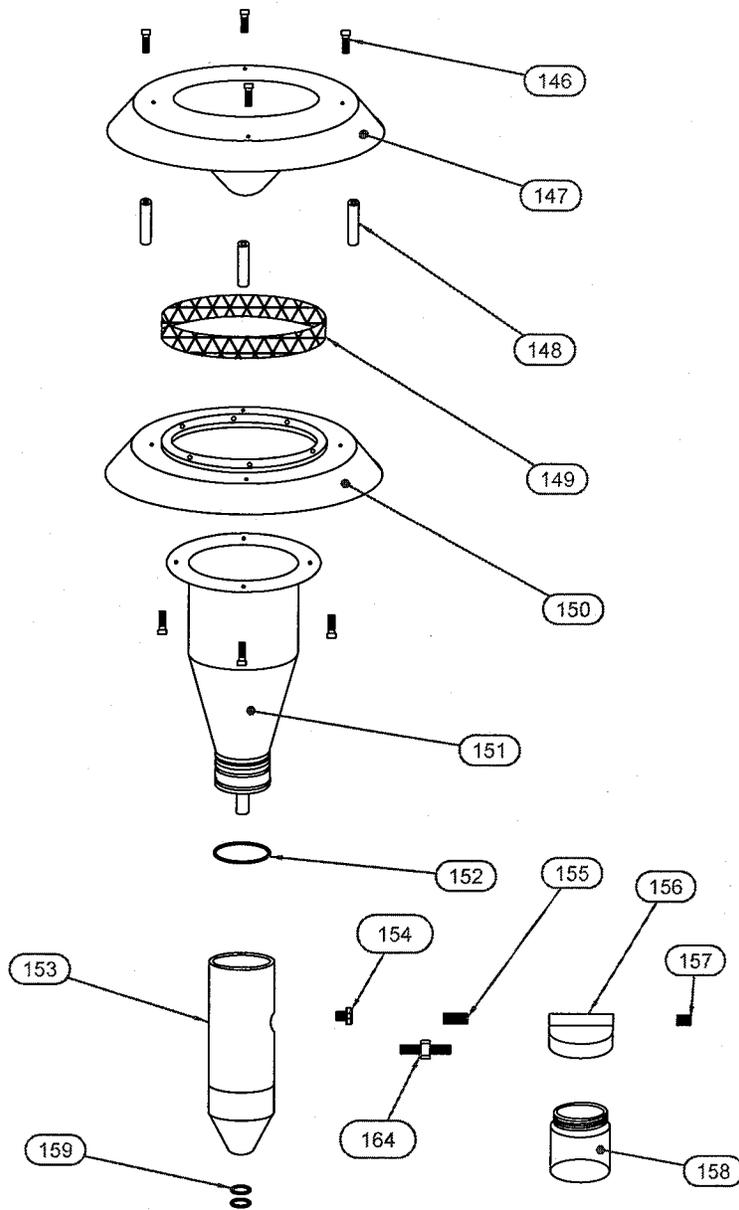
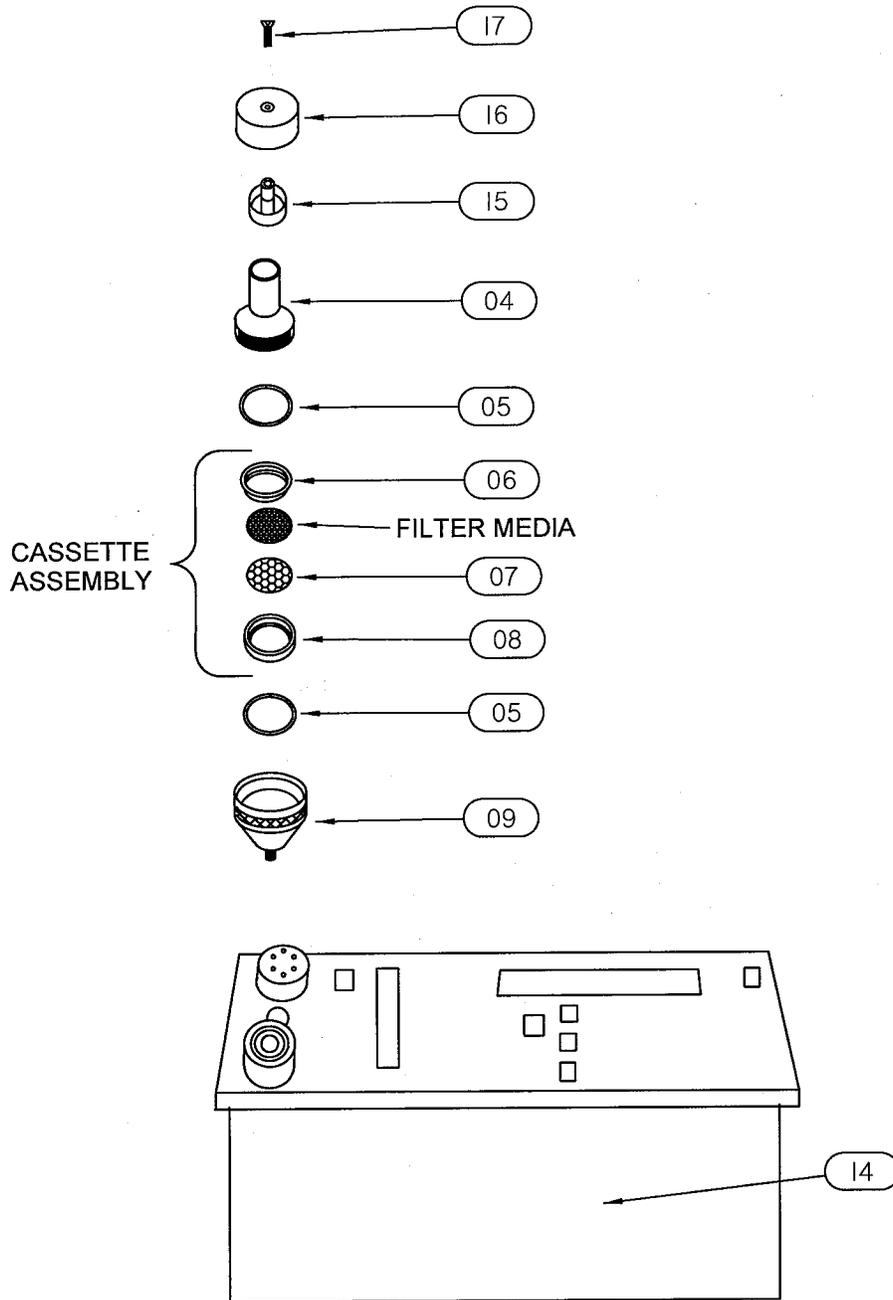


Figure 7. Exploded View of PM10 Inlet

1791



2419

Figure 8. PQ100 Front with Filter Assembly

APPENDIX L. FILTER HANDLING AND WEIGHING

Note: The following guidelines are based on the regulations developed for sampling PM_{2.5}. It is recommended that these guidelines be followed for PM₁₀ sampling using the PQ100.

Filter Specifications

For exact compliance with EPA procedures for PM_{2.5}, refer to 40 CFR Part 50, Appendix L, and Section 2.12 of EPA's Quality Assurance Handbook.

In brief, the filter should have the following characteristics:

Size: Circular, 46.2 mm diameter \pm 0.25 mm. Medium. Polytetrafluoroethylene (PTFE Teflon), with integral support ring.

Support ring: Polymethylpentene (PMP) or equivalent inert material, 0.38 \pm 0.04 mm thick, outer diameter 46.2 mm \pm 0.25 mm, and a width of 3.68 mm (+0.00 mm, -0.51mm).

Pore size: 2 μ m as measured by ASTM F316.94.

Filter thickness: 30 to 50 μ m.

Maximum pressure drop (clean filter): 30 cm H₂O column @ 16.67 Lpm clean air flow.

Maximum moisture pickup: Not more than 10 μ g weight increase after 24-hour exposure to air of 40 percent relative humidity, relative to weight after 24-hour exposure to air of 35 percent relative humidity.

Collection efficiency: Greater than 99.7 percent, as measured by the DOP test (ASTM D 2986-91) with 0.3 μ m particles at the sampler's operating face velocity.

Alkalinity: Less than 25 microequivalents/gram of filter, as measured by the guidance given in reference 2 in section 13.0 of this appendix.

One current source of these filters is Pallflex Products Corp. Of Putnam, CT, USA; Type TK15-S3M.

Filter Handling

Filters should be handled delicately using non-serrated forceps, never using fingers (even in laboratory gloves) to touch any part of the filter. When not in use, filters should be stored in protective cartons in conditions of moderated temperature and relative humidity.

Filters should from the always be transported from the laboratory to the sampling location in the filter cassette, which should be protected within a metal canister. These canisters may be ordered directly from BGI.

Filter Cassette Handling

The filter cassettes provided for use with the PQ100 have been designed with an interference fit to prevent the cassette from coming apart easily, therefore some care must be exercised when opening and closing the cassette, especially when a filter is inside. Always maintain the cassette in an upright position, especially if the filter has already been used to collect particles. To open, place a clean, flat blade device (knife edge, screwdriver blade) against the outside edge of the cassette between the upper and lower halves and gently wedge them apart. **DO NOT TWIST THEM APART**, this could tear the filter. Set the upper half of the cassette aside.

To close the cassette, place it the upper and lower halves together and gently press them together, being careful not to twist them. When closed, the two halves should seat snugly together with the backing screen securely held in place between the two halves.

Filter Weighing

Because of the small amounts of material collected, an extremely high quality microbalance and carefully, temperature and humidity controlled filter weighing room are recommended. For complete EPA recommended details, consult 40 CFR 50 Appendix L8.0, Federal Register, July 18, 1997, and Section 2.12 of EPA's Quality Assurance Handbook.

The analytical balance used to weigh filters must be suitable for weighing the type and size of filters specified and have a readability of $\pm 1 \mu\text{g}$. The balance should be calibrated as specified by the manufacturer at installation and should be recalibrated immediately prior to each weighing session.

APPENDIX M. EXTERNAL DATALOGGER

Effective Oct. 10, 2003

This section is retained for reference purposes only.

**Please refer to the BGI Website at:
www.bgiusa.com/aam/pocketpc.pdf
for our newer downloading equipment.**

The BGI Datatrans is a "Download Data Collector" designed to extract the "Data Download" from a PQ100 at the end of its sample period and store it until it can be uploaded to a personal computer running BGI PQ software, for more permanent storage. This device facilitates rapid "Filter and Data" collection in the field while providing trouble free data collection at extended temperature range (-30° to +60°C). The Datatrans was designed specifically to address the problem of field data collection at these extended temperatures where notebook, laptop or palmtop computers are not designed to operate below 0°C.

To use the Datatrans

1. Turn the unit on with the power switch on the front panel (See Figure M1).
2. The following light sequence should be observed: red, yellow then green.
3. The green light will remain on (This indicates a ready condition). If the yellow light is also illuminated, one or more runs are currently stored in the Datatrans and it should either be downloaded or erased as described below.

NOTE: The Datatrans should be fitted with a fresh, new 9-Volt battery prior to each field use.

Downloading the PQ100

1. Place the connection switch, located on the front panel of the Datatrans, in the "Samp" (sampler) position.
2. Insure the PQ100 Sampler is powered on and at the Main Idle Screen.
3. Attach the PQ100 Adapter to the Datatrans (See Figure M2) and plug the other end of the adapter into the Utility Port on the front panel of the PQ100.
4. Press and hold the pushbutton on the front of the Datatrans.
5. The red light will turn on, the green light will turn off and if communication is successful the yellow light will flash for each line of data received. When the download is complete, the yellow light will remain on, the red light will stop flashing and turn off and the green light will turn on.

Note that the PQ100 takes less than 5 seconds to download.

6. Repeat the above steps for each sample run that is to be collected (multiple samplers) realizing that the "Runs" are stacked up using **First In, Last Out methodology**.

NOTE: You must remember how many runs that you've stored in the Datatrans. 20 is the maximum. If you try to store 21 runs, the Datatrans will not accept the 21st run. You will notice that the yellow light flashes while data is transferring. When memory becomes full, the red light will not flash indicating that the run was not accepted.

7. It is now safe to turn the unit off.

NOTE: The data will be retained in the Datatrans, even if the 9-Volt battery fails, until it has been uploaded into a computer and the unit is erased using the data deletion procedure described below.

To upload to the Computer

1. Plug the Datatrans into the RS232 serial port of the computer.
2. Turn on the power switch and observe the following light sequence: red, yellow then green. (Green light indicates unit is ready and yellow on indicates Runs are stored). Red light turns off.
3. Place the connection switch, located on the front panel, in the **(Comp)** computer position.
4. Insure the computer is running BGI PQ Software for DOS. (B)egin a new job, then import data from the sampler should be selected and should be ready to receive data as if it were attached directly to the sampler.
5. Press any key on the computer keyboard to initiate the transfer.
6. Green light will turn off, Red Light will turn on and "Run Data" will be stored in the Datatrans.
7. When the transfer is complete, the software will step to the next screen indicating that the "Run" has been transferred.
8. If multiple runs have been stored in the Datatrans, the last run captured is the current resident run. While a run is resident, the Datatrans retains the characteristics of the sampler type it was captured from. To step the Datatrans to the next run, you must first download the current run and then press the pushbutton. Repeat for multiple runs pushing the Datatrans button after each sample is uploaded. You must "Begin"
 - a new run for each sample run to be uploaded to the computer. When all runs have been uploaded, the yellow light will remain off.
9. To use the device again for new runs from the field, you must erase it as described below:

NOTE: TO RECYCLE SAMPLE RUNS:

If after all runs have been downloaded, a lost file, mistake or a problem is discovered and you must download a run again, the Datatrans allows the runs to be recycled as long as it has not yet been erased as described in the Erasure Procedure below.

AFTER GREEN LIGHT GOES OFF, INDICATING ALL RUNS HAVE BEEN DOWNLOADED, PRESSING BUTTON WILL RETRIEVE THE SERIES OF

RUNS AND REMAIN UNTIL DELETED.

THIS IS HELPFUL IF YOU ARE UNSURE OF AN UPLOADED RUN.

DATA DELETION PROCEDURE

(TO ERASE THE DATATRANS AFTER ALL RUNS HAVE BEEN TRANSFERRED)

1. Turn the power switch off.
2. Hold down the pushbutton.
3. While holding the pushbutton down, turn the power switch On.
4. The Red light will turn on, now release the button.
5. When erased, all three lights will flash 2 times in unison and 1 time in series.
6. Unit is now cleared and ready for new downloads.

Maintenance

The Datatrans requires no maintenance except for replacement of the 9-volt battery. A spare, fresh battery should always be taken to the field.

Troubleshooting

Most of the problems that occur with the device can be traced to a bad 9-Volt battery. It is recommended that the user purchase Duracell Alkaline Batteries which come packaged with a cell tester. Follow the instructions given on the box or cell and determine if the cell requires replacement or not. It is highly recommended that the user install a brand new, fresh cell before each field use (If you forget to turn the unit off for some reason, you will have about 18 full hours of battery use).

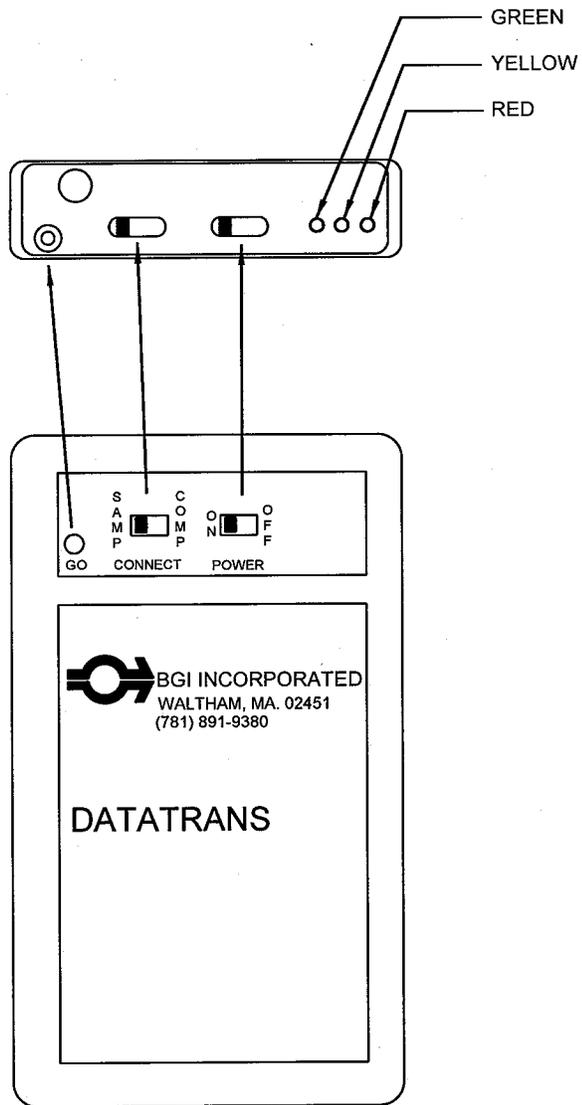


Figure M1. Schematic Diagram of Datatrans

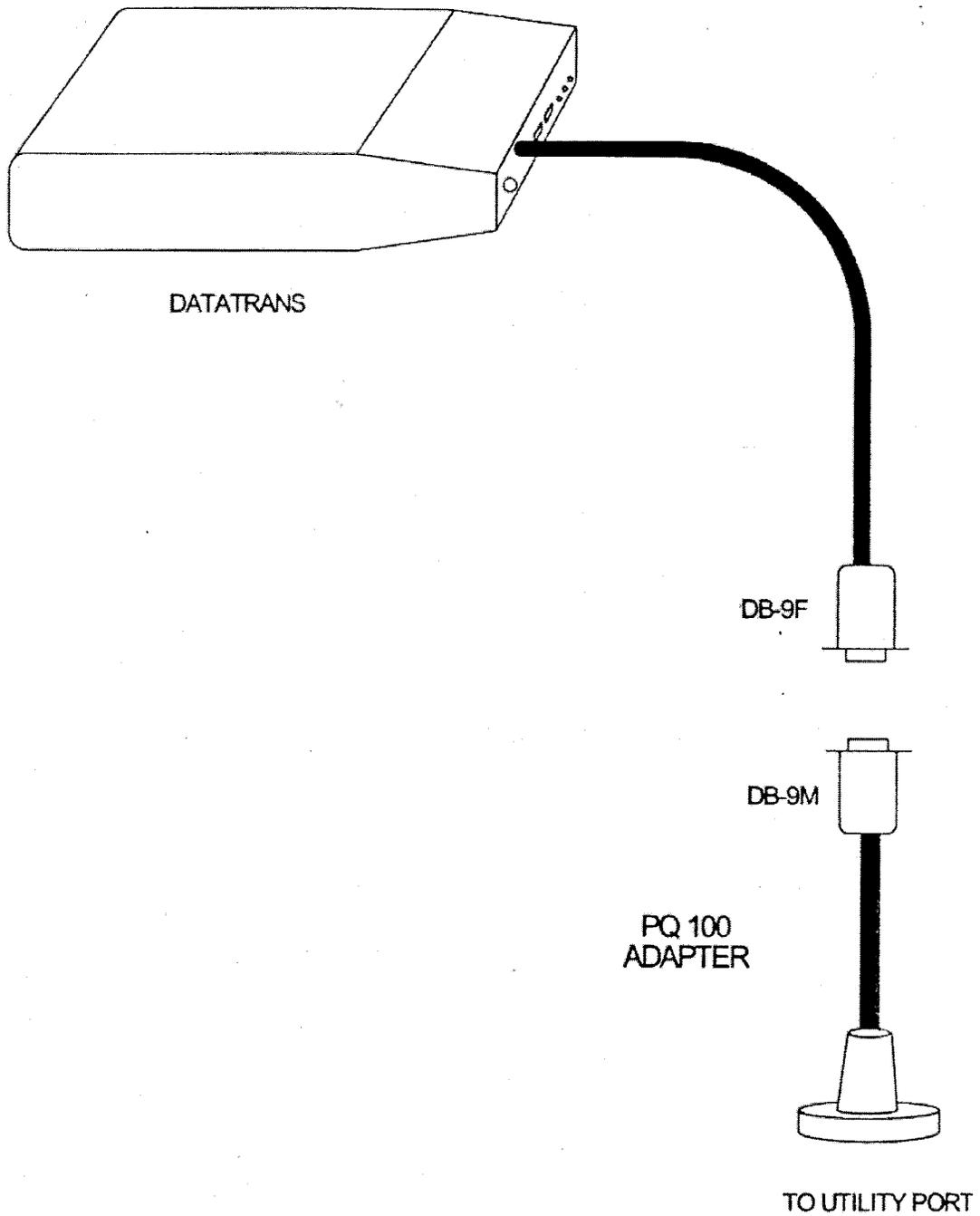


Figure M2. Datatrans with Adapter for use with PQ100

APPENDIX N. SOLAR PANEL POWER SUPPLY

Introduction

The SP32, solar panel kit is intended to permit the PQ100 to run for extended or, indefinite periods of time depending on the available sunlight (solar radiation) at a given location. The solar panel may only be used as the sole source of power for a U.S. EPA-designated instrument if sampling is not being performed every day (i.e., continuously).

Because of the low current draw of the instruments they are highly amenable to this technique. Given sufficient sunlight, they may be deployed in locations where no line power is available. The basic components of the solar kit are:

1. 32-watt solar panel with mounting brackets.
2. Built in voltage regulator.
3. 100+ amp hour (approx.) ballast battery. (User supplied).

The purpose of the external high capacity battery is to provide back up power on days when there is little or no sunlight. The recommended battery capacity will provide 7-8 days run time with little or no sunlight. It will recharge, almost completely, after one days' use during a day of full sunlight while the instrument is non-operational. Complete recharging of a fully depleted system would require 10 days.

This type of system should not be considered for latitudes higher than 45-50° N or S, or particularly overcast regions.

Operational Considerations

While the use of solar power is highly desirable from the standard of utilizing a renewable energy source and being freed from the need to locate a source of power in difficult situations, there are some preliminary considerations. Clearly, the PQ100 is not operating directly from the received energy of the sun but rather from a battery, which has been charged by that energy. If a PQ100 were to be run continuously from the internal and (recommended) external battery, 7 to 8 days run time could be achieved. However, considering only EPA designated sampling conditions, i.e. sampling from midnight to midnight, then it would be possible to run on alternate days yielding one day to replenish the energy used. Given that this is accomplished in full sunlight while the instrument is running, the extra day recovery reduces the need for full sunlight by 50%. If the popular, one in 3 days, or one in 6 days schedule is utilized, the probability of complete replenishment is greatly increased.

Experience has shown that on cloudless days in the Boston area, 5 Kwh/M² insolation will replenish the energy used by a PQ100. In order to determine the suitability of the PQ100 solar system for a given location, Appendix A of the cited reference gives the insolation index for 54 locations in the US and other places throughout the world. Given a one in 6 day sampling schedule; only Fairbanks Alaska is unsuitable for solar application in the months

of November, December and January. These are clear sky tables and seasonal overcast must be considered in individual locals. Table N1 comprises locations at various US latitudes and indicates operational months vs. sampling schedules.

There are other factors which will reduce the energy replenishment of the system and make accurate performance predictions difficult. Amongst these are:

1. Dirt on the solar panel.
2. Extreme cold weather affecting battery performance.
3. Extremely high particulate loadings causing high filter resistance and consequent high current drain.
4. Old "used up" batteries -- more than two years old.

While all the preceding factors are to be considered in the deployment of a solar powered PQ100. They are not easy to quantitate. The effect of too little sunlight will be noticed on the "percent charge remaining" on the PQ100's main screen. Given perfect replenishment, it will always read 99%. If at any time it falls below 50% it is well to consider replacing the large battery with a fully charged one. At a minimum, given winter gloom, a fully charged battery and an every other day sampling schedule, a one month operating period is achievable at any location below 45° latitude.

Setting up

Subsequent to unpacking a new unit, it is attached to the rear leg of the PQ100 as shown in Figure N1. It is important that the board provided be located as shown in the figure with the battery placed on top of it. This serves to anchor the lower end of the panel to prevent its lifting during high winds. Failure to do so could result in damage to the solar panel and the PQ100. **NOTE:** In due consideration of weight, shipping expense and ready, local availability, a battery is not furnished with the solar panel kit.

However, the recommended battery is known as a "trolling motor" battery. This is a marine type battery used for low speed, electric outboard motors. They are equipped with handles and 5/16 inch binding posts with wing nuts. Because of their marine specifications, they are a "deep discharge" battery, which is also the type recommended for solar panel applications⁽¹⁾.

Direction

The direction of the solar panel will be with its long axis from the north to south, with the foot (low) end of the panel to the south. Inasmuch as the cell will be attached to the rear leg of the PQ100, this means that the back of the PQ100 is pointing due south and the front of the instrument is due North as illustrated in Figure N2.

Tilt Angle

The tilt angle is defined as the angle of inclination of a solar collector measured from the horizontal. The reason for tilt angle is because of the sun's elevation will vary over a range of 47° from winter solstice to summer solstice ⁽¹⁾.

For the greatest annual energy production, the tilt angle should equal the latitude at the location of deployment. For best energy production, the wintertime the angle should be the latitude plus 15° . The maximum summertime production is obtained at latitude minus 15° . The tilt angle and one method of setting is shown in Figure N3.

It may also be set with a user supplied protractor/bubble level.

Wiring Connections

On the back of the solar panel is a rectangular box from which two cables exit as shown in Figure N4. The cable with 5/16 inch ring terminals is intended to connect to the external battery described in section N 2. The white wire is positive (+). The black wire is negative (-) and the green wire, with the tinned end is ground. A 12-inch ground spike and terminal is provided.

The other wire emanating from the box is equipped with a CPC connector. This wire is installed on the PQ100 panel normally used for the power supply cable. This wire is installed in place of the power supply cable when running on solar power.

Overall Operation and Troubleshooting

Prior to deploying a PQ100 with solar panel, it is prudent to ensure that the internal battery is fully charged. This is accomplished by plugging the PQ100's power supply into a source of line current for 16 hours. Full internal battery charge will be indicated on the main menu display as 99% or charged when the battery is full charged and the power supply is disconnected.

The external solar panel battery may be initially charged from any automotive battery charger. Alternatively, the PQ100 may simply set in a sunny location or the actual field sampling site and not run for 10 days. The solar panel will fully charge both batteries.

Troubleshooting

Battery is not maintaining at least 50% charge – caused by inclement weather or excessive current drain. Excessive current drain is caused by an excessively dirty filter or a worn out pump. After installing a new filter, if problem persists, check for worn pump valves or diaphragms.

If either battery is in excess of two years old – replace.

Reference

- (1) Stand-Alone Photovoltaic Systems, A Handbook of Recommended Design Practice.
 Available from National Technical Information Service
 US Department of Commerce
 5285 Port Royal Road
 Springfield, VA 22161
 Document No. SAND87-7023

Solar Panel Parts List

<u>Quantity</u>	<u>Figure</u>	<u>Part Number</u>	<u>Description</u>
1	N 1	SP-21	Solar panel assembly
1	N 4	A1920	PQ100 adapter cable

TABLE N1. Clear Sky Insolation Data from Northernmost to Southernmost U.S. cities¹.

Months wherein full charge can be maintained.

City	N. Latitude	Continuous Sampling	Every other day Sampling	Third day Sampling	Sixth day Sampling
Caribou, ME	46° 52'	Mar-Aug	Jan-Oct	Jan-Dec	Jan-Dec
Boston, MA	41° 40'	May-Sept	Jan-Nov	Jan-Dec	Jan-Dec
Raleigh-Durham, NC	35° 52'	Apr-Aug	Jan-Dec	Jan-Dec	Jan-Dec
Miami, FL	25° 48'	Feb-Sep	Jan-Dec	Jan-Dec	Jan-Dec

NOTE: This approximation is based upon 5 Kwh/M² received, as being necessary to fully restore the PQ100 system whilst drawing 500 MA (typical).

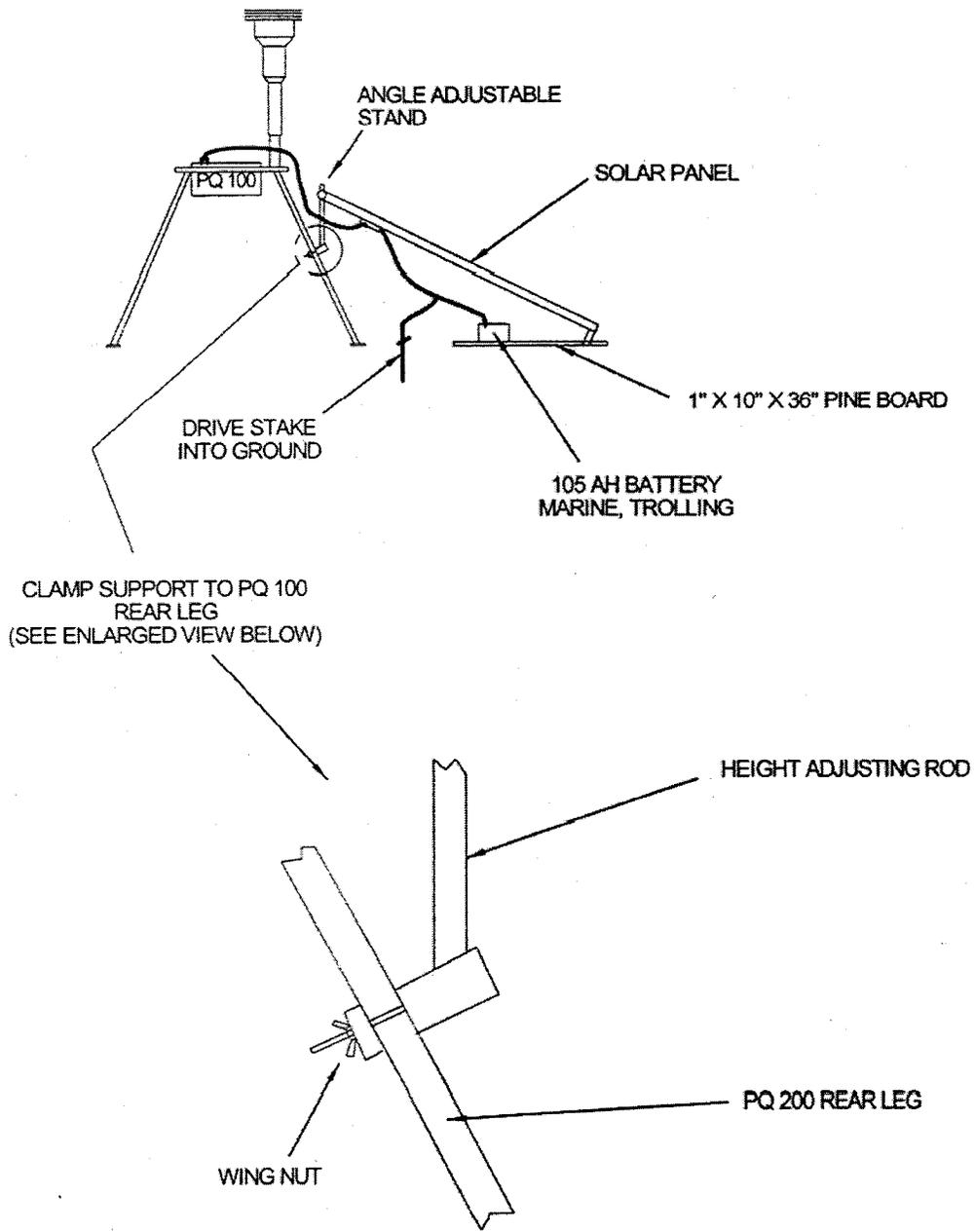


Figure N1. Setup of Solar Panel

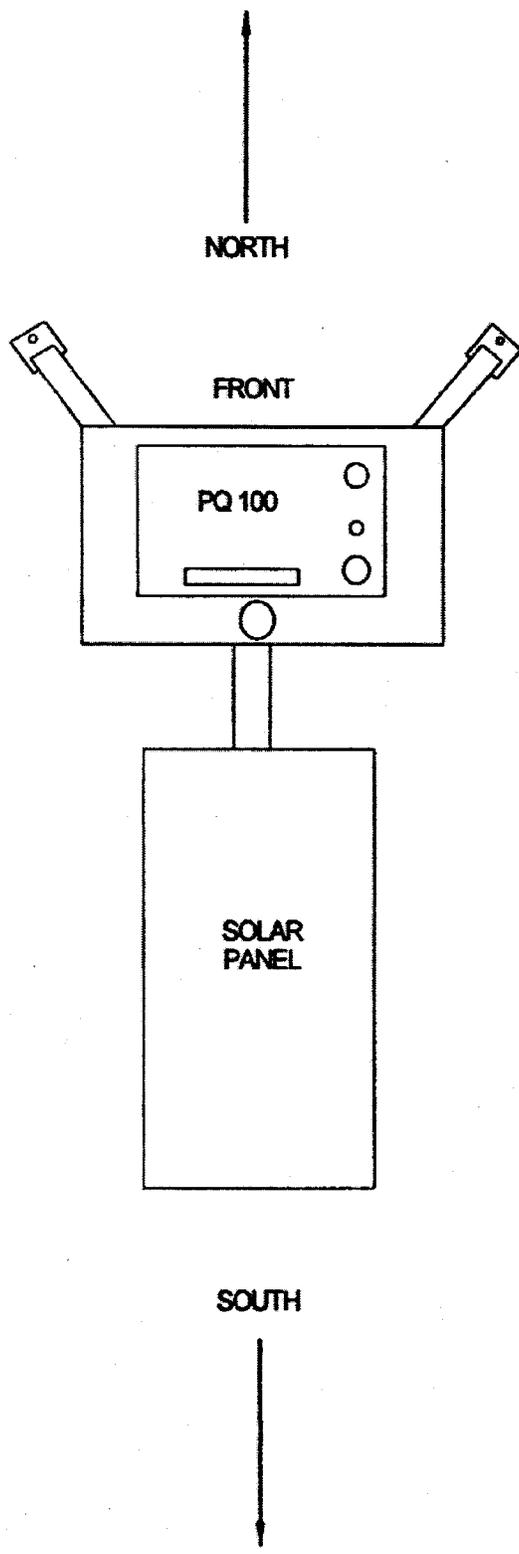
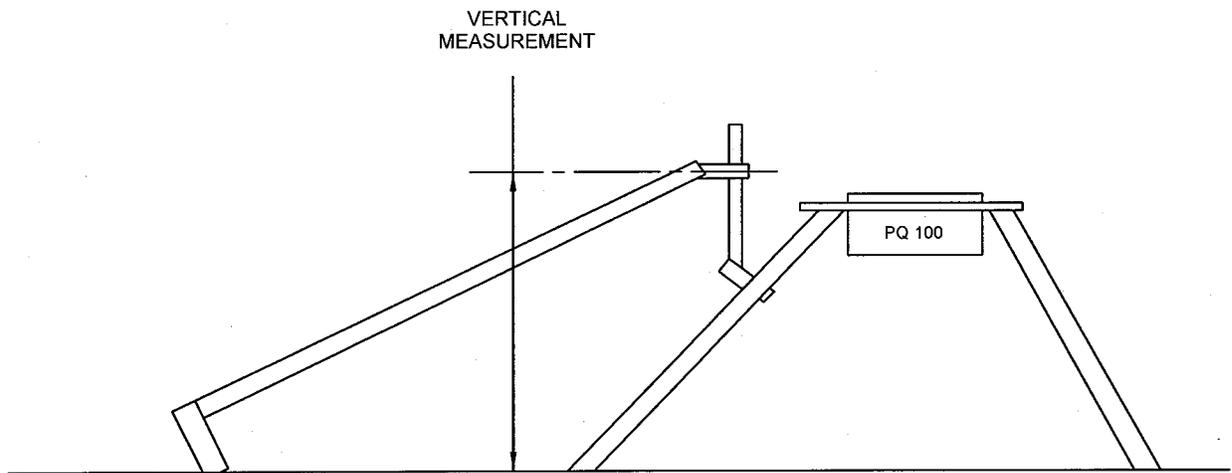


Figure N2. Orientation



BEFORE USING THE CHART BELOW DETERMINE WHETHER YOU HAVE THE LONG STYLE (13" WIDE x 51" LONG) OR THE SHORT STYLE (21" WIDE x 25" LONG) SOLAR PANEL

VERTICAL MEASUREMENT				TILT ANGLE
SHORT STYLE (21"x25")		LONG STYLE (13"x51")		
INCHES	CM	INCHES	CM	DEGREES
12.2	30.0	18.7	47.5	15
16.1	40.9	27.5	69.8	25
19.8	50.3	35.2	89.4	35
22.3	56.6	42.2	107.2	45
24.5	62.2	48.0	121.9	55
25.5	64.8	51.8	131.6	65

Figure N3. Setting Tilt Angle

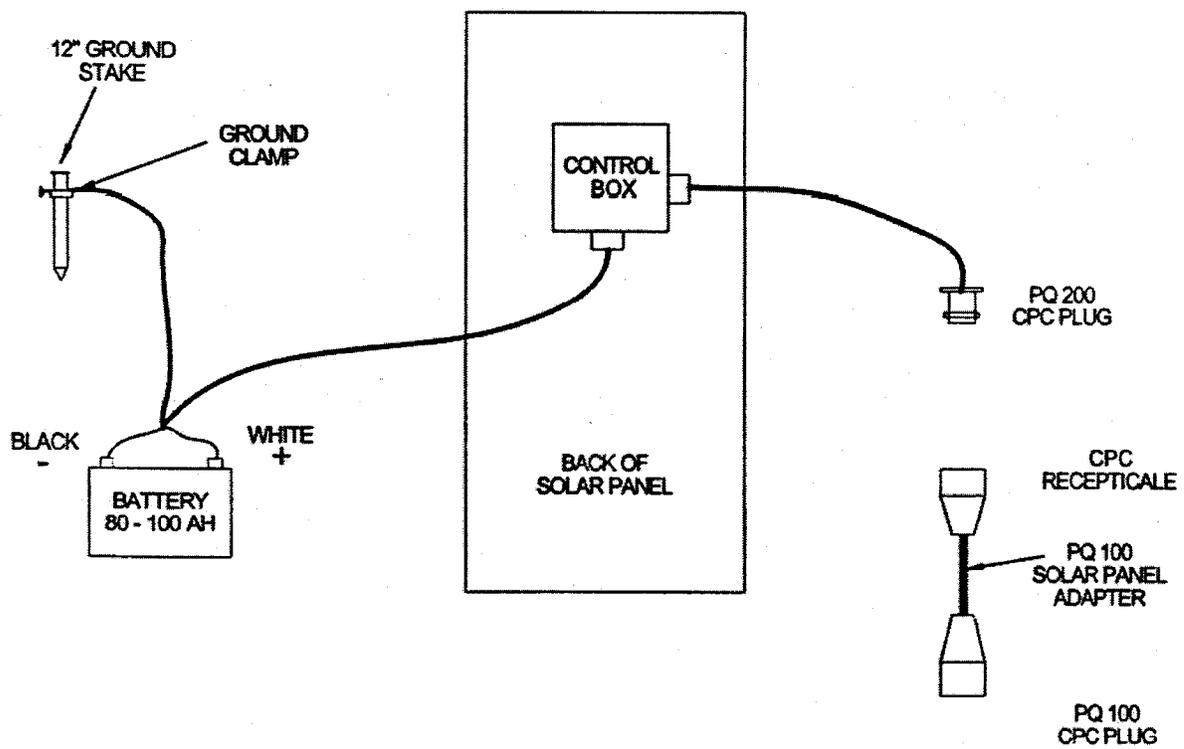


FIGURE N4 WIRING CONNECTIONS

APPENDIX O. RIGID MOUNTING ASSEMBLY

Introduction

The original PQ167 utilized a tripod assembly, which held the PQ100 pump in a swinging cradle. This assembly, now designated PQ167S, is detailed in Figures 4, 5, and 6. A new, improved rigid assembly is available designated PQ167R. Details of this new assembly are shown in Figures O.1 and O.2. *(January 2000: Only PQ167R is now in production.)*

Description

The inlet is still maintained at a height of two meters above the ground, with the filter holder plugged directly into the bottom of the PM10 inlet, as previously done.

An outlet cap for the bottom of the filter holder has been designed which is similar to the EPA L30 component with the addition of an "O" ring. This allows the filter holder to be placed onto a down tube which is a longer version of the EPA designed L19 component. Inasmuch as particulate matter is removed from the air stream prior to passage through the tube its increased length is not a consideration.

The downtube slips over a support member welded into a plate, which serves multiple functions. The support member serves as a water trap and is fitted with the same drain valve as is used in the PQ200 water trap. The support plate has a rectangular slot into which the PQ100 pump module can be placed, this supports the PQ100 at waist height for ease of use. Three stub legs are welded to the bottom of the support plate, which permits the attachment of 3 legs, which are interchangeable with the legs on the PQ200.

ASSEMBLING THE PQ167R PM10 AIR SAMPLING SYSTEM

Included with your PQ167R PM10 Air Sampler System are the following items. Item #'s are indicated on the appended drawings.

Item #	Quantity	Part Number	Description
14	1	PQ100	Air Sampler Main Unit
*	1	PQ101	Battery Charger/Auxiliary Power Supply
34	1	PQ102	Hose Adapter
*	1	CQ1	Charger/External Battery Cable
*	1	CQ2	PC Communication Adapter Cable
*	1	PQMAN	Manual
12	1	HS5	1 foot; Rubber Hose
11A	1	TP100R	Tripod Frame
*	3	A1634	Legs
01	1	SSI-2.5	Inlet
3	1	JR3035	Water Jar
4,5,9,10	1	F20	Filter Holder (Requires F21 Cassette)
6,7,8	2	F21	47mm Filter Adapter Cassette w/Screen
162	1	A1741	Long Down Tube
161	1	A1904	Filter Adapter
*	1	QD3	3.5" PQ Software Diskette

For complete system assembly refer to Figures 4, 5, 6, O.1 and O.2.

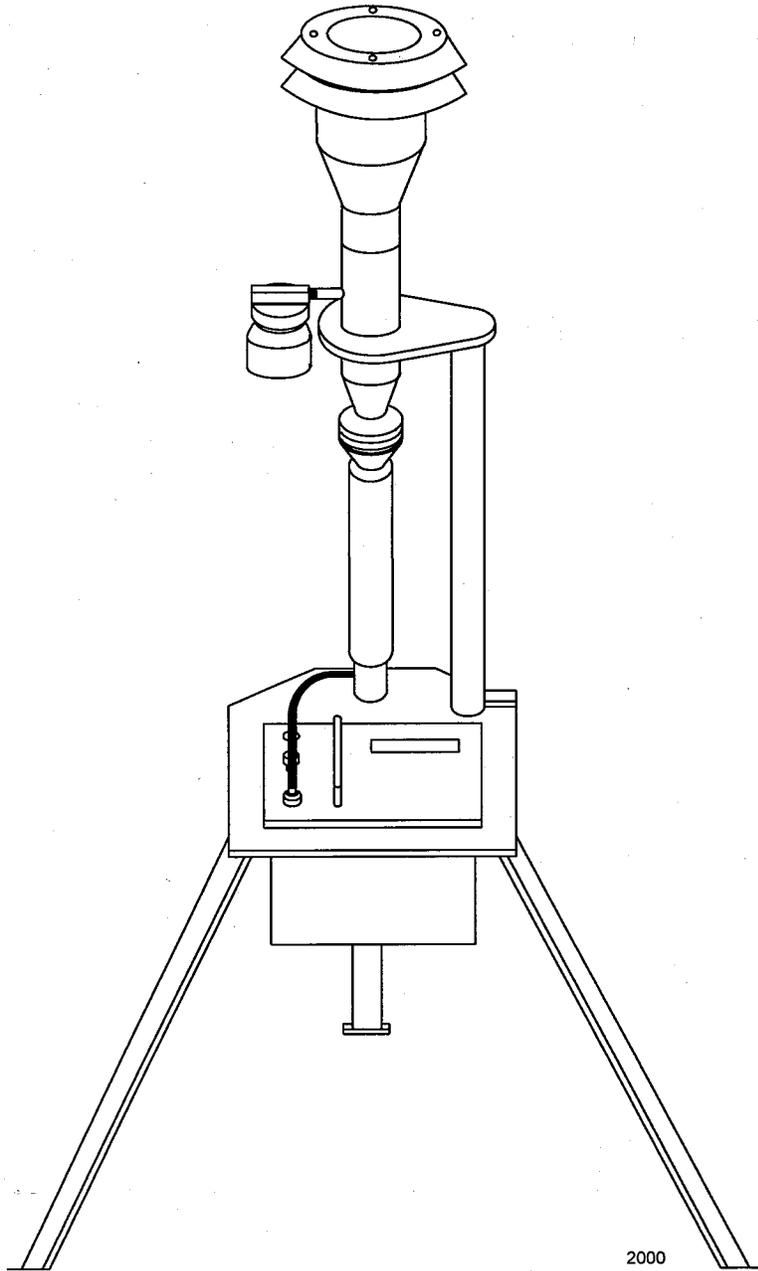


FIGURE 0.1 PQ167R Rigid Mounting Stand

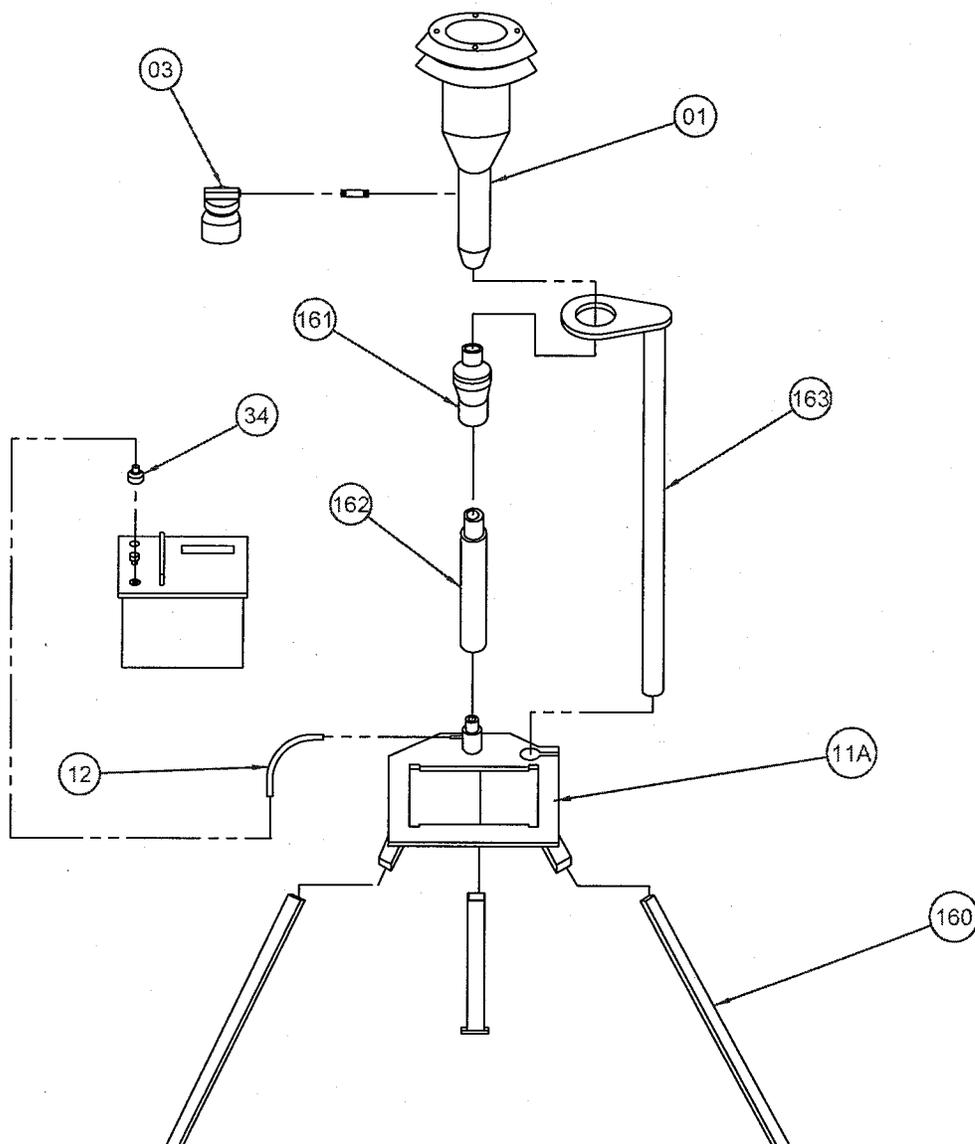


FIGURE 0.2 EXPLODED VIEW OF PQ167R STAND

1999

APPENDIX P. PQ167 High Altitude (*mini*PM Inlet)

IMPORTANT: FLOW RATE MUST BE SET FOR 5 lpm

1.0 Size selective inlet

The size selective inlet will be familiar to all who have had experience with the Standard EPA Louvered Inlet in its original 16.7 lpm configuration. The only two differences are that it has been scaled down to 1/3 its original dimensions and the acceleration jet in the impactor is changeable over five size ranges. An exploded diagram of the inlet is shown in Figure 9 with all parts identified.

2.0 Jet Differential

If a Size Selective Jet (SSJ) other than PM10 was ordered/furnished with your instrument it was furnished as a separate item. The individual jets are hand detachable and removed/installed by screwing in and out. A light grease should be applied to the threads to prevent seizure. Jets manufactured prior to May,2005 were not marked. As a guide to their functional size refer to the table of approximate internal dimensions below. Later jets were color coded and their functional size can also be found in the following table.

Function	P/N	I.D. (In.)	I.D. (mm)	Color
TSP	2599	0.38	9.6	Clear
PM 10	2616	0.26	6.6	Blue
PM 4.0	2741	0.14	3.6	Green
PM 2.5	2617	0.11	2.8	Red
PM 1.0	2618	2 holes	2 holes	Black

3.0 Maintenance

Items which require cleaning and maintenance are common to all ambient air sampling devices fitted with size selective inlets. The inlet and the sampler may be considered two separate items for cleaning and maintenance purposes.

Cleaning should occur once every 90 days or sooner in highly polluted environments. Until such time as sufficient experience has been gathered, the unit should be inspected once a month. In order to perform an inspection it is only necessary, after removing the inlet from the top of the filter holder to unscrew the top from the bullet as shown in Figure 10.

Normal cleaning of air sampling inlets is generally, best done with clean water and lint free wiping cloths. If an ultrasonic cleaner is available it is the preferred device as it will remove dirt from deep corners and pockets, avoiding the need for further disassembly. After ultrasonic, or any liquid cleaning, be certain to dry thoroughly before reassembling and placing in service.

Summary of Maintenance Items:

Frequency*

Maintenance item

Every 5 sampling days

1. Service water collector bottle

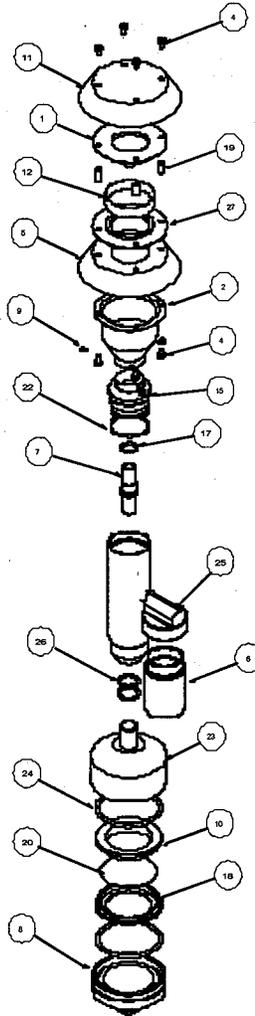
Monthly

1. Clean inlet surfaces
2. Check inlet screen for any clogging

Quarterly (every 3 months)

1. Inspect O-rings. Remove and lightly coat them with Vacuum grease.
2. Clean impaction surface.

*Frequency may vary depending on climate, amount of particulate matter in the air, weather, and so on.



Detail #	Part #	Qty.	Description
1	2585	1	2585 WIND DEFLECTOR
2	2583	1	2583 NOZZLE ENTRY
3	2602	1	2602 EXIT ADAPTER
4		8	4-40x1-4 PAN HEAD
5	2586	1	2586 LOWER PLATE
6		1	JAR
7	2617	1	2617 NOZZLE INSERT, PM 2.5
8		1	1425 FILTER HOLDER, LOWER
9		3	2-56x1-8 PAN HEAD
10		1	1727L27 CASSETTE UPPER SECTION
11	2584	1	2584 TOP
12	2589	1	2589 SCREEN
13	2596	3	2596 RECEIVER TUBE
14	2595	1	2595 TARGET PLATE
15	2598	1	2598 IMPACTOR NOZZLE
16		1	NIPPLE
17	013 ORING	1	013 ORING
18		1	1729-L29 CASSETTE LOWER SECTION
19	2588	4	2588 SPACER
20		1	1728 FILTER SCREEN
21	2597	1	2597 OUTER TUBE
22	024 BUNA	1	024 ORING
23	2672	1	2672 UPPER FILTER HOLDER
24		2	135 ORING
25		1	JAR TOP
26	015 BUNA	2	015 ORING
27	2587	1	2587 RAIN DEFLECTOR

Fig. 9 Exploded Diagram of Inlet with Filter Holder

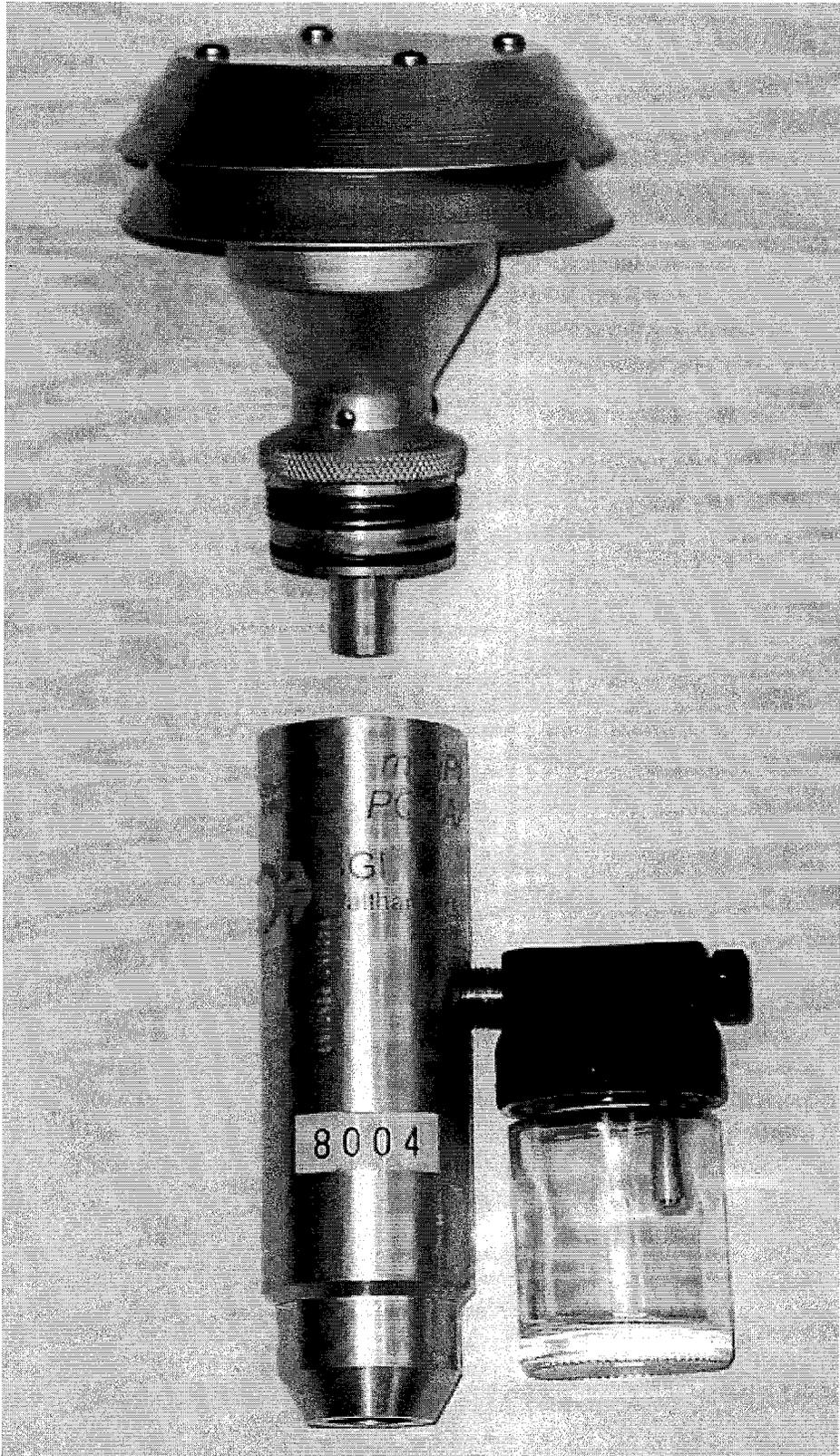


Figure 10: Photo of Initial Disassembly of Inlet

The jet may also be removed from the top of the inlet as shown in Figure 11.



Figure 11: Photo of Jet Removed for Cleaning or Size Change

PQ100 Instruction Manual Revision History

Version 5.0	Updated to WP6.0 format	March 1998
Version 6.0	Added Preface, Safety, Appendix L, M, N, and O Added Designation Information	December 1998
Version 6.01	Corrections to Replacement Component List	February 1999
Version 6.02	Corrections to Appendix M	April 1999
Version 6.03	Corrections to Appendix N	January 2000
Version 6.1	Miscellaneous corrections	January 2000
Version 6.2	Miscellaneous corrections	May 2002
Version 6.21	Added note to Appendix M	October 2003
Version 6.22	Added Appendix P	September, 2005
Version 6.23	Ch'd tetraCal to TetraCal	May, 2007