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Quality Systems and Implementation Plan for Human Exposure Assessment

Research Triangle Institute
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Field Operations Protocol **RTI/ACS-AP-209-010**

Title: Personal, Indoor and Outdoor Air Sampling Procedures for Total Inspirable and PM_{10} Aerosols

Source: Research Triangle Institute

U.S. Environmental Protection Agency
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TITLE: PERSONAL, INDOOR AND OUTDOOR AIR SAMPLING PROCEDURES FOR TOTAL INSPIRABLE AND PM_{10} AEROSOLS

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PERSONAL, INDOOR AND OUTDOOR AIR SAMPLING PROCEDURES FOR TOTAL INSPIRABLE AND PM_{10} AEROSOLS

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1.0 SCOPE AND APPLICATION

1.1 Study Description

The primary goal of NHEXAS is to reduce uncertainties in exposure and risk assessments, by (a) producing reliable estimates of the status and trends in total human exposures (via inhalation, ingestion and transdermal routes) to potentially harmful environmental agents, (b) determining the incidence and causes of high exposures, especially for biologically susceptible persons, and (c) establishing relationships between environmental concentrations, exposure, dose and health response. A specific objective of NHEXAS is to estimate the distribution of exposures of selected contaminants, especially the mean, median, and 90th percentile for the general population and subsets of special interest.

1.2 Data Use

The data collected under this protocol for the NHEXAS study will be used to develop concentration distributions for the affected populations. These distributions will be combined with personal activity information to estimate the study population exposure distributions. The precision and accuracy requirements for measurements in the NHEXAS data base are derived primarily from the study goals to define the mean, median and 90th percentile of these exposure distributions. The distributions will then be used to conduct hypothesis testing proposed as the bases for the program.

1.3 Target Analytes

The NHEXAS contaminants of interest, specifically relevant to this protocol, are size-specific aerosol mass concentrations from personal, indoor and outdoor sampling, with subsequent analyses to be conducted on selected samples for trace metals, including lead, cadmium, chromium and arsenic.

1.4 Quantitation Limits

The mass concentration quantitation limit (QL) for the Total Inspirable and PM_{10} samplers are a function of a) the total integration interval, b) the sampling flowrate, c) the repeatability (standard deviation) of the weighing process used to perform mass measurements, and d) the allowable coefficient of variation. Using a) a total sampling window integration interval of six 24-hour days with an ON/OFF cycle ratio of 1/3 over the integration window to give a total sampling time of 2880 minutes, b) sampling flowrates of

2.0 lpm, c) a "best-case" repeatability for weighing 25 mm Teflo® filter of 6.7 Fg, and d) an allowable accuracy (coefficient of variation) of ±10%, a QL of 20 Fg/m^3 is expected (see reference 2.2.6).

1.5 Responsibilities

1.5.1 Co-Principal Investigator (CPI) will be responsible for final review and approval of this procedure. The Co-Principal Investigator will be responsible for: a) providing equipment and supplies to the Field Coordinator (FC) to utilize this protocol, and b) monitoring the field operating information relative to the quality control measures specified for this protocol and relaying corrective instructions to the FC as necessary.

1.5.2 Field Coordinator (FC) will be responsible for a) training the Field Technicians (FT's) in the application of this protocol and utilization of the described equipment and supplies, b) training the FT's in the proper recording of field data, c) training the FT's in the quality control measures needed to support this protocol, d) corresponding with the CPI on equipment and supply needs to support continued application of this protocol, e) corresponding with the CPI on any problems encountered with this protocol.

1.5.3 Field Technician (FT) will be responsible for a) understanding and following the procedures described in this protocol, b) understanding and following the quality control measures supporting this protocol, c) insuring that the field sampling and QC data are properly recorded, d) following the procedures for sample custody, handling and shipment of filters, and e) notifying the FC on any problems encountered with this protocol.

1.5.4 Laboratory Technician (LT) will be responsible for a) understanding and following the procedures described in this protocol, b) understanding and following the quality control measures supporting this protocol, c) insuring that the aerosol sampling systems are properly checked and validated prior to transferring the samplers to the FT's, d) insuring that the aerosol system validation data are properly recorded and archived at the ASSL, e) pre- and

post-weighing the study filter samples and field blanks and properly record the archiving of the results at the ASSL, and f) notifying the CPI on any problems encountered with this protocol.

2.0 SUMMARY OF THE METHOD

2.1 Overview

The purpose of this Analytical Operating Protocol is to describe the field application of personal, indoor and outdoor sampling systems to collect integrated aerosol samples for the NHEXAS program conducted by the RTI/EOHSI consortium. This protocol describes the sampling systems, their set-up, check-out, calibration, field deployment, substrate (filter) loading and unloading, operation, sample validation and operating data collection procedures. Note that the procedures describing the flow control portion of the aerosol systems are applicable to other collection substrates in place of the aerosol inlets that operate at 2.0 lpm and have up to 10 inches of water pressure drop. Separate protocols have been prepared for NHEXAS describing (a) the aerosol field sample storage and shipment procedures, (b) the aerosol filter pre- and post-weighing processes for the determination of mass concentration, and (c) filter analyses, other than mass concentration. The basis for many of the procedures used in NHEXAS were derived from the PTEAM study (see reference 2.2.13).

2.2 Method References

2.2.1 BGI Incorporated, "Instruction Leaflet - AFC123 Personal Air Sampler", Waltham, MA, November, 1989

2.2.2 British Health and Safety Executive, "General Methods for the Gravimetric Determination of Respirable and Total Inhalable Dust", Method MDHS 14, Occupational Medicine and Hygiene Laboratory, London NW2 6LN, October, 1989.

2.2.3 Gelman Sciences, Inc., "Laboratory Filtration - The Gelman Sciences Filter Book", PN 32378, Ann Arbor, MI, 1994.

2.2.4 Mark, D. and J.H. Vincent, "A New Personal Sampler for Airborne Total Dust in Workplaces", **Ann. Occup Hyg.**, Vol. 30, No. 1, pp. 89-102, 1986.

2.2.5 Rodes, C. E., "Design and Construction of a Programmable Timer/Data Storage Unit to Control and Monitor the Performance of a Personal Sampling Pump", internal NHEXAS project report, Research Triangle Institute, Center for Aerosol Technology, Research Triangle Park, NC 27709, December, 1993.

2.2.6 Rodes, C. E., "NHEXAS Filter Weighing Issues", internal NHEXAS project report, Research Triangle Institute, Center for Aerosol Technology, Research Triangle Park, NC 27709, November, 1993.

2.2.7 Rodes, C. E. and R.J. Newsome, "Moisture Uptake of Selected Sampling Substrates Proposed for the NHEXAS Program", internal NHEXAS project report, Research Triangle Institute, Center for Aerosol Technology, Research Triangle Park, NC 27709, February, 1994.

2.2.8 SKC, Inc., "IOM Inhalable Dust Sampler, Product Data Bulletin", Issue 9204, Eighty Four, PA 15330

2.2.9 U. S. Environmental Protection Agency, "Determination of Respirable Particulate Matter in Indoor Air Using Size Specific Impaction", Method IP-10, in **Compendium of Methods for the Determination of Pollutants in Indoor Air**, EPA publication EPA-600/S4-90/010, Research Triangle Park, NC 27711, 1990.

2.2.10 Vincent, J.H., "Perspectives on International Standards for Health-Related Sampling of Airborne Contaminants", **Applied Occup. Environ. Hyg.**, Vol. 8, No. 4, pp. 233-238, 1993.

2.2.11 Gilian Instrument Corp., "Instruction Manual for the Gilibrator", Caldwell, NJ, 1986.

2.2.12 Research Triangle Institute, "Quality Systems and Implementation Plan for Human Exposure Assessment Study - CR 821902-01-0", RTI Report Draft RTI/5740/02-02QSIP, Research Triangle Park, NC, April, 1995.

2.2.13 Pellizzari, E., "Particle Team Exposure Assessment Methodology (PTEAM) Pilot Study, Volume II: Protocols for Environmental Sampling and Analysis, Addendum to the Workplan", report for EPA Contract 68-02-4544, Work Assignment 67, ARB Agreement No. A833-060, Research Triangle Institute, Research Triangle Park, NC 27709, February, 1992.

2.3 Definitions

EPA - Environmental Protection Agency

NHEXAS - National Human Exposure Assessment Survey

RTI - Research Triangle Institute (Research Triangle Park [RTP], NC)

EOHSI - Environmental and Occupational Health Sciences Institute (Piscataway, NJ)

PM_{10} - particulate matter meeting the Environmental Protection Agency definition for particles with an aerodynamic diameter less than or equal to 10 micrometers

Inspirable Particulate Matter - particulate matter meeting the criteria of Reference 2.2.8 for particles inspired through the oral and nasal entry planes

IOM - Institute for Occupational Medicine (Edinburgh, Scotland)

SKC - Commercial manufacturer (Eighty Four, PA) of a conductive plastic version of the IOM sampler to collect the inspirable particulate matter fraction

lpm - liters per minute

STP - standard temperature and pressure (25 EC and 760 mm Hg)

MSP - Commercial manufacturer (Minneapolis, MN) of the personal PM_{10} aerosol inlets proposed to be used in this program

LOD - Limit of Detection

CPI - Co-Principal Investigator

FC - Field Coordinator

FT - Field Technician

LT - Laboratory Technician

HVAC - Heating Ventilation and Air Conditioning (system)

Participant - the primary respondent at each residence who carries the personal monitoring system

ASDA - Aerosol Sampling Data Acquisition software

AWDA - Aerosol Weighing Data Acquisition software

QL - Quantitation Limit

3.0 SAMPLE COLLECTION MATERIALS AND SYSTEMS

3.1* Aerosol Size Fractionating Inlets

The focus of NHEXAS on collection of total human exposure, led to a decision to collect airborne aerosol samples via a size fraction representing the aerosols capable of passing the oral and nasal entry planes into the body. This fraction is described in detail and referred to in References 2.2.4 and 2.2.10 as Total Inspirable and can be collected by using the IOM personal sampling inlet sold commercially by SKC, Inc. The collected fraction has an aerodynamic cutpoint (D_{50}) of approximately 50 Fm. The IOM inlet commercially available from SKC, Inc. (Reference 2.2.4) with an approximate total weight without filter of 24.3 g. A 25 mm diameter filter is used at a total flowrate of 2.0 lpm. To minimize handling of the filter substrate, the inlet has a two piece, integral plastic cassette assembly, that can be tare weighed along with the filter, if necessary. A shipping clip is provided to contain the larger particles that may dislodge from the filter and be lost in shipment. The specific sampling procedures described in Reference 2.2.2 are applicable to this inlet. A guard screen attaches to the face of the IOM inlet to protect the personal and indoor samples from foreign objects (e.g., children's fingers). No information is currently available on the potential loss of aerosol particles to the shipping clip during shipment.

In order to place the Total Inspirable fraction collected by the IOM sampling inlet in perspective with currently measured PM_{10} samples, the aerosol sampling system will also be operated on a limited, collocated basis with a commercially available PM_{10} inlet. The PM_{10} inlet validated (at 4.0 lpm) for use in the EPA PTEAM study is manufactured by MSP, Inc. An oil-soaked, sintered impaction surface provides the aerosol size fractionation, with samples collected on a 37 mm diameter filter at a flowrate of 2.0 lpm. The collected fraction has an aerodynamic cutpoint (D_{50}) of approximately 10 Fm. Exposed filters are stored and shipped in special petri dishes (Gelman 7231 or equivalent).

A common flow control system designed by RTI specifically for the NHEXAS program and operating at 2.0 lpm is used for both Total Inspirable and PM_{10} sampling. The aerosol sampling inlet and the filter collection substrates utilized within each inlet type define the only differences between systems for indoor or outdoor sampling. Collocated IOM and PM_{10} inlets, and collocated inlets of the same type (IOM and IOM, PM_{10} and PM_{10}), will be

collected at indoor and outdoor (not personal) locations to obtain comparability and precision information, respectively.

3.2 Sampling Substrates

3.2.1* Total Inspirable

Aerosol samples will be collected at 2.0 lpm on filter substrates over a predetermined integration interval. The primary filter substrate for Total Inspirable sampling will be Gelman 25 mm diameter, 3.0 Fm Teflo® filters, or equivalent (Reference 2.2.3). These filters consist of a 3.0 Fm porosity PTFE Teflon layer stretched across a 25 mm diameter, polymethylpentene annulus ring and heat sealed. To add rigidity to the Teflon layer during sampling and minimize pattern blinding caused by the filter holder support grid, a backup supporting material may be added under the Teflo® filter. The exposed area for aerosol collection is approximately 21 mm in diameter.

The inlet has an operating face velocity of 9.18 cm/s (based on a 21.5 cm exposed area). Specific issues and supporting laboratory data concerning selection of filters for the NHEXAS program can be found in references 2.2.6 and 2.2.7. The 3.0 Fm Teflo® filter has an extremely low pressure drop, and a change to the system or the addition of a backup support pad can dramatically increase the total pressure drop. The relationship of flow to pressure drop is important for personal sampling, since the pressure drop across the filter determines the rate of battery power consumption drawn by the sampling pump. The collection of a valid sample, requires that the battery voltage be greater than a pre-determined level over the entire sampling interval in order for the flow control system to maintain the required 2.0 lpm flowrate. Three randomly selected unexposed filters from each lot should be tested for pressure drop over the range of 1 to 3 lpm to determine if the operating flowrate pressure drop is within ±10% of the target value.

The expected tare weight for the Teflo® filters is approximately 0.040 g (40 mg), which should be easily accommodated by analytical balances with either a 10 Fg or a 1.0 Fg resolution. Stability tests of the Teflo® filter tare weight over the range of typical relative humidities (20 to 80%) has shown less than a 10 Fg

change. Repeated weighings of a Teflo® filter with a Mettler AT261 Analytical balance with a 10 Fg resolutions supported on a marble weighing table showed a reproducibility of 6.7 Fg. Repeated weighings of this filter with a Mettler AT20 analytical balance with a 1 Fg resolution showed a reproducibility of 2.0 Fg. Of concern for tare weight stability of the Teflo® filter are losses of shards of the PTFE and polymethylpentene materials left partially attached to the filter during manufacture. Filter examination must be conducted on <u>each</u> filter prior to tare weighing to identify and remove these loosely held fragments that may become dislodged during subsequent handling, or reject the filter as unusable. This examination must also include a "candling" step where the filter is held in front of a bright light and examined on both sides for pin holes or tears caused by the manufacturing process or rough handling. Suspect filters should be rejected. Filters that were noticeably deformed by the heat sealing process, to include more than 2.0 mm of out-of-roundness and annulus rings bowed (will not lie flat) by more than 5.0 mm are also to be rejected.

3.2.2 <u>PM_{10}</u>

Aerosol samples will be collected at 2.0 lpm on filter substrates over a predetermined integration interval. The primary filter substrate for PM_{10} sampling will be Gelman 37 mm diameter, 3.0 Fm porosity Teflo® filters, or equivalent (Reference 2.2.3). These filters consist of a 3.0 Fm porosity PTFE Teflon layer stretched across a 37 mm diameter, polymethylpentene annulus ring and heat sealed. To add rigidity to the Teflon layer during sampling and minimize pattern blinding caused by the filter holder support grid, a backup supporting material may be added under the Teflo® filter. Only fixed location indoor and outdoor aerosol sampling are anticipated for the PM_{10} size fraction, and only at locations collocated with Total Inspirable sampling. Only Teflo® filter materials will be used for PM_{10} sampling. The tare weight of a 37 mm Teflo® filter is approximately 0.100 g (100 mg). The exposed area for aerosol collection is approximately 32 mm in diameter.

3.3* Personal Sampling

Personal exposure to aerosols is to be estimated by collection of samples using a personal sampling system designed specifically for the RTI/EOHSI phase of the NHEXAS program. The general principles and procedures described in reference 2.2.8 are applicable.

As shown in Figure 1, this system consists of (a) a Total Inspirable aerosol sampling inlet (personal sampling will not utilize the PM_{10} size fraction for the RTI/EOHSI NHEXAS study) attached to the body, a flow-controlled sampling pump operating at 2.0 lpm, (b) a pack of four standard AA-size alkaline batteries (Duracell, or equivalent), (c) a set of parameter sensors collecting data on the system performance, with storage in a data logger, (d) a timer to cycle the pump ON and OFF in a pre-determined manner to effectively represent a specified extended integration period, while conserving the pump battery capacity, and (e) a carrying case to ease transporting the system in a personal sampling mode, while reducing the burden (noise, weight, bulkiness) on the study subject as much as possible.

3.4 Indoor Sampling

The basic aerosol sampling package for monitoring aerosol concentrations at a fixed location indoors incorporates the same basic components as the personal monitoring system. The primary exceptions are that instead of mounting the system on a person, a sound-proofed, thermally insulated elliptical form supported by a tripod is utilized to simulate the body, while the form's interior cavity serves as a container for the system components. Batteries are utilized to operate the system, which eliminates wires that may prove intrusive or unsafe. For the indoor sampler, the same 4-cell, AA battery packs as in the personal samplers are used to power the samplers during the 6-day sampling interval. The Total Inspirable and/or PM_{10} aerosol inlet (or inlets if collocated sampling is required) are/is mounted on the outside surface of the elliptical form, with the tubing connecting the pump routed through holes in the form's exterior. Adequate soundproofing is incorporated inside the form's cavity to reduce the noise level at 1 meter to a design goal of 40 db to reduce obtrusiveness. The appearance, physical size and layout of the package are designed to be as unobtrusive as possible.

3.5* Outdoor Sampling

The aerosol sampling package for monitoring aerosol concentrations at a fixed location outdoors incorporates the same basic components as the indoor monitoring system. The primary exceptions are the addition of a removable rain shield and the optional replacement of the tripod base with a metal ground stake that can be conveniently driven into the ground for support at the necessary 2 meter elevation above the ground. A door on the top under the rain shield provides access to the interior, with removal from the tripod or stake, as needed, if reach is a problem. D-cell battery packs are used to operate each sampler in the system, which eliminates wires that may prove intrusive or unsafe. The degradation of battery performance with ambient temperature in winter conditions may necessitate the addition of thermal insulation and a heater inside the form cavity. The additional space inside the form accommodates up to three pump battery packs and an AC-powered cavity heater. The total inspirable aerosol inlet (or collocated inlets) is (are) mounted on the outside surface of the elliptical form, with the tubing connecting the pump routed through holes in the form's exterior.

4.0 PREPARATIONS FOR SAMPLING

4.1 Filters

Filters for PM_{10} sampling are similarly screened by laboratory personnel for acceptable mechanical attributes (see Section 3.2), weighed, assigned an identification code, and then placed into special petri dishes with a tightly sealed lid at the RTI weighing facility at RTP, NC before shipment to the field locations. The filters need only by checked by the FT for obvious physical changes during shipment, including tears or holes in the Teflon substrate. Additional details on filter handling are provided in NHEXAS protocol RTI/CAT-AP-209-011, NHEXAS Filter Receiving, Weighing and Archiving Procedures for Aerosol Samples.

4.2 Loading/Unloading Filters and Cassettes

The Total Inspirable and PM_{10} aerosol inlets have been loaded with the correct filters at the RTI laboratory, prior to being shipped to the field location. Aerosol cassettes will not be loaded or unloaded in the field. If a leak is determined to exist in the aerosol inlet during the sampling system flow checks, the inlet should be removed, marked as “LEAKS” on a

piece of tape, and returned to the RTP lab for checking. The following additional information is provided for information purposes only.

The SKC IOM cassette and 25 mm filter have been placed in the IOM sampling base, to rest on the rubber O-ring. A special torque driver is used in tightening the screw cap into the base to assure that the proper pressure is applied to seal the IOM cassette and filter. Similarly, a special press is used at the RTI laboratory with the MSP PM_{10} inlet to properly seat the 37 mm filter. To avoid tampering with the assembly by unauthorized persons, the assembly screws are of a drilled spanner security type, which require a special screwdriver. For the assembly to seal consistently, it is necessary that the two assembly screws draw the PEM head against the impactor plate and the rest of the filter sandwich with an evenly distributed force. This is accomplished using the provided screw press with an adjustable torque clutch. This clutch is adjusted so that the filter assembly is pressed tightly enough to crush the filter sandwich, but not so tight that the metal parts (which are aluminum) begin to deform. After pressing the assembly together using this press, the assembly screws are snugged down to just take up the force exerted by the press. The sintered metal impaction surface inside the MSP PM_{10} inlet were carefully greased according to the procedures developed previously for the EPA PTEAM pilot study.

5.0 SAMPLE COLLECTION

Many of the laboratory setup and checkout phases are very similar for the personal, indoor, and outdoor sampling systems. We describe the activities in each phase, making clear any differences in procedures specific to one or the other sampler in particular.

5.1 Laboratory Sampler Set-up/Checkout

This procedure applies to personal samplers, the indoor stand-mounted sampler, and the outdoor pole-mounted sampler. This phase of sampler set-up can be performed in the mobile laboratory, prior to arriving at the participant's residence. Personal samplers come in both the adult waist pack (Fieldtex) version and the child's back pack (REI) version; there are only minor differences in access to the sampler units and lengths of connecting tubing. Each indoor sampler can have 1, 2 or 3 channels (filters and pumps); each outdoor sampler can have 1, 2, or 3 channels. Each channel in the sampler form is treated as a separate sampler

in these procedures. The only external differences between indoor/outdoor types are that the outdoor sampler additionally has (1) a rain shield connected with 2 screws and rubber o-rings through the top and (2) a different support stand.

5.1.1 Sampler Attachment to Stick *Indoor/Outdoor*

This procedure will be followed when first assembling an indoor/outdoor sampling system or when replacing a failed unit. Once indoor/outdoor samplers have been assembled, they will remain in use and require no further assembly.

1. *Outdoor:* Place the pair of dummy wooden AA batteries into the battery holder slots adjacent to the flow rate adjustment hole on the blue box. Orient the dummy Red battery with the screw on the dummy battery pointing down towards gray box and in the outside slot. Place the Black battery similarly next to the Red. (Align with the red and black wires on the battery holder).
   Indoor: Install 4 (four) AA batteries for indoor sampling.
2. Fasten a Velcro strap around the blue box and batteries.
3. Lay pump and data logger boxes into the rabbets on the alignment stick (see Figure 2). The battery strap goes into the deepest rabbet.
4. Attach a Velcro strap around each box as shown in Figure 2 to hold the units firmly to the stick.

5.1.2 Opening Forms *Indoor/Outdoor*

1. Remove the 2 side screws holding gray plastic top; remove the top.
2. Using finger holes (see Figure 3), remove the top insulation layer.

5.1.3 Pump Battery Replacement

1. Open pack or indoor/outdoor form and partially remove pump box/data logger assembly from the container. Do not disconnect the tubing from the barbed hose connector unless absolutely necessary to avoid damaging components.
2. *Personal and indoor:* Undo the Velcro strip from the battery pack and remove the old batteries. Replace the old batteries with 4 fresh AA alkaline ProCell batteries and re-wrap the battery pack with the Velcro strip to hold them in place.

Outdoor: Remove the old batteries from the insulated battery box, replace with 4 new D-cell batteries, and close the box allowing the battery connectors to exit at the top.

3. Old batteries are to be stored for later return and recycling by manufacturer or will be disposed of properly.

5.1.4* Pump Operation Test

1. Remove the **unshorted** plug and insert a **shorted (on flow check device)** plug into the phono jack on the blue box. See Figure 4 to identify plug types. This places the pump into **CONTINUOUS** mode. Verify (by ear or touch) that the pump is running. If not, check to see that the plug is properly connected, that no external wires are obviously broken and that the new batteries are really new.

2.* Remove the **shorted** plug. This is the arrangement for the **TIMED CYCLE** mode. Verify that the pump stops within 60 ± 10 seconds. If not, repeat step 1 and try again. If the pump still does not cycle, the **Cycle Timer** is defective and the data logger must be replaced. Note defect in pump/data loggerlog.

3. Reset the pump to **CONTINUOUS** mode by inserting a shorted plug.

4. Connect an IOM **Test Inlet** (loaded with a filter) to the sampler to apply a pressure drop.

5. As a leak test, cover the **Test Inlet** opening with the palm of the hand for a few seconds (3 - 5) to determine if the pump motor stalls *(Personal and Indoor)* or operates very slowly *(Outdoor)*. If OK, prepare to check the flow rate setting. If the pump does not stall, determine if all of the tubing connections are sound.

6.* Using a multimeter set to read milliamps, test the power draw for each pump. A pump/data logger log will be kept for each pump to follow pump operation. Record mA value each time a reading is taken.

5.1.5 Flow Rate Setting

1. Connect the flow calibration adapter to the proper Magnehelic gauge. See Figures 5 and 6.

2. With the Magnehelic gauge standing (or hanging) vertically, make sure that the gauge is set to zero with no flow. If not, use a small screwdriver to adjust the screw at the lower center of the face.
3. Turn the locking tab on the calibration adapter to the open position, place the adapter on the face of the inlet and turn the locking adapter 90 degrees to seal the adapter in place.
4. Allow the Magnehelic reading to stabilize for 30 seconds and read the Magnehelic gauge to the nearest 0.05 inches of water.
5.* Referring to interpolated calibration table for the flow check orifice (see Appendix 1 for example), determine the actual flow rate in liters/minute (lpm) and enter this value on the checklist.
   - If the flow rate is **1.90 to 2.10 lpm** the pump flow is within acceptable limits and no adjustments are necessary.
     If not, use a small screwdriver (alignment tool) to slowly reset the **Pump Flow Adjustment** on the side of the Data Logger box.
6. Allow the reset flow to stabilize for 20 seconds, and if the flow is still within limits, the flow setting is acceptable.

5.1.6 Data Logger Tests

5.1.6.1 Laptop Computer Connection/Operation

The computer needs to be turned on one time in the laboratory setup and should remain on until all the samplers are set up. Aerosol sampling data (sample number, participant, location, etc.) are entered into the NHEXAS Quattro Pro spreadsheet, rather than requiring hand entry. The procedures for accessing this program are provided in RTI/ACS-AP-209-086. After WINDOWS is installed, the data logger software (READER) and the Quattro Pro spreadsheet are loaded in parallel. Use **ALT-TAB** to switch between programs.

1. Plug in the data cable to connect the COM1 port on the laptop computer to the data port on the end of any blue Data Logger box.
2. From the WINDOWS menu, double click on the "READER" icon. (The program will run from the DOS prompt but should be started from within

WINDOWS.) If the cable connection is OK, the display will show the opening **Main Menu** screen (see Figure 7) with the last data logger ID# (XXXXX) and pump ID# (XXX) on the upper left of the screen. If the cable is not connected to the laptop, the computer will beep 10 times before displaying the **Main Menu** - Check the cable connections.

5.1.6.2 Data Logger Connection

1. Move the cursor to "**Test Logger**" and hit ENTER to initialize the data access. The logger ID# should appear on the status line near the top of the screen. If the logger ID# or the pump ID# don't match ID#'s on sides of the blue and gray boxes, correct the file entry.

2.* Note that the display updates (numbers blink faintly) every 8 seconds as the data logger reads the system sensors. If the numbers are not updating, Exit to the **Main Menu**, move the cursor to "**Test Logger**" again and hit ENTER. If the numbers are still not updating the logger is not functioning and must be replaced. Note defect in pump/data logger log.

5.1.6.3 Sensor Parameter Tests

1. With the logger stationary and the pump still set in the **CONTINUOUS** mode (shorted plug inserted), note the readings of the Movement, Battery Voltage and Pump Pressure (last column to the right).
   - If the Movement number is **50 to 200** with the logger stationary, it is OK.
   - If the Ambient Temperature is within **± 5 degrees F** of the room thermometer, it is OK.
   - If the Battery Voltage is 5.00 to 6.50 with the pump running, the sensor is OK and the batteries are fresh. If the voltage reading is low, replace with a new set of batteries and retry. Mark the batteries that are removed as "USED".
   - If the Pump Pressure is **0.5 to 6.5 inches H_2O** with the test inlet attached and pump running, it is OK.

   The display also provides "OK" indicators for these parameters, but some of them require more testing.

2.* Set the pump into **TIMED CYCLE** mode (remove shorted plug) while gently moving the data logger and note the Movement readings. The Movement reading should change substantially, but become no higher than **255**. While the pump is running, the battery voltage and pressure should read **OK**; when the pump cycles off, the battery voltage and pressure should read **OFF**.
If any of the channels, except internal temperature, are not functioning within limits, the data logger should not be used. Replace the data logger with another unit, mark the defective unit as **"DEFECTIVE"** and return it to RTI/RTP for repair. Note defect in pump/data logger log.

3. Check that the Time Ratio Switch located on the side of the blue box is in the **1:3 CYCLE** position.

5.1.6.4 Updating/Presetting Sampler and Participant Data

1. To correct the data logger ID# or pump ID#, return to the **Main Menu** and move the cursor to **"File Data"** and hit ENTER. The screen displayed in Figure 8 should be shown.
2. Move the cursor to the **"Logger Serial No."** or **"Pump Serial No."** position, as required, and edit the number as necessary.
3. If the information is available, enter the **"Sample"** (from back of aerosol inlet), **"Participant," "County"** and **"Description"**, as required. **"Sample"** will usually be entered at the participant's location to avoid having to match the Sample ID with the sampler at that location.
4.* *Personal:* Check that Channels active is "1111-", 8 second multiplier is "8", and pump duty cycle agrees with pump setting.
Indoor/Outdoor: Check that Channels active is "111--", 8 second multiplier is "8", and pump duty cycle agrees with pump setting.
5. Exit this screen to the **Main Menu** to automatically update the new data into memory.
6. Remove the Test Inlet from the quick connect.
7. Remove the **shorted plug** and insert an **unshorted plug** to put the sampler into standby mode for transportation.

8. *Personal:* Replace the pump system in the waist pack or child's pack. *Indoor/Outdoor:* Place pump/logger sampling unit into a locator slot in insulating foam on bottom inside of form. Orient as shown in Figure 3. *Outdoor:* Insert D-cell battery pack and connect to samplers if not already in place.
9. Exit the READER program, if no more data loggers are to be interrogated.

The **Samplers** are ready to take to the participant's residence.

5.2 Field Deployment

These set-up/check-out procedures are to be conducted at the participant's residence. Again, all the tests are similar for the personal, indoor, and outdoor samplers. The height of the outdoor sampler will require that it is temporarily attached to a stand for the indoor sampler and tested indoors, before deployment outdoors.

5.2.1 Siting/Setup

1. Take both the indoor and outdoor samplers indoors or to a convenient location to test the units, prior to deployment. Transport the samplers indoors, being **very careful** not to hit furniture, walls, doors, etc.
2. Locate the sites for the indoor sampler and the outdoor sampler (if one is to be established).

5.2.1.1 Siting Guidance and Deployment (Indoor Sampler)

1. Locate the indoor sampler in the room/area most occupied during non-sleeping activities.
2. Let the participant suggest the most occupied area and a specific, unobtrusive location.
3. Locate the base so that the inlet is facing toward the central area of the room.
4. Try not to locate the inlet closer than 3 feet to a wall or similar obstruction.
5. Try to avoid locating the sampler in the draft flow of a fan or vent duct.
6. Mount the indoor sampler on its stand with pumps running (see following sections.)

5.2.1.2 Siting Guidance and Deployment (Outdoor Sampler)

The order may vary with site.

1. Locate the outdoor sampler within 100 ft of the residence, but no closer than 10 ft.
2. Let the participant suggest an unobtrusive location.
3. Locate the stand so that the inlet is facing toward the residence.
4. Try not to locate the inlet closer than 3 feet to a wall, tree or similar obstruction.
5. Avoid placing the sampler within 10 feet of a road or driveway.
6. Avoid placing the sampler within 10 feet of a combustion source (e.g incinerator).
7. Assess the need for security and relocate the sampler, if necessary.
8. Drive the outdoor stake into the ground (or alternative set-up) so that the form faces the residence.
9. Return indoors and remove the indoor sampler form from the indoor stand and temporarily install the outdoor form to complete the subsequent tests.
10. Deploy the outdoor sampler form with pump(s) functioning (see following sections.)
11. Return indoors, replace the indoor form on its stand and complete the testing of the indoor sampler.

5.2.2 Software Loading: Quattro Spreadsheet Data Entry and Reader Program

Aerosol sampling data (sample number, start time, start flow, etc.) are entered into the NHEXAS Quattro Pro spreadsheet, rather than requiring hand entry. After WINDOWS is started, the Quattro Pro spreadsheet is loaded at the beginning of the deployment.

1. Plug in the data cable to connect the COM1 port on the laptop computer with the data port on the end of the blue Data Logger box.
2. From the WINDOWS menu, double click on the "READER" icon. If the cable connection is OK, the display will show the opening **Main Menu** screen (see Figure 7) with the last data logger ID# (XXXXX) and pump ID# (XXX) on the upper left of the screen. If the cable connection is not correct, the computer will beep 10 times. If so, exit the READER program, check the cable connections, and re-hit ENTER.

3. Use **ALT-TAB** to switch between the READER and Quattro Pro programs.

5.2.3 System Performance Testing

Performance testing of the flow system on-site must be done with the aerosol inlet selected and attached. These checks ensure the integrity of the sampling system and filter together.

5.2.3.1 Accessing Prepared Loggers

1. Open the personal or indoor/outdoor samplers enough to plug the data cable into the logger RS232 port.
2. Move the cursor to "**Test Logger**" and hit ENTER to initialize the data access. If the logger ID# or the pump ID# are incorrect (don't match ID#'s on sides of the blue and gray boxes), correct the entry as described in **5.1.1.4.3**.
3. If not already on the "**File Data**" screen, from the **Main Menu** proceed to the "**File Data**" screen.
4. Update the "**Logger Serial No.**" and "**Pump Serial No.**" if necessary.

5.2.3.2 Aerosol Inlet Attachment

1. Remove and store the yellow shipping clip from the inlet and attach the aerosol inlet to the quick connect corresponding to the sampling unit under test.
2. Move the computer cursor to the "**Sample No.**" position and enter the ID# from the back of the inlet (**AAXXXX** for IOM or **ATXXXX** for PM_{10}) into the field. This should be done by using the light pen to scan the bar code on the back of the inlet; it can be done manually if the light pen fails to work.
3. Exit this screen back to the **Main Menu** to automatically update the file. Do not exit the "READER" program yet.
4. Switch to the Quattro spreadsheet and enter the **Sample No.** and the **Flow Check Orifice No.**.
5.* *Personal:* Attach the aerosol inlet to the waist pack and secure to the hole in the center of the pin with a cable tie. Attach the guard clip to the inlet. *Indoor/Outdoor:* Attach the inlet to the outside of the form using the thumb nut corresponding to the internal position of the sampler under test.

5.2.3.3 Flow rate Check

1. Connect the flow calibration adapter to the proper Magnehelic gauge. See Figures 5 and 6.
2. With the Magnehelic gauge standing (or hanging) vertically, make sure that the gauge is set to zero with no flow. If not, use a small screwdriver to adjust the screw at the lower center of the face.
3. Turn the locking tab on the calibration adapter to the open position, place the adapter on the face of the inlet and turn the locking adapter 90 degrees to seal the adapter in place.
4. Place the pump into **CONTINUOUS** mode (shorted plug inserted).
5. Allow the Magnehelic reading to stabilize for 30 seconds and read the Magnehelic gauge to the nearest 0.05 inches of water.
6. Referring to the interpolated calibration table for the flow check system, determine the actual flow rate in liters/minute (lpm) and enter this value on the spreadsheet if this is the **Stop** reading.
7.* If this is the **Start** flow rate, and it is **1.90 to 2.10 lpm,** the pump flow controller is within acceptable limits and the value should be recorded as the **Start** value on the Quattro spreadsheet. *If the Data Logger will be placed in service within a few minutes, record the start date and start time along with the flow rate.* No adjustments are necessary.
8. If not acceptable, use a small screwdriver to reset the **Pump Flow Rate Adjustment** on the side of the blue Data Logger box. (Not the Balance Adjustment on the other side of the box.)
9. If the flow is reset, allow the flow to stabilize for 20 seconds, and if still within acceptable limits, record the Magnehelic reading and associated actual flow (lpm) on the Quattro form.
10. Remove the flow check adapter from the inlet.

5.2.3.4 Data Logger Reset

1. Move the cursor to "**Reset Logger**" and hit ENTER, if you are ready for the 6 day sampling period to begin. Answer "Y" to the question "Reset anyway?". Wait for the cursor to return to the main menu. This **MUST** be accomplished to establish the start of the sampling period.
2. If not already done, enter the **Start Time** in the Quattro spreadsheet.
3. Place the pump into the **TIMED CYCLE** mode (remove the shorted plug, insert unshorted plug) and unplug the RS-232 plug from the blue box.
4. If no other samplers are to be set up, exit to the **Main Menu** screen and exit the READER program.

5.2.4 Pack Fitting (Personal Samplers)

1. Prior to fitting, provide the adult participant (or child and supervising adult) a copy of the brief participant instruction sheets (see Appendix 2) for the Aerosol Sampler.
2.* Select the appropriate waist belt length (small, medium, large).
3. Fit the pack to the participant and indicate the possible wear positions.
4. Demonstrate the catches and adjustments on the shoulder straps and waist belt (adult pack only).
5. Stress that the inlet opening should be unobstructed at all times, whether worn or set aside.
6. Demonstrate pack removal, proper inlet positioning when not worn. Note that when not being worn, the inlet should not be accidentally covered with clothing or other items, nor allowed to sample too close to a surface such as the floor.
7. Re-fit the pack to the participant to begin the 6 day sampling.
8.* Make a final check for tubing crimps, ensure that the pack is closed and place a lock or cable tie on the zipper.

   NOTE: If the participant is performing occupational monitoring, the VOC badge cover may be kept in the waist pack; do not lock or cable tie the zipper.)

5.2.5 Participant Instructions

1. If not already done, provide the adult participant (or child and supervising adult) a copy of the brief participant instruction sheets (see Appendix 2) for the Aerosol Sampler.
2. If not already described, discuss (a) the information on the instruction sheet, (b) how and when to wear the personal monitor or pack, and (c) the care that must be taken (fragility and loss).

5.2.6 Final Checks

Prior to leaving the participant's residence, check that the number of **Unshorted** plugs in hand is equal to the number of samplers deployed at the residence. Be sure the participant has no other questions.

5.3* Retrieval

Conduct these procedures to retrieve the sampler from the participant. The retrieval consists of a final flow check, transferring the sampler's logger data to the laptop, and floppy disk entry of the stop time(s) into the Quattro Pro spreadsheet, disconnecting and capping the aerosol inlet, stopping the pump, and careful removal of the sampler from the participant's premises. Complete the personal sampler testing first, before the indoor or outdoor samplers, as a courtesy to the participant. Then, complete the indoor sampler testing, remove it from the stand, retrieve the outdoor sampler, place it on the stand, and complete its testing. Start the laptop programs from within WINDOWS.

5.3.1 Final Flow rate Check

Final flow rate checks of the personal sampler are performed at the end of the sampling period with the sampler removed from the participant. Make sure that the **correct** inlet is being tested (**check** the inlet ID#) before entering the **Stop** reading in the spreadsheet.

1. Connect the flow calibration adapter to the proper Magnehelic gauge. See Figures 5 and 6.
2. With the Magnehelic gauge standing (or hanging) vertically, make sure that the gauge is set to zero with no flow. If not, use a small screwdriver to adjust the screw at the lower center of the face.

3. Turn the locking tab on the calibration adapter to the open position, place the adapter on the face of the inlet and turn the locking adapter 90 degrees to seal the adapter in place.
4. Set the pump to **CONTINUOUS** mode.
5. Allow the Magnehelic reading to stabilize for 30 seconds and read the Magnehelic gauge to the nearest 0.05 inches of water.
6. Referring to the interpolated calibration table for the flow check system, determine the actual flow rate in liters/minute (lpm). Access the **Quattro Pro** spreadsheet and enter the **Final flow rate** and **Stop Time**.
7. Remove the flow check adapter from the inlet.
8. Turn **OFF** the pump (insert unshorted plug).

5.3.2 Logger Data Retrieval

1. Plug in the data cable to connect the COM1 port on the laptop computer with the RS-232 data port located on the end of the blue box.
2. Move the cursor to "**Test Logger**" and hit ENTER to initialize the data access. If the sample ID# is incorrect (doesn't match ID#'s on back of aerosol inlet), make sure the correct RS-232 socket has been connected.

3.* Place a formatted floppy data disk in the laptop drive.

4. Move cursor to **Dump Logger** and hit **ENTER** to start data transfer. Transfer will require - 1 minute.
5. Screen display will indicate the transfer by showing "XXX out of YYY done" as the transfer proceeds. At completion, XXX will equal YYY.
6. A data check will take less than a minute. It will summarize the mean, minimum, and maximum value for each channel (temperature, movement, battery voltage, and pressure drop), plus the number of points considered to be "Bad" for a few seconds. The time-block averages will be displayed. (If you miss the display of the summary, you can see it later under "View Data"; if you miss the time-block averages, you can see them again under "Review Blocks."

7. If 2 or more channels show more than 15 to 20 data points as “Bad”, the data dump was questionable, and should be repeated. Check the time-blocks for reasonable, continuous values.
8. Review the blocks, looking for the following characteristics in the block averages:
   - Internal temperatures should not display.
   - Movement should average 3-6, except at night, where 1-2 is acceptable. If the movement is always 1-2, ask whether the pack was worn regularly (The sensor may have malfunctioned or the pack may not have been worn.)
   - External temperatures should be between 50 and 90 EF; higher during the day and lower at night. Very steady temperatures or very high or low temperatures should trigger questions about the wearer's environment.
   - Battery voltage should decline gradually from 5.5-6 volts to 4-4.5 volts over the test period. If it declines and then drops suddenly to 2-3 volts, the filter may have plugged. If so, question the wearer's exposure to smoke or dusty environments.
   - Pressure should change no more than 3-5 inches over the test period (it is somewhat temperature sensitive.) If the pressure rises above 7-10 inches, the filter may have plugged. If so, question the wearer's exposure to smoke or dusty environments.

   Be polite about these questions. We are looking for explanations for strange operation, not to blame the participants for failure to wear the units. The transducers may have failed to operate properly, but there will be no other time to record any observations about the wear period.
9. Return to the **Main Menu**, move the cursor to “**Store to Floppy**” and hit **ENTER**. Answer the drive? question with "A". Floppy drive light should indicate the data transfer. (If for some reason the floppy storage fails, the data should be retrievable from the laptop at a later date. However, it is best to carry a second formatted disk in case of failure and to try the second disk before giving up on the storage.)

10. If no other loggers are to be dumped, when control returns to the **Main Menu,** exit the **READER** program.

5.3.3* Aerosol Inlet Retrieval

The aerosol inlet must be handled carefully after sampling to avoid dislodging material from either the filter or the internal surfaces of the inlet. The foam-lined shipping case may be taken to the residence for the retrieval if needed to protect the collected samples during transport.

1. *Indoor/Outdoor:* Detach the aerosol inlet(s) from the quick disconnect; remove the screw holding the inlet(s) to the form.
   Personal: Detach the aerosol inlet from the quick disconnect.
2. *IOM:* Place a yellow shipping clip on the IOM inlet and place the inlet in a Ziplok bag.
   PM_{10}: Place the PM_{10} inlet in a Ziplok bag; no shipping clip is used.
3. Place the bagged inlet into the shipping case for transport.

5.3.4 Indoor/Outdoor Sampler Removal from Site

1. Remove the outdoor stand from the ground by rocking back and forth until loose enough to pull out.
2. Carefully repair/cover the stand hole to the participant's satisfaction.
3. Remove the indoor sampler and stand from the sampling location and return the room to its original state, if necessary.
4. Leave the premises in the same or better condition than they were found.
5. Transport the samplers to the van, being **very careful** not to hit furniture, walls, doors, etc.

6.0 FILTER STORAGE/SHIPMENT

6.1 Total Inspirable Samples

The IOM aerosol inlet is not to be disassembled in the field, but used as the transport device for sending the filter back to the RTI/RTP laboratory for subsequent analyses. After removal of the inlet from the sampling system at the field location, immediately re-install a cassette shipping clip over the inlet opening (see Figure 9). The shipping clip and cassette

should then be placed in the supplied storage box for subsequent on site storage and shipment to the laboratory at RTI/RTP.

On-site storage shall consist of room temperature (15 to 25 EC) storage in the study mobile laboratory. Refrigerated storage may be necessary if staging area temperatures are higher than room temperatures; do not leave the samples in an automobile during the summer for more than a few minutes without either air conditioning or storage in an ice chest).

Shipment to the RTI/RTP laboratory will be bi-weekly (at least every 14 days), after completing sampling in each country, via air freight. Samples must be shipped in the special foam padded boxes in which the preweighed filters and cassettes were initially shipped from RTP. All sample shipments must include the proper documentation (original of the sampling data form for each sample set and floppy disks with the logger data for the samples) to identify the samples, to allow immediate entry of identifying data.

6.2 PM_{10} Samples

The PM_{10} aerosol inlet is not to be disassembled in the field, but used as the transport device for sending the filter back to the RTI/RTP laboratory for subsequent analyses. On-site storage shall consist of room temperature (15 to 25 EC) storage in the study mobile laboratory. Refrigerated storage may be necessary if staging area temperatures will be higher than room temperatures; do not leave the samples in an automobile during the summer for more than a few minutes without either air conditioning or storage in an ice chest). Elevated temperatures may affect the character of the collected aerosol, and in extreme situations, cause the grease used on the impaction ring to possibly drip onto the filter surface.

Shipment to the RTI/RTP laboratory will be bi-weekly (at least every 14 days), after completing sampling in each country, via air freight. Samples must be shipped in the special foam padded boxes in which the preweighed filters and cassettes were initially shipped from RTP. All sample shipments must include the proper documentation (original of the sampling data form for each sample set and floppy disks with the logger data for the samples) to identify the samples and allow immediate entry of identifying data.

7.0 QC PROCEDURES

7.1 Quality Assurance Goals

The QA goals for the RTI/EOHSI portion of the NHEXAS program are described in detail in the Quality Systems and Implementation Plan (QSIP) for Human Exposure Assessment Study document (RTI/5740/02-02QSIP, see reference 2.2.12). This QSIP document describes the completeness, accuracy and precision, representativeness, and comparability of the data to be collected under NHEXAS for mass and metals (see QSIP Table 44).

7.2 Sample ID Codes

Sample ID#'s for the NHEXAS program are identified in protocol RTI/ACS-AP-209-070.

7.3 Sample Custody

Sample custody is described in NHEXAS protocol RTI/ACS-AP-209-071.

7.4 Collocated Samplers

Collocated samples will be collected to estimate precision for the NHEXAS program with the number to be scheduled are given in Table 46 of reference 2.2.12. For aerosols, this goal is at least 1 collocated measurement pair per county.

7.4.1 Personal Sampling

The excessive burden of a single personal aerosol sampling system will prevent collocated personal samples from being routinely collected. The precision of the personal sampling process must be inferred from the collocated IOM indoor samplers.

7.4.2* Indoor Sampling

Collocated indoor sampling in the NHEXAS program is conducted to obtain a) comparability between collocated IOM and PM_{10} sample types, and b) precision for collocated duplicate IOM and PM_{10} samples. Collocated sampling for comparability between IOM and PM_{10} sampling will be performed for approximately one pair of samples per county.

7.4.3 Outdoor Sampling

Collocated outdoor sampling in the NHEXAS program is conducted at a subset of the total locations (3 per county) to obtain a) comparability between collocated IOM and PM_{10} sample types, and b) precision for collocated duplicate IOM and PM_{10} samples. Collocated sampling for comparability between IOM and PM_{10} sampling will occur at approximately 33.3% of the outdoor locations.

7.5* Blanks

Unexposed filters, loaded into aerosol sampling cassettes, preweighed in the lab, shipped to the field site in Ziplok bags but not exposed, return shipped to the lab, and final weighed during the normal post-weighing steps will serve as field blanks. Each set of 25 mm Total Inspirable filters and 37 mm PM_{10} filters shipped every 2 weeks from the lab will contain at least 1 extra aerosol cassette of each type, designated as field blanks. These inlets will be taken to one of the randomly selected participant residences and returned. At the conclusion of sampling in the county, the IOM and PM_{10} field blanks (still sealed in the Ziplok bags) will be returned to the RTP/RTI laboratory along with the normally exposed filters. These samples will be used to identify potential substrate mass and metals concentration changes that occurred without air sampling.

7.6 Data Capture

The data capture goal for valid aerosol sampling is 90% (18 out of 20 per county). Data capture of less than 90% will result in a re-evaluation of the sampling systems and qualification procedures - laboratory and field - to determine if corrective actions are needed to assure that future data capture exceeds the 90% control limit.

7.7 Performance Tests

Orifice/Magnehelic gauge flow measurement devices will be recalibrated by shipping these devices on a quarterly basis to the RTI CAT laboratory.

7.8* Data Entry/Tracking

The basic sample/data tracking procedures to be used for the RTI/NHEXAS program are described in detail in protocol RTI/ACS-AP-209-071. Specific data relevant to aerosol sample identification, quantification and qualification are collected and archived at both the

field sampling mobile laboratory and the RTI Aerosol Sampling Support Laboratory (ASSL) at RTP.

Aerosol sampling system check-out and validation testing results collected at the RTI ASSL (before shipment to NHEXAS field locations) will be archived by the LT in a separate binder. Aerosol sampling system field check-out at the mobile laboratory, prior to sampler deployment.

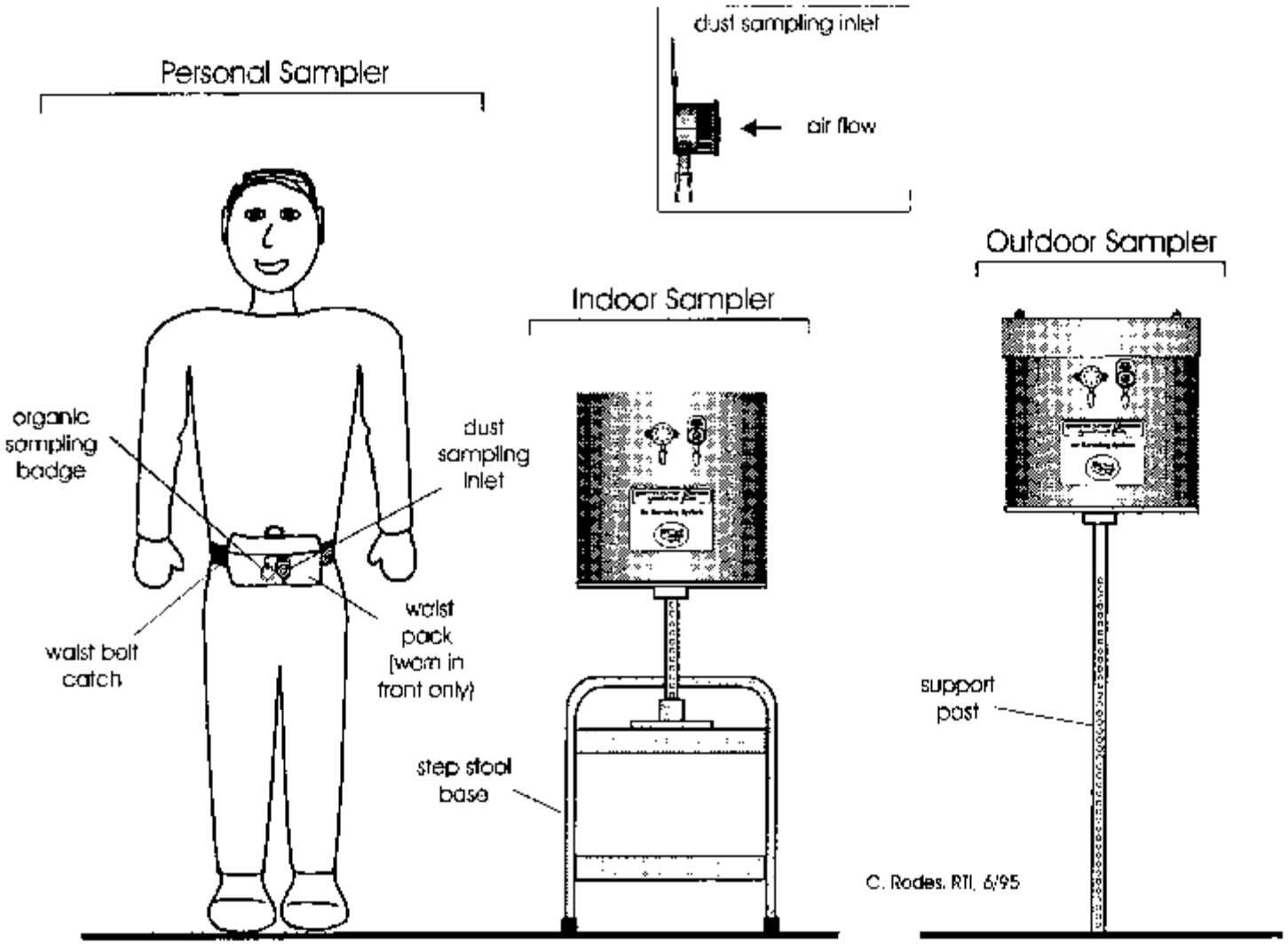

Figure 1. NHEXAS air samplers.

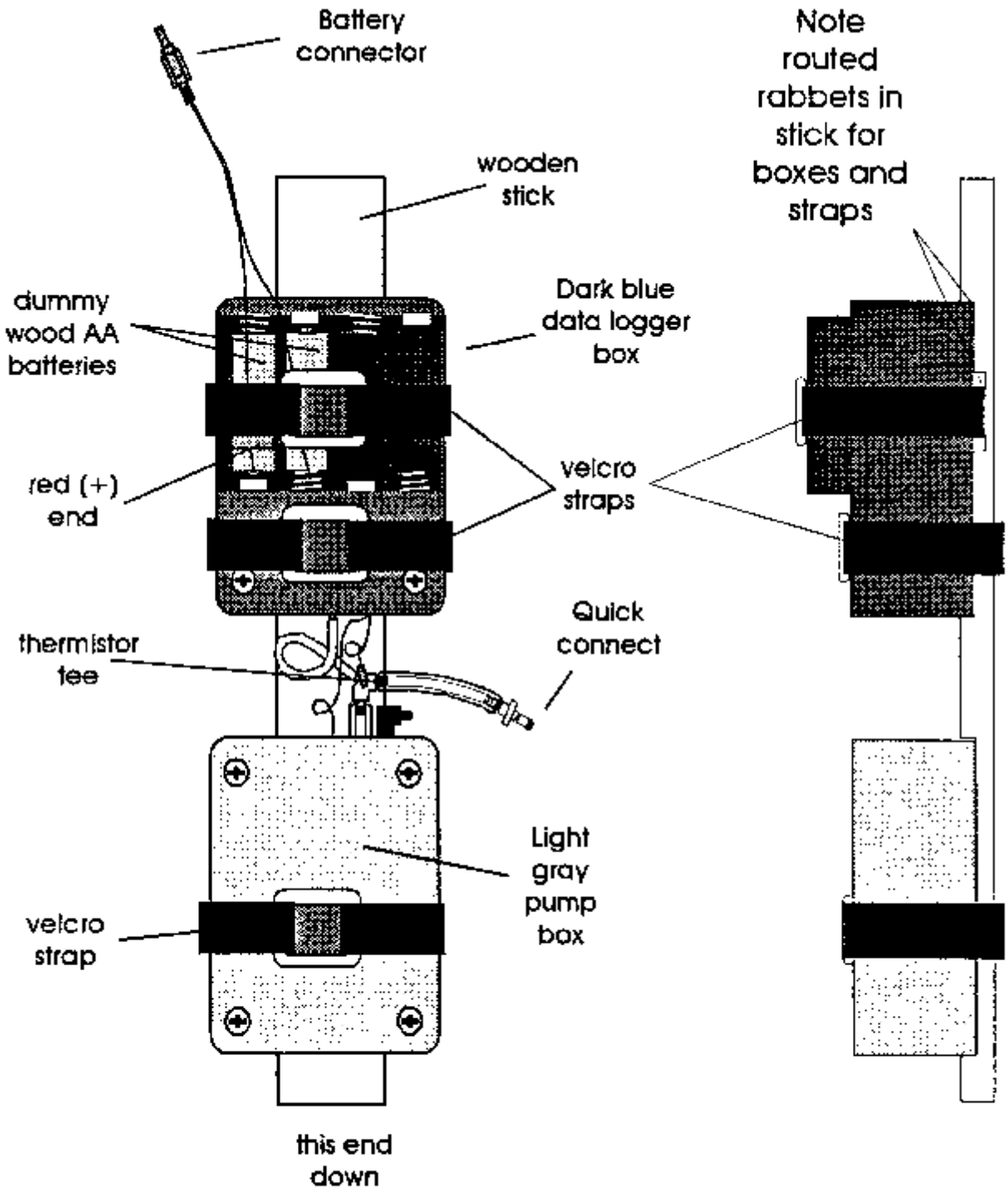

Figure 2. Pump/logger assembly on mounting stick for indoor or outdoor samplers.

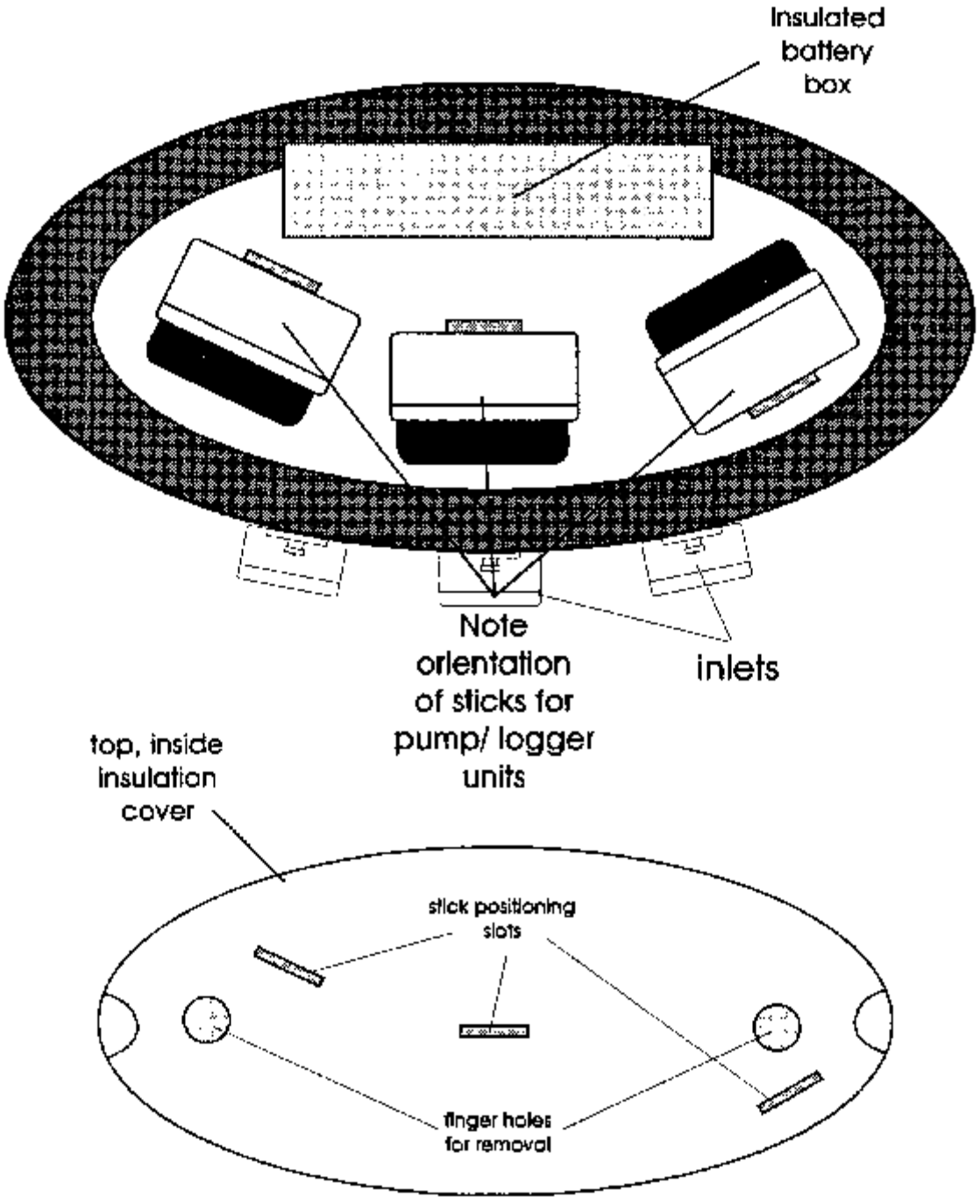

Figure 3. Top view of indoor/outdoor NHEXAS air sampler interior.

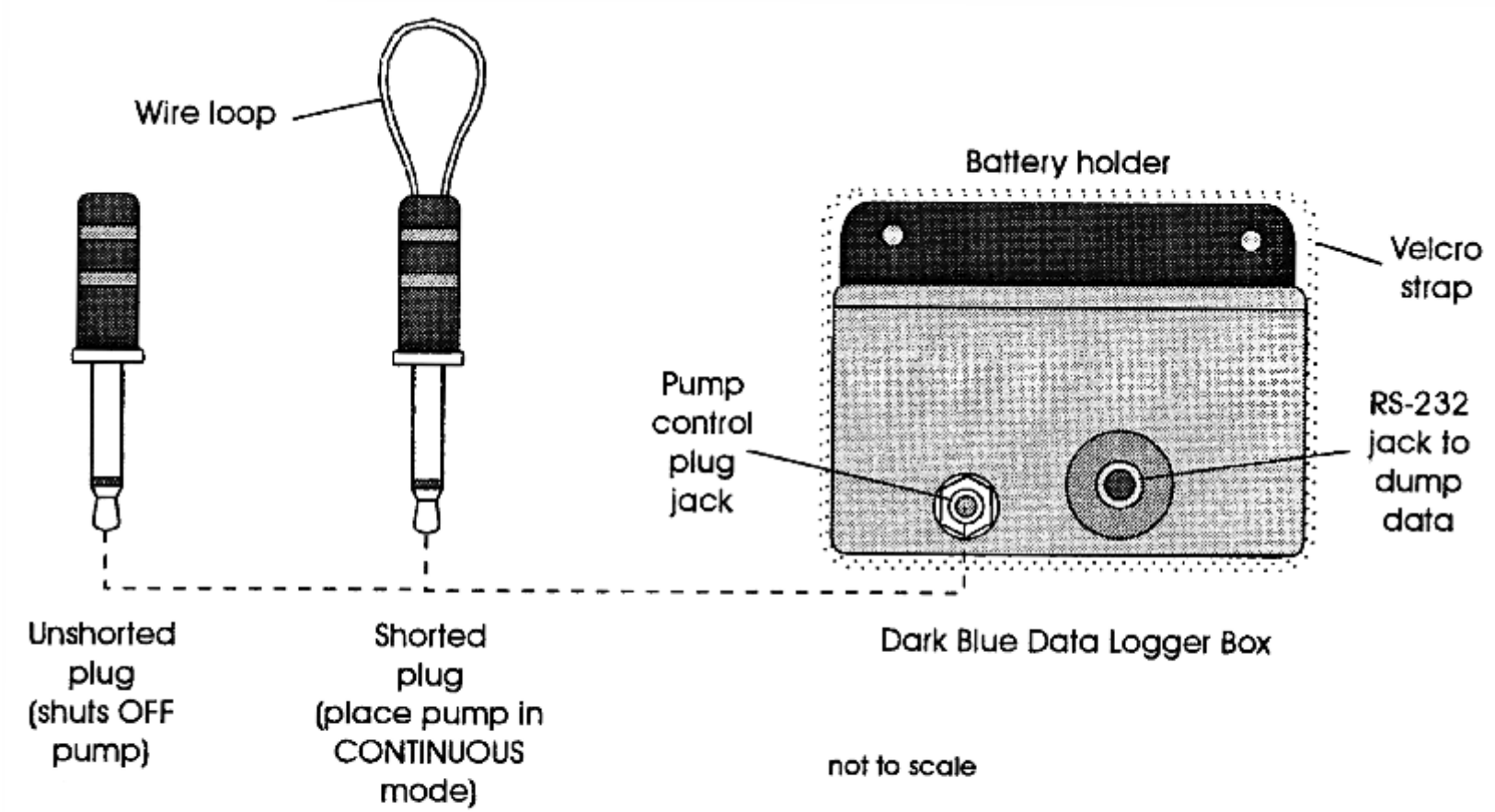

Figure 4. Shorting plugs used to control sampling systems.

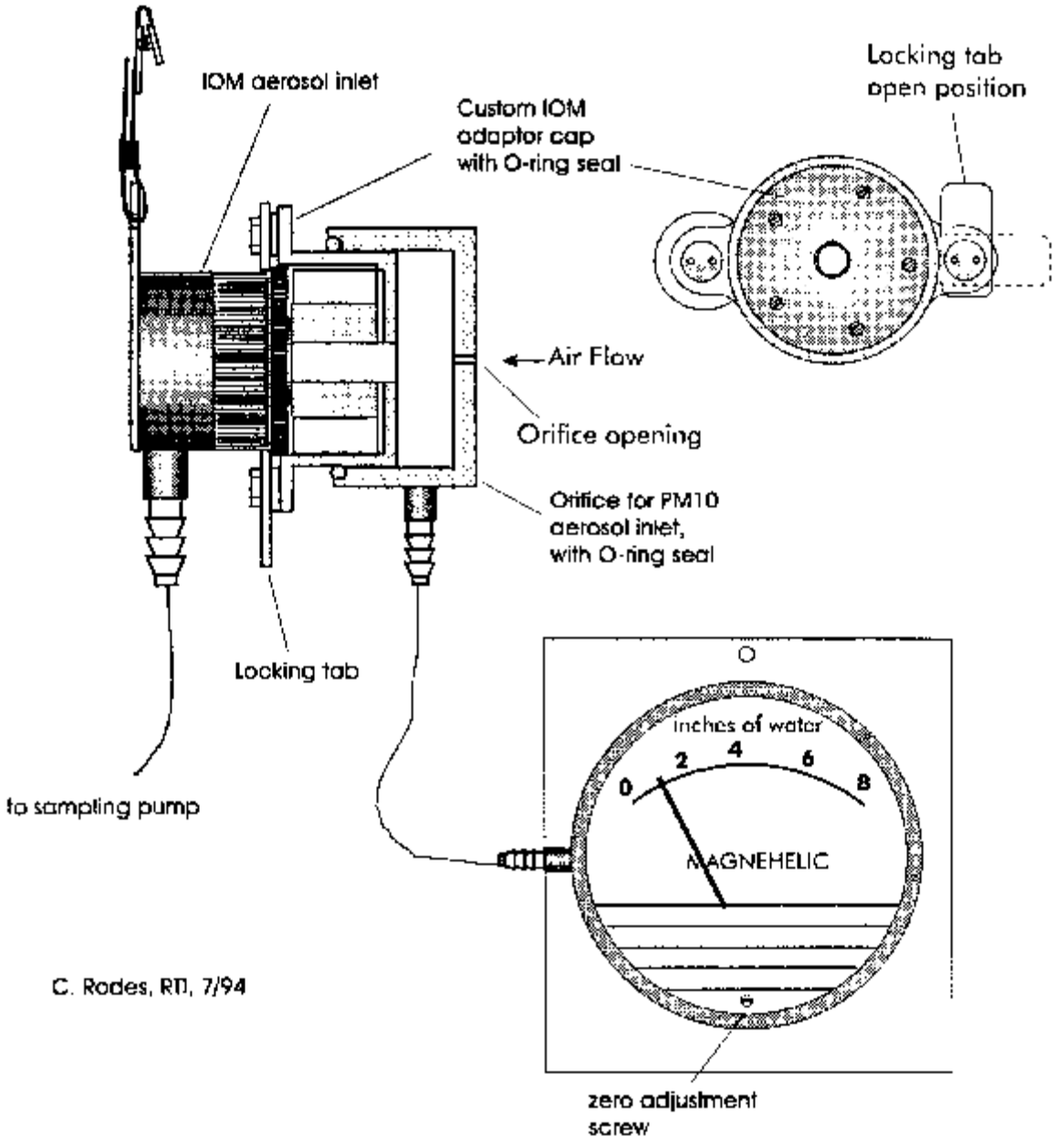

Figure 5. IOM total inspirable aerosol sampling inlet flow check system.

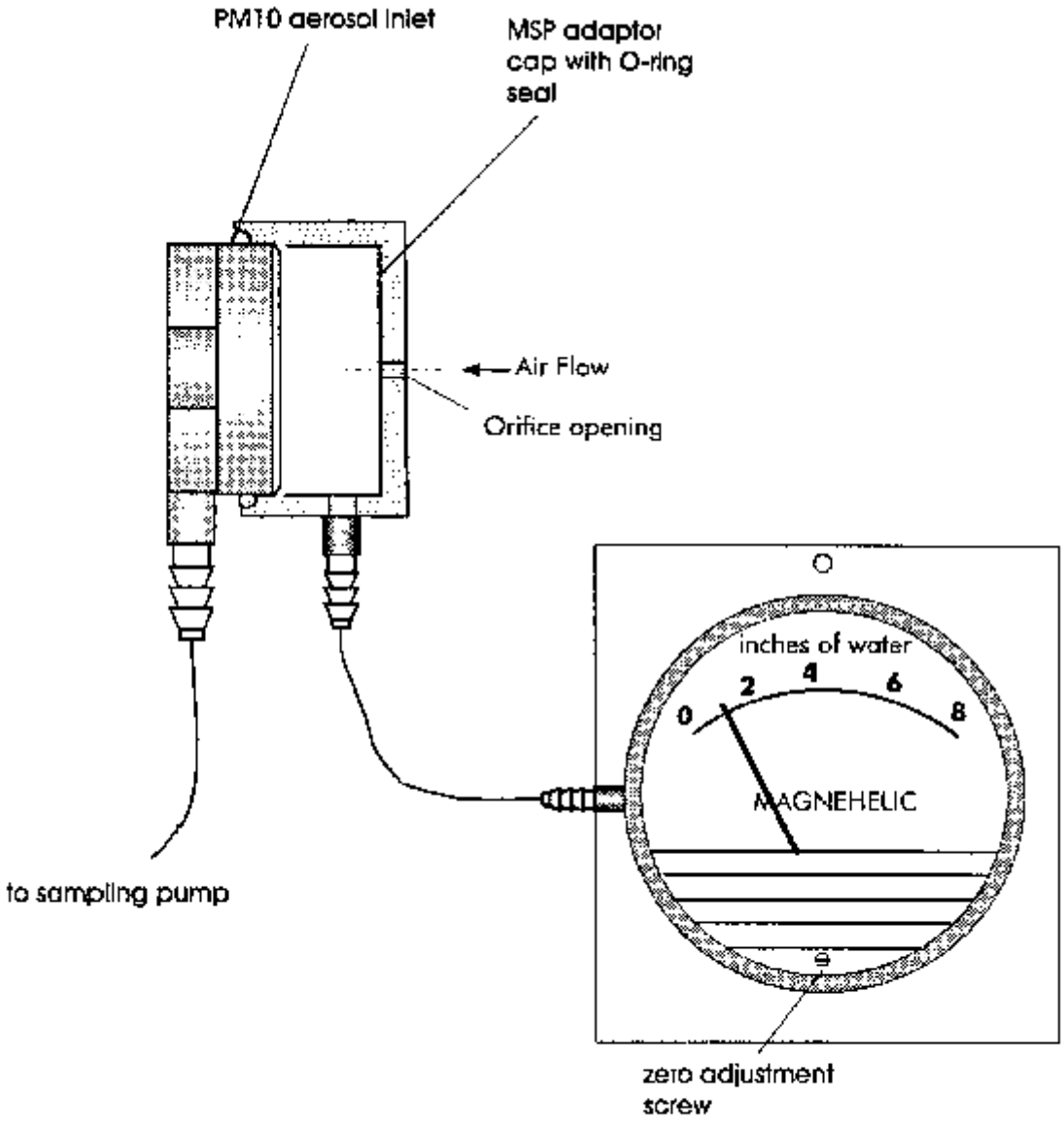

Figure 6. PM_{10} aerosol sampling inlet flow check system.

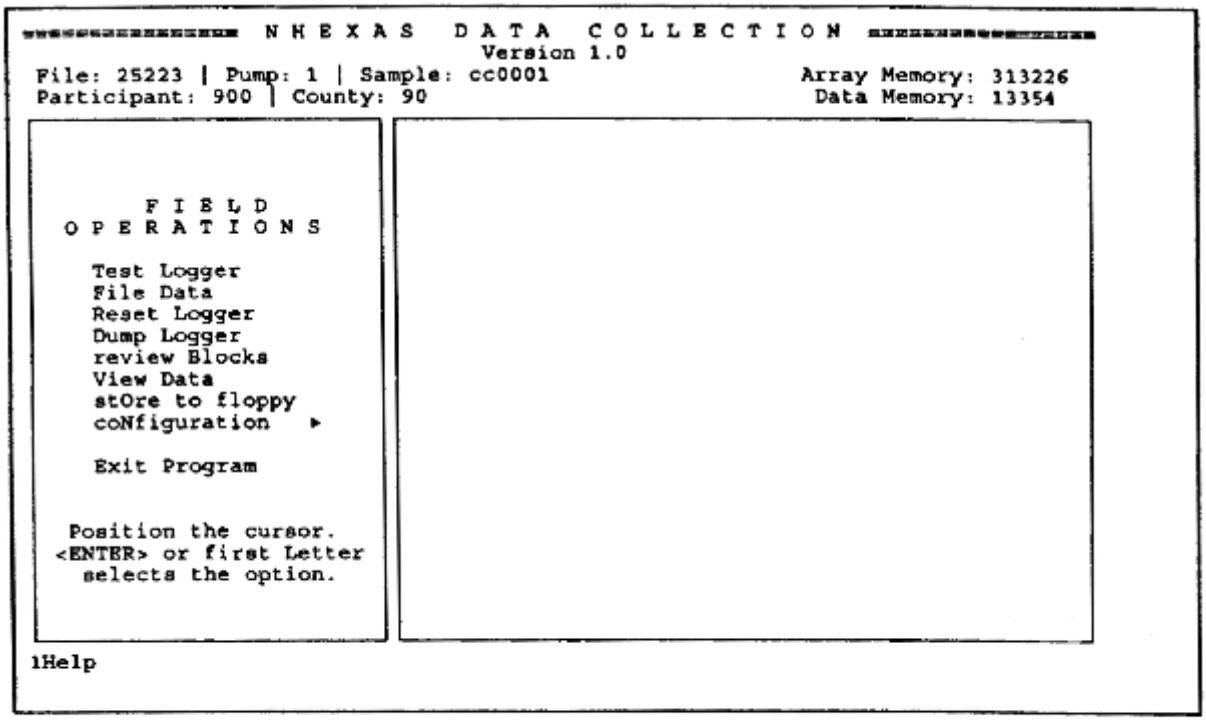

Figure 7. Main menu screen.

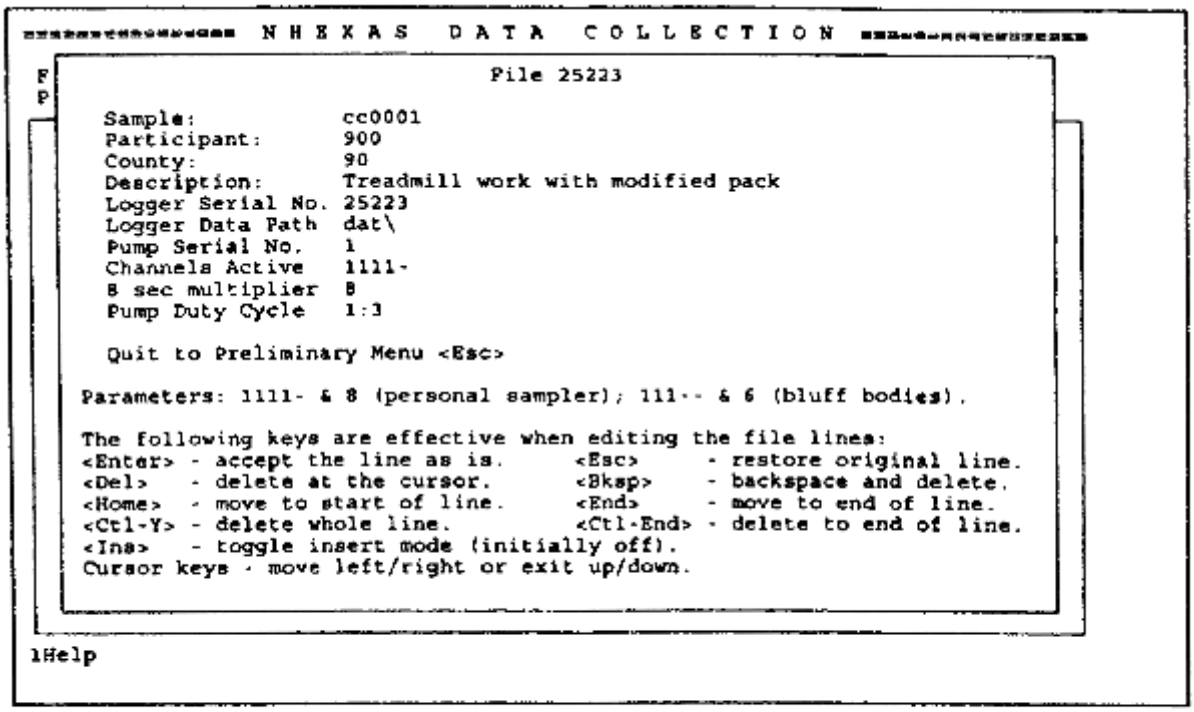

Figure 8. Test logger system.

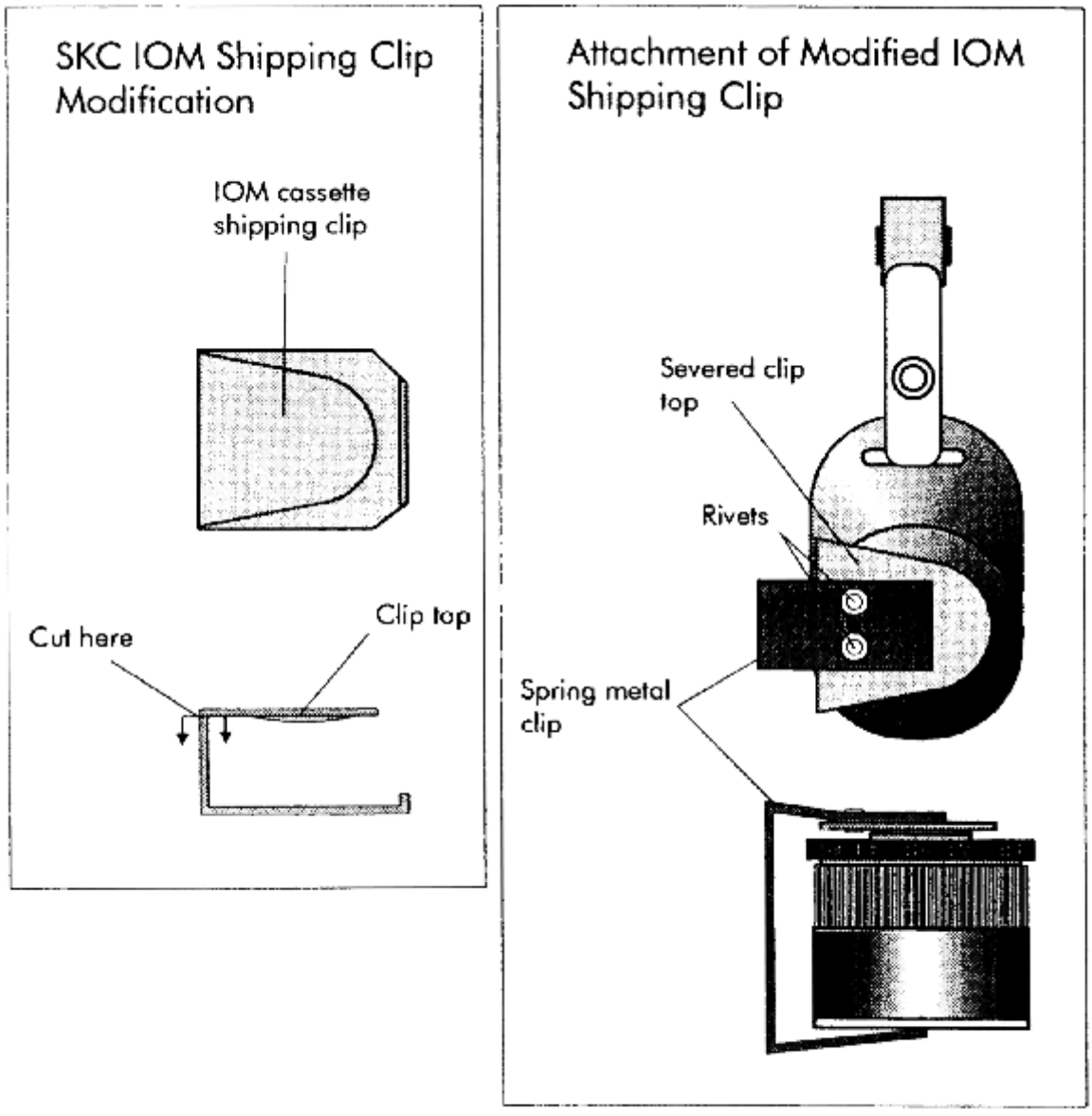

Figure 9. Modified shipping clip for IOM aerosol sampling inlet.

Appendix 1. NHEXAS IOM Audit Orifice Calibration

Orifice #:	1	
Adapter #:	1	
Magnehelic #:	1	
Mass Flowmeter #:	10897	
Calibration date:	8/15/94	
Temperature, deg. F | deg. C:	78	25.56
Atm. Press., mm Hg:	759.6	

Magnehelic Reading for actual flow of 2.00 lpm: **4.90**

Magnehelic Reading, inches of H_2O	Flowrate actual lpm	Flowrate standard lpm
4.00	1.772	1.768
4.05	1.785	1.781
4.10	1.798	1.794
4.15	1.811	1.807
4.20	1.824	1.820
4.25	1.837	1.833
4.30	1.850	1.845
4.35	1.863	1.858
4.40	1.875	1.871
4.45	1.888	1.883
4.50	1.900	1.896
4.55	1.913	1.908
4.60	1.925	1.921
4.65	1.938	1.933
4.70	1.950	1.945
4.75	1.962	1.958
4.80	1.974	1.970
4.85	1.987	1.982
4.90	1.999	1.994
4.95	2.011	2.006
5.00	2.022	2.018

Magnehelic Reading, inches of H_2O	Flowrate actual lpm	Flowrate standard lpm
5.00	2.022	2.018
5.05	2.034	2.029
5.10	2.046	2.041
5.15	2.057	2.053
5.20	2.069	2.064
5.25	2.080	2.075
5.30	2.092	2.087
5.35	2.103	2.098
5.40	2.114	2.109
5.45	2.126	2.120
5.50	2.137	2.131
5.55	2.148	2.142
5.60	2.159	2.153
5.65	2.169	2.164
5.70	2.180	2.175
5.75	2.191	2.186
5.80	2.202	2.196
5.85	2.212	2.207
5.90	2.223	2.218
5.95	2.233	2.228
6.00	2.244	2.238

Appendix 2
Participant Instructions for the Air Samplers Used in the National Human Exposure Assessment Study (NHEXAS)

Your exposure to particles in the air for the next 6 days may be measured in three ways as shown in the Figure 1: using a **Personal** sampler that you carry with you during your daily activities, a sampler at a central **Indoor** location in your residence, and a sampler at a nearby **Outdoor** location. Not all residences will have an Outdoor sampler. All three sampler types operate intermittently (cycle ON and OFF) every few minutes and use a tiny pump to draw a measured air sample through filters to trap suspended dust in the air. These filters are sent to the Research Triangle Institute laboratory in the Research Triangle Park, North Carolina for analysis.

Indoor Sampler - The indoor sampler is supported by a household step stool and will be located (based on your suggestion) by a NHEXAS technician to be reasonably central to the majority of activities in your residence. It should have minimal interference on your daily activities. The sampler operates on low voltage batteries and requires no consideration on your part.

Outdoor Sampler - The outdoor sampler will be similarly located by a NHEXAS technician to be close to the residence in a secure location with minimal interference to your daily activities. This sampler also operates on batteries and requires no consideration on your part.

Personal Sampler - The personal sampler will examine the air you breath by locating the inlet on the shoulder strap of a belt pack (for adults) or a backpack (for children). It is worn (or carried) while conducting your daily activities. The NHEXAS technician will assist you in the initial fitting. While every attempt has been made to reduce the size, weight and noise burden caused by this sampler, we recognize that its presence may pose some burden.

- Please try to become comfortable with the personal sampler as quickly as possible, such that it has a minimal influence on what you do and how you do it. If you are aware of specific situations that the personal sampler may impede, please discuss them with the technician.

- The waist belt can be adjusted to wear the pack in the front or on the left or right sides, whichever is more comfortable. The belt pack cannot readily be worn in the back. The shoulder strap should be adjusted to keep it snug and the inlet near your head. Only the waist catch needs to be undone (on either side) to remove the pack.

- The personal sampler must be worn <u>outside</u> the clothing and the straps should be re-adjusted to accommodate coats and jackets. <u>Do not allow loose clothing (e.g., lapels, scarves) and long hair to cover the dust sampling inlet</u>.

- The personal sampler must be with you <u>at all times</u> during the 6 days to sample the air near your nose and mouth. Exception times include: sleeping, bathing and swimming, in which cases the waist pack and shoulder strap should be placed as close by as possible with the inlet unobstructed and facing horizontally toward you. After sleeping, bathing or swimming, begin wearing the pack again as soon as possible.

- The personal sampler is reasonably rugged, but may be damaged if dropped. If the pack becomes visibly damaged, the pump noise ceases, or the noise level from the pump increases substantially, please call the technician.

- Feel free to call the NHEXAS technician if you have any other questions.

EXPLANATION OF REVISIONS

Revisions Made 4/96; Denoted by *

Section 3.1

Revised to include a guard screen to be placed over personal and IOM inlets.

Section 3.2.1

Revised to include weighing reproducibility.

Section 3.3

Revised to remove language about collection near the breathing zone since samples are now collected at waist level by attaching the inlet to the waist pack.

Section 3.5

Revised to reflect the change that if a heater is needed it will be an AC-powered system.

Section 5.1.4

Step added for testing the current draw of the pump to determine if the motor load will drain the batteries too soon. Also, a step for recording pump system problems was included.

Section 5.1.5

Typo corrected; correct range of 1.90 to 2.10 L/min inserted.

Section 5.1.6.2

A step for recording pump system problems was included.

Section 5.1.6.3

A step for recording pump system problems was included.

Section 5.1.6.4

The multiplier setting was corrected from "6" to "8".

Section 5.2.3.2

A shoulder strap is no longer used. The procedure for attaching aerosol inlets to the waist pack was inserted.

Section 5.2.3.3

A typo for the acceptable flow rate range was corrected.

Section 5.2.4

Changes were included in the setup of the waist pack, including selection of different size belts and the note that if a participant was also performing occupational VOC, the waist pack would not be locked so that the cover could be kept in the waist pack.

Sections 5.3 and 5.3.2

Saving the data to floppy disk was included.

Section 5.3.3

Use of the foam-shipping case to transport aerosol inlets to and from the homes was made optional.

Section 7.4.2

Revised to show the collection rate per county rather than a total for the study.

Section 7.5

Revised to state that "at least" one set will be exposed per county.

Section 7.8

A paper form for system information collection was dropped.

Figure 1

Revised to remove the shoulder strap from the personal system.