OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION

<table>
<thead>
<tr>
<th>CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 SCOPE AND APPLICATION</td>
</tr>
<tr>
<td>2.0 METHOD SUMMARY</td>
</tr>
<tr>
<td>3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE</td>
</tr>
<tr>
<td>3.1 Filter Holder</td>
</tr>
<tr>
<td>3.2 Filter Media</td>
</tr>
<tr>
<td>3.3 Filter Handling</td>
</tr>
<tr>
<td>3.4 General Radioactive Material Handling Precautions</td>
</tr>
<tr>
<td>4.0 INTERFERENCES AND POTENTIAL PROBLEMS</td>
</tr>
<tr>
<td>5.0 EQUIPMENT/APPARATUS</td>
</tr>
<tr>
<td>6.0 REAGENTS</td>
</tr>
<tr>
<td>7.0 PROCEDURES</td>
</tr>
<tr>
<td>7.1 Inlet Radius Clearance</td>
</tr>
<tr>
<td>7.2 Set Up</td>
</tr>
<tr>
<td>7.3 Start Sampling Activity</td>
</tr>
<tr>
<td>7.4 Temporary Suspension of Sampling Activity</td>
</tr>
<tr>
<td>7.5 Terminate Sampling Activity</td>
</tr>
<tr>
<td>7.6 Data Storage and Retrieval</td>
</tr>
<tr>
<td>7.6.1 Start Data Storage</td>
</tr>
<tr>
<td>7.6.2 Terminate Data Storage</td>
</tr>
<tr>
<td>7.6.3 Transfer Files</td>
</tr>
<tr>
<td>7.7 Set Date and Time</td>
</tr>
<tr>
<td>8.0 CALCULATIONS</td>
</tr>
<tr>
<td>9.0 QUALITY ASSURANCE/QUALITY CONTROL</td>
</tr>
<tr>
<td>9.1 General QA/QC Procedures</td>
</tr>
<tr>
<td>9.2 Calibration</td>
</tr>
<tr>
<td>9.2.1 General Calibration Guidelines</td>
</tr>
<tr>
<td>9.2.2 Perform Calibration</td>
</tr>
<tr>
<td>10.0 DATA VALIDATION</td>
</tr>
<tr>
<td>11.0 HEALTH AND SAFETY</td>
</tr>
</tbody>
</table>
12.0 REFERENCES

CONTENTS (cont’d)

13.0 APPENDICES

A - Specifications
B - Maintenance
The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.
1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the start-up, check out, operation, calibration, and routine use of the digital portable F&J Specialty Products, Inc. DH-100 high volume air sampling system. The procedures and figures contained in this SOP are taken from the High Volume Air Sampler Model DH-100V.2-30 Technical Manual (2008) with the written consent (9/8/2015) of F&J Specialty Products, Inc.

Air monitoring is performed to identify and monitor airborne radioactive material. The DH-100 High Volume Air Sampler draws a high volume of air for extended periods of time through a filter medium. Airborne particulate matter that carries very small particles of radioactive material are collected on the filter surface. The radioactive material might be natural, such as, radon decay products, or manmade, usually fission or activation products, or a combination of both. Airborne radioactive contaminants are of concern to radiological control organizations due to the biological effects of the ionizing radiation emitted by those contaminants. The inhalation of radioactive airborne particles is one of the most important routes for entry of radionuclides into the human body.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

The DH-100V is a digital portable high volume air sampling system. This system features electronic flow regulation, precision flow measurement, volume totalization, auto shut-off by time or volume, and data storage. The digital flow measurement system is microprocessor controlled and provides flows and volumes corrected to a reference temperature of 20 degrees Centigrade (°C) (70 degrees Fahrenheit [°F]) and reference pressure of 1 atmosphere. The typical operating flow range varies from 140 liters per minute (LPM) – 850 LPM (5 cubic feet per minute (CFM) to 30 CFM) using a two-stage, dual ball bearing, bypass type air pump with an independent cooling system for the motor. The air sampling system schematic is shown below.
3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Filter Holder

The high volume sampler has a 46.5 millimeter (mm) (1.83 inch) female pipe thread which accepts a standard F&J plastic combination filter holder. However, adaptors are available to convert from 101.6mm (4 inch) to the 46.5mm (1.83 inch) thread for standard filter holders. Filter holders are available with radioiodine adsorption cartridges in combination with 47 mm, 50 or 2 inch diameter particulate filter paper. The F&J combination filter holders have dual O-rings to ensure that the airflow path is through the filter cartridge and does not bypass the filter.

The filter is disassembled by twisting the two separate segments of the filter holder in opposite directions. The entire filter holder may be removed from the air sampler by turning the base of the filter holder counter clockwise. Conversely, the filter holder can be installed by rotating the filter holder clockwise until a seal is achieved between the pump housing and the O-ring on the base of the filter holder.

3.2 Filter Media

Several different filter media are available for the collection of aerosol particulates which include polytetrafluoroethylene (PTFE), glass fiber, cellulose, and quartz. While most filters are surface collectors and can readily be analyzed, the user should determine the need to dissolve the filter for composite analysis or further specific isotopic analyses.

3.3 Filter Handling

Filters should be handled delicately using non-serrated forceps. Never use fingers to touch any part of the filter. When not in use, filters should be stored in protective cartons under temperature and relative humidity control. Filters should always be transported from the laboratory to the sampling location in the filter holder.
3.4 General Radioactive Material Handling Precautions

- Radioactive Material Warnings must be posted when feasible in work and storage areas. For emergency responses, personnel may enter areas that are not characterized for presence of radioactive materials and the purpose of the high volume sampling for airborne particulate collection is to determine type and amount of airborne radioactive materials.
- Posting must include the message: Caution - Radioactive Material and display the radiation symbol when required.
- Handle and store radioactive material only in specifically designated and authorized locations. Aside from low-activity radioactive sources, select analytical equipment and rare environmental samples, the U.S. EPA Environmental Response Team (ERT) has limited involvement with unknown radioactive materials.
- Doors/lids of cabinets/containers in which radioactive materials are stored and doors to labs using radioactive materials must be labeled.
- Properly dress and cover open wounds before working with radioactive materials.
- Wear disposable gloves at all times when handling radioactive material or potentially contaminated items.
- Wear lab coats and safety glasses when working with radioactive material and remove them when leaving the work area or lab.
- After each procedure and before leaving the area, monitor hands, shoes, and clothing for contamination using appropriate radiation detection instrumentation, such as portal monitor, and hand and foot monitor.
- Properly survey the work area for contamination during handling or processing of samples that may be radioactive and at the end of the day.
- If any contamination is found, decontaminate before leaving the work area.
- Remember, time, distance and shielding are the means of reducing the radiation dose when working with radioactive materials.
- Plan work in advance to save time and thereby limit potential exposure.
- Use appropriate shielding to reduce the radiation.
- Select dosimetry in accordance with Radiological Work Permit.
- Wear dosimetry in accordance with Radiological Work Permit procedures.
- Use mechanical devices such as tongs, clamps, or tweezers when manipulating radioactive materials to help minimize exposure.
- **No Food or Drink** in sample handling or analysis area.
- Use disposable absorbent material with impervious backing to cover work surfaces wherever radioactive material is used.
- Clearly label the work area with radioactive tape and identify the radionuclide when possible and amount of radioactive material in use when known.
- Store radioactive material in clearly labeled and tightly closed containers, and secure against unauthorized removal.
- Only dispose of radioactive materials in specially designated and clearly identified waste containers.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- Large extraneous objects, such as, insects or leaves, may be swept into the filter.
OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION

- Liquid aerosols, such as oil mists and fog droplets, may be retained by the filter, and if the amount of liquid collected is appreciable, the filter can become wet and impair function.
- As the filter becomes loaded with collected matter, the flowrate through the filter is reduced; this is not adjusted for in the total volume calculation.
- Power failure or voltage change during the test period will lead to an error, depending on the extent and time duration of such failure.
- If two or more samplers are used at a given location, they should be placed at least 2 meters apart so that one sampler will not affect the results of an adjacent sampler.
- Possible sampling errors may occur as a function of sampler orientation in atmospheres containing high relative concentrations of large particles.
- The data logger record is a continuous file as a function of time and unable to differentiate between different monitoring events.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for the operation of the DH-100V High Volume Air Sampler:

- DH-100V.2-30 High Volume Air Sampler
- Digital Flow Meter Module
- Data Storage Device
- Digital Venturi Calibrator
- Cartridge filter holder
- Calibrator interface adapter
- Appropriate filter media
- 47mm filter adapter
- Mounting tripod
- RS-232 data cable
- Personal Computer with ASCII data communication software
- User’s Manual

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Inlet Radius Clearance

- The inlet must have a one meter radius free of any objects that may influence airflow characteristics, including the inlets of other instruments.
- The inlet must be at least 20 meters from the drip line of any overhanging trees.
- There must be at least a 270 degree arc of unrestricted airflow around the inlet.
- The DH-100V inlet must be located away from obstructions such as short walls, fences, and penthouses, so that the inlet is unobstructed for 2 meters in all directions.
- If located beside a major obstruction, such as, a building, the distance between the DH-100V and the obstruction must be equal to twice the height of the obstruction.
OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION
7.2 Set-Up

1. Unfold the tripod legs and secure DH-100/Digital Flow Meter (DFM) Module to tripod.
2. Visually inspect unit, wires, and accessories.
3. Confirm that the serial number and model number on the instrument Manufacturer’s Data Plate matches the information stated on the calibration documents.
4. Confirm the line power requirements stated on the Manufacturer’s Data Plate matches the line power available.
5. Press **RESET** on DFM Module to turn unit on.
6. Move Controller Module power toggle switch to **HIGH**.
7. Depress the power **ON** button on the DFM.
Digital Flow Meter

8. Confirm there are no unusual unexpected noises indicative of possible internal damage such as a misaligned fan.
9. Install the filter media to be utilized with the air sampler and confirm that the desired maximum flow rate on the instrument matches the maximum flow rate stated on the calibration documentation.
10. Move Controller Module power switch to VARIABLE.
11. Confirm that the flow meter is responding properly to changes in motor speed by adjusting the Flow Control Knob on the Controller Module.
12. Press the SET button on the DFM to advance to the first enabled feature.
13. Selection of Serial Data Frequency Feature, 1 second, 1 minute, 6 minutes, or 1 hour appears on the display.
14. Press the UNITS or RESET button to change the frequency at which data are sent to the data storage device.
15. Press the SET button to advance to the next feature.
16. Selection of Actual or Standard Flow Feature, Y or N appears in the display.
17. Press the UNITS or RESET button to change this value.
18. Selecting a Y provides Actual Flow readings on the display and selecting N provides Standard Flow readings on the display.
19. Press the SET button to advance to SAVE.
20. Save the Settings, Y appears on the display if you have made changes to the setup.
21. If no changes were made, the program returns to the regular display mode.
22. Press the UNITS or RESET buttons to change from Y to N.
23. Press the SET button to save the changes.
24. DONE is briefly displayed, then the program returns to the regular display mode.

7.3 Start Sampling Activity

1. Press the ON-OFF button to place the DFM in standby mode.
2. Press the UNITS button to view the elapsed time value and total volume value to ensure that values are zero.
3. If the values are not zero, press the RESET button when the green LED is in the Time position to zero the elapsed time.
4. Press the RESET button when the green LED is in the Total Volume position to zero the total volume value.
5. Press the UNITS button to return the green LED to the flow position.
6. Turn on the motor to start the sample event by pressing RESET.

7.4 Temporary Suspension of Sampling Activity

1. With unit in the Flow Mode, shut off the pump motor by pressing RESET.
2. Accumulated elapsed time and volume up to the time of suspension are saved and viewable by the operator.

Note: Elapsed time is not counted and the total volume value is not increased with the pump motor off.
3. To resume the sample activity turn the pump motor back on by pressing **RESET** with the unit in Flow Mode.

7.5 Terminate Sampling Activity

1. With the unit in Flow Mode, turn off the pump motor by pressing **RESET**.
2. The elapsed time and total volume values are preserved.
3. Record the elapsed time and total volume values.
4. Press the **ON-OFF** button to remove power from the DFM.
5. Remove filter from the holder for laboratory analysis.

7.6 Data Storage and Retrieval

The Data Storage Device (DSD) records and stores data gathered from the DFM. Data are collected from the DFM by a serial data communication connection and stored to a standard 128Mega Byte (MB) Secure Digital Card.

7.6.1 Start Data Storage

1. Attach the serial data connector from the DSD to the DFM

![DSD Serial Data Port](image1)

![DFM Serial Data Port](image2)

2. Plug the data storage device into 110 VAC power.
3. The POWER LED should light and all other LEDs will flash on once briefly.
4. The ERROR LED should then be blinking.
5. Put the SECURE DIGITAL card into the socket label side up.
6. Press the **RESET** button on the DSD.
7. All LEDs except POWER LED should flash on once briefly and then go off.
8. Turn on the DFM by pressing **RESET**.
9. As the DFM sends new data to the storage device, the SERIAL LED will light.
10. After 512 bytes of data have been received, the WRITE LED will light indicating that
OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION

the data from the buffer are being written to the card.
7.6.2 Terminate Data Storage

1. Press the **FINISH** button.
2. The WRITE LED will blink a few times while buffered data are being written to the SECURE DIGITAL card.
3. After all data are written, the FINISH LED will blink indicating it is safe to remove the SECURE DIGITAL card.
4. Remove the card by pushing in on the card gently until it clicks and then releases.
5. The card should be protruding from the slot a little farther than it was before and can now be withdrawn from the card slot.

7.6.3 Transfer Files

Use a USB flash memory drive to transfer stored data files to a computer. Data are in a comma-delimited `.CSV` text file format.

7.7 Set Date and Time

1. Remove SECURE DIGITAL card.
2. Connect the DSD to a computer serial port.
3. Start HYPERTERMINAL and set up a connection using 9600, 8-N-1.
4. Turn on the DSD.
5. The error light should be blinking.
6. If it is not, make sure you have removed the SECURE DIGITAL card and press the **RESET** button.
7. In HYPERTERMINAL, type “c” in lower case and no quotes.
8. Enter ‘t’ to get the current time.
9. Enter ‘y’ to change the year.
10. Enter ‘m’ to change the month.
11. Enter ‘d’ to change the day number.
12. Enter ‘h’ to change the hour.
13. Enter ‘n’ to change the minutes.
14. Enter ‘s’ to change the seconds.
15. To finish with the REAL TIME CLOCK setting, either press the **RESET** button or disconnect the Data Storage Device from power.

8.0 CALCULATIONS

The DH-100 is a direct reading instrument requiring no analyst calculations of operational measurements. The readings are displayed or logged in units of standard cubic feet per minute (SCFM) flow and standard cubic feet (SCF) volume along with time and date information.
Calculations will need to be performed to ensure that sufficient air volume and flow rate have been determined for all site specific radionuclides of concern for radiological air sampling and analyses to ensure that Minimum Detectable Concentrations (MDCs) will be met. NOTE: Different detection limits will be required for worker protection and public exposure concentrations.

However, the calibration procedure requires calculation of percent (%) deviation between the calibrator reference instrument and the rotameter at each measured point according to the following formula.

\[
% \text{ deviation} = \left| \frac{\text{Flow Rate of Reference Instrument} - \text{Flow Rate of Rotameter}}{\text{Flow Rate of Reference Instrument}} \right| 
\]

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 General QA/QC Procedures

- All data must be documented on field data sheets or in site logbooks.
- Equipment maintenance and calibration must be documented in an equipment logbook.
- The instrument must be operated according to the operating instructions supplied by the manufacturer, unless otherwise specified in the site-specific UFP QAPP.
- Instrument checkout activities must occur prior to operation and must be documented.

9.2 Calibration

9.2.1 General Calibration Guidelines

- Instrument must be calibrated by the manufacturer annually.
- A calibration should be made immediately after each repair involving the rotameter or the motor.
- The calibration procedure involves the comparison of the flow value displayed on the DFM to the flow value displayed on a reference calibrator.
- The filter media to be utilized during sampling should also be utilized during the calibration process.
- A calibration should be performed any time there is a suspicion of erroneous readings or if a filter medium different than the calibration filter medium is utilized.

9.2.2 Perform Calibration Check

NOTE: Be sure to insert the proper filter media into the air sampler filter holder prior to attaching the adaptor to the air sampler.

1. Connect the calibrator interface adapter to filter holder of the air sampler and the venturi tube of the calibrator.
2. Ensure the both air sampler and calibrator are on a level surface.
3. Ensure the Digital Venturi Calibrator has warmed up at least 10 minutes.
4. Confirm the filter paper in the air sampler is the same filter paper to be utilized for the sampling activity.
5. Turn on the air sampler by placing the Controller Module On-Off switch in the variable speed position.
6. Ensure that the speed control knob is rotated fully counter clockwise at the start.
7. Slowly bring up the air sampler motor speed to a maximum flow rate for the specific media being utilized by turning the flow control knob in a clockwise direction.
8. Allow the unit to temperature stabilize for 5 minutes.
9. Compare the reading on the rotameter with the reading on the calibrator as close in time as possible.
10. Record the values on a data sheet.
11. Adjust the rotameter backpressure needle valve with a small slot head screwdriver until the reading on the rotameter equals the reading on the calibrator.

NOTE: To access the adjustment screw of the rotameter needle valve, remove the yellow cap on the top of the Control Module and loosen the locking nut on the rotameter needle valve stem.

12. Tighten the locking nut on the needle valve stem carefully without changing the flow on the rotameter.
13. Compare the flow on the rotameter with the flow on the calibrator for at least three additional flow rates throughout the range of interest by turning the flow control knob counter clockwise to reduce motor speed and flow rate.
14. Allow 5 minutes at each new flow rate to stabilize the temperature.
15. Calculate the absolute difference between the flow on the reference instrument and the flow on the rotameter.
16. Compare this absolute difference against the full-scale accuracy of the rotameter.
17. Compute the %deviation between the reference instrument and the
The rotameter utilized in the HV Series Air Samplers has an accuracy of ± 5%. If the average of the absolute differences calculated in Step 15 above do not exceed ± 5% of the full-scale value of the rotameter, the unit is considered to be operating in an acceptable manner.

If the absolute deviation exceeds 7% on any single value, or more than 5% of the average of all values, an investigation should be made to determine the cause of the deviation prior to placing the instrument in service.

A calibration file for each serial numbered instrument should be created to monitor changes or trends evident from a series of calibrations and to record maintenance performed on the unit.

10.0 DATA VALIDATION

The analyst will ensure that the air sampler is operated in accordance with this SOP, and all operational checks have been completed and are within the criterion specified. Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. The ERT contractor’s Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA’s ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

The EPA sets air emission (and drinking water) standards for radioisotopes. In 10 CFR Part 20, Standards for protection against radiation, Subpart C, the NRC provides the occupational dose limits for radiation exposure. In 29 CFR 1910.1096, Ionizing radiation, OSHA provides additional guidance on radioactive materials and areas, but internally references the NRC occupational dose limits. A site specific QAPP will be generated to document minimum flow rate and minimum sample collection volumes required to meet radionuclide specific Measurement Quality Objectives (MQOs).

See Section 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE for safe handling guidelines for radioactive samples and material.

12.0 REFERENCES


13.0 APPENDICES

A - Specifications
B - Maintenance
APPENDIX A
Specifications
SOP: ERT-PROC-2201
June 2020

Technical Manual)
OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION

<table>
<thead>
<tr>
<th>PUMP TYPE:</th>
<th>STANDARD COMBINATION FILTER HOLDERS</th>
</tr>
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<tbody>
<tr>
<td>Two-stage, dual ball bearing, bypass type with an independent cooling system for the motor that provides thermal overload protection.</td>
<td>FILTER MODEL</td>
</tr>
<tr>
<td></td>
<td>DIMENSIONS</td>
</tr>
<tr>
<td>MAXIMUM CAPACITY:</td>
<td>FJ-19P</td>
</tr>
<tr>
<td>94 cubic feet per minute (CFM) at 29.92&quot; Hg and 68°F. (Free air flow).</td>
<td>FJ-34P</td>
</tr>
<tr>
<td></td>
<td>FJ-39P</td>
</tr>
<tr>
<td></td>
<td>FJ-52P</td>
</tr>
<tr>
<td></td>
<td>FJ-54P</td>
</tr>
<tr>
<td>ULTIMATE VACUUM:</td>
<td>TYPICAL MAXIMUM FLOW RATES THROUGH VARIOUS FILTER COMBINATIONS:</td>
</tr>
<tr>
<td>80&quot; H₂O at standard temperature, pressure and zero flow restriction.</td>
<td>CARTRIDGE (2 ½&quot; Diameter)</td>
</tr>
<tr>
<td>TEMPERATURE OPERATING RANGE:</td>
<td>TE1C</td>
</tr>
<tr>
<td>18 to 122°C (-10 to 50°C)</td>
<td>TE3C</td>
</tr>
<tr>
<td></td>
<td>TE2C</td>
</tr>
<tr>
<td>POWER REQUIREMENTS:</td>
<td>--------</td>
</tr>
<tr>
<td>110-120VAC, 50/60Hz, 6 amperes; single phase</td>
<td>FP47</td>
</tr>
<tr>
<td>FUSE PROTECTION:</td>
<td>--------</td>
</tr>
<tr>
<td>8 amperes, slow blow fuse</td>
<td>FP47M</td>
</tr>
<tr>
<td>DIMENSIONS:</td>
<td>TE3C</td>
</tr>
<tr>
<td>23 ½&quot;L x 10 ½&quot;W x 11&quot;H</td>
<td>TE2C</td>
</tr>
<tr>
<td>(60.3L x 26.7A x 27.9 cm Alt)</td>
<td></td>
</tr>
<tr>
<td>WEIGHT:</td>
<td>24 lbs.</td>
</tr>
</tbody>
</table>

ELECTRONIC SPECIFICATIONS:

- Measurement Accuracy:
  - Air flow: ± 2.5% of full scale
  - Temperature: ± 0.9°F (0.5°C)
  - Barometric Pressure: 1% over measured range

- Operating Temperatures: -10°F to 104°F (-23°C to 50°C)
- Storage Temperature: -20°F to 158°F (-29°C to 70°C)
- Calibration: Factory calibration 1 per year

- Communications Interface: RS-232

Data Storage:

- Simultaneous data storage of all measured parameters in Non-Volatile memory; time and date stamp on record. Data storage for continuous sampling
  - Data Recording Options of 1, 10, 20, 30 or 60 days; 1 record per hour for 60 day option
- Optional reporting of all stored data and/or summary record for host computer or local printer via RS-232 serial link.

On-Board Calculations:

- Flow calculation from differential pressure value using best-fit curve method.
- Flow correction for standard temperature and pressure
- Auto-zero correction utilizing electro-pneumatic method to compensate for offset and drift (automatic once every minute)
- Minimum and maximum values of measured parameters.

Optional Items:

- Optional data communications software to download data from instrument to IPAQ PDA or PC after completion of sampling activity.
APPENDIX B
Maintenance
SOP: ERT-PROC-2201
June 2020

SERVICE and MAINTENANCE INSTRUCTIONS

CAUTION: Prior to performing any maintenance disconnect the air sampler cord from the power source.

The HV Air Sampler Series is designed to require minimum maintenance.

Motor Brush Replacement:

The HV Air Sampler Series uses a brush type motor with a nominal brush life of 600 to 700 hours. The brush assemblies must be changed before they are depleted to prevent damage to the armature. The part number of the individual brush assembly (2 per motor) is available in the spare parts listing contained in this manual. The brushes can be changed using the following procedure.

1. Remove the bell-shaped cover that protects the motor by unscrewing the four screws that secure the bell-shaped cover to the cast aluminum housing.

2. Remove the two-spring clips holding the plastic motor guard. Examine the brush assembly. Note the arrangement and clamping method. Note how the wire is attached to a connector that slides between the brush insulator and the metal brush housing. Compare the new brush assemblies with the ones on the motor.

3. Remove the brush assembly by backing out the two round head screws retaining the clip, which secures the brush assembly.

4. The brush assembly is now secured to the unit only by the wire leading to the field windings. This wire is secured to the brush assembly by a flat metal connector, which slides into a slot in the brush assembly.

5. Grasp the outer end of the brush assembly and gently work the brush assembly away from the commutator part of the armature until the connector almost touches the clamp.

6. While holding the brush assembly, insert the screwdriver blade between the connector and insulator. Turn the screwdriver to force the connector toward the commutator.

CAUTION — DO NOT push or drive the connector toward the commutator. The connector may release suddenly or the tool may slip and damage the commutator.

Continue working the brush assembly out of the clamp, using the screwdriver to slide out the connector.
7. After the brush assembly has been removed, examine the commutator. If it is scored or pitted, it should be turned and polished by a competent motor-repair technician. If it is smooth but blackened, use cloth dipped in cleaning solvent to clean the commutator. Use fingers or socket wrench to rotate the armature from the air-input end. Never use a tool at the commutator end to rotate the armature.

8. Place the connector on top of the new brush metal housing. Insert the end of the connector between the brush housing and the insulator. Use the flat face of the screwdriver to slide the connector between the brush housing and insulator. The connector should be against the insulator.

9. Place the new brush assembly in position. The inner end of the insulator should be approximately ¼” from the inner end of the mounting pad, and the end of the brush housing should be from 1.5 to 3 mm (1/16 to 1/8 inch) from the commutator. A short round stud on the mounting pad keeps the brush holder from sliding in or out.

10. When the new brush assembly is in position and seated on the stud, press the clamp downward and partially tighten the screws. Move the brush assembly to see that it is properly seated. Tighten the screws. Check to see that the wires to the brushes do not touch the metal of the motor frame.

11. Follow the preceding instructions to remove and replace the second brush.

12. Reassemble by performing the above steps in reverse order.

13. Connect the power cord to the power outlet. Turn the unit on and allow the sampler to run for 15 to 20 minutes to seat the brushes. To reduce operating noise, install a filter or the office-type calibrator before operating the blower.

**Removal and Replacement of Motor:**
The vacuum motor assembly can be replaced using the following procedure.

1. Remove the bell-shaped cover that protects the motor by unscrewing the four screws that secures the bell-shaped cover to the cast aluminum housing.

2. The motor is mounted on an aluminum plate with 4 screws. **Do Not** remove the motor from this plate.

3. To remove the motor from the housing, insert 2 slot head screwdrivers 180° apart underneath the aluminum plate and gently pull up. The motor can then be detached from the housing by pulling it out and disconnecting the two wires (one wire-nutted to the power cable and the other connected to pin-5 of the molex connector).

4. The aluminum plate can now be removed from the motor in order to clean and replace the gaskets between the plate and housing and between the motor and plate.
5. The rubber seal at the base of the motor, which forms an airtight seal between the aluminum housing and the motor, may become detached with the motor, or may stay attached to the housing. In either case, the application of silicone sealant on both sides of the rubber seal is necessary upon reinstallation of a repaired motor or installation of a new motor. To ensure a good vacuum tight seal, remove the old silicone adhesive prior to applying the new adhesive. F&J recommends the use of Dow-corning general purpose adhesive.

6. The new or repaired motor can be installed by performing the above steps in reverse order.

Removal of Controller Module with Protective Guard:
The HV Series Air Samplers are provided with a removable controller module containing a protective cover guard for the air sampler control panel. The protective cover guard is made of rugged plastic.

1. The controller module is easily removed by unscrewing the four hex nuts located on the front of the control panel of the cover guard.

2. Carefully remove the controller module from the aluminum housing by pulling the cover guard away from the housing with one hand and holding the housing with the other. (Note: the electrical connections to the controller module components are connected to a molex connector, which needs to be disconnected prior to performing the desired maintenance. Refer to the electrical system diagram of this manual for proper electrical connection prior to reassembling controller components).

3. To reassemble, perform the above steps in reverse order.

Flowmeter Replacement:
To remove the flowmeter you must first remove the controller module as instructed above. Then remove the two screws on the backside of the control panel that attach each flowmeter. When replacing the flowmeter be careful that you place the intake O-Ring back on the bottom opening of the flowmeter prior to securing it. Replace the controller module as described above only in reverse order.
OPERATION OF DH-100V.2-30 HIGH VOLUME AIR SAMPLER FOR RADIOACTIVE AIRBORNE PARTICULATE COLLECTION

Removal of Toggle Switch:
Removal of the toggle switch is accomplished by first removing the controller module as instructed above.

1. Remove the toggle switch rubber boot.
2. Remove the hexagonal securing nut from the outer threads of the toggle switch located on the front of the control panel within the protective cover guard.
3. Disconnect the three wires that are connected to the switch to complete removal.
4. Replace the switch by performing the above steps in reverse order.

SERVICE and MAINTENANCE INSTRUCTIONS (Cont.)

Removal of Speed Controller:
Removal of the motor speed controller is accomplished by removing the controller module as instructed above.

1. Remove the two screws at the top of the housing, which secure the speed controller. This will separate the speed controller from the housing.
2. Remove all wires connected to the speed controller to complete its removal.
3. To install a new motor speed controller, perform the above steps in reverse order. Use the electrical system diagram to properly connect the motor speed controller. Be careful when assembling to line up the controller with the top retainer brackets.

Removal of Timer (if applicable):

1. Remove the timer cover by unscrewing the securing screws on the outside of the metal timer case.
2. Disconnect the wires from the timer if a replacement timer is to be installed.
3. Install a new timer by following the above steps in reverse order. Refer to the electrical wiring diagram to properly connect wires to the timer poles.