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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the start-up, check out, operation, calibration and routine use of the TSI, Inc. DustTrak DRX Model 8533EP aerosol monitor. The procedures and figures contained in this SOP are taken from the copyrighted DUSTTRAK DRX MODEL 8533/8534/8533EP OPERATION AND SERVICE MANUAL (2017). Some material is excerpted without change from this manual. This SOP will be used for educational and training purposes only.

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 UFP-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 UFP-QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

The TSI DustTrak DRX is a light-scattering laser photometer which produces size-segregated mass fraction concentration measurements of particulates with diameters of 10 microns (µm) [PM10], 2.5 µm (PM2.5), 1 µm (PM1), respirable particulates (Resp), and total suspended particulates (TSP), simultaneously. The DustTrak DRX provides real-time continuous monitoring and electronic recording of particulate concentration data. Refer to the DustTrak DRX Aerosol Monitor Operation and Service Manual for detailed operating procedures. Instrument specifications are presented in Appendix A, Specifications. Advanced users should consult Appendix B, Theory of Operation, for a more detailed explanation of the principle of operation.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- Good measurement accuracy is dependent on the measured aerosol having a wide particle size distribution, that is, the more monodisperse the aerosol, the lower the accuracy.
- Measurement accuracy may be affected due to differential light scattering by particles with equivalent aerodynamic diameters, but with different optical characteristics, such as density, refractive index, size, shape, and composition.
- High humidity or the presence of fog, especially frozen water droplets, may cause elevated readings. Through the use of the Heated Inlet Sample Conditioning module, a constant sample inlet stream relative humidity level can be maintained.

**WARNING:** The DustTrak DRX must be protected from all forms of precipitation. If there is a potential for exposure, operation should be conducted using the appropriate outdoor enclosure.

5.0 EQUIPMENT/APPARATUS

The following equipment is provided for the operation and transport of the DustTrak DRX aerosol monitor:
• DustTrak DRX 8533EP (desktop) or DustTrak DRX 8534 (Handheld) unit
• Inlet cap
• External pump, including power cable, air hose and exhaust adapter (8533EP Model only)
• Outdoor enclosure, including omni-directional sampling inlet, condensation catch and tripod (8533EP Model only)
• Heated inlet (8533EP Model only)
• Auto-zero module (8533EP Model only) and/or zero filter for manual zeroing
• Instruction Manual
• TrakPro communications software
• Digital output cable
• Charger/power supply (Desktop 8533EP; Part# 801692 or Handheld 8534; Part# 801694)
• External batteries and wiring harness (8533EP Model only)
• External battery charger (Desktop 8533EP; Part# 801685 or Handheld 8534; Part# 801686)
• Spare internal filters (Desktop 8533EP; Part# 801673 or Handheld 8534; Part# 801666)
• 37-millimeter (mm) filter (8533EP Model only)
• 37-mm filter cartridge opening tool (8533EP Model only)
• Filter removal tool (8533EP Model only)
• Stylus
• PM$_{2.5}$ calibration impactor kit (impactor top, impactor bottom and impaction plate)
• Impactor oil
• Pelican storage and transport cases (8533EP Model only)
• Viper network data management (Optional)

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Air Monitoring Guidelines

For typical short-term area monitoring applications, such as fires, construction or remediation activities, the DustTrak DRX 8533EP units should be operated within their enclosures and placed in strategic fixed locations around the area of concern, away from localized air currents such as those caused by fans, blowers, ventilation intakes or exhausts. This is to ensure representative results for protection of local sensitive receptors. The handheld DustTrak DRX Model 8534 units are more suitable to mobile monitoring or situations where the monitoring locations may be moved frequently. The following siting and set-up conditions are recommended for the DustTrak DRX Model 8533EP:

• The inlet should be away and above any obstructions whose wake may affect sampling representativeness.
• The inlet should be at least 1 meter (m) above the ground or any major horizontal surface, such as, a roof.
• The Omni-directional Inlet should be used under typically horizontal and variable wind conditions to prevent loss of particles with aerodynamic diameters larger than 1 µm.
• At ambient relative humidity above 65 percent (%) to 70%, airborne particles are likely to grow by accumulation of water. If only the solid portion of the particulates is to be measured, the heated inlet should be used, especially when monitoring under fog or water mist conditions.

• When the heated inlet is utilized, federal reference methods dictate what the setting should be. As most SERAS mobilizations will perform either PM$_{2.5}$ or PM$_{10}$ monitoring, the Heated Inlet Sample Conditioning module should be set to 40%. See Appendix C, Relative Humidity Setting on the Heated Inlet.

• To operate the DustTrak DRX Model 8533EP outdoors, provisions must be made to protect the external pump from any form of precipitation. The DustTrak Model 8533EP-specific outdoor enclosure should always be used for outdoor monitoring activities. If environmental extremes are a possibility, such as temperatures beyond the specified operational range (32-120 degrees Fahrenheit [°F]), a small shelter or roof may be required with a heating source that does not create any perturbation in airborne particulate levels. Heating sources with fan motors can be an issue (i.e. move particulates into the air column).

NOTE: At freezing temperatures, the DustTrak DRX cannot differentiate between solid particulates and frozen water droplets. A heated inlet (applicable to Desktop DRX 8533EP) may be used if the temperatures are below freezing and the instrument is functioning properly.

NOTE: Wood or coal-burning stoves can produce airborne particulate matter both indoors and outdoors.

7.2 Operation

7.2.1 Instrument Set-Up

1. Before powering on the unit, it must be properly set up.
   • Model 8533EP; Open the battery door in the back of the unit and ensure that there are two internal batteries installed. If not, or if the batteries need to be replaced, install new batteries by sliding each battery into the slot with the label side facing upwards. Use only the rechargeable batteries supplied by TSI.
   • Model 8534; Open the bottom door of the unit to install handheld model specific battery secured by a screw. Use only the rechargeable batteries supplied by TSI.

   NOTE: Units are supplied with only one battery. Operating the unit with only one internal battery will provide up to 6 hours run time; therefore, two internal batteries are typically used.

2. This setup pertains to Model 8533EP only. Attach the external pump to the DustTrak DRX unit. The pump draws power from the DustTrak DRX and pulls air through for analysis via connection to the unit’s exhaust port.
   • There are two ports on the pump module; the top (silver) port is the air intake and the bottom (black) is a power connector. First, attach one end of the air hose quick-connect to the silver air intake port of the pump.
   • Connect one end of the power cable to the black power connector on the pump, turning the locking connector to ensure that it stays in place.
   • Attach the opposite end of the power cable to the appropriate port on the back of the DustTrak DRX. There is only one port where it will seat properly.
3. If the instrument is being operated outdoors, set up the outdoor enclosure (below setup procedures pertain to Model 8533EP only):
   - Set up the tripod to the desired height.
   - Remove the nut from the bottom of the enclosure with an Allen wrench. Center the enclosure onto the tripod so that the screw threads are visible from below. Secure onto the tripod using the attached bolt.
   - Open the enclosure, undo the Velcro and insert the DustTrak DRX, external pump and external batteries (if required) into the appropriate spaces, as shown below.

   - Secure with Velcro. Note: External batteries and line power cannot be used simultaneously; only one power source may be connected at a time.
   - With the inlet cap removed from the DustTrak inlet, press the auto-zero module onto the inlet and connect the power cable to the appropriate port on the back of the DustTrak unit.
   - Press the heated inlet module onto the inlet of the auto-zero module. Use the thumbscrews to secure the module to the metal plate behind the DustTrak. Refer to Appendix D, Heated Inlet for Environmental Enclosure, for additional information.
   - Press the black tubing into the recessed port on the left side of the heated inlet module. Attached the opposite end of the tubing onto the barb on the inlet on the
ceiling of the enclosure.

- Attach the water catch to the bottom of the inlet on the ceiling of the enclosure.
- Loosen the gray cord grip fitting on the left side of the enclosure. Remove the metal protector from the temperature/relative humidity probe. Insert the bare (uncorded) end of the sensor through the cord grip fitting so that it is protruding to the outside of the enclosure. Tighten the fitting and clip the protector onto the probe. Plug the end of the cord into the appropriate port on the front of the heated inlet module.
- Plug the power wires into the DustTrak unit and the heated inlet. Attach the opposite end to the power source (either line power or the external batteries).
- Remove the plug from the black fitting in the outside back left corner of the enclosure to allow exhaust.
- Attach the omni-directional inlet to the top of the enclosure.

Refer to the DustTrak Aerosol Monitor Environmental Enclosure Model 8535 Operation and Maintenance Manual for additional information.

Note: With an exception of single ‘Analog Out’ port and menu option on Model DRX 8533, remaining firmware menus are identical with the Model 8534).

7.2.2 Battery Charging

This instrument will charge the Lithium Ion battery packs. Insert the battery/batteries into the battery compartment, plug the instrument into alternating current (AC) power, and turn the instrument on, typically this happens automatically. Batteries will charge only when the instrument is on and in stand-by mode. Batteries will not charge if the instrument is turned off or is actively taking measurements. Charging will stop when the batteries are fully charged. Note that when charging the battery the ambient temperature must not exceed 107°F.

7.2.3 Start-Up

1. Ensure that the external pump (Model 8533EP only) and internal batteries are installed in the DustTrak DRX before powering on the unit by pressing the gray power button on the front of the instrument. The START UP screen is displayed initially when the instrument is turned on, following the initial TSI logo splash screen.
Using a stylus or fingertip, touch the “buttons” on the screen to activate different menus. If “No pump is connected” is displayed on the screen, power off the unit, then power on.

2. Pressing **Setup** (located in the bottom right corner of the screen) activates the Setup Menu touchscreen buttons along the left edge of the screen. Setup is not accessible when the instrument is sampling. The main screen of the **Setup** screen displays the following information:

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>The instruments serial number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Number</td>
<td>The instruments model number.</td>
</tr>
<tr>
<td>Firmware Version</td>
<td>Instruments current version of firmware.</td>
</tr>
<tr>
<td>Calibration Date</td>
<td>Date of the last factory calibration.</td>
</tr>
<tr>
<td>Pump Run Time</td>
<td>Pump running time in hours.</td>
</tr>
<tr>
<td>Cum Mass Conc</td>
<td>Amount of mass run through instrument over life.</td>
</tr>
<tr>
<td>Cum Filter Conc</td>
<td>Amount of mass run through instrument since last filter change.</td>
</tr>
<tr>
<td>Filter Time</td>
<td>Date of last filter change.</td>
</tr>
</tbody>
</table>

3. To zero, attach the zero filter to the DustTrak DRX inlet and select **Zero Cal** from the top left corner of the screen within the Setup menu. Press the **Start** button to begin the zeroing process. A count-down clock will appear, indicating the time remaining. The screen will indicate “Zero Cal Complete” when done. Remove the zero filter when finished.

Alternatively, the auto-zero module may be used if the unit is setup within the outdoor enclosure (see Section 7.2.4 for programming instructions). The module remains in place during sampling and will zero automatically at user-defines intervals over the course of the sample period. The initial zero should still be performed with the zero filter.

Note: Never perform a zero cal without attaching a zero filter or using an auto-zero module. Run Zero Cal the first time the instrument is used and repeat prior to
redeployment and/or when specified by manufactures recommended maintenance interval. Zero Cal must also be performed if the unit is reading negative concentrations, as it is not possible for the DustTrak monitor to read negative concentrations and this a symptom of zero drift.

4. The **Flow Cal** option in the Setup menu allows for calibration of air flow to the factory set point of 3.0 liters per minute (L/min). Flow calibration should be performed when tubing in excess of normal lengths (i.e. longer than what is normally used in the outdoor enclosure) is attached to the DustTrak inlet or when the unit is utilized to collect a sample; these are not typical SERAS applications. Calibration is necessary as the unit requires a predetermined volume of air to accurately measure particulate concentrations; adding resistance to the inlet may alter the amount of air flow and skew concentration measurements.
The flow set point is factory set to 3 L/min total flow. Two (2) L/min of the total flow is measured aerosol flow. One (1) L/min of total flow is split off, filtered, and used for sheath flow. There is an internal flowmeter in the DustTrak DRX instrument that controls flow rate to plus or minus (±) 5% of factory set point. TSI recommends checking the flows with an external flow reference meter, especially when collecting data. The pump will automatically start when entering the Flow Cal screen.

- Attach a flow calibrator (reference flow meter) to inlet port. You may use a bubble buret, mass flow meter, dry piston or rotameter as flow measurement devices.
- Move the arrows up or down to achieve desired flow on the reference flowmeter. Each up or down arrow will change the flow about 1%. Allow time between button presses to let pump change to the new flow rate.
- Select **Save** once the desired flow rate is achieved. Select **Undo** to return to the factory set point.

5. Make sure that the correct date and time are set prior to use. Select **Settings** from the bottom right corner of the Setup menu, and then select Date Time from the drop-down menu that appears. Select the desired parameter and use the arrows to adjust to the correct value.

### 7.2.4 Starting a Run

From the main screen, select the **RunMode** option from the bottom of the screen. The RunMode tab brings up sampling options, including Survey Mode, Manual Log and Log Mode 1-5. Preprogrammed tests are set in the Log Modes. The modes are described below. Select the desired mode from the pull-down list. After selecting the appropriate mode and parameters, Press **Main** to return to the main screen, then press the green **Start** button to begin the run.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>Survey Mode runs a real-time, continuous active sample, but does not log data.</td>
</tr>
<tr>
<td>Manual</td>
<td>Manual Log sets the instrument to log data for a specified run time</td>
</tr>
<tr>
<td>Log Modes</td>
<td>Log Mode starts and stops the instrument at specified times, runs for a specified test length, and perform multiple tests of the same length with a specified time period between tests. Use of the auto-zero module requires this function.</td>
</tr>
</tbody>
</table>

When a mode is selected, a pull-down list of parameters will appear below it. Parameters (as shown below) may be changed by selecting each from the menu; the screen will display set options for the parameter after selection.
**Survey Mode**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Constant</td>
<td>Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.</td>
</tr>
<tr>
<td>Auto Start on Power Up</td>
<td>When set to “Yes”, unit will start a measurement upon being powered on, if the unit was set to “Survey” when it was turned off. When set to “No”, the unit will be in idle when it is powered on.</td>
</tr>
</tbody>
</table>

**Manual Mode**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Length</td>
<td>Test length can be set from 1 minute to the limit of the data storage.</td>
</tr>
<tr>
<td>Log Interval</td>
<td>The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.</td>
</tr>
<tr>
<td>Time Constant</td>
<td>Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.</td>
</tr>
</tbody>
</table>

**Log Mode (1-5) (Test 1-5, able to be renamed)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Name</td>
<td>Log Name, brings up a virtual keypad to name the Logged Data file.</td>
</tr>
<tr>
<td>Test Length</td>
<td>From 1 minute to the limit of the data storage.</td>
</tr>
<tr>
<td>Log Interval</td>
<td>The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.</td>
</tr>
<tr>
<td>Number of Tests</td>
<td>Number of tests, 1 to 999.</td>
</tr>
<tr>
<td>Time between Tests</td>
<td>Time between tests, 1 minute to 30 days.</td>
</tr>
<tr>
<td>Time Constant</td>
<td>Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.</td>
</tr>
<tr>
<td>Use Start Date</td>
<td>Use Start Date, option to use programmed start date or by pass programmed start date.</td>
</tr>
<tr>
<td>Start Date</td>
<td>Start Date, select the date the test will start.</td>
</tr>
<tr>
<td>Use Start Time</td>
<td>Use Start Time, option to use programmed start time or bypass programmed start time.</td>
</tr>
<tr>
<td>Start Time</td>
<td>Start Time, select the time the test will start.</td>
</tr>
<tr>
<td>Use Auto Zero</td>
<td>Use Auto Zero, Option to use the Auto-Zero accessory</td>
</tr>
</tbody>
</table>
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534

| Auto Zero Interval | Interval between re-zeroing the instrument using the Auto-Zero accessory. Model 8533 desktop only. |

Note: The auto-zero module can only be used in the Log Modes. To set this function, select one of the log modes and scroll down to “Use Auto-Zero”. Select this line (live key) and use the displayed arrows to select yes or no. The Auto Zero Interval, or the period of time between auto zero readings, must then be set from the Log Mode pull-down menu. In addition, the log interval for data logging must be set to 2 minutes or greater, as data will not be recorded when the zero module is activated.

Refer to Appendix E, Troubleshooting, for troubleshooting instructions.

7.2.5 Data Logging Management Using Viper (Optional)

VPER= Instrument (Unit) + Telemetry (Viper) + Data Translation (Data)

VPER is a wireless network based communication system designed to enable real-time transmission of data from the field to a local computer or remote computer. VPER allows direct wireless data transfer from DustTrak DRX unit without having to download data.

Individual LINCs communicate with each DustTrak DRX unit. Data is transferred from the DustTrak’s Universal Serial Bus (USB) port to the LINC via a null-modem RS232-to-USB cable. Communication is at a baud rate of 9600. LINCs may be operated within the outdoor enclosure.

The LINC(s) connect to a Gateway (hardware that provides telemetry from the LINC to the instrument specific Meter Apps and Survey Controller software) Survey Controller is the primary software component of VPER which allows real-time viewing of individual instrument readings instead of waiting to download from a data logger software.

Refer to Appendix F, Viper Guide for DustTrak DRX8533, for LINC and Meter App information.

NOTE: For more VIPER information please refer to the latest user guide and software available at https://response.epa.gov/viper

7.2.6 Size Correction Factor

Under typical operating conditions, either the Factory Cal, for indoor workplace aerosol monitoring, or the Ambient Cal, for outdoor dust or fugitive dust monitoring, should be selected. However, the user can create and save up to 10 additional calibrations.

Size correction is used to improve the relative accuracy between the five mass channels (PM1, PM2.5, Resp, PM10 and TSP) in response to the aerosol of interest. Size correction changes the factory calibration of the particle distribution based on Arizona Road Dust to that of the aerosol being measured. The process uses the PM2.5 Calibration Impactor which must be cleaned before each use (refer to Section 7.3.3). Attach Impactor to Inlet Flow Tube and Inlet Fitting inside lid of Enclosure.

To conduct the Standard Size Correction, select User Cal from Setup Menu; select Size
Corr from drop down list, press Custom Cal and follow on-screen directions. A full calibration will take over 40 minutes and should be performed at or near operating temperatures and humidity. Save calculated value to User Profiles.

Note: Photometric calibration and advanced size correction are covered in the manual, and are beyond the scope of this SOP.

7.3 Maintenance

7.3.1 Maintenance Schedule

There are no user-serviceable parts inside the DustTrak DRX. The instrument should only be opened by TSI or a TSI-approved service technician. Basic maintenance and cleaning should be performed according to the schedule below to keep the instrument functioning properly.

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform zero check</td>
<td>Before each use (refer to Section 7.2.3).</td>
</tr>
<tr>
<td>Clean inlet</td>
<td>350 hr. at 1 mg/m³</td>
</tr>
<tr>
<td>Clean 2.5 µm calibration impactor</td>
<td>Before every use.</td>
</tr>
<tr>
<td>Replace internal filters</td>
<td>350 hr. at 1 mg/m³ or when indicated by the main screen filter error indicator.</td>
</tr>
<tr>
<td>Return to factory for cleaning and calibration (TSI recommends that both the DustTrak monitor and the External Pump Module be returned to TSI)</td>
<td>Annually</td>
</tr>
<tr>
<td>Replace the internal HEPA filters in the External Pump module</td>
<td>Annually</td>
</tr>
</tbody>
</table>

Instruments will be checked on a monthly basis to ensure satisfactory operation. The Contractor’s maintenance checklist is presented in Appendix G, Maintenance Worksheet.

7.3.2 Cleaning the Inlet

The inlet should be cleaned based on the schedule in Section 7.3.2. Clean the inlet only with the instrument powered off.
To clean, unscrew the inlet nozzle from the instrument.

Use a cotton swab to clean the outside of the inlet port. The swab can be dampened with water or a light solvent (such as isopropanol). Clean the inside of the sample tube by using a small brush along with a light solvent. Dry the tube by letting it air-dry thoroughly. Do not blow air directly into the inlet port. Screw (hand-tighten) the inlet back into the instrument.

7.3.3 Cleaning the 2.5µm Calibration Impactor

The Calibration impactor should be cleaned prior to every use when using it to perform a Standard Calibration (size correction) on the instrument (refer to Section 7.2.6).

- Unscrew the impactor and check the O-ring on the impactor base.
- Clean the outside and inside of the impactor and the impactor plate using a clean brush and a light solvent. Dry impactor parts by blowing with compressed air or let it air dry thoroughly.
- Apply two drops of impactor oil to the impactor plate. Do not over-fill the impaction plate.
- Screw (hand-tighten) the impactor plate back together.

7.3.4 Replacing the Internal Filters

Replace the internal filters based on the schedule in Section 7.3.1 or when the filter indicator on the main screen turns to red.

- Turn the instrument off.
- To remove the old filters from the instrument, open the filter access door on the back of the instrument.
- Use the filter removal tool to unscrew the filter cap.
- Pull out the single cylindrical filter from the filter well. If the filter well is visibly dirty, blow out with compressed air.
• Insert a new filter into the filter well and screw the filter cap back in place.
• Open the blue retention clip (to the left of the filter cap) by pinching the ends inward and pushing down.

• Remove the 37-mm cassette by pulling downward and outward.
Open the filter cassette using the filter tool.

Remove the screen mesh from the filter cassette and blow out using compressed air. Blow in reverse direction to remove captured particulate.

Replace mesh in filter and press halves together. Ensure the filter has been fully closed by rotating the flat end of the filter opening tool around the cassette edges.

Place the filter cassette back into position and close the blue retaining clip. Make sure the retaining clip snaps back into place.

It is important to reset the instrument’s filter counter after replacing internal filters. Resetting the counter will clear the filter error condition shown on the main screen.

Turn on the instrument.
• Press the Setup button to open the Setup screen.
• Touch the Cum Filter Conc: (live key) to reset the aerosol mass.
• “Replace user serviceable filters?” dialog will appear. Press OK.
• “Reset filter concentration?” dialog will appear. Press Yes to reset the cumulative filter concentration to zero.
• The Setup screen will now show zero for the Cum Filter Concentration and the current date for the Filter Time.

7.3.5 Replacing the Filters in the External Pump Module

The external pump module provided with Model 8533EP is designed to run continuously for about a year (8760 hours). There are two HEPA filters that protect the pump from contamination - one on the suction side of the pump and the other on the discharge side of the pump. The discharge side of the pump collects particles shedding from the vanes of the pump and will turn black over time. The HEPA filters will have to be replaced once a year.

To access the filters, open the top cover of the pump module. The two HEPA filters are identified in the figure below. The two filters can be replaced by disconnecting the soft tubing between the filters, pump, and the casing connectors.

8.0 CALCULATIONS

The DustTrak DRX is a direct reading instrument requiring no calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 General QA/QC Procedures

• All data must be documented on field data sheets (Appendix H Particulate Monitoring Worksheet), logbooks or as per requirements dictated by field activities.
• The instrument must be operated and maintained according to the instructions supplied by the manufacturer, unless otherwise specified in the UFP-QAPP. Compliance will be documented on Maintenance Worksheets (Appendix G).
• Instrument calibration and maintenance records are maintained by the Contractor’s staff and are located in Edison, New Jersey (NJ) and Las Vegas, Nevada (NV).
• Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

9.2 Annual Calibration

DustTrak DRX units should be returned to TSI for factory calibration once per year during normal operation. Instruments may require additional factory calibrations if malfunctions occur and repairs are necessary.

The DustTrak DRX monitor is calibrated with Arizona Road Dust at TSI against a reference photometer that is gravimetrically calibrated (also with Arizona Road Dust). This specific dust has a wide size distribution covering the entire size range of the DustTrak DRX and is representative of a wide variety of ambient aerosols. Because the instrument combines photometry with single particle sizing for mass measurement, both photometry and size need to be calibrated.

10.0 DATA VALIDATION

The user will ensure that the particulate monitor was operated in accordance with this SOP, within instrument specifications (Appendix A) and all operational checks have been completed and are within the criteria specified in the site-specific UFP-QAPP. The Contractor’s Task Leader is responsible for completing the UFP-QAPP verification checklist prior to 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 Environmental Response Team (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.

Safety concerns specific to the operation of the DustTrak DRX include:

• Do not operate when highly corrosive aerosols or solvent fumes are present.
• Do not attempt to disassemble the instrument.
• The DustTrak DRX should be operated only from the type of power sources described in this SOP.
• Never operate the DustTrak DRX without the internal filters in place.

12.0 REFERENCES


13.0 APPENDICES

A- Specifications
B- Theory of Operation
C- Relative Humidity Setting on the Heated Inlet
D- Heated Inlet for Environmental Enclosure
E- Troubleshooting
F- Viper Guide for DustTrak DRX8533
G- Maintenance Worksheet
H- Particulate Monitoring Worksheet
APPENDICES
Operation of the DustTrak DRX Model 8533EP Aerosol Monitor
SOP: ERT-PROC-2078-20
June 2020
APPENDIX A
Specifications
SOP: ERT-PROC-2078-20
June 2020
DUSTTRAK™ DRX Aerosol Monitors Models 8533, 8533EP and 8534

Real-time dust and aerosol monitoring for any environment, any application

Features and Benefits

All Models:
- Real-time mass concentration and size fraction readings as well as data-logging allow for data analysis during and after sampling
- Simultaneously measure size-segregated mass fraction concentrations corresponding to PM1, PM2.5, Respirable, PM10, and Total PM size fractions
- Easy-to-use graphical user interface with color touch-screen for effortless operations

Handheld Model (8534):
- Long-life internal pump for continuous sampling
- Single-point data collection for walk-through surveys
- Lightweight design with ergonomic handle for portable applications

Desktop Models (8533 and 8533EP):
- Energy-efficient, long lasting external pump for continuous, unattended, 24/7 outdoor monitoring applications (Model 8533EP gray)
- Long life internal pump for shorter work-shift or IAQ sampling applications (Model 8533)
- Granulometric reference sampling capability for custom reference calibrations
- Automatic zeroing (with optional zero module) to minimize the effect of zero drift
- TTL-level output for tracking 15-minute average mass concentrations
- Standard and advanced calibration capabilities for consistent accuracy
- Environmental protected and tamper-proof secure (with an optional environmental enclosure)
- Inter-sample conditioning (with optional heated inter-sample conditioner) to reduce the effect of humidity on photometric mass measurements (for use with an environmental enclosure)
- Cloud Data Management System hosted by Netronix™
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534

Unsurpassed Technology and Performance
DustTrak DRX monitors are laser photometers that simultaneously measure 6 size-segregated mass fraction concentrations at once—something no other monitor can do.

The desktop/desktop with external pump and handheld monitors are continuous, real-time, NM, light-scattering laser photometers that simultaneously measure 6 size-segregated mass fraction concentrations corresponding to PM10, PM10/2.5, respirable, PM10, and Total PM fractions. They combine a particle cloud (total area of scattered light) and single particle detection to achieve mass fraction measurements.

This size-segregated mass fraction measurement technique is superior to either a photometer or optical particle counter (OPC). It delivers the mass concentration of a photometer and the size resolution of an OPC. Typically, photometers can be used at high mass concentration, but they do not give any size information (unless used with size selective inlet conditioners) and significantly underestimate large particle mass concentrations. OPCs provide size and count information; however, they do not provide any mass concentration information and cannot be used in high mass concentration environments. The DustTrak DRX can do both.

Handheld Models: Perfect for Walk-Through Surveys and Single Point Data Collection Applications
The DustTrak DRX handheld Model EST is lightweight and portable. It is perfect for industrial hygiene surveys, point source location monitoring, indoor quality investigations, and on-demand inspections. It is also suitable for monitoring, indoor air quality investigations, and on-demand inspections. It is also suitable for monitoring, indoor air quality investigations, and on-demand inspections.

Desktop Models: Ideal for Long-Term Surveys and Remote Monitoring Applications
The DustTrak DRX is also offered as a standard desktop (Model BESI) and in a desktop with external pump (Model BESI-EP). Both models have manual and programmable data logging functions, making them ideal for unattended applications. The standard dust top model is suitable for indoor, continuous monitoring, while the desktop with external pump is designed for 24/7 unattended, remote monitoring conditions.

The DustTrak DRX desktop models come with USB (device and host) and Ethernet, and analog and alarm outputs allowing remote access to data. User-adjustable alarm setpoints for instantaneous or 15-minute, short-term excursion limit (STEL) are also available on desktop models. The alarm output will users-defined setpoint alarm when upset or changing conditions occur.

The DustTrak DRX Desktop Monitors has several unique features:
- External pump (Model BESI-EP) with low power consumption for continuous, unattended monitoring in remote outdoor locations.
- Geometric sampling capability using 37-mm filter cassette which can be inserted in-line with the aerosol stream allowing you to perform an integral geometric analysis for custom reference calibrations.
- Zeros automatically using the external zeroing module. This optional accessory is used when sampling over extended periods of time. By zeroing the monitor during sampling, the effect of zero drift is minimized.
- STEL alarm feature for tracking 15-minute average mass concentrations when alarm setpoint has reached for applications like monitoring fugitive emissions at hazardous waste sites.
- Provide for environmental protection and tamper-proof security using an environmental enclosure. This optional accessory encloses the instrument within a waterproof, lockable, custom-designed case.
- Condition the sample air stream before entering the instrument optics using a heated/inlet sample conditioner (designed for use with the environmental enclosure) This optional accessory is used in humid environments. By conditioning the sample, the humidity and water vapor are minimized.
- Standard and advanced calibration capabilities. The DustTrak DRX Aerosol Monitor has two calibration factors: a photometric calibration factor (PCF) and a size calibration factor (SCF). The PCF accounts for the photometric response difference between A1 Test Dust and the aerosol under measurement, while the SCF accounts for the aerodynamic size difference.
- The primary goal of the standard calibration is to obtain the SCF for the aerosol of interest. The standard calibration process is very easy and does not require comparison to gravimetric samples. Measure with and without a PM2.5 impactor, and the instrument takes the ratio of these two size distributions and compares this reading to the PM2.5 impactor transmission efficiency curve to calculate the SCF. However, the absolute mass concentration may not be as accurate as the advanced calibration.
- The advanced calibration method yields high size-segregated mass concentration accuracy. It involves two separate gravimetric measurements to obtain ICF and SCF in sequence. The advanced calibration will accurately measure size segregated mass concentrations.

<table>
<thead>
<tr>
<th>Application</th>
<th>Desktop</th>
<th>Handheld</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerated research studies</td>
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<td>4</td>
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<tr>
<td>Baseline trending and screening</td>
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<tr>
<td>Engineering control evaluations</td>
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<td>Engineering studies</td>
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<tr>
<td>Epidemiology studies</td>
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<td>4</td>
</tr>
<tr>
<td>Indoor air quality investigations</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Industrial/radiation hygiene surveys</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Point source monitoring</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Outdoor environmental monitoring</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Process monitoring</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Remote monitoring</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
STANDARD OPERATING PROCEDURES

OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534

DustTrak DRX Aerosol Monitor Features
- All Models:
  - Li-Ion rechargeable batteries
  - Internal and external battery charging capabilities
  - Outlet port for倥isokinetic sampling applications
  - User serviceable sheath flow and pump filters
  - Logged test programming
  - Log and test programming
  - Display screen (either manual mode or program mode)
  - TRAKPRO™ Data Analysis Software via a PC
  - User adjustable custom calibration settings
  - Instantaneous alarm settings with visual and audible warnings
  - Real-time graph display
  - View statistical information during and after sampling
  - On-screen instrument status indicators: FLOW, LISS, and FILTER
  - Filter service indicator for user preventative maintenance

Desktop Models (8533 and 8533EP):
- Long-life external pump (8533EP)
- Internal pump (8533)
- Hot-swappable batteries
- Gasometric reference sample capability
- STEL alarm sensitivity

Optional Accessories
- Auto zeroing module
- Protective environmental enclosure (8535 and 8537)
- Heated inlet sample conditioner (for use with an environmental enclosure)
- Cloud Data Management System as hosted by Netronix™

Handheld Model (8534):
- Long-life internal pump
- Single-point data collection for walk-through surveys

Easy to Program and Operate
The graphical user interface with color touch-screen puts everything at your fingertips. The easy-to-read display shows real-time mass concentration and graphical data, as well as other statistical information along with instrument pump, laser and flow status, and much more. Perform quick walk-through surveys or program the instrument’s advanced logging modes for long-term sampling investigations. Program start times, total sampling times, logging intervals, alarm settings, and many other parameters. You can even set up the instrument for continuous, unattended operation.

TRA$PRO™ Software Makes Monitoring Easier than Ever
TRAKPRO™ Data Analysis Software allows you to set up and program directly from a PC. It even features the ability for remote programming and data acquisition from your PC via wireless communication options or over an Ethernet network. As always, you can print graphs, raw data tables, and statistical and comprehensive reports for recordkeeping purposes.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Desktop Model 8533EP and 8533EP (Typical)</th>
<th>Battery (Typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery runtime (hours)</td>
<td>Up to 24</td>
<td>Up to 48</td>
</tr>
<tr>
<td>Charge time (hours)</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Battery runtime (hours)</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting</th>
<th>Handheld Model 8534 (Typical)</th>
<th>Battery (Typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery runtime (hours)</td>
<td>Up to 6</td>
<td></td>
</tr>
<tr>
<td>Charge time (hours)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Charge time (hours)</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

* If a fully disposable battery
**SPECIFICATIONS**

**OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534**

- **Sensor Type**: 90° light scattering
- **Particle Size Range**: 0.1 to 15 μm
- **Aerosol Concentration Range**:
  - 8533EP Desktop: 0.01 to 150 mg/m³
  - 8533EP Desktop with External Pump: 0.01 to 150 mg/m³
  - 8534 Handheld: 0.01 to 10 mg/m³
- **Display**: Size segregated mass fractions for PM10, PM2.5, and TSP
- **Resolution**: 0.1% of reading or 0.01 mg/m³ whichever is greater
- **Zero Stability**: ±500 mg/m³ per 24 hours at 30°C; site-specific variability
- **Flow Rate**: 50 L/min
- **Flow Accuracy**: ±5% of factory set point, internal flow controlled
- **Temperature Coefficient**: ±1% per °C
- **Operational Temp**: 30 to 70°F (0 to 25°C)
- **Storage Temp**: -4 to 140°F (-20 to 65°C)
- **Operational Humidity**: 0 to 80% RH, non-condensing
- **Data Logging**: 24-hour on-board memory (+60,000 data points); 3-day at minimum data logging interval
- **Log Interval**: User adjustable, 1 second to 1 hour

### Physical Size (W x H x D)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Handheld</th>
<th>Desktop</th>
<th>External Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>4.8 x 4.8 x 10.5 in</td>
<td>5.5 x 5.5 x 6.6 in</td>
<td>10.5 x 10.5 x 10.5 in</td>
</tr>
<tr>
<td>Height</td>
<td>5.5 x 5.5 x 6.6 in</td>
<td>10.5 x 10.5 x 10.5 in</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>10.5 x (2.5 x 2.5 cm)</td>
<td>10.5 x (2.5 x 2.5 cm)</td>
<td></td>
</tr>
</tbody>
</table>

### Weight

<table>
<thead>
<tr>
<th>Type</th>
<th>Handheld (1.3 lb)</th>
<th>Desktop (1.6 lb)</th>
<th>External Pump (2.3 lb)</th>
</tr>
</thead>
</table>

### Communications

- **8534EP**
  - USB host and device
  - Ethernet
  - Stored data accessible using flash memory drive
- **8534 Handheld**
  - USB host and device
  - Stored data accessible using flash memory drive

### Power-AC

- Switching AC power adapter with universal line cord included.

### Analog Out

- 8533EP/8534EP
  - User selectable output: 0 to 5 V or 0 to 20 mA
  - User selectable scaling range

### Alarm Out

- 8534EP
  - Relay or audible buzzer
  - Relay: Non-latching 250 VAC switch
  - Audible: 85 dB
  - Connector: 4-pin, 250 VAC connector

### Screen

- 8534EP
  - 5.7 in VGA color touchscreen

### Geometric Sampling

- 8534EP
  - Removable 37 mm cartridge (user supplied)

### CF Rating

- Immunity
- EMI/RFI

TSI Incorporated - Visit our website www.tsi.com for more information.

- USA: Tel: +1 800-874-3813
- UK: Tel: +44 1494 450200
- France: Tel: +33 4 38 81 87 64
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APPENDIX B
Theory of Operation
SOP: ERT-PROC-2078-20
June 2020
DUSTTRAK™ DRX AEROSOL MONITOR THEORY OF OPERATION

APPLICATION NOTE EPNMN-002

The Models 8533 and 8534 are not versions of the basic DustTrak™ II Aerosol Monitor, they are advanced versions known as the DRX models. The DustTrak Model 8533 is a desktop instrument while the Model 8534 is a handheld. The primary difference between the basic single-channel DustTrak™ II photometer and the Advanced DRX models is in the ability of the DRX advanced models to measure size fractions of the sampled aerosol in addition to making a mass based photometric measurement. This employs a patented patenting method to simultaneously measure size segregated mass fraction concentrations (PM₁₀, PM₂₅, PM₁₀⁻₂₅, Respirable/PM₁₀, PM₁₀⁻₂₅/Thoracic, and TPM) over a wide concentration range (0.001-150 mg/m³) in real time. This method combines a photometric measurement to cover the mass concentration range and a single particle detection measurement to be able to size discriminate the sampled aerosol.

The schematic is very similar to that of the basic DustTrak™ II Aerosol Monitor. Aerosol is drawn in to the sensing chamber in a continuous stream using a diaphragm pump. Part of the aerosol stream is split ahead of the sensing chamber and passed through a HEPA filter and injected back in to the chamber around the inlet nozzle as sheath flow. The remaining flow, called the sample flow passes through the inlet entering the sensing chamber. Here, it is illuminated by a sheet of laser light. This sheet of laser light is formed by a laser diode. First, the light emitted from the laser diode passes through a collimating lens and then through a cylindrical lens to create a thin sheet of light. A gold coated spherical mirror captures a significant fraction of the light scattered by the particles and focuses it on to a photodetector.

The signal processing is however very different from a typical photometer. Although the voltage across the photodetector, which is proportional to the mass concentration, is used to determine the concentration of the aerosol, the individual pulses from the photometer are also used to make single particle measurements. As shown in the schematic below, the photodetector signal is separated in to two components: the photometric signal and the single particle pulses. The voltage across the photodetector is proportional to the PM₁₀ fraction of the total sampled aerosol over a wide range of concentrations. The voltage is then multiplied by a calibration constant which is determined from the ratio of a known PM₁₀ mass concentration of the test aerosol to the voltage response of the DustTrak DRX Aerosol Monitor. Typically, the test aerosol is Arizona Test Dust (or ISO 12103-1, A1 test Dust). The single particle pulses are calibrated to measure the aerodynamic size of the A1 test dust. To reduce coincidence error, only particles greater than 1 μm are recorded. The particle mass is calculated and recorded in one of the four size segregated mass fractions (PM₁₀, PM₁₀⁻₂₅, Respirable/PM₁₀, PM₁₀⁻₂₅/Thoracic, and TPM). The size segregated mass concentration is obtained as follows:

\[
PM₁₀ = PM₁₀⁻₂₅ - PM₁₀⁻₄₅ \\
PM₁₀⁻₂₅ = Photometric signal \times \text{calibration factor} \\
Respirable/PM₁₀ = PM₁₀ + PM₁₀⁻₄₅ \\
PM₁₀⁻₂₅/Thoracic = PM₁₀ + PM₁₀⁻₄₅ \\
TPM = PM₁₀ + PM₁₀⁻₄₅
\]

DustTrak™ II and DustTrak DRX are trademarks of TSI Incorporated.
The algorithms used by the DustTrak DRX Aerosol Monitor yield a mass measurement technique that is superior to either a basic photometer or Optical Particle Counter (OPC). While photometers can be used at high mass concentrations, they do not give any size information (unless used with size selective inlet conditioners) and significantly underestimate particle mass contributed by large particles. On the other hand, OPCs provide size information, however they cannot be used at high mass concentration. The DustTrak DRX Aerosol Monitor is able to combine the advantages of both the measurement techniques to improve the overall accuracy of the mass measurement.

The DustTrak DRX Aerosol Monitor is able to measure mass concentrations with greater accuracy because of its ability to measure single particles >1 μm, since the photometric signal is less sensitive to large particles. In addition, the DustTrak DRX compensates for coincidence error using a dead-time correction algorithm. Furthermore, the DustTrak DRX Aerosol Monitor corrects the single particle pulses to aerodynamic size by proprietary factory or custom calibrations, significantly reducing mass calculation errors due to particle density, refractive index and shape in the calculated mass concentration. As a result, the DustTrak DRX Aerosol Monitor size segregated mass fraction measurement has the size resolution of an OPC along with a much higher mass concentration range like a typical photometer.

Although the DustTrak DRX monitor comes with a couple of calibration impingers, they are recommended for use only during custom calibrations. The greatest advantage of using the DustTrak DRX Aerosol Monitor over other photometers in the market including the DustTrak II Aerosol Monitor basic is the lack of need for a size-selective inlet conditioner. PM₁₀, PM₂.₅, Respirable PM₁₀, PM₁₀Thoracic and TPM fractions can all be measured simultaneously without the use of any size-selective inlet conditioners.

To improve the accuracy of the mass measurement, the unit can be calibrated with gravimetric sample(s) by conducting side-by-side comparisons with the DustTrak DRX Aerosol Monitor readings to gravimetric samples. On the Desktop Model 8533, a 37-mm filter cassette sampler can be inserted in-line with the aerosol stream at the outlet of the optics chamber allowing the user to perform a gravimetric analysis without the need for using an external pump and filter holder.
At TSI, the DustTrak DRX Aerosol Monitor is calibrated against a reference photometer (Model 8587) that is gravimetrically calibrated to ISO 12103-1, A1 test dust (Arizona Test Dust). This test dust has a wide size distribution covering the entire size range of the DustTrak DRX Aerosol Monitor and is representative of a wide variety of ambient aerosols.

The optics inside the DustTrak DRX Aerosol Monitor is kept clean by surrounding the aerosol stream with a sheath of clean filtered air. This sheath air confines the aerosol to a narrow stream and prevents particles from circulating around the optics chamber and depositing on the optics. It reduces coincidence errors in the single particle measurements and make the pulse height more uniform by retaining the particles within the Gaussian profile of the laser beam that produces more uniform pulse widths regardless of where the particles enter the inlet nozzle. Sheath flow also improves the response time of the instrument. The user can also access the sheath and main flow filters that need to be changed periodically to maintain the flow ratio between the sample flow and sheath flow at constant. The DustTrak DRX’s firmware will automatically detect the life of those filters and warn the user to change them before the pressure drop across those filters become excessive.
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534
APPENDIX C
Relative Humidity Setting on the Heated Inlet
SOP: ERT-PROC-2078-20
       June 2020
WHAT RELATIVE HUMIDITY SETTING
DO I USE WITH THE HEATED INLET

Introduction
The Heated Inlet Sample Conditioning module is designed to maintain a constant relative humidity level in the sample air stream before entering the Environmental DustTrak optics. The module uses a Relative Humidity/Temperature sensor to measure the atmospheric conditions. The module is programmed to maintain the necessary temperature to control the R_h to the selected set point during the aerosol capture time through the module.

The TSI Heated Inlet Sample Conditioning Module can be set to condition the sample to 30%, 40% and 50% relative humidity.

Setting Selection
What setting do I choose? This question goes back to the approved federal reference method and analytical methods for measuring ambient aerosol in the region.

- In the US, the EPA requires humidity control to 30-40% for PM10 particle sampling, and 35% for PM2.5 particle sampling.
- In the UK, EN12341 requires humidity control to 50% ± 5% for PM10 particulates, and 30-40% for PM2.5 particulates.

The NIOSH Analytical Method 0600 for Particulates, not otherwise classified, Respirable, specifies the sample filter media be equilibrated in an environmental chamber at 20°C ± 1°C and 50±5% Relative Humidity.

Summary

<table>
<thead>
<tr>
<th></th>
<th>Outdoor environmental sampling for PM2.5</th>
<th>35% R_h</th>
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<tbody>
<tr>
<td>Outdoor environmental sampling for PM10</td>
<td>30-40% R_h</td>
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</tr>
<tr>
<td>Occupational Exposure sampling for respirable dust</td>
<td>50% R_h</td>
<td></td>
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<tr>
<td>UK</td>
<td>Outdoor environmental sampling for PM2.5</td>
<td>30-40% R_h</td>
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<tr>
<td>Outdoor environmental sampling PM10</td>
<td>50% R_h</td>
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APPENDIX D
Heated Inlet for Environmental Enclosure
SOP: ERT-PROC-2078-20
June 2020
Thank you for purchasing a DustTrak™ Aerosol Monitor Heated Inlet Accessory. This guide will help you quickly begin using your Heated Inlet.

Unpacking
1. Carefully unpack the Heated inlet shipping container and verify that all the items listed in the following table are present.
2. Contact TSI immediately if items are missing or broken.
3. Additional items may be included if you ordered accessories or spare parts.

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Item Description</th>
<th>Reference Picture</th>
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<tbody>
<tr>
<td>1</td>
<td>Heated Inlet Column</td>
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</tr>
<tr>
<td>1</td>
<td>Temp/RH Probe</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Temp/RH Grommet</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Power Cable – Model 8535</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Power Cable – Model 8537</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>90° Inlet</td>
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</tr>
<tr>
<td>1</td>
<td>Mounting Bracket Model 8536</td>
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</tr>
<tr>
<td>1</td>
<td>Mounting Bracket Model 8537</td>
<td></td>
</tr>
</tbody>
</table>

Preparation of Environmental Enclosure (8535) for Heated Inlet

1. The Environmental Enclosure may need a hole feature added, if purchased prior to ordering the Heated Inlet.

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DustTrak is a trademark of TSI Incorporated. Velcro is a registered trademark of Velcro Industries B.V.
2. The Environmental Enclosure Bracket may need two holes added. Check the back left section of the large black sheet metal bracket for the installed 6-32 PEM nuts.

3. If they are present, no modification is needed.
4. If there are no 6-32 PEM nuts installed in the bracket, drill two Ø.189 holes as indicated in the drawing below.

5. Then use two 6-32 locking nuts on the back side of the flange when attaching the "Mounting Bracket."

3. Install the Heated Inlet on top of the Auto-Zero Module.

4. If the Enclosure has the 6-32 PEM nuts, install the "Mounting Bracket" as shown—do not tighten.

5. If the Environmental Enclosure does not have the PEM nuts, install the "Mounting Bracket" using the 6-32 nuts—do not tighten.

6. Attach the Mounting Bracket to the Heated Inlet with 6-32 thumbscrews—do not tighten.

7. Approximately level the Heated Inlet and tighten all screws.

8. Attach inlet tube to Heated Inlet.

10. Push Temp/RH Probe through grommet and attach cable. Tighten grommet to secure probe with the sintered cover extending ¾ (19mm) past the grommet.

11. Attach Power Cable for Model 8535 to incoming power, DustTrak monitor, and Heated Inlet.

Installing Heated Inlet - Model 8537

1. Connect the Power Cable for Model 8537 to back panel.

2. Insert the DustTrak monitor with Zero Module into its tray.

3. Attach the DustTrak monitor to the tray with the Velcro® strap.

4. Cut black inlet tubing to 7" length.

5. Mount the Impactor (optional), the inlet fitting and connect the tubing.

6. Attach the bracket-8537 to the Heated Inlet Assy.


8. Align slots of bracket to holes in back panel and insert thumbscrews.

9. Check that Heated Inlet sits horizontal and tighten mounting thumbscrews.
10. Push Temp/RH Probe through grommet and attach cable. Tighten grommet to secure probe with the sintered cover extending 1/8" (3 mm) past the grommet.

11. In areas with intense sun it may be necessary to use the "Temp-Humidity-Screen" to obtain correct ambient temperature and humidity measurements. The screen easily clamps on the temperature humidity probe as shown. Make sure the "clamp" portion of the screen is in contact with the solid stainless steel part of the probe and is not touching the sintered part (see pictures of probe).

12. Attach the power cable to the Heated Inlet.

---

### Operating Instructions

1. When powered and attached to the DustTrak monitor, the Heated Inlet will automatically function.
2. Select RH set point that will be controlled at the entrance to DustTrak monitor to be 30, 40 or 50% RH via the DIP switches. Heated Inlet will then power heaters to heat incoming air and thereby decrease RH to the targeted level.

---

### The LED describes the status of the heated inlet:

| Solid Green | Inlet temp. is > 1°C below set point and controlling to maintain set point. |
| Blinking Green | Inlet temp. is between -1 to -5°C of set point and controlling to improve. |
| Blinking Red | Inlet temp. is more than 5°C below set point and controlling to improve. This will occur when unit is first turned on and coming to temperature. |
| Solid Red | Sensor unplugged or has issue. |

---

### Warning Labels

![Warning Label](image)

Warms that the instrument could be hot to the touch or a burn hazard.

---

### Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>12 Volts DC, 13 Watts</td>
</tr>
<tr>
<td>Dimensions</td>
<td>7.6” x 3.5” x 2.3”</td>
</tr>
<tr>
<td>Weight</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Temp Range</td>
<td>0 to 50°C</td>
</tr>
<tr>
<td>RH Range</td>
<td>0 to 60%</td>
</tr>
<tr>
<td>RH Set Points</td>
<td>30% RH, 40% RH, 50% RH</td>
</tr>
<tr>
<td>Warm-up Time</td>
<td>17 minutes</td>
</tr>
<tr>
<td>CE</td>
<td>IEC 61326 &amp; IEC 61015-1</td>
</tr>
</tbody>
</table>
APPENDIX E
Troubleshooting
SOP: ERT-PROC-2078-20
June 2020
### Operation of the DustTrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erratic zero reading</td>
<td>Leak</td>
<td>Check connections for leaks. Replace zero filter.</td>
</tr>
<tr>
<td></td>
<td>Dirty inlet port and/or sample tube</td>
<td>Clean inlet port. Clean or replace tubing.</td>
</tr>
<tr>
<td></td>
<td>Internal filter(s) not installed properly (leaking)</td>
<td>Inspect internal filter wells to make certain the filters and O-rings are seated properly. Replace internal filters if necessary.</td>
</tr>
<tr>
<td>DustTrak reading negative</td>
<td>Zero Drift</td>
<td>Perform Zero Cal.</td>
</tr>
<tr>
<td>concentrations</td>
<td>Zero Cal was performed without the Zero Filter in-line</td>
<td>Perform Zero Cal again and make sure the Zero Filter is attached to the DustTrak inlet.</td>
</tr>
<tr>
<td>Error completing Zero Cal</td>
<td>Too much light scatter in the optics chamber due to dust deposits</td>
<td>Clean the inlet nozzle. Attach the zero filter and sample for about 2 minutes. During sampling, pulse the flow going into the DustTrak monitor by intermittently plugging the zero filter. Any dust in the optics chamber will break loose during flow pulsations and will be cleared out by the pump. Perform Zero Cal again. If the Zero Cal still cannot be performed, factory service may be required.</td>
</tr>
<tr>
<td>Run Mode Error: The start time has passed</td>
<td>The selected Run Mode program has “Use Start Date” selected, but the start date is prior to the current date</td>
<td>Correct or change the run mode program.</td>
</tr>
<tr>
<td>Run Mode Error: The selected log mode will exceed the allowed number of samples</td>
<td>The selected Run Mode program is programmed to save more samples then is room in memory</td>
<td>Reduce the number of samples by reducing the test length or increasing the logging interval.</td>
</tr>
<tr>
<td>Instrument runs slow</td>
<td>Large amount of data in memory</td>
<td>Large data files or many small data files will cause instrument to slow, due to need to read and display large amounts of data.</td>
</tr>
<tr>
<td>No display</td>
<td>Unit not switched on</td>
<td>Switch unit on.</td>
</tr>
<tr>
<td></td>
<td>Low or dead batteries</td>
<td>Recharge the batteries or plug in the AC adapter.</td>
</tr>
</tbody>
</table>
### Operation of the DustTrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No touch-screen response</td>
<td>Instrument currently busy</td>
<td>The instrument will take time to open large data files and save configuration information. During this time, the instrument will not respond to additional touch-screen touches</td>
</tr>
<tr>
<td></td>
<td>Instrument Touchscreen is locked</td>
<td>If the lock in the title bar is red, unlock the instrument following the instructions in Appendix A, DustTrak DRX User’s Manual (Chapter 3, Operation: Title Bar section).</td>
</tr>
<tr>
<td>Analog output does not work</td>
<td>Cable/connector not correctly installed</td>
<td>Make sure cable connector is fully seated.</td>
</tr>
<tr>
<td></td>
<td>Output wired with reverse polarity</td>
<td>Make sure analog out (+) and analog ground (-) are wired correctly to data-logger.</td>
</tr>
<tr>
<td>Analog output is not in proportion to display</td>
<td>Analog output range in DustTrak monitor may be set incorrectly</td>
<td>Check analog output setting in the Setup-&gt;Analog screen. Make sure the channel of interest is selected. Make sure that the correct output (0 to 5V, 4 to 20 mA) is selected.</td>
</tr>
<tr>
<td></td>
<td>Data logger scaling factor may be set incorrectly</td>
<td>Review the scaling factor set in the Setup-Analog screen.</td>
</tr>
<tr>
<td>Alarm output does not work</td>
<td>Alarm does not turn on correctly</td>
<td>Turn the alarm function on in the Settings-&gt;Alarm screen.</td>
</tr>
<tr>
<td></td>
<td>Alarm function not turned on</td>
<td>Check the alarm settings in the Settings-&gt;Alarm screen.</td>
</tr>
<tr>
<td></td>
<td>Alarm setting incorrect</td>
<td>Make sure the logging interval and time constant are set as short. as possible (30 seconds or lower)</td>
</tr>
<tr>
<td></td>
<td>Alarm output wired with reverse polarity</td>
<td>Alarm wires are polarized. Voltage input must be wired to alarm input (+).</td>
</tr>
<tr>
<td>Instrument does not store new data</td>
<td>Memory is full</td>
<td>Delete or transfer historic data.</td>
</tr>
<tr>
<td></td>
<td>Instrument is in Survey mode</td>
<td>The instrument does not store data in survey mode. Can to manual or program log mode.</td>
</tr>
</tbody>
</table>
# Operation of the Dusttrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Error is indicated on front screen</td>
<td>If sampling from a duct, instrument may have problems overcoming pressure differences</td>
<td>Attach both the input and the exhaust port into the duct.</td>
</tr>
<tr>
<td></td>
<td>Flow obstruction</td>
<td>Remove obstruction if still present. Press any key to bypass.</td>
</tr>
<tr>
<td></td>
<td>Internal pump failing, indicated by inability to adjust flow rate to full range</td>
<td>Factory service may be required.</td>
</tr>
<tr>
<td></td>
<td>Filter Cassette clogged or has mass loading</td>
<td>Replace the filter cassette. See Section 7.3.4.</td>
</tr>
<tr>
<td>Laser Error indicated on front screen</td>
<td>External pump module (for Model 8533EP only) is not connected to the DustTrak monitor</td>
<td>Make sure both the External Pump cable and the flow tubing connector are connected to the DustTrak monitor and the External pump module. Lock the External Pump Cable in place by rotating the connector clockwise until you hear it snap in place. Make sure the tubing between the DustTrak monitor and the External pump module is not kinked and is free of any sharp bends. Make sure the exhaust adapter is connected to the exhaust of the DustTrak monitor. Make sure the External Pump module filters are not clogged. If found dirty, replace the two HEPA filters.</td>
</tr>
<tr>
<td></td>
<td>Laser background is too high</td>
<td>Remove and clean inlet nozzle. Pay close attention to the tip of the nozzle that is inserted into the instrument to ensure it is clear of any contamination.</td>
</tr>
<tr>
<td></td>
<td>Laser is failing</td>
<td>Factory service may be required.</td>
</tr>
</tbody>
</table>
### Operation of the Dusttrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Error indicated on front screen</td>
<td>Filters need to be replaced</td>
<td>Replaced the filters per instructions in the maintenance section of this manual. Make sure to reset the filter mass and date once the filters have been changed. Note: This is only a warning. The unit will continue to operate normally until the increase in pressure drop across the filter is so high that the pump can no longer maintain the set flow rate.</td>
</tr>
<tr>
<td>System Error has Occurred!</td>
<td>The processor did not receive the input it expected. This can also happen if the optics chamber is saturated with light, or the External Pump Cable is accidentally disconnected during the middle of sampling.</td>
<td>Reboot the instrument. If the error does not go away, factory service is required.</td>
</tr>
</tbody>
</table>
APPENDIX F
Viper Guide for DustTrak DRX8533
SOP: ERT-PROC-2078-20
June 2020
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534
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CONFIGURING THE DUSTTRAK DRX 8533 2
  Background 2

SETUP WITHOUT EXTERNAL POWER TO THE LINC 2
  Part Needed 2
  Hardware Connections 3

SETUP WITH EXTERNAL POWER TO LINC 5
  Parts Needed 6
  Hardware Connections 6
  Helpful tips 9
CONFIGURING THE DUSTTRAK DRX 8533

Background

The DustTrak DRX8533 can work with Viper using either a Gen 2 LINC or Gen 3 LINC. The Gen 3 LINC can receive power from the DustTrak USB Port. The following guide addresses both configurations and what parts are needed for both.

SETUP WITHOUT EXTERNAL POWER TO THE LINC

Part Needed

To connect the DustTrak to a Gen 2 LINC (internal battery power only), the following part is necessary:

- USB to SERIAL Adapter.
  NOTE: Although there may be many USB to Serial Adapters on the market, ERT has tested and recommends the CH340X USB to Serial (USB-D232 to RS232) with the DustTrak setup.
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534

Hardware Connections

1. Connect the LINC Cable (Gen 2 - 3-Pin Data Cable Connection) to the USB to Serial Adapter.

2. Plug the USB connection into the left side of the instrument, behind the rubber protective plug—second (2nd) port—on the DustTrak instrument.
Once VIPER Survey Controller is running, data streams from the instrument to the LINC, without modification to the DustTrak while it is in Run Mode.
 SETUP WITH EXTERNAL POWER TO LINC

Parts Needed

Both internal (battery source) and external power sources can be configured on the Gen 3 (7-pin) LINC through the mini-USB on the bottom of the Gen 3 LINC.

To connect the DustTrak to a Gen 3 LINC (internal/external power), the following parts are necessary:

- USB A to USB Mini 5 Pin Cable. Note: ERT has tested and recommends cables from www.firefold.com, 3A USB to USB Mini Cable – 5 pin.

- USB A to USB A multiport splitter Hub. Note: This equipment is only needed when external power to the LINC is needed from the instrument. ERT has tested and recommends the Sabrent SA HB-UMLS 4-port hub with individual switches available from www.sabrent.com.

ERT Support: 800-993-6960
1. Connect the 4-port USB Multipoint Splitter (Hub) to the 2nd Port on the DustTrak.
2. Connect the USB A to USB mini-5 Pin Cable from the Gen 3 LINC (mini USB) to the USB Port Splitter (Hub). This provides power to the Gen 3 LINC.

3. Connect the LINC Cable (7-Pin) to the USB to Serial Connector and plug into the USB Port Splitter.
OPERATION OF THE DUSTTRAK AEROSOL MONITORS; DESKTOP DRX MODEL 8533EP AND HANDHELD DRX MODEL 8534

Once VIPER Survey Controller is running, data streams from the instrument to the LINC, without modification to the DustTrak while it is in Run Mode.
Helpful tips

- The LINC Baud rate must be set to 9600.
- Only Gen 3 LINCs can be powered through the mini USB port on the bottom.
- If Survey Controller turns green and then immediately grays out, there is a problem with one of the cables (either LINC Cable or the USB A to USB Mini 5 pin cable).
- By default, the DustTrak MeterApp will not launch full screen. To have the MeterApp launch full screen automatically, unlock the MeterApp. On the Data Input Settings tab, put a checkmark in the 'Popup on Connect'. The MeterApp will launch full screen on the next run.
• To help maintain better connectivity, we suggest that the TCP Timeout timer for the LINCs connected to the DustTraks be changed from 5 seconds to 0 (zero). The TCP Timeout setting for Serial Port 1 can be found under the Configuration Tab in the Connection Settings option. Please see below.

• The DustTrak instruments display numerous sensors in Deployment Manager. Sensors that do not need to be displayed (i.e., SN, Firm, Model, etc.) can be turned off in Deployment Manager and will not view in Deployment Manager. Below are example screen shots showing all sensors being displayed and sensors being turned off and not displayed. Please call 1-800-999-6990 or email srtsupport@epa.gov to modify how your sensors are displayed in Deployment Manager.

Example: All Sensors Displayed in Deployment Manager

Example: Sensors turned off and not Displayed in Deployment Manager
Recommend running the MeterApp at a 2 second polling rate. Running it at a 1 second polling rate does not allow the TSI's com port buffer to completely empty before asking for another reading. To change the polling rate, unlock the MeterApp. Under the Data Input Settings, change the Poll Rate (ms) to 2000 as the default. NOTE: This is only an issue with the serial I/O (9600 MHz) not using IP packet LinCs.
APPENDIX G
Maintenance Worksheet
SOP: ERT-PROC-2078-20
June 2020
NOTE: To charge battery, Unit must be plugged in, turned on and in standby mode. Battery will not charge when unit is off or when pump is running.

MONTHLY DUSTTRAK DRX CALIBRATION CHECKLIST
(New 11/16)

<table>
<thead>
<tr>
<th>Task</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform Zero Check</td>
<td>Monthly</td>
</tr>
<tr>
<td>Clean 2.5 μm calibration impactor</td>
<td>And: Before Each Use or When negative values are displayed. Before each use of impactor (not regular part of maintenance)</td>
</tr>
<tr>
<td>Clean Inlet</td>
<td>Quarterly, if unit has been used. Or, every 350 hours at 1 mg/m³ concentration (Equals 2 weeks of 24-hour operation or 30 12-hour days). This is concentration dependent, i.e. 700 hours at 0.5 mg/m³. 350 hours at 1 mg/m³, or when filter error light indicates</td>
</tr>
<tr>
<td>Replace Internal filters</td>
<td>Annually</td>
</tr>
<tr>
<td>Return to factory for cleaning and calibration – send both the DustTrak AND the External Pump Replace the internal HEPA filters in the External Pump Module</td>
<td>Annually-have done during annual cal</td>
</tr>
</tbody>
</table>

Maintenance

Zero Instrument
1. Set up instrument with external pump
2. Attach zero filter to inlet
3. Press Zero Cal button from Setup menu
4. Press Start
5. Wait for countdown, screen should indicate “Zero Cal Complete” when finished

Zero Calibration completed (Monthly)? YES/NO
Time and Date Verified/Set? YES/NO

Internal Filters Replaced (As Necessary)? YES/NO
If “YES”, was filter count re-set? YES/NO
From Setup Screen: (Check on “Cum Filter Mass,” in Setup and follow directions)
Filter Last changed: ___

Inlet Clogged (As Necessary)? YES/NO
Unit Discharged (Once per Quarter)? YES/NO
External Batteries Charged (Monthly)? YES/NO
APPENDIX H
Particulate Monitoring Worksheet
SOP: ERT-PROC-2078-20
June 2020
# Operation of the DustTrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534

**Air Monitoring Work Sheet**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>EPA #</th>
<th>Location/Description</th>
<th>Reading</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**General Comments:**