# Model 200
# Personal Environmental Monitor
# (PEM™)
# User Guide

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PEM-200-6000 Rev. A, March 2006
US Pat. # 4,827,779

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# 1. INTRODUCTION

**SAVE THESE INSTRUCTIONS** - This User Guide contains important safety and operating instructions for the Model 200 Personal Environmental Monitor, PEM™. Any use other than that prescribed by the manufacturer in this user guide is not proper use of the Model 200 PEM™.

The Model 200 Personal Environmental Monitor, PEM™, is a single-stage impactor with an after-filter. The impactor stage removes particles larger than the cut size (either 2.5-µm or 10-µm aerodynamic diameter), and the smaller particles are collected on the after-filter. The particles on the impaction ring (those larger than the cut size) are normally discarded, and the particles collected on the after-filter are available for gravimetric and/or chemical composition analysis. The PEM™ can be used to obtain personal exposure data while the wearer goes about his/her normal activities. An appropriate personal sampling air pump worn by the user is necessary to provide the necessary air flow. See Appendix B for typical PEM™ pressure drops.

**TECHNICAL NOTE:** Six versions of the Model 200 PEM™ are available from MSP. There are two impactor cut sizes, either 2.5 µm or 10 µm aerodynamic diameter, and each particle cut size can be achieved at three different flow rates: 2, 4, or 10 L/min. The specific cut size and flow rate for each PEM™ configuration are stamped inside the nozzle cap. Figure 1 below shows the six PEM™ versions. Each PEM™ version is manufactured in a different color to facilitate proper identification by the user.

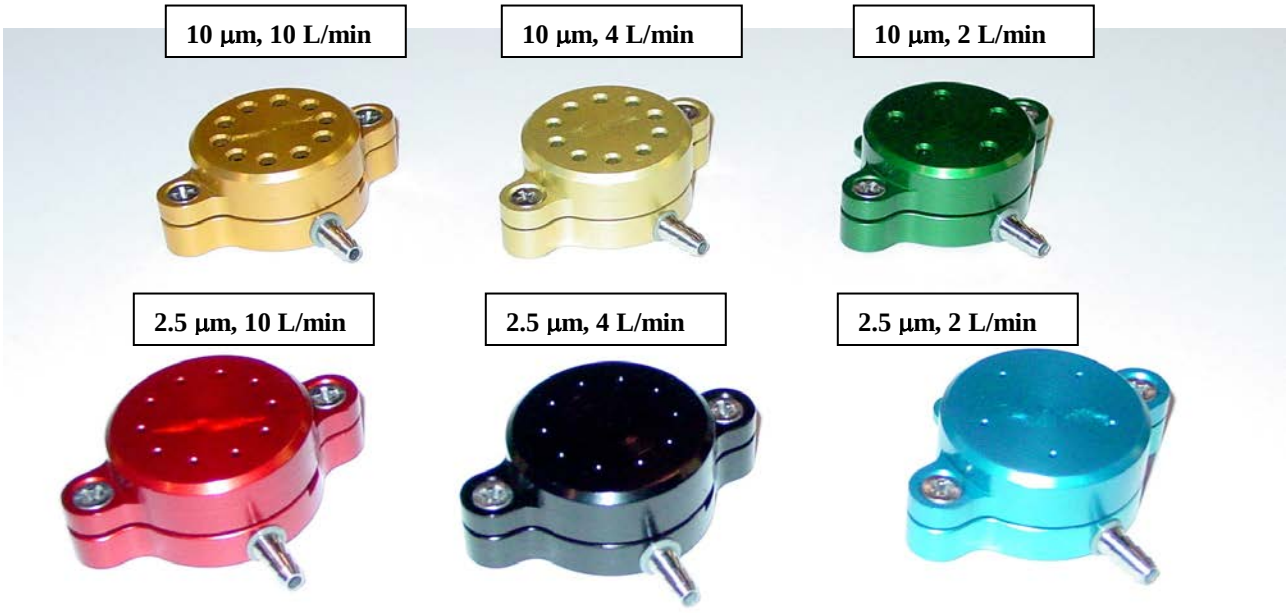


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**Figure 1. PEM™ Configurations**

## 2. UNPACKING INSTRUCTIONS

Carefully remove the Model 200 PEM™ from its shipping box and visually inspect the PEM™ for any damage it may have suffered in transit. Please contact your shipping company if any damage is noted. The Model 200 PEM™ is shipped with this User Guide.

## 3. PRINCIPLE OF OPERATION

The operation of the PEM™ is based on the inertial separation of airborne particles using a conventional single-stage impactor. For more information on impactors, see Marple (2004). In this device the particle-laden air is accelerated through a number of identical nozzles, and the exiting jets impinge upon a porous metal ring. The large particles, because of their inertia, cross the air streamlines and impact on the ring, and the small particles are carried along the air streamlines and are collected on the after-filter.

## 4. DESCRIPTION OF THE MODEL 200 PEM™

A schematic diagram of the Model 200 PEM™ is shown in Figure 2. The sampler consists of three basic parts: a nozzle cap, an impaction ring assembly, and a base. The impaction ring serves both as an impaction surface and as a clamping ring for the after-filter. The after-filter is supported by the filter support screen and the base.

The impactor stage has 5 or 10 nozzles, depending on the flow rate and cut size, located in a circle along the outer edge of the nozzle cap. Air passing through these nozzles impinges on the annular impaction surface. This annular disk of porous stainless steel is cemented onto the ring that clamps the after-filter to the base.

The clamping force is applied by attaching the nozzle cap, forcing the after-filter hold-down ring onto the outer edge of the filter. This force clamps the after-filter to the filter support screen and base to aid in forming a seal between the filter and the base.

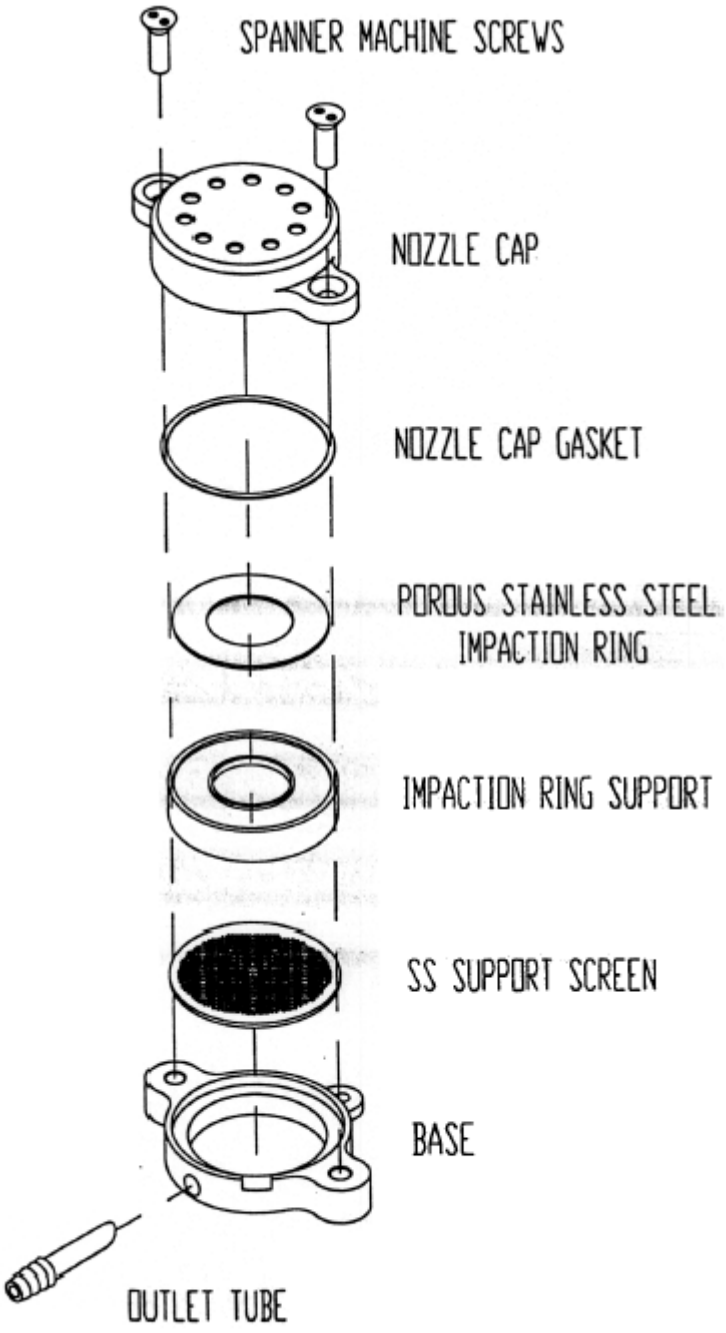


**Figure 2. Schematic Diagram of Personal Environmental Monitor (PEM ™). Phillips flat head screws are normally used instead of the spanner screws.**

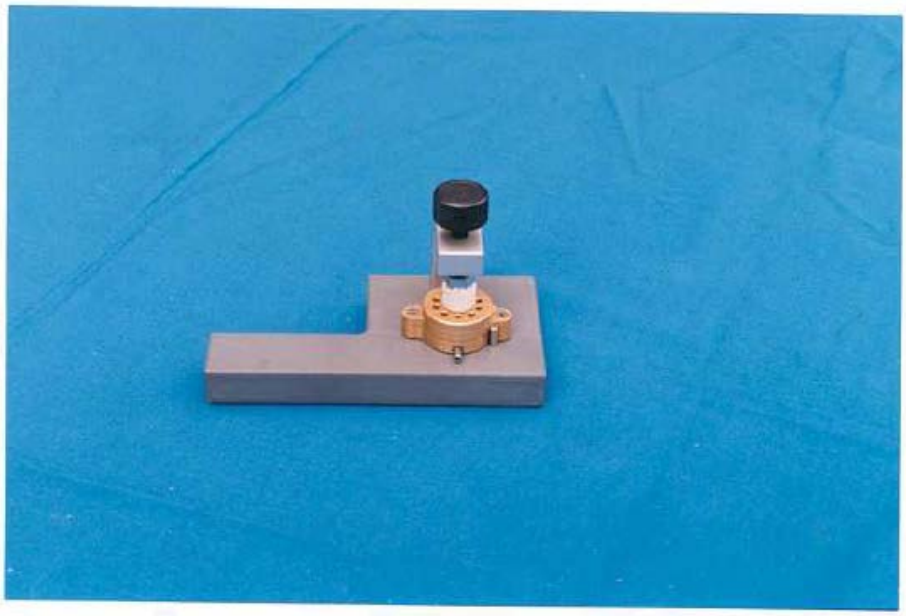

**Figure 3. Model 200 PEM™ in Clamping Device**

**Figure 4. Assembled Model 200 PEM™.**

# 5. OPERATION

## 5.1 Disassembly Procedure

The Model 200 PEM™ is disassembled by removing the two screws holding the nozzle cap to the base. Optional spanner screws (flat head with two holes) and matching screw driver could be used for applications where there is a risk of the wearer opening the sampler. After the screws are removed, the nozzle cap is lifted straight up and clear of the impaction ring assembly. Next, the impaction ring assembly is removed exposing the after-filter.

## 5.2 Coating the Impaction Plate

To keep the particles from bouncing off the impaction ring, light mineral oil should be applied to this surface.

For most sampling applications, saturating the porous metal with a light mineral oil is best. As the particles strike the ring, the oil will wick up through the deposit and continually provide a fresh surface for new particles to strike. The oil can be applied to the ring with an eye dropper by placing the drops evenly about the disk. Fourteen drops is about the maximum that the plate will hold. When it takes 5 to 10 seconds for a drop to disappear into the ring, the ring is saturated, and no more oil should be added. Excess oil can be removed from the ring by touching a tissue to the porous surface. If oil drips from the ring when it is held vertically, too much has been applied.

After each use, the particles on the impaction ring should be removed by scraping the surface with a knife or razor blade and, periodically, more oil should be added. An alternate technique is to remove all the oil and re-coat the ring after each run. Oil can be removed from the ring by placing it in a soap solution or in a solvent such as cyclohexane, and then rinsing and drying completely.

If the particles are very coarse, such as sand, they may still bounce from the oiled ring. In this case a thin layer of grease (i.e. heavy-duty silicon grease) should be spread on the surface of the impaction ring. This grease will have to be removed and replaced between runs.

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## 5.3 Assembly Procedure

To assemble the PEM™, a filter support screen and a 37-mm filter are placed in the base, and the impaction ring assembly is set on top of the filter. Next, the nozzle cap is placed over the impaction ring assembly, and the nozzle cap is attached to the base with two 8-32x1/2" flat-head screws. When tightening the screws care must be taken to ensure that the same torque is applied to both screws.

Another way of assembling the Model 200 is with the PEM™ Clamping Device shown in Figure 3. This device insures that the nozzle cap is clamped parallel to the base and that the correct clamping force is applied to the after-filter. The handle of the clamping device is turned until the clutch in the handle slips. The screws are tightened, and the sampler is now completely assembled (Figure 4) and can be removed from the clamping device.

## 5.4 Operating Procedure

First, the PEM™ is disassembled, as described above, and the parts are cleaned. The nozzle cap can be cleaned by rinsing it with isopropyl alcohol. After the parts are cleaned, the filter support screen and filter are placed in the base and assembled as described above.

**TECHNICAL NOTE: The porous metal impaction ring needs to be coated as described in Section 5.2 to eliminate particle bounce.**

After assembly is completed, the vacuum source (personal sampling pump) is attached to the PEM™ outlet, drawing either 2.0, 4.0 or 10 L/min through the Model 200 PEM™. A PEM™ calibration cap (sold separately by MSP as an accessory) can be used to measure the flow rate at the inlet of the Model 200 PEM™. See Appendix A for the proper use of the PEM™ Calibration Cap and Appendix B for typical PEM™ pressure drops.

**TECHNICAL NOTE: The inlet flow rate to the Model 200 PEM™ must be measured and controlled to within ± 5% of the specified flow rate. The specified cut size for the Model 200 PEM™ is valid as long as the required flow rate is maintained by the sampling pump throughout the complete sampling period.**

The total sampling time depends on the flow rate of the specific PEM™ and on the particle concentration at the selected sampling location. A typical sampling time is 8 hours to determine the 8-hr average concentration at a work-place environment.

## 6. SPECIFICATIONS

| | |
|---|---|
| Sampling flow rate: | 2.0 L/min, 4.0 L/min, or 10.0 L/min |
| Cut-point aerodynamic diameter: | 2.5 μm or 10 μm |
| Filter diameter: | 37 mm |
| Dimension (L x W x H): | 60 x 65 x 22 mm (2.3” x 2.5” x 0.9”) |
| Weight: | 48 g (1.7 oz) |

## 7. WARRANTY

MSP Corporation warrants the Model 200 Personal Environmental Monitor, PEM™, for a period of twelve (12) months from the date of shipment, and will, at its option, repair or replace parts which are found to be defective in material or workmanship during this period. Warranty service and after-warranty service is to be completed at MSP, Shoreview, Minnesota, or at an MSP-authorized service contractor.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced, or removed.

## 8. SPARE PARTS & ACCESSORIES LIST

All replacement parts must be factory approved. Call the manufacturer for details. MSP Corporation, Shoreview, Minnesota. Voice: (651) 287-8100. FAX: (651) 287-8140.

| Item No. | Description | MSP Part No. | Quantity |
|---|---|---|---|
| 1. | Kit of nozzle cap gaskets (4) | 0200-82-0001A-X | 1 |
| 2. | SS Filter support screen | 0200-81-0017A-X | 1 |
| 3. | Screws, 8-32x½" FH (4) | 9999-89-0110A-X | 1 |
| 4. | Alligator Clip | 0200-81-1119A-X | 1 |
| 5. | Ring Split | 0200-81-1026A-X | 1 |
| 6. | Calibration cap | 0200-78-0002A-X | 1 |
| 7. | Clamping Device | 0200-78-0003A-X | 1 |

## 9. REFERENCES


1) Marple, V.A. "History of Impactors-The First 110 Years". Aerosol Science and Technology, 38:247-292, 2004.

2) Marple, V. A., “PEM Development, Fabrication, Evaluation and Calibration”, Final Report submitted to Research Triangle Institute, July 1989.

# APPENDIX A: PEM™ FLOW CALIBRATION INSTRUCTIONS

A correct flow calibration of the PEM™ requires a special attachment known as the Flow Calibration Cap (Figure 4). The PEM™ flow calibration cap is intended to provide for a single inlet to the PEM™ sampler to which a flow meter can be attached. The calibration cap is used by pressing the cap onto the nozzle cap of the PEM™. A flow meter is attached to the ½-inch diameter inlet tube on top of the calibration cap. The barbed fitting on the side of the cap is for the purpose of attaching a pressure gauge. Measuring the pressure between the flow meter and the PEM™ is only necessary if there is a large pressure drop across the flow meter. If the flow meter has a low pressure drop, such as a mass flow meter, bubble flow meter, or a laminar flow element meter, the pressure at the calibration cap does not need to be measured, and the pressure tap can be closed off with a rubber policeman.

The steps in using the PEM™ Flow Calibration Cap are:

1. Connect a flow meter to the inlet of the flow calibration cap
2. Turn on pump connected to the PEM™
3. Place the calibration cap on the PEM™ (be sure O-ring is properly seated in the O-ring groove inside the calibration cap)
4. Check PEM™ flow rate with a flow meter connected to the flow calibration cap

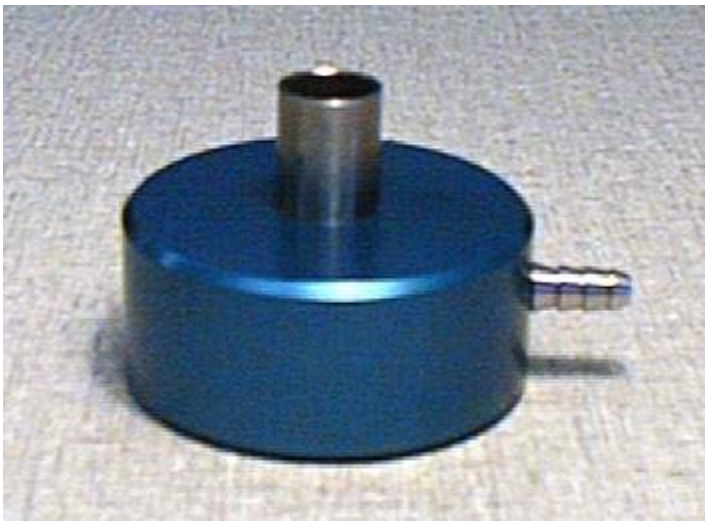

**Figure 5. Flow Calibration Cap**

## APPENDIX B: TYPICAL MODEL 200 PEM™ PRESSURE DROPS

This table shows the typical pressure drop that is characteristic for each type of PEM when it is used with a 37-mm glass fiber filter (e.g. Gelman Type A/E)

| PEM Description | Cut Point | Flow Rate | # of Nozzles | Nozzle Diameter | Nozzle ΔP | Filter ΔP | Total ΔP |
|---|---|---|---|---|---|---|---|
| | (μm) | (L/min) | | (in) | (in wg) | (in wg) | (in wg) |
| PEM 2-10 | 10 | 2.0 | 5 | 0.1200 | 0.003 | 1.37 | 1.37 |
| PEM 4-10 | 10 | 4.0 | 10 | 0.1200 | 0.003 | 2.73 | 2.73 |
| PEM 10-10 | 10 | 10.0 | 10 | 0.1520 | 0.008 | 6.83 | 6.84 |
| PEM 2-2.5 | 2.5 | 2.0 | 5 | 0.0430 | 0.190 | 1.37 | 1.56 |
| PEM 4-2.5 | 2.5 | 4.0 | 10 | 0.0430 | 0.190 | 2.73 | 2.92 |
| PEM 10-2.5 | 2.5 | 10.0 | 10 | 0.0670 | 0.201 | 6.83 | 7.03 |

Filter pressure drop assumes typical 37 mm glass fiber filter