Model 130
High-Flow Impactor

User Guide

April 2007, Revision B

Prepared by: MSP Corporation
5910 Rice Creek Parkway
Suite 300
Shoreview, MN 55126
651-287-8100
651-287-8140 (fax)
e-mail : sales@mspcorp.com

TABLE OF CONTENTS

1. Introduction

SAVE THESE INSTRUCTIONS - This user guide contains important safety and operating instructions for the family of High-Flow Impactors (Models 128, 129, 130 and 131).

The Model 130 High-Flow Impactor is a high-flow-rate, low-pressure-drop cascade impactor intended for general-purpose aerosol sampling. This impactor is specifically suited for sampling applications where a large volume of air needs to be sampled with a low power consumption such as in aircraft sampling (Romay et al., 1999). However, this use does not preclude other types of ground-based applications such as atmospheric, industrial or health-related air sampling applications.

The following High-Flow Impactor configurations are currently available from MSP:

Model 128: 3-stage impactor (10, 2.5 and 1.0 µm cutpoints @ 100 L/min)
Model 129: 4-stage impactor (10, 2.5, 1.0 and 0.25 µm cutpoints @ 100 L/min)
Model 130: 5-stage impactor (2.5, 1.4, 0.77, 0.44 and 0.25 µm cutpoints @ 100 L/min)
Model 131: 6-stage impactor (10, 2.5, 1.4, 0.77, 0.44 and 0.25 µm cutpoints @ 100 L/min)

In the following pages any description related to the Model 130 also applies to the Models 128, 129 and 131.

The Model 130 High-Flow Impactor has several unique features not found in conventional cascade impactors. These features contribute to the overall versatility of the instrument for high-flow rate aerosol sampling, and include:

1. Use of micro-orifice nozzles to extend the cut sizes of the lower stages to 0.25 µm without creating an excessive pressure drop across the impactor (Marple et al., 1991).

2. Use of interchangeable impaction plates so the impaction plate substrates can be loaded and unloaded in the laboratory, decreasing the chance of damaging the collected particle deposits during in-the-field substrate removal.

3. Use of transport covers for impaction plates so the impaction plates can be transported to and from the test site without contamination. The covers also minimize evaporative loss of samples during storage and any chemical reaction with ambient gases. The covers also allow the user to save all of the samples for analysis at the end of a test.

1.1 Unpacking Instructions

The Model 130 High-Flow Impactor is shipped partially assembled. The impaction plates and covers are shipped separately in a separate plastic box with the other accessories. Carefully

remove the Model 130 High-Flow Impactor from the shipping box and visually inspect it for any damage it may have suffered in transit. Please contact MSP Corporation if any damage is noted.

2. Principle of Operation

The principle of operation of the family of High-Flow Impactors (Models 128, 129, 130 and 131) is inertial impaction using multiple-nozzle stages in series. At each stage jets of particle-laden air impinge upon an impaction plate. Particles larger than the cut-size of that stage cross the flow streamlines and are collected on the impaction plate below the nozzles. Particles smaller than the cut-size can follow the flow streamlines and proceed on to the next stage where the nozzles are smaller, the air velocity through the nozzles is higher and the cut-size is smaller. This continues on through the cascade impactor until the smallest particles unable to impact on the last impaction plate are collected by a final filter.

3. Description of Model 130 High-Flow Impactor

The Model 130 High-Flow Impactor consists of an inlet (which is also a large-particle pre-separator), five impaction stages and a filter holder-base. Stages 1 through 5 and the filter holder-base support the removable 75-mm impaction plates for the pre-separator inlet and stages 1 through 5 respectively. Figure 1 shows a picture of the Model 130 High-Flow Impactor.

Figure 2 is a picture of a partially disassembled Model 130 High Flow-Impactor showing the inlet, the impactor stages, the filter holder-base and a stack of 75-mm impactor plates. The filter holder has a perforated screen to support a standard 90-mm after-filter.

The impactor inlet has an outer diameter of 1.25" (31.8 mm). The impactor base has a barbed fitting exhaust port designed to fit flexible tubing with an internal diameter of ½" or 13 mm and a wall thickness of 0.125" or 3 mm.

The last stage body has a barbed pressure tap to monitor the total pressure drop through all impactor stages. This pressure drop can also be used to monitor the impactor volumetric flow rate as long as the stage nozzles are clean.

Figure 3 shows the 75-mm impaction plate, the substrate hold-down ring and the impaction plate cover. Only the impaction plate and the substrate hold-down ring fit inside the stage bodies. The impaction plate covers are used to protect the substrates during handling before and after sampling with the impactor.

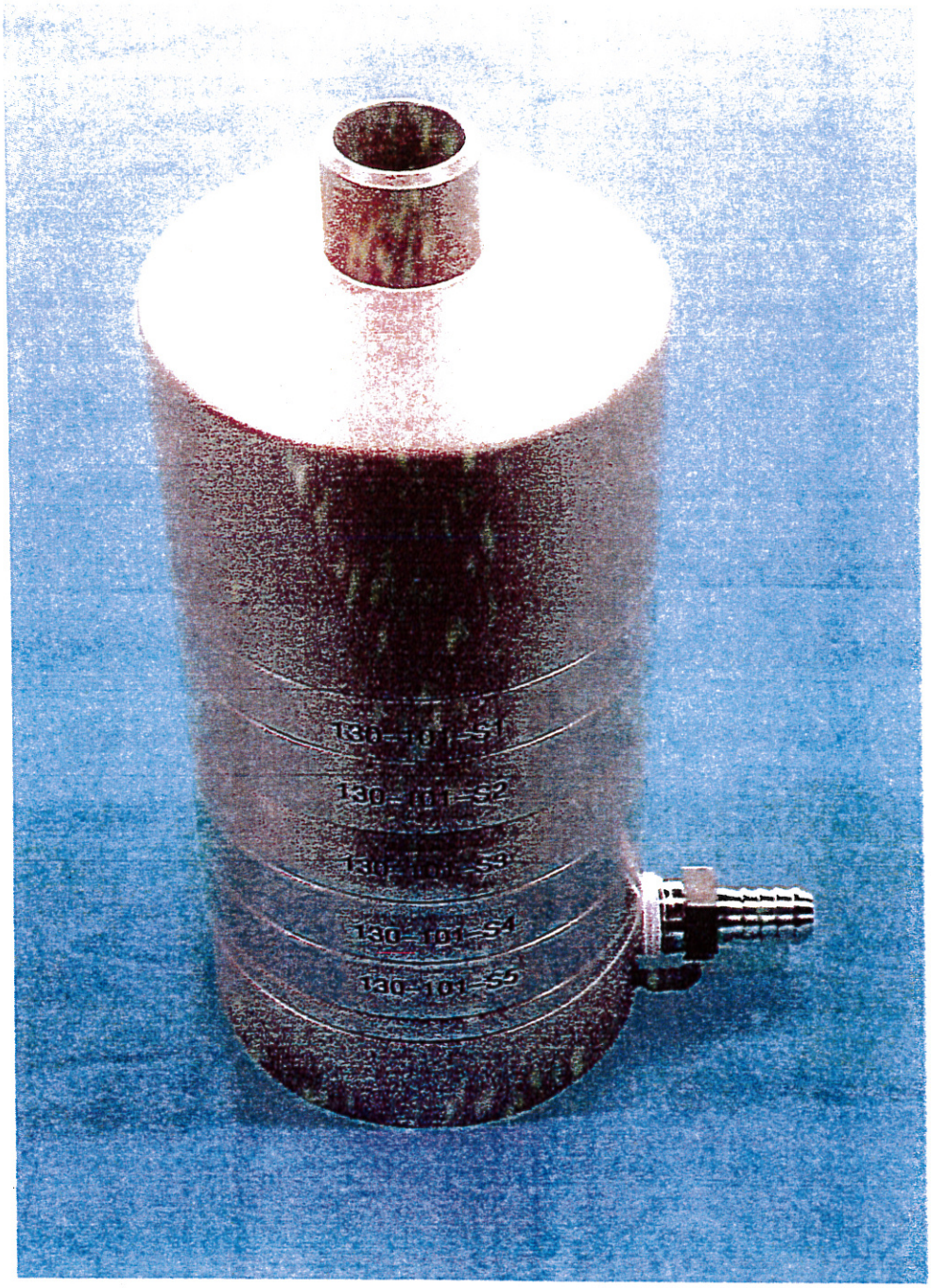

Figure 1. Model 130 High-Flow Impactor

Figure 2. Model 130 High-Flow Impactor disassembled

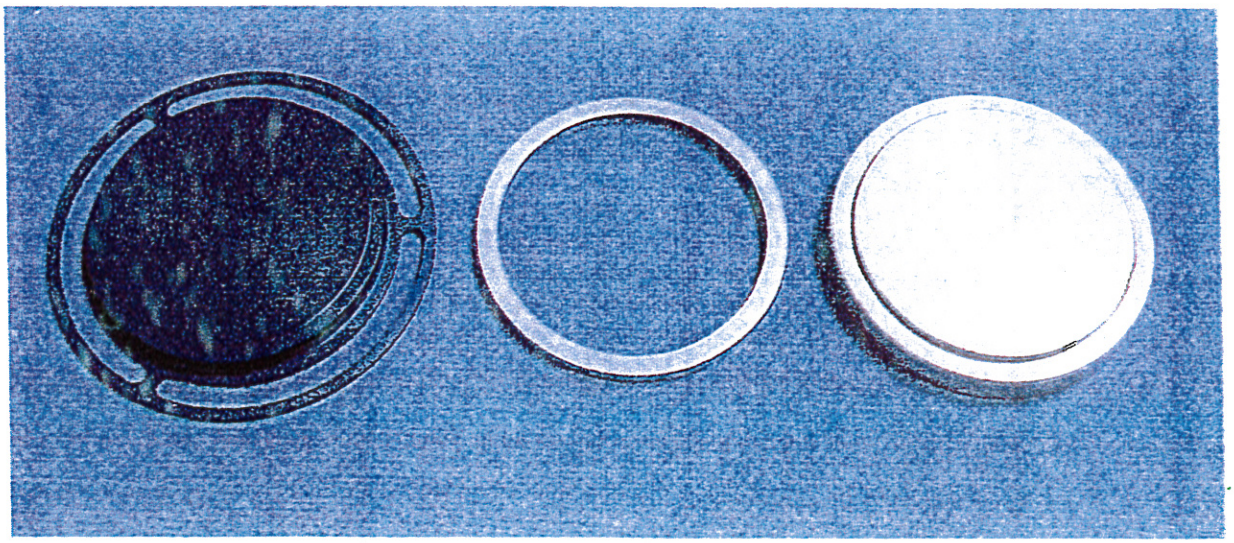

Figure 3. Impaction plate, retaining ring and cover

3.1. Cut Sizes and Efficiency Curves

Table 1 shows the nominal cut-size at 100 L/min inlet flow rate (1 atm and 20 °C), the number of nozzles and the nozzle diameter for all the impactor stages available for this family of High-Flow impactors. These cut-sizes are based on the application of current impactor theoretical predictions (Rader and Marple, 1985).

Table 1
Cut Sizes, Number of Nozzles and Nozzle Diameters

Stage	Cut Size, µm	Number of Nozzles	Nozzle Diameter, mm
0	10	12	7.67
1	2.5	32	2.20
2	1.4	120	0.991
3a	1.0	280	0.600
3	0.77	280	0.508
4	0.44	800	0.260
5	0.25	1796	0.150

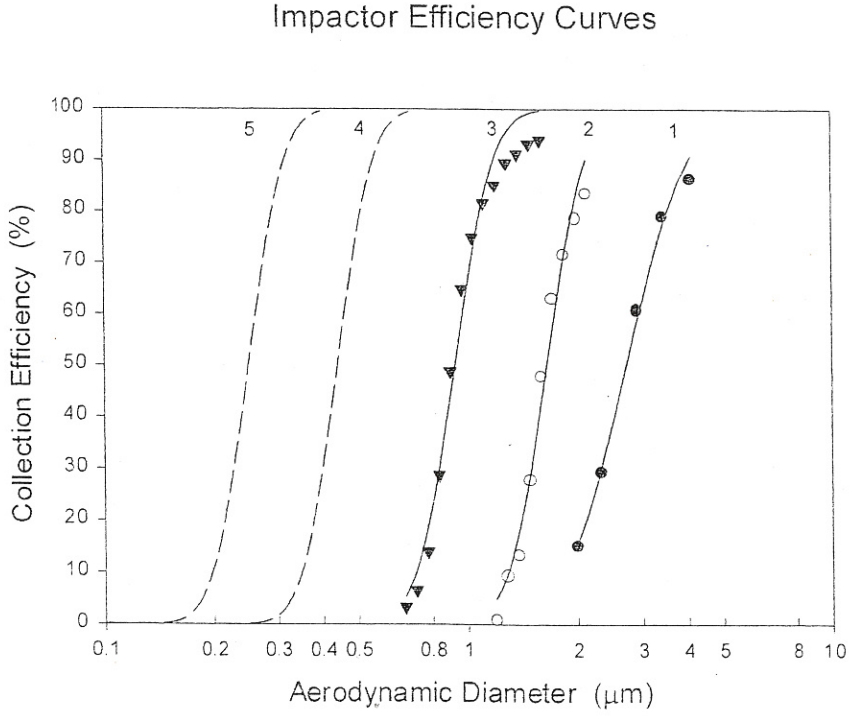

Figure 4. Model 130 High-Flow Impactor Efficiency Curves

Figure 4 shows the calibration efficiency curves of the five standard impaction stages. These curves have been fitted with cumulative lognormal distributions to determine the calibration cut-size and geometric standard deviation for each stage.

4. Operation

4.1 Disassembly and Substrate Removal

Each impactor stage consists of a body with multiple-orifice nozzles for that stage and the impaction plate for the stage above. The impactor is disassembled by first removing the inlet and then each stage of the impactor from the top down to the base. The impaction plates need to be removed so that the impaction substrates can be replaced. Removal of the impaction plate substrates and the after-filter can be performed at the laboratory.

The final step in disassembling the impactor is to remove the after-filter. This is accomplished by removing the filter holder cover below the stage five body. The 90-mm filter goes on top of the support screen located at the base of the impactor.

4.2 Assembly and Substrate Installation

Assembly of the Model 130 High-Flow Impactor is the reverse of disassembly. First, 75-mm substrates are placed into the impaction plate holders by removing the ring, inserting a substrate, and then pressing the ring back onto the holder. A 90-mm filter is placed on top of the support screen, in the same fashion.

Next, place an impaction plate on the filter holder cover and on all stage bodies. Assemble the stages in reverse order with the smallest cut-size at the bottom and the largest at the top. The stages are numbered on the outside of each stage body. Lastly, place the inlet cap on top of the impactor.

Caution: *Periodically apply a small amount of silicone grease (supplied with the accessories) to the stage body O-rings when reassembling the Model 130 High-Flow Impactor.*

4.3 Preparation of Impaction Plates

The impaction plates can be prepared in the laboratory and inserted into the impactor at the time of use. Covers are provided for the impaction plates to keep them clean during transit from the laboratory to the test site and again from the test site to the laboratory after sampling has been completed.

Caution: *The impaction plate covers must be removed before the impaction plates are assembled in the impactor.*

Nearly any type of substrate can be used in the impactor. The only requirement is that it be thin (< 0.1 mm) and flexible enough to be clamped into the holder by the hold-down ring. The substrates must also be flat after pressing the retaining ring (see Figure 5).

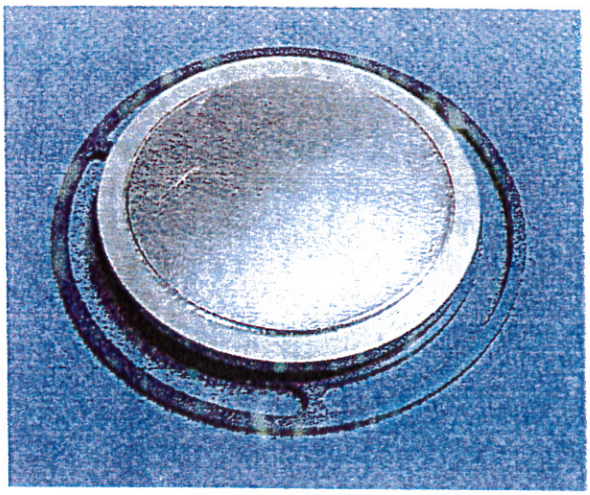

Figure 5. Impaction Plate with Aluminum Substrate and Retaining Ring

Note: The Model 130 High-Flow Impactor was designed for and calibrated with 0.001 inch thick substrate material. Normally either aluminum foil, Teflon, PVC (or other plastic films) or other thin filters can be used as substrates. ***The substrates are 75-mm in diameter. The after-filter is 90-mm in diameter.*** The after-filter can be of any type as long as the total pressure drop can be handled by the pump. A significant portion of the total pressure drop is determined by the type of final filter used.

In some cases it may be necessary to apply a sticky surface coating to the substrates to eliminate or reduce particle bounce. This is normally the case if foils are used and the particles are dry. We have found that a particular type of heavy-duty silicon spray (provided with the accessories) works best and is the only anti-bounce coating MSP recommends. For the 75-mm diameter substrates, a plastic sheet (an overhead transparency works well) with a 65-mm diameter hole punched in the center can be used as a coating mask. Center the mask on the substrate and apply the silicone spray. The solvent must evaporate completely from the substrates before they are used.

If the aerosol mass size distribution is to going to be determined from the impactor, the substrates must be weighed before and after a test. It is important that the weight of the sticky material applied to the substrates is stable. Therefore, it is essential that all the volatile components in the applied coating are evaporated before the initial weight of the substrate is measured.

4.4 Operating Procedure

Prepare the impaction plates according to the instructions in Section 4.3 and disassemble the impactor according to the instructions in Section 4.1. Install the plates and the after-filter in the unit and assemble according to the instructions in Section 4.2. The Model 130 High-Flow Impactor is now ready to be connected to the vacuum pump.

Figure 6 shows a typical impactor installation setup. The Magnehelic pressure gage (provided with the accessories) can be used to monitor the inlet flow rate through the impactor. The low pressure side of the gage is connected to the pressure tap on the last impactor stage body. The exhaust port of the impactor is connected to the suction side of a suitable vacuum pump. A flow control valve is needed to adjust the impactor inlet flow rate to 100 L/min. The flow rate can alternatively be controlled by adjusting the speed of the vacuum pump. This approach is preferable when using a DC vacuum pump (such as Thomas TF-8).

Figure 7 shows the performance curve of a Thomas VTE 8 rotary vacuum pump capable of handling the flow and pressure drop demanded by the Model 130 High-Flow Impactor.

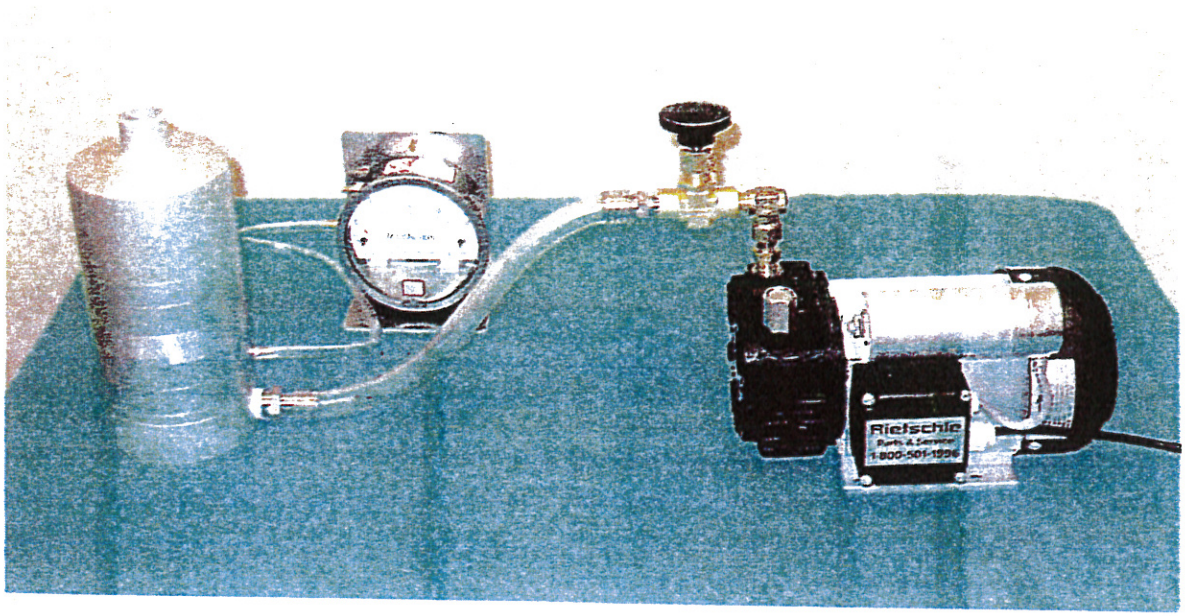

Figure 6. Model 130 High-Flow Impactor Installation Setup

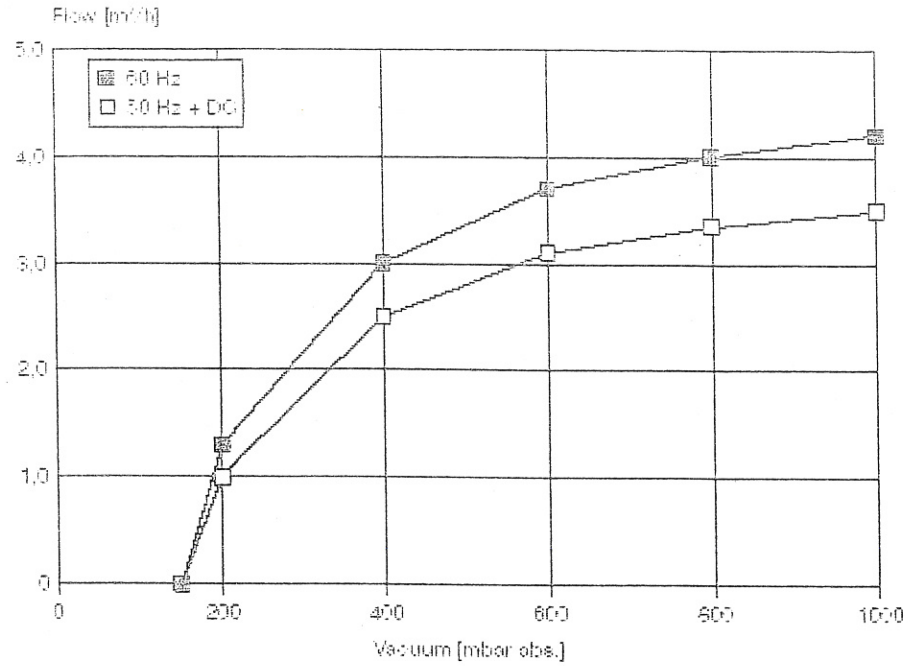

Figure 7. Thomas VTE 8 Vacuum Pump Flow Curves

4.5 Impactor Cleaning Procedure

The proper ***cleaning procedure*** for the impactor parts (after removing the O-rings) is to soak them in cleaning solvent (i.e. isopropyl alcohol, acetone). ***Sonication*** *in a warm bath of water with a mild detergent can be done if there is severe particle build-up inside the impactor nozzles.*

Caution: ***If sonication is required, it must be done only for short periods of time (no more than 5 minutes).***

The final cleaning step is rinsing the bodies with distilled water and then with alcohol. The impactor bodies can then be air-dried with particle-free clean compressed air.

5. Specifications

	Model 128 High-Flow Impactor	Model 129 High-Flow Impactor	Model 130 High-Flow Impactor	Model 131 High-Flow Impactor
Inlet Flow Rate	100 ± 2.5 L/min	100 ± 2.5 L/min	100 ± 2.5 L/min	100 ± 2.5 L/min
Total Pressure Drop @ 100 L/min without final filter	0.6 kPa	5 kPa	6 kPa	6 kPa
Size (D x H)	108 x 216 mm (4.25 x 8.5 ")	108 x 236 mm (4.25 x 9.3 ")	108 x 250 mm (4.25 x 9.7 ")	108 x 280mm (4.25 x 11.0 ")
Weight	1.50 kg (3.3 lb)	1.65 kg (3.6 lb)	1.65 kg (3.6 lb)	2.00 kg (4.4 lb)
Pump Requirements	8 to 10 m^3/h maximum flow 150 mbar max vacuum Motor Power, 0.40 kW	8 to 10 m^3/h maximum flow 150 mbar max vacuum Motor Power, 0.40 kW	8 to 10 m^3/h maximum flow 150 mbar max vacuum Motor Power, 0.40 kW	8 to 10 m^3/h maximum flow 150 mbar max vacuum Motor Power, 0.40 kW

6. Warranty

MSP Corporation warrants the Model 130 High-Flow Impactor for a period of ninety (90) days 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.

7. Parts List

Impactor

Item No.	Description	MSP Part #
1	Impactor Inlet (1" ID)	0130-78-0008A-A
2	Impactor Inlet (2" ID, optional)	0130-78-0001A-A
3	Stage 0 (10 µm, optional)	0130-78-0016A-A
4	Stage 1 (2.5 µm)	0130-78-0015A-A
5	Stage 2 (1.4 µm)	0130-78-0003A-A
6	Stage 3a (1.0 µm, optional, without pressure tap)	0130-78-0017A-A
7	Stage 3a (1.0 µm, optional, with pressure tap)	0130-78-0019A-A
8	Stage 3 (0.77 µm)	0130-78-0004A-A
9	Stage 4 (0.44 µm)	0130-78-0005A-A
10	Stage 5 (0.25 µm)	0130-78-0006A-A
11	Filter Clamp Ring	0130-78-0007A-A
12	Impactor Base	0130-78-0009A-A
13	Exit port (for ½" ID tubing)	9999-84-0643A-X
14	Filter Support Screen	0130-78-0013A-B
15	Impaction Plate, 75-mm	0130-78-0010A-A
16	Retaining Ring	0130-78-0011A-A
14	Transport Cover	0130-78-0012A-A
15	O-Ring, Stage Body	0130-81-6001A-X
16	O-Ring, Impactor Base	0130-81-6002A-X
17	O-Ring, Impaction Plate	0130-81-6003A-X
18	75-mm aluminum foil substrates (300)	0130-96-0575A-X
19	Anti-bounce silicone spray	0100-96-0559A-X
20	O-ring silicone lubricant	0100-96-0558A-X

8. References

Marple, V.A., Rubow, K.L. and Behm, S.M., *"A Micro-Orifice Uniform Deposit Impactor (MOUDI): Description, Calibration, and Use"* Aerosol Science and Technology, 14: 434-446, 1991.

Rader, D. J. and Marple, V. A., *"Effect of Ultra-Stokesian Drag and Particle Interception on Impaction Characteristics"* Aerosol Science and Technology, 4: 141-156, 1985.

Romay, F. J., Marple, V. A., Olson, B. A., Roberts, D., Liu, B. Y. H., Rosen, M. J., *"Development of a Light-weight, Low-power Cascade Impactor for Aircraft Sampling"*, Proceedings of the 1999 Scientific Conference on Obscuration and Aerosol Research, June 15-17, 1999.