TABLE OF CONTENTS

1. INTRODUCTION

The Model 310 Universal Air Sampler™ (UAS™) is a general purpose air sampler for atmospheric aerosol sampling and for mass concentration, and organic or inorganic analysis. The sampler has a design inlet sampling flow rate of 300 Liters per minute (Lpm). Fully equipped, it includes two virtual impactors for size fractionation of airborne particles and a Poly-Urethane Filter (PUF) sampler for analysis of volatile organic compounds (VOCs) in the air sample.

The sampler is provided with an omni-directional inlet, a PM10 (10 µm cut) virtual impactor classifier, either a PM2.5 or PM1.0 virtual impactor classifier, a fine particle filter and a PUF sampler. This allows operation as a high volume dichotomous sampler for size fractionation of airborne particles in the 0-2.5 µm (0-1.0 µm) and 2.5-10 µm (1.0-10 µm) aerodynamic size ranges. When only one virtual impactor is installed, it can be operated as a PM10, PM2.5 or PM1.0 sampler, depending on the cut point diameter of the classifier used.

2. PRINCIPLE OF OPERATION

Figure 1 is a schematic diagram of the Model 310 Universal Air Sampler™. Air is sampled at 300 Lpm (10.6 acfm) from the ambient atmosphere through an omni-directional, cylindrical inlet. Particles greater than 10 µm aerodynamic equivalent diameter are removed from the sampled air stream by the PM10 classifier and discarded. Particles less than 10 µm flow to the PM2.5 (or PM1.0) classifier located downstream. Particles in the 2.5-10 µm (1.0-10 µm) range are collected on a 62 mm x 165 mm (2.5" x 6.5") filter and those smaller than 2.5 µm (1.0 µm) are collected on a 200 mm x 250 mm (8" x 10") final filter. The filtered air stream is then directed through the PUF sampler to collect the volatile organic compounds in the filtered air stream.

The air flow in the sampler is maintained by a sample blower directly coupled to an AC motor. Main sample air flow is adjusted by varying the speed of the sample blower. A seven day, solid-state timer can be programmed to start and stop the blower at any time during a seven day period. It is also capable of multiple start and stop functions. For instance, the blower can be set to start each day at 6 a.m. and stop at 6 p.m. to allow daytime samples to be collected over the seven day period.

3. DESCRIPTION OF THE SAMPLER

The Model 310 UAS™ is housed in an instrument cabinet as shown in Figure 2. The base cabinet contains the blower and variable frequency drive, the PUF sampler, and the instrument package. The omni-directional inlet with the attached PM10 classifier is mounted on the top of one side of the cabinet and can be removed. Located directly below the PM10 classifier is the PM2.5 (PM1.0) classifier, and then the PUF sampler.

3.1 Virtual Impactor Classifiers

The virtual impactor classifiers used for size fractionation of airborne particles in the Model 310 are based on patented, multiple-nozzle, virtual impactor technology developed by MSP. In the PM10 classifier, three nozzles are used in parallel, while in the PM2.5 (PM1.0) classifier, 10 parallel nozzles are used. (The virtual impactor particle classifier installed has 40 parallel nozzles and is calibrated to operate at a flow rate of 1 acfm/nozzle. The classifier installed in the UAS™ has all but 10 of these nozzles blocked for operation at an inlet flow rate of 10 acfm, or 285 Lpm.) The coarse particle fraction is withdrawn from each virtual impactor particle classifier in a 15 Lpm flow.

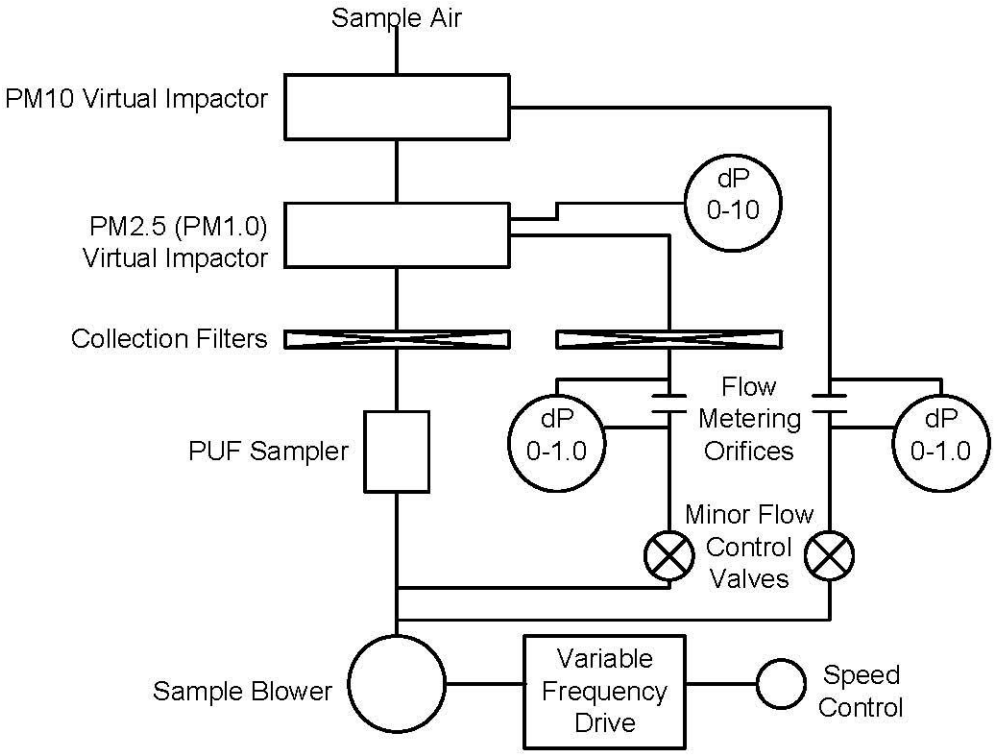


Figure 1 - Model 310 UAS™ Flow Schematic

Figure 2 - Model 310 Universal Air Sampler™ Cabinet

The various flow streams in the sampler are as follows:

- Total inlet sample flow 300 Lpm

- 10 µm virtual impactor classifier
  - Total inlet sample flow 300 Lpm
  - Coarse particle minor flow 15 Lpm
  - Fine particle major flow 285 Lpm

- 2.5 µm(1.0 µm) virtual impactor classifier
  - Total inlet flow 285 Lpm
  - Coarse particle minor flow 15 Lpm
  - Fine particle major flow 270 Lpm

Appendix B includes calibration data for the 10 µm, 2.5 µm, and 1.0 µm virtual impactor classifiers

3.2 Flow Adjusting and Monitoring

The Model 310 is provided with two manual flow control valves for the coarse particle minor flows and a variable frequency drive control for the flow entering the PM2.5 (PM1.0) HVVI. An overall flow schematic is shown in Figure 1. The two minor flows are measured by the differential pressure across a calibrated orifice flow

meter in each line. The flow entering the PM 2.5 (PM1.0) virtual particle classifier is measured by the pressure differential across one of the classifier nozzles. The differential pressure gauges, flow control valves, and blower speed control are mounted in the instrument compartment.

Pressure differentials for the flow meters installed are tabulated in Appendix A. The flow entering the PM2.5 (PM1.0) virtual impactor classifier should be first adjusted to 285 Lpm. The two minor flows should be then adjusted to 15 Lpm each. This sequence should be repeated until the flow indications are correct.

4. SYSTEM OPERATION

4.1 Hookup

Place the Model 310 UAS™ in the area to be sampled. Make sure that the sampler is level. Connect the sampler to a 220 VAC source. Place the appropriate filters in the PM2.5 (PM1.0) classifier. Place a fresh PUF sampler in the PUF holder.

4.2 Operation

The operation of the sampler is controlled by the solid-state timer. The blower may be manually controlled with timer switch #1 or automatic on/off times may be set. Timer switch #2 is wired at the factory to operate in parallel with switch #1. Please refer to the Omron H5F instruction manual in Appendix D for timer operating procedures.

When the blower is on, the differential pressure gauges indicating flow for all three flow channels may be read on the instrument panel. Refer to Appendix A for proper gauge settings. Adjust the valves and blower speed control until the proper differential readings are indicated.

The differential readings may show some variation during startup when the blower warms up. Experience has shown that once the flow stabilizes, it will remain stable for long periods. However, when the sampler is first put into operation at a given location, we recommend that the sampler be closely monitored to insure that the sampler operates properly.

4.3 Shut Down

When the sampling run is completed, the unit is shut down by turning the power switches on the timer off. To transport the unit, disconnect the 220 VAC main power cord. The sampler may then be removed from the site.

5. SERVICE

Between test runs:

1. Release the 4 clamps holding the inlet to the base cabinet. Be sure to disconnect the PM10 minor flow line.

2. Remove the 4 Allen screws holding the head of the PM2.5 (PM1.0) classifier. Remove the two smaller Allen head screws and lift off the gasket plate. Replace the PM2.5 (PM1.0) minor flow filter.

3. Remove the two wing nuts and the 4 star-wheel bolts holding the base plate to the screen and cabinet. Replace the PM2.5 (PM1.0) major flow filter.

4. Remove the screen filter holder to gain access the PUF sampler. Unscrew the PUF holder cap and replace the sampler.

5. Reassemble the Model 310 UAS™ in reverse order.

The following items are available as optional spares to allow rapid replacement of filters in the field with all filter handling in the laboratory:

- 8”x10” filter holder
- Base plate
- 2.5”x6.5” gasket plate
- A blank cover plate to protect the 2.5”x6.5” filter

The following routine service should be undertaken as required:

- Rinse the PM10 and PM2.5 (PM1.0) classifiers with alcohol and blow them dry.
- Clean the cabinet inside and out.

6. WARRANTY

MSP Corporation warrants the Model 310 Universal Air Sampler™ for a period of 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.

APPENDIX A - FLOW METER DIFFERENTIAL SETTINGS

The following differential gauge settings are for UAS™ Serial number:
310-220-11-0301

Flow stream	Flow	Meter Differential
PM10 minor flow	15 Lpm	0.54 inwg
PM2.5 minor flow	15 Lpm	0.43 inwg

The following differential gauge settings are for High Volume Virtual Impactor™ (HVVI™) Serial number:
HVVI-2.5-0301

Flow stream	Flow	Nozzle Differential
Flow entering the PM2.5 classifier	285 Lpm	6.4 inwg

APPENDIX B - VIRTUAL IMPACTOR CLASSIFIER CALIBRATION CURVES

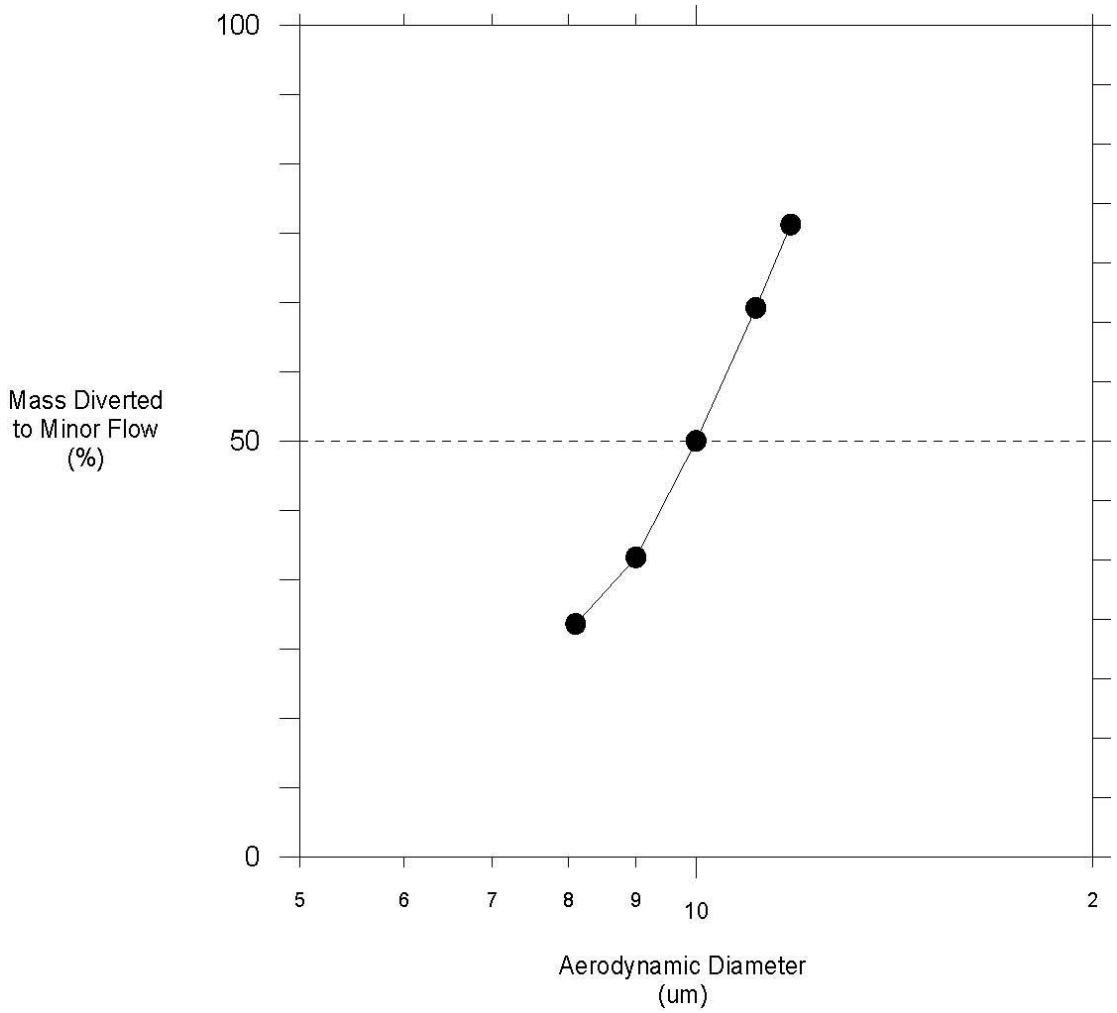


Figure B-1 PM10 Virtual Impactor Classifier

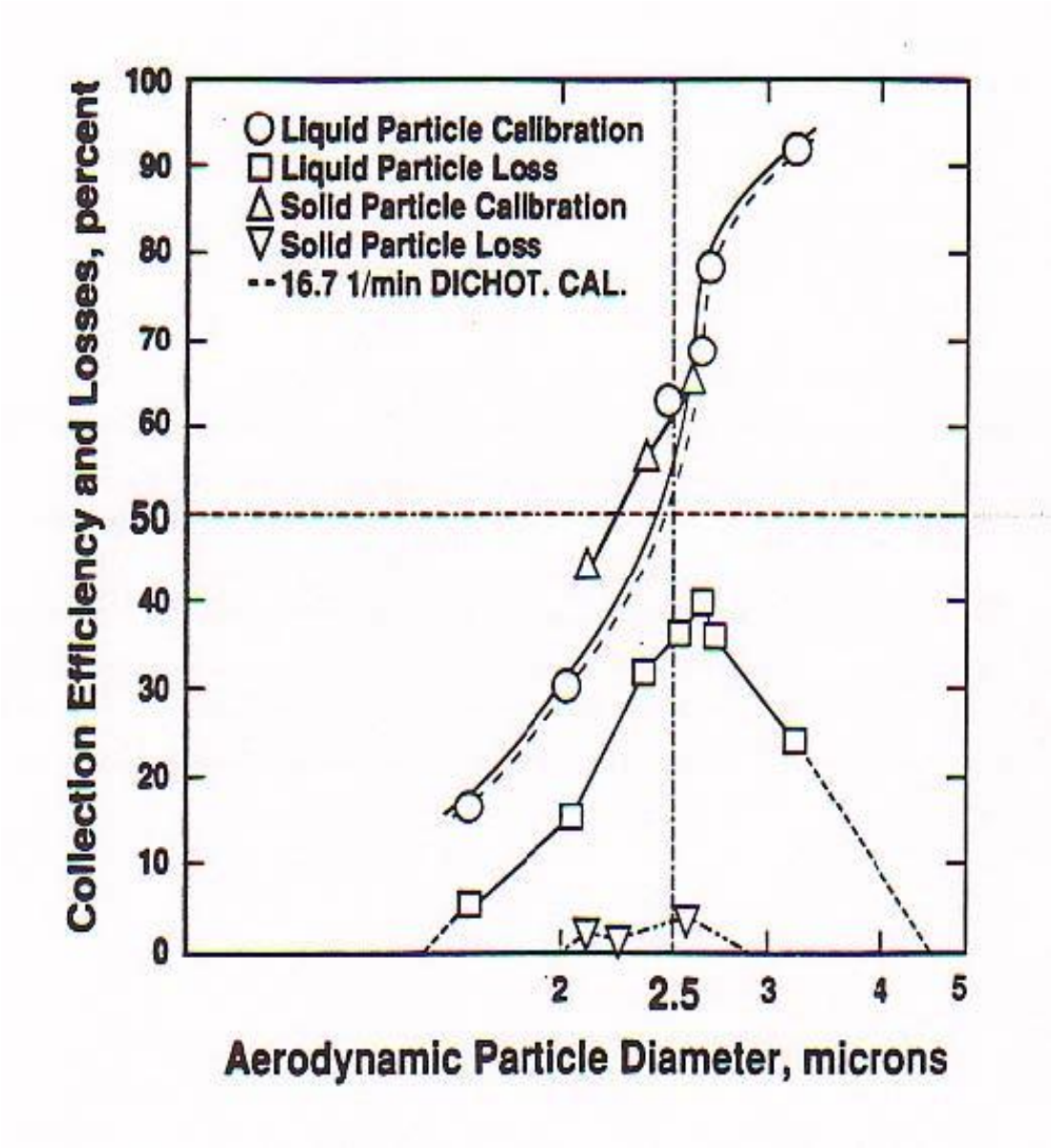


Figure B-2 PM2.5 Virtual Impactor Classifier

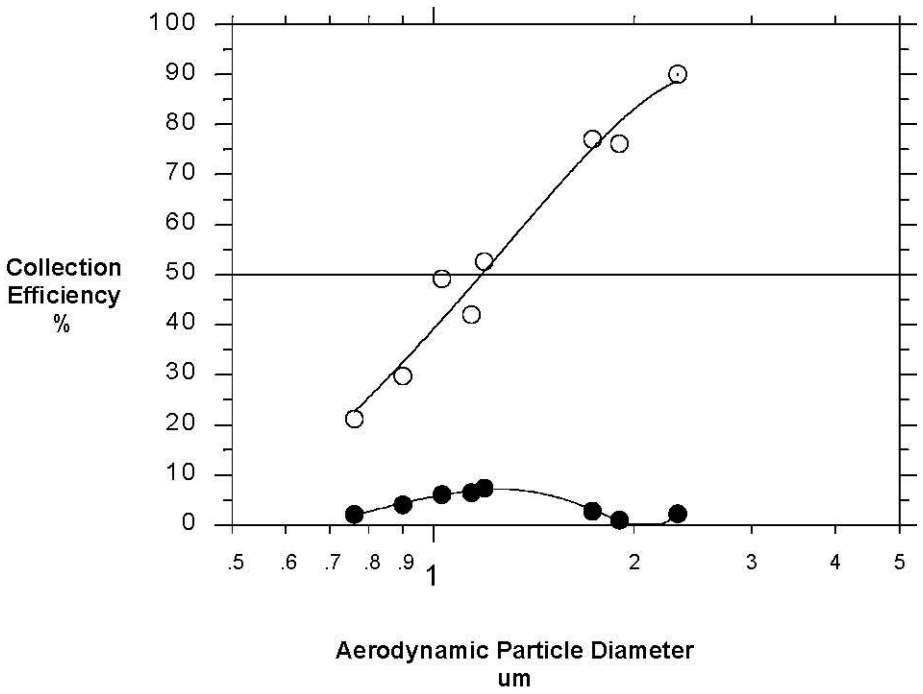
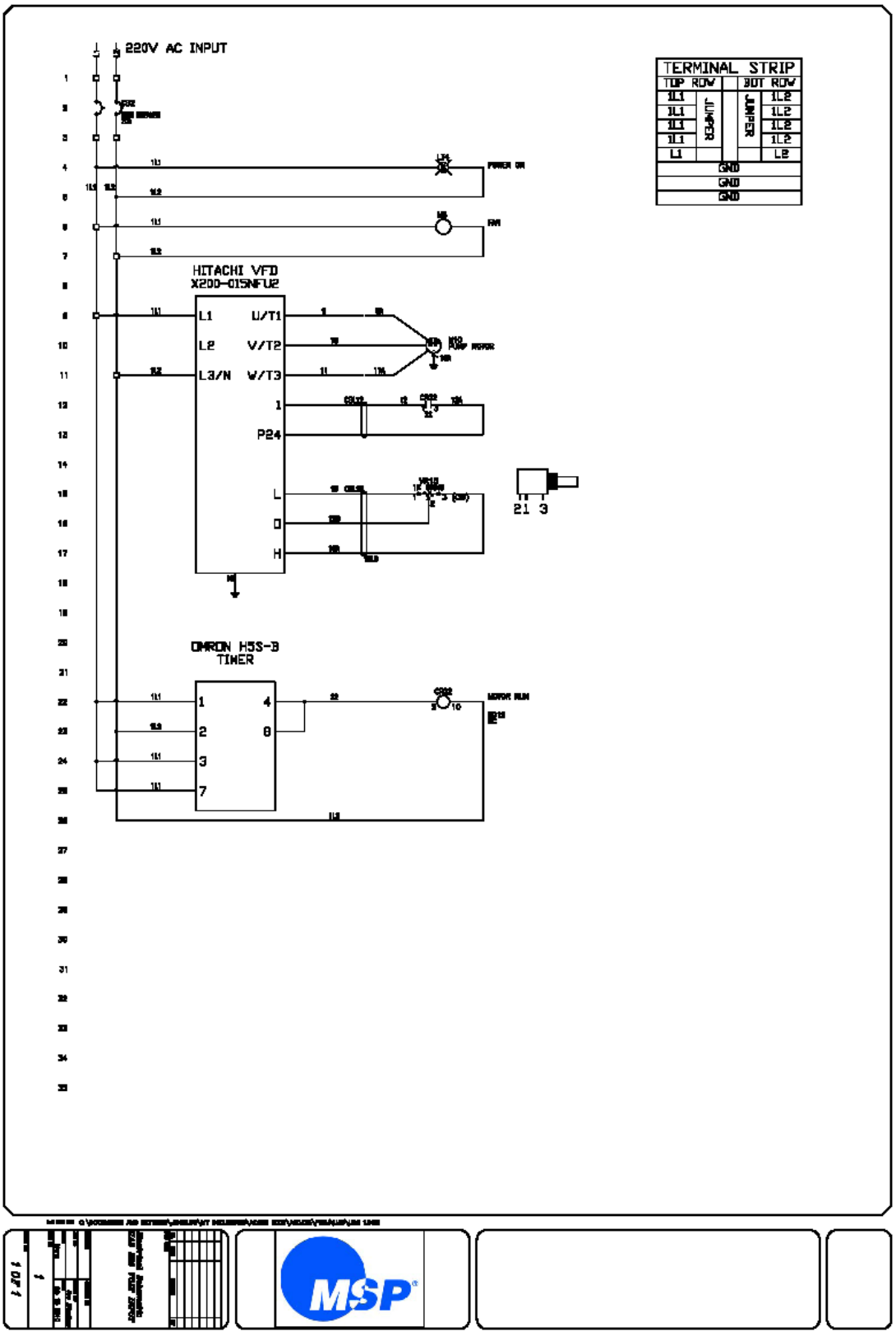


Figure B-3 PM1.0 Virtual Impactor Classifier

Dp (µm)	Coarse Particle Collection Efficiency	Collection Probe Losses	Major Flow Cavity Losses	Minor Flow Cavity Losses
0.76	21.2%	2.1%	-	-
0.90	29.8%	4.1%	1.2%	0.9%
1.03	49.2%	6.1%	1.7%	0.6%
1.14	42.1%	6.5%	-	-
1.19	52.7%	7.4%	-	-
1.73	77.2%	2.8%	-	-
1.90	76.2%	1.0%	-	-
2.32	90.1%	2.3%	-	-

APPENDIX C - WIRING DIAGRAM



APPENDIX D – OMRON H5F TIMER INSTRUCTION MANUAL

D1 Setting the time

1. Press the “MODE” key for 1 s to enter the time adjustment mode. A clock symbol flashes.
2. Use the “d” key to move the ▼ symbol to the current day (Sunday to Monday).
3. Use the “h” and “m/Ⓟ WD” keys to change the hour and minute to the current time.
4. Press the “WRITE” key.
5. Press the “MODE” key three times to return to run mode.

D2 Setting timer operation

1. Press the “MODE” key for 1 s to enter the time adjustment mode. A clock symbol flashes.
2. Press the “MODE” key to enter the operation time setting mode. A “P” symbol flashes.
3. Set the ON time by using the “h” and “m/Ⓟ WD” keys.
4. Press the “WRITE” key.
5. Set the OFF time by using the “h” and “m/Ⓟ WD” keys.
6. Press the “WRITE” key.
7. Press the “MODE” key to enter operation date setting mode.
8. Use the “d” key to move the ▼ symbol to select the operation day. Press the “WRITE” key to tell the timer whether it is an operation day. A “▬” under the date indicates that is an operation day. No “▬” means it is a non-operation day.
9. Press the “MODE” key to return to run mode.
10. Turn the “ON/AUTO/OFF” switch to “AUTO”. The timer operation now is determined by the settings.

D3 Clearing the settings

1. Press the “MODE” key for 1 s to enter the time adjustment mode. A clock symbol flashes.
2. Press the “MODE” key to select the program you are going to clear.
3. Press the “CLR” key to delete the settings.
4. Press the “MODE” key twice to return to run mode.