2.3.2 PROCEDURES FOR CALIBRATION AND MAINTENANCE FOR MANUAL MONITORING EQUIPMENT

2.3.2.1 ROOTSMETER

The rootsmeter is a positive displacement, rotary type device for measuring the volume flow of gas (air). It is used for calibration of the Hi-Vol orifice(Top Hat). Volumetric accuracy of the rootsmeter is permanent and non-adjustable. The volume of air measured at a specific set of atmospheric conditions, pressure and temperature, can not be immediately compared to the same volume of air at different conditions. However a calculation can convert the relative volume at another temperature/ pressure. We use Standard Temperature and Pressure (STP), 25EC(298EK) and 29.92 in.Hg as a reference for comparison. By using the following calculation, we can convert volumes to the STP conditions.

$$\frac{P_S V_S}{T_S} = \frac{P_1 V_1}{T_1} \quad \text{or} \quad V_S = \frac{P_1 V_1 \times T_S}{T_1 \times P_S}$$

2.3.2.1.1 SET UP AND MAINTENANCE

Insure that the meter is level using a carpenter's level (check the horizontal plane of the metal unit). If the unit is not level, correct the problem. Check the oil levels of the three different reservoirs. See the "INSTALLATION, OPERATION, AND MAINTENANCE MANUAL" for sight gages and fill ports. NOTE: Use only the oil supplied by the instrument manufacturer - Instrument grade number 50. The oil should be changed every 10 years(due to the limited run time and clean, controlled environment.) Documemnt this and any maintenance in the rootsmeter logbook.

2.3.2.1.2 DIFFERENTIAL RATE TEST

The purpose of this test is to insure that the accuracy has not changed since being put into service from the manufacturer. This is accomplished by comparing the existing meter performance with the original performance documented after set-up. This test is to be accomplished after the meter is first installed, before and after maintenance, and annually thereafter.

It is the responsibility of the Supervisor of the Electronics and Calibration Branch to check the data and verify the data calculations. This duty may be assigned to a Technician III knowledgable in the task (not the individual performing the task).

The following equipment must be available to accomplish the differential rate test:

Digital manometer (in. Hg)	Differential manometer (in.H_2o)
Top Hat and restriction plates(4,5,6,7,8,10,13)	Scientific calculator
Hardware fitting to adapt the rootsmeter	Digital stopwatch
Manual event counter	PM-10 motor or TSP motor
Vari-ac	Multi meter (volts, ac)

Set up is as depicted in the diagram depicted on Figure 2.3.2.1.1, p5.

Remove the lower pressure plug (see figure 2.3.2.1.1, p5) and install a tube connector fitting. **DO NOT** remove the oil drain plug on the bottom or the oil fill plugs on the top of the rootsmeter. Attach the “0 in.” side of the differential manometer()P) to the upper vacuum tap on the side of the unit. Attach the “1 in.” side of the differential manometer to the lower vacuum tap on the side of the unit (normally plugged). Install the Top Hat orifice on top with a 4 hole restrictor plate. Attach and turn on the digital manometer to the orifice side port()H). Install the PM-10 motor.

2.3.2.1.2.1 PROCEDURE

a. Insert the 4 hole resistance plate between the rootsmeter and the orifice.

b. Pressurize the meter slowly by starting the PM-10* motor using the Vari-ac until the motor is running at 115v as read on the multi meter. Warm up for 5 minutes.

c. Time the passage of 110 ft^3 of air with a stop watch. Each revolution of the rootsmeter displaces 10 ft^3 of air. Therefore, by counting 11 completed revolutions of the shaft (see figure 2.3.2.1.1,p5) as observed through the compensated temp gage equals 110 ft^3.

d. Record the)H from the orifice, "in.Hg" manometer.

e. Record the)P "differential pressure" in. H_2O from the differential manometer.

f. Read and record the ambient temperature (E C) and barometer (in.Hg)

g. Repeat steps **b** thru **f** 2 more times (total 3 times) and average results.

h. Repeat steps **a** thru **g** for plates 5,6, 7,and 8.

*Note: If using a TSP motor use plates 5,7,8,10,13.

CALCULATIONS AND FORMULA

EK = EC +273 P_1 ,T_1 = (ambient) = Pressure (in.Hg), Temp (EK) t = time(min)

$$Vol_{STD} = \frac{(P_1 -)H)(25.4)(298)}{T_1\ (760)} \times 110 = \frac{(P_1 -)H)\ (1095.5)}{T_1}$$

$$Rate\ Q_{STD} = \frac{Vol_{STD}}{t}$$

a. Calculate the Vol_{STD} for each holed plate.

b. Calculate Rate Q_{STD}

c. Using a scientific calculator

1. Use linear regression function with x = Q_{STD} vs y =)P for each plate. note the correlation coefficient, slope (m), and intercept (b).
2. Using this curve, find the corresponding points for x = 35, 40, 45, 50 CFM.
3. Compare these values to the 1989 initial values established on initial

1989 values

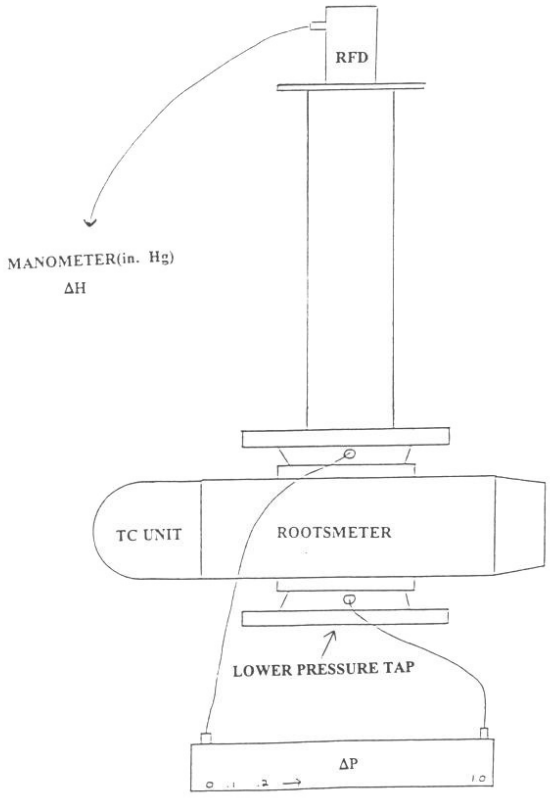
35 CFM.2384
40 CFM.3041
45 CFM.3698
50 CFM.4355

Determine % difference

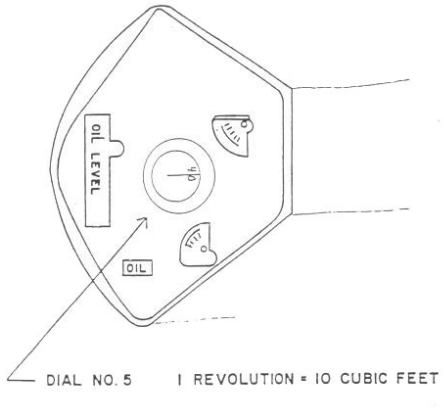
$$\frac{\text{(new value) - (1989 value)}}{\text{1989 value}} \times 100$$

A 50% difference will reflect less than a 1% change in calibrated volume. Therefore, less than a difference of 50% is considered within calibration. If the differential pressure differs by more than 50%, a meter problem is likely. Check the meter for : binding impellers, worn bearings, too heavy (wrong type) oil, or too much oil. Correct the problem and retest. If unable to correct the problem, contact the manufacturer for further guidance.

ROOTSMETER DIFFERENTIAL TEST SET-UP



RED OIL DIFFERENTIAL MANOMETER
(in. H_2O)



END VIEW OF ROOTSMETER

Figure 2.3.2.1.1

Rootsmeter Differential Test Data

Rootsmeter No.8918139 Temp_____EC Barometer_____ in. Hg
273.15 + EC(**xx.x**) = _____EK(T_1) **xx . xx**

Initial Volume **110 ft^3** **115-116 volts** 2/2000

Plate #	**)H** in.Hg **. xxx**	**Vol$_{STD}$** 110 ft^3 STP corrected **xxx . xx**	Run Time Min + sec **x + xx.xx**	Min **x . xx**	Rate (Q_{STD}) **Vol$_{STD}$** / **t** **xx . xx**	Diff Press in.Water Column **. xx**
Avg.						
Avg.						
Avg.						
Avg.						
Avg.						

Technician_____ Date _____

CALCULATIONS AND FORMULA

EK = EC +273.15 ambient Pressure (in.Hg)= P_1 , ambient Temp (EK)=T_1 t = time (min)

$$Vol_{STD} = \frac{(P_1 -)H)(25.4)(298)}{T_1\ (760)} \times 110 = \frac{(P_1 -)H)\ (1095.5)}{T_1}$$

Rate $Q_{STD} = \frac{Vol_{STD}}{t}$

Inserted Q (CFM) **xx**	1989 Data Diff Pres **x . xxxx**	_____ Data Diff Press(dp) (from Calculator) **x . xxxx**	% Diff **xx .xx**
35	0.2384		
40	0.3041		
45	0.3698		
50	0.4355		

Note: 1. The 1989 Diff Pres data was recalculated with CFM rounded to one decimal place and d.p. to two.
2. You may check your calculation by plotting CFM(x) vs Differential Pressure(y) for each plate, draw the best line, and then go to the corresponding value(35, 40,etc.) and determine the y value.

Calculate:

$$\% \text{ Difference} = \frac{(\text{current dp}) - (1989\ \text{dp})}{(1989\ \text{dp})} \times 100$$

1989

slope(m) = .0131 intercept = -0.2213 Correlation = .9957

_____(current year)

slope(m) = _____ intercept = -0._____ Correlation = _____

Technician_____ Date _____

Supervisor_____ Date _____