



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20
PAGE: 1 of 10
REV: 1.1
EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

CONTENTS

DISCLAIMERS

- 1.0 SCOPE AND APPLICATION
- 2.0 METHOD SUMMARY
- 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE
- 4.0 INTERFERENCES AND POTENTIAL PROBLEMS
- 5.0 EQUIPMENT/APPARATUS
- 6.0 REAGENTS
- 7.0 PROCEDURE
 - 7.1 Rotameter Calibration
 - 7.2 Field Rotameter Calibration
- 8.0 CALCULATIONS
- 9.0 QUALITY ASSURANCE/QUALITY CONTROL
- 10.0 DATA VALIDATION
- 11.0 HEALTH AND SAFETY
- 12.0 REFERENCES
- 13.0 APPENDIX
 - A - Figures



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 2 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20
PAGE: 3 of 10
REV: 1.1
EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for calibrating rotameters both on an annual basis and in the field.

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

2.0 METHOD SUMMARY

Rotameters consist of one or two "floats" that are free to move up and down within a vertical tapered tube. As air passes through the tube, the float rises until the flow rate is sufficient to hold it stationary.

Rotameters are secondary calibration devices, which are used in the calibration of sampling pumps and other flow-moving devices. Prior to their use, rotameters must be calibrated to a primary device (i.e., Bios Defender Dry Cal Flowmeter) that ensures accuracy to a National Institute of Standards and Technology (NIST) standard.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Rotameters must be inspected regularly for buildup of dust or other contamination inside the tube or on the ball. This will affect the ability of the float to move smoothly.

Rotameters should be field calibrated when used under environmental conditions that are deemed to be substantially different from those conditions that the rotameters are typically calibrated (i.e., room temperature).

5.0 EQUIPMENT/APPARATUS

- Rotameters, Model SKC 320-4A5, SKC 320-4A20L and SKC 320-530, SKC Inc., Pennsylvania (PA) or equivalent, measuring in milliliters per minute (mL/min) or liters per minute (L/min)
- Sampling pumps, SKC 224-PCXR8, SKC Inc. PA or equivalent
- Surgical tubing
- Primary flow standard, Bios Defender Series volumetric primary flow standard, DryCal dry flowmeter, Bios International Corporation, New Jersey (NJ), calibrated annually accompanied by a certificate of analysis
- Representative calibration train

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Calibration of Rotameters



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 4 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

Rotameter calibration must be conducted on an annual basis according to the following procedure:

1. Verify that the rotameter is in good working condition.
2. Select the appropriate primary flow standard for the range of the rotameter. The ranges for the three DryCal models are as follows:
 - Model 510L/520L: 5-500 ml/min primary flow for low flow pumps
 - Model 510M/520M: 50-5000 ml/min primary flow for medium flow pumps
 - Model 510H/520H: 300-30000 ml/min primary flow for high flow pumps
3. Assemble the calibration train in the order shown using a sampling pump, rotameter, tubing and the Bios Defender primary flow standard (See Figure 1) ensuring the rotameter is on a level surface. To the best extent possible, minimize the length of tubing between connections.
4. If equipped with a valve, open rotameter valve. Turn on the sampling pump and primary flow standard.
5. The middle 80 percent (%) of each scale on the rotameter will be calibrated. The top and bottom 10% are not calibrated due to the possibility of obtaining inaccurate readings. Calibration will be performed at the following intervals:
 - Every 10 cubic centimeters (cc) for low flow rotameters
 - Every 500cc for medium flow rotameters
 - Every 1000cc for high flow rotameters
6. Adjust the flow of the sampling pump until the flow rate on the primary flow standard is stable. Using the arrow keys located to the right of the display on the primary flow standard, select the measure option and press the enter key. Next, select the continuous option, which will provide an average of ten samples. The average of the ten sample readings must be within $\pm 5\%$ of the desired interval.
7. Record the average flow rate reading from the primary flow standard and the corresponding point on the rotameter scale.
8. Repeat step 6 and 7 for the remaining intervals.
9. Develop a table that shows rotameter scale readings and actual flow rates (See Figure 2). This information needs to be provided for the range that was calibrated at appropriate intervals depending on the rotameter scale. Attach a copy of this table to the rotameter and either record all observations of flow versus set point in the rotameter calibration log book or tape the original table in the rotameter calibration logbook.

7.2 Field Calibration (optional)

Prior to use in the field, rotameters should be calibrated to the target flow rate for the field sampling effort according to the following procedure:

1. Use a rotameter that has been calibrated within one year and within the range of the target flow



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 5 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

rate.

2. Ensure that the rotameter is in good working order.
3. Select the appropriate Bios Defender primary flow standard.
 - 5-500 ml/min primary flow standard for low flow pumps
 - 50-5000 ml/min primary flow standard for medium flow pumps
 - 300-30000 ml/min primary flow standard for high flow pumps
4. Assemble the calibration train using a sampling pump, representative sampling media, rotameter, tubing and a primary flow standard (See Figure 3) ensuring the rotameter is on a level surface. To the best extent possible, minimize the length of tubing between connections.
5. Turn on the sampling pump and the primary flow standard.
6. The calibration table on the side of the rotameter should be used to determine the approximate rotameter reading for the target flow rate. Adjust the pump until this rotameter reading is attained.
7. Adjust the flow of the sampling pump until the rotameter float ball is stationary at the selected interval. Using the arrow keys located to the right of the display on the primary flow standard, select the measure option and press the enter key. Select the continuous option, which will provide an average of ten samples.
8. Adjust the flow on the pump and repeat step 7 until the target flow rate is attained. Record at least three readings at this flow rate. The readings must be within $\pm 5\%$ of each other.
9. Record the rotameter number, rotameter reading, flow rate and the date calibrated in the logbook or on field data sheets. Record this information on a sticker, initial the sticker and affix it to the rotameter.

8.0 CALCULATIONS

Average flow rates are calculated using the following equation

$$q_{\text{avg}} = \frac{q_1 + q_2 + \dots + q_n}{n}$$

Where:

- q = flow rates of primary flow standard
- n = number of measured flow readings

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on field data sheets or within site/personal logbooks.
2. All instruments must be operated in accordance with operating instructions as provided by the



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 6 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

manufacturer, unless otherwise specified in a Quality Assurance Project Plan (QAPP). Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3. Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to rotameter readings, flow rates, rotameter number, etc. These data are essential to providing an accurate and complete final deliverable.

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.

12. REFERENCES

Mesa Laboratories Inc. 2016. Application Note. *Connecting Volume*.

Miller, R.W. *Flow Measurement Engineering Handbook*. Third Edition. McGraw-Hill Company. 1996.

Mesa Laboratories Inc. 2018. User Manual. *Defender 500 Series*, MK01-24, Rev. G.

Mesa Laboratories Inc. 2018. User Manual. *Defender 530+*, MK01-51, Rev. B.

13.0 APPENDIX

A - Figures



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20
PAGE: 7 of 10
REV: 1.1
EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

APPENDIX A
Figures
SOP: ERT-SOP-2118-20
October 2020



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 8 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

FIGURE 1. Calibration Train for Calibrating Rotameters





STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20
 PAGE: 9 of 10
 REV: 1.1
 EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

FIGURE 2. Example Rotameter Calibration Table

Rotameter MA	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MB	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MC	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MD	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter ME	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MF	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MG	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	

Rotameter MH	
Black Ball Center Scale	
Set Point	Vol. (cc)
	500
	1000
	1500
	2000
	2500
	3000
	3500
	4000
	4500
	5000
ExpDate: 4/16	



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20

PAGE: 10 of 10

REV: 1.1

EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION



STANDARD OPERATING PROCEDURES

SOP: ERT-PROC-2118-20
PAGE: 11 of 10
REV: 1.1
EFFECTIVE DATE: 10/19/20

ROTAMETER CALIBRATION

FIGURE 3. Field Calibration of a Rotameter

