



# STANDARD OPERATING PROCEDURES

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## OPERATION OF DRYCAL DEFENDER SERIES PRIMARY FLOW CALIBRATOR

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### 1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the start-up, operation and routine use of the Bios International Corporation DryCal® Primary Flow Calibrator. The procedures and figures contained in this SOP are taken from the *DryCal® Manual* (2004) with the written consent (11/19/2015) of Bios International Corporation and Mesa Labs.

The DryCal Defender is a field portable primary flow calibrator that is used for industrial hygiene, environmental and laboratory measurement applications. The DryCal Defender is a National Institute of Standards and Technology (NIST) primary calibration standard that uses dry piston technology and infrared sensors to obtain volumetric flow rates. The DryCal Defender can be used to measure gas flow for either a vacuum flow source or a pressure flow source. Applications include precise calibration of secondary standard calibration equipment, such as rotameters, and industrial hygiene and environmental air sampling bags or pumps. Rapid calibrations are accomplished without the use of a soap solution thus reducing the uncertainty associated with other flow meters or rotameters.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the UFP-QAPP for a particular site.

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

### 2.0 METHOD SUMMARY

The DryCal Defender is a primary flow standard. The time required for a graphite composite piston to traverse a known distance within a glass flow cell is precisely measured, and an internal computer calculates the flow. When a flow reading begins, an internal valve closes, diverting gas into the glass flow cell for measurement. The piston rises at the rate of gas flow between two collimated light beams at a known distance apart. After a suitable acceleration period, the rate of piston travel between the beams is timed. As the piston passes the second beam, the flow reading ends, the valve opens, the gas is released, and the piston drops. The volumetric flow measurement, based upon the parameters of length and time, is instantly displayed on the liquid crystal display (LCD) in milliliters per minute (mL/min) or liters per minute (LPM).

### 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

- Air samples require no preservation or special handling.
- DryCal Defender calibrators can remain on charge until needed without causing damage to the battery.
- If the calibrator is stored for long periods of time, the battery should be charged at least once every three months.
- Always store calibrators in a clean, dry environment with intake/exhaust valve caps on and recharge the unit prior to use after long-term storage.



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### 4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- Flow reading error sources include:
  - When the DryCal Defender is used with pump models that pulsate (small shifts in flow rate during pulsation) the readings are affected accordingly.
  - Closure of the calibrator valve at the beginning of each flow reading results in a small pressure spike in the flow stream that can impact flow rate reading.
- Air containing cigarette smoke, excessive dust, or other particulates interferes with readings.
- Potential safety problems are presented in *Section 11.0 Health and Safety*.

### 5.0 EQUIPMENT/APPARATUS

The following equipment is provided for the operation and transport of the DryCal Defender Primary Flow Calibrator:

- DryCal Defender Flow Calibrator

Model	Optimum Flow Range ( $\pm 1\%$ )	Type/Type per Measurement
520L / 530L	5–500 mL/min	Single, Continuous, Burst /(1-15sec)
520M / 530M	50–5,000 mL/min	Single, Continuous, Burst /(1-15sec)
520H / 530H	300–30,000 mL/min	Single, Continuous, Burst /(1-15sec)

- Single-Station Battery Charger
- Tubing Kit
- Leak-test Accessory
- Additional High Flow Tubing with L, M, and H models
- Certificate of Calibration
- Instruction Manual

### 6.0 REAGENTS

This section is not applicable to this SOP.

### 7.0 PROCEDURES

#### 7.1 Air Flow Train Setup

An isolation device is recommended to smooth the pulsation input and calibrator valve pressure spikes. To smooth flow, install a 25-millimeter (mm), 0.8-micrometer ( $\mu\text{m}$ ) filter cassette in the flow train to create a suitable backpressure as needed.



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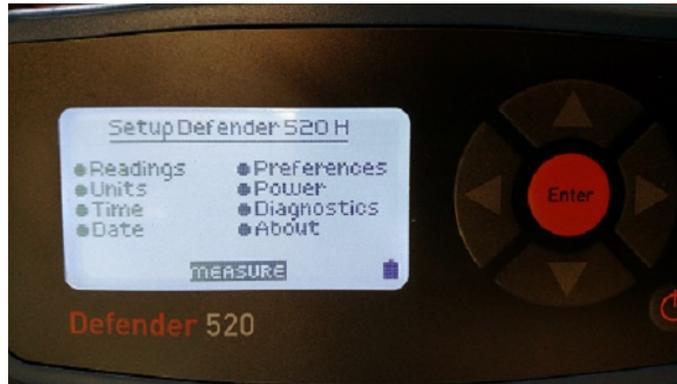
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### 7.2 Panel Buttons



### 7.3 Power ON

1. Press the **ON** button to turn the calibrator on.
2. An initializing screen will be displayed first showing the computer revision number then the standard flow display screen, choose **SETUP** to proceed.

**Note: A Reset button is located on the lower back panel. If pressed, this button will quickly reset the unit to the initializing screen.**

**Note: The Defender has an “energy saving” 5 minute inactivity shut-off feature.**

3. Press and hold the **POWER** button, choose the **ON/OFF** button then scroll down to **CONFIRM** setup.

### 7.4 Take Readings

#### 7.4.1 Single Flow Reading

1. Connect tubing between the calibrator and the flow source with both instruments **ON**.

**Note: The calibrator connecting air flow ports are located on the right side of the unit. The upper port is for suction (outlet) and the lower port is for pressure (inlet).**



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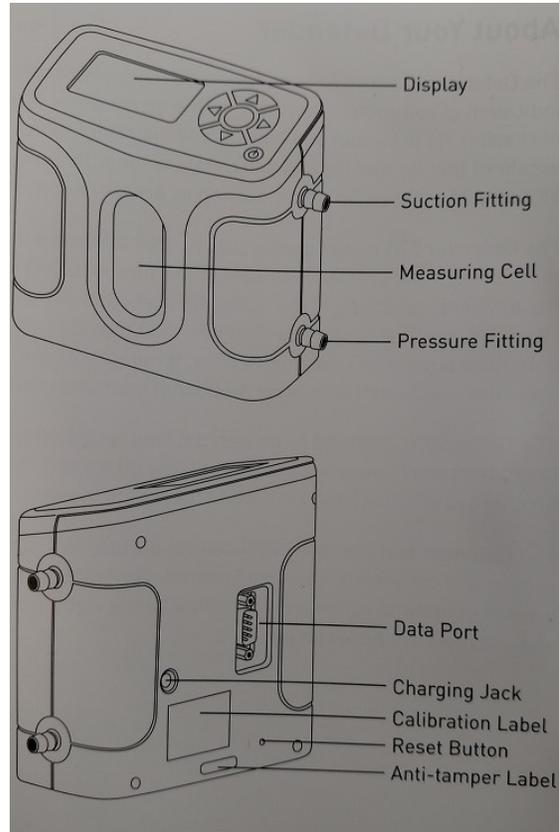
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**Note: For industrial hygiene or environmental applications, the sampling medium should also be connected in-line.**

2. Press the **READ** button **once** to obtain a single flow measurement display on the LCD screen.
3. A reading begins when the valve clicks shut, the white light-emitting diodes (LEDs) light, and the piston rises within the flow cell.
4. Continue the procedure to obtain the required number of flow readings.

**Note: All successive readings in an averaging sequence will be used to calculate the average flow. The unit will automatically clear the average after ten readings and begin a new averaging sequence.**

#### 7.4.2 Continuous Mode Reading

1. From main menu choose **Preferences** > press **Enter**; under **Read Defaults** choose **“Single”**, **“Continuous”** or **“Burst”** and scroll down to Confirm setup.
2. To stop the continuous read session, press the **STOP** button once.



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The display will indicate the current flow reading (FLOW), the average flow value (AVERAGE) and the number of readings in the average (NUMBER IN AVERAGE) with a maximum of 10 readings as the average flow rate.

### 7.5 Stop and Reset

1. To stop a flow reading at any time, press and release **STOP** button.
2. To reset, press and hold the **STOP** button for two full seconds.
3. For a **Hard Reset** when the calibrator does not respond to push-button commands, press the recessed button on lower right side of the back panel near the parallel port.

### 8.0 CALCULATIONS

The DryCal Defender Primary Flow Calibrator is a direct reading instrument requiring no calculations.

The flow rate is calculated by the unit. The time required for a graphite composite piston to traverse a known distance within a glass flow cell is precisely measured, and an internal computer calculates the flow. The time the piston takes to move the known distance and implied volume yields the volumetric flow as:

$$q = \frac{v}{t} = \pi r^2 h/t$$

Where:

- $q$  = volumetric flow rate
- $v$  = measurement volume
- $t$  = measurement time
- $r$  = radius
- $h$  = measurement path length

### 9.0 QUALITY ASSURANCE/QUALITY CONTROL

#### 9.1 General Quality Assurance/Quality Control Procedures

- All data must be documented on field data sheets or in site logbooks.
- The instrument must be operated according to this SOP and the operating instructions supplied by the manufacturer, unless otherwise specified in the UFP- QAPP.
- Consult *Appendix B* Maintenance Records “Blue Book” (Quarterly Defender Bios Calibrator) for quarterly maintenance procedures.
- Records must be maintained, documenting the level of competency for the Contractor’s personnel who will operate the instrument.

#### 9.2 Annual Calibration

The DryCal Defender must be calibrated annually by an accredited vendor.



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### 10.0 DATA VALIDATION

The operator will ensure that the DryCal® Defender Primary Flow Calibrator was operated in accordance with this SOP within instrument specifications and all operational checks have been completed and are within the criteria specified in the site-specific UFP-QAPP. The contractor's Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

### 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.

Safety concerns specific to the operation of the DryCal Defender include:

- The DryCal Defender is not rated intrinsically safe and is not for use with explosive gases or for use in explosive environments.
- The Defender is not designed for pressurization above 0.35 bar (5 pounds per square inch [PSI]) or gas flows above the rated specifications of the flow cell in use. Consult *Appendix A: Specifications* for acceptable gas flow ranges.
- Use only with clean laboratory air or other inert, non-corrosive gases only.

### 12.0 REFERENCES

Mesa Laboratories, Inc. 2017. *Defender™ 500 Series User Manual (MK01-24 REV F)*.  
Mesa Laboratories, Inc. 2016. *Defender™ 530+ User Manual (MK01-51 REV A)*.

### 13.0 APPENDICES

A - Specifications  
B - Quarterly Maintenance Procedures



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### APPENDIX A

#### Specifications

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(Source: Bios International Corporation. - 2004. *DryCal® Defender Manual*)



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### Defender 500 Series Specifications

#### Models:

510L/520L, from 5-500 mL/min

510M/520M, from 50-5,000 mL/min

510H/520H, from 300-30,000 mL/min

#### Measurements:

**Volumetric Accuracy:**  $\pm 1\%$  of reading

**Time per Measurement:** 1-15 seconds (approximate)

**Type:** Single, Continuous or Burst

**Volumetric Flow Units:** cc/min, mL/min, L/min, cf/min

**Pressure Units (Defender 520):** mmHg, PSI, kPa

**Temperature Units (Defender 520):** °C, °F

#### Basics:

**Dimensions (H x W x D):** 5.5 x 6 x 3 in / 140 x 150 x 75 mm

**Weight:** 29 oz / 820 g

**Configuration:** Integrated flow measuring cell, valve and timing mechanism

**Temperature & Pressure Sensors (Defender 520 model only):**

In the flow stream

Press.: 3.5 mmHg (typical), 7.0 mm (max);

Temp.: 0.8° C (typical), 1.3° C (max)

**AC Adapter/Charger:** 12V DC, >250ma, 2.5 mm, center positive

**Battery:** 6V rechargeable, sealed lead-acid, 6-8 hours typical operation



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**Battery Operational Time (5 cycles/min):**

3 hrs backlight on, 8 hrs backlight off

**Pressure & Suction Fittings:** ¼" barbed tube fittings

**Display:** Backlit graphical LCD

**Usage:**

**Flow Modes:** Suction or Pressure

**Operating Pressure (Absolute):** 15 PSI

**Operating Temperature:** 0-50° C

**Ambient Humidity:** 0-70%, non-condensing

**Storage Temperature:** 0-70 °C

**Warranty:** 1 year; battery 6 months

**Bios Optimizer Software**

Requires Windows XP-SP2 or Windows 2000-SP3 compatible PC and RS-232 (serial) connection

Bios Optimizer 110 installation CD (supplied);  
no restrictions apply

RS-232 cable (supplied) for Defender 500 Series data port to  
PC RS-232 (serial) port connection

PC Card (optional and as necessary) creates an RS-232 port  
on your PC

Licensed upgrade to Bios Optimizer 120 is available



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### 7.0 Defender 530+ Series Specifications

#### Technical data about your Defender 530+

**Models:**

530+ L, from 5-500 cc/min

530+ M, from 50-5,000 cc/min

530+ H, from 300-30,000 cc/min

**Measurements:**

**Standardized Accuracy:**  $\pm 1\%$  of reading

**Volumetric Accuracy:**  $\pm 0.75\%$  of reading

**Time per Measurement:** 1-15 seconds (approximate)

**Type:** Single, Continuous or Burst

**Volumetric Flow Units:** cc/min, mL/min, L/min, cf/min

**Standardized Flow Units:** scc/min, smL/min, sL/min, scf/min

**Pressure Units (Defender 530+):** mmHg, PSI, kPa

**Temperature Units (Defender 530+):** °C, °F

**Basics:**

**Dimensions (H x W x D):** 5.5 x 6 x 3 in / 140 x 150 x 75 mm

**Weight:** 29 oz / 820 g

**Configuration:** Integrated flow measuring cell, valve and timing mechanism

**Temperature & Pressure Sensors:** In the flow stream

**Press Accuracy:** 3.5 mmHg (typical), 7.0 mm (max);

**Temp Accuracy:** 0.8° C (typical), 1.3° C (max)

**AC Power Adapter/Charger:** 12VDC, >250ma, 2.5 mm, center positive

**Battery:** 6V rechargeable, sealed lead-acid, 6-8 hours typical operation



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**Battery Operational Time (5 cycles/min):** 3 hrs backlight on, 8 hrs backlight off  
**Pressure & Suction Fittings:** 1/4" ID Swagelock® fittings for Low and Medium models, 3/8" ID for High model  
**Display:** Backlit graphical LCD

**Usage:**

**Flow Modes:** Suction or Pressure

**Operating Pressure (Absolute):** 15 PSI

**Operating Temperature:** 0-50°C

**Ambient Humidity:** 0-70%, non-condensing

**Storage Temperature:** 0-70°C

**Warranty:** 1 year; battery 6 months

**DryCal Pro Software:**

DryCal Pro Software System Requirements

- Windows® XP, Windows® 7
- Microsoft Excel® 2003 and up
- RS-232 port, or if your PC does not have an RS-232 port you will need a USB to RS-232 adapter



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### APPENDIX B

Quarterly Maintenance Procedures

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(Source: "Quarterly Defender Bios Calibrator")



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Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Prior to verification of each Unit check if below parameters are set correctly.**

Connect SKC pump via Tygon® tubing to "Suction Port" of the Defender unit.

"Setup Readings" (Press Enter) > "No. in Avg": 010 / "Time Between": 00 / "Type": Vol > Press Confirm & Exit

"Setup Units" (Press Enter) > "ml/min/Pressure": mmHg / "Temp": F > Press Confirm & Exit

Setup "Time and Date" following Menu as above.

"Preferences" (Press Enter) > "Read Default": Continuous / "Default Settings": No / "Data Port": BIOS / "Magnification": Detail > Press Confirm & Exit; now the Unit is ready for flow verification readings in ml/min.

Back to main menu and press "Measure" > "Continuous" = Record readings under "Readings ±1%"

Pass = Volumetric count functioning properly. Fail = Unit/Display/Counter not working; specify in comments.

Model Type	Volumetric Range	Unit S/N	Last Cal. Date	Cal. Due Date	Pass	Fail	Comments
Defender 520-L	5 - 500ml/min	111952					
Defender 520-L	5 - 500ml/min	111953					
Defender 530-L	5 - 500ml/min	136257					
Defender 530-L	5 - 500ml/min	136258					
Defender 520-M	50 - 500ml/min	111888					
Defender 520-M	50 - 500ml/min	111889					
Defender 530-M	50 - 500ml/min	136224					
Defender 530-M	50 - 500ml/min	136225					
Defender 520-H	300 - 30000ml/min	111511					
Defender 520-H	300 - 30000ml/min	111512					
Defender 530-H	300 - 30000ml/min	136060					
Defender 530-H	300 - 30000ml/min	136061					