CDEM-1000

Coal Dust Explosibility Meter



Operation Manual

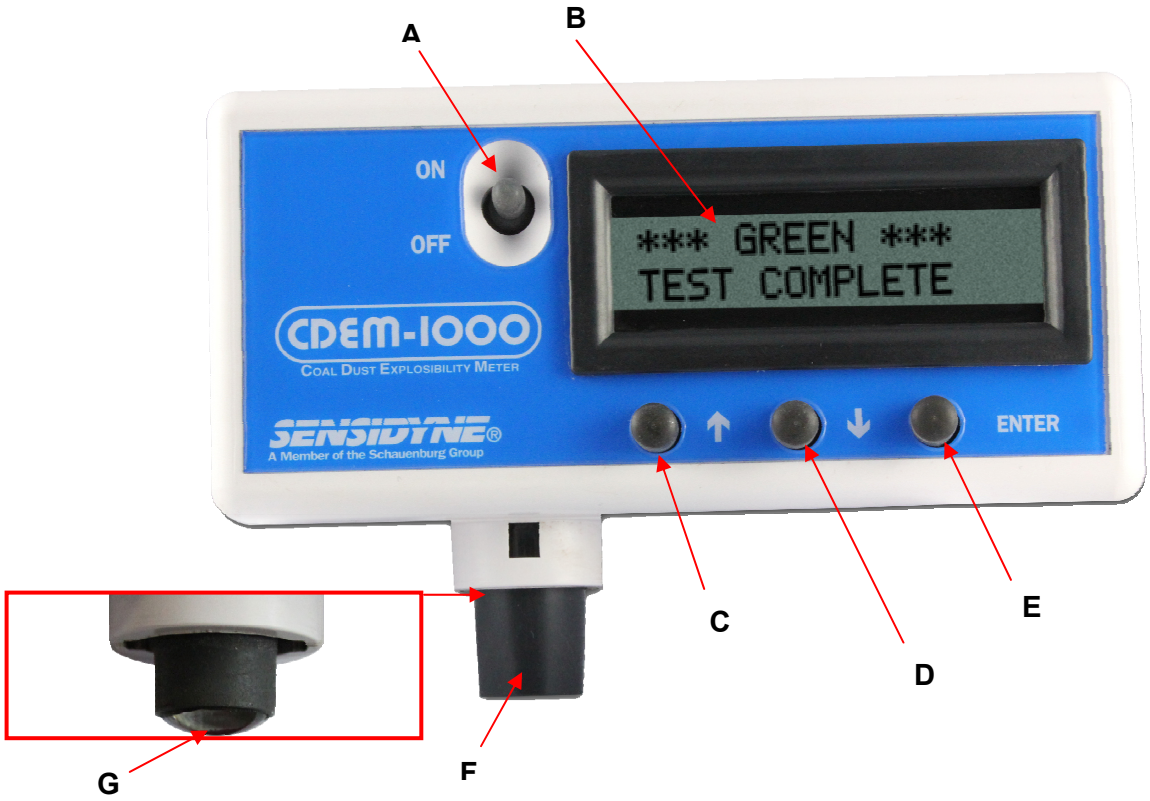
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REF 360-0149-01 Rev. D

CDEM-1000 Identifiers



A	***On/Off Power Switch***
B	***LCD Display***
C	***Up Push Button***
D	***Down Push Button***
E	***Enter Push Button***
F	***Serialized Reflective Standard and Protective Shipping Cup (Removable)***
G	***Optical Probe and Lens***

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Quality Policy Statement

At Sensidyne, we are committed to providing products and services that consistently meet customer needs and comply with all applicable statutory and regulatory requirements.

Our products are designed and manufactured in accordance with ISO 9001:2008, EN 13980:2002, ATEX Directive 94/9/EEC, and IECEx.

Through ongoing review of our designs, supplier performance, and customer feedback we strive to ensure continuous improvement.

All employees at Sensidyne share the responsibility to provide products that are produced efficiently and economically representing the best value to our customers.

We are committed to meeting or exceeding customer expectations in everything we do.

Sensidyne, LP

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Warranty

Sensidyne warrants that, at the time of delivery, the CDEM-1000 shall be free of all defects in workmanship and material. Sensidyne will repair or replace, at its sole option, any CDEM-1000 found to be defective by Sensidyne if notified by Purchaser within the warranty time period.

The warranty time period shall be for one (1) year from the date of original shipment by Sensidyne, except as noted below.

A. Exceptions to the above one year warranty time period:
   1. Consumables have a ninety (90) day warranty.

B. This warranty shall be null and void on any product which:
   1. Is operated or used in excess of the product's operating specifications;

   2. Has been repaired or modified by persons other than authorized Sensidyne personnel or Factory Trained Service Centers, unless such work is authorized in advance in writing by Sensidyne; or

   3. Has been damaged, abused, or misused.

C. Warranty on Service and Repairs:
   1. Goods which have been repaired or replaced during the warranty period are warranted only for the remainder of the unexpired portion of the original warranty period.

   2. Repairs or service provided not pursuant to warranty: 180 days from date of shipment by Sensidyne.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT BEING LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE FOR A PARTICULAR PURPOSE, WHICH ARE EXPRESSLY DISCLAIMED, AND CONSTITUTES THE ONLY WARRANTY OF SENSIDYNE WITH RESPECT TO GOODS SOLD OR DELIVERED.

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Table of Contents

CDEM-1000 Identifiers II
Quality Policy Statement III
Warranty IV

SECTION ONE: Preface 1
Notices 1
Warnings 3

SECTION TWO: Introduction 6
2.1. Product Overview 6
2.2. Features 7
2.3. Accessories 7

SECTION THREE: Set-Up and Use 8
3.1. Use of the Coal Dust Explosibility Meter 8
3.1.1. Initialization 9
3.1.2. Required Calibrations 10
3.2. Sample Preparation 12
3.2.1. Drying a Sample 12
3.2.2. Sample Transfer 13
3.2.3. Sample Test 13
3.3. Meter Calibration 13
3.4. Sample Test Mode 20
3.5. Error Messages 26
3.6. Checking Meter Reflectance 28
3.6.1. Reflectance Error Messages 31

SECTION FOUR: Care and Maintenance 32

SECTION FIVE: Appendices 33
Appendix A: The Effects of Particle Size 33
Appendix B: Parts & Accessories List 35
Appendix C: Specifications 36
Appendix D: Kit Configuration 37
Appendix E: Factory Calibration and Service 38

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SECTION ONE: Preface

Proprietary Notice

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WARNINGS

READ AND UNDERSTAND ALL WARNINGS AND INSTRUCTIONS BEFORE USE.

Failure to read, understand, and comply with ALL accompanying literature, instructions, product labels, and warnings could result in property damage, severe personal injury, or death.

Read and understand ALL applicable federal, state and local environmental, mine safety and occupational health and safety laws and regulations before operating this product. Ensure complete compliance with ALL applicable laws and regulations before and during the use of this product.

DO NOT remove, cover, or alter any label or tag on this product, its accessories, or related products.

UNDER NO CIRCUMSTANCES should this product be used except by qualified, trained and technically competent personnel.

The CDEM-1000 unit is not waterproof. NEVER submerge the unit in water. Device failure, faulting or user injury may result.

The CDEM-1000 has received MSHA approval under Approval Number 18-A110002-0 for Intrinsic Safety in methane air mixture environments. This approval requires the use of Duracell 9 volt alkaline battery no. MN1604**. This instrument is not rated intrinsically safe when used with any other type or brand of battery.**

DO NOT change the battery in a hazardous atmosphere. The act of removing and/or replacing the battery can create an ignition source. Always move to a safe location to remove and/or replace the battery.

DO NOT operate this product should it malfunction, require repair, or have a cracked or broken case or other visible or known damage.

DO NOT repair or modify this product, except as specified in this Operation Manual.

Use ONLY specified Sensidyne parts when performing maintenance procedures described in this Operation Manual. Intrinsic safety certifications become void by substitution of unauthorized components, unauthorized repair or alteration. All other Service should be performed by Sensidyne Authorized Service Centers only.

If the CDEM-1000 comes into contact with a destructive substance(s) it is the responsibility of the user to take suitable precautions that prevent the device from being adversely affected, thus ensuring that the Intrinsic Safety protection is not compromised. Destructive substances include acidic liquids or gases that may attack metals, solvents that may affect polymeric materials, other solvents, or corrosives. Suitable precautions are regular checks as part of routine inspections and establishing from material data sheets that chemicals known to be present do not have an adverse effect on the material of the device (ABS, PVC, polycarbonate, polystyrene plastic, silicone rubber, and stainless steel).

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WARNINGS

READ AND UNDERSTAND ALL WARNINGS AND INSTRUCTIONS BEFORE USE.

The CDEM-1000 is designed to provide a direct indication of the potential explosibility of a coal and rock dust mixture in accordance with Title 30, Code of Federal Regulations, Part 75.403. ***The instrument provides an indication of the percent rock dust contained in a coal dust mixture only and does not measure the total incombustible content of the coal dust mixture since it does not measure the inherent incombustible ash and moisture content of the mixture.***

The CDEM-1000 is not intended to replace the MSHA laboratory low temperature ashing (LTA) analysis of coal dust mixtures since the LTA analysis measures the total incombustible content of the coal dust mixture.

Due care should be exercised at all times when collecting and preparing coal dust samples for use with the CDEM-1000 to ensure accuracy and consistency of results. ***Improper coal dust sample collection and preparation will result in inaccurate readings and can endanger mine operations and personnel.*** Users should follow industry best practices and sample collection guidelines as contained in Bureau of Mines Information Circular I.C. 7113 or MSHA Handbook Number PH-08-V-1.

The CDEM-1000 has not been designed to be and should never be used as an analytical instrument. The instrument is designed to be a “go” or “no-go” screening tool for use by mine operators, safety officers and regulators to help manage daily rock dusting operations and to help identify and mitigate the explosion hazard potential of inadequate rock dusting applications.

The CDEM-1000 is programmed to require a minimum of 80% rock dust in the absence of methane for a safe or ***GREEN*** indication. Where methane is present in the sample background atmosphere the percent of rock dust is increased 0.4 percent for each 0.1 percent of methane. ***It is critical that the user accurately measure and properly input the background methane percentage in the CDEM-1000 when conducting a sample test to ensure an accurate reading. Failure to accurately measure and properly input the correct background methane percentage in the CDEM-1000 will result in inaccurate readings and can endanger mine operations and personnel.***

The sample cups, probe and lens of the CDEM-1000 should be brushed clean and/or vacuumed to remove all dust and debris between each calibration and sample step to prevent cross contamination between samples.

It is very important to thoroughly dry all coal and rock dust mixtures using the activated molecular sieves provided by Sensidyne in accordance with this Operation Manual prior to using with the CDEM-1000. ***Failure to properly dry the sample mixtures with activated molecular sieves can result in inaccurate readings and can endanger mine operations and personnel.***

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WARNINGS

READ AND UNDERSTAND ALL WARNINGS AND INSTRUCTIONS BEFORE USE.

Use only rock dust which complies with the Rock Dust definitions contained in 30 CFR Section 75.2. ***Failure to calibrate the CDEM-1000 with the actual rock dust used in a mine and which complies with the Rock Dust definitions contained in 30 CFR Section 75.2 can result in inaccurate readings and can endanger mine operations and personnel.***

The CDEM-1000 is designed to be calibrated with Pittsburgh Pulverized Coal (PPC). ***Users should not attempt to calibrate the CDEM-1000 with coal from their own mine due to differences in coal particle size distribution which could have an adverse impact on CDEM-1000 readings. (See Appendix A, The Effects of Particle Size).***

The CDEM 1000 is designed for a pass/fail (green/red) criteria of 80% RD. If the CDEM 1000 is calibrated to a pass/fail (green/red) criteria other than 80%, the methane value must be entered as zero, or the unit will not function properly.

The CDEM 1000 is designed and calibrated for use in measuring dust concentrations of bituminous coal.

The CDEM 1000 is designed to be operated with pass/fail (green/red) criteria of 80% rock dust, and must be calibrated using 80% rock dust, as described elsewhere in this manual. If it is calibrated and operated at some other pass/fail criteria, the methane enhancement mode and extended red information mode will not function properly.

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SECTION TWO: Introduction

2.1. Product Overview

The Sensidyne CDEM-1000 Coal Dust Explosibility Meter is a portable, handheld, easy-to-use instrument, which is designed to provide a direct indication of the potential explosibility of a coal and rock dust mixture in accordance with Title 30, Code of Federal Regulations, Part 75.403. Originally developed at the NIOSH Office of Mine Safety and Health Research Laboratory in Pittsburgh, the CDEM-1000 meets the needs of both mining operators and safety inspectors when following the sample collection guidelines as described in Bureau of Mines Information Circular I.C. 7113 or MSHA Handbook, Number PH-08-V-1.

Current regulations require the application of inert rock dust in all underground areas of a coal mine to mitigate the propagation of a coal dust explosion. The CDEM-1000 is intended to be used by mine operators, safety officials and regulators as a screening tool to help manage daily rock dusting operations and to help mitigate the explosion hazard potential by identifying inadequate rock dusting applications. The CDEM-1000 can also be used as an effective tool by mine operators to help determine a more efficient balance between coal dust and rock dust levels.

The operation of the CDEM-1000 is based on the difference in optical reflectance between the darker coal dust and the lighter inert rock dust. The mixture of coal dust and the lighter inert rock dust becomes lighter in color as the concentration of rock dust increases. The higher the concentration of rock dust, the lower the explosion potential of the coal dust mixture. The instrument is intended to be a “go”, “no-go” device which displays a ***RED*** indication for insufficient rock dust levels and a ***GREEN*** indication when the minimum safe level of rock dust is reached. The CDEM-1000 sets the minimum safe level of rock dust at not less than 80 percent in the absence of methane and increases the minimum safe level of rock dust by 0.4 percent for each 0.1 percent of background methane at the sample site.

The CDEM-1000 is not intended to be used as an analytical instrument. It is also not intended to replace the current MSHA laboratory low temperature ashing (LTA) analysis of coal mine dust samples for incombustible content. The instrument provides an indication of percent rock dust only and does not measure the total incombustible content of the coal dust mixture since it does not measure the inherent incombustible ash and moisture content of the mixture.

The CDEM-1000 has been designed with an extra margin of safety due to the fact that it does not include the incombustible ash and moisture content of the coal when determining whether the minimum safe level of rock dust is reached in accordance with Title 30, Code of Federal Regulations, Part 75.403.

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2.2. Features

- Accuracy of ±2 % rock dust for mixtures above 70% rock dust.
- Ambient Methane (CH4) compensation.
- Low Battery Indicator.
- Power-down after ~10 minutes of inactivity.
- Stored Calibration Parameters for multiple tests.
- Temperature Compensation from 10 to 40 degrees Celsius (50 to 104 degrees F).
- Shipping Cup with Reflectance Standard.

2.3. Accessories

The CDEM-1000 Starter Kit ships complete with everything required to create and dry calibration samples, along with the supplies to dry and perform fractional rock dust mine sampling.

The following accessories are standard in every kit:

- **Carrying Case (includes shoulder strap)**
- **Calibration Preparation Supplies:**
- 3ea. Funnels with 20-mesh (850 µm screen) to fit 4oz. calibration vials.
- 2ea. 50(g) PPC calibration coal dust standards in 4oz. vials.
- 1ea. 4oz. vial filled with Activated Molecular Sieves.
- 1ea. 4oz. vial labeled for 100% PPC coal dust standard.
- 1ea. 4oz. vial labeled for 100% RD rock dust standard.
- 1ea. 4oz. vial labeled for 80% Green/Red Boundary sample standard.

- **Sample Preparation Supplies:**
- 6ea. 2oz. Plastic Vials with Activated Molecular Sieves.
- 2ea. Funnels with 20-mesh (850 µm screen) to fit 2oz. calibration vials.
- 5ea. Sample Cups with minimum fill line indicated.
- 1ea. Spatula
- 1ea. Lens Brush

See Appendix D, Kit Configuration for further kit details.

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SECTION THREE: Set-Up and Use

The following section describes the use of calibration samples, instrument initialization at power ON, the basics of sample preparation, and instrument Calibration.

3.1. Use of the Coal Dust Explosibility Meter

The CDEM-1000 must be calibrated prior to conducting a sampling series. The CDEM-1000 is calibrated using a sample of the mine's pure rock dust (100% rock dust), a sample of Pittsburgh Pulverized Coal (PPC) provided with the kit and a coal dust mix of 80% rock dust and 20% PPC by weight. Upon sampling, the CDEM-1000 menu will prompt the user to input the background methane (CH4) at the location of the sample.

The CDEM-1000 is a screening tool which provides the user with an indication of the potential explosibility of the coal dust sample mixture. An indication of ***GREEN*** represents a condition where there is sufficient rock dust in accordance with Title 30, Code of Federal Regulations, Part 75.403. An indication of ***RED*** represents a potentially explosive condition requiring further application of inert rock dust in the mine.

NOTE: Users should follow best industry practices and the sample collection guidelines as described in Bureau of Mines Circular I.C. 7113 or MSHA Handbook, Number PH-08-V-1 when collecting and preparing the coal dust sample for use on the CDEM-1000. Failure to follow proper sample collection practices will result in inaccurate readings and can endanger mine operations and personnel.

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Pittsburgh Pulverized Coal (PPC)

The CDEM-1000 is designed to be calibrated with Pittsburgh Pulverized Coal (PPC). ***Users should not attempt to calibrate the CDEM-1000 with coal from their own mine due to differences in coal particle size distribution which could have an adverse impact on the CDEM-1000 readings.*** PPC is pulverized coal from the Pittsburgh coal seam and is particle size characterized as shown in Table1 below:

Table 1

Size Range (microns)	Particle Size Distribution %
212 – 300	0.40%
150 – 212	0.85%
106 – 150	5.10%
75 – 106	15.40%
53 – 75	21.65%
38 – 53	20.00%
< 35	13.15%
18.7 – 25.5	11.80%
< 18.7	11.65%

3.1.1. Initialization

The CDEM-1000 has three operating modes when the power switch is turned **ON**.

A. Sample Test Mode –

- The CDEM-1000 automatically enters the Sample Test Mode when it is turned ON without depressing any other buttons.

B. Calibration Mode –

- Pressing and holding the **ENTER** button upon start up will initiate the Calibration Mode.

C. Reflectance Standard Check Mode –

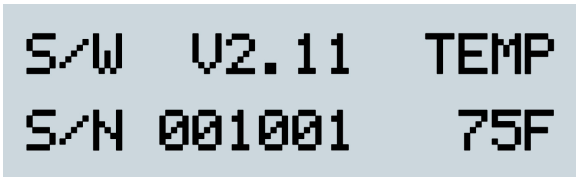
- Pressing and holding the **UP** button (left) upon start up will initiate the Reflectance Standard Check Mode.

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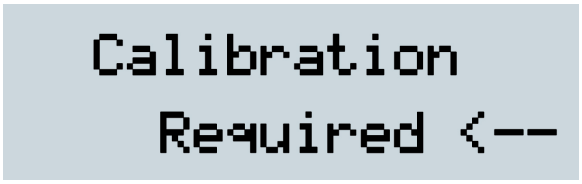
3.1.2. Required Calibrations

The CDEM-1000 is designed to require a Calibration after every 200 samples and a Reflectance Standard Check after every 1000 samples taken.

When the power switch is turned **ON**, a battery test is performed and a start up sequence will begin with the LCD display indicating the software version, serial number of the unit and the CDEM-1000 internal temperature.



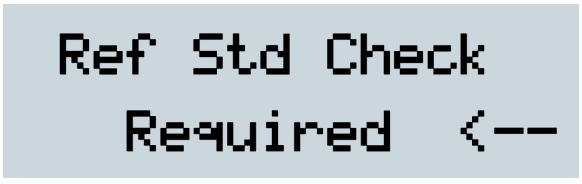
If 200 samples have been taken since the last Calibration was performed, the following screen will be displayed:



After pressing **ENTER** to acknowledge the message, the following screen will be displayed:



If 1000 samples have been taken since the last Reflectance Standard Check was performed, the following screen will be displayed:



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After pressing **ENTER** to acknowledge the message, the following screen will be displayed:

```
TURN OFF METER
```

If 100 or more samples have been taken since the last Calibration was performed, the following screen will be displayed:

```
Cal Req'd In
NNN Samples  <--
```

Where “NNN” indicates the number of samples that may be taken before a calibration is required. After pressing **ENTER** to acknowledge the message, the CDEM -1000 will proceed to the next step.

If 900 or more samples have been taken since the last Reflectance Standard Check was performed, the following screen will be displayed:

```
Ref Std Req'd In
NNN Samples  <--
```

Where “NNN” indicates the number of samples that may be taken before a reference standards check is required. After pressing **ENTER** to acknowledge the message, the CDEM-1000 will proceed to the next step.

After all operational checks have been performed, (temperature, calibration count and reflectance standard check count), the selected operating mode will be activated.

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3.2. Sample Preparation

This section describes the process for preparing all calibration and test samples for use on the CDEM-1000.

The CDEM-1000 must be calibrated prior to performing any coal dust sample testing. Calibration samples must be prepared for:

- PPC Coal Dust (PPC) – The CDEM-1000 is designed to be calibrated with Pittsburgh Pulverized Coal (PPC). PPC is supplied with the CDEM-1000 kit. *Note: Coal dust is abbreviated as "CD" on the CDEM-1000 LCD screen*.
- Rock Dust (RD) – The CDEM-1000 must be calibrated with the actual rock dust used in the mine.
- GREEN/RED Boundary Sample – The boundary sample is made by mixing RD with PPC to achieve a mixture that is 80% dried RD and 20% dried PPC by weight. For example, an 80% RD sample can be achieved by mixing 40 grams of dry RD with 10 grams of dry PPC.

3.2.1. Drying a Sample

All calibration samples and all coal dust test samples must be thoroughly dried using the activated molecular sieves provided by Sensidyne prior to using with the CDEM-1000. Included in the CDEM-1000 kit are vials containing activated molecular sieves which are the drying agent for drying both the calibration samples (i.e., PPC, RD and GREEN/RED Boundary Sample) and the collected coal dust samples from the mine.

Note: Failure to properly dry the calibration and coal dust sample mixtures using activated molecular sieves before using with the CDEM-1000 can result in inaccurate readings and can endanger mine operations and personnel.

The procedure for drying a sample with molecular sieves is as follows:

- Fill a vial with clean, unused activated molecular sieves to about ⅓ full; then add the sample material until the vial is ¾ full. Close the cap on the vial and shake for a minimum of sixty (60) seconds. The molecular sieves will remove the moisture from the sample material so that the sample can be used for calibration and testing on the CDEM-1000. **Note: Molecular sieves should be used on a single sample only and should be discarded after each use to avoid cross contamination between samples.**
- The CDEM-1000 kit contains 4 ounce vials for drying and preparing the PPC, RD and GREEN/RED Boundary calibration samples. The smaller 2 ounce vials are intended for drying and preparing the mine coal dust samples for testing.

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3.2.2. Sample Transfer

Included in the CDEM-1000 kit are three large (for calibration) and two small (for sampling) funnel attachments that are used for screening the molecular sieves and the larger particles from the sample mixture and to transfer the sample mixtures to the sampling cups.

- Attach (snap) the funnel assembly onto the top of a dried calibration / sample vial.
- Place the sample cup onto the small end of the funnel, invert, and shake until the sample cup is about 2/3 full and above the fill line (the 20 mesh / 850 µm screen will prevent oversized particles / sieves from entering the sample cup).
- Remove the funnel from the vial and close the sample vial.

3.2.3. Sample Test

Once a sample has been dried, screened and transferred to the sample cup, follow the meter's on-screen step-by-step instructions. The sample cup must be pressed firmly over the probe during the entire reading. After each step, the meter will wait for the user to push the **ENTER** button to acknowledge the completion of the indicated step before moving on to the next step. In this way the meter allows the user to work at a self directed pace.

Note: The CDEM-1000 will power down after ~10 minutes of non-use and turn off. Any in process sample data will be lost when the meter powers down automatically.

3.3. Meter Calibration

The CDEM-1000 must be calibrated with the actual rock dust used in the mine. In addition, the instrument should be recalibrated whenever there are changes in rock dust supply in any given mine.

Use only rock dust which complies with the Rock Dust definition as contained in 30 CFR Section 75.2 when using the CDEM-1000.

Note: Failure to calibrate the CDEM-1000 with the actual rock dust used in a mine and which complies with the Rock Dust definition as contained in 30 CFR Section 75.2 can result in inaccurate readings and can endanger mine operations and personnel.

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To calibrate the CDEM-1000, follow the steps outlined below:

- Push and hold the **ENTER** button as you turn **ON** the CDEM-1000.
- The meter will display the software version, CDEM-1000 serial number, and the operating temperature. After about five seconds, the display will change to the Calibration Mode.

```
S/W  V2.11  TEMP
S/N 001001   75F
```

- At each screen, when the **<--** is displayed, the CDEM-1000 is waiting for the user to complete the instructions and then press **ENTER** to confirm that the screen instructions have been followed before continuing to the next screen.

```
 Start Cal?
OFF or ENTER <--
```

- At this point you can exit the Calibration Mode by turning the instrument **OFF** or press **ENTER** to continue for calibration.

```
CALIBRATE
METER        <--
```

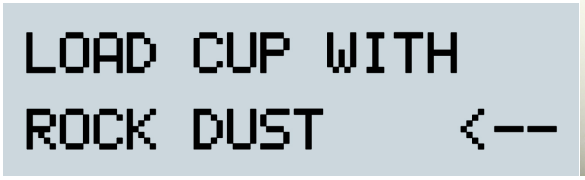
- Press **ENTER** to continue to the next step.

```
CLEAN CUP, PROBE
AND LENS     <--
```

- Ensure that the sample cup, probe and lens is free of all dust and debris by cleaning with the brush provided with the CDEM-1000 kit and/or with a vacuum.

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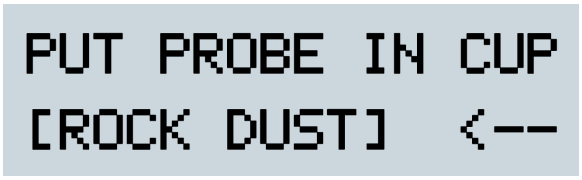
- Once completed, press **ENTER** to continue to the next step.





- Fill the sample cup with pure rock dust to just above the fill line inside the cup. Ensure the rock dust sample has been properly dried in accordance with Section 3.2.1., Drying a Sample.

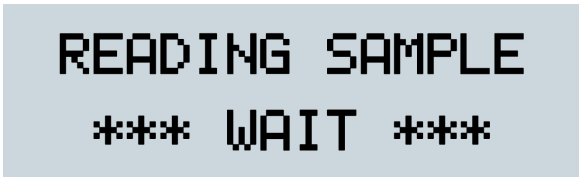
- Once completed, press **ENTER** to continue to the next step.



- Press cup onto the optical probe and hold firmly in place so that the sample material maintains constant and consistent contact with the optical lens during the calibration. **Note: There should be a slight spill over of sample material around the lens to indicate an appropriate amount of rock dust sample material was used.**

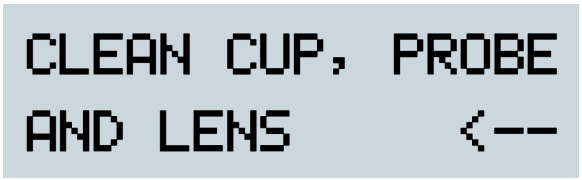
- Once completed, press **ENTER**.

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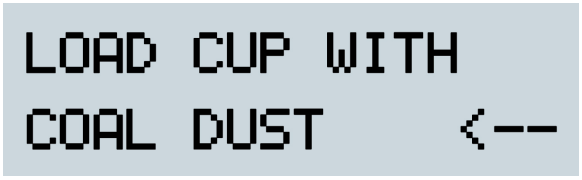




- When this message is displayed, the sample cup can be removed.



- All rock dust sample material should be thoroughly cleaned from the sample cup, probe and optical lens using the brush provided with the CDEM-1000 kit and/or with a vacuum.
- Once completed, press **ENTER** to continue to the next step.



- Fill the sample cup with PPC to just above the fill line inside the cup. Ensure that the PPC sample has been properly dried in accordance with Section 3.2.1., Drying a Sample.
- Once completed, press **ENTER** to continue to the next step.

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```
PUT PROBE IN CUP
[COAL DUST]  <--
```

- Press cup onto the optical probe and hold firmly in place so that the PPC sample material maintains constant and consistent contact with the optical lens during the calibration. **Note: There should be a slight spill over of PPC material around the lens to indicate an appropriate amount of sample material was used.**

- Once completed, press **ENTER**.

```
  READING SAMPLE
   *** WAIT ***
```

```
COAL DUST SAMPLE
COMPLETE
```

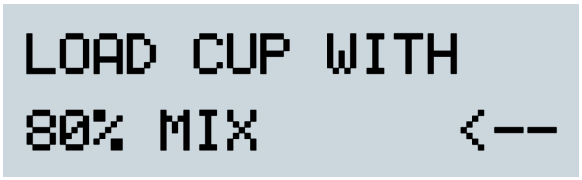
- When this message is displayed, the sample cup can be removed.

```
CLEAN CUP, PROBE
AND LENS     <--
```

- All PPC sample material should be thoroughly cleaned from the sample cup, probe and optical lens using the brush provided with the CDEM-1000 kit and/or with a vacuum.

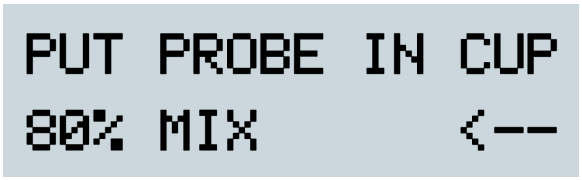
- Once completed, press **ENTER** to continue to the next step.

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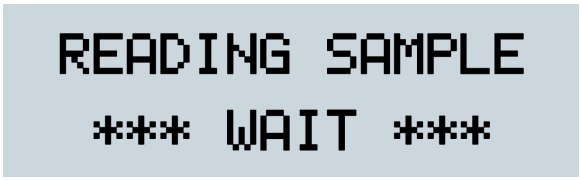
- Fill the sample cup with the 80% GREEN/RED Boundary Sample mixture to just above the fill line inside the sample cup. Ensure the GREEN/RED Boundary Sample mixture has been properly dried in accordance with Section 3.2.1., Drying a Sample.

- Once completed, press **ENTER** to continue to the next step.



- Press cup onto the optical probe and hold firmly in place so that the sample material maintains constant and consistent contact with the optical lens during the calibration. **Note: There should be a slight spill over of sample material around the lens to indicate an appropriate amount of sample material was used.**

- Once completed, press **ENTER**.

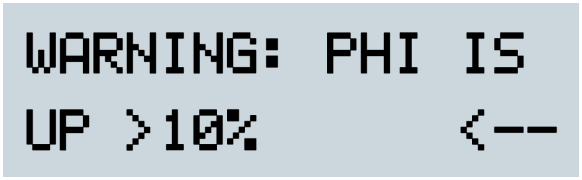


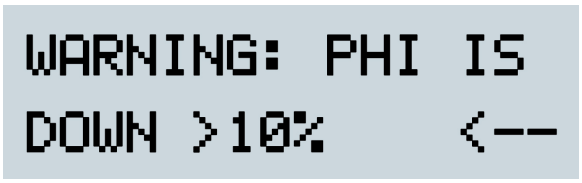


- When this message is displayed, the sample cup can be removed.

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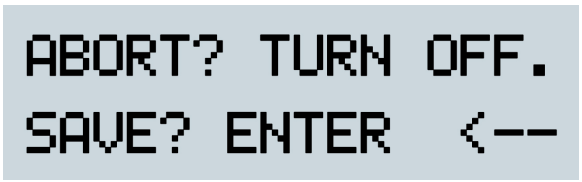
- ***Note: If the meter detects calibration values with a difference of more than 10% from the previous calibration values, one of the following two warning messages will appear. This is an indication of possible contamination of the calibration samples. (PHI is a reference to the meter's response signal).***





Note: The CDEM-1000 is factory calibrated before shipment. Your initial calibration may cause this warning message to appear due to differences in the color of the rock dust from the factory calibration. Variations in rock dust lots may also produce this warning message.

- Press **ENTER** for the next screen, you will then have the option to disregard the current calibration results and revert to the previously stored calibration data or to accept the new calibration results. ***However, it is recommended to disregard the current calibration when these warning messages appear and to repeat the current calibration process.***



- To save the new calibration to the instrument, press **ENTER**.



- Once completed, press **ENTER** to continue to the next step.

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Following the calibration routine, it is recommended that the CDEM-1000 should be checked for proper function before use by using the 80% GREEN/RED Boundary sample in the Sample Test Mode. [Note: Due to minor variations inherent in sampling, the 80%RD check sample can sometimes give a Red indication. However, when checked in the Extended Red Data Display Mode (see details in Section 3.4.) the upper end of the measured range should indicate 80%RD in the absence of methane].

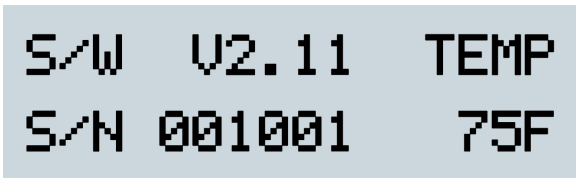
3.4. Sample Test Mode

The following steps outline the process for conducting coal dust sample testing using the CDEM-1000 after the unit has been properly calibrated.

During a sample test, prompts will guide the operator through the required steps to perform a sample test. At each screen, when the prompt **<--** is displayed, the CDEM-1000 is waiting for the user to complete and acknowledge the instructions. Press **ENTER** to continue to the next screen.

- Turn **ON** the CDEM-1000.

- The start-up screen will display the software version, serial number of the CDEM-1000 and the CDEM-1000 internal temperature (in Fahrenheit) for approximately 5 seconds.



- The first prompt indicated is:

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- The Ambient Methane value is required for the CDEM-1000 to continue and measure a sample. This value should be obtained from a properly calibrated and maintained methane detection instrument operating in the area of the sample. (The CDEM-1000 does not detect methane). Simply scroll up or down using the UP and DOWN arrow buttons, and select the area Methane value using the ENTER button. The CDEM-1000 allows input of methane values from 0.0% to 2.0% methane by volume. This methane value causes the percent rock dust green indication to increase at a rate of 0.4% for every 0.1% of methane increase. See Table 2 below.

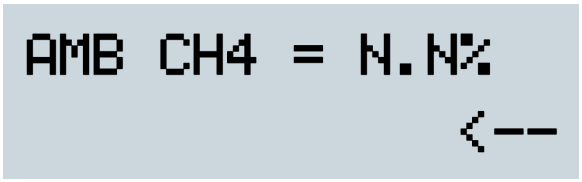
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Table 2

Methane % Volume	Minimum % RD Required for Green
0.0	80.0
0.1	80.4
0.2	80.8
0.3	81.2
0.4	81.6
0.5	82.0
0.6	82.4
0.7	82.8
0.8	83.2
0.9	83.6
1.0	84.0
1.1	84.4
1.2	84.8
1.3	85.2
1.4	85.6
1.5	86.0
1.6	86.4
1.7	86.8
1.8	87.2
1.9	87.6
2.0	88.0

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- Once completed, press **ENTER** to continue to the next step.



- The operator must confirm the correct Ambient Methane value (i.e., AMB CH4) has been entered in the instrument and then press **ENTER** to continue. If an incorrect methane value was entered the meter should be turned off and re-started prior to sampling.



- Ensure the sample cup, probe and optical lens are thoroughly clean of all dust and debris using the brush provided with the CDEM-1000 kit and/or with a vacuum.

- Once completed, press **ENTER** to continue to the next step.



- Dry the coal dust sample using activated molecular sieves as described in Section 3.2.1., Drying a Sample.

- Once completed, press **ENTER** to continue to the next step.



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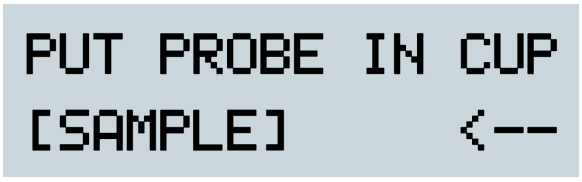
- Once completed, press **ENTER** to continue to the next step.



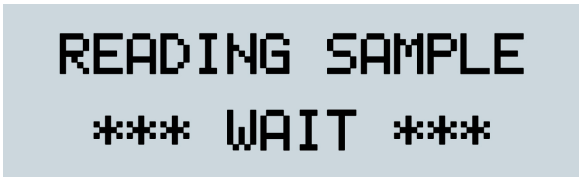
- Once completed, press **ENTER** to continue to the next step.



- Fill sample cup with sample coal dust mixture to just above the fill line inside the sample cup.
- Once completed, press **ENTER** to continue to the next step.



- Press cup onto the optical probe and hold firmly in place so that the coal dust sample material maintains a constant and consistent contact with the optical lens during the test. **Note: There should be a slight spill over of coal dust sample material around the lens to indicate an appropriate amount of sample material was used.**
- Once completed, press **ENTER** to continue to the next step.



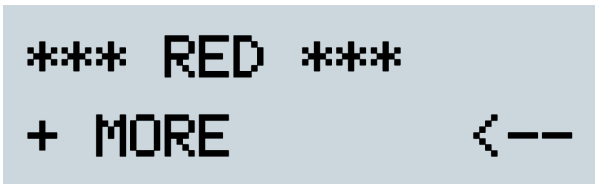
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- Once completed, the CDEM-1000 will display the results automatically.



- When this message is displayed, the sample cup can be removed.

When the sample tested is below the GREEN/RED boundary threshold the result will display as ***RED***.



The CDEM-1000 provides an Extended RED Data Display Mode to display a range of rock dust percentage at or above 70% as detected in the sample test. This information is available only in the event of a ***RED*** indication. It is intended for informational purposes solely as a gauge of the relative rock dust in the mine to assist mine operators to determine additional rock dusting requirements.

To access the Extended RED Data Display Mode press the **UP** button (left); alternatively press **ENTER** to complete the sample.



The CDEM-1000 will display a range of approximate RD% as detected in the tested sample.

- Once completed, press **ENTER** to continue to the next step.

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When the sample tested is at or above the GREEN/RED boundary threshold for fractional rock dust the result will display as ***GREEN***.



- Once the result has been displayed and acknowledged, press **ENTER** to continue to the next step.

The CDEM-1000 will continue to display the results and notify the operator that the test is now complete.





The CDEM-1000 will now return to the beginning of the sample test mode and start another sample test or can be turned **OFF** at this time.

3.5. Error Messages

The CDEM-1000 has several error messages to warn the user under certain circumstances as follows:



- The battery voltage is too low for standard operation to continue. Replace with specified batteries only.

WARNING: DO NOT remove or replace the battery in a hazardous atmosphere.

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```
ERR1: TEMP < 10C
T=XX.XC      <--
```

```
ERR1: TEMP > 40C
T=XX.XC      <--
```

- The internal temperature of the CDEM-1000 unit is outside the specified upper or lower operating temperature range of the device. The CDEM-1000 is designed to operate in temperatures from 10°C to 40°C (50° F to 104° F). The CDEM-1000 will not operate outside of its specified operating temperature range, and it will automatically power down if ambient conditions go outside the operating temperature range.

```
ERR2: SUT LIGHT-
ER THAN RD   <--
```

```
ERR3: SUT DARK -
ER THAN CD   <--
```

Sample Test error messages indicate the **Sample Under Test (SUT)** measured is outside the CDEM-1000 calibrated range of acceptable reflectance. This is an indication of a potential problem with the instrument calibration and/or sample test.

```
ERR4: V > 3.8V
              <--
```

This calibration error message indicates the rock dust presented exceeds the factory preset optical reflectance values. Please contact your sales representative or the factory for additional assistance.

```
ERR5: INVALID
CAL VALUES   <--
```


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This calibration error indicates that the optical reflectance calibration values are out of sequence. Check the calibration samples and re-calibrate the instrument to see if this condition clears. Please contact your sales representative or the factory for additional assistance if this condition persists.

3.6. Checking Meter Reflectance

Performance of the CDEM-1000 optics is critical to instrument accuracy and overall performance. Periodically, it will be necessary to perform a reflectance check to test the performance of the optics in the meter against the original factory calibration settings to confirm the optics continue to function as expected. The meter reflectance check can be performed at any time. However, the meter requires a reflectance check to be performed after every 1000 samples.

The CDEM-1000 is supplied with a protective shipping cup, which also serves as a Reflectance Standard for checking the operation of the CDEM-1000 optics. The Reflectance Standard is designed to be unique and specific to each CDEM-1000 and should not be used on another instrument. There is a unique serial number on each Reflectance Standard that is correlated to the unique serial number of each meter.

Note: Using a mismatched Reflectance Standard from another CDEM-1000 can lead to inaccurate reflectance test results.

The protective shipping cup should be stored on the CDEM-1000 when the instrument is not in use, or when the meter is being transported, to protect the optics from damage.

The Reflectance Standard cup should never be used to hold samples for calibration or to perform sample testing.

The procedures below should be followed when prompted to perform the reflectance standard check:

1. Attach the Reflectance Standard cup (serialized to match the meter) supplied with the CDEM-1000 so that the label faces the operator (forward). The Reflectance Standard cup attaches to the meter by sliding the cup over the lens and aligning the ears of the cup to the openings on the unit. Push up slightly and turn the cup counter-clockwise to lock the ears into position.
2. Do Not push or hold the Reflectance Standard cup against the lens. The Reflectance Standard cup is designed to remain in the proper position once locked in place on the meter.
3. Hold the meter upright and push and hold the **UP** button (left) and turn the power **ON**.

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To check the meter reflectance, power up the instrument. The start up screen will display the software version, serial number of the CDEM-1000 and the CDEM-1000 internal temperature for ~ 5 seconds.

```
S/W  V2.11  TEMP
S/N 001001   75F
```

- The next prompt is:

```
REF STANDARD
CHECK        <--
```

- Once completed, press **ENTER** to continue to the next step.

```
PUT PROBE IN CUP
[REF STD]    <--
```

Press **ENTER** to continue to the next step.

- The unit will display:

```
READING STANDARD
  *** WAIT ***
```

- Followed by:

```
STANDARD CHECK
   COMPLETE
```


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- The following screen will display the results of the test:

```
REF STD WITHIN
+/-10%
```

Note: Should the optics within the CDEM-1000 unit change intensity from the original factory reflectance settings, either of the two following error messages may appear and service may be required (Refer to Section 3.6.1).

```
REF STD < 10%
HIGH          <--
```

```
REF STD > 10%
LOW           <--
```

- Once completed, press **ENTER** to continue to the next step.

```
REF STD CHECK
COMPLETE
```

```
 TURN OFF METER
```

The Reflectance Standard Check is now completed and normal use of the instrument can continue after cycling the power switch **OFF**.

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3.6.1. Reflectance Error Messages

Should the optics within the CDEM-1000 unit change intensity from the original factory reflectance settings, either of the two following error messages may appear:



This is an indication that the meter has detected a change in the reflectance characteristics of the optics. Clean the lens and the Reflectance Standard by brushing with the brush supplied in the CDEM-1000 kit and/or vacuuming and repeat the reflectance standard test.

DO NOT USE the instrument if these error messages continue to appear. The unit should be returned to the factory or an authorized Factory Service Center for repair or replacement.

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SECTION FOUR: Care and Maintenance

The CDEM-1000 is a robust low power electronic meter that has been constructed to meet the use of dust sampling in a coal mine environment. The unit and optic lens may be cleaned by use of a moist damp cloth and allowed to dry.

The use of soap solutions and other mild chemicals are not recommended due to residue that may interfere with reflectance and operational accuracy. At no time should the instrument be subjected to running water or be submerged for cleaning, this will damage the instrument and void the warranty.

The sample cups, probe and lens of the CDEM-1000, should be brushed clean and/or vacuumed to remove all dust and debris between each calibration and sample step to prevent cross contamination between samples.

Periodically, it will be necessary to replace the battery for continued use. The meter will display a Low Battery condition to indicate the need for battery replacement (See Error Messages). Replace with the specified battery only, Duracell MN 1604.

WARNING: DO NOT remove or replace the battery in a hazardous atmosphere.

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SECTION FIVE: Appendices

Appendix A: The Effects of Particle Size

The Pittsburgh Pulverized Coal (PPC) samples that are provided with the CDEM-1000 kit are prepared to a certain size distribution as shown in the table in Section 3.1. It is imperative that the unit be calibrated using this PPC sample and that calibration mixtures are prepared with this PPC sample and the rock dust that is currently in use in the mine and which complies with the Rock Dust definitions contained in 30 CFR Section 75.2.

The CDEM-1000, like the explosibility of coal mine dust, is sensitive to particle size. Finer coal particles are more explosible than coarse particles and finer rock dust particles are better at suppressing an explosion than coarse particles. The reflectance of the coal mine dust responds in a similar manner. The CDEM-1000 measures this reflectance to determine explosibility of a dust sample. The ability of the CDEM-1000 to discern the effect of particle size on explosibility is one reason CDEM-1000 results may vary from laboratory incombustible content measurements.

Figure 1 on the following page shows the change in the amount of rock dust required to inert 3 different particle sizes of coal dust. The horizontal line expressing the explosibility threshold was determined by NIOSH testing. Coal dust with a 57 micron mean diameter, the size of the pulverized coal (PPC) used in NIOSH explosion testing and provided as a calibration standard with the CDEM-1000, requires 80% rock dust. Coal dust 10% finer (i.e., 51.3 microns) requires about 82% rock dust while coal dust 10% coarser (i.e., 62.7 microns) requires only about 78% rock dust.

Figure 2 on the following page shows the same relationship as *Figure 1* for variations in rock dust particle size. The nominal rock dust particle size used in explosion experiments by NIOSH was 26 microns and should comprise 80% of the coal mine dust to be considered inert. A 10% increase in rock dust particle size (i.e., 28.6 microns) would require almost 82% rock dust to be inert while rock dust 10% finer (i.e., 23.4 microns) would be inert at a 78% fraction of the mine dust.

If a mine dust contains coal dust finer than the PPC and/or rock dust coarser than a median 26 micron particle size, the CDEM-1000 may indicate explosibility (RED) even though the dust is >80% incombustible content. This result is not an error but an indication that the dust is more explosible than measuring incombustible content alone can determine. NIOSH testing indicates the mine dust sample is likely explosible.

If a mine dust contains coal dust coarser than the PPC and/or rock dust finer than a median 26 micron particle size; the CDEM-1000 may indicate non-explosibility (GREEN) even though the dust is <80% incombustible content. This result is not an error but an indication that the dust is less explosible than measuring incombustible content alone can determine. NIOSH testing indicates the mine dust sample is likely not explosible.

Note: The information above and the following charts have been provided by NIOSH and are reproduced here with their approval.

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Figure 1

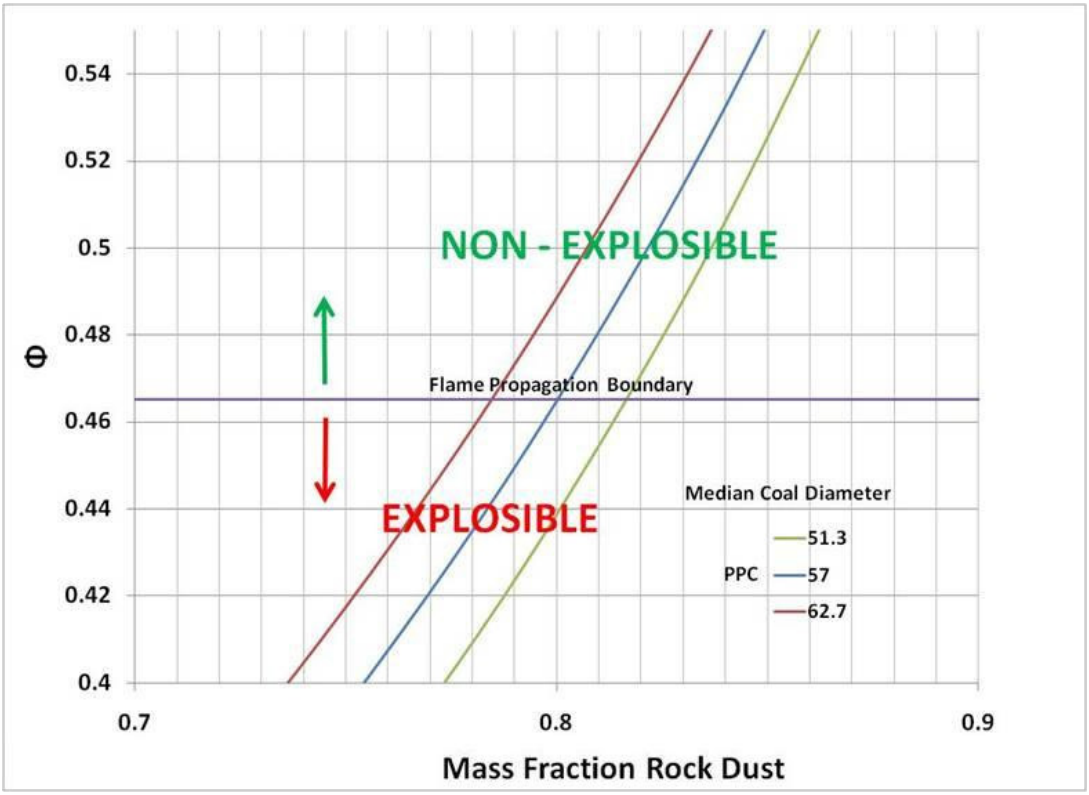
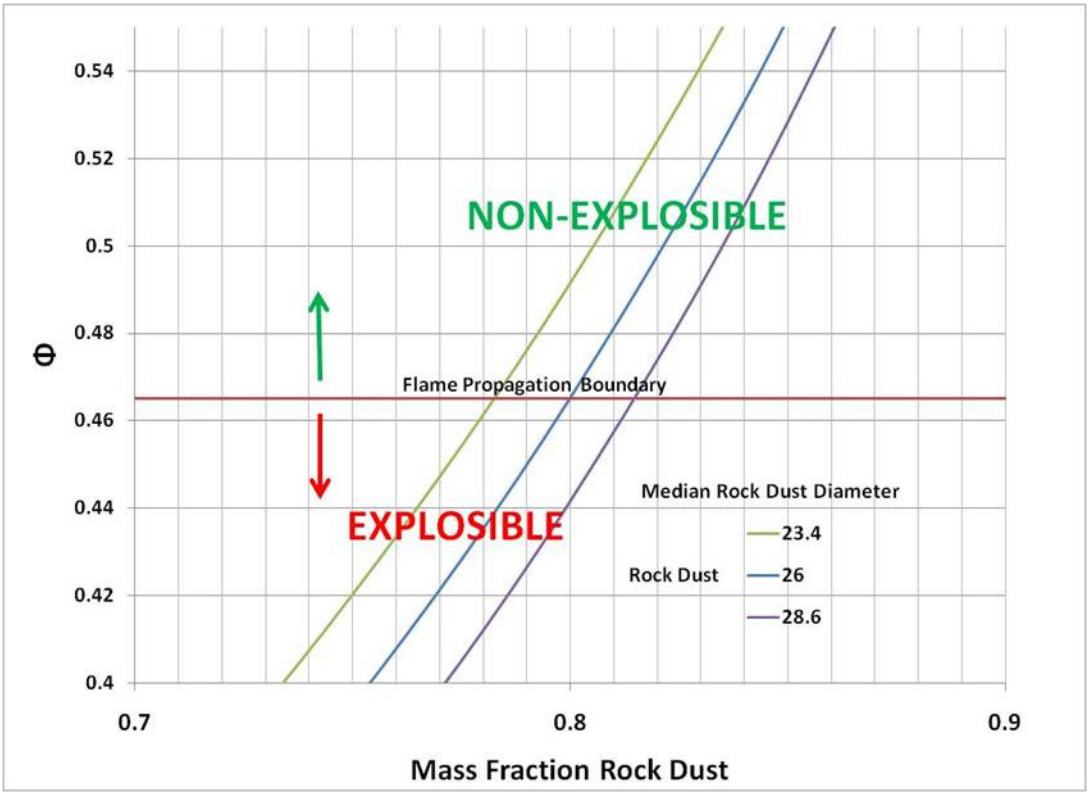


Figure 2



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Appendix B: Parts & Accessories List

Part Number	Description
810-1101-01	CDEM-1000 Coal Dust Explosibility Meter Kit
360-0149-01	Operation Manual CDEM-1000
811-1107-01	Carrying Case, CDEM-1000 (includes shoulder strap)
529-0003-01	Carrying Case, CDEM-1000 Shoulder Strap
811-1101-01	Funnel, CDEM-1000, small, 2 pack
811-1101-02	Funnel, CDEM-1000, large, 3 pack
580-0016-01	Spatula
580-0017-01	Sample Brush
811-1103-12	2 oz. Sample Vials, Pack of 12 with Activated Molecular Sieves
811-1103-24	2 oz. Sample Vials, Pack of 24 with Activated Molecular Sieves
811-1104-01	PPC Calibration Standard 50g x2
811-1103-01	Molecular Sieves Replacement 80g
811-1105-01	Calibration Kit, Replacement (includes PPC, Activated Molecular Sieves, and three 4 oz vials, pre-labeled)
811-1106-01	Accessories Kit, Replacement (includes spatula, brush and ten sample cups)
811-1102-01	Sample Cup 5-pack
7013586	Canvas Carrying Pouch

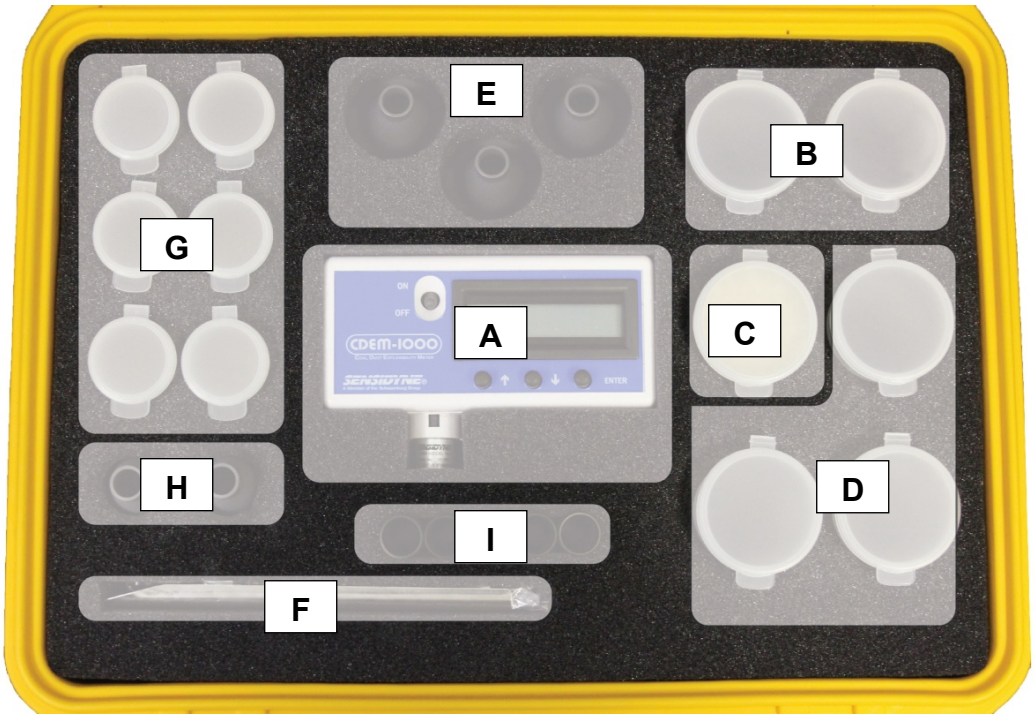
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Appendix C: Specifications

Size	5.4 x 2.4 x 1.2 inches (13.7 x 6.2 x 3.2 cm)
Weight	0.5 pounds (0.23 kg)
Display	LCD
Range	70 – 100% rock dust by weight
Calibration Frequency	Every 200 tests or with a change in rock dust supply
Reflectance Standard Check	Every 1000 tests
Power	9 volt alkaline battery (Duracell MN1604)
Power Functions	Low battery indicator and auto power down
Operating Temperature Range	10 to 40 degrees C (50 to 104 degrees F)
Accuracy	+/- 2% rock dust for dust mixtures above 70% rock dust when proper sample preparation and unit calibration is performed
Extended Red Display	Displays a % rock dust range for ***Red*** indications at or above 70% rock dust

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Appendix D: Kit Configuration



A	***CDEM Instrument***
B	***Calibration PPC***
C	***Calibration Molecular Sieves***
D	***Calibration Vials***
E	***Calibration Funnels with Screens***
F	***Brush and Spatula***
G	***Sample Vials with Molecular Sieves***
H	***Sample Funnels with Screens***
I	***Sample Cups***

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Appendix E: Factory Calibration and Service

U.S.A.

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Notes

Notes

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CDEM-1000

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