CAMERON

Measurement Systems

NuFlo™

MC-II ™ Plus Portable Rate Meter

User Manual

INTRINSICALLY SAFE FOR USE IN HAZARDOUS ENVIRONMENTS.
CLASS 1, DIV. 1
GROUPS A, B, C and D

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TABLE OF CONTENTS

Introduction 5

Specifications 5

Operation 6

Error Detection 7

Calibration 7

- Liquid Measurement Using Preprogrammed Units of Measure 8
- Gas Measurement Using Preprogrammed Units of Measure 11
- Liquid Measurement Using a Calculated Divisor and Rate Multiplier 16
- Gas Measurement Using a Calculated Divisor and Rate Multiplier 20
- Time Out Feature 23
- Nominal Meter Factor 24
- Reading Frequency 25

Presetting Total Volume 25

Setting Flow Rate Filter 27

Setting Input Sensitivity 27

Setting a Security Code 28

Accessing With a Security Code 29

Appendix A – Maintenance A-1

- Battery Replacement A-1
- Circuit Assembly Replacement A-2
- Switchplate Replacement A-2
- Spare Parts List A-3

Appendix B - Configuration Menu Flowchart B-1

Appendix C– User Interface Prompt Glossary C-1

Appendix D – Data Tables D-1

Table 1 – Determining Atmospheric Pressure from Elevation D-1

Table 2 – Table of Conversions of Temperatures D-2

Table 3 – Table of Conversions of Liquid Volumes D-2

Table 4 – Table of Conversions of Gas Volumes D-2

Appendix E - Lithium Battery Information E-1

Lithium Battery Disposal E-1

Transportation Information E-1

Material Safety Data Sheet (Lithium Batteries) E-2

Appendix F – Turbine Meter Information F-1

Turbine Meter Nominal Factors F-1

Introduction

The NuFlo Model MC-II *Plus* Portable Rate Meter is a portable readout instrument which provides a continuous display of flow rate and total volume of liquids and gases. Since it uses the same advanced circuitry of the rest of the MC-II *Plus* family of instruments, it shares many of the same features. Being portable, it can be transported to multiple field locations to verify proper operation of turbine flowmeters of any size. When connected to a Turbine Flowmeter, the MC-II *Plus* Portable Rate Meter becomes an accurate system for the display of current flow rate and total volume.

A security access code prevents unauthorized personnel from altering the calibration of the instrument. The security code may the disabled if this feature is not required. The input sensitivity may be adjusted from the front panel, eliminating the necessity to connect test equipment or open the meter enclosure for this adjustment.

The one piece LCD simultaneously displays seven digit volume, six digit flow rate as well as a selection of commonly used engineering units. The seven digit volume is displayed on the upper line of the LCD with a decimal point position selected by the operator during calibration. The six digit flow rate is displayed on the lower line of the LCD where the decimal point position is determined internally by the MC-II *Plus* Portable Rate Meter. The flow rate decimal point will shift positions as the flow rate changes to provide maximum resolution.

Low power microprocessor technology enables the MC-II *Plus* Portable Rate Meter to operate a minimum of two years on a single lithium battery. Due to the long battery operating life no power switch is necessary.

Specifications

Certification	CSA approved, Class 1, Div. 1, Intrinsically Safe
Enclosure	Black ABS Plastic. Weatherproof when the lid is closed and latched 3 7/16” H x 7 7/8” D x 8 7/8” W (including hinge and handle)
System Power	3 VDC, D-size lithium battery, 2 year minimum life
Operating Temperature	-30°C to 75°C (-22°F to 167°F)
LCD Display	Simultaneous display of 7 digit volume, 6 digit flow rate, 0.3” character height Units of measurement: Volume - BBL, GAL, MCF and M^3 Flow Rate - BPD, GPM, MCF/D and M^3/D Updates every 2 seconds
Keypad	4 key membrane switch
Input	Pulse input from flowmeter, non-zero crossing, 10 to 3500 Hz, 20mV to 10V amplitude, input sensitivity configurable from 20mV to 120mV

Operation

The MC-II *Plus* Portable Rate Meter is shipped completely assembled. It will have to be calibrated before being used to read rates or volumes. The Calibration section (page 3) provides a step-by-step procedure for entering data in to the MC-II *Plus* Portable Rate Meter.

Once calibrated, the pickup with the pickup adapter located on the end of the coiled cord may be inserted into the recess in the body of the meter opposite the existing magnetic pickup. If the meter has no recess in the body, or the recess is inaccessible, the magnetic pickup on the MC-II *Plus* Portable Rate Meter may be threaded in place of the existing pickup. It is recommended to use the magnetic pickup supplied with the MC-II *Plus* Portable Rate Meter instead of the existing magnetic pickup on the flowmeter in case the existing pickup is faulty.

The MC-II *Plus* Portable Rate Meter has two modes of operation, Run Mode and Calibrate Mode.

The Run Mode is the operational function of the MC-II *Plus* Portable Rate Meter where it is placed in service to display rates and total volume.

The Calibration mode allows entry of calibration data into the instrument memory. One line of the display will have prompts consisting of abbreviated words with each letter formed on a seven segment display. Due to the limitations of a seven segment display, some of the letters will be upper case and the remainder will be lower case. On the other line of the display the calibration data is entered. While in Calibrate Mode, each digit is changed one at a time. The digit selected to be changed will be blinking on and off.

In the following operation and calibration examples, display prompts and keypad names will be shown in **BOLD** type. The prompts will be shown in upper and lower case letters to illustrate approximately the way that they will appear on the display.

The keypad operation is described as follows:

ACCESS: The **ACCESS** button if pressed while the MC-II *Plus* Portable Rate Meter is in the Run Mode will place the MC-II *Plus* Portable Rate Meter in the Calibrate Mode. Pressing the **ACCESS** button while the MC-II *Plus* Portable Rate Meter is in the Calibrate Mode will return the instrument to the Run Mode.

STEP: The **STEP** button functions only in the Calibrate Mode. Pressing the **STEP** button while calibrating advances the digit to be changed to the left. If the left most digit is selected, pressing the **STEP** button again advances the digit to be changed to the right most digit.

INCR: The **INCR** (increment) button functions only in the Calibrate Mode. Pressing the **INCR** button while calibrating advances the value of the digit to be changed by

one from its initial value each time it is pressed. If the **INCR** button is pressed when the digit is nine, the value rolls over to zero.

ENTER: The **ENTER** button functions only in the Calibrate Mode. Pressing the **ENTER** button while calibrating enters the displayed data for the current calibration function and advances to the next calibration function.

Error Detection

The MC-II *Plus* Portable Rate Meter will inform the operator of a detected error while in the Run Mode. The Error Message will be displayed to the operator in the form of the word **Error** being displayed on the lower line of the display.

When the **Error** message is displayed, press any of the four buttons on the switchplate and the nature of the error will be shown on the top line of the display. The **ENTER** button may be pressed to return to the Run Mode or the **ACCESS** button may be pressed to enter the Calibrate Mode to correct the errors as shown below in this section.

There is one error message in the current version of firmware, **rAtE.**

The **rAtE** message indicates a rate overflow, which means that the rate is in units too large to be displayed on the LCD. Normally this error may be corrected by entering the Calibrate Mode and moving the rate display decimal point to the right to allow a larger number to be displayed or change the rate units of measure. These changes are covered in the Calibration section below.

Calibration

Calibration of the MC-II *Plus* Portable Rate Meter is a simple matter of entering the necessary parameters into the instrument using the keypad. The user friendly prompts plus the ability of the microprocessor circuitry to calculate the divisor for volume and the rate multiplier for flow rate make calibrating the instrument a simple process.

The steps to be followed to calibrate the MC-II *Plus* Portable Rate Meter depend on whether liquid or gas is being measured and the units of measure. There are four categories of measurement:

- Liquid Measurement Using Preprogrammed Units of Measure
- Gas Measurement Using Preprogrammed Units of Measure
- Liquid Measurement Using a Calculated Divisor and Rate Multiplier
- Gas Measurement Using a Calculated Divisor and Rate Multiplier

Each of these categories is outlined in the following sections.

Liquid Measurement Using Preprogrammed Units of Measure

When the liquid volume is to be expressed in barrels (BBL), gallons (GAL) or cubic meters (M^3) and the flow rate is to be expressed in barrels per day (BPD), gallons per minute (GPM) or cubic meters per day (M^3/D), the MC-II *Plus* Portable Rate Meter calculates the divisor and rate multiplier. The information needed to calibrate is the units of measure for volume, the decimal point setting for the volume display, decimal point setting of the meter factor, the meter factor in pulses per gallon (**PgAL**), and units of measure for the flow rate. An outline of the user prompts and the steps followed for this type of calibration are below:

1. Press the **ACCESS** key to enter the Calibrate Mode.

2. At the prompt **tot Eng**, press **INCR** to select BBL, GAL, or M^3. Press **ENTER**.

3. At the prompt **tot d.P**, press **INCR** to change the decimal point position for the volume. Press **ENTER**.

4. At the prompt **SEt tot**, press **INCR** to toggle between **yES** or **no**. If **no** is selected, press **ENTER**. If **yES** is selected, see the section *Presetting Total Volume* on page 21.

5. At the prompt **PgAL d.P**, press **INCR** to set the pulse per gallon decimal point. Press **ENTER**.

6. At the prompt **Ent.P.gAL**, use the **INCR** and **STEP** keys to enter the meter factor in pulses per gallon. Press **ENTER**.

7. At the prompt **rAtE.Eng**, press **INCR** to select BPD, GPM, or M^3/D. Press **ENTER**.

8. At the prompt **rAtE.dLY**, press **INCR** to set the flow rate filter. Press **ENTER**.

9. At the prompt **inP.SenS**, press **INCR** to set the input sensitivity. If the input sensitivity is set as desired, press **ENTER**. If the input sensitivity needs to be changed, see the section *Setting Input Sensitivity* on page 23.

10. At the prompt **PULS.oUt**, press **INCR** to select **oFF** and press **ENTER** (the Pulse Output feature is not used in this instrument).

11. At the prompt **4-20.oUt**, press **INCR** to select **oFF** and press **ENTER** (the Analog Output feature is not used in this instrument).

12. At the prompt **CodE**, press **INCR** to select **oFF** or **on** for the security code feature. If **oFF** is selected, press **ENTER**. If **on** is selected, see the section *Setting a Security Code* on page 24.

A detailed example of this method, using actual meter factors and step-by-step data entry is below.

Example: Liquid Measurement Using Preprogrammed Units of Measure

The MC-II *Plus* Portable Rate Meter will be mounted on a 1" NuFlo liquid turbine meter. The meter factor is 907.68 pulses per gallon. The volume will be measured in barrels and displayed to the tenth of barrel. The security code is disabled and the MC-II *Plus* Portable Rate Meter is in the Run Mode. No preprogrammed volume is to be entered. The input sensitivity is to be left at the factory default of 20 mV.

1. Press the **ACCESS** key to enter the Calibrate Mode. The MC-II *Plus* Portable Rate Meter enters a self-diagnostics routine by performing a segment test that momentarily displays all segments of the LCD. It then displays the firmware version by showing **Prog no** on the upper line of the display and the firmware version on the lower line of the display.

2. After the diagnostics routine is complete, the upper line of the display will show the prompt **tot Eng**. Pressing **INCR** will select the engineering units of measurement from BBL, GAL, M^3, MCF, which are displayed on the right side of the display or **USEr** on the lower line of the display (factory default is BBL). Press **INCR** until BBL is selected. Press the **ENTER** key to confirm the selection.

3. The MC-II *Plus* Portable Rate Meter displays **tot d.P** on the upper line of the display and zeros with a decimal point on the lower line of the display. This prompt is requesting the decimal point position for the volume display (factory default is 0.0). The currently selected volume and flow rate units of measure are also displayed (factory default is BBL). Repeatedly pressing the I**NCR** key will move the decimal point from 0.0 to 0.00 to 0.000 to 0 and return to 0.0. Press the **INCR** key until 0.0 is displayed. Press the **ENTER** key to confirm the selection.

4. The upper line of the display will show the prompt **SEt tot** with either **yES** or **no** on the lower line of the display prompting for a decision if a preprogrammed volume is to be entered (factory default is **no**). Since no preprogrammed volume is to be entered, press **INCR** to toggle between **yES** or **no** until **no** is displayed. Press the **ENTER** key to confirm the selection. (See the section *Presetting Total Volume* on page 21 to preset a volume.)

5. The upper line of the display will show the prompt **PgAL d.P**. The available selections are 0.0, 0.00, 0.000 and 0 (factory default is 0.00). Since the meter factor in this example is 907.68, a decimal point in the 0.00 position is to be selected. Press **INCR** until 0.00 is shown on the lower line of the display. Press the **ENTER** key to confirm the selection.

6. The upper line of the display will show the prompt **Ent.P.gAL,** which is the prompt to enter the meter factor in pulses per gallon. The lower line of the display will show the previously entered meter factor. The factory default is 900.00. The right-most digit, the hundredths position, will be blinking indicating it is the digit currently selected for editing.

   Since 8 is to be entered in this position (factor of 907.68) press **INCR** until 8 is displayed. (Remember that if the desired digit is accidentally passed, continue to press **INCR** until that digit is displayed again.)

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 6 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 7 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 0 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 9 is displayed. Since the meter factor (907.68) is now entered, the remaining digits to the left of the factor must all be zero.

   Press **STEP** to proceed to the left-most digit. Press **INCR** until 0 is displayed.

   Press the **ENTER** key to confirm the entry of the meter factor.

7. The upper line of the display will show the prompt **rAtE.Eng**, which is the prompt to enter the units of measure for the flow rate. Pressing **INCR** will select the engineering rate units of measure from barrels per day (BPD), gallons per minute (GPM), cubic meters per day (M^3/D), or **USEr** (default is based on the volume units setting in Step 2, in this example BPD will be displayed). Press **INCR** until BPD is shown on the right side of the display. Press the **ENTER** key to confirm the selection.

8. The upper line of the display will show the prompt **rAtE.dLY**. The lower line of the display will show the flow rate filter value in terms of the number of samples required to reach 90% of the final value. The factory default setting is “nonE.” The available settings are nonE, 5, 10, and 20. Press **INCR** until 10 is displayed. Then, press **ENTER**. (See the section *Setting Flow Rate Filter* on page 23 to change the flow rate filter.)

9. The upper line of the display will show the prompt **inP.SEnS** with the lower line of the display showing the input sensitivity in terms of millivolts peak-to-peak (mV). The factory default input sensitivity is 20 mV. The available settings are 20, 40, 60, 80, 100 and 120 mV. If the lower line of the display shows 20 (for 20 mV),

then press **ENTER**. If any other value is shown, press **INCR** until 20 is displayed, then press **ENTER**. (See the section *Setting Input Sensitivity* on page 23 to change the input sensitivity.)

10. The upper line of the display will show the prompt **PULS.oUt** with the lower line of the display showing **oFF** or **on** (factory default is **oFF**). Press **INCR** until **oFF** is shown since the pulse output is to be disabled. Press **ENTER**.

11. The upper line of the display will show the prompt **4-20.oUt** with the lower line of the display showing **oFF** or **on** (factory default is **oFF**). Press **INCR** until **oFF** is shown to disable the 4-20 mA output circuitry. Press **ENTER**.

12. The upper line of the display will show the prompt **CodE** with the lower line of the display showing **oFF** or **on** (factory default is **oFF**). Press **INCR** until **oFF** is shown, since the security code feature is to be disabled. (See the section *Setting a Security Code* on page 24 to enter a security code.) Press **ENTER**. Since this is the last step of calibration, the MC-II *Plus* Portable Rate Meter automatically returns to the Run Mode. The **ACCESS** key of the MC-II *Plus* Portable Rate Meter does not have to be pressed to return to Run Mode unless Calibrate Mode is exited before the last step of calibration.

Gas Measurement Using Preprogrammed Units of Measure

When the gas volume is to be expressed in thousands of cubic feet (MCF) and the flow rate is to be expressed in thousands of cubic feet per day (MCF/D), the MC-II *Plus* Portable Rate Meter calculates the divisor and rate multiplier, compensating the volume and flow rate to standard conditions. The information needed to calibrate the MC-II *Plus* Portable Rate Meter is the decimal point setting for the volume display, the decimal point setting for the meter factor, the meter factor expressed in pulses per actual cubic foot (**PACF**), atmospheric pressure, base pressure, flowing pressure, base temperature, flowing temperature and supercompressibility factor (optional). An outline of the user prompts and the steps followed for this type of calibration are below:

1. Press the **ACCESS** key to enter the Calibrate Mode.

2. At the prompt **tot Eng**, press **INCR** until MCF is selected. Press **ENTER**.

3. At the prompt **tot d.P**, press **INCR** to change the decimal point position for the volume. Press **ENTER**.

4. At the prompt **SEt tot**, press **INCR** to toggle between **yES** or **no**. If **no** is selected, press **ENTER**. If **yES** is selected, see the section *Presetting Total Volume* on page 21.

5. At the prompt **PACF d.P**, press **INCR** to set the pulses per actual cubic foot decimal point. Press **ENTER**.

6. At the prompt **Ent.P.ACF**, use the **INCR** and **STEP** keys to enter the meter factor in pulses per actual cubic foot. Press **ENTER.**

7. At the prompt **bAro.Psi,** use the **INCR** and **STEP** keys to enter the barometric pressure in pounds per square inch absolute (PSIA). Press **ENTER**.

8. At the prompt **bASE.Psi,** use the **INCR** and **STEP** keys to enter the base pressure in PSIA. Press **ENTER**.

9. At the prompt **Ent.Psig**, use the **INCR** and **STEP** keys to enter the flowing line pressure in pounds per square inch (PSIG). Press **ENTER**.

10. At the prompt **bASE F,** use the **INCR** and **STEP** keys to enter the base temperature in degrees Fahrenheit (F). Press **ENTER**.

11. At the prompt **Ent F,** use the **INCR** and **STEP** keys to enter the flowing temperature in degrees F. Press **ENTER**.

12. At the prompt **Ent FPv**, use the **INCR** and **STEP** keys to enter the supercompressibility factor. Press **ENTER**.

13. At the prompt **rAtE.dLY**, press **INCR** to set the flow rate filter. Press **ENTER**.

14. At the prompt **inP.SenS**, press **INCR** to set the input sensitivity. If the input sensitivity is set as desired, press **ENTER**. If the input sensitivity needs to be changed, see the section *Setting Input Sensitivity* on page 23.

15. At the prompt **PULS.oUt**, press **INCR** to select **oFF** and press **Enter** (the Pulse Output feature is not used in this instrument).

16. At the prompt **4-20.oUt**, press **INCR** to select **oFF** and press **Enter** (the Analog Output feature is not used in this instrument).

17. At the prompt **CodE**, press I**NCR** to select **oFF** or **on** for the security code feature. If **oFF** is selected, press **ENTER.** If **on** is selected, see the section *Setting a Security Code* on page 24.

A detailed example of this method, using actual meter factors and step-by-step data entry is below.

Example: Gas Measurement Using Preprogrammed Units of Measure

The MC-II *Plus* Portable Rate Meter will be mounted on a 2" NuFlo standard range gas turbine meter. The meter factor is 129.42 pulses per actual cubic foot. The volume units of measure will be in thousands of standard cubic feet (MCF) and the rate units of measure will be in thousands of standard cubic feet per day (MCF/D). The average flowing pressure is 120 PSIG. The average flowing temperature is 50 degrees Fahrenheit. The base pressure is 14.73 PSIA and the base temperature is 60 degrees Fahrenheit. The atmospheric pressure is not known but the elevation of the installation is 1000 feet above sea level. The security code is to be disabled. The input sensitivity is to be left at 20 mV and no preprogrammed volume is to be entered. The MC-II *Plus* Portable Rate Meter has not been calibrated, so all of the data is set to factory default. The MC-II *Plus* Portable Rate Meter is in the Run Mode.

1. Press the **ACCESS** key to enter the Calibrate Mode. The MC-II *Plus* Portable Rate Meter enters a self-diagnostics routine by performing a segment test that momentarily displays all segments of the LCD. The firmware version is then displayed by showing **Prog no** on the upper line of the display and the firmware version on the lower line of the display.

2. After the diagnostics routine is complete, the upper line of the display will show the prompt **tot Eng**. Pressing **INCR** will select the engineering units of measurement from BBL, GAL, M^3, MCF, which are displayed on the right side of the display or **USEr** on the lower line of the display (factory default is BBL). Press **INCR** until MCF is selected. Press the **ENTER** key to confirm the selection.

3. The MC-II *Plus* Portable Rate Meter will show the prompt **tot d.P** on the upper line of the display and zeros with a decimal point on the lower line of the display. The currently selected engineering units of measurement are also displayed (MCF in this example). This prompt is requesting the decimal point position for the volume display. Repeatedly pressing the I**NCR** key will move the decimal point from 0.0 to 0.00 to 0.000, 0 and return to 0.0 (factory default is 0.0). Press the **INCR** key until 0 is displayed. Press the **ENTER** key to confirm the selection.

4. The MC-II *Plus* Portable Rate Meter will show the prompt **SEt tot** on the upper line of the display with either **yES** or **no** on the lower line of the display prompting for a decision if a preprogrammed volume is to be entered (factory default is **no**). The currently selected engineering units of measurement are also displayed (MCF is shown in this example). Since no preprogrammed volume is to be entered, press **INCR** to toggle between **yES** or **no** until **no** is displayed. Press **ENTER**. (See section *Presetting Total Volume* on page 21 to enter a preset volume.)

5. The upper line of the display will show the prompt **PACF d.P**. The available selections are 0.0, 0.00, 0.000 and 0 (factory default is 0.00). Since the meter factor in this example is 129.42 pulses per actual cubic foot, a decimal point in the 0.00 position is to be selected. Press **INCR** until 0.00 is shown on the lower line of the display. Press **ENTER**.

6. The upper line of the display will show the prompt **Ent.P.ACF,** which is the prompt to enter the meter factor in pulses per actual cubic foot. The lower line of the display will show the previously entered meter factor (factory default is 125.00). The right-most digit, the hundredths position, will be blinking indicating it is the digit currently selected for editing. Since 2 is to be entered in this position (factor of 129.42) press **INCR** until 2 is displayed. (Remember that if the desired digit is accidentally passed, continue to press **INCR** until that digit is displayed again.) Press **STEP** to proceed to the next digit to the left. Press **INCR** until 4 is displayed.

7. Press **STEP** to proceed to the next digit to the left. Press **INCR** until 9 is displayed.

8. Press **STEP** to proceed to the next digit to the left . Press **INCR** until 2 is displayed.

9. Press **STEP** to proceed to the next digit to the left. Press **INCR** until 1 is displayed.

10. Since the meter factor is now entered, the remaining digits to the left of the factor must all be zero. Press **STEP** to proceed to the leftmost digit. Press **INCR** until 0 is displayed.

11. Press **ENTER** to confirm the entry of the meter factor.

12. The upper line of the display will show **bAro.PSi** prompting for barometric pressure in pounds per square inch absolute (PSIA) (factory default is 14.73 and the decimal point is fixed at 0.00). Since the barometric pressure is not known but the elevation is known to be 1000 feet above sea level, refer to Appendix D, Table 1. The average barometric pressure for this altitude is 14.21 PSIA. Enter the barometric pressure in the lower line of the display using the **INCR** and **STEP** keys in the same manner as the meter factor was entered in Step 6. Once the barometric pressure is entered, press **ENTER**.

13. The upper line of the display will show **bASE.PSi** prompting for the base pressure in PSIA (factory default base pressure is 14.73 PSIA). The decimal point is fixed at 0.00. Enter the base pressure of 14.73 in the lower line of the display using the **INCR** and **STEP** keys in the same manner as the meter factor was entered in Step 6. Once the base pressure is entered, press **ENTER**.

14. The upper line of the display will show **Ent.PSig** prompting for the average flowing pressure in pounds per square inch (PSIG) (factory default pressure is 100.0 PSIG with the decimal point fixed at 0.0). The flowing pressure is 120 PSIG. Enter 120.0 in the lower line of the display in the same manner as the meter factor was entered in Step 6. Once the average flowing pressure is entered, press **ENTER**.

15. The upper line of the display will show **bASE F** prompting for entry of the base temperature in degrees Fahrenheit (F) (factory default is 60.0 degrees with the decimal point fixed at 0.0). The base temperature is 60 degrees F. Enter 60.0 in the lower line of the display in the same manner as the meter factor was entered in Step 6. Once the base temperature is entered, press **ENTER**.

16. The upper line of the display will show **Ent F** prompting for the entry of the average flowing temperature in degrees F (factory default is 60.0 degrees with the decimal point fixed at 0.0). The average flowing temperature is 50 degrees F. Enter 50.0 in the lower line of the display in the same manner as the meter factor was entered in Step 6. Once the average flowing temperature is entered, press **ENTER**.

17. The upper line of the display will show **Ent FPv** prompting for entry of the supercompressibility factor (factory default is 1.00000 with the decimal point fixed at 0.00000). Since the supercompressibility factor will not be entered, the number 1.00000 should be placed in the lower line of the display. Since the default value is 1.00000, press **ENTER**. (If a supercompressibility factor is to be entered, it can be entered in the same manner as the meter factor was entered in Step 6. While entering the supercompressibility factor, keep in mind that the decimal point position is fixed.)

18. The upper line of the display will show the prompt **rAtE.dLY**. The lower line of the display will show the flow rate filter value in terms of the number of samples required to reach 90% of the final value. The factory default setting is “nonE.” The available settings are nonE, 5, 10, and 20. Press **INCR** until 10 is displayed. Then, press **ENTER**. (See the section *Setting Flow Rate Filter* on page 23 to change the flow rate filter.)

19. The upper line of the display will show **inP.SEnS** prompting for the entry of the input sensitivity. Since the input sensitivity (default 20 mV), pulse out (default off), 4-20 mA out (default off) and security code (default off) are all to be left in the default condition, press **ACCESS** to return to the Run Mode. (Keep in mind that the example for this unit was factory default. Bypassing these steps in this case is acceptable. If the MC-II *Plus* Portable Rate Meter was previously calibrated and the settings of these functions is unknown, these functions must be stepped through to ensure that they are set as desired.)

Liquid Measurement Using a Calculated Divisor and Rate Multiplier

Calculating the divisor and rate multiplier for liquids is necessary when registering the volume in units other than cubic meters, barrels, or gallons. **USEr** units may be used for the volume and preprogrammed units for the rate, or **USEr** units may be used for both the volume and the rate. When the **USEr** units are used for the volume or rate, nothing will be shown on the right side of the display where the units are normally displayed. The divisor, divisor decimal point, rate multiplier, and rate multiplier decimal point must be determined, then entered directly into the MC-II *Plus* Portable Rate Meter. The formula for calculating the divisor is:

$$Divisor = FC \times CON$$

Where:
FC = meter factor in pulses per gallon (P/G)
CON = The conversion factor for number gallons per unit volume of desired measure.

Note: When calibrating the MC-II *Plus* Portable Rate Meter, enter the six most significant digits of the divisor regardless of the setting of the volume decimal point. The divisor does not have to be adjusted to the volume decimal point setting as is it does in many other flow analyzers.

The formula for calculating the rate multiplier is:

$$RateMultiplier = \frac{TC}{(FC \times CON)}$$

Where:
TC = Time Constant (seconds per unit time)

Note: The term rate multiplier is the same as **rAtE. FAC.**

Normally used time constants are:

Units/minute rate, $TC = 60$
Units/hour rate, $TC = 3600$
Units/day rate, $TC = 86400$

The rate multiplier entry is limited to six significant digits regardless of the decimal point position.

An outline of the user prompts and the steps followed for this type of calibration are below:

1. Press the **ACCESS** key to enter the Calibrate Mode.

2. At the prompt **tot Eng**, press **INCR** to select **USEr**. Press **ENTER**.

3. At the prompt **tot dP**, press the **INCR** to set the decimal point position for the volume. Press **ENTER**.

4. At the prompt **SEt tot**, press **INCR** to toggle between **yES** or **no**. If **no** is selected, press **ENTER**. If **yES** is selected, see the section *Presetting Total Volume* on page 21.

5. At the prompt **div d.P**, press **INCR** to set the divisor decimal point position. Press **ENTER**.

6. At the prompt **Ent div**, use the **INCR** and **STEP** keys to enter the divisor. Press **ENTER**.

7. At the prompt **rAtE d.P**, press **INCR** to set the rate multiplier decimal point. Press **ENTER**.

8. At the prompt **rAtE.FAC,** use the **INCR** and **STEP** keys to enter the rate multiplier. Press **ENTER**.

9. At the prompt **rAtE.dLY**, press **INCR** to set the flow rate filter. Press **ENTER**.

10. At the prompt **inP.SenS**, press **INCR** to set the input sensitivity. If the input sensitivity is set as desired, press **ENTER**. If the input sensitivity needs to be changed, see the section *Setting Input Sensitivity* on page 23.

11. At the prompt **PULS.oUt**, press **INCR** to select **oFF** and press **Enter** (the Pulse Output feature is not used in this instrument).

12. At the prompt **4-20.oUt**, press **INCR** to select **oFF** and press **Enter** (the Analog Output feature is not used in this instrument).

13. At the prompt **CodE**, press I**NCR** to select **oFF** or **on** for the security code feature. If **oFF** is selected, press **ENTER.** If **on** is selected, see the section *Setting a Security Code* on page 24.

A detailed example of this method, using actual meter factors and step-by-step data entry is below.

Example: Liquid Measurement Using a Calculated Divisor and Rate Multiplier

A NuFlo ¾" turbine meter is being used to measure injected water for a water flood project. The turbine meter factor (*FC*) is 2977.01 pulses per gallon. The volume is to be measured in kiloliters and displayed to the tenth of kiloliter. The units of measure for flow rate will be kiloliters per day. No preprogrammed volume is to be entered. The input sensitivity is to be left at factory default. The security code is disabled and the MC-II *Plus* Portable Rate Meter is in the Run Mode. The instrument has not been calibrated and is at factory default settings.
Referring to Table 3 in Appendix D on page D-2, there are 264.17 gallons per kiloliter.

Therefore, *CON = 264.17*

Substituting into the formula, the divisor is:

Divisor = FC x CON = 2977.01 x 264.17 = 786,436.73 ≈ 786,437

The manually (**USEr**) entered divisor is rounded off to 786,437 since the MC-II *Plus* Portable Rate Meter will take only the six most significant digits of the divisor.

Substituting into the formula, the rate multiplier is:

$$RateMultiplier = \frac{TC}{(FC \times CON)} = \frac{86400}{2977.01 \times 264.17} = 0.10986262 \approx 0.10986$$

Since the rate multiplier entry is limited from 0.00001 to 99999.9, it is rounded off to 0.10986 as shown above.

Note: The rate multiplier in this example was determined by the time constant divided by the previously calculated divisor. This will save a calculation step when calculating the rate multiplier. This applies if the flow rate is in the same units as the volume (in this example kiloliters and kiloliters per day rate). When the volume and flow rate are to be in different units, such as kiloliters and liters per hour, the volume divisor and divisor for the rate multiplier must be calculated separately.

The step-by-step entry of the calibration is as follows:

1. Press the **ACCESS** key to enter the Calibrate Mode. The MC-II *Plus* Portable Rate Meter enters a self-diagnostics routine by performing a segment test that momentarily displays all segments of the LCD. The firmware version is then displayed by showing **Prog no** on the upper line of the display and the firmware version on the lower line of the display.

2. After the diagnostics routine is complete, the upper line of the display will show the prompt **tot Eng**. Pressing **INCR** will select the engineering units of

measurement from BBL, GAL, M³, MCF, which are displayed on the right side of the display or **USEr** on the lower line of the display (factory default is BBL). Press **INCR** until **USEr** is selected. Press **ENTER** to confirm the selection.

3. The MC-II *Plus* Portable Rate Meter shows the prompt **tot d.P** on the upper line of the display and zeros with a decimal point on the lower line of the display (factory default is 0.0). This prompt is requesting the decimal point position for the volume display. Repeatedly pressing the **INCR** key will move the decimal point from 0.0 to 0.00 to 0.000 to 0 and return to 0.0. Press the **INCR** key until 0.0 is displayed. Press the **ENTER** key.

4. The upper line of the display of the MC-II *Plus* Portable Rate Meter will show the prompt **SEt tot** with either **yES** or **no** on the lower line of the display prompting for a decision if a preprogrammed volume is to be entered (factory default is **no**). Since no preprogrammed volume is to be entered, press **INCR** to toggle between **yES** or **no** until **no** is displayed. Press **ENTER**. (See the section *Presetting Total Volume* on page 21 to preset a volume.)

5. The upper line of the display will show the prompt **div d.P**. The available selections are 0.0, 0.00, 0.000 and 0 (factory default is 0.00). Since the divisor is 786,437, the 0 position, for whole number only, is selected. Press INCR until 0 is shown on the lower line of the display. Press **ENTER**.

6. The upper line of the display will show **Ent div** which is prompting for the entry of the divisor. The lower line of the display will show the previously entered meter factor (factory default is 230.00). The right-most digit (the ones position) will be blinking indicating it is the digit currently selected for editing. Remember to enter the divisor calculated for units of registration regardless of the location of the volume decimal point set in Step 3.

   Since 7 is to be entered in this position (factor of 786,437) press INCR until 7 is displayed. (Remember that if the desired digit is accidentally passed, continue to press INCR until that digit is displayed again.)

   Press STEP to proceed to the next digit to the left. Press **INCR** until 3 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 4 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 6 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** until 8 is displayed.

Press **STEP** to proceed to the next digit to the left. Press **INCR** until 7 is displayed.

Press **ENTER** to confirm the entry of the divisor.

7. The upper line of the display will show **rAtE d.P** prompting for entry of the rate multiplier decimal point. The selections for the rate multiplier decimal point are 0.0, 0.00, 0.000, 0.0000 and 0.00000 (factory default is 0.0). Press **INCR** until 0.00000 is displayed. Press **ENTER**.

8. The upper line of the display will show **rAtE. FAC** prompting for entry of the rate multiplier (factory default is 1.00000). Enter the rate multiplier (.10986) in the same manner as the divisor was entered in Step 6 and press **ENTER**.

9. The upper line of the display will show the prompt **rAtE.dLY**. The lower line of the display will show the flow rate filter value in terms of the number of samples required to reach 90% of the final value. The factory default setting is "nonE." The available settings are nonE, 5, 10, and 20. Press **INCR** until 10 is displayed. Then, press **ENTER**. (See the section *Setting Flow Rate Filter* on page 23 to change the flow rate filter.)

10. The upper line of the display will show **inP.SEnS** prompting for entry of the input sensitivity in millivolts. Since the input sensitivity (factory default of 20 mV), pulse output (factory default is off), 4-20 mA output (factory default is off) and security code (factory default is off) are to be left at factory default settings, press **ACCESS** to return to Run Mode. (Keep in mind that the unit for this example was at factory default. Bypassing these steps in this case is acceptable. If the MC-II *Plus* Portable Rate Meter had been previously calibrated and the settings of these functions unknown, they must be stepped through to ensure that they are set as desired.)

Gas Measurement Using a Calculated Divisor and Rate Multiplier

Calculating the divisor and rate multiplier for gases is necessary when registering in units other than MCF and MCF/D. The **USEr** volume and rate functions of the MC-II *Plus* Portable Rate Meter are used in this case. The divisor, divisor decimal point, rate multiplier, and rate multiplier decimal point must be determined, then entered directly into the MC-II *Plus* Portable Rate Meter. The divisor is calculated as follows:

$$Divisor = \frac{FC \times Ps \times Tf \times CON}{(Pg + Pa) \times Ts \times (Fpv)^2}$$

Where:

FC = Meter factor in pulses per actual cubic foot (PACF)

Ps = Standard pressure in PSIA

Tf = Line (flowing) temperature in degrees Rankine (°R)
CON = Conversion factor for number of standard cubic feet (SCF) per unit volume of desired measure.

Pg = Line (flowing) pressure in PSIG

Pa = Atmospheric pressure in PSIA

Ts = Standard temperature in degrees Rankine (°R)

Fpv = Supercompressibility Factor (enter a factor of 1 if supercompressibility factor is not to be entered)

The formula for calculating the rate multiplier is:

$$RateMultiplier = \frac{TC}{Divisor}$$

TC = Time Constant (seconds per unit time)

Normally used time constants are:

Units/minute rate,	*TC = 60*
Units/hour rate,	*TC = 3600*
Units/day rate,	*TC = 86400*

An outline of the user prompts and the steps followed for this type of calibration are below:

1. Press the **ACCESS** key to enter the Calibrate Mode.
2. At the prompt **tot Eng**, press **INCR** to select **USEr**. Press **ENTER**.
3. At the prompt **tot dP**, press **INCR** to change the decimal point position for the volume. Press **ENTER**.
4. At the prompt **SEt tot**, press **INCR** to toggle between **yES** or **no**. If **no** is selected, press **ENTER**. If **yES** is selected, see the section *Presetting Total Volume* on page 21.
5. At the prompt **div d.P**, press **INCR** to set the divisor decimal point position. Press **ENTER**.

6. At the prompt **Ent div**, use the **INCR** and **STEP** keys to enter the divisor. Press **ENTER**.

7. At the prompt **rAtE d.P**, press **INCR** to set the rate multiplier decimal point. Press **ENTER**.

8. At the prompt **rAtE. FAC,** use the **INCR** and **STEP** keys to enter the rate multiplier. Press **ENTER**.

9. At the prompt **rAtE.dLY**, press **INCR** to set the flow rate filter. Press **ENTER**.

10. At the prompt **inP.SenS**, press **INCR** to set the input sensitivity. If the input sensitivity is set as desired, press **ENTER**. If the input sensitivity needs to be changed, see the section *Setting Input Sensitivity* on page 23.

11. At the prompt **PULS.oUt**, press **INCR** to select **oFF** and press **Enter** (the Pulse Output feature is not used in this instrument).

12. At the prompt **4-20.oUt**, press **INCR** to select **oFF** and press **Enter** (the Analog Output feature is not used in this instrument).

13. At the prompt **CodE**, press I**NCR** to select **oFF** or **on** for the security code feature. If **oFF** is selected, press **ENTER.** If **on** is selected, see the section *Setting a Security Code* on page 24.

An example of this method, using actual meter factors and data is below.

Example: Gas Measurement Using a Calculated Divisor and Rate Multiplier

A NuFlo 2" High Range gas turbine meter will be measuring gas flow with an average flowing pressure of 120 PSIG and an average flowing temperature of 50 degrees Fahrenheit (°F). The meter factor is 72.56 pulses per actual cubic foot (PACF). The unit of measure for volume is to be cubic meters and the unit of measure for the rate is to be cubic meters per day. The standard conditions to compensate to are 60°F and 14.73 PSIA. The atmospheric pressure is unknown but the elevation is 1000 feet above sea level.

The supercompressiblity factor from a reference table is determined to be 1.0102

Therefore, *Fpv = 1.0102*

Referring to Appendix D Table 1, it is determined that the average atmospheric pressure at 1000 feet above sea level is 14.21 PSIA.

Therefore, *Pa = 14.21 PSIA*

Referring to Appendix D Table 2, it is determined that conversion from °F to °R is: °R = °F + 459.67.

Substituting:

Tf = 50°F + 459.67 = 509.67°R
Ts = 60°F + 459.67 = 519.67°R

Referring to Appendix D Table 4, there are 35.31 cubic feet per cubic meter.

Therefore, *CON = 35.31*

Ps = 14.73 PSIA (Given); *Pg = 120 PSIG* (Given); *FC = 72.56 PACF* (Given)

Substituting in the formula:

$$Divisor = \frac{FC \times Ps \times Tf \times CON}{(Pg + Pa) \times Ts \times (Fpv)^2} = \frac{72.56 \times 14.73 \times 509.67 \times 35.31}{(120 + 14.21) \times 519.67 \times (1.0102)^2} = 270.2462 \approx \underline{270.246}$$

The divisor is rounded off to 270.246 since the MC-II *Plus* Portable Rate Meter will take only the six most significant digits of the divisor.

Substituting into the formula, the rate multiplier is:

$$RateMultiplier = \frac{TC}{Divisor} = \frac{86400}{270.2462} = 319.7085 \approx \underline{319.708}$$

The rate multiplier is rounded off to 319.708 since the rate multiplier entry will accept only the six most significant digits.

Note: The rate multiplier in this example was determined by the time constant divided by the previously calculated divisor. This will save a calculation step when calculating the rate multiplier if the flow rate is in the same units as the volume (in this example cubic meters for volume and cubic meters per day for rate). When the volume and flow rate are to be in different units, such as cubic meters and liters per hour, the volume divisor and divisor for the rate multiplier must be calculated separately.

The divisor and rate multiplier are entered in the same manner as the divisor and rate multiplier were entered in the *Liquid Measurement Using a Calculated Divisor and Rate Multiplier* example.

Time Out Feature

The MC-II *Plus* Portable Rate Meter has a Time Out Feature which prevents it from being left in the Calibrate Mode indefinitely. If the MC-II *Plus* Portable Rate Meter is left in the Calibrate Mode and no keypad activity is seen for approximately 10 minutes, it will return to the Run Mode. Any data entered with the ENTER key being pressed afterward will be saved to memory. Any data entered but not locked in

using the ENTER will not be saved and the data entered from a previous calibration will be retained. An MC-II *Plus* Portable Rate Meter may give erroneous readings if left partially calibrated in this manner. For example, the MC-II *Plus* Portable Rate Meter is re-calibrated through the totals divisor entry but the rate multiplier is not entered. The instrument will calculate volume correctly but incorrect flow rate readings will result.

Nominal Meter Factor

Typically when using the MC-II *Plus* Portable Rate Meter, the flow rate of many meters of the same brand and same size are to be measured. Since the meter factors of flowmeters of the same size are normally close to each other, the actual meter factor of each meter need not be entered. A nominal factor may be entered to eliminate the necessity of re-calibrating the MC-II *Plus* Portable Rate Meter before measuring the flow rate for each flowmeter. The nominal meter factor is calculated by adding the meter factor of the flowmeter with the highest calibration factor of the group of meters to the meter factor of the flowmeter with the lowest calibration factor of the same group of meters and divide that sum by two. That meter factor is then entered into the MC-II *Plus* Portable Rate Meter as shown in the previous calibration examples.

Example:

A particular field location has 30 of the 1” NuFlo Turbine Flowmeters. The rate is to be read in BPD. A review of the documentation for these meters indicates that the meter with the highest meter factor is 906.54 pulses per gallon and the meter with the lowest meter factor is 898.36 pulses per gallon. To determine the nominal factor for the meters in this field:

906.54 + 898.36 = 902.45 P/G = Nominal Factor

The factor of 902.45 is entered into the MC-II *Plus* Portable Rate Meter in step 6 of the example Liquid Measurement Using Preprogrammed Units of Measure.

In instances where NuFlo Turbine Flowmeters of the same size are being used and documentation is not readily available on meter factors, the factory nominal factor may be used. The factory nominal factors for all sizes of NuFlo liquid and gas Turbine Meters are located on a chart in the lid of the MC-II *Plus* Portable Rate Meter or in Appendix F.

Example:

The rates of the 1” NuFlo Turbine Flowmeters in the same field as above are to be measured. Time is not available to review the documentation on the meter factors. Reviewing the chart in the lid of the MC-II *Plus* Portable Rate Meter, reveals a factor of 900. The factor of 900.00 is entered into the MC-II *Plus* Portable Rate Meter in step 6 of the example Liquid Measurement Using Preprogrammed Units of Measure.

Reading Frequency

1. Reading the frequency of the flowmeter may be accomplished as follows.

2. Press the **ACCESS** button to enter the calibrate mode. The MC-II *Plus* Portable Rate Meter will enter the self diagnostics routine.

3. After the diagnostics routing is complete, **tot Eng** appears on display. Press **INCR** till **USEr** appears on the lower line of the display. Press **ENTER**.

4. The display shows **tot d.P** on the upper line of the display. Press **INCR** till **0** appears on the lower display (no decimal points are showing). Press **ENTER**.

5. The display shows **SEt tot** on the upper line of the display. Press **INCR** till **yES** appears on the lower line of the display. Press **ENTER**.

6. The display shows **SEt.tot** on the lower line of the display. Set the upper display to **0.** Press **ENTER**.

7. The display shows **Div d.p** on the upper line of the display. Press **INCR** till the lower display shows **0** (no decimal point displayed). Press **ENTER**.

8. The display shows **Ent div** appears on upper line of the display. Change the divisor on the lower display to **1**(no decimal point is displayed)**.** Press **ENTER**.

9. The display shows **rAtE d.p** on upper line of the display. Press **INCR** till the lower display shows **0.0**. Press **ENTER**.

10. The display shows **rAtE.FAC** on upper line of the display. Change the rate factor to **1.0**. Press **ENTER**.

11. Press **ACCESS** to enter the Run mode. The lower display will show the rate. The upper display may be used as a pulse counter. Keep in mind that the first few pulses from the flowmeter will not be counted.

Presetting Total Volume

Typically when a portable rate meter is placed in service, normally the rate is the only parameter of interest and accumulated volume will start at 0. In some applications it is preferable to resume the total volume where another instrument left off. The MC-II *Plus* Portable Rate Meter has the capability to preset volume. In the previous calibration examples, the total volume was left at the default (0.0) value.

As an example of how to preset total volume in the MC-II *Plus* Portable Rate Meter, we will return to the example illustrated in the section Liquid Measurement Using Preprogrammed Units of Measure. A preset volume of 84693.0 is to be entered:

1. Follow Steps 1 through 3 as shown in the example on page 5.

2. In Step 4, the upper line of the display will show **SEt tot** with either **yES** or **no** on the lower line of the display prompting for a decision if a preprogrammed volume is to be entered (factory default is **no**). Also on the left side of the display the current volumetric units of measurement will be displayed (factory default is BBL). Since a preset volume (84693.0) is to be entered, press INCR to toggle between **yES** or no till **yES** is displayed. Press **ENTER**.

3. The lower display will show **SEt.tot** prompting for a preset volume to be entered. The right most digit (tenths) on the upper display will be blinking indicating it is the first digit to be set. (Keep in mind that in this example the decimal point was set in step 3 to read in tenths.)

4. Since 0 is to be entered in this position (preset volume = 84693.0) press **INCR** till 0 is displayed (Remember that if the desired digit is accidentally passed, continue to press **INCR** till that digit is displayed again.)

   Press **STEP** to proceed to the next digit to the left. Press **INCR** till 3 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** till 9 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** till 6 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** till 4 is displayed.

   Press **STEP** to proceed to the next digit to the left. Press **INCR** till 8 is displayed.

   Press **STEP** to proceed to the left most digit. Press **INCR** till 0 is displayed. (If 0 is already displayed you may skip this step.)

   Press **ENTER** to accept the entry of the preset volume.

5. Follow steps 5 through 12 on pages 5 through 7 to complete the calibration.

Setting Flow Rate Filter

The flow rate filter smoothes out sudden changes in the rate indication and 4-20 mA rate output due to variations in flowmeter frequency. In all cases, the display will still update once per second.

Although the 4-20mA rate output function is not applicable to the MC-II *Plus* Portable Rate Meter, the user can achieve a smoother display of rate data by setting the flow rate filter.

The degree of filtering is set by accessing the **rAtE.dLY** selection in the calibration menu. It is located just after the **rAtE.EnG** selection.

From the **rAtE.dLY** selection, you may choose any of four filter settings, as described below.

Display	Setting
nonE	Filter disabled – **factory default setting**
5	Time equal to 5 rate samples to reach 90% of final value
10	Time equal to 10 rate samples to reach 90% of final value
20	Time equal to 20 rate samples to reach 90% of final value

The ***nonE*** setting disables the filter. At this setting, the calculated flow rate tracks the input frequency so any variation in the meter frequency will produce the corresponding variation in the rate indication and 4-20 mA rate output.

Each subsequent setting of ***5, 10*** and ***20*** will dampen the changes in flowmeter frequency, resulting in an increasingly smooth display of the flow rate.

The steps required to change flow rate filtering on a calibrated unit are:

1. Enter the Calibrate Mode by pressing the **ACCESS** key.
2. Accept the current settings by pressing **ENTER** until the **rAtE.dLY** prompt is displayed.
3. Press **INCR** or **STEP** until the desired flow rate filter is shown on the lower line of the display. Press **ENTER**.
4. At this point, the flow rate filtering has been configured. Pressing **ACCESS** exits the Calibrate Mode without making any further changes, or the remaining steps may be implemented.

Setting Input Sensitivity

Input sensitivity of the MC-II *Plus* Portable Rate Meter is measured in millivolts (thousandths of a volt) also abbreviated as mV. This is the threshold value where the circuitry responds to an input signal. If the input signal is below this value, the

MC-II *Plus* Portable Rate Meter will not count the electrical pulses from the turbine meter received at the input. If the input signal is equal to or above this value, the electrical pulses received at the input will be counted. Care must be taken to ensure that the input sensitivity is high enough to reject any electrical noise on the signal line but not too high to miss pulses from the flowmeter. The input sensitivity of the MC-II *Plus* Portable Rate Meter may be set to 6 different input sensitivities: 20mV, 40mV, 60mV, 80mV, 100mV and 120mV (factory default is 20mV).

In our example in the section Liquid Measurement Using Preprogrammed Units of Measure, it is determined that there is 30mV of noise on the signal line. It is also known that the 1" NuFlo turbine meter outputs a pulse amplitude of 100mV to 2500mV over its flow range. To ensure that no pulses are missed, the 80mV input sensitivity setting is to be selected.

1. Follow Steps 1 through 9 as shown in the examples on pages 5 and 6.

2. In Step 9, the upper display prompt **inP,SEnS** with the lower display showing the input sensitivity in millivolts (mV). The default input sensitivity is 20mV (20 is shown on the lower display). Press **INCR** till 80 is shown on the lower display. Press **ENTER**. If you accidentally bypass by the desired setting, press **INCR** till the 80 is shown on the display again.

3. Follow Steps 10 through 12 to complete the calibration as shown on page 7.

Setting a Security Code

In the previous calibration examples, the security code was always shown disabled. Setting a security code will prevent altering of calibration data or volume data by unauthorized personnel and is recommended to preserve data integrity of the system. Any 4 digit number may be selected for the security code (It is recommended that 0000 not be selected as the security code since it is the default number displayed when the MC-II *Plus* Portable Rate Meter requests security code entry. If 0000 is set as the security code, simply pressing **ENTER** at this point will access the Calibration Mode). Select a number that will be easy to remember, but do not use a number that will be easy for unauthorized personnel to figure out.

In the example Liquid Measurement Using Preprogrammed Units of Measure, the security code 8469 is to be entered.

1. Follow Steps 1 through 12 in the example as shown on pages 5 through 7.

2. The upper display will show **CodE** prompting to enable or disable the security code. The lower display will show **oFF** or **on** (factory default is **oFF**). Press **INCR** till **on** is shown since the security code feature is to be enabled. Press **ENTER**.

3. The upper display will show **Ent.CodE** prompting to enter the 4 digit security code. The lower display will show the previously entered code (factory default code is 0000). The right most digit will be blinking.

   a. Press **INCR** till 9 (security code is 8469) is displayed in the rightmost digit. Press **STEP**.

   b. Press **INCR** till 6 is displayed. Press **STEP**.

   c. Press **INCR** till 4 is displayed. Press **STEP**.

   d. Press **INCR** till 8 is displayed.

   e. Press **ACCESS** to return to the Run Mode.

Accessing With a Security Code

Accessing the Calibrate Mode of a MC-II *Plus* Portable Rate Meter using a security code obviously requires knowledge of the security code plus an additional step.

Using the example of Liquid Measurement Using Preprogrammed Units of Measure enter the Calibrate Mode as shown below, the security code is 8469.

1. Press the **ACCESS** button to enter the Calibrate Mode. The MC-II *Plus* Portable Rate Meter enters a self diagnostics routine by performing a segment test displaying al 8's and decimal points in the volume and rates display as well as the units of measure on the right hand side of the display. It then displays the firmware version by showing **Prog no** in the upper line of the display and the firmware version on the lower line.

   After the diagnostics routine is complete, the instrument displays **SEC.CodE** on the upper line with 0000 displayed on the lower line with the right most zero blinking.
2. Press **INCR** till a 9 is shown in the rightmost digit. Press **STEP**.

3. Press **INCR** till a 6 is shown. Press **STEP**.

4. Press **INCR** till a 4 is shown. Press **STEP**.

5. Press **INCR** till an 8 is shown. Press **ENTER**.

6. Follow Steps 2 through 12, as shown on pages 5 through 7, to complete the calibration.

Maintenance

The MC-II *Plus* Portable Rate Meter is designed to provide many years of service with minimal maintenance. Typical maintenance of the MC-II *Plus* Portable Rate Meter is periodic replacement of the lithium battery, which is designed to last two or more years in normal service. Other maintenance of the MC-II *Plus* Portable Rate Meter covered in this section is circuit assembly or switchplate replacement.

Caution **The lithium battery used to power the MC-II *Plus* Portable Rate Meter is a sealed unit. However, should one of these batteries leak, there is the possibility of toxic fumes being present when the enclosure is opened. Select a well-ventilated area in which to open the enclosure and avoid breathing fumes which may be trapped inside the enclosure. Care must be taken in handling and disposing of a spent or damaged battery. See additional Safety Information in Appendix D of this manual.**

Battery Replacement

The MC-II *Plus* Portable Rate Meter uses a lithium battery with a life expectancy in excess of two years. Due to the flat discharge curve characteristics of the lithium battery, it is difficult to determine how much life remains in a battery. It is recommended that the battery be replaced at two-year intervals to preserve calibration and totals data.

Caution **There are two battery cable connectors on the lower right corner of the circuit assembly labeled J3 and J4. The original battery cable will be connected to one of these connectors. When replacing the battery, plug the replacement battery cable into the unused connector before removing the used battery. Failure to connect the replacement battery before disconnecting the existing battery will result in loss of all volume and calibration data.**

To gain access to the inside of the MC-II *Plus* Portable Rate Meter, remove the four screws on the front panel. Lift the front panel from the enclosure. Leave the battery cable connected to the circuit assembly. Remove the wire battery retainer clip. Remove the battery from the battery holder in the enclosure ensuring that the battery cable stays connected to the circuit assembly.

Install the replacement battery in the battery holder in the same position as the original battery. Reinstall the wire battery retainer clip. Plug the replacement battery into the circuit assembly at J3 or J4. Disconnect the existing battery from the circuit

assembly. Replace the front panel in the enclosure, fastening it with the four screws.

Circuit Assembly Replacement

If the circuit assembly to be replaced is still fully or partially functional, record all available totals and calibration data before removing the circuit assembly,

To gain access to the inside of the MC-II *Plus* Portable Rate Meter, remove the four screws on the front panel. Lift the front panel from the enclosure. Disassemble as follows:

- Using a small standard blade screwdriver, remove the signal cable wiring from terminal block TB2, terminals 11 and 12.
- Unplug the battery cable from the circuit assembly.
- Remove the wire battery retainer clip.
- Remove the battery from the battery bracket.
- Unplug the switchplate ribbon cable from the J1 on the circuit assembly.
- Remove the four 4-40 nuts attaching the circuit assembly to the front panel.
- Remove the original circuit assembly allowing the switchplate ribbon cable to slip through the slot in the circuit assembly.

Install the new circuit assembly as follows:

- Insert the ribbon cable of the switchplate through the slot in the replacement circuit assembly and plug it in to J1.
- Mount the circuit assembly to the front panel with the four #4-40 nuts.
- Connect the battery cable to J3 or J4 on the circuit assembly.
- Reinstall the battery in the battery bracket.
- Reinstall the wire battery retainer clip.
- Connect the signal cable to terminal block TB2 terminals 11 and 12.
- Reattach the front panel to the enclosure using the four front panel screws.
- Reenter the calibration data.

Switchplate Replacement

It is not necessary or recommended to remove the signal cable or battery connector from the circuit assembly when replacing the switchplate. Disconnecting the battery connector from the circuit assembly will cause loss of all calibration and volume data.

To gain access to the inside of the MC-II *Plus* Portable Rate Meter, remove the four screws on the front panel. Remove the existing switchplate and replace with a new switchplate as follows:

- Lift the front panel from the enclosure.
- Unplug the switchplate ribbon cable from J1 on the circuit assembly.
- Remove the switchplate assembly from the front panel by lifting a corner of the self-adhesive switchplate and peeling it from the front panel.
- Remove any adhesive that is left on the front panel.
- Place the new switchplate on the front panel by removing the paper backing.
- Position the switchplate over the panel, inserting the ribbon through the small slot and the slot in the circuit assembly.
- Align the viewing window in the switchplate with the large rectangular opening in the front panel. Once the switchplate is in position, press the self-adhesive switchplate in place.
- Plug the ribbon cable in to J1. Reattach the front panel to the enclosure using the four front panel screws.

Recommended Spare Parts List for the MC-II *Plus* Portable Rate Meter

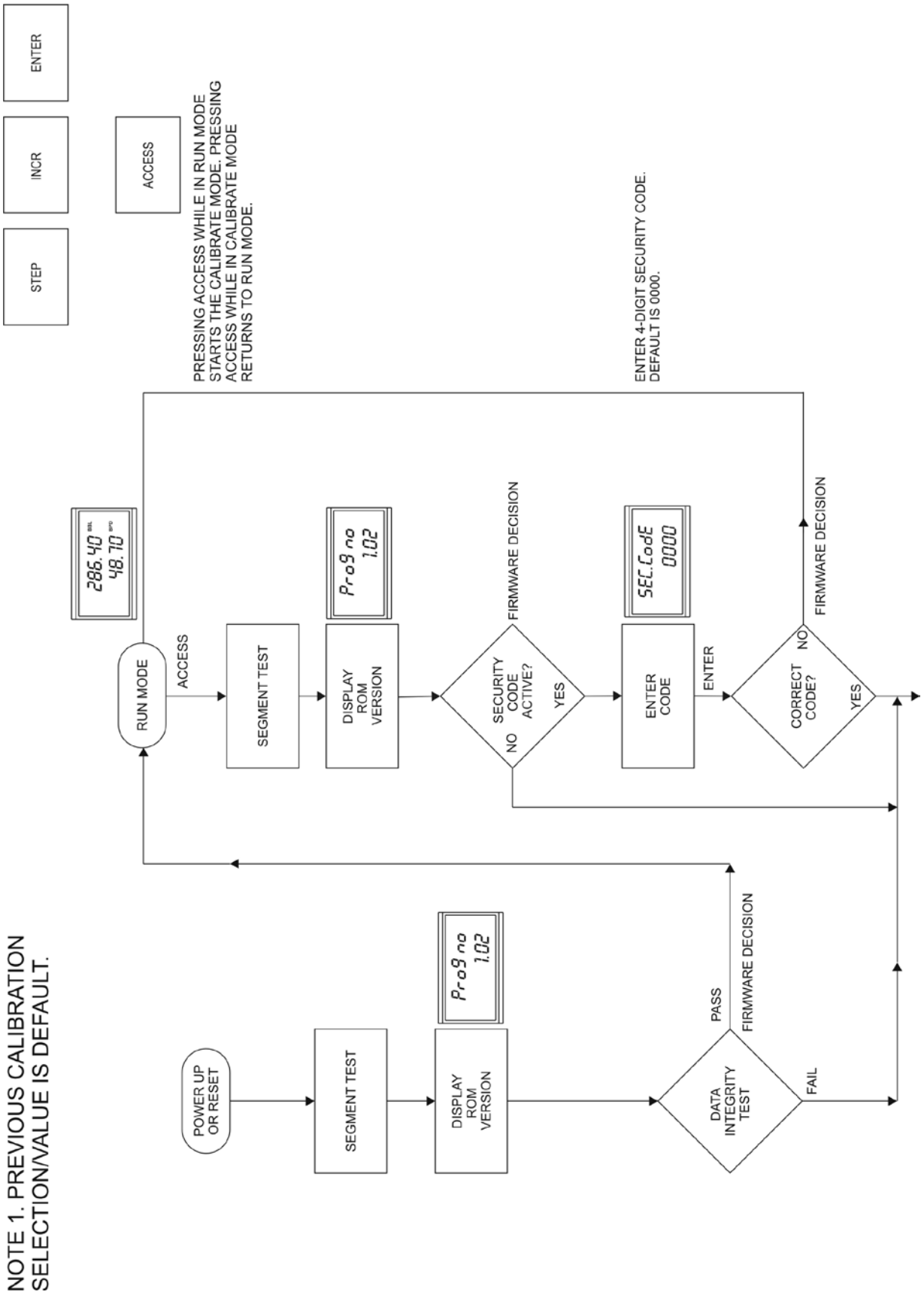
Quantity	Part Number	Description
1	9A-101222928	Switchplate Assembly
1	9A-101001372	CPU/Display Circuit Assembly
1	9A-101227999	Cable Assembly – Flowmeter
1	9A-100005111	Battery – Lithium – 3.6V
1	9A-100002337	Magnetic Pickup

WARNING

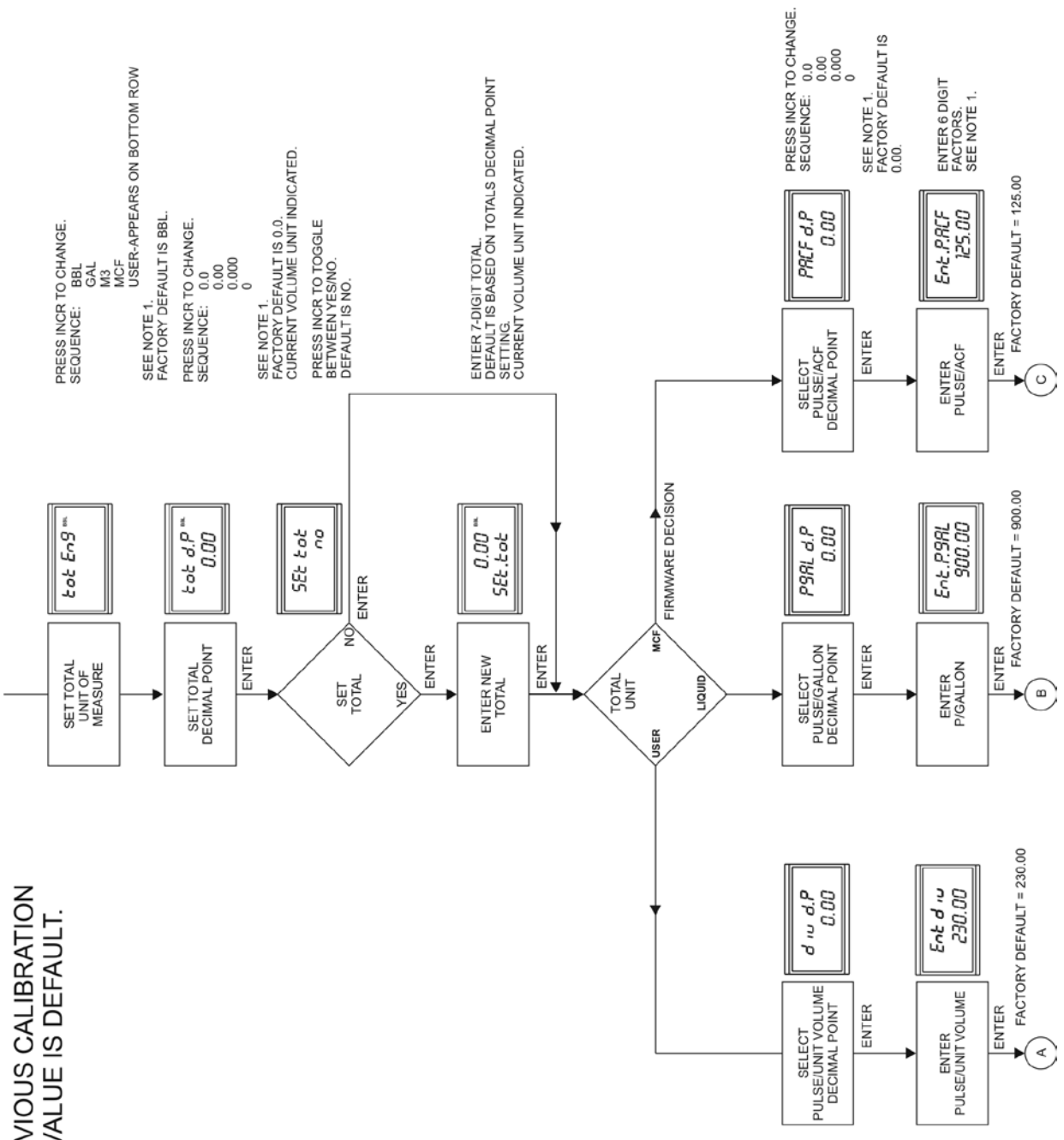
EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIV. 1 CERTIFICATION.

USE OF SPARE PARTS OTHER THAN THOSE IDENTIFIED BY CAMERON INTERNATIONAL CORPORATION (“CAMERON”) VOIDS CSA CERTIFICATION. CAMERON BEARS NO LEGAL RESPONSIBILITY FOR THE PERFORMANCE OF A PRODUCT THAT HAS BEEN SERVICED OR REPAIRED WITH PARTS THAT ARE NOT AUTHORIZED BY CAMERON.

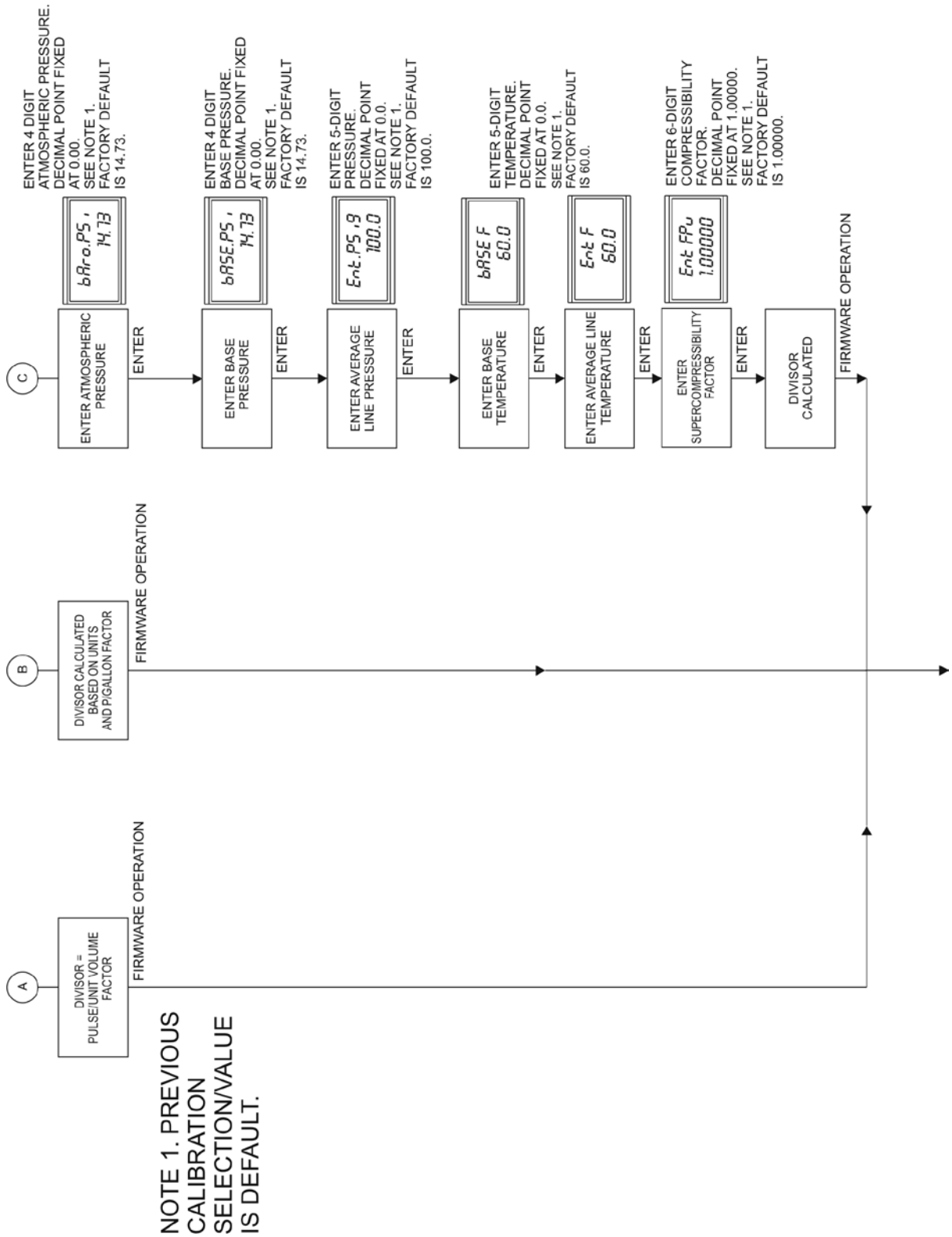
Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart



Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart



Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart



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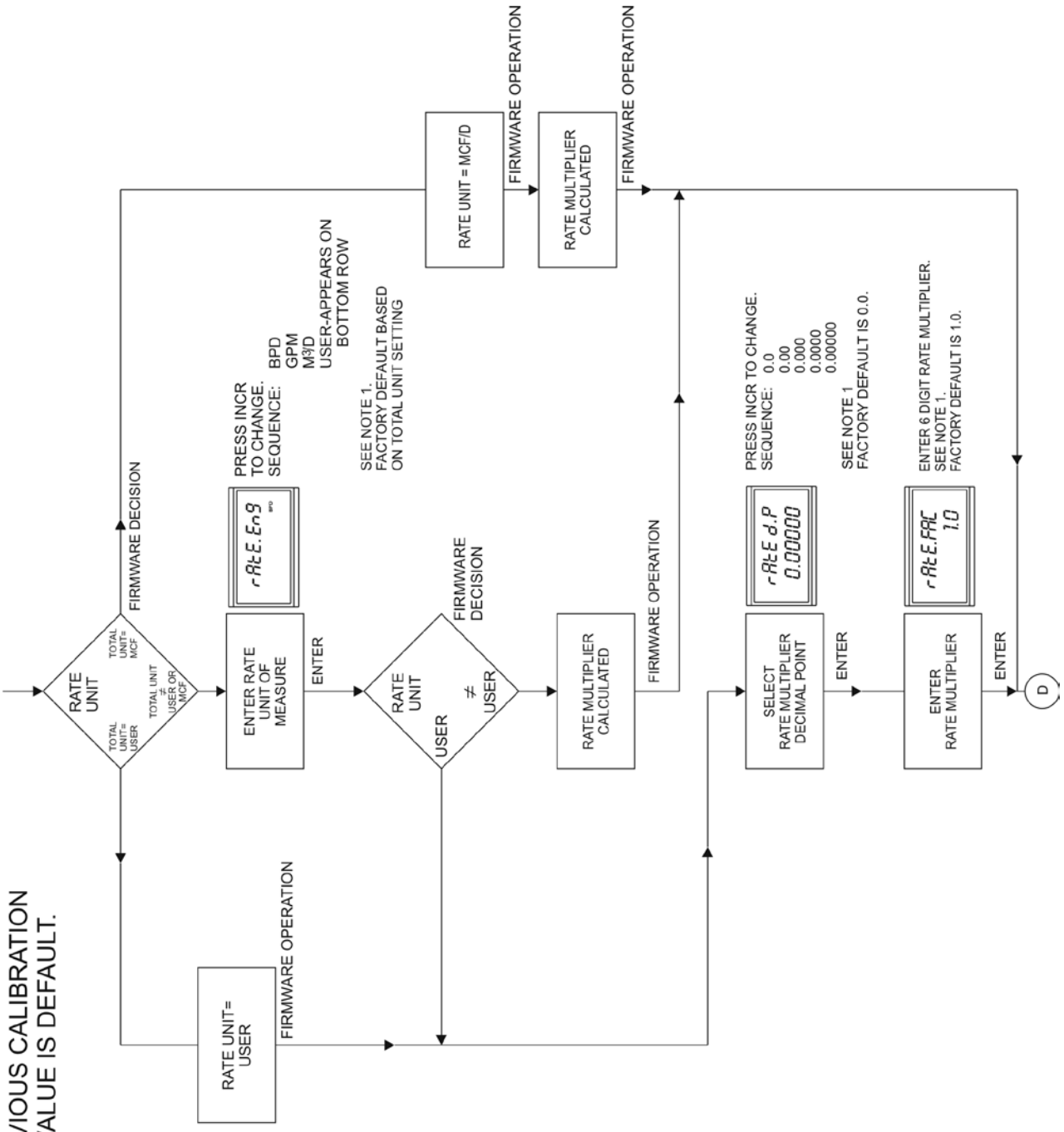
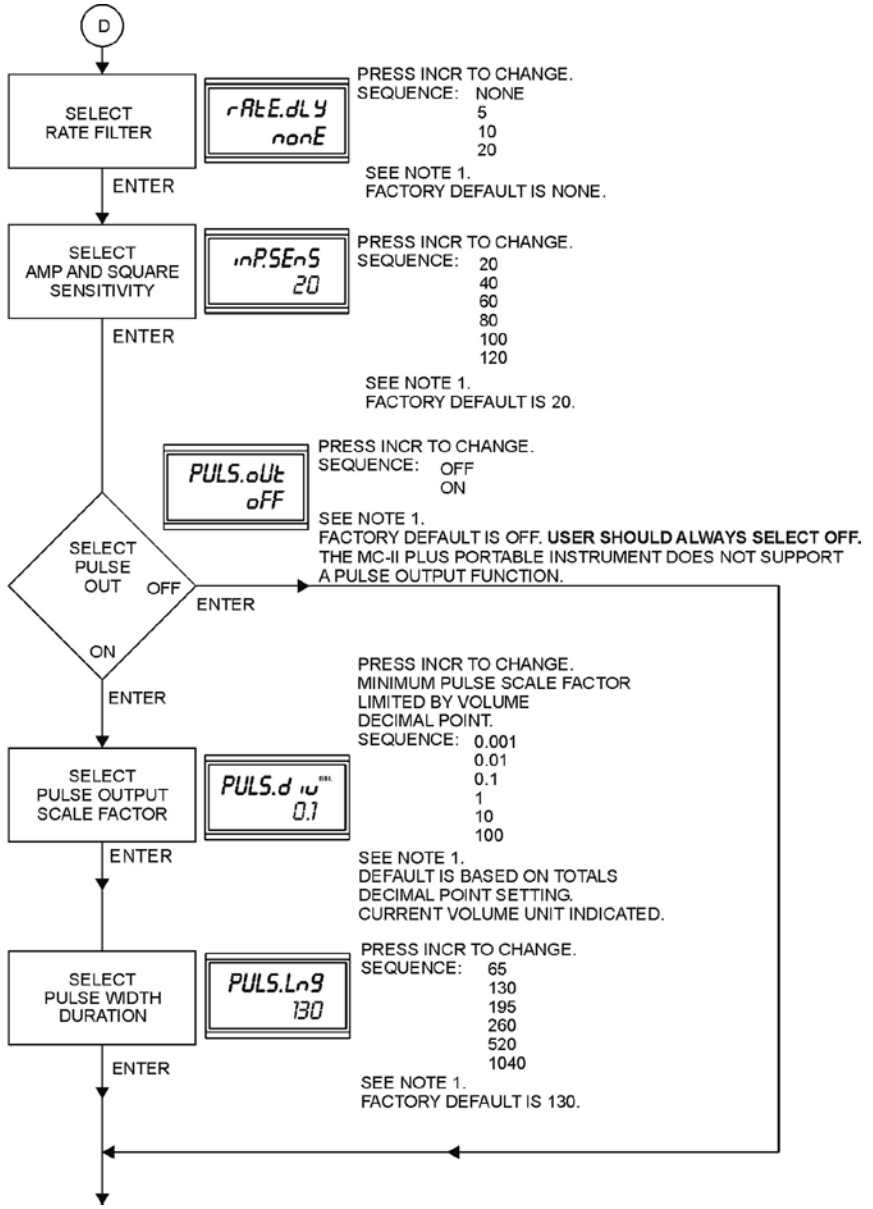
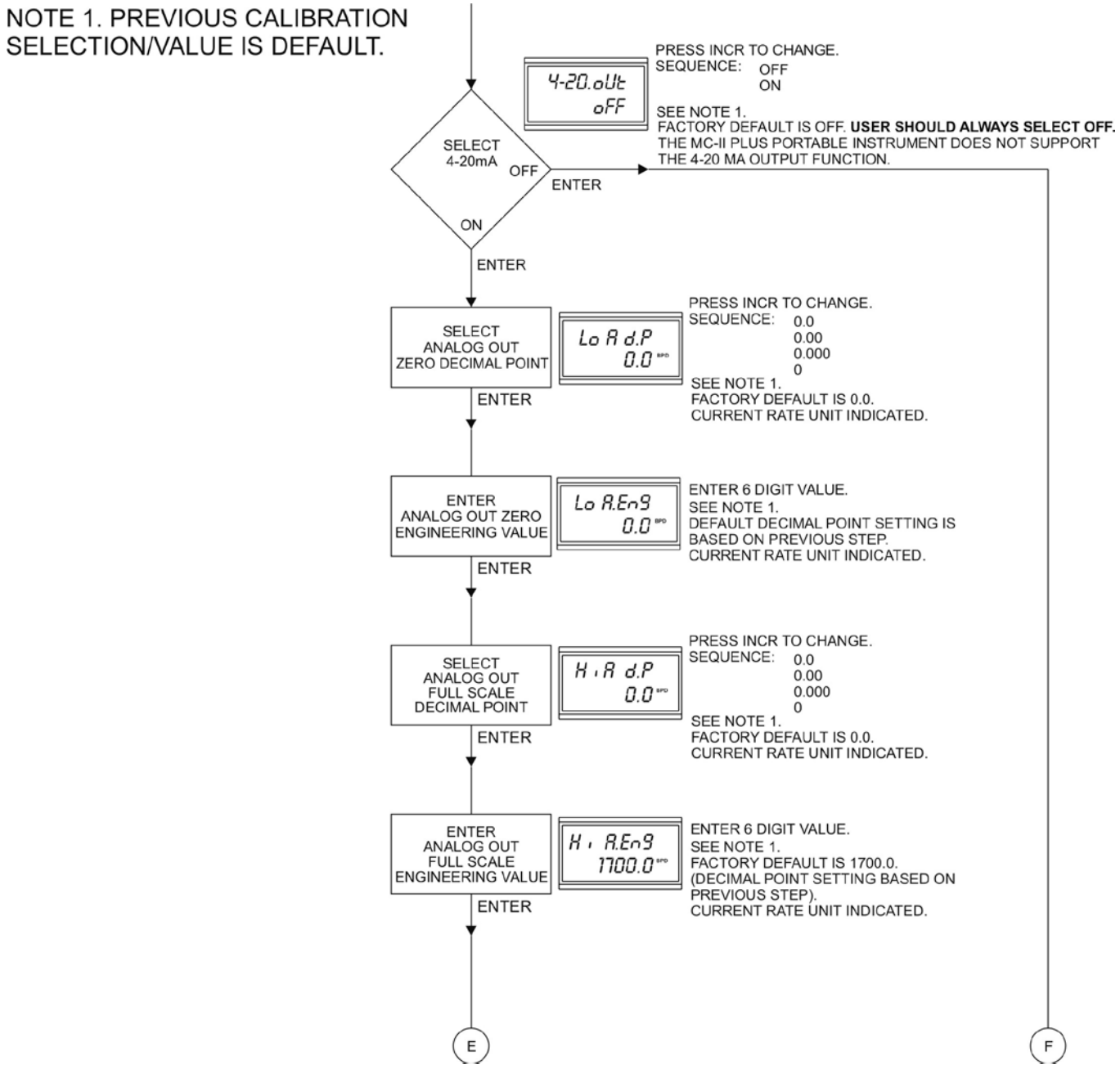


Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart

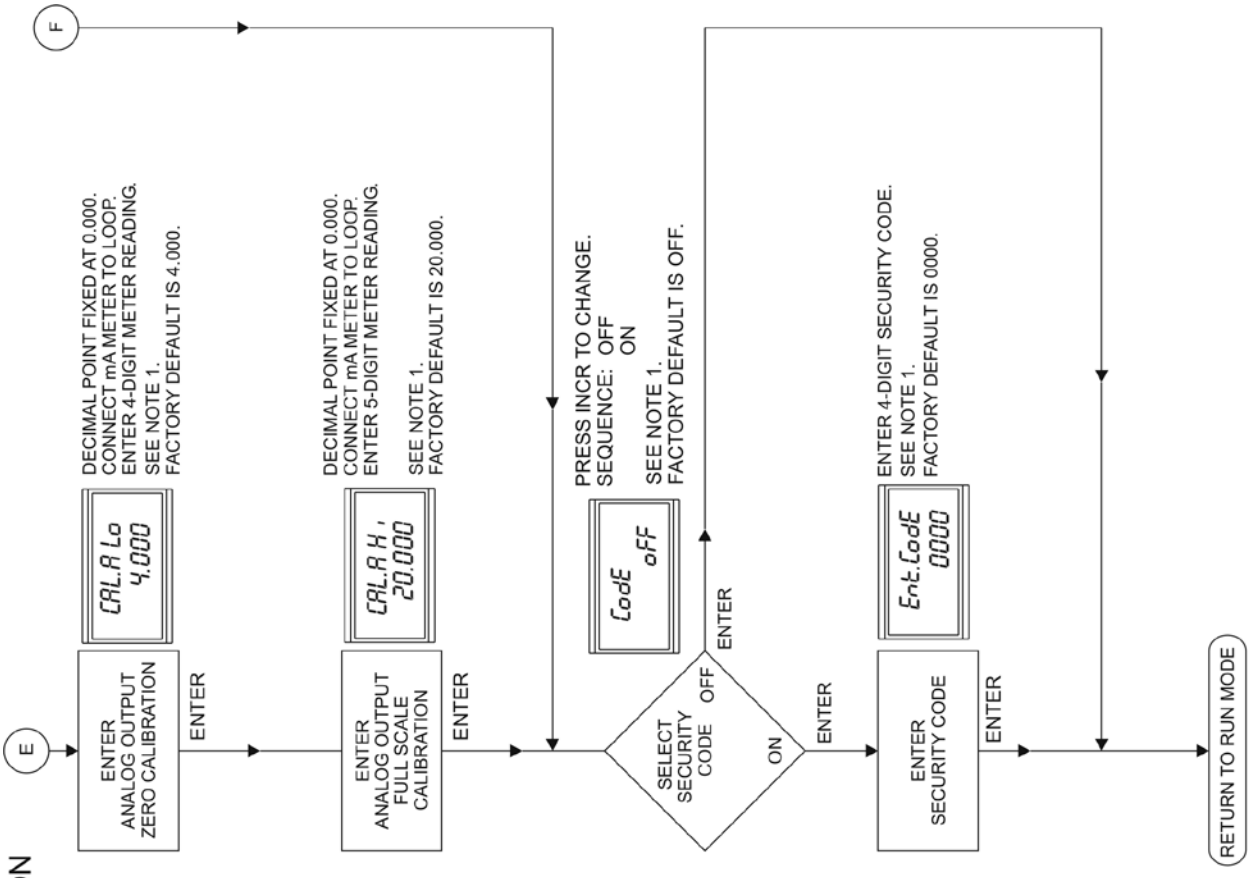
NOTE 1. PREVIOUS CALIBRATION SELECTION/VALUE IS DEFAULT.



Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart



Appendix B - MC-II *Plus* Portable Configuration Menu Flowchart



User Interface Prompt Glossary

Prompt	Where Displayed	Definition	Page Reference
8888888 **888888**	Upper row Lower row	Segment test, which shows momentarily on the display during power up, reset or when entering the calibrate mode, to verify that all segments of the display are functioning. This prompt requires no action.	5
bAro.PSi	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the average barometric pressure in Pounds per Square Inch. The current barometric pressure entry is displayed on the lower row.	8
bASE F	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the temperature in degrees Fahrenheit for standard conditions (the temperature to compensate to). The current base temperature is displayed on the lower row.	8
bASE.Psi	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the pressure in Pounds per Square Inch for standard conditions (the pressure to compensate to). The current base pressure entry is displayed on the lower row.	8
CodE	Upper row	The display prompts to enable or disable the requirement for a security code by toggling the **on** or **oFF** selection shown on the lower display.	23
div d.P	Upper row	When **USEr** defined unit of measure was previously selected, the display prompts for entry of the pulses per unit volume decimal point. The current decimal point placement is shown on the lower row of the display.	13
Ent div	Upper row	When **USEr** defined unit of measure was previously selected, the display prompts for entry of the divisor in pulses per unit volume. The current divisor is displayed on the lower row.	13

Prompt	Where Displayed	Definition	Page Reference
Ent F	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the average flowing temperature in degrees Fahrenheit. The current flowing temperature entry is displayed on the lower row.	11
Ent FPv	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the supercompressibility factor. The currently entered supercompressibility factor is shown on the lower row. (Enter 1.00000 if supercompressibility factor is not to be used.)	11
Ent.CodE	Upper row	The display prompts for the entry of a 4 digit security code, while programming a new security code, which is to be entered in the lower row of the display (only if the **CodE** function is enabled).	24
Ent.P.ACF	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the meter factor in pulses per actual cubic foot. The current pulses per cubic foot entry is displayed on the lower row.	8
Ent.P.gAL	Upper row	When units of liquid measure were previously selected (BBL, GAL M3), the display prompts for entry of the meter factor in pulses per gallon. The current pulses per gallon entry is displayed on the lower row.	6
Ent.PSig	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of the average flowing pressure in Pounds per Square Inch. The current flowing pressure entry is displayed on the lower row.	10
Error	Lower row	Is displayed when there is an error detected by the MC-II Plus firmware. Pressing any key while in the Run Mode will display the nature of the error in the upper row of the display	3
inP.SEnS	Upper row	The display prompts for the selection of the input sensitivity in millivolts. The lower row of the display shows the current input sensitivity setting.	6
no	Lower row	The no selection is shown on the display when the value of the item shown in the upper row of the display is not to be changed.	4

Prompt	Where Displayed	Definition	Page Reference
		This selection may be toggled between **yES** and **no**.	
oFF	Lower row	The **oFF** selection is shown on the display when the function shown by the prompt on the upper row is to be disabled. This selection may be toggled between **on** and **oFF**.	7
on	Lower row	The **on** selection is shown on the display when the function shown by the prompt on the upper row is to be enabled. This selection may be toggled between **on** and **oFF**.	7
PACF d.P	Upper row	When MCF was previously selected for units of measure, the display prompts for the entry of pulses per actual cubic feet decimal point. The current decimal point placement is shown on the lower row.	8
PgAL d.P	Upper row	When units of liquid measure were previously selected(BBL, GAL M3), the display prompts for entry of the pulses per gallon decimal point. The current decimal point placement is shown on the lower row.	5
Prog no	Upper row	Displays the current version of firmware incorporated in the MCII Plus on the lower row. This display is shown momentarily during power up, reset or when entering the calibration mode. This prompt requires no action.	5
rAtE	Upper row	Is displayed as an **Error** message indicating a rate overflow which may be corrected by rescaling the rate multiplier or shifting the rate decimal point	3
rAtE.dLY	Upper line	The display prompts for the selection of the flow rate filter. The lower line of the display shows the present rate filter setting.	23
rAtE d.P	Upper row	When the **USEr** unit of measure was previously selected, the display prompts for the selection of the rate multiplier decimal point. The current decimal point position is displayed on the lower row.	15

Prompt	Where Displayed	Definition	Page Reference
rAtE.Eng	Upper row	When BBL, GAL or M3 was previously selected for the units of measure, the display prompts for the selection of the rate units of measure. The current rate units of measure are displayed on the right side of the display unless **USEr** is selected which is displayed on the lower row.	6
rAtE.FAC	Upper row	When the **USEr** unit of measure was previously selected, the display prompts for the selection of the rate multiplier. The current rate multiplier is displayed on the lower row.	13
SEC.CodE	Upper row	Prompts for the entry of a 4 digit security code. All zeros are initially displayed on the lower row until the security code is entered. This prompt will not be displayed if the security code is not enabled.	24
SEt tot	Upper row	Prompts for a **yES** or **no** decision to set a total (other than zero) into the display. The current setting is shown on the lower row.	4
SEt.tot	Lower row	Prompts for a total volume number to be entered into the display. The current volume is displayed on the upper row.	21
tot d.P	Upper row	Prompts for the entry of the total volume decimal point. The current decimal point setting is shown on the lower row.	5
tot Eng	Upper row	Prompts for total volume engineering values (BBL, GAL, MCF, M3 or **USEr** defined) to be selected. The current engineering value is shown on the right hand side of the display (unless **USEr** is selected which is shown on the lower row of the display.	5
USEr	Lower row	Is displayed when **tot Eng** (select totals engineering units of measure) or **rAtE.Eng** (select rate units of measure) is on the upper row and a **USEr** defined units of measure is selected.	12
yES	Lower row	The **yES** selection is shown on the display when the value of the item shown in the upper row of the display is to be changed. This selection may be toggled between **yES** and **no**.	5

Table 1

Determining Atmospheric Pressure from Elevation

Elevation (Ft Above Sea Level)	Atmospheric Pressure (Pounds per Square Inch)
0	14.73
500	14.47
1000	14.21
1500	13.95
2000	13.70
2500	13.45
3000	13.21
3500	12.97
4000	12.74
4500	12.51
5000	12.28
5500	12.06
6000	11.84
6500	11.63
7000	11.41
7500	11.20
8000	11.00
8500	10.80
9000	10.60
9500	10.40
10000	10.21

The above values were determined by the following formula:

PSIA = (55096-(Elevation-361)) / (55096+(Elevation-361) x 14.54

Where: Elevation is in feet above sea level
PSIA is pounds per square inch absolute

This formula is referenced in AGA Report No. 3-A, 1985, Page 18

Table 2

Table of Conversions of Temperatures

Deg F to Deg R = F + 459.67
Deg C to Deg F = (C x 1.8) + 32
Deg C to Deg R = (C + 273.15) x 1.8

Deg F = Degrees Fahrenheit
Deg C = Degrees Celsius (Centigrade)
Deg R = Degrees Rankine

Table 3

Table of Conversions of Liquid Volumes

Gallons per Barrel = 42
Gallons per Cubic Meter = 264.17
Gallons per Liter = 0.26417
Gallons per Kiloliter = 264.17
Gallons per Pound = 1 / (SG x 8.337)

This table is based on the US liquid gallon
and 42-gallon (API) barrel.

Table 4

Table of Conversions of Gas Volumes

Cubic Feet per Liter = 0.035316
Cubic Feet per Kiloliter = 35.316
Cubic Feet per Cubic Meter = 35.316

Appendix E – Lithium Battery Information

Lithium Battery Disposal

Once a lithium battery is removed from a device and/or is destined for disposal, it is classified as solid waste under EPA guidelines. Depleted lithium batteries are also considered to be hazardous waste because they meet the definition of Reactivity, as per 40 CFR 261.23(a)(2), (3) and (5). This document describes how the lithium reacts violently with water, forms potentially explosive mixtures with water, and when exposed to certain pH conditions, generates toxic cyanide or sulfide gases. Federal law requires that depleted lithium batteries be sent to a fully permitted Treatment, Storage and Disposal Facility (TSDF) or to a permitted recycling/reclamation facility.

Important: Do not ship lithium batteries to Cameron's Measurement Systems Division. Cameron facilities are not permitted recycling/reclamation facilities.

Caution	**Profiling and waste characterization procedures must be followed prior to shipping a lithium battery to a disposal site. It is the shipper's responsibility to comply with all applicable federal transportation regulations (see below).**

Transportation Information

Warning	**The MC-II *Plus* Portable Rate Meter contains lithium batteries. The internal component (thionyl chloride) is hazardous under the criteria of the Federal OHSA Hazard Communication Standard 29 CFR 1920.1200. Before shipping a lithium battery or equipment containing a lithium battery, verify that the packaging and labeling conforms to the latest version of all applicable regulations.**

The transport of the lithium batteries is regulated by the United Nations, "Model Regulations on Transport of Dangerous Goods," (special provisions 188, 230, and 310), latest revision.

Within the US the lithium batteries and cells are subject to shipping requirements under Part 49 of the Code of Federal Regulations (49 CFR, Parts 171, 172, 173, and 175) of the US Hazardous Materials Regulations (HMR), latest revision.

Shipping of lithium batteries in aircraft is regulated by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) requirements in Special Provisions A45, A88 and A99, latest revision.

Shipping of lithium batteries on sea is regulated the International Maritime Dangerous Goods (IMDG) requirements in special provisions 188, 230 and 310, latest revision.

Shipping of lithium batteries on road and rail is regulated by requirements in special provisions 188, 230 and 310, latest revision.

Material Safety Data Sheet

For a link to the current MSDS for the lithium batteries used to power the MC-II *Plus* Portable Rate Meter, see Cameron's Measurement Systems Division website: *www.c-a-m.com/flo*.

NuFlo Turbine Meter Nominal Factors

Liquid Meters

Meter Size	GPM	BPD	M3/D	Nominal P/GAL	Maximum Frequency HZ
3/8"	0.3 - 3	10 - 100	1.6 -16	22,000	1,100
1/2"	.75 - 7.5	25 - 250	4 - 40	14,500	1,815
3/4"	2 - 15	68 - 515	11 - 80	2,950	740
7/8"	3 - 30	100 - 1,000	16 - 160	2,350	1175
1"	5 - 50	170 - 1,700	27 - 270	900	750
1 1/2"	15 - 180	515 - 6,000	80 - 980	325	975
2"	40 - 400	1,300 - 13,000	220 - 2,180	55	365
3"	80 - 800	2,750 - 27,500	436 - 4,360	57	570
4"	100 - 1,200	3,400 - 41,000	540 - 6,540	30	600
6"	250 - 2,500	8,600 - 86,000	1,363 - 13,630	7	290
8"	350 - 3,500	12,000 - 120,000	1,910 - 19,080	3	175

Gas Meters

Meter Size	ACF/MIN	ACF/DAY	Nominal P/ACF	Maximum Frequency HZ
2" Low	7 - 30	10,080 - 43,200	325	165
2" Std	10 - 150	14,400 - 216,000	125	315
2" High	25 - 250	36,000 - 360,000	70	290

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