CalTool™ for RPM3™

A PC Based Calibration Utility

User's Manual

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

Document No. 550106b-03
001114
Printed in the USA.

TABLE OF CONTENTS

TABLES

FIGURES

ABOUT THIS MANUAL

Manual Conventions

(CAUTION) is used in manual to identify user warnings and cautions.

(NOTE) is used in the manual to identify operating and applications advice and additional explanations.

[ ] indicates direct function keys (e.g., **[RANGE])**.

< > indicates screen displays (e.g., **<1yes>**).

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

CalTool for RPM3 is intended to provide assistance in the calibration of RPM3 reference pressure monitor. CalTool steps the operator through the calibration process, gathers data, calculates optimum calibration adjustment coefficients, writes new coefficients to RPM3 and generates calibration reports.

Before using CalTool, read and thoroughly familiarize yourself with the RPM3 Operation and Maintenance Manual, CALIBRATION OF REFERENCE TRANSDUCERS.

NOTES

2. GETTING STARTED

2.1 OVERVIEW

This section explains how to install CalTool™ for RPM3™ on your computer and provides an overview of the startup procedures.

2.2 SYSTEM REQUIREMENTS

CalTool for RPM3 requires the following minimum PC configuration. If your PC does NOT meet these minimum requirements, the software will NOT run as designed.

- Windows 3.1x or Windows 95
- 20 MHz 100 % IBM compatible 386 processor
- 4 Mbytes of RAM
- 4 Mbytes of free hard disk space

2.3 INSTALLING CALTOOL FOR RPM3

2.3.1 WINDOWS 3.1X USERS

❶ Start Microsoft Windows.

❷ Insert the CalTool for RPM3 Installation disk #1 in your floppy drive.

❸ From Program Manager, select the **File** menu and choose **<Run>.**

❹ In the Run dialog box, type **a:\setup** or **b:\setup**, depending on which drive you placed the installation disk in.

❺ The setup program will step through the installation process prompting you for entry of the desired information.

❻ To run CalTool for RPM3, double click the RPM3 CalTool icon in the **DHI** program group.

2.3.2 WINDOWS 95

❶ Start Windows 95.

❷ Insert the CalTool for RPM3 Installation disk #1 in your floppy drive.

❸ Press the **[Start]** button then select **<Run>**.

❹ In the Run dialog box, type **a:\setup** or **b:\setup**, depending which drive you placed the installation disk in.

❺ The setup program will step through the installation process prompting you for entry of the desired information.

❻ To run CalTool for RPM3, press the **[Start]** Button, select **<Programs>,** select **<DHI>** and click on the **CalTool** icon.

2.3.3 INSTALLATION FILES

Some users require knowledge of all files that are copied to their PC to avoid conflicts between different versions of the same file. For this reason, a list of installation files is in Table 1. The majority of users will have little use for this information. The program executable and default configuration and test files are always copied to the directory selected in the Setup process. All Windows based library files are copied to your computer's Windows system directory.

Table 1. Installation Files

FILE	DATE
CT_RPM3.exe	Changes with version
CT_RPM3.cfg	Changes with version
Default.Tst	Changes with version
GRID.VBX	1994/3/25
CMDIALOG.VBX	1993/4/28
GRAPH.VBX	1993/4/28
MSCOMM.VBX	1993/4/28
THREED.VBX	1996/8/24
TX4VBB.VBX	1995/3/15
TABPRO11.VBX	1995/9/8
IMPPRO11.VBX	1994/9/16
VTSS.VBX	1995/2/8
FM.DLL	1995/3/15
TX_BMP.FLT	1995/3/15
TX_RTF.DLL	1995/3/15
TX_TIFF.FLT	1995/3/15
TX_WMF.FLT	1995/3/15
TXTOOLS.DLL	1995/3/15
TXB.DLL	1995/3/15
VBRUN300.DLL	1993/5/12
VTSSDLL.DLL	1995/2/8
GSWDLL.DLL	1993/4/28
GSW.EXE	1993/4/28
WNDTOOLS.DLL	1995/3/15
IC.INI	1995/3/15
IC.DLL	1995/3/15

2.3.4 RUNNING THE PROGRAM

Before running CalTool, establish a remote connection with the host PC by connecting your PC to the RPM3 using a standard RS-232 cable and connecting one of the PC's communications ports to the RPM3's Com1.

CEC and National Instruments IEEE-488 cards are also supported by CalTool for remote operation using the RPM3's IEEE-488 interface. IEEE-488 users should connect a GPIB cable to the IEEE-488 port on the RPM3 and to the desired IEEE card in the host PC.

See the RPM3 Operation and Maintenance Manual (Remote) for additional information on RPM3 communication interfaces and settings.

Once you have set up the interface between the RPM3 and your PC you are ready to run the program. Double click the CalTool Icon in the RPM3 CalTool program group or select the **CalTool** Icon from the **Windows 95 Start - Programs** menu.

When CalTool for RPM3 first loads, it attempts to use the communication settings that were in use when the program was last run or the default communications settings (from the CT_RPM3.cfg configuration file). If communications are correctly established, all communications-based menu options are enabled and the RPM3 information is loaded and displayed. Otherwise, the menu options will remain disabled until communications are properly established.

2.3.5 OPERATING PRINCIPLES

CalTool for RPM3 is an application designed to provide assistance in the calibration of RPM3 reference pressure monitors. It contains all of the necessary tools to simplify and enhance the efficient performance of valid calibrations on the unit.

All tests are separated into two phases.

- Data acquisition
- Data manipulation

The data acquisition phase is the process of obtaining test data that is later manipulated to obtain new calibration coefficients. Data can be obtained by either running a test through the **Run Test** menu option, which steps through points in a test file or by entering each test point manually using the Manual Entry Test option. All test information is written to a comma delimited data file that can be imported into other applications for further analysis.

In the data manipulation phase of a test, you can view the calculated calibration coefficients (PA/PM) for the RPM3 test range and the predicted as left data. The new calibration coefficients can be activated to any range equal to or less than the range tested on the same RPT. After the calibration is activated, a report including a graph can be created to document the calibration.

NOTES

3. MAIN PROGRAM FORM

3.1 OVERVIEW

The main program form contains all of the necessary display information and menu options to set up and calibrate all ranges of the RPM3. There are two folders on this form.

- One folder containing the current setup information
- One folder containing the current test data display

The following sections contain information on the contents and purpose of the two folders followed by itemized information on the menu options. Following the description of each menu option, are forms and other visual information associated with that option.

3.2 CURRENT SETUP FOLDER

The current setup folder displays the currently selected RPM3, pressure reference and test file information.

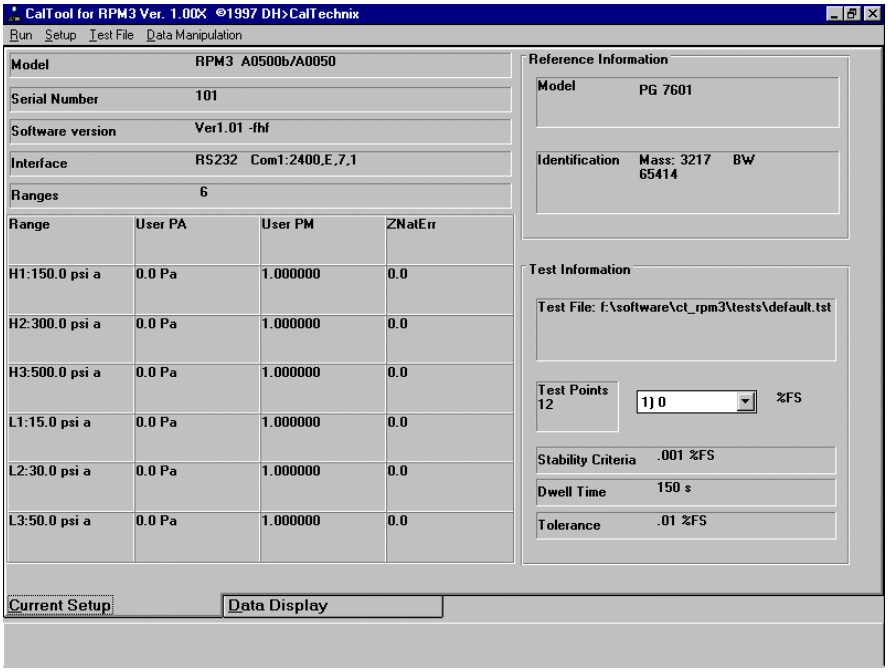

Figure 1. Main Form: Current Setup Folder

3.2.1 RPM3 INFORMATION

The top left quadrant of the current setup folder contains all of the relevant RPM3 information for running a test. Once communication is established with the RPM3, this data is read and displayed automatically. This data is only updated when communications are first established (e.g., a double click is made anywhere on the display), or when **<Read RPM3>** is selected from the **Setup** menu. Each of the fields are read-only so NO edits or selections can be made by choosing any particular field (see Section 4.2.2).

3.2.2 REFERENCE INFORMATION

The top right quadrant of the current setup folder contains information on the device that will be used to supply reference pressure to the RPM3 in the calibration process.

At startup, the last **<Pressure Reference Model>** and **<Identification Used>** displays in the corresponding field. Double clicking any area within the pressure reference frame is a shortcut to choosing the **<Setup Reference>** menu option which gives you the ability to edit reference information (see Section 4.2.3).

3.2.3 TEST INFORMATION

The bottom right quadrant of the current setup folder contains test information. Test Information refers to the definition of the calibration test routine that will be run.

The test points from the currently selected test file display in this section. At startup, the last test used prior to the closing of the program should display in these fields. If an error occurs in the process of loading the previous test file, NO test information displays. Any time a new test is selected or edited it displays in this area the number and value of all test data points in the list box. Test points can be viewed by scrolling down in the list box. Test units can either be in % FS of the current DUT range or in RPM3 supported pressure units. The stability criterion is also based on a % FS value of each range. Dwell time is the only range independent value that can be entered in a test file. Double click any test information field as a shortcut to the **<Select Test>** menu option or right click any field as a shortcut to all **<Test File>** menu options.

3.3 TEST DISPLAY TAB

While running a test, the test display tab should be the main focus of attention. All relevant test information displays for the range under calibration. The current range, test progress, operator and starting date and time also display.

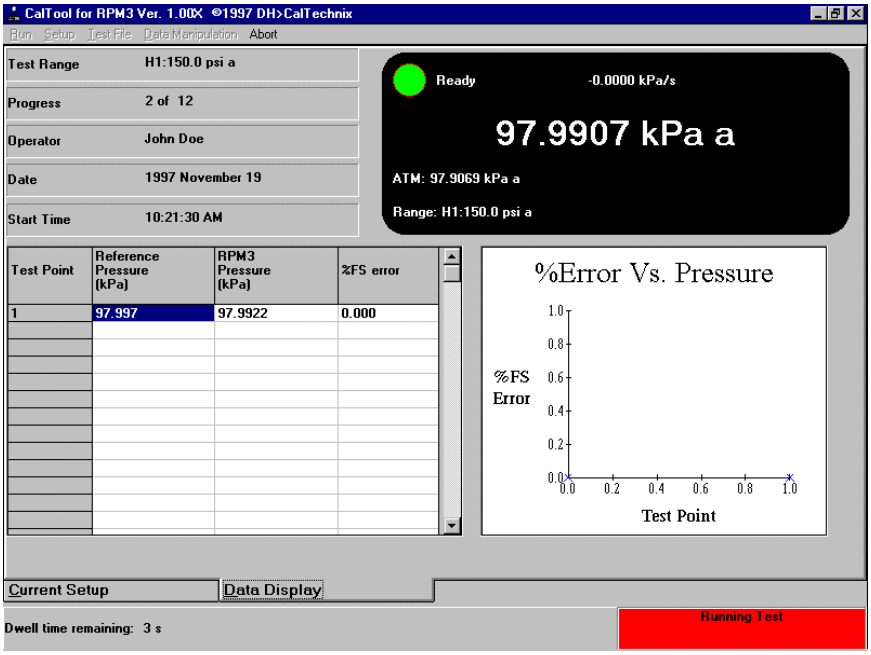

Figure 2. Main Form: Test Display Tab

3.3.1 DATA GRID

The data grid displays the RPM3 and reference pressures and the % FS error for each test point. This is the only data that displays during the data acquisition phase of the test. Only the current test data displays at any given time during a test. To view old data, one of the data manipulation options should be used to view the corresponding data file (see Section 5). After the test is complete, the data will remain on the form for view purposes only. The data is NOT erased until the next test is setup.

3.3.2 DATA GRAPH

The graph provides a real time plot of all data up to the current point of the range being tested. The % FS error (difference between RPM3 pressure and reference pressure) is plotted. NO data is plotted until at least two test points are taken. For this reason, the graph is blank at the beginning of a test.

3.3.3 PANEL DISPLAY

Above the graph is a real time display of RPM3 pressure, atmospheric pressure, ready status, and the current rate of change of pressure. This information only displays after a test is started. The ready status will turn GREEN when the pressure meets the stability criteria as specified in the test file. Otherwise, the ready status is RED.

4. MAIN FORM MENU OPTIONS

4.1 RUN MENU

The **RUN** menu offers the following selections:

- Run Test
- Manual Data Entry
- Remote Communications
- Exit

The function of each choice is in the following sections.

4.1.1 RUN TEST

RUN TEST should be selected to calibrate an RPM3 range. All tests, including Manual Entry Tests, have four main areas:

- Test Setup
- Data Acquisition
- Data Verification
- Data Manipulation

Each of these steps are in the following sections.

4.1.1.1 TEST SETUP

TEST SETUP is valid for both run test and manual entry test options (see Section 4.1.2). The process is the same. You may use current valid settings or the software can allow the reference and test to be selected as part of the setup procedure. It all depends on your responses to the setup prompts. Following is a list of steps that are followed as part of the test setup.

Any time you press [ESC] or choose [CANCEL] for an option, the setup procedure is aborted, as well as the test.

- Verify pressure reference
- Verify test file
- Determine test units

When the selected test file contains test points in % FS, you must select the **pressure units to use for the test**. Select the units and the corresponding measurement mode from the Test Units form and press **[OK]**. Press the **[↓]** to scroll through the units list. The RPM3 will change to the selected units so make sure that your Reference device is in the same units.

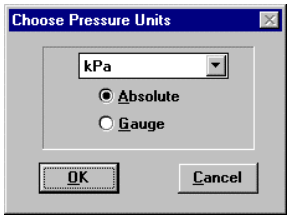

Figure 3. Choose Pressure Units Screen

- Manual entry tests require the user to enter the desired test tolerance. The RPM3 information is also required if there is NOT a remote RPM3 or the test data does NOT correspond to the current remote unit. The RPM3 setup form is used to facilitate the input of the RPM3 information. Information pertaining to the model and software version fields can be obtained by pressing and holding the **[ESC]** key on the RPM3 front panel. The model, which represents the internal RPTs of the RPM3, displays first followed by the RPM3 software version on the bottom half of the display. Select the desired test range and corresponding full scale value and measurement mode.

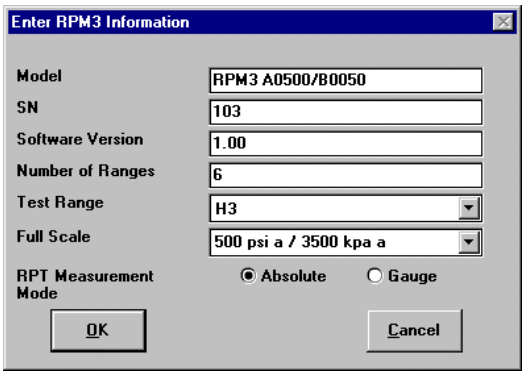

Figure 4. Enter RPM3 Information Screen

- Select the range to calibrate from the range selection form. All ranges of the RPM3 will list in the drop down list box. Press the **[↓]** to scroll through the list of RPM3 ranges.

Only one range can be calibrated at a time. Select the range you wish to calibrate and press [ENTER] or select the [OK] button.

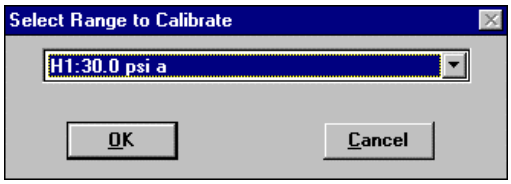

Figure 5. Select Range to Calibrate Screen

- Next, you are asked whether you wish to run the test with the RPM3 AutoZ function ON or OFF. Selecting **<Yes>** will turn AutoZ ON and selecting **<No>** will turn it OFF. Your selection should correspond to how the RPM3 is normally used so that the **as received** data from the test is meaningful. The current state of AutoZ displays with this prompt when there is an RPM3 remotely connected. For more information, see the RPM3 Operation and Maintenance Manual, AutoZ and Principle, As Received/As Left Data.

- CalTool sets the RPM3 to the desired test range, stability test, measurement units and mode. The RPM3 Head value is set to **0** (see RPM3 Operation and Maintenance Manual, HEAD). If a Manual Entry test is being set up, this part is skipped.

- Enter your name when prompted to enter the operator name.
- Finally you are prompted to **<Run the Test>**. Press **[OK]** when ready. Make sure that the supply pressure is below the upper limit of the test range then press **[OK]**. This will deactivate SDS for the RPT that is being calibrated (see RPM3 Operation and Maintenance Manual, SDS Self Defense Systems).

Invalid Test Setup

During the setup process certain combinations of test ranges, test files and measurement units and mode are invalid. When this occurs, an error message displays and the test setup is aborted. The following conditions lead to an invalid test setup:

- Gauge RPM3 RPT (Reference Pressure Transducer) and absolute measurement mode. Gauge RPTs can only be run in gauge mode.

- A manual entry test is being set up with an absolute RPT in gauge measurement mode and AutoZ is turned ON. A calibration in this mode requires knowledge of real time pressure offset values to achieve a valid calibration. For this reason, manually entering the RPM3 and Reference pressures would lead to an invalid calibration.

- Pressure values in the test file exceed the selected RPT range.

4.1.1.2 DATA ACQUISITION

Data acquisition is the process of acquiring test data from both the RPM3 and pressure reference. During this phase of the test, the RPM3 pressure is updated continuously in the pressure display area above the graph.

For each point there is a process of:

❶ Setting the pressure as specified by the test file and dwelling for the test dwell time

❷ Entering the reference pressure

❸ Logging the RPM3 pressure

At each step, you are prompted by a pop-up panel that appears in the upper left-hand corner of the test display folder.

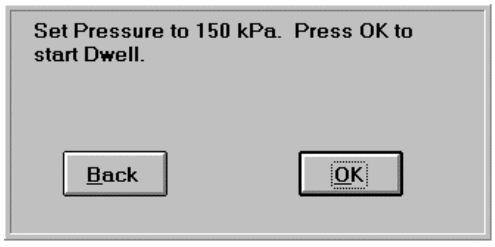

Figure 6. Pop-up Panel Screen

The **[Back]** button on the panel should be used to repeat steps that occurred incorrectly. For instance, you entered the wrong reference pressure. On the first point of a test, the **[Back]** button is disabled. Beyond the first point, choosing **[Back]** will take you to the previous step up to the setting of the previous test pressure On the last test point, a message box displays asking to repeat the last step. Selecting **<Yes>** is identical to pressing the **[Back]** button.

Setting Test Pressure

As mentioned above, you will be prompted by a pop-up panel to set each pressure of the test. If the test file has % FS test points, they are converted to the test pressure units in the correct percentage of the RPM3 pressure range before being displayed on the panel. While the panel displays, you should set the test pressure to the displayed pressure within reasonable limits (see RPM3 Operation and Maintenance Manual, Equipment Required).

Once the reference pressure has been set, press **[OK]** to start the dwell count down. Press **[Back]** to go the previous step in the data acquisition phase of the test. In this case, pressing **[Back]** will take you to Step 3. Take RPM3 reading.

Whenever the **[OK]** button is pressed, the panel hides and the dwell count down begins. Every second is updated on the status bar until **<0>** displays. Meanwhile, the RPM3 pressure is still constantly updated in the test display. During the dwell, NO pressure adjustments should be made. This time should be used to allow the pressure and system to stabilize (two to three minutes dwell time is recommended). At the end of the dwell, a check of the stability is made. If the pressure is unstable, a warning message displays. This is just a warning to avoid taking data when the pressure stability is outside of the stability limit.

Enter Reference Pressure

After the dwell countdown and stability check are complete, the pop-up panel will prompt you to enter the reference pressure. The expected reference pressure value is the nominal test point value of the test file in the current test units. This number will display in the entry field. Enter the actual reference pressure and press **[OK]**. Press **[Back]** if you want to reset the RPM3 pressure.

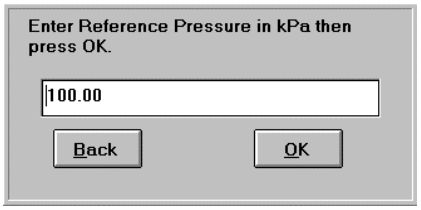

Figure 7. Enter Reference Pressure Screen

If it is impractical to enter the actual reference pressure values the **nominal** values which prompt automatically at each test point can be entered. The **actual** reference pressures can be entered after running the test during the data verification phase. However, this field cannot be left blank.

If nominal reference pressure values are entered while running the test, the graph and % FS error to display will follow along with the test but will NOT be accurate.

Take RPM3 Pressure

Following the entry of the reference pressure the pop-up panel again displays but this time it prompts you to press **[OK]** to log the RPM3 pressure. The reference pressure displays in a non-editable field so you can confirm that it was entered correctly. To change the reference pressure pressing **[Back]** will go to the previous step and allow the edit of the reference pressure. Clicking **[OK]** will log the current RPM3 pressure and update the main data grid and graph with this value and the corresponding % FS error. **<T>** appears with the % FS error display to flag out of tolerance values. An **s** appears if the RPM3 pressure was unstable (outside of the stability limit) at the time of the reading. Return to Setting Test Pressure Section 4.1.1.2, **Setting Test Pressure**. The three step process repeats until all test points are completed.

Any time the next test file point is **exactly** the same as the current test point, the data of the point taken is automatically copied to the next point. This is to assure proper weighting of the end point in a typical ascending and descending calibration sequence. This does NOT mean that a test full of identical points will just log data for the first point. The software only checks the first point from current test point to copy data to. So identical data is logged in pairs.

4.1.1.3 DATA VERIFICATION

After the final test point is taken the data verification form displays allowing the reference pressure values to be edited. The RPM3 model, serial number, test units and test range display at the top of the form followed by all of the data taken during the test. This final edit is available for users who can NOT enter actual reference pressures during the test and must enter them now. The **[Clear Display]** button is disabled because this erases all test data. This button is only used for manual entry tests.

Only existing reference pressure values can be edited. NO new test points can be added and NO existing test points can be deleted. Edit reference pressure values by selecting the desired row and editing the displayed value. Make sure to enter the reference pressure value in the current test units. After the edit, press **[ENTER]** and the % FS error is recalculated based on the entered reference pressure. If undesired edits were made, click the **[Restore Data]** button to refresh the display with the original test data.

Restore updates all data, NOT just the currently selected field. If there is an unexpected problem in the test data, click the [Repeat Test] button to re-run the entire test without going through the Test Setup process.

If **[CANCEL]** is pressed on the data verification form, the entire test is aborted. The test data is NOT completely lost because there is a default test data file (named CT_RPM3.dat) created for every test. This file is created to preserve test information in the event of an accidental abort or an error. Any text editor or word processor can be used to view the contents of CT_RPM3 if desired.

4.1.1.4 SAVING TEST DATA

After all data is verified, click **[OK]** to save the data to a test data file. The data file makes it possible to manipulate the test data to determine new calibration coefficients. A standard Windows file box appears to facilitate this step. CalTool will create a directory named by the serial number of the RPM3. It is a good procedure to save all data files for any RPM3 in the corresponding directory. Determine the name and extension of the data file and click **[OK]**. By default, the data file name is the calibrated range (H1, L1, etc.), the year, and the Julian Day (0 to 365 or 366 for leap year) with a .dat file extension (RR_YYDDD.dat). After the data file is properly saved, the Data Manipulator form displays with all of the calibration information stored in the data file (see Section 5).

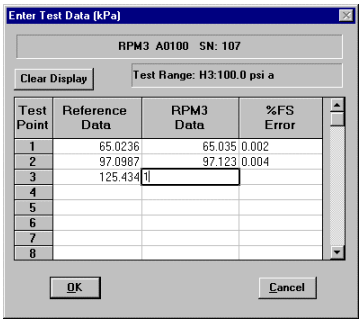

Figure 8. Enter Test Data (kPa) Screen

4.1.1.5 DATA MANIPULATION

After a data file is saved in the data verification process, the data manipulation form displays. This form automatically calculates new calibration coefficients for the test range and gives you the option to activate the new calibration coefficients to any ranges that are less than the test range on the same RPT (see Section 5).

4.1.2 MANUAL ENTRY TEST

A manual entry test is available to allow you to enter RPM3 and reference pressure data independently from actually running a calibration. With this feature, you can input and perform calculations using data that were collected earlier or independently from CalTool. CalTool will need to know the calibration coefficients and RPM3 conditions.

For complete manual entry, the following RPM3 information will need to be available:

- Range
- Pressure measurement units and mode
- AutoZ ON or OFF when test data was taken
- PA/PM
- ZOFFSET (if AutoZ ON, both start and finish values if gauge mode)
- ZNATERR (if AutoZ ON, absolute mode)

If you are interfaced to the RPM3 with the calibration coefficients and settings corresponding to the test data, CalTool will read all these values automatically from the RPM3.

A manual entry test is identical to running a normal test with the exception of the data acquisition phase.

4.1.2.1 MANUAL TEST SETUP

After choosing the **<Manual Entry Test>** menu option, you must perform the same test setup as when running a test using the **<Run Test>** menu option (see Section 4.1.1.1, **Invalid Test Setup**). The test file name for manual entry tests is always manual entry data since there is NO file. The dwell and stability times (see Section 4.3.2.3) are logged as **<N/A>** (NOT Applicable) on the displays and in the data file. This is to indicate that the test data was manually entered and NOT obtained through the regular test process. This type of test can NOT be used for calibrating an absolute RPT in gauge mode with AutoZ ON as real time ATMOFFSET values are required to obtain a valid calibration under these conditions. Therefore, an error message will display during the setup of an absolute RPT in gauge mode.

4.1.2.2 MANUAL TEST, DATA ENTRY

After the test setup is complete, the Data Verification form immediately displays with NO data. Enter the reference and RPM3 pressure readings in the current measurement units (displayed at the top of the form). The % FS error value is automatically calculated after data has been entered into the other columns in the same row. Place data in consecutive rows because the first blank row marks the end of the data when the data file is being created. This nulls all data entered after the blank row. The **<Repeat Test>** and **<Restore Data>** options that display at the end of a test run using the Run Test option are NOT available. However, the **[Clear Display]** button is available allowing you to clear all data entered, NOT just the currently selected field. Use the **[BACKSPACE]** key to clear an individual cell.

For valid calibration coefficients to be calculated, calibration data points in gauge measurement mode must start and end with zero.

Clicking **[OK]** has the same effect as described in Section 4.1.1.4. It triggers the saving of a data file and displays the Data Manipulator form (see Section 5). Clicking **[CANCEL]** aborts the test in the same manner as in a automated test, however there is NO default data file to fall back on. All test information is lost after **[CANCEL]** is pressed.

After **[OK]** is pressed and before the data file can be created, the calibration coefficients must be entered. For Absolute RPT gauge mode calibrations and gauge RPT calibrations with AutoZ ON, you must also enter separate Starting and Ending ZOFFSET values in Pascal (Pa) units. This is because ZOFFSET can change over the course of a test. For all other test configurations, the Ending value of ZOFFSET displays as **<N/A>** and only the Starting ZOFFSET value is required.

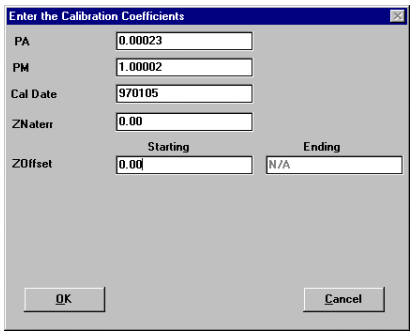

Figure 9. Enter the Calibration Coefficients Screen

4.1.3 REMOTE COMMUNICATIONS

Remote communications can be used to send discrete commands to the RPM3 using RPM3 remote commands (see the RPM3 Operations and Maintenance Manual, Remote Operation Descriptions). Any data that is typed into the Command window is transmitted to the RPM3 after the **[Send]** button is clicked or **[Enter]** is pressed. The commands can be entered manually or selected from the drop down list box of commands previously sent.

After a command is transmitted, a maximum 10 second delay is used to wait for a response. If a response is NOT received within this interval, **<Device Error>** displays in the Reply field. Otherwise, the response of the RPM3 will display. In the event of a Device Error, make sure that the RPM3 and PC are connected and that the interface settings match the current settings of the RPM3. Click **[Exit]** or press **[Esc]** to exit.

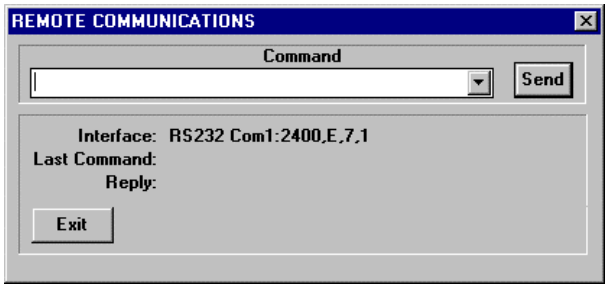

Figure 10. Remote Communications Screen

4.1.4 EXIT

Selecting **[Exit]** causes the RPM3 calibration utility to exit.

4.2 SETUP MENU

4.2.1 COMMUNICATIONS

If communications are NOT automatically established when the program first loads, all communications-based menu options are disabled. Use this option to determine the correct interface and enable all menu options.

The Communications menu contains two sub-menus:

- RS-232
- IEEE

Choose the option that corresponds to the type of remote interface that you intend to use to communicate with the RPM3 from a host PC. When valid communications are established, the RPM3 data is loaded into memory and displayed on the current setup folder of the main form. Then all communications-based menu options are enabled. Before choosing either option, make sure the PC and RPM3 are properly connected and that the RPM3 power is ON. For additional information on interfacing RPM3, see the RPM3 Operation and Maintenance Manual, Remote.

4.2.1.1 RS-232

To use RS-232 communications, choose the PC's Com Port, Baud Rate, Parity, Data Bits and Stop bits from the RS-232 Setup Form that correspond to the setting of the RPM3 Com1 port. To change a setting, press the corresponding **[↓]** and click the desired value. After all selections are complete, click **[OK]**. Pressing **[CANCEL]** aborts the operation and closes the form.

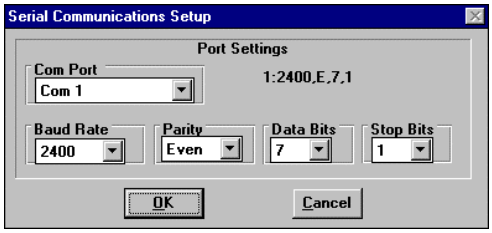

Figure 11. Serial Communications Setup Screen

4.2.1.2 IEEE-488

Only CEC and National Instruments IEEE-488 controller cards are supported by CalTool. Choose the **desired controller card** and make sure the card and DUT address fields are set to the correct value and click **[OK]**. If a communication link is established, all settings are updated as previously described. Pressing **[Cancel]** aborts the form.

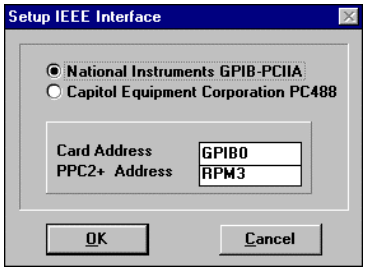

Figure 12. Setup IEEE Interface Screen

4.2.2 READ RPM3

The **<Read RPM3>** menu option should be used to re-load all RPM3 information into memory and display it on the main form. This option should be used if changes are made to any calibration coefficient value after the program has already loaded the RPM3 data, or if a new RPM3 has been connected. Other than the menu option, users may double click any of the RPM3 display fields on the Current Setup folder of the main form to perform the same task.

4.2.3 SETUP REFERENCE

The Reference Setup form is provided to define the instrument that will be used to supply reference pressure values in the calibration. This information will be saved in the test data file.

Selecting the **<Setup Reference>** menu choice displays the Reference Setup Form. Fill in the Model and Identification fields for the applicable reference and press **[OK]**. In most cases, the Identification field should contain the serial number of the pressure reference used as well as any other M&TE information for that particular standard.

Both fields have 60 character limits. After 60 characters are entered, all non-delete or backspace characters are killed. Double clicking any of the Reference Setup information on the Current Setup display folder of the main form is a short cut to this menu option.

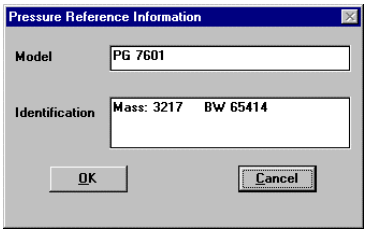

Figure 13. Pressure Reference Information

4.3 TEST FILE MENU

The Test File menu is provided to allow selecting, creating and editing of the test files that define the calibration sequence and conditions.

Clicking any test display field with the right mouse button is a short cut to this menu. The options in this menu allow the user to select, edit, create, and destroy test files.

4.3.1 SELECT TEST FILE

Use this selection to choose a test file. Once selected, a standard file box displays listing the test files available in the test directory. Choose the desired test file and click **[OK]**. If the test file is valid, it is loaded into memory and displayed on the main form's Current Setup folder in the test information area. Double click any Test Information field as a short cut to selecting a test file.

4.3.2 EDIT/CREATE TEST

This action displays the test file editor loaded with any current test information. The test editor is used to create a file that defines a test sequence and corresponding criteria to be used during a test. The test editor is divided into three sections:

- Auto Fill Setup
- Test Point Data
- Test Criteria

After all of the necessary test settings are determined, press the **[Save]** button to save the test file. Determine the path and file name of the test file in the file box that displays then press **[OK]**. It is good practice to save all test files to the test directory. However, it is NOT required. The default extension to all test files is **.tst**. The test editor will close and all of the test settings will display in the test information fields of the main form.

4.3.2.1 AUTO FILL SETUP

The auto fill setup is a shortcut tool for quickly defining a set of test points that are evenly incremented. Starting pressure defines the starting test point and ending pressure defines the last test point. The step value determines the step increment between the starting and ending pressures. Test points will be defined incrementing by the step value from the starting pressure to the ending pressure and back to the starting pressure. The ending pressure is always repeated. If the values are such that the range from starting to ending pressures is NOT an even multiple of the step value, the last step value will be adjusted to end exactly on the ending pressure. Test point values defined by the auto fill setup are copied into the test point fields when auto fill is pressed. All test points can be cleared by choosing the **[Clear]** button. The user is allowed to modify points created by an auto fill.

Auto fill erases all current test points before filling.

4.3.2.2 DEFINING TEST POINTS

Only positive test point values are allowed. Make sure that test points are always entered sequentially. Do NOT skip fields between points. Test points must be specified in either % Full Scale (% FS) or in pressure. % FS points are in % FS of the current RPM3 range being tested. A single properly setup % FS test can be used to calibrate all ranges of any RPM3. Pressure units and measurement mode for % FS tests are determined during the test setup process after a test option is chosen (see Section 4.1.1.1). When pressure points are entered, the pressure measurement units and mode must be determined from the list box below the option.

When defining test points, it is preferable that the points step in consistent increments throughout the span of the current test range in first ascending then descending order. Every ascending pressure point should have a corresponding descending pressure point. This will properly balance the data for the linear regression that occurs after all data is acquired (see Section 6).

For all calibrations performed in gauge measurement mode, the test sequence must start and end at zero.

4.3.2.3 TEST CRITERIA

The test criteria include the following three fields:

- Stability Test
- Dwell Time
- Test Tolerance

Stability Test

The stability test uses the RPM3 Ready**<*>**/NOT Ready (**<↑>** or **<↓>**) determination (see RPM3 Operation and Maintenance Manual, Pressure Ready**<*>/**NOT Ready (**<↑>** or **<↓>**) Indication) as a simple means of helping to assure that calibration measurements are made only when the pressure applied to the RPM3 is stable within a set limit. The stability test is defined in terms of % FS of the current range/second. If the stability test is NOT met, the stability indicator LED by the measured pressure will be RED and indicates **NOT Ready**. If the stability test is met, the indicator LED is GREEN and indicates **Ready**. If the stability test was NOT met when the RPM3 reading was logged, an **<s>** will appear after the % FS error in the display and with the % FS error value logged in the data file. The stability test value (SS) has the following limits: 0.0005< SS < 1.

Dwell Time

The dwell time is the delay after a reference pressure is set before the data for that point can be recorded. Dwell time helps assure that full stabilization of the pressure system occurs at each calibration point before data is taken. Dwell time is specified in seconds and must be within 0 < Dwell < 600s. The recommended dwell time is 120 to 180 seconds.

Test Tolerance

The test tolerance value is the maximum allowable % FS error value of a test. The % FS error is calculated as (Test - Reference)/Test Range FS. If the error was outside of the test tolerance when the RPM3 reading was logged, a **<t>** will appear after the % FS error in the display and with the % FS error value logged in the data file. The tolerance has the following limits: 0.0005 < Tolerance < 1 % FS. For RPM3 RPT measurement specifications, see the RPM3 Operation and Maintenance Manual, Pressure Measurement Specifications. The typical value for the test tolerance is ± 0.01 % FS.

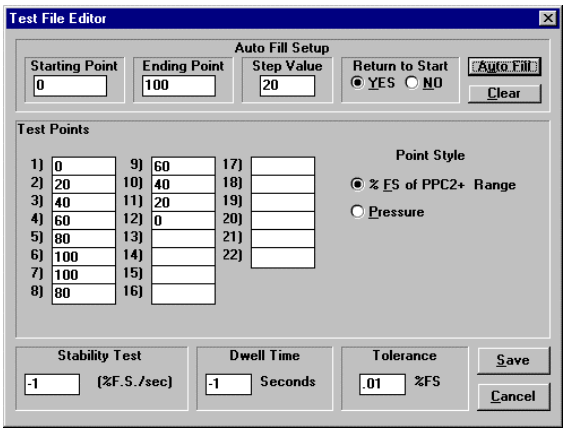

Figure 14. Test File Editor

4.3.2.4 DEFAULT.TST FILE

During the installation of CalTool, a default test file, default.tst, was installed. This file contains the following settings:

- Test points: % FS test points from 0 to 100 % and back in 20 % increments
- Stability limit: ± 0.001 % FS/second
- Dwell time: 150 seconds
- Tolerance: ± 0.01 % FS

The default test defines a typical RPM3 calibration test file. It can be edited as desired if a different testing scheme is desired.

4.3.3 DELETE TEST FILE

This option is provided to allow undesired or obsolete test files to be deleted from the hard disk. A file selection box appears with all test files with a **.tst** extension. Choose the **file** that you wish to delete and press **[OK]**. You will be asked more than once if you want to delete the test file. If **<Yes>** is selected, the file is removed from the hard disk.

4.4 DATA MANIPULATION MENU

4.4.1 VIEW CALIBRATION COEFFICIENTS

Choose this **Menu Option** to view a snapshot of the complete set of currently active calibration coefficients for all ranges of the RPM3. This includes: PA/PM, ZOFFSET, and ZNATERR for each range. All of this information is displayed on the coefficient viewer form. The options menu is the only **Main** menu option on this form. In the **Options** menu are three sub-menus:

- Print
- Re-load
- Exit

The information displayed can only be viewed and cannot be saved to a file or to the RPM3.

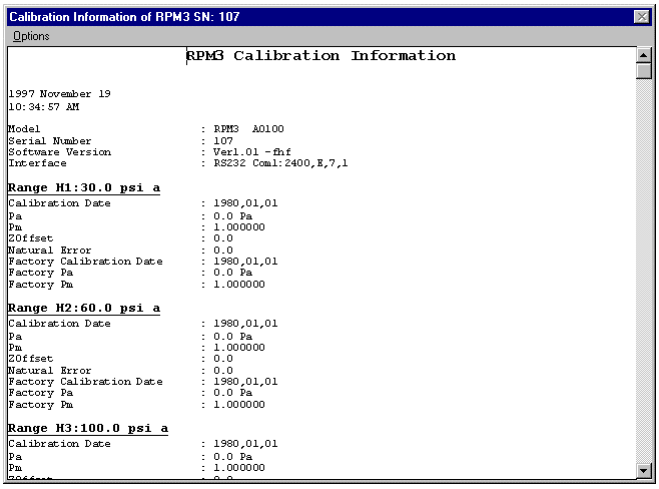

Figure 15. Calibration Information of RPM3 SN: 107

4.4.1.1 PRINT

To print the contents of the view calibration coefficients display to the default printer select the **Print** menu option.

If a new printer is selected in the print dialog box, this printer is automatically changed to the default system printer.

4.4.1.2 RE-LOAD RPM3

Reload rereads RPM3 calibration coefficients and refreshes the view calibration display with that information. This function can be used to obtain current coefficients if RPM3 calibration coefficients have been changed, for example by front panel entry.

4.4.1.3 EXIT

Choose **[Exit]** or press **[ESC]** to close the view calibration form.

4.4.2 OPEN CURRENT DATA FILE

This option allows the current data file to be opened and viewed in the data manipulator form. The last valid data file is automatically loaded into the data manipulator form. Valid log files include data files just created, data files resulting from an aborted test and data files previously viewed using one of the options on the data manipulator form. If there is NO current valid data file, a message displays stating this (see Section 5).

4.4.3 OPEN SAVED DATA FILE

Use this option to view an old data file. At times a user may want to regenerate a report or simply view the contents of an old data file. To do so, select the **desired file** from the displayed file box and press **[OK]**. The data manipulator form will then display with the contents of the data file. Functionally, this menu option is the same as opening a data file from within the data manipulator form (see Section 5).

4.5 ABORT

The **<Abort>** menu option is only displayed when a test is in progress and all other menu options are disabled. It is the equivalent of pressing the **[Esc]** key which gives users the option to abort a test.

NOTES

5. DATA MANIPULATOR

5.1 OVERVIEW

This form is only accessible through the data preview options on the main form or it is called directly after completion of data verification following a test. The sole purpose of this form is to view as received and calculated as left calibration data and coefficients. The data manipulator can only operated with data from a valid test data file.

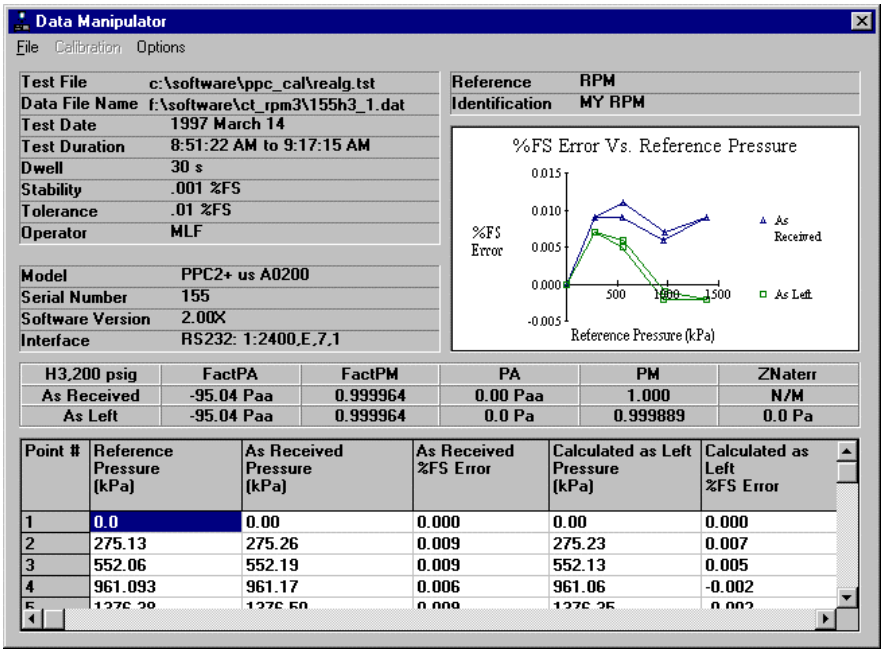

Figure 16. Data Manipulator Screen

5.2 DISPLAY INFORMATION

The same data viewed during the test on the main form is also viewed here. However, only one set of range data is displayed at any given time. All data displayed corresponds to the currently loaded data file.

5.2.1 TEST INFORMATION

This field displays the test file data read from the data file.

5.2.2 REFERENCE INFORMATION

Reference model and identification are also read directly from the data file and displayed on the form. In many cases the identification string will exceed the length of the display field and scroll out of view of the user. The information is still there, it just is NOT visible. When reports are created, the entire identification string will be displayed.

5.2.3 DATA GRAPH

The graph displays % FS errors for both **As Received** and **Calculated As Left** RPM3 readings versus reference pressures in current pressure units. If the user clicks the graph, it is automatically maximized until it is clicked again or the user presses escape.

5.2.4 RPM3 INFORMATION

The same RPM3 information is available in the data manipulator form as on the main form. The major difference is that the display is for the current range only. The first row of the imprint displays the as received calibration coefficients and the second the new calculated calibration coefficients.

5.3 MENU OPTIONS

5.3.1 FILE MENU

5.3.1.1 OPEN DATA FILE

Opening a data file gives the user the ability to load any number of existing test data files. The files can be viewed or used to generate reports. If the data file is valid, all data is loaded into the display. If an RPM3 is currently remotely connected and its serial number is the same as the serial number of the data file RPM3, the **Calibration** menu is enabled. Otherwise the Menu is disabled to prevent calibration data of one RPM3 from being saved to another.

5.3.1.2 VIEW CURRENT REPORT

The objective of the report function is to provide a convenient standard report format. To create your own customized report either open the comma delimited data file and manipulate it in another program such as Excel, Lotus, etc. or copy the report into a word processor by cutting and pasting.

When selected, the standard report displays. The report can be edited in any way desired and saved by using the **<Save Report>** option. This is NOT a true report editor, so many typical word processor features are unavailable. To export the report into a true word processor, select the **entire document** by clicking the beginning of the document and holding the mouse button down, then drag it to the end of the report. Press **[Ctrl] + [C]** to copy the information to the Windows clipboard. Paste the information into the desired word processor document. To close the report, press **[Esc]** or choose **<Return to Data View>** which is in place of the **<View Current Report>** menu option while the report is visible.

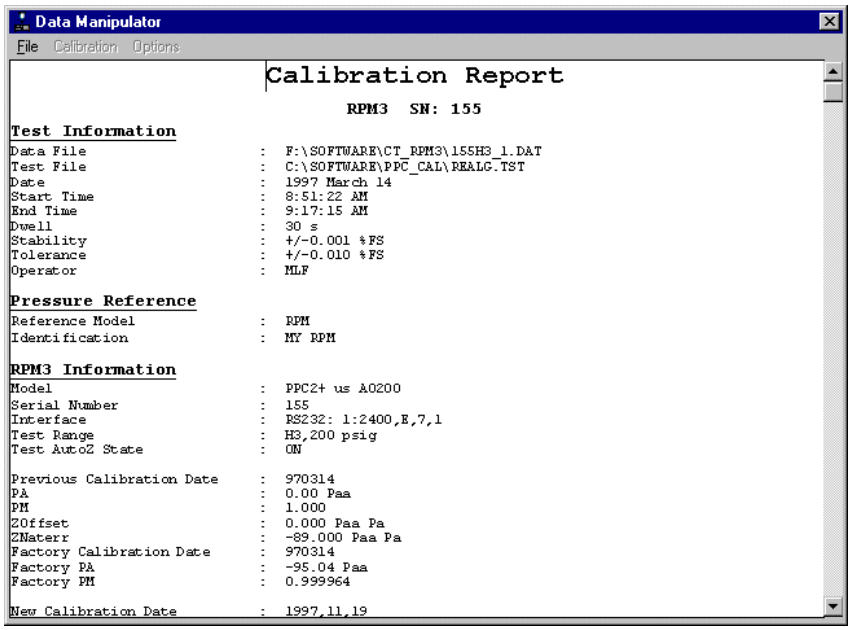

Figure 17. Data Manipulator: Calibration Report Screen

5.3.1.3 VIEW SAVED REPORT

Only reports created by using the **<Save Report>** option can be viewed. Choose the desired report from the file box and press **[OK]**. The report will display in the same fashion as the previous option.

5.3.1.4 SAVE REPORT

This choice allows the user to save the report. If edits were made to the report, this option must be selected while the report is visible for the edits to be saved. When the report is NOT visible, the default report is always saved. The default name of a report is the same as the current data file except the file extension is **.rpt**. Determine the path and filename of the report on the displayed file box and press **[OK]** to activate the save.

5.3.1.5 PRINT CURRENT REPORT

Select **<Print Current Report>** to print the default report. If edits were made to the report, this option must be selected while the report is visible to print the edits. Otherwise, only the standard report generated from the data file is printed.

If a new printer is selected in the print dialog box, this printer is automatically changed to the default system printer. This is the case for all printing options within the program.

5.3.1.6 PRINT SAVED REPORT

Choose the report to print from a standard Windows file box. If the file is a valid report saved using the **<Save Report>** option, it is sent to the default Windows printer.

5.3.1.7 EXIT

Pressing **[Exit]** closes the data manipulator form and returns control to the main form of the program. If calibration coefficients are activated to the RPM3, the main form will re-load RPM3 information and display the current information.

5.3.2 CALIBRATION MENU

All items in the calibration menu are unavailable unless there is an RPM3 remotely connected to the host PC and the data file contains data that corresponds to that RPM3.

5.3.2.1 ACTIVATE CALIBRATION

<Activate Calibration> writes the calculated calibration coefficients (PA, PM, and ZNaterr) and the new calibration date to the RPM3 for the test range. The calibration date always uses the year month day format (YYYYMMDD). Zoffset is set to zero after all calibrations except an absolute calibration in gauge mode, this Zoffset value is NOT modified. A check mark **<√>** will appear next to any calibration that was successfully activated. If an error occurs during the activation process, the original calibration data is restored automatically.

5.3.2.2 COPY CALIBRATION TO

This menu choice is provided to allow the calibration coefficients of a range to be applied to lower ranges. This is used if one does NOT want to calibrate all the ranges of an RPT but would like to be sure that they are consistent with each other. Calibrations can only be copied to lower ranges and NOT to higher ranges because of the risk of out of tolerance results by extrapolation in the part of a range that is greater than the calibrated range.

Use **<COPY CALIBRATION TO>** to apply the current calibration coefficients of a higher range to lower ranges on the same RPT. If the test range was the lowest range of an RPT, none will display because there are NO other ranges to apply the calibration to. Otherwise the other possible ranges are listed. When the desired range is selected, the current calibration coefficients and date are written to that range. A check mark **<√>** will appear next to any calibration that was successfully activated.

5.3.2.3 RESTORE

<Restore> allows the old RPM3 calibration coefficients to be restored after new calibration coefficients have been activated so long as the current data file remains open.

Restore is available after a calibration is activated to the RPM3. Choose **<Restore>** when you wish to undo any calibration that was activated. The RPM3 calibration coefficients are restored back to the values that were replaced when the new calibration was activated. They are NOT restored to the values recorded in the data file. Only calibrations activated during the current run of a data file can be restored. Each time a new data file is opened, the restore option is disabled until a new calibration is activated. So if a calibration is activated in one data file it cannot be restored while another data file is open.

5.3.2.4 VIEW CALIBRATION COEFFICIENTS

This option is equivalent to the view calibration coefficients form on the **Main** menu (see Section 4.4.1).

5.3.3 OPTIONS

5.3.3.1 INCLUDE GRAPH IN REPORT

If you want your report to include the graph of the as received and as left errors, make sure that there is a check mark **<√>** next to this option. Click on the option to add or remove the check mark **<√>**.

NOTES

6. CALCULATIONS

6.1 OVERVIEW

This section describes the mathematical manipulation used by CalTool to determine new calibration coefficients and calculate as left data. The coefficients used include: PA (Pressure Adder), PM (Pressure Multiplier), ZOFFSET, ZNATERR and ATMOFFSET. All of these values are always recorded and displayed in Pascal (Pa) pressure units but applied mathematically in the current measurement units. For more information on these coefficients, see the RPM3 Operation and Maintenance Manual, CALIBRATION OF REFERENCE PRESSURE TRANSDUCERS, AutoZ. New calibration coefficients and as left data are determined as described in the following sections.

Data used for calculations is read directly from the selected data file. All data acquired during tests is simply written to this file without any manipulation regardless of the type of test run. During any calibration of an absolute RPT in gauge mode, the values of ZOFFSET and ATMOFFSET are also recorded for every As Received pressure point if AutoZ is ON (see the RPM3 Operation and Maintenance Manual, AutoZ, PRINCIPLE, Gauge Mode with an Absolute RPT, Dynamic Compensation for Atmospheric Pressure).

The first step in manipulating any set of calibration coefficients is to determine the RPM3 "factory pressure" for each calibration point (see Section 6.2). The factory pressures are then regressed against the reference pressures to obtain new PA/PM values (see Section 6.3). Next, the AutoZ values are modified depending upon the RPT type and measurement mode (see Section 6.4). Finally, the new PA/PM values are re-applied to the factory pressure to determine calculated as left pressure and error values.

6.2 DETERMINING FACTORY PRESSURE

The RPM3 factory pressure is obtained by removing all calibration coefficients from the as received RPM3 pressures in the data file. Depending on the state of AutoZ (ON or OFF) at the time of calibration, ZOFFSET may or may NOT be removed. In addition, in the case of an absolute RPT calibrated in gauge mode, ATMOFFSET may or may NOT be removed depending on the state of AutoZ.

6.2.1 ABSOLUTE RPTS IN ABSOLUTE MEASUREMENT MODE AND GAUGE RPTS

- AutoZ ON

  Factory Pressure = (Pressure AsRecd - PA + ZOFFSET) / PM

$$P_{factory} = \frac{P_{asreceived} - PA_{user} + dP_{offset}}{PM_{user}}$$

- AutoZ OFF

  Factory Pressure = (Pressure AsRecd - PA) / PM

$$P_{factory} = \frac{P_{asreceived} - PA_{user}}{PM_{user}}$$

6.2.2 ABSOLUTE RPT IN GAUGE MEASUREMENT MODE

- AutoZ ON

  Factory Pressure = (As Recd - PA + ZOFFSET + ATMOFFSET) / PM

$$P_{factory} = \frac{P_{Asreceived} - PA_{user} + dP_{offset} + dP_{AtmOffset}}{PM_{user}}$$

- AutoZ OFF

  Factory Pressure = (Pressure AsRecd - User PA + ZOFFSET) / User PM

$$P_{factory} = \frac{P_{asreceived} - PA_{user} + dP_{offset}}{PM_{user}}$$

6.3 DETERMINING PA/PM

To determine the new pressure adder (PA) and pressure multiplier (PM) a linear regression is performed to arrive at the lowest value of the residuals of errors of the RPM3 factory pressures relative to the reference pressures. The regressions are different for absolute and gauge measurement modes because the gauge mode calibrations are biased at zero.

6.3.1 ABSOLUTE RPT IN ABSOLUTE MEASUREMENT MODE

$$PM = \frac{n\sum P_{Factory_i} P_{Std_i} - \left(\sum P_{Factory_i}\right)\left(\sum P_{Std_i}\right)}{n\sum P_{Factory_i}^2 - \left(\sum P_{Factory_i}\right)^2}$$

$$PA = \frac{\sum P_{Std_i}}{n} - PM\frac{\sum P_{Factory_i}}{n}$$

6.3.2 ABSOLUTE RPT IN GAUGE MEASUREMENT MODE AND GAUGE RPTS

$$PM = \frac{\left(\sum P_{Factory_i}\right)\left(\sum P_{Std_i}\right)}{\left(\sum P_{Factory_i}\right)^2}$$

$$PA = \frac{\left(P_{std(1)} - P_{factory(1)}\right) + \left(P_{std(n)} - P_{factory(n)}\right)}{2}$$

For absolute RPTs calibrated in gauge measurement mode:

$$P_{Std} = P_{reference} + dP_{offset} + dP_{ATMOffset}$$

6.4 ZNATERR, ZOFFSET MODIFICATIONS

When new calibration coefficients are activated to the RPM3:

- For absolute RPTs calibrated in absolute mode, ZOFFSET is set to zero.
- For gauge RPTs ZOFFSET is set to zero.
- For absolute RPTs calibrated in gauge mode ZOFFSET is unaffected.
- For absolute RPTs calibrated in gauge mode, ZNATERR is determined by the predicted difference between the test and reference at 101.325 kPa.
- For absolute RPTs calibrated in gauge mode ZNATERR is set to 0.0.
- ATMOFFSET is unaffected by the calibration process.

6.5 DETERMINING AS LEFT DATA

Absolute RPTs calibrated in gauge measurement mode with gauge reference pressures cannot be used for accurate absolute measurements and the calibration will NOT yield accurate absolute as left data.

To determine as left data, the new PA/PM values (Section 6) are applied to the factory pressures to arrive at the as left pressures. The reference pressures are the same as the as received reference pressures.