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STANDARD OPERATING PROCEDURE FOR APPLICATION OF PRESSURE GAUGE CALIBRATION DATA

ENVIRONMENTAL TEST FACILITY BRANCH
STRUCTURAL AND ENVIRONMENTAL TEST DIVISION
TEST LABORATORY
ENGINEERING DIRECTORATE

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STANDARD OPERATING PROCEDURE FOR APPLICATION OF PRESSURE GAUGE CALIBRATION DATA

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ATTACHMENT A

1.0 GENERAL INFORMATION

1.1 SCOPE

This document describes the procedures for determining the slope and intercept coefficients used to program data acquisition software (DAS) for a particular ion and convectron pressure gauge.

1.2 PURPOSE

The procedures and practices outlined in this document are to be followed in the programming of DAS for a specific ion and convectron pressure gauge. This document provides a record copy of pressure gauge programming.

1.3 APPLICABLE DOCUMENTS

ET24-ETF-OWI-001	Environmental Test Facility Test Operations
MPR 8715.1	Marshall Safety, Health, and Environmental (SHE) Program

1.4. DEFINITIONS

1.4.1	CCC	Calculated Calibration Coefficients. Values of slope and intercept used to improve accuracy of pressure data recorded and displayed in DAS.
1.4.1	DAS	Data Acquisition System, which consists of a scanner, a computer and the data acquisition software
1.4.2	ETF	Environmental Test Facility
1.4.3	EUD	Engineering Unit Data
1.4.4	FOP	Facility Operating Procedure
1.4.5	Intellution	Commercial software used for control and data acquisition
1.4.5	PACRATS	Payload and Components Real-time Acquisition Test System. Software developed by Marshall Space Flight Center (MSFC).

1.5 SAFETY

All test personnel working in the Environmental Test Facility (ETF) shall be familiar with the safety documents listed above, and shall report any safety hazards or unsafe practices to the ETF Branch Chief or the 4619/4612 Assistant Building Manager.

1.6 EMERGENCY TELEPHONE NUMBERS

Dial **911** for all emergencies, including:

Medical	**911**
Fire	**911**
Ambulance	**911**
Security	**911**
Chemical Spills	**911**

Other numbers that can be used to obtain information about emergency, security, safety, and utilities are:

Medical Center	544-2390
Security	544-4357
Safety	544-0046
Medical Center	544-2390
Utilities	544-3919

1.7 RESPONSIBILITIES

ETF personnel shall be responsible for the safe operation during application of pressure gauge calibration data. These responsibilities include safety for personnel and the facility.

Other task assignments and responsibilities at the ETF shall be in accordance with ET24-ETF-OWI-001.

2.0 DESCRIPTION

2.1 PRESSURE GAUGE CALIBRATION

The pressure gauges and gauge controller are calibrated together as mated sets by the MSFC calibration laboratory. Upon completion of the calibration, the pressure gauges and controller are returned to the ETF with a data sheet for each gauge and controller set. Each pressure gauge data sheet provides three or more columns of data. There is a column for calibration lab standard pressure, a column for the pressure EUD displayed on the pressure gauge controller, and a column for the voltage output from the pressure gauge controller.

2.2 PRESSURE GAUGE DESCRIPTION

The pressure gauge controllers used in the ETF are Granville Phillips model GP307 vacuum gauge controllers. The Granville Phillips model GP307 controller connects to one ion gauge and two convectron gauges. Ideally, the GP307 provides a voltage output to the DAS that is proportional to the log of the pressure being measured, offset by an ideal constant.

$V = \log_{10} P + C$

Where:

V is the controller output voltage

P is the pressure being measured (in units of torr)

C is the ideal offset constant.

The voltage output for each gauge/controller set can then be converted to EUD ideal pressure by performing the reverse math function on the voltage as appropriate for the gauge in question. The constant C is dependent on the type of gauge. For convectron gauges, the ideal offset constant is -4. For ion gauges, the ideal offset constant is -12.

2.3 CALCULATED CALIBRATION COEFFICIENT (CCC)

The typical pressure gauge was determined to respond slightly different from the ideal conversion equation. In order to improve the accuracy of data recorded and displayed on the DAS computer, the amplitude and offset were adjusted mathematically in the voltage to pressure equation. A voltage was calculated for the standard and display pressures given in the calibration laboratory report. These calculated voltages are used as ordinate values and the controller output voltage use as abscissa values. Two lines were calculated (one for standard pressures and one for the controller display pressures) using first order linear regression (also called method of least squares) that best fit these data points. The slope and offset of these regression lines are the CCC used to adjust the output voltage so that the EUD in DAS are approximately the same as the controller display pressure and the standard pressure. A gauge that responds like a ideal gauge would have a slope of one and no offset on this volt-calculated versus voltage-output line (i.e., the regression line is a 45 degree line that intersects at the origin).

The ideal equation is:
$\log_{10} P = V - C$

or

$P = 10^{(V-C)}$

The adjusted equation is

$P = 10^{(MV-C+I)}$

Where:

M is the slope (or amplitude) coefficient.

I is the intercept (or offset) coefficient.

The ETF maintains a spreadsheet workbook containing a worksheet for each pressure gauge. This worksheet calculates and records the CCC for each gauge. The CCCs are used to convert the GP307 gauge/controller output voltages to EUD in DAS that are approximately the same as the controller display pressure and the standard pressure. The CCCs are determined by entering the three columns of data mentioned above (standard pressure, displayed pressure, and voltage) into the worksheet in the appropriately labeled columns. A macro command is then executed which performs two linear regressions. The results of the linear regressions are the slope and intercept coefficients for each regression line, which are the CCCs for that gauge. Each GP307 gauge/controller set has up to three gauges and one voltage output for each gauge. Each output voltages require two calculations (one for the display pressure and one for the standard pressure). Thus, up to six sets of slope and intercept coefficients may be required for each GP307.

2.4 DATA ACQUISITION SYSTEM (DAS)

For PACRATS, the DAS is designed to read the output from a data scanner as delineated in a test file containing all measurement information. This test file is editable by the Notepad program available on the computer. In this file, there is to be a voltage measurement for each of the three pressure gauges mated to the GP307. There are two calculations for each of those three voltages. These calculations convert the voltage measurement back to the pressure as displayed by the GP307 or to the calibration laboratory standard pressure.

For Intellution iFix, the calculation values are input by selecting an Ion Cal and Conv Cal button.

3.0 COEFFICIENT CALCULATION AND PROGRAMMING

The calculation and programming methodology is presented in the following paragraphs. After completion of this process, Attachment A shall be maintained as a quality record in accordance with the ETF Master List.

3.1 PROCEDURE FOR CALCULATING COEFFICIENTS

These steps may be performed immediately after the calibrated gauge returns from the calibration laboratory.

3.1.1. Start up Microsoft Excel on the computer where the pressure gauge calibration workbook is located.

3.1.2. Open the pressure gauge calibration workbook.

3.1.3. Select the worksheet for the gauge of interest.

3.1.4. Enter the data provided by the calibration laboratory into the worksheet.

3.1.5. Execute the macro command to perform the two linear regressions. The worksheet has an instruction telling how to invoke the macro command.

3.1.6. Save the workbook file. This ensures your work is not lost.

3.1.7. The required slope and intercept coefficients have now been calculated for this gauge.

3.1.8. Repeat 3.1.3 through 3.17 of this procedure for each gauge for which new calibration data is available.

3.1.9. Save the workbook file for further use by DAS.

3.1.10. Shutdown Excel.

3.2 PROCEDURE FOR USING COEFFICIENTS IN PACRATS DAS

These steps shall be performed following completion of Section 3.1 and prior to recording data on the test chamber DAS.

3.2.1. Note the serial number of the gauges installed at the chamber of interest.

3.2.2. Start up Microsoft Excel version 5.0 or later on the computer where the pressure gauge calibration workbook is located.

3.2.3. Open the pressure gauge calibration workbook.

3.2.4. Select the worksheet for the gauge of interest.

3.2.5. Note the slope and intercept coefficients for the gauge. There are four for each gauge; two for display pressure and two for standard pressure. These coefficients are slope and intercept values for display pressure and standard pressure.

3.2.6. Return to step 4 and continue the process for each gauge in the GP307.

3.2.7. Shutdown Excel without saving the workbook as no changes have been made to the pressure gauge calibration workbook.

3.2.8. On the DAS at the chamber, open the test file of interest for editing. The first file edited shall be the file labeled blanktest.tst and then any other test files required.

3.2.9. Locate the math conversion equations for the pressure gauges measurements of interest.

3.2.10. Type into the appropriate location for each calculation, those slope and intercept coefficient noted earlier. The voltage is multiplied by the slope, the intercept is added, the constant subtracted, and the result is used for the power of 10.

3.2.11. When all the calculated coefficients have been entered, save the test file.

3.2.12. Close the test file.

3.2.13. Record in the chamber log book the identification of the GP307 installed on the chamber, the date and time completed, and list for each gauge the coefficients entered in the test file. Ensure that the voltage measurement leads from the data scanner are correctly connected to the GP307.

3.3 PROCEDURE FOR USING COEFFICIENTS IN INTELLUTION DAS

3.3.1 Start Intellution.

3.3.2 For chambers with an ion gauge, click on the Ion Cal button.

3.3.3 Enter the slope and intercepts values in the Ion Cal window and press Enter.

3.3.4 Close the Ion Cal window.

3.3.5 For chambers with a convectron gauge, Click on the Conv Cal button.

3.3.6 Enter the slope and intercept values in the Conv Cal window and press Enter.

3.3.7 Close the Conv Cal window.

As-run Buy-off Sheet for Pressure Gauge Coefficient Calculation and Programming

Gauge Calibration Tracking Number _____ Date _____

Controller Serial Number _____

Chamber _____

Standard Coefficients: Slope _____ Intercept _____

Attach this sheet to the hard copy of the coefficient calculation sheet and place both in the gauge calibration file.