Calibrate Rosemount 3051S Pressure Transmitter using HART Communicator

Tank Farm Maintenance Procedure

MAINTENANCE

USQ # Routine Maintenance

<table>
<thead>
<tr>
<th>Rev-Mod</th>
<th>Release Date</th>
<th>Justification</th>
<th>Summary of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-2</td>
<td>11/07/2018</td>
<td>Maintenance Request</td>
<td>Added Radiation and Contamination Control, Added new Figure(s), Added Attachment.</td>
</tr>
<tr>
<td>D-1</td>
<td>08/07/2017</td>
<td>PER 2016-2031</td>
<td>Added item to Section 4.1 three performance documents to Section 4.2, New Step5.1.1 and Sub steps 5.1.1.1 and 5.1.1.2, Attachment 1, Figure 5 and Records Section Update</td>
</tr>
<tr>
<td>D-0</td>
<td>09/22/2016</td>
<td>Periodic Review</td>
<td>Rework 1st and 3rd bullets @Step 5.1.4. Rework Steps 5.1.4, 5.2.1, 5.2.4, 5.2.5.2, 5.2.5.4, 5.2.8, 5.2.9, 5.3.2, 5.3.3.</td>
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<td>C-1</td>
<td>10/20/2014</td>
<td>CHAMPS Removal</td>
<td>CHAMPS removal, new records statement.</td>
</tr>
<tr>
<td>C-0</td>
<td>05/29/2013</td>
<td>Periodic Review</td>
<td>Removed vague phrases, worded note to step, and added clarification where applicable.</td>
</tr>
</tbody>
</table>

Table of Contents

1.0 PURPOSE AND SCOPE................................................................................................. 3
   1.1 Purpose............................................................................................................... 3
   1.2 Scope................................................................................................................. 3

2.0 INFORMATION........................................................................................................ 3
   2.1 General Information.......................................................................................... 3
   2.2 Terms and Definitions....................................................................................... 3

3.0 PRECAUTIONS AND LIMITATIONS...................................................................... 4
   3.1 Personnel Safety............................................................................................... 4
   3.2 Radiation and Contamination Control.............................................................. 4

4.0 PREREQUISITES ................................................................................................. 5
   4.1 Special Tools, Equipment and Supplies........................................................... 5
   4.2 Performance Documents..................................................................................... 5

5.0 PROCEDURE........................................................................................................... 6
   5.1 Obtain As-Found Data....................................................................................... 6
   5.2 Calibration......................................................................................................... 8
   5.3 Restoration....................................................................................................... 12
   5.4 Acceptance Criteria......................................................................................... 12
| 5.5  | Review ................................................................. | 12 |
| 5.6  | Records .................................................................... | 13 |
| Attachment 1 – Water Trap/Pressure M&TE ........................................................................ | 14 |
| Figure 1 – HART Communicator Test Connection ................................................................. | 16 |
| Figure 2 – Transmitter Data Flow and Calibration Options .................................................. | 17 |
| Figure 3 – HART Communicator Fast Key Sequence Menu ...................................................... | 18 |
| Figure 4 – HART Communicator Menu Tree ........................................................................... | 19 |
| Figure 5 – How the Trap Works ............................................................................................ | 20 |
| Figure 6 - Negative Pressure Connection ............................................................................ | 21 |
| Figure 7 - Positive Pressure Connection ............................................................................ | 22 |
| Attachment 2 - Calibration Instruction ................................................................................ | 23 |
1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instructions for Calibrating Rosemount Model 3051S Series Pressure Transmitter.

1.2 Scope

This procedure involves Rosemount Model 3051S Series Pressure Transmitter.

2.0 INFORMATION

2.1 General Information

2.1.1 To reset the Transmitter Sensor trim and Analog trim to “as shipped” factory settings perform the following:

- Recall factory Sensor Trim - Fast key sequence (1, 2, 3, 4, 1)
- Recall factory Analog Output - Fast key sequence (1, 2, 3, 4, 2).

2.1.2 HART communicator requires latest device description to access advanced device functions. If “software version” message is displayed on startup User must either select “no” and continue with only basic functions or install updated HART device description. If adjustment of advanced features is required and a HART with current software is not available, those features must be adjusted using Local Display Controls.

2.1.3 If the transmitter is bench calibrated with external power, a 250 ohm resistor must be placed in series with current loop to enable communication with the HART communicator.

2.1.4 See Figure 3 for HART Fast key sequences and Figure 4 for HART Communicator Menu Tree for Rosemount 3051S pressure transmitter.

2.2 Terms and Definitions

- URV - Upper Range Value
- LRV - Lower Range Value
- AO - Analog Output
- PV - Process Variable.
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 If a lock and tag is required during the performance of this procedure, perform Lockout/Tagout in accordance with DOE-0336, Hanford Site Lockout/Tagout Procedure.

3.1.2 Job specific protective equipment requirements should be addressed during the pre-job brief and be in accordance with TFC-ESHQ-S_IS-C-02. Failure to use protective equipment when working on or near energized systems could result in serious injury.

3.1.3 Comply with DOE–0359, Hanford Site Electrical Safety Program. An Energized Electrical Work Permit is not required when working energized parts that operate at less than 50 volts potential.

The maximum voltage encountered when connecting and disconnecting from terminal strips is less than 42.0 Vdc.

3.2 Radiation and Contamination Control

3.2.1 Work in radiological areas will be performed using a Radiological Work Permit following review by Radiological Control per the ALARA Work Planning procedure TFC-ESHQ-RP_RWP-C-03.
4.0 PREREQUISITES

4.1 Special Tools, Equipment and Supplies

The following supplies may be needed to perform this procedure:

NOTE - Measuring and test equipment used to collect qualitative data during performance of this procedure must meet the following requirements:

- Be within its current calibration cycle as evidenced by an affixed calibration label
- Be capable of desired range and tolerance per Data Sheet

- HART Communicator
- 250 Ohm precision resistor @ 1%, ½ watt
- Digital Multimeter (DMM), 3.5 digit, 0.25% accuracy (if performing Digital-to-Analog trim, two (2) DMMs will be used [see Figure 1])
- Power Supply, 10.5 to 42.4 Vdc (e.g., Transmation)
- Druck Pressure Calibrator, or equivalent
- Water trap device (Figure 5)
- Other tools, equipment and supplies as identified by Shift Manager/OE/FWS/User.

4.2 Performance Documents

The following documents may be needed to perform this procedure:

- Rosemount Reference Manual, 00809-0100-4801, Rev CA
- Radiological survey plan
- Waste planning checklist
- Pressure M&TE vendor manual.
5.0 PROCEDURE

5.1 Obtain As-Found Data

5.1.1 IF performing this procedure on a system that has the potential for free liquids or moisture to enter the Pressure M&TE, USE a water trap device.

5.1.1.1 ENSURE the Water Trap is installed in a vertical position to operate correctly. (Figure 5)

5.1.1.2 IF liquids or moisture gets into the Water Trap or Pressure M&TE REFER to Attachment 1.

5.1.2 IF performing this procedure on a system that is potentially contaminated, FOLLOW Calibration Instructions. (Attachment 2)

5.1.3 IF any step is not required for procedure completion, RECORD “N/A” in the applicable space(s) on the Data Sheet AND DOCUMENT explanation in the Data Sheet’s Comments/Remarks section.

5.1.4 REMOVE pressure transmitter from service.

5.1.5 CONNECT AND INITIALIZE Test Equipment as follows:

5.1.5.1 CONNECT DMM #1 (mAdc) in series with negative terminal, observing proper polarity (ref Figure 1).

5.1.5.2 CONNECT HART Communicator in parallel on current loop for input pressure reference as applicable.

5.1.5.3 CONNECT power supply and 250Ω load resistor.

5.1.5.4 CONNECT pressure source to transmitter Hi pressure side AND VENT Low pressure side to atmosphere.

5.1.6 APPLY input pressure values per Data Sheet AND RECORD the following As-Found values on Data Sheet,

- PSIG readout at Local Display (PLC)
- As-Found loop current (4-20 mA) from DMM
- Pressure Low Alarm (PAL 008) at PLC (Raw Water) Display
- PSIG indication (PIC 008) at PLC Display.
5.1 Obtain As-Found Data (Cont.)

5.1.7 IF As-Found values are not within specified tolerance per Data Sheet, GO TO Calibration Section 5.2, OR

IF As-Found values are within specified tolerance, but deemed marginal, and optimization is desired, GO TO Calibration Section 5.2, OR

IF As-Found values are within specified tolerance, RECORD As-Found values in As-Left column of Data Sheet AND

GO TO Restoration, Section 5.3.
Calibrate Rosemount 3051S Pressure Transmitter using HART Communicator

5.2 Calibration

Choosing a Trim Procedure

NOTE - To decide which trim procedure to use, you must first determine whether the “analog-to-digital section” OR, the “digital-to-analog section” of the transmitter electronics need calibration.

5.2.1 CONNECT test equipment as given in Step 5.1.5, AND

ESTABLISH communication between the transmitter and the HART communicator.

5.2.2 APPLY Maximum input value per Data Sheet AND

COMPARE Applied Pressure to the Process Variable (PV) line at HART Communicator On-Line Menu.

5.2.2.1 IF PV reading does not match Applied Pressure, GO TO Full Sensor Trim, Step 5.2.4.

5.2.3 COMPARE Analog Output (AO) line, on HART communicator to the digital readout device.

5.2.3.1 IF AO reading does not match digital readout device, GO TO Digital-to-Analog Output Trim, Step 5.2.9.

Full Sensor Trim

NOTE - Full trim is a two-point sensor calibration where two end-point pressures are applied, and all output is linearized between them. The low trim value should always be performed first to establish the correct offset.

- An input pressure source that is as least three (3) times more accurate than the transmitter is required to meet the specified tolerances.

5.2.4 CONNECT test equipment as given in Step 5.1.5, AND

ESTABLISH communication between transmitter and HART communicator.

5.2.5 CALIBRATE sensor with a HART Communicator using the full trim function as follows:

5.2.5.1 FROM at HOME screen, INPUT Fast Key sequence (1, 2, 3, 3) for full trim (ref Figure 3) AND

SELECT 2: Lower sensor trim.
5.2 Calibration (Cont.)

Full Sensor Trim (Cont.)

5.2.5.2 ALLOW the input pressure to stabilize for 10 seconds before entering any values.

5.2.5.3 APPLY Minimum input pressure value per Data Sheet AND FOLLOW commands provided by HART Communicator to complete adjustment of the Lower Range Value (LRV).

5.2.5.4 STARTING at HOME screen, INPUT Fast Key sequence (1, 2, 3, 3) for full trim (ref Figure 3) AND SELECT 3: Upper sensor trim.

5.2.5.5 APPLY Maximum input pressure value per Data Sheet AND FOLLOW commands provided by HART Communicator to complete adjustment of the Upper Range Value (URV).

5.2.6 AFTER Full Sensor Trim has been completed, APPLY inputs values per Data Sheet AND CHECK output values for tolerance.

5.2.7 IF values are within tolerance per Data Sheet, RECORD As-Left values on Data Sheet AND GO TO Restoration, Section 5.3.

5.2.8 IF values are not within tolerance per Data Sheet, REPEAT Steps 5.2.4 through 5.2.7 twice to obtain tolerance.

5.2.8.1 IF values cannot be brought into tolerance, NOTIFY FWS for resolution AND STOP WORK until further directed.
5.2 Calibration (Cont.)

Digital-to-Analog Trim

NOTE - The Analog Output Trim commands allow adjustment of the transmitter’s current output at the 4 and 20 mA points to match Data Sheet values. This command adjusts the digital to analog signal conversion (ref Figure 2).

5.2.9 PERFORM a digital-to-analog trim with HART Communicator as follows:

5.2.9.1 FROM HOME screen, ENTER Fast Key sequence (1, 2, 3, 2, 1).

5.2.9.2 WHEN prompted by HART Controller, SET control loop to manual AND SELECT OK.

5.2.9.3 AT “CONNECT REFERENCE METER” prompt, CONNECT DMM #2 positive lead to positive terminal and negative lead to Test terminal in transmitter terminal compartment AND SELECT OK after Reference Meter is connected (ref Figure 1).

5.2.9.4 AT “SETTING FLD DEV OUTPUT TO 4 MA” prompt, SELECT OK.

5.2.9.5 RECORD actual output value from the Reference Meter (DMM #2) AND ENTER that value at “ENTER METER VALUE” prompt.

NOTE - HART Communicator prompts you to verify whether or not the output value equals value on the Reference Meter.

5.2.9.6 IF Reference Meter value equals transmitter output value, SELECT 1 (Yes) AND GO TO Step 5.2.9.7

OR

IF Reference Meter value does not equal the transmitter output value, SELECT 2 (No) AND

RETURN to Step 5.2.9.5.

5.2.9.7 SELECT OK at “SETTING FLD DEV OUTPUT TO 20 MA” prompt.
5.2 Calibration (Cont.)

**Digital-to-Analog Trim (Cont.)**

5.2.9.8 **RECORD** the actual output value from the Reference Meter AND

**ENTER** that value at “ENTER METER VALUE” prompt.

**NOTE** - HART Communicator prompts you to verify whether or not the output value equals the value on reversion meter.

5.2.9.9 **IF** Reference Meter value equals transmitter output value, **SELECT 1 (Yes) AND**

**GO TO** Step 5.2.9.10,

**OR**

**IF** Reference Meter value does not equal transmitter output value, **SELECT 2 (No) AND**

**RETURN** to Step 5.2.9.8.

5.2.9.10 **RETURN** control loop to automatic control AND **SELECT OK.**

5.2.10 **AFTER** the Digital-to-Analog Trim has been completed, **APPLY** inputs values per Data Sheet AND **CHECK** output values for tolerance.

5.2.11 **IF** values are within tolerance per Data Sheet, **RECORD** As-Left values on Data Sheet AND **GO TO** Restoration, Section 5.3.

5.2.12 **IF** values are not within tolerance per Data Sheet, **REPEAT** Steps 5.2.9 through 5.2.11 until values are within tolerance

**OR**

**IF** values cannot be brought into tolerance, **NOTIFY** FWS for resolution AND **STOP WORK** until further directed.
5.3 Restoration

5.3.1 IF any problems were encountered with calibration, INFORM FWS.

5.3.2 ENSURE Test Equipment information and calibration status are recorded on Data Sheet.

5.3.3 IF not already removed; DISCONNECT AND REMOVE Test Equipment.

5.3.4 ENSURE pressure transmitter has been properly valved in and returned to service.

5.3.5 ENSURE equipment system restoration by observing indications are consistent with expected conditions.

5.3.6 NOTIFY Operations that testing is complete and system may be returned to desired configuration.

5.4 Acceptance Criteria

Acceptance Criteria has been met when Steps in this procedure have been satisfactorily performed and As-Left values meet the specifications and tolerance(s) per the Data Sheet.

5.5 Review

5.5.1 INFORM FWS test is complete.

5.5.2 FWS REVIEW AND ENSURE the following:
- Completed Data Sheets meet the acceptance criteria
- Comments sections are filled out appropriately
- Work requests needed as a result of this procedure are identified and generated
- Work request number(s) of any work documents generated as a result of this procedure, are recorded in the Comments/Remarks section of the Data Sheet.
5.6 Records

This procedure is performed within a work package, as such, the procedure in its entirety will be maintained as a record per the Work Control process.

The record custodian identified in the Company-level Records Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Water Trap with Potentially Contaminated Liquid

1. If potentially contaminated liquid gets into Water Trap, Suspend the work.
2. Notify the FWS.
3. When provided approval from the FWS proceed as follows.
4. Remove Pressure M&TE from field.
5. Return to a RMA.
6. Disassemble the Water Trap.
7. Allow trap to dry overnight.
8. Survey disassembled trap components in accordance with Radcon survey plan.
9. If the Water Trap can be released return it to tool crib.
10. If the Water Trap cannot be released, dispose of it per waste planning checklist.

Water Trap with Clean Liquid (NOT Contaminated)

1. If clean liquid gets into Water Trap, disassemble the Water Trap.
2. Allow Water Trap to dry overnight.
3. Re-assemble the Water Trap.
4. Return the Water Trap to the tool crib.
Attachment 1 – Water Trap/Pressure M&TE (Cont.)

M&TE with Potentially Contaminated Liquid

1. If potentially contaminated liquid gets past water trap and inside Pressure M&TE, Suspend the work.

2. Notify FWS.

3. Wait for further directions.

M&TE with Clean Liquid (NOT Contaminated)

1. If clean liquid gets past the water trap disassemble and dry out Pressure M&TE per manufactures direction.

2. Return the M&TE to the tool crib.

3. Request the M&TE to be returned to NIST calibration lab for recalibration.
Figure 1 – HART Communicator Test Connection

NOTE: DMM #2 is ONLY connected and used if/when performing Digital-to-Analog Trim
NOTE - Value on PV line should equal the input pressure. Value on the AO line should equal the output device reading.

Data Flow Summarized in Four Major Steps as Follows:

1) A change in pressure is measured by a change in the sensor output (Sensor Signal).
2) Sensor signal is converted to a digital format that is understood by the microprocessor (Analog-to-Digital signal conversion).
3) Corrections are performed in the microprocessor to obtain a digital representation of the process variable input (Digital PV).
4) The Digital PV is converted to an analog value (Digital-to-Analog signal conversion).

The above figure also identifies the approximate transmitter location for each calibration task. Data Flows from left to right, and a parameter change affects all the values to the right of the changed parameter.
## Figure 3 – HART Communicator Fast Key Sequence Menu

<table>
<thead>
<tr>
<th>Function</th>
<th>HART Fast Key Sequence</th>
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<tbody>
<tr>
<td>Alarm Level Config.</td>
<td>1, 4, 2, 7, 7</td>
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<tr>
<td>Alarm and Saturation Levels</td>
<td>1, 4, 2, 7</td>
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<tr>
<td>Analog Output Alarm Direction</td>
<td>1, 4, 2, 7, 6</td>
</tr>
<tr>
<td>Analog Output Trim</td>
<td>1, 2, 3, 2</td>
</tr>
<tr>
<td>Burst Mode On/Off</td>
<td>1, 4, 3, 3, 3</td>
</tr>
<tr>
<td>Burst Options</td>
<td>1, 4, 3, 3, 4</td>
</tr>
<tr>
<td>Damping</td>
<td>1, 3, 6</td>
</tr>
<tr>
<td>Date</td>
<td>1, 3, 4, 1</td>
</tr>
<tr>
<td>Descriptor</td>
<td>1, 3, 4, 2</td>
</tr>
<tr>
<td>Digital to Analog Trim (4-20 mA Output)</td>
<td>1, 2, 3, 2, 1</td>
</tr>
<tr>
<td>Field Device Information</td>
<td>1, 4, 4, 1</td>
</tr>
<tr>
<td>Loop Test</td>
<td>1, 2, 2</td>
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<tr>
<td>Lower Sensor Trim</td>
<td>1, 2, 3, 3, 2</td>
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<td>Message</td>
<td>1, 3, 4, 3</td>
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<tr>
<td>Meter Configuration</td>
<td>1, 3, 7</td>
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<tr>
<td>Number of requested Preambles</td>
<td>1, 4, 3, 3, 2</td>
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<tr>
<td>Pressure Alert Config.</td>
<td>1, 4, 3, 5, 3</td>
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<tr>
<td>Poll Address</td>
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<tr>
<td>Poll a Multidropped Transmitter</td>
<td>Left Arrow, 4, 1, 1</td>
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<tr>
<td>Re-Mapping</td>
<td>1, 4, 3, 6, 4</td>
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<tr>
<td>Re-range- Keypad Input</td>
<td>1, 2, 3, 1, 1</td>
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<tr>
<td>Saturation Level Config.</td>
<td>1, 4, 2, 7, 8</td>
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<tr>
<td>Scaled D/A Trim (4-20mA Output)</td>
<td>1, 2, 3, 2, 2</td>
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<tr>
<td>Scaled Variable Config.</td>
<td>1, 4, 3, 4, 7</td>
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<tr>
<td>Self Test (Transmitter)</td>
<td>1, 2, 1, 1</td>
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<tr>
<td>Sensor Information</td>
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<td>Sensor Temperature</td>
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<td>Sensor Trim</td>
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<td>Sensor Trim Points</td>
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<tr>
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<tr>
<td>Tag</td>
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<tr>
<td>Temperature Alert Config.</td>
<td>1, 4, 3, 5, 4</td>
</tr>
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<td>Transfer Function (Setting Output Type)</td>
<td>1, 3, 5</td>
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<tr>
<td>Transmitter Security (Write Protect)</td>
<td>1, 3, 4, 5</td>
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<tr>
<td>Units (Process Variable)</td>
<td>1, 3, 2</td>
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<tr>
<td>Upper Sensor Trim</td>
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<tr>
<td>Zero Trim</td>
<td>1, 2, 3, 3, 1</td>
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1. Gas/Air enters through the top slot which goes into the chamber.
2. Dirt and Moisture particles are collected in the chamber, which is visible through the clear transparent glass window.
3. Then Gas/Dry Air goes into the centre slot where it enters the instrument.
Figure 6 - Negative Pressure Connection
Figure 7 - Positive Pressure Connection
Calibrate Rosemount 3051S Pressure Transmitter using HART Communicator

Attachment 2 - Calibration Instruction

**Positive pressure calibrations:**

Note: Vent Valve assembly is required on all positive pressure calibrations to ensure MT&E is not contaminated by venting potential process air back through MT&E.
Install vent valve assembly Per Figure 7
Ensure IV is open and VV is closed
Proceed with calibration per work package
  ➢ Whenever venting is required during calibration steps, vent stored pressure as follows.

NOTE- Valve IV can remain open when reading is required via M&TE.

Ensure IV valve is closed
Ensure VV valve is opened
Repeat sequence as necessary to complete the calibration.
After all steps are completed for the calibration, perform RCT survey release plan XXX

**Negative pressure calibrations:**

Note: use of surrogate filter is required for negative pressure calibrations to ensure MT&E is not contaminated by pulling process air into MT&E while drawing Vacuum.
Negative calibrations should be performed as follows.
Ensure surrogate filter holder has media installed.
Connect filter in-line per Figure 6
Ensure IV is open.
Pull a representative vacuum into MT&E through filter
Ensure IV is closed.
Vent through VV
RCT to perform survey of the media.
IF no contamination found remove surrogate filter holder/manifold and proceed with calibration.