

# Performing Automated EPA Audits using a DAS for the Thermo Scientific Model 81i Mercury Calibrator and Model 84i Permeation Source

Jeremy Whorton & Bryan Marcotte, Thermo Fisher Scientific, Franklin, MA, USA

## Key Words

- Mercury Calibrator,
- Permeation Source
- Mercury Freedom System
- Automated Audits
- Data Acquisition System (DAS)
- Emission System

## Goal

The following information explains how a user can externally perform an EPA Audit on their Thermo Scientific™ Model 81i Mercury Calibrator by means of the Modbus protocol using the Thermo Scientific™ Model 84i Permeation Source in the Thermo Scientific™ Mercury Freedom System.

Before initiating an EPA Audit to maintain NIST-traceability of a mercury (Hg) source (i.e. Model 81i mercury calibrator), it is up to the user to read and understand the “EPA Traceability Protocol for Qualification and Certification of Elemental Mercury Gas Generators” document. Also, for clarification, in this document “DAS” refers to Data Acquisition System. This can be a Programmable Logic Controller (PLC), Datalogger, or other control system such as a standard PC. These are typically used for compliance monitoring of mercury emissions of point sources.

All communication using Modbus is written to and read from the Model 80i Mercury Analyzer. Control of the Model 81i Calibrator and the Model 84i Permeation Source is achieved through the mercury analyzer. See Appendix C, “Modbus Addresses Supported”, in the most recently published Model 80i Analyzer manual for a list of all Write Coils, Read Coils and Read Registers. Also, the user should be familiar with the Model 84i Permeation Source manual. Specifically, Section 3 “Operation,” which



explains how to calculate and determine whether an audit passes or fails.

When using a DAS to run EPA audits, the Automatic Permeation Schedule should be Disabled in the Model 80i menu structure at the screen Calibration > Auto Permeation Sch.

In the event that Modbus is unavailable, this automation routine can also be performed using standard TTL style relay inputs and outputs located on the Model 80i Analyzer.

Please note that all communication via relay interface is between the DAS and the Analyzer. The DAS does not need to interface with the Calibrator or the Permeation Source instrument to perform this automated check.

## Basic Sequence of Events for Performing an Audit

1. Zero air sent from the Model 81i Calibrator to the Model 80i Analyzer for at least 10 minutes.
  - A. Perform a Zero Background adjustment
2. Span sent from the Model 81i Calibrator to the Model 80i Analyzer for 20 minutes.
  - A. Record span reading from the analyzer.
3. Permeation span sent from the Model 84i Permeation Source to the Model 80i Analyzer for 25 minutes.
  - A. Record span reading from the analyzer.
4. Calculate the Permeation/Generator ratio.

## Performing an EPA Audit through DAS using the Mercury Freedom System and the Model 84i Permeation Source via Modbus Commands

Note: In order to achieve the most representative span readings, the user may want to increase the averaging time. This can be done at the Model 80i Analyzer screen: Main Menu > Averaging Time.

1. Put the system in the Hg<sup>0</sup> only mode by activating and holding **Write Coil 101**. This will allow the user to perform the EPA audit more quickly compared to a system in speciation mode. This Write Coil should be activated for the entire duration of the audit. **Read Coil 2**, Hg<sup>0</sup> mode, will now be activated.
2. Turn on the Instrument Zero gas mode by activating and holding **Write Coil 104**. This will supply the zero air from the Model 81i Calibrator to the Model 80i Analyzer. Remain in this gas mode for 12 minutes. **Read Coil 6**, Instrument Zero gas mode, will be activated during this time.
3. Next, set the Zero Background of the Model 80i Analyzer by temporarily activating the **Write Coil 112** for at least two seconds. The Zero Background value at **Read Register 49&50** will be updated.
4. Deactivate Instrument Zero gas mode, **Write Coil 104**.
5. Select the desired Model 81i Instrument Span value by choosing the correct Instrument Span integer 1, 2 or 3. This is done by temporarily activating the Instrument Span integer **Write Coil 126, 127** or **128**. The Write Coil should be activated for at least 2

seconds and then can be deactivated.

6. Turn on the Instrument Span gas mode by activating and holding **Write Coil 105**. This will supply calibration gas from the Model 81i Calibrator to the Model 80i Analyzer. Remain in this gas mode for about 20 minutes. **Read Coil 7**, Instrument Span mode, will be activated during this time.
7. At the end of the 20 minutes, record the averaged Hg<sup>0</sup> concentration of the last three minutes from the **Read Register 1&2**.
8. Deactivate Instrument Span gas mode, **Write Coil 105**.
9. Turn on the Permeation Span mode by activating and holding **Write Coil 134**. This will supply span gas from the Model 84i Permeation Source to the Model 80i Analyzer. Remain in this gas mode for about 25 minutes. **Read Coil 53**, Permeation Span mode, will be activated during this time.
10. At the end of the 20 minutes, record the averaged Hg<sup>0</sup> concentration of the last three minutes from the **Read Register 1&2**. The audit is now finished.
11. To return the system to Sample mode, deactivate the Permeation Span mode, **Write Coil 134**. By default, the system will return to Sample mode if no gas mode Write Coils are activated.
12. Deactivate Hg<sup>0</sup> only mode, **Write Coil 101**. To return the system to Hg<sup>0</sup>/Hg<sup>T</sup> Speciation mode, use **Write Coil 103** (**Read Coil 4** will be activated). Or, to return the system to Hg<sup>T</sup> only mode use **Write Coil 102** (**Read Coil 3** will be activated).
13. Determine the Permeation/Generator Ratio. See the top of this document to locate documentation on how to calculate the Perm/Gen Ratio.

## Performing an EPA Audit through DAS using the Mercury Freedom System and the Model 84i Permeation Source via Discreet I/O Relay Commands

The procedure is the same as using Modbus, only each Modbus coil number should be assigned to available relay inputs on the Model 80i Analyzer. Consult the Model 80i manual for instructions on how to configure the digital inputs and outputs.

For more information, visit our website at [thermoscientific.com](http://thermoscientific.com)

© 2014 Thermo Fisher Scientific Inc. All rights reserved. All trademarks are the property of Thermo Fisher Scientific Inc. and its subsidiaries. Specifications, terms and pricing are subject to change. Not all products are available in all countries. Please consult your local sales representative for details.

**USA**  
27 Forge Parkway  
Franklin, MA 02038  
Ph: (866) 282-0430  
Fax: (508) 520-2800  
customerservice.epm@thermofisher.com

**India**  
C/327, TTC Industrial Area  
MIDC Pawane  
New Mumbai 400 705, India  
Ph: +91 22 4157 8800  
india@thermofisher.com

**China**  
+Units 702-715, 7th Floor  
Tower West, Yonghe  
Beijing, China 100007  
+86 10 84193588  
info.eid.china@thermofisher.com

**Europe**  
Takkebijsters 1  
Breda Netherlands 4801EB  
+31 765795641  
info.aq.breda@thermofisher.com

**Thermo**  
SCIENTIFIC

A Thermo Fisher Scientific Brand