

# Calibration vs. calibration verification: ICAL, ICV and CCV explained.

Three standards, three different questions. Treat them as one check  
and your calibration record stops answering the auditor.

## SUMMARY

The initial calibration builds the model. The initial calibration verification checks it against an independent source, and the continuing calibration verification checks that it still holds during the run. This paper sets out the purpose, source, timing and limits of each under EPA SW-846, the 2016 TNI standard and DoD QSM 6.0, and works a twenty-analyte CCV through the percent drift rule.

## THE SHORT VERSION

- 01 The ICAL builds the model, the ICV checks its standards against a second source, and the CCV checks it still holds.
- 02 Under Method 8260D, ICV recovery must fall within 70–130%, and CCV drift within 20%.
- 03 If more than 20% of compounds fail the CCV, stop and correct before you run samples.

## Three standards, three questions.

The sequence is loaded and the curve looks clean. Three standards sit near the top of the run, at similar concentrations, scored with similar arithmetic. It is easy to read them as three passes at one check.

An environmental GC/MS sequence usually opens with exactly these three: the initial calibration (ICAL), the initial calibration verification (ICV) and the continuing calibration verification (CCV). Each one answers a different question. Each one closes a different gap in the evidence that a reported result is correct.

FIGURE 1 Where each standard sits in an analytical sequence



## ICAL, ICV and CCV side by side.

|                          | ICAL                                                 | ICV                                                                 | CCV                                       |
|--------------------------|------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------|
| <b>Question answered</b> | What is the concentration-response model?            | Were the calibration standards made correctly?                      | Is the model still valid during this run? |
| <b>Standard source</b>   | Calibration stock                                    | Second source: different manufacturer or independently prepared lot | Same source as the ICAL                   |
| <b>Level</b>             | Five or more levels across the range                 | Within the calibration range                                        | Near the midpoint of the ICAL range       |
| <b>When</b>              | Before any samples; repeated when verification fails | After each ICAL, before samples                                     | Each analytical period or batch           |
| <b>Typical limit</b>     | RSD, $r^2$ or RSE, plus percent error at each level  | 70–130% of expected (8260D)                                         | ±20% drift or difference (8260D, QSM 6.0) |

Limits shown are from EPA SW-846 Method 8260D and DoD/DOE QSM 6.0. The determinative method and your lab's accreditation program set the limits that apply to a given analysis.

## The initial calibration builds the model.

The ICAL sets the model that turns response into concentration. Its criteria test that model: the RSD of the response factors, or  $r^2$  for a regression, and the error each standard shows when back-calculated against the curve.

Method 8000D requires at least five levels for a linear model. It limits the percent error of each standard to 30% <sup>[1]</sup>. The 2016 TNI standard requires a measure of relative error in every calibration: either RSE, or the relative error of the lowest and midpoint standards <sup>[3]</sup>. [Insights 02](#) covers the ICAL in more depth.

What the ICAL cannot test is whether its own standards were made correctly. A dilution error that runs through the whole stock gives a perfect-looking curve with the wrong slope.

## The initial calibration verification checks the stock.

The ICV closes that gap. It comes from a second source, independent of the calibration stock, and is quantitated against the new curve. If the curve and the second source agree, the standards behind the curve are confirmed.

Method 8260D asks for a standard from a second source to the calibration standard. It sets the limit at 70–130% of the expected concentration, and samples should not be analyzed for analytes that fail <sup>[2]</sup>. The 2016 TNI standard requires every initial calibration to be verified with a standard from a second manufacturer. A separate lot shown to be independently prepared also qualifies <sup>[3]</sup>.

So the second-source claim has to hold up on paper. If your records cannot show a different manufacturer or a documented independent lot, the ICV cannot confirm the stock.

## The continuing calibration verification checks the run.

The CCV asks a third question: is the curve built this morning still valid this afternoon? Detector response drifts with source contamination, column aging and temperature. The CCV uses the same source as the ICAL on purpose, so any difference reflects the instrument and leaves the standards out of it.

Method 8260D requires a CCV at the start of each twelve-hour analytical period, near the midpoint of the ICAL range. A compound is in control when its percent difference or drift is 20% or less <sup>[2]</sup>.

The 2016 TNI standard requires calibration verification at the start and end of each analytical batch, with exceptions for some internal standard methods <sup>[3]</sup>. DoD/DOE QSM 6.0 sets the CCV limit for GC/MS organics at ±20% of the true value. It widens that to ±50% for the end-of-batch CCV <sup>[4]</sup>.

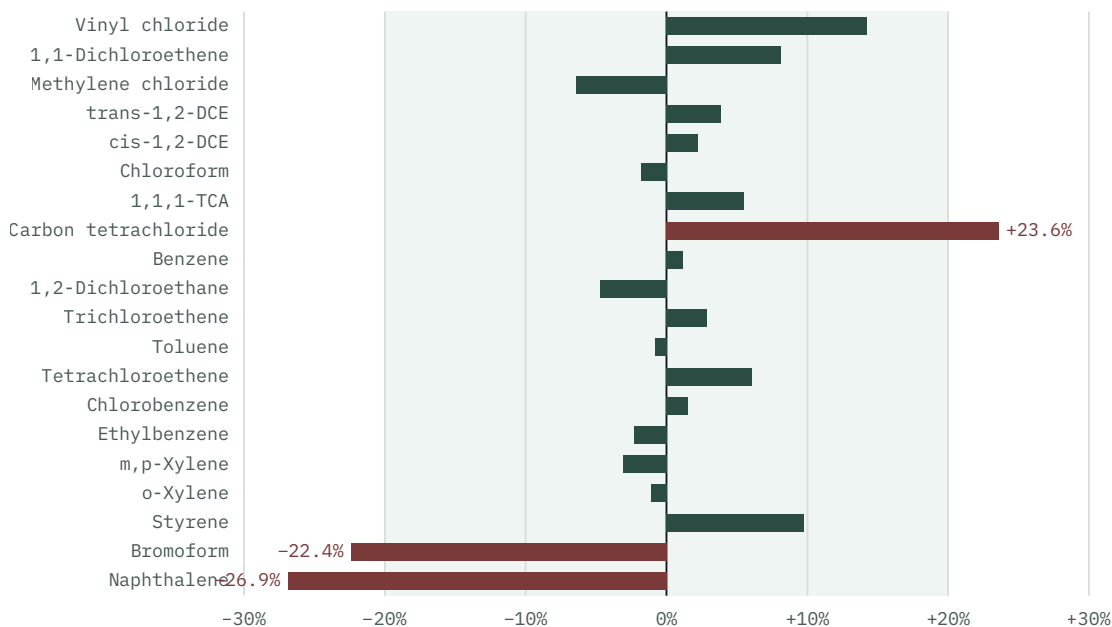
### PERCENT DRIFT

$$\% \text{ Drift} = 100 \times (C_{\text{calculated}} - C_{\text{expected}}) / C_{\text{expected}}$$

Used for regression calibrations. For average response factor calibrations, the equivalent is percent difference between the CCV response factor and the mean ICAL response factor.

## A CCV worked through the drift rule.

Method 8260D adds a rule for multi-analyte methods. If more than 20% of the compounds in the ICAL, or of those to be reported, exceed the 20% limit, you must take corrective action before samples are analyzed <sup>[2]</sup>. The chart below is a twenty-analyte volatiles CCV.

FIGURE 2 CCV percent drift by analyte,  $\pm 20\%$  limit shaded**3 of 20**ANALYTES OUTSIDE  $\pm 20\%$ **15%**

SHARE OF COMPOUNDS FAILING

**20%**

8260D THRESHOLD FOR STOPPING THE RUN

Illustrative CCV results constructed for this article.

3 of 20 analytes exceed 20%, which is 15% of the list. That sits exactly on the threshold. Under Method 8260D, the sequence may go on without corrective action for the whole run.

## A passing run can still carry failing analytes.

The three failing analytes are a separate matter. Carbon tetrachloride is biased high, while bromoform and naphthalene are biased low. Each must be handled under the method and your lab's qualification rules before any of its results are reported.

One more failure and the whole run stops.

## When the CCV fails.

When a CCV fails, the 2016 TNI standard allows corrective action and then a second, immediate verification. If that second CCV also fails, the lab performs a new initial calibration before analyzing new samples [3]. QSM 6.0 adds that the second CCV must run within one hour, with no samples in between [5].

Outside those two cases, a result reported against a failed CCV carries a qualifier.

## 01 Confirm the ICAL passed.

## 02 Prove the ICV is second source.

### 03 Check ICV recovery per analyte.

#### 04 Check CCV timing.

## 05 Count CCV failures.

## 06 Trace each failing analyte.

Every result is qualified, reanalyzed or covered by a documented exception.

WLTR is calibration data integrity infrastructure for regulated analytical laboratories. For each analyte, it derives nine calibration regression models: average response factor, plus linear and quadratic fits across four weightings each. It scores every model against fifteen ICAL parameters, including RSE. All of it is computed orthogonally to the CDS, under U.S. Patent 12,038,448 B2 [P].

## CALIBRATION VERIFICATION

See ICAL, ICV and CCV results for every analyte in one record, evaluated against your method's limits.

[GET COMPLIANCE GAP ASSESSMENT](#)

WLTR.TECH

## SOURCES

1. U.S. EPA, SW-846 Test Method 8000D, *Determinative Chromatographic Separations*, Revision 5, March 2018, Sec. 11.5. [www.epa.gov/hw-sw846/sw-846-test-method-8000d-determinative-chromatographic-separations](http://www.epa.gov/hw-sw846/sw-846-test-method-8000d-determinative-chromatographic-separations)
2. U.S. EPA, SW-846 Test Method 8260D, *Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry*, Revision 4, June 2018, Secs. 11.3.6 and 11.4. [www.epa.gov/sites/production/files/2018-06/documents/method\\_8260d\\_update\\_vi\\_final\\_06-11-2018.pdf](http://www.epa.gov/sites/production/files/2018-06/documents/method_8260d_update_vi_final_06-11-2018.pdf)
3. The NELAC Institute, 2016 TNI Environmental Laboratory Sector Standard, Volume 1, Module 4, Secs. 1.7.1.1 and 1.7.1.2, as reproduced in the New York State ELAP Chemistry Checklist, Revision 1, July 2023. [cfwww10-origin.wadsworth.org/sites/default/files/WebDoc/NYSELAP\\_ChemChecklist\\_Final\\_07262023.pdf](http://cfwww10-origin.wadsworth.org/sites/default/files/WebDoc/NYSELAP_ChemChecklist_Final_07262023.pdf)
4. DoD/DOE Consolidated Quality Systems Manual for Environmental Laboratories, Version 6.0, Table B-4, as published in QSM 6.0 Supplemental Information, Version 9, April 2026. [www.denix.osd.mil/edqw/denix-files/sites/43/2026/04/QSM-6.0-Supplemental-Information-Version-9-20260409\\_.pdf](http://www.denix.osd.mil/edqw/denix-files/sites/43/2026/04/QSM-6.0-Supplemental-Information-Version-9-20260409_.pdf)
5. DoD/DOE QSM 6.0, Module 4, Sec. 7.1.2, as reproduced in PJLA checklist LF-56, Revision 1.0, May 2024. [www.pjllabs.com/downloads/LF-56-DoD-DOE-QSM-60-M4.pdf](http://www.pjllabs.com/downloads/LF-56-DoD-DOE-QSM-60-M4.pdf)
6. U.S. Patent 12,038,448 B2, inventor Walter "Chip" Hinchman Sr. [patents.google.com/patent/US12038448B2](http://patents.google.com/patent/US12038448B2)

**Walter Hinchman, MBA**

WLTR, INC. • NEVADA C-CORP

WLTR