TECHNICAL GUIDE

ICV vs. CCV: Calibration Verification Explained

How initial and continuing calibration verification support ICP-MS and ICP-OES quality control

> **Quick Answer:** An ICV checks the initial calibration after it is established. A CCV checks that calibration remains acceptable during the analytical sequence. The exact source, concentration, frequency and acceptance criteria are method-specific.

About the EPA Method Examples in This Guide

The calibration-verification principles discussed in this guide apply across a broad range of ICP-MS and ICP-OES methods and laboratory applications. EPA Methods 200.8 and 200.7 are referenced throughout as practical, publicly available examples of how established analytical methods address initial and continuing verification of calibration performance. Their repeated use is illustrative and does not mean that ICV and CCV standards, the underlying quality-control concepts or the CPI products discussed are limited to these methods or to the analysis of water and waste samples.

Terminology and requirements for calibration verification vary among regulatory methods, consensus methods, industry procedures and laboratory-developed methods. Laboratories should confirm the required verification function, source, analytes, concentration, matrix, frequency, acceptance criteria and corrective actions using the analytical method, validated SOPs and quality system applicable to their work.

Calibration verification is not the same as calibration

ICP-MS and ICP-OES calibration establishes the relationship between known analyte concentrations and instrument response. Calibration verification evaluates whether that relationship is performing acceptably.

In routine laboratory language, two of the most common calibration-verification terms are ICV and CCV. They are closely related, but they answer different analytical questions.

- ICV means Initial Calibration Verification.
- CCV means Continuing Calibration Verification.
- Both are used to evaluate calibration performance, but they are typically analyzed at different points in the analytical sequence.
- The exact terminology, frequency, acceptance limits and source requirements should always be verified in the applicable analytical method and laboratory quality system.

For environmental metals analysis, EPA Method 200.8 is an ICP-MS method for determination of trace elements in waters and wastes, while EPA Method 200.7 is an ICP atomic emission/ICP-OES method for metals and trace elements in water and wastes. Both contain calibration and quality-control requirements, but their procedures should not be treated as universal rules for every ICP workflow.

ICV vs. CCV: quick comparison

Term	ICV	CCV
Full name	Initial Calibration Verification	Continuing Calibration Verification
Primary question	Did the initial calibration produce acceptable results?	Has the calibration remained acceptable during the analytical sequence?
Typical timing	After initial calibration and before routine sample reporting.	Periodically during the run and/or at method-defined points.
Function	Confirms the calibration before the analytical sequence proceeds.	Monitors calibration performance over time.
Source requirement	May require an independent or second source depending on the method/quality program.	Method-specific. Do not assume the same source requirement as the ICV.
Corrective action	Follow the applicable method/lab procedure if the verification fails.	Follow the applicable method/lab procedure to determine affected samples and corrective action.

What is an Initial Calibration Verification (ICV) standard?

An Initial Calibration Verification (ICV Standard is a known calibration-verification material analyzed after initial calibration to evaluate whether the calibration is producing acceptable results.

In practical terms, calibration establishes the concentration-response relationship. The ICV checks that relationship before the laboratory relies on it for sample results.

Depending on the method and quality system, the ICV may need to be prepared or obtained from a source independent of the standards used to establish calibration. This is often described as a second-source check. However, the source requirement should be verified directly in the applicable method rather than assumed.

What is a Continuing Calibration Verification (CCV) standard?

A Continuing Calibration Verification (CCV) Standard is a known calibration-verification material analyzed during an analytical sequence to evaluate whether calibration remains acceptable.

Even when the initial calibration and ICV are acceptable, instrument response can change during a run. Drift, matrix buildup, sample-introduction effects, contamination, memory effects and other changes can affect measurement performance.

The CCV provides a periodic check of calibration status. If a CCV result falls outside the applicable method or laboratory acceptance criteria, the laboratory should follow the required corrective-action procedure before reporting affected sample results.

When is each analyzed?

The timing is method-specific, but the concepts are straightforward:

- ICV is generally analyzed after the calibration has been established.
- CCV is generally analyzed periodically after sample analysis begins.

- Some methods also require calibration blanks, continuing calibration blanks, interference checks, laboratory control samples, spikes, duplicates or other QC materials at defined points.
- Do not transfer the frequency from one method to another without checking the current procedure.

For example, EPA Method 200.7 specifies calibration verification and calibration blank checks following daily calibration, after every tenth sample or more frequently if required, and at the end of the sample run. That requirement is specific to EPA Method 200.7 and should not be generalized to unrelated methods.

Do source requirements differ by method?

Yes. Source requirements can differ by analytical method, laboratory quality system, regulatory program and accreditation procedure.

The most important rule is simple: verify the source requirement in the method.

A method may specify that a quality-control sample or verification material be obtained from a source external to the laboratory and different from the calibration standard source. Other procedures may define calibration verification differently or use different terminology.

This is why product labels and purchasing descriptions should be matched to the method's actual requirement. A bottle labeled as a calibration verification standard may not automatically satisfy a method-specific independent-source requirement unless the documentation supports that use.

Why ICV and CCV are not interchangeable

ICV and CCV standards may contain similar analytes and concentrations in some workflows, but they are not interchangeable by name alone.

They differ because the analytical question is different:

- The ICV asks whether the calibration is valid before sample analysis proceeds.
- The CCV asks whether the calibration is still valid as the run continues.
- The method determines how each material must be prepared, documented, analyzed and evaluated.

Using the wrong standard or applying the wrong acceptance criterion can create avoidable QC failures, data review issues or regulatory questions.

How ICV and CCV fit into an ICP analytical sequence

> **Typical conceptual sequence:** instrument setup/tuning → calibration blank and calibration standards → initial calibration verification → samples and QC → continuing calibration verification → corrective action if required

Actual sample sequences should follow the applicable method and laboratory procedure. The conceptual sequence is useful for understanding function, but it is not a substitute for the method.

ICV and CCV in EPA Method 200.8 and EPA Method 200.7

EPA Method 200.8 defines calibration standards as solutions prepared from dilution of stock standards and used to calibrate instrument response with respect to analyte concentration. It also defines a Quality Control Sample as a solution of method analytes from an external source different from the calibration-standard source, used to check laboratory or instrument performance.

EPA Method 200.7 similarly defines the calibration blank and calibration standards and provides method-specific calibration-verification requirements for its ICP atomic emission workflow.

The important point for content and purchasing decisions is not that every ICP method uses identical terminology. The important point is that calibration, initial verification and continuing verification are separate functions. Each should be matched to the exact method requirement.

What should laboratories check before selecting an ICV or CCV?

1. Applicable method: Identify the method and revision being followed.
2. Analyte list: Verify which elements must be included.
3. Concentration: Confirm the required or appropriate verification concentration.
4. Matrix: Match the required acid matrix and diluent where applicable.
5. Source requirement: Determine whether an independent or second source is required.
6. Certification/documentation: Confirm whether a CRM, RM or other documented material is needed.
7. Acceptance criteria: Use the method or quality system criteria; do not create universal limits.
8. Frequency: Follow the method-defined points in the sequence.
9. Corrective action: Define what happens if the ICV or CCV fails before the run begins.

Common causes of ICV or CCV failure

A failed verification result does not automatically identify the root cause. It indicates that the calibration or measurement system no longer satisfies the applicable criterion.

- Incorrect standard preparation or dilution
- Wrong standard, analyte list, concentration or matrix
- Contamination in standards, blanks, labware, reagents or sample-introduction components
- Instrument drift or changing sensitivity
- Carryover or memory effects
- Matrix effects or physical interferences
- Spectral or polyatomic interference
- Degraded, expired or improperly stored standards
- Transcription or sequence setup errors

Laboratories should investigate according to the analytical method, instrument procedure and quality system before deciding whether recalibration, reanalysis, maintenance, dilution, preparation of fresh standards or other corrective action is required.

How CPI organizes ICP calibration verification products

Clear product categories help laboratories select the standard according to the analytical function it needs to perform.

- ICP Calibration Standards establish the concentration-response relationship.
- Initial Calibration Verification (ICV) Standards support initial calibration verification.
- Continuing Calibration Verification (CCV) Standards support ongoing calibration verification.
- Interference Check Standards support evaluation of potential interference effects.
- ICP Tuning and Setup Solutions support instrument setup and performance checks.
- Custom Inorganic Standards can be formulated around specific analytes, concentrations, matrices and volumes when a catalog formulation does not match the method.

For laboratories performing routine ICP-MS or ICP-OES analysis, separating these categories can simplify procurement, inventory management and method alignment.

Frequently asked questions

What is the difference between ICV and CCV?

An ICV checks the initial calibration after it is established. A CCV checks that calibration remains acceptable during the analytical sequence. Both verify calibration performance, but they are used at different points and may have different method-specific requirements.

When is an ICV analyzed?

An ICV is generally analyzed after initial calibration and before routine sample results are reported. The exact timing and acceptance criteria depend on the method and quality system.

When is a CCV analyzed?

A CCV is generally analyzed periodically during the analytical sequence and/or at method-defined points. Frequency is method-specific.

Does an ICV need to be from a second source?

Not universally. Some methods or quality systems require an independent or second-source verification material. Others may define requirements differently. Always verify the specific method and revision.

Is a CCV the same as a calibration standard?

No. A calibration standard establishes calibration. A CCV verifies that calibration remains acceptable. They may contain known analyte concentrations, but their analytical functions are different.

What happens if a CCV fails?

The laboratory should follow the applicable method and quality procedure to determine corrective action and which sample results may be affected. Do not report affected results until method requirements have been satisfied.

Can the same bottle be used for ICV and CCV?

Only if the method and laboratory quality system allow it and the standard's analytes, concentrations, matrix, documentation and source requirements are appropriate for both uses. Do not assume interchangeability from the label alone.

Key takeaway

> **ICV and CCV are both calibration-verification tools, but they answer different questions.** The ICV evaluates the initial calibration. The CCV monitors calibration during the run. The method, not the product category name alone, determines the required source, concentration, matrix, frequency and acceptance limits.

Standardize Your Standards

Select standards based on the method, instrument, analytes, concentration, matrix, documentation and QC function required by your laboratory.

CPI International supports analytical laboratories with ICP Calibration Standards, Initial Calibration Verification (ICV) Standards, Continuing Calibration Verification (CCV) Standards, Interference Check Standards, ICP Tuning and Setup Solutions, Single Element ICP Standards and Custom Inorganic Standards.

Explore CPI ICP Calibration Standards for ICP-MS and ICP-OES workflows.

References and source notes

U.S. EPA Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Revision 5.4. https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.8.pdf

U.S. EPA Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4. https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.7.pdf

EPA ESAM page for Method 200.8: Current EPA listing for Method 200.8. https://www.epa.gov/esam/epa-method-2008-determination-trace-elements-waters-and-wastes-inductively-coupled-plasma-mass

EPA ESAM page for Method 200.7: Current EPA listing for Method 200.7. https://www.epa.gov/esam/method-2007-determination-metals-and-trace-elements-water-and-wastes-inductively-coupled

Technical note: This guide intentionally avoids assigning universal QC frequencies or acceptance limits as those requirements depend on the applicable analytical method, method revision, regulatory program and laboratory quality system.