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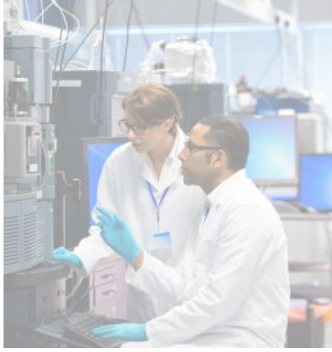

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MESSAGE FROM **IAS PRESIDENT**

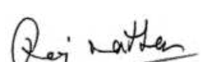
Dear Readers,

Looking back through past issues of this journal feels a bit like taking a trip through time. The articles and themes explored throughout earlier editions continue to resonate, often reappearing in new ways and contexts. Together, they form a continuum of ideas and insights, but In more recent issues, along with this continuity, there's a growing sense of urgency and reflection, influenced by rapid technological change, institutional shifts, and broader uncertainty in the world around us. In such times, publications like this play an especially important role. They provide practitioners with a forum not only to share real-world experience, but also to seek perspective, reassurance, and validation from peers.

From its inception, IAS established this journal with a clear purpose: to create a platform where practitioners can exchange insights drawn from practice, and where readers are encouraged to actively engage with those contributions. That mission remains unchanged. We invite our readers to read thoughtfully, respond critically, and contribute their own perspectives—helping to sustain an ongoing and meaningful professional dialogue.

As we continue to strengthen and refine the themes explored in these pages, we are also pleased to welcome a group of distinguished experts who have agreed to serve on our editorial advisory group. Their experience and judgment, combined with the dedication of our editorial team, will help ensure that the journal continues to expand its reach, deepen its relevance, and serve the needs of our professional community.

Thank you for taking the time to read and engage with this issue. I hope you find it both thought-provoking and rewarding.



Raj Nathan

President
International Journal of Conformity Assessment (IJCA)
May 2026

MESSAGE FROM **IJCA EXECUTIVE EDITOR'S DESK**

Dear Readers,

As we face an ongoing evolution of conformity assessment practices, this edition of the *International Journal of Conformity Assessment (IJCA)* turns its attention to one of the field's most fundamental pillars: metrology. Here, we examine the critical role metrology plays in ensuring accuracy, consistency, and confidence in the work of testing and calibration laboratories, the cornerstones of global accreditation and quality infrastructure.

Metrology—as the science of measurement—is more than a technical discipline; it is the foundation of the trust we place in conformity assessment. Reliable measurement results help ensure product safety, validate environmental data and industrial processes, and underpin the competence of accredited testing and calibration laboratories. Accurate and traceable measurements provide the assurance needed by regulators, industry, and consumers alike.

Because metrology directly influences key quality indicators—such as measurement uncertainty, traceability to national or international standards, and the validity of test results—these elements are required under internationally recognized standards such as ISO/IEC 17025.

In this issue, we present a collection of articles exploring how modern quality infrastructure, spanning accreditation, metrology, calibration, proficiency testing, and external quality assessment, supports accuracy, safety, efficiency, and trust across diverse sectors.

Topics include the digital transformation of calibration management through the eTransCal system; the role of accreditation in economic diversification in the Gulf region; updated risk-based requirements for proficiency testing and interlaboratory comparisons; the importance of measurement traceability; the value of external quality assessment in improving diagnostic reliability; metrology's central role in conformity assessment; applications in sports; and the alignment of standards and regulations with sustainable development goals.

Across these articles, a shared narrative emerges: reliable measurement, robust accreditation systems, and consistent quality assessment processes are essential for safety, economic development, regulatory compliance, and trust—whether in laboratories, industries, sports, or national policy.

Thank you for your support and commitment to excellence in conformity assessment. We look forward to continuing this important conversation in the pages ahead.

Alberto Herrera
Executive Editor
International Journal of Conformity Assessment (IJCA)
May 2026

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USA

LETTERS TO THE **EDITOR**

Dear Editors,

I had the opportunity to review the article, "The Evolution of Quality Management in Laboratory Services" (V. Mishra et al., IJCA, Vol. 4). The article clearly traces the development of quality management in laboratory services and highlights key milestones, including ISO standards, CLSI guidelines, and regulatory frameworks such as CLIA, which form the foundation of modern laboratory quality practices.

The discussion of the integration of quality control, total quality management, and comprehensive quality management systems (QMS)—supported by automation, digital tools, and laboratory information management systems—is particularly valuable in illustrating improvements in reliability, turnaround times, and operational performance. However, the article could benefit from a more detailed examination of the practical challenges laboratories face in implementing and sustaining these systems, particularly in resource-limited settings.

While the authors effectively outline core QMS components—such as quality policy, document control, audits, corrective and preventive actions, training, equipment maintenance, customer feedback, and continuous improvement—the discussion would be strengthened by including real-world examples or case studies demonstrating how these elements are applied in practice and how barriers to compliance are addressed.

Overall, the article emphasizes the importance of sustained commitment to QMS and continuous improvement in meeting evolving clinical, regulatory, and patient-care demands. Expanding on implementation challenges and measurable outcomes would further enhance its practical relevance for laboratory professionals.

Thank you for publishing this article and for contributing to a broader understanding of the role of QMS in public health.

Best regards,

Burr Brown
Principal
BHB Consulting
Floral Park, New York

I had the opportunity to review the article *"Evaluation of the Capability of Generative AI to Interpret ISO/IEC 17025"* and would like to offer a brief comment.

The study effectively illustrates that generative AI systems may arrive at similar conclusions while relying on different lines of reasoning. In regulatory and accreditation contexts, this distinction is particularly significant, as conclusions must be supported by transparent, standards aligned justification to be defensible.

In this regard, the article highlights an important direction for further development. The personalized AI approach exemplified by L Squad demonstrates how domain specific training and specialization can substantially enhance the quality and reliability of AI generated responses. This focus on contextual alignment outlines a promising pathway for the responsible application of generative AI in technical and regulatory environments.

Thank you for publishing this contribution. I look forward to continued research addressing the role of specialized artificial intelligence in conformity assessment and related fields.

Marvin Arce
Environmental Engineer,
Lima, Peru

I would like to offer a brief professional perspective on the article *"Evaluation of the Capability of Generative AI to Interpret and Provide Guidance on the Application of ISO/IEC 17025 Standard"* by Diego Uribe (IJCA, Vol. 4).

From the standpoint of an auditor, the study underscores the value of training generative AI systems using well defined criteria and expert judgment. The results illustrate how a purpose configured model such as L Squad can effectively support auditors by identifying risks and opportunities and by contributing to process optimization, while clearly not replacing professional expertise or decision making responsibility.

The article would be further strengthened by extending the evaluation to include a broader set of questions or real world case scenarios. Such expansion would allow for a more comprehensive assessment of AI's practical utility as an auditing support tool, while reinforcing the principle that human judgment remains central to conformity assessment activities.

Thank you for publishing research that thoughtfully addresses both the potential and the limitations of artificial intelligence in technical and accreditation contexts.

Angela Huerto Santillan
ISO Lead Auditor / Quality Management Systems Consultant
Madrid, Spain

I would like to offer several technical observations regarding the article *"Evaluation of the Capability of Generative AI to Interpret and Provide Guidance on the Application of the ISO/IEC 17025 Standard."*

The paper presents a relevant and innovative approach by examining the use of generative artificial intelligence in the interpretation of ISO/IEC 17025:2017. The methodology is generally well structured, and the results are presented with clarity. However, certain aspects of the study may affect the objectivity and generalizability of its conclusions and therefore merit further consideration.

There appears to be a potential conflict of interest arising from the dual role of the author as both developer and evaluator of the customized AI model (L Squad). While this circumstance does not invalidate the findings, it introduces a risk of bias that would benefit from explicit disclosure and appropriate mitigation measures.

Additionally, aspects of the experimental design may have inadvertently favored the evaluated model. The L Squad system was specifically configured and trained to respond in alignment with the ISO/IEC 17025 standard, whereas the comparator tools are general purpose models without equivalent domain specific fine tuning. Similarly, some evaluation criteria, most notably those related to criteria based comprehension, closely align with the capabilities for which the customized model was optimized. Furthermore, limited detail regarding the assessment instrument (including question selection, coverage of the standard, and difficulty level) restricts the reproducibility of the study.

The absence of independent or blind evaluation, together with a lack of fully equivalent testing conditions across the compared models, suggests that the results should be interpreted with appropriate caution.

From a perspective consistent with the principles of impartiality, transparency, and risk management, future work in this area would be strengthened by explicitly declaring potential conflicts of interest, incorporating independent evaluation mechanisms, ensuring equivalent comparative conditions, and providing full transparency regarding the assessment instruments used.

In conclusion, the article represents a valuable and timely contribution to the discussion on the application of generative AI in technical and regulatory contexts. Nonetheless, the considerations outlined above suggest that the findings should be viewed as exploratory and context dependent, and that additional research is warranted to further substantiate the conclusions.

Thank you for the opportunity to provide these comments.

Sincerely,
M.Sc. Jonathan Tuya Salas
Lima, Peru

Thank you, Jonathan, for your thoughtful feedback and for taking the time to review the article.

The use of L Squad's specific configuration was intentional and central to the study's objective. The research aimed to assess whether a model tailored to ISO/IEC 17025 could produce responses more closely aligned with the normative framework than general purpose tools, rather than representing an unintended advantage.

With respect to reproducibility, all models were assessed using the same 40 question instrument under consistent prompting conditions. I agree, however, that providing the full question set and greater detail on scope and difficulty would enhance transparency and reproducibility in future studies.

Regarding impartiality, my role as both the developer of L Squad and the author of the study presents a potential source of bias that should be acknowledged. While this does not invalidate the results, it does warrant careful interpretation. To mitigate this risk, reference answers were developed through consensus among five subject matter experts, and identical evaluation conditions were applied across all models. Nonetheless, future work would benefit from independent or blinded evaluation.

Thank you again for your valuable observations, which are helpful in clarifying the study's scope and informing future research.

Diego Uribe
Lima, Peru

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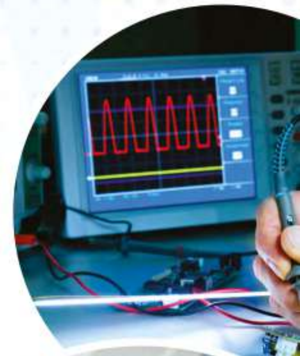

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Calibration Laboratory Accreditation Program

Digital Transformation of Calibration Data Management: Implementation and Impact of the eTransCal System at TransCal Technologies LLP

By **V. Vijayakumar**, Executive Technical Director, TransCal Technologies LLP, Bangalore

GENERAL INFORMATION

DOI: 10.55459/IJCA/v5i1/VV

Keywords: *Calibration management; Digital transformation; ISO/IEC 17025; ISO/IEC 17025 compliance; eTransCal; Database management; Traceability; Calibration workflows; Cloud-based calibration tools; Digital record-keeping; Quality assurance*

ABSTRACT

Manual calibration data management is highly vulnerable to errors, duplication, and delays and often poses significant challenges for compliance with ISO/IEC 17025 requirements. TransCal Technologies LLP implemented the cloud-based eTransCal system to centralize calibration data, digitize workflows, and improve traceability across its laboratory operations. This article describes the motivation behind the digitization initiative, outlines the design and core functional elements of the eTransCal platform, and discusses its impact on data accuracy, operational efficiency, and customer transparency.

Key improvements achieved through the system include automated certificate generation, role-based access controls, real-time job tracking, and the elimination of repeated manual data entries. Since its implementation in January 2017, eTransCal has contributed to a 30% reduction in turnaround time and a 40% reduction in certificate errors, supporting faster service delivery and improved data reliability. The customer portal further enhances accessibility by allowing users to monitor service requests, view calibration statuses, and download certificates directly, and the system's effectiveness has been recognized through positive client feedback and external recognition.

This paper presents an overview of the implementation process, summarizes lessons learned, and highlights the broader relevance of digital tools for strengthening quality systems in accredited calibration laboratories.

INTRODUCTION

Accurate, reliable, and traceable data management is essential for calibration laboratories operating in accordance with ISO/IEC 17025. Yet many laboratories still rely on manual or semi-manual systems to record service requests, calibration data, instrument movement, and certificate details. These manual processes—often dependent on spreadsheets, paper registers, or decentralized file structures—can introduce inconsistencies, delay turnaround times, and make compliance with ISO/IEC 17025 requirements more difficult.

To address these challenges, TransCal Technologies LLP implemented eTransCal, a cloud-based platform designed to centralize data, automate routine steps, and support end-to-end traceability for both internal staff and customers. The eTransCal software, developed by ACTouch as the original equipment manufacturer (OEM), was adopted to reduce human error, strengthen data integrity, and improve workflow efficiency across all stages of the calibration process.

Digitization has since played a critical role in enhancing operational transparency, enabling real-time tracking of calibration activities, and ensuring secure, audit-ready documentation. The experience at TransCal Technologies LLP illustrates how a well-structured digital platform can support more consistent, efficient, and reliable calibration services in an accredited environment.

Challenges in Manual Database Management

Before adopting a digital system, TransCal Technologies LLP relied on traditional manual processes to record, store, and retrieve calibration information. While familiar, these methods introduced operational limitations and compliance risks. Common issues included:

1. **Data Entry Errors:** Manual entry increases the likelihood of typographical mistakes, duplicated entries, and missing information. Re-entering the same data across multiple forms or registers further raises the risk of human error
2. **Time-Consuming Processes:** Updating records, retrieving files, and cross-checking information requires significant staff time and slows down workflow efficiency.
3. **Data Inconsistency:** Maintaining uniformity across paper files, spreadsheets, and decentralized folders is difficult. Multiple versions of the same information may exist simultaneously.
4. **Difficulty in Data Retrieval:** Searching for specific details within large volumes of paperwork or unstructured digital folders is cumbersome and can delay reporting or certificate issuance.
5. **Limited Data Security:** Physical registers can be misplaced, damaged, or accessed by unauthorized individuals. There is no inherent protection, encryption, or user-friendly control
6. **Data Storage Issues:** Paper records require physical space and face risks of deterioration, water damage, pest exposure, and accidental loss.
7. **Lack of Backup and Recovery:** In the event of loss, fire, or system damage, manual records cannot be restored, and no automated backup exists.
8. **Challenges in Data Analysis and Reporting:** Generating summaries, statistics, or audit-ready reports is labor intensive and prone to mistakes.
9. **Compliance and Audit Difficulties:** Manual systems often lack timestamps, revision histories, and traceability, making it harder to meet ISO/IEC 17025 documentation and audit requirements.

TransCal Technologies LLP staff also faced practical daily workflow problems, such as record retrieval delays, difficulty tracking which instruments were at which stage, inconsistent file naming, and risk of unauthorized access to sensitive calibration data.

Comparison of Manual and Digital Database Management

A comparison of manual and digital database management highlights how many of these limitations can be mitigated through an integrated software-based approach. Table 1 summarizes the key differences between traditional manual handling of calibration records and the functionality enabled by a digital system, such as eTransCal.

Aspect	Manual Database Handling	With Software / Digital Database
Data Entry	Prone to human errors, duplication, missing data	Automated checks, validation rules reduce errors
Time Efficiency	Very time-consuming to update and retrieve	Quick entry, search, and retrieval
Data Consistency	Difficult to maintain uniformity across records	Centralized system ensures consistency
Data Retrieval	Manual search is slow and cumbersom	Instant filtering, sorting, and querying
Security	Physical files can be lost, stolen, or accessed by anyone	Role-based access control and encryption
Storage	Requires large physical space, risk of damage	Stored electronically, minimal space required
Backup & Recovery	No reliable backup, loss is permanent	Automated backup and easy recovery
Scalability	Becomes unmanageable as data grows	Easily handles large and growing datasets
Analysis & Reporting	Manual summaries, slow and error-prone	Automated analysis, real-time reports
Compliance & Audit	Difficult to trace, lacks version control	Timestamped, traceable, audit-ready

Table 1. Comparison of manual and software-based database management approaches.

These limitations underscored the need for a structured, centralized system capable of supporting consistent data entry, secure storage, traceability, and efficient workflow management. To address these gaps, TransCal Technologies LLP implemented eTransCal, a cloud-based platform that streamlines calibration activities and supports ISO/IEC 17025 compliance. The next section outlines the system's core functionalities.

Overview of the eTransCal System

The eTransCal platform was developed to centralize, organize, and streamline calibration-related information across TransCal Technologies LLP's operations. The system serves as a unified digital environment for managing instrument details, calibration histories, service schedules, certificates, customer records, and associated workflow documentation. By transitioning from paper-based and spreadsheet-driven processes to a structured digital platform, TransCal Technologies LLP sought to reduce errors, eliminate redundant data entry, and improve operational efficiency.

Key capabilities of the eTransCal system include:

- **Centralized Data Management:** Maintains a single, unified database for instruments, service requests, calibration activities, asset management, repair tracking, and external subcontracting records.
- **Automated Scheduling:** Tracks calibration intervals and due dates, reducing the risk of overdue activities.
- **Traceability Compliance:** Supports ISO/IEC 17025 traceability through structured data capture and complete revision histories
- **Certificate and Report Generation:** Produces calibration certificates, summaries, and audit trails automatically.
- **Secure, Role-Based Access:** Ensures data integrity and controlled access through user permissions and authentication protocols
- **Cloud-Based Functionality:** Enables remote access, digital approvals, and real-time workflow monitoring across locations.
- **Paperless Operation:** Reduces dependence on physical documentation and supports digital recordkeeping.
- **Backup and Recovery:** Provides automated backup and restoration options to prevent data loss.
- **Data Validation:** Applies automated checks to improve accuracy and reduce manual errors.
- **Efficient Retrieval:** Offers fast search and filtering capabilities for instruments, certificates, and job records.
- **Customer Portal Access:** Allows customers to log in, monitor the status of their instruments, view summaries, and download certificates directly.

By adopting the eTransCal platform, TransCal Technologies LLP has improved data reliability, enhanced workflow efficiency, and strengthened compliance with accreditation requirements, including a reported 30% reduction in turnaround time and a 40% reduction in certificate errors.

An overview of the system's multi-location workflow and the way data is accessed across departments is illustrated in Figure 1.

The diagram illustrates how the eTransCal platform supports centralized data access across TransCal Technologies LLP's operations. Service counters, laboratories, management personnel, remote offices, and onsite engineers all connect to the system through secure cloud-based pathways. This structure enables consistent real-time access to calibration records, job status, and customer information regardless of location.

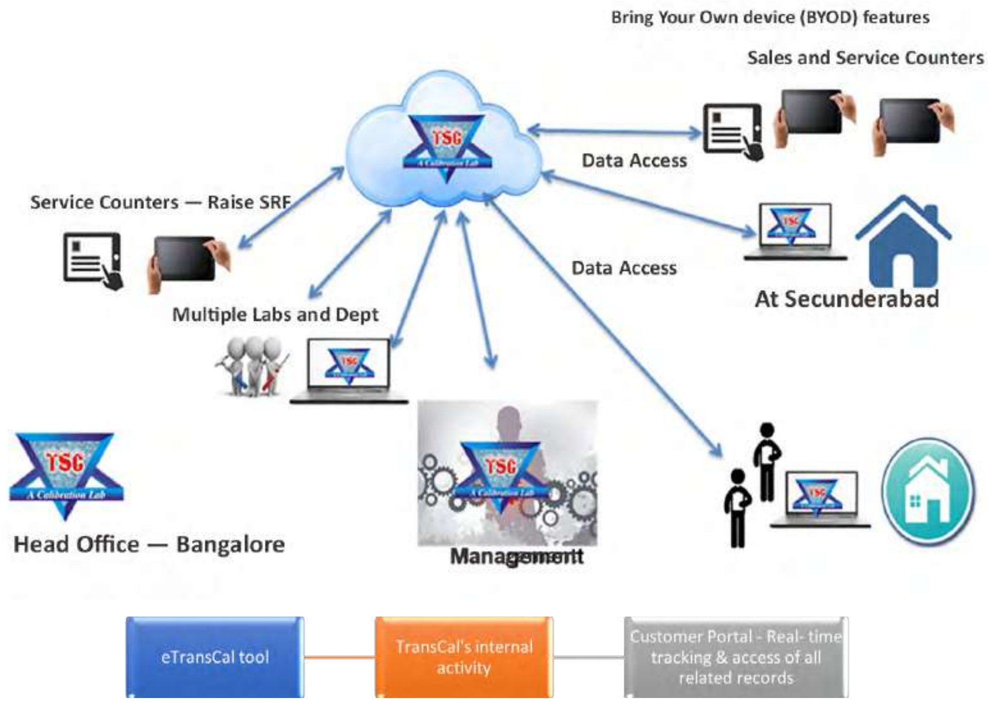

Figure 1. Overview of eTransCal's cloud-based workflow and data access structure.

Summary of Features of the Tool

1. Customer Relationship

- SRF Generation (new or against a confirmed order)
- Reject or accept instruments
- Generation and tracking of job work
- Transfer of instruments to laboratories
- Delivery of calibrated instruments after payment, with a delivery challan (DC), or delivery note, issued upon receipt of payment

2. Transactions, Certification, and Reports

- Ability to add multiple laboratories: Supports configuration across separate TransCal locations
- Creation of calibration procedures and output screens
- Calibration measurements, gauges, and procedures
- Conducting calibration work based on job work
- Tracking job work at each stage of operation (open, in progress, closed, etc.)
- Tracking instruments sent for repair or to outside parties
- Certificate preparation and approval
- Invoice generation
- Payment collection
- Generation of a delivery challan (DC) and dispatch of materials to customers
- Reports for tracking of items, instruments, and calibration details

3. Customer Portal (End Users Interface)

- Creation of user IDs and password controls for each customer
- Customer login access from TransCal's website to the eTransCal customer portal
- Ability to submit a service request form online and view a dashboard showing SRF status, instruments, invoices, and related information

Workflow Transformation and Process Mapping

Service Request and Job Workflow

To illustrate how service requests move through the eTransCal system—from customer intake through job workflow creation and laboratory assignment—Figure 2 summarizes the current process flow.

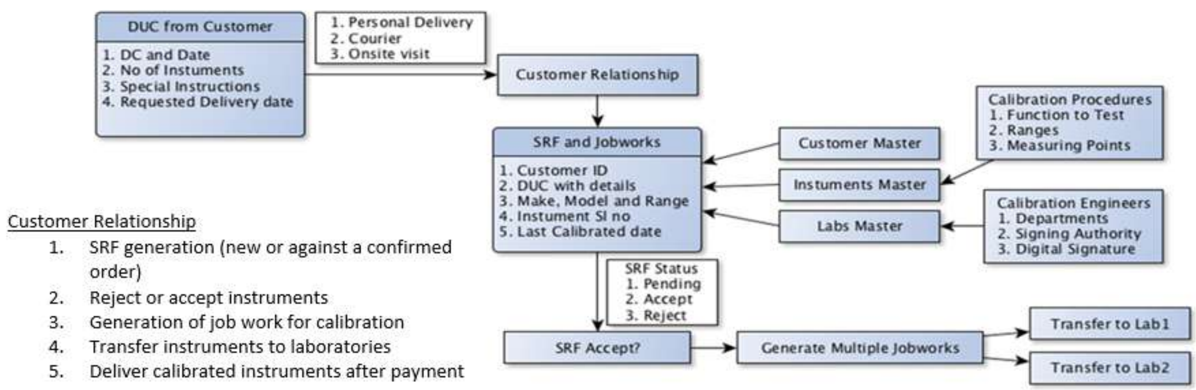

Figure 2. Process flow for service request (SRF) creation, job work generation, and laboratory assignment within the eTransCal system.

The diagram shows how a customer's delivery information (DUC) is received and entered into the service request form (SRF). Once SRF details are verified, the system determines whether the request is accepted, pending, or rejected. Accepted requests generate one or more job work entries, which are then routed to the appropriate calibration laboratory. Supporting information—including customer, instrument, laboratory, and calibration procedure data—is automatically integrated through linked master records within the eTransCal platform.

Internal Process – TransCal Technologies LLP

Figure 3 shows the internal workflow used by TransCal Technologies LLP to manage calibration activities, illustrating how job work moves through laboratory execution, measurement entry, review, approval, invoicing, and final instrument delivery.

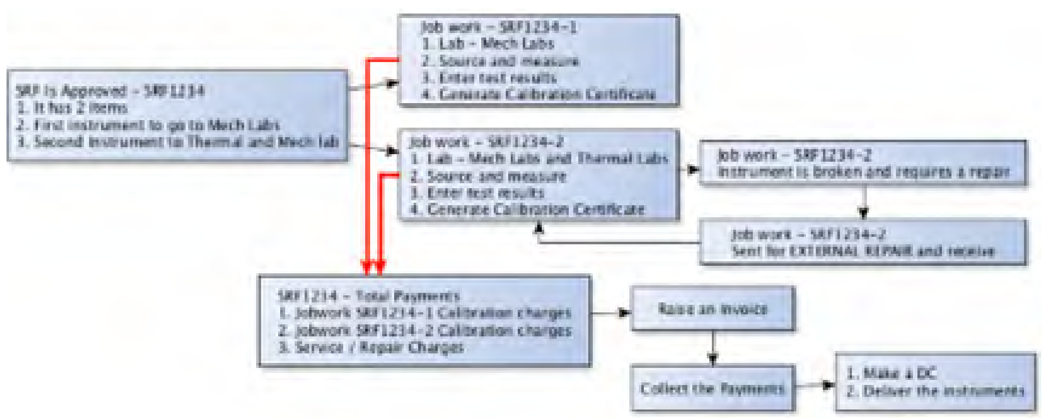

Figure 3. Internal process flow for calibration activities within TransCal Technologies LLP, including job work execution, repair routing, approval stages, and instrument delivery.

The diagram illustrates how approved service requests are divided into job work entries and assigned to the appropriate laboratories. Each job work step includes measurement activities, entry of test results, and certificate generation. Instruments requiring repair may follow an additional routing to an external service provider before returning to the main workflow. After job work is completed, charges are consolidated, an invoice is raised, and payments are collected. Finally, a delivery challan (DC) is generated and the calibrated instruments are returned to the customer.

Review and Approval Workflow

Figure 4 illustrates the review and approval workflow used in eTransCal, including certificate generation, correction routing, and supporting steps involved before the certificate is finalized.

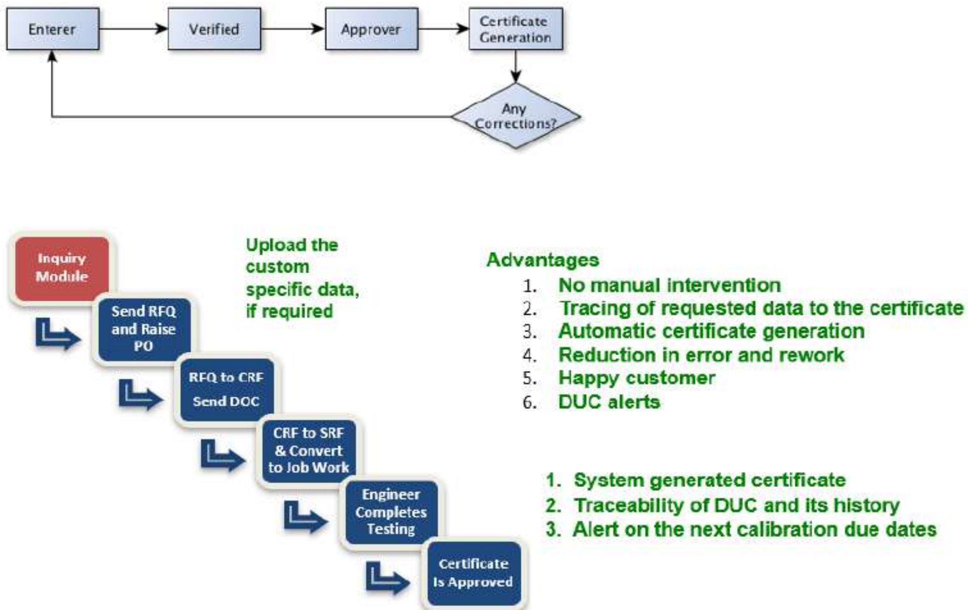

Figure 4. Review and approval workflow for measurement entry, verification, approval, and certificate generation within eTransCal.

The workflow illustrates how measurement data is entered, verified, and forwarded for approval before a certificate is generated. If corrections are required, the process loops back to the appropriate step until the information is validated. The sequence beneath the diagram highlights earlier workflow stages—including RFQ handling, job work conversion, and testing completion—along with advantages of automated tracking and alert features within the system.

System Dashboard and Navigation Overview

Figure 5 provides an example of the eTransCal home dashboard, showing the core calibration modules, common navigation tools, and real-time operational counts used by TransCal Technologies LLP staff.

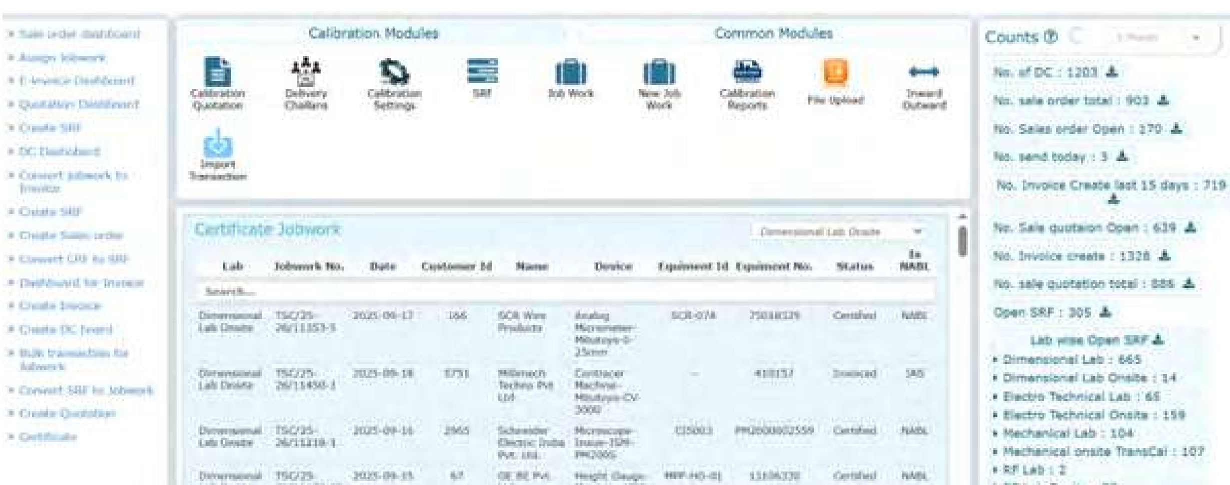

Figure 5. Home dashboard view within the eTransCal system, showing calibration modules, job work listings, and real-time operational metrics.

The dashboard displays all major calibration functions—including quotation generation, delivery challans, calibration settings, SRF creation, job work management, and reporting tools. The right-side panel provides real-time counts for open service requests, delivery challans, quotations, invoices, and lab-wise workload distribution. This interface serves as the central access point for staff to monitor activity, initiate transactions, and manage calibration workflows efficiently.

Workflow at TransCal Technologies LLP

Figure 6 illustrates the end-to-end workflow followed at TransCal Technologies LLP—from service request creation through job work assignment, report upload, verification, approval, digital signature, and final release to the customer.

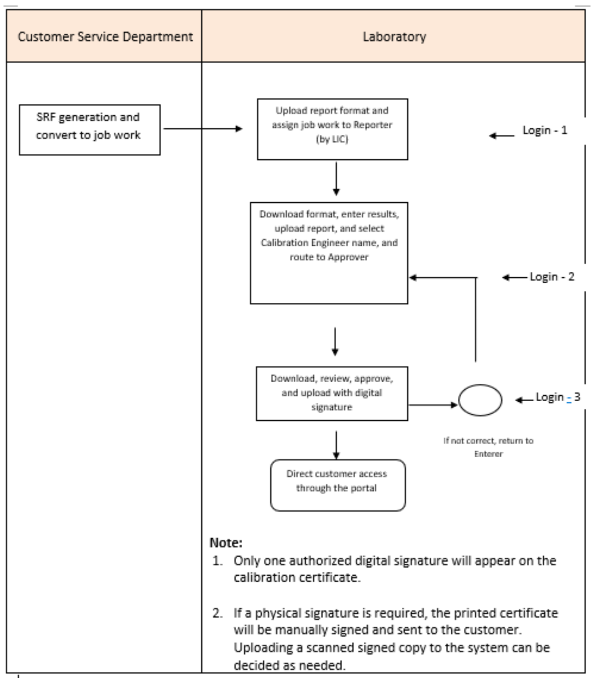

Figure 6. Workflow for job work assignment, report upload, verification, approval, and certificate release within the TransCal Technologies LLP laboratory process.

This workflow shows how the customer service department converts an SRF into job work, after which the laboratory uploads the required report format and assigns tasks to the appropriate personnel. Engineers enter measurement results, upload completed reports, and route them for approval. Approved reports receive a digital signature and are made available to customers through the online portal. The figure also illustrates the system's multiple login points for reporters, verifiers, and approvers, as well as notes regarding digital versus physical signature requirements.

Customer Portal Dashboard

Figure 7 provides an example of the customer portal interface, showing how users can submit requests, view RFQ status, and track quotation and CRF conversions.

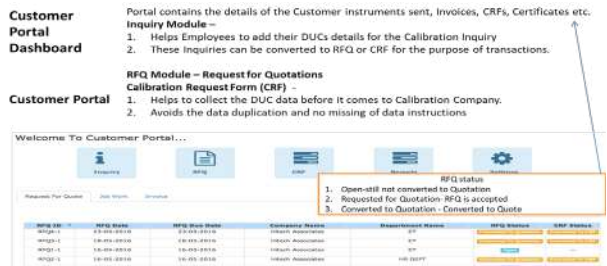

Figure 7. Customer portal dashboard showing RFQ listings, status tracking, and navigation options for inquiry, quotation, CRF, job work, and reports.

The customer portal allows users to submit and monitor RFQs, view conversion status (e.g., open, requested for quotation, converted to quotation), and track CRF updates. The top navigation icons provide access to key modules, while the tabular display lists RFQ details such as ID, date, company name, and current status. The summary/history of all activity is available in the "Reports" module. This interface enables customers to follow the progression of their requests and stay informed on outstanding actions.

Effectiveness

The eTransCal tool has been in use at TransCal Technologies LLP since 2017 and has significantly improved operational performance. The system enables faster service, immediate and accurate tracking, and greater overall reliability. Customers have noted increased transparency and consistency in the process, strengthening their confidence in the qualities of the organization's services

Strict access controls support data integrity and help prevent unauthorized changes. As a cloud-based platform, eTransCal allows staff to work seamlessly from onsite locations and monitor real-time progress across calibration activities.

By minimizing repeated data entry, the likelihood of human error is reduced. Master traceability certificates are maintained under controlled conditions, eliminating common issues associated with manual certificate handling. The system also provides value-added insights by offering customers a consolidated view of their calibration activities and convenient access to calibration certificates through the Customer Portal.

Recognition

The digitization of data management within TransCal Technologies LLP's operations has been well-received by customers, who value improved transparency, accuracy, and accessibility of information. The transition from manual record-keeping to a digital system has streamlined internal workflows and enhanced the overall customer experience.

GE Healthcare Quality Award – 2017

In 2017, TransCal Technologies LLP received the GE Healthcare Quality Award in recognition of the organization's sustained commitment to excellence, accuracy, and customer-focused service. This honor from a global leader in healthcare technology highlights the confidence placed in TransCal Technologies LLP's operations and affirms its dedication to maintaining high standards of quality.

The recognition also serves as a meaningful benchmark in the organization's development and reflects ongoing efforts to strengthen quality and operational performance.

Figure 8. GE Healthcare Quality Award presented to TransCal Technologies LLP in 2017.

Conclusion

The adoption of the eTransCal digital platform has strengthened the consistency, reliability, and traceability of calibration activities at TransCal Technologies LLP. By replacing manual record-keeping with an integrated, cloud-based system, the organization has reduced the risk of errors, improved data accessibility, and supported more efficient workflows across customer service, laboratory operations, and certificate management. These enhancements align with ISO/IEC 17025 expectations for documentation, control of records, and process traceability.

Customers have benefited from increased transparency, real-time access to information, and clearer visibility into calibration progress and history. As TransCal Technologies LLP continues to refine its digital processes, the system provides a foundation for ongoing quality improvement and future scalability.

References

ISO/IEC 17025:2017. *General requirements for the competence of testing and calibration laboratories. ISO standard.*

Notes

- **eTransCal** is a cloud-based laboratory information management system (LIMS) implemented by TransCal Technologies LLP to support calibration workflows, data management, certificate generation, and customer access.
- **ACTouch** is the software development vendor responsible for the development of the eTransCal platform.

Author Biography

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The Impact of Accreditation on Growth and Development in the Gulf Region

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GENERAL INFORMATION

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ABSTRACT

This article outlines the role of accreditation systems in supporting the economic development and strategic modernization of the Gulf Cooperation Council (GCC) countries. The Gulf region's economies have historically depended on oil but are now pursuing comprehensive national development visions, such as Saudi Vision 2030 and the UAE Vision 2030, aimed at diversifying economic foundations, attracting global investment, and boosting innovation. Accreditation emerges in this context as a key component of national quality infrastructure, supporting trade facilitation, consumer safety, regulatory confidence, and investment credibility as the region continues to integrate into global quality and trade systems.

1.0 INTRODUCTION

GCC countries are investing in industries such as healthcare, education, infrastructure, food production, and energy, aligning with sustainability and diversification targets. These new sectors demand credible systems of quality assurance to maintain consistency, safety, and international compatibility. Accreditation provides formal recognition of an organization's technical competence to perform specific processes, tasks, or tests in accordance with international standards. It functions as a core element of quality infrastructure, linking government objectives with the private sector, regulatory bodies, and consumers.

2.0 How Accreditation Drives Economic Development in the Gulf

Accreditation serves as a cornerstone of modern economic governance, particularly as Gulf countries transition toward knowledge-based, innovative-driven economies. Globally recognized quality standards help meet the needs of an expanding regional and international trade environment. Within this context, accreditation delivers tangible value in the Gulf across three interconnected pillars: standardization and global recognition, consumer safety, and regulatory compliance.

2.1 Standardization & Global Recognition

Accreditation aligns local practices with internationally accepted benchmarks, including those developed by:

- ISO (International Organization for Standardization)
- ASTM International (formerly American Society for Testing and Materials)
- Codex Alimentarius (food standards)
- API (American Petroleum Institute)

By adhering to these standards through accredited conformity assessment bodies (CABs), Gulf industries can:

- **Facilitate Export Readiness:** Goods and services tested or certified by accredited laboratories gain faster access to international markets through mutual recognition arrangements (MRAs) and reduced technical barriers to trade (TBTs).
- **Attract Foreign Investment:** Investors seek markets where compliance with global standards is demonstrable and independently verified.
- **Enhance Industrial Reputation:** Accreditation strengthens the brand image of Gulf-based industries, positioning them as reliable, high-quality producers on the global stage.
- **Support Industrial Diversification:** Standardized systems enable the emergence of new sectors—such as renewable energy, medical devices, and digital infrastructure—reliant on recognized conformity to international norms.

In essence, accreditation acts as the Gulf region's passport to global trade and industrial legitimacy.

2.2 Consumer Safety

Accreditation is an effective tool for consumer protection, a growing priority for GCC economies. The importance is amplified by rapid urban development and expanding markets for healthcare services, consumer products, food imports, and infrastructure development. Accreditation ensures that goods and services reaching end-users are:

- **Thoroughly Tested and Verified:** Whether it's drinking water, a medical device, imported cosmetics, or concrete used in high-rise construction, accredited testing helps ensure products meet stringent safety and quality parameters.
- **Reliable and Traceable:** Accredited organizations are required to maintain transparency, documentation, and repeatability—ensuring traceability in case of defects or recalls.
- A**ligned with Public Health Goals:** ISO 15189 accreditation of medical laboratories enhances diagnostic reliability, directly influencing patient outcomes, disease surveillance, and epidemic control.
- **Part of a Consumer Confidence Strategy:** Governments and businesses that demonstrate compliance with accreditation send a clear message of responsibility and credibility to the public.

In sum, accreditation activities help protect lives, preserve public health, and build trust—an essential factor in sectors such as pharmaceuticals, construction, and food safety.

2.3 Regulatory Compliance

Gulf nations are increasingly introducing advanced regulatory frameworks to meet international expectations and improve domestic governance. Accreditation supports this transformation by:

- **Providing Credibility to Regulators:** Regulatory agencies rely on accredited laboratories and certification bodies to enforce product standards, reducing the burden on government inspectors and improving overall efficiency.
- **Streamlining Business Processes:** Businesses working with accredited bodies benefit from clearer and more efficient pathways to licensing, certification, and export approval.
- **Reducing Legal and Financial Risk:** Accreditation lowers the likelihood of product failures, non-compliance penalties, recalls, and international trade rejections.
- **Supporting Mandatory Conformity Programs:** Several national schemes in the Gulf require accredited conformity assessments as part of their certification regimes, including SALEEM in Saudi Arabia, ECAS in the UAE, and KUCAS in Kuwait.

Additionally, regulatory alignment enabled through accreditation, including participation in ILAC and IAF MRA/MLA arrangements, allows Gulf countries to participate in multilateral trade agreements, harmonize intra-GCC regulations, and transition toward more unified market practices that bolster regional integration.

A Strategic Imperative: Together, these three pillars illustrate that accreditation is not simply a technical or administrative tool; it is a strategic necessity for the Gulf's ambition to become a global hub for quality manufacturing, healthcare, infrastructure, and innovation. It supports government policy, boosts public confidence, and enhances business competitiveness in both domestic and international markets.

3.0 Economic Value of Accreditation

Accreditation is more than a technical endorsement; it is a strategic economic asset that fuels sustainable growth, reduces systemic risks, improves quality of life, and enhances international credibility. Across the Gulf region's economic sectors, accreditation plays a pivotal role in ensuring that goods and services meet high standards of safety, reliability, and performance. The sections below illustrate how accreditation directly contributes to economic value across priority industries

3.1 Healthcare and Pharmaceuticals

The healthcare sector in the Gulf is undergoing rapid expansion, driven by population growth, rising healthcare demand, and government investment in medical infrastructure and biotechnology.

Medical Laboratories: Accreditation to international standards such as ISO 15189 (Medical Laboratories – Requirements for Quality and Competence) ensures the accuracy and reliability of diagnostic results. This strengthens clinical decision-making while reducing misdiagnosis, unnecessary treatments, and medical errors.

Pharmaceutical Manufacturing: Accreditation of Good Manufacturing Practices (GMP) and testing laboratories supports consistent product quality, which is essential for safeguarding public health and complying with global export regulations.

Public Trust and Medical Tourism: Gulf countries seeking to become regional hubs for medical tourism (e.g., the UAE and Qatar) use accreditation to demonstrate hospital quality, infection control, and patient safety—key criteria for international patients and insurers.

Cost Efficiency: Accredited healthcare facilities can reduce costs associated with malpractice claims, treatment failures, and public health crises by supporting early, accurate, and standardized interventions.

3.2 Construction and Infrastructure

With multibillion-dollar infrastructure projects such as NEOM (Saudi Arabia), Lusail City (Qatar), and Expo City (UAE), the Gulf's construction industry is among the fastest growing in the world. Accreditation plays a critical role in this sector by supporting quality, safety, and long-term performance across the built environment.

Material Compliance: Laboratories accredited to ISO/IEC 17025 test critical construction materials—including concrete, steel, insulation, etc.—to verify compliance with applicable safety, durability, and sustainability requirements.

Structural Integrity: Accredited inspection and certification bodies confirm that buildings, bridges, and public infrastructure meet local and international codes (e.g., British Standards, Eurocodes, ASTM), helping to mitigate risks related to structural failure, fire, and collapse.

Sustainable Building Practices: Green building programs such as LEED and Estidama often rely on data and verification from accredited energy and environmental testing labs, supporting climate objectives and energy-efficiency mandates.

Project Credibility and Investment Confidence: Accredited quality assurance processes enhance investor and developer confidence, facilitate regulatory approvals, and support timely, code-compliant delivery of infrastructure projects.

3.3 Food and Water Safety

As the Gulf region relies heavily on imported food while also investing in local agriculture and food processing, accredited conformity assessment is central to safeguarding public health and supporting international trade.

Food Testing Labs: Accreditation to ISO/IEC 17025 enables laboratories to test for pesticide residues, heavy metals, microbial contamination, and allergen presence in accordance with Codex Alimentarius, EU food safety regulations, and U.S. FDA standards.

Water Quality Monitoring: Accredited environmental laboratories support water safety by testing for chemical and microbiological contaminants in drinking water, desalination outputs, and municipal water supplies.

Export Readiness: Accreditation helps local producers meet stringent quality, safety, and labeling requirements in international markets—particularly in Europe, the United States, and Asia—thereby supporting food exports and diversifying revenue streams.

Public Health Assurance: Foodborne illnesses and contaminated water pose significant public health risks. Accreditation of testing services mitigates these risks by ensuring consistent, science-based safety controls and reliable monitoring systems.

3.4 Oil and Gas

The energy sector remains a cornerstone of the Gulf economy, and accreditation plays a central role in ensuring that oil and gas operations maintain high standards of safety, efficiency, and technical performance.

Equipment and Process Testing: Accredited facilities conduct critical testing of drilling equipment, pipelines, storage tanks, and refining systems in accordance with API, ISO, and ASTM standards, which minimizes operational failures and environmental risks.

Personnel Certification: Accredited certification of professionals—including welders, inspectors, and safety engineers—helps ensure that only qualified personnel operate in high-risk environments.

Environmental Compliance: Oil and gas operations are subject to stringent environmental regulations governing emissions, water discharge, and waste disposal. Accreditation supports reliable monitoring of these parameters through competent laboratory testing.

Market Access and Contract Qualification: International oil companies and government entities often require third-party accredited conformity assessments to validate quality and performance before awarding contracts or entering joint ventures. In this context, accreditation functions as a gateway to high-value commercial partnerships.

Measurable Impact Across Sectors: By embedding accreditation into industrial and service ecosystems, Gulf nations are reducing waste and rework, improving international trade performance, increasing returns on infrastructure investment, strengthening public health safeguards, and attracting foreign investment and specialized technical expertise. Each accredited test, inspection, or certification contributes to a more resilient, efficient, and trusted economy. These activities reinforce accreditation as a cornerstone of the Gulf's broader development framework.

4.0 Sectoral Impact of Accreditation in the Gulf

Accreditation serves an essential role in supporting industrial development across the Gulf Cooperation Council (GCC) nations. As these countries invest in diversified growth sectors, the ability to demonstrate compliance with international quality, safety, and sustainability standards has become essential. Across sectors, accreditation provides a trusted framework that enables operational reliability, effective risk mitigation, and participation in global markets.

4.1 Food and Agriculture

In a region characterized by harsh climatic conditions and heavy reliance on food imports, accreditation strengthens the food and agriculture sector:

- **Traceability and Quality Control:** Laboratories and certification bodies accredited to international standards ensure that food products—from raw agricultural inputs to processed goods—can be traced throughout the supply chain. This traceability is essential for managing food safety risks and responding effectively to contamination events or product recalls.
- **Export Market Access:** Gulf nations are seeking to expand food exports, particularly from emerging agricultural hubs in Saudi Arabia, the UAE, and Oman. Accredited compliance with standards such as Codex Alimentarius, ISO 22000, and HACCP (Hazard Analysis and Critical Control Points) is often a prerequisite for entry into regulated global markets, including the EU, the United States, and Japan.
- **Support for National Food Security Strategies:** Accreditation supports local food producers in meeting recognized quality and safety requirements. This strengthens investor and consumer confidence in domestic agricultural production and contributes to long-term food security objectives.

4.2 Water and Environment

Environmental sustainability is a central pillar of the Gulf's long-term development strategy, particularly in a region facing water scarcity, rapid urbanization, and climate-related pressures. Accreditation supports effective environmental governance and green initiatives by helping ensure that monitoring, testing, and reporting activities are technically competent, reliable, and internationally recognized.

Pollution Monitoring and Control: Accredited environmental laboratories measure air, water, and soil quality to detect pollutants and toxic substances in line with global benchmarks such as ISO/IEC 17025. These verified results play a central role in shaping public policy, enforcing environmental regulations, and managing industrial emissions and environmental degradation.

Sustainable Water Management:
Water scarcity remains a major challenge across the GCC. Accreditation ensures the reliability of testing for water treatment plants, desalination outputs, groundwater monitoring, and municipal water supplies—supporting public health protection and long-term water security strategies.

ESG and Green Finance Compliance:
Organizations seeking to meet Environmental, Social, and Governance (ESG) criteria or qualify for green financing must demonstrate verified environmental performance. Accredited testing, measurement, and reporting services provide the technical credibility required for sustainability disclosures and investor confidence.

Climate Adaptation and Reporting:
In support of international climate commitments, including the Paris Agreement, Gulf countries rely on data generated by accredited bodies to report emissions, implement mitigation strategies, and monitor environmental performance indicators. Accreditation ensures the integrity and comparability of this data across national and international platforms.

4.3 Construction and Building Materials

With significant investments in smart cities, transportation infrastructure, residential mega-projects, and large-scale commercial developments, construction remains a cornerstone of economic growth in the Gulf. Accreditation establishes consistent safety, quality, and sustainability requirements for construction activities.

Assuring Material Safety and Durability:
Testing laboratories accredited under ISO/IEC 17025 evaluate construction materials—including concrete, rebar, insulation, fireproofing, and structural steel—to confirm compliance with national building codes and international performance standards.

Reducing Structural Risk and Failure:
Accreditation ensures that inspection bodies and engineering consultants follow recognized best practices in design review, structural audits, and load-bearing assessments. This reduces the risk of catastrophic failures and enhances public safety across major infrastructure projects.

Supporting Building Regulations and Permitting:
Across the GCC, municipalities require test results from accredited laboratories as part of building permit and regulatory approval processes. Accreditation promotes consistency, transparency, and uniform application of construction standards.

Enabling Sustainable Urban Development:
Accredited testing supports green building certifications such as LEED, BREEAM, and Estidama, which are increasingly embedded within urban planning and smart city frameworks. These certifications contribute to improved energy efficiency, reduced environmental impact, and more resilient built environments.

4.4 Oil and Gas Operations and Energy Infrastructure

The energy sector remains the economic backbone of the GCC, and accreditation supports operational excellence, safety, and global credibility across oil and gas activities.

Standardized Testing for Equipment and Products:
Accreditation establishes confidence that testing for critical infrastructure—such as pipelines, valves, compressors, and drilling equipment—is conducted using consistent, globally recognized methodologies defined by organizations such as API, ISO, and ASTM.

Operational Safety and Risk Mitigation:
Accredited inspection bodies support oil and gas operators by verifying pipeline integrity, corrosion control measures, equipment reliability, and occupational safety compliance, thereby managing high-risk operational environments.

Supply Chain and Vendor Qualification:
National oil companies and international energy operators often require third-party accredited certification of components, materials, and service providers to maintain quality control across complex, multinational supply chains.

Support for Downstream and Refining Operations:
Within refineries and petrochemical complexes, accreditation underpins calibration services, emissions testing, quality assurance of chemical inputs, and compliance with hazardous materials regulations.

Enabling Investment and Joint Ventures:
Accredited compliance is a common prerequisite

for attracting international investors, partners, and insurers in large-scale oil and gas ventures. In public-private partnership (PPP) models, accreditation serves as a key enabler of commercial trust and risk management.

4.5 Building a Culture of Quality Across Industries

From agriculture to infrastructure and from environment to energy production, accreditation serves as a foundation for the Gulf region's development. By establishing consistent, internationally recognized frameworks for testing, inspection, and certification, accreditation supports the integration of quality, safety, and reliability across complex and rapidly evolving economic systems.

In practice, this cross-sector approach ensures that:

- **Products and services meet world-class quality standards**, supporting consumer confidence and international market access.
- **Processes are transparent, repeatable and reliable**, reducing variability, inefficiencies, and operational risk.
- **Economic activities align with safety, sustainability, and strategic goals**, reinforcing long-term policy objectives and regulatory coherence.

The sectoral impact of accreditation enhances national competitiveness while reinforcing the resilience and integrity of critical industries and global economic shifts and regulatory pressures.

5.0 Growth of Accredited TIC Services in the Gulf

The Gulf region is experiencing a rapid and sustained expansion of the Testing, Inspection, and Certification (TIC) industry, driven by ambitious national development strategies, expanding industrial activities, and increasing regulatory sophistication. As Gulf countries advance economic diversification and deepen integration into global markets, accredited TIC services have become essential infrastructure for ensuring that products, processes, and systems meet safety, quality, and international competitiveness requirements.

Industry projections indicate strong growth across the Middle East and Africa (MEA) TIC market. The sector was valued at approximately USD 12 billion in 2021 and is expected to reach USD 19 billion by 2030, representing a compound annual growth rate (CAGR) of about 4.9 percent. This growth reflects not only the expanding scale of economic activity across the Gulf, but also the increasing prioritization of quality assurance, regulatory compliance, and internationally recognized certification as strategic enablers of sustainable development and market access.

6.0 Key Drivers of TIC Growth in the Gulf

The rapid expansion of accredited Testing, Inspection, and Certification (TIC) services across the Gulf is being driven by a convergence of large-scale infrastructure investment, evolving regulatory frameworks, and increasing integration into global trade systems. Together, these forces are elevating accreditation from a technical function to a strategic driver of economic resilience, market access, and consumer trust.

6.1 Expanding Infrastructure and Mega-Projects

Gulf nations are home to some of the world's most ambitious construction and infrastructure developments, including:

- **NEOM (Saudi Arabia)** – a $500 billion smart city and industrial hub
- **Lusail City (Qatar)** – a futuristic urban center with advanced mobility systems
- **Mohammed Bin Rashid City (United Arab Emirates)** – a large-scale luxury residential and commercial development

These projects demand extensive TIC involvement across:

- Material testing and site inspections
- Mechanical and structural certification
- Environmental impact assessments
- Occupational health and safety auditing

Accredited TIC services are critical for managing risk, enabling compliance with international engineering standards, and improving access to financing from global investors and development partners.

6.2 Rising Regulatory Requirements and Government Reforms

Across the Gulf Cooperation Council (GCC), governments are implementing updated technical regulations, mandatory conformity assessment schemes, and national quality frameworks to strengthen product safety, regulatory oversight, and market confidence. Examples include:

- **SALEEM and SABER (Saudi Arabia)** – product safety and compliance systems administered by the Saudi Standards, Metrology and Quality Organization (SASO)

• **ECAS and Emirates Quality Mark (United Arab Emirates)** – mandatory certification and conformity assessment programs for consumer products

•**KUCAS (Kuwait), DGSM (Oman), and BSMD (Bahrain)** – national systems regulating imports and compliance with product safety requirements

As regulatory oversight and enforcement intensify, businesses increasingly rely on accredited TIC services to maintain market access and manage legal, financial, and reputational risk.

6.3 Enhancing Global Trade Competitiveness

Accredited TIC services play a critical role in reducing technical barriers to trade (TBTs) and enabling Gulf-based manufacturers and exporters to compete in regulated global markets. By aligning conformity assessment practices with internationally recognized standards, TIC services help ensure that products meet the regulatory and quality requirements of destination markets.

In practice, this includes:

- **Verifying conformity** with international standards and schemes such as ISO, IEC, Codex, and ASTM
- **Supporting mutual recognition agreements (MRAs)** that enable cross-border acceptance of test results and certifications
- **Helping local manufacturers qualify for export** to regulated markets in the European Union, United States, and Asia

This function is especially important as Gulf countries position themselves as global hubs for manufacturing, logistics, and re-exports. Export-oriented businesses depend on accredited TIC services to prevent delays, shipment rejections, and non-compliance penalties at international borders.

By facilitating smoother market entry and regulatory acceptance, accredited TIC services strengthen trade flows, enhance supply chain reliability, and reinforce the Gulf's integration into global trade systems.

6.4 Growing Demand for Consumer Protection and Transparency

Alongside regulatory evolution, consumer awareness and expectations for safe, high-quality, and ethically sourced products are rising across the Gulf. This shift is reflected in growing reliance on accredited conformity assessment to verify that:

- Food products are safe and traceable
- Consumer goods meet labeling and safety requirements
- Construction materials comply with fire resistance and durability benchmarks
- Pharmaceuticals are tested and manufactured under validated protocols

In parallel, retailers, insurers, and multinational brands increasingly require third-party, accredited conformity assessments as part of broader risk management and supply chain transparency strategies. These requirements further reinforce demand for accredited TIC services and strengthens confidence in products placed on the market.

6.5 Broader Economic Contributions of TIC Growth

Beyond its technical functions, the expansion of accredited TIC services generates a multiplier effect within the Gulf's broader economy:

• **Job Creation and Workforce Development:** Demand for skilled technicians, auditors, engineers, data analysts, and regulatory specialists supports employment in technical and STEM fields.

• **Support for R&D and Innovation**: Accredited laboratories provide the technical backbone for product development, prototype testing, and industrial innovation, fostering homegrown technologies and strengthening intellectual property protection.

• **SME Enablement and Market Access:** Access to accredited TIC services enables small and medium-sized enterprises to meet quality benchmarks, participate in public procurement programs, and compete in international markets.

• **Investment and Economic Confidence:** Robust conformity assessment systems strengthen investor confidence by reducing risk and signaling regulatory maturity.

6.6 Building a Future-Ready Quality Ecosystem

The expansion of accredited TIC services reflects a strategic transformation of the Gulf's economic foundation. By embedding accreditation at the core of industrial, regulatory, and export systems, Gulf countries are cultivating a future-ready, globally integrated, and innovation-driven quality ecosystem.

This ecosystem supports national development agendas such as Saudi Vision 2030 and UAE Vision 2030, while strengthening the region's position as a leader in global standards, safety, and excellence.

6.7 Regional Accreditation Programs and Bodies

Each GCC country has established national accreditation and conformity assessment frameworks designed to safeguard product quality, consumer safety, and international competitiveness. These systems oversee laboratories, inspection bodies, and certification agencies in alignment with recognized standards such as ISO/IEC 17025, ISO/IEC 17020, and ISO/IEC 17065.

Collectively, these national and regional frameworks reinforce regulatory enforcement, consumer protection, and international trade facilitation within the Gulf's quality infrastructure. They serve a dual purpose:

1. **National quality guardians:** ensuring products and services meet domestic regulatory, safety, and performance requirements.
2. **Global trade facilitators:** enabling exporters and manufacturers to access international markets through internationally recognized conformity assessment and certification.

Through participation in international accreditation arrangements and mutual recognition frameworks, these bodies strengthen trust in regionally issued certificates and test results. This cooperation reduces technical barriers to trade, enhances regulatory confidence, and supports smoother import and export processes across global markets.

Key accreditation and conformity assessment authorities operating across the GCC are outlined below, illustrating how each country structures its national quality infrastructure while aligning with shared regional and international standards.

Key Accreditation and Conformity Assessment Authorities in the GCC

Country	Key Authorities
Saudi Arabia	SASO (Saudi Standards, Metrology and Quality Organization) – Establishes national standards, manages conformity assessment schemes, and regulates product safety and labeling. SALEEM – A national product safety program under SASO. SABER – An electronic platform through which conformity assessments and certificates are issued.
United Arab Emirates (UAE)	ESMA (Emirates Authority for Standardization and Metrology) – Formerly responsible for technical regulations and conformity assessment; now operates under the Ministry of Industry and Advanced Technology. ECAS (Emirates Conformity Assessment Scheme) – Mandates product certification for regulated categories including electronics, cosmetics, food, and automotive products
Kuwait	PAI (Public Authority for Industry) – Oversees industrial policy, standardization, and conformity assessment activities. KUCAS (Kuwait Conformity Assurance Scheme) – Ensures that imported and locally manufactured products meet national safety and quality requirements.
Oman	DGSM (Directorate General for Standards and Metrology) – A department under the Ministry of Commerce, Industry and Investment Promotion responsible for national standardization and metrology services
Bahrain	BSMD (Bahrain Standards and Metrology Directorate) – Oversees standards development, market surveillance, and conformity procedures under the Ministry of Industry and Commerce.
GCC-wide Programs	G-Mark (Gulf Conformity Marking) – A regional conformity mark for low-voltage electrical equipment and children's toys sold in GCC markets. RCAS (GCC Rapid Alert System) – A regional alert mechanism for unsafe or non-compliant non-food products. VOC Programs (Verification of Conformity) – Used by many Gulf states to confirm that imported products comply with applicable technical regulations prior to market entry.

These national and regional frameworks form a central pillar of the GCC's quality infrastructure, supporting regulatory enforcement, consumer protection, and international trade facilitation.

Core Functions of These Agencies

- **Product and Equipment Testing:** Verifying items meet mechanical, chemical, and safety requirements before entering the market.
- **Conformity Certification:** Issuing accredited certificates that verify a product's compliance with relevant national and international standards.
- **Market Surveillance:** Monitoring and enforcing compliance through inspections, audits, and corrective actions.
- **Consumer Protection:** Reducing health and safety risks associated with substandard, non-compliant, or counterfeit goods.
- **Trade Facilitation:** Enabling smoother import and export processes by aligning national conformity assessment practices with international benchmarks.

By operating within internationally recognized accreditation frameworks and mutual recognition arrangements, these agencies significantly enhance trust in GCC-manufactured and imported products. They also protect consumers and businesses from unsafe or unverified goods, reinforcing the region's reputation for quality, safety, and regulatory credibility.

7.0 Challenges to Accreditation Adoption and Effectiveness in the Gulf

While accreditation systems have advanced significantly in recent years throughout the Gulf, several systemic and operational challenges still inhibit their full potential. These challenges affect how effectively accreditation supports national objectives in economic diversification, industrial modernization, and long-term trade competitiveness.

7.1 Regulatory Fragmentation Across the Region

Each GCC country has developed its own independent set of technical regulations, accreditation schemes, and enforcement practices. While this reflects localized needs, it also creates:

- Duplication of efforts for companies operating across multiple countries.
- Increased compliance costs due to differing documentation and testing requirements.
- Additional complexity for foreign investors who must navigate disparate systems within a unified economic bloc.

This fragmentation limits regional standardization, slows down mutual recognition of certificates, and reduces the efficiency of cross-border commerce within the GCC.

7.2 Limited Awareness and Access for SMEs

Small and medium-sized enterprises (SMEs), which make up most businesses in the region, often face:

- **Knowledge Gaps** – Many SMEs are unaware of the benefits of accreditation or how to begin the process.
- **Cost Barriers** – Certification, testing, and auditing can be expensive, especially for start-ups and small manufacturers.
- **Limited Institutional Support** – There are insufficient advisory services and funding mechanisms to support SME participation in accredited programs.

As a result, many SMEs miss opportunities to participate in public procurement, export markets, and industrial supply chains that require accredited compliance.

7.3 Capacity Constraints in Infrastructure and Human Resources

In several GCC countries, there is an imbalance between growing demand for TIC services and local capacity, including:

- Shortages of accredited testing laboratories in specialized areas such as environmental monitoring, biotechnology, and advanced materials.
- Limited availability of skilled professionals, such as laboratory technicians, auditors, and metrology specialists.
- Dependence on international providers, which may delay service delivery, increase costs, and limit local R&D and innovation.

This lack of capacity affects the timeliness, coverage, and accessibility of accreditation services, particularly in remote or underserved areas.

7.4 Lack of Harmonization Across National Systems

Despite regional efforts, such as the G-Mark initiative and GCC Standardization Organization (GSO), deeper harmonization of accreditation and conformity assessment processes remains limited. Challenges include:

• Inconsistent implementation of mutual recognition agreements (MRAs).

• Differing technical standards and testing methodologies.

• Lack of unified digital platforms for cross-border conformity verification.

These discrepancies hinder intra-GCC trade, complicate logistics and certification for exporters, and dilute the region's ability to present a coherent and unified quality system on the global stage.

The Path Forward

To unlock the full value of accreditation, Gulf nations must work toward a cohesive regional framework that:

• Encourages intergovernmental collaboration on mutual recognition and harmonization.
• Strengthens capacity-building programs for laboratories and technical personnel.
• Enhances public-private outreach and support for SMEs.
• Invests in digital infrastructure for accreditation management and market surveillance.

Overcoming these challenges will enable the GCC to develop a truly integrated, efficient, and globally respected quality assurance ecosystem—one that aligns with its long-term visions of economic leadership, innovation, and sustainability.

8.0 Conclusion

This paper demonstrates that accreditation is not optional; it is a strategic necessity for the Gulf region's economic diversification, industrial modernization, and global trade ambitions. As GCC countries pursue national development agendas aligned with long-term visions such as Saudi Vision 2030 and UAE Vision 2030, accreditation serves as a foundational mechanism for ensuring trust, safety, and international credibility across sectors.

To fully realize the value of accreditation, Gulf nations must prioritize coordinated investment and policy action in several key areas:

• **Encouraging accreditation adoption across sectors**, particularly among SMEs and export-oriented businesses, to broaden participation in regulated markets and global supply chains.

• **Expanding laboratory capacity and accredited TIC infrastructure** to meet growing domestic demand and reduce reliance on external service providers.

• **Aligning regional and global standards** to strengthen mutual recognition, facilitate trade, and reduce regulatory fragmentation.

• **Leveraging accreditation as a platform for innovation**, ensuring that research, advanced manufacturing, and high-technology services are developed in accordance with globally recognized best practices.

Taken together, these priorities point toward a regional culture of quality and trust powered by accreditation. Rather than acting solely as a consumer of global standards, the Gulf is increasingly positioned as a leader in quality infrastructure development—capable of shaping international norms, supporting innovation-driven growth, and meeting the evolving demands of the global economy.

Author Biography

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Measurement Traceability: Foundations, Practice, and Implications for Conformity Assessment

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ABSTRACT

Measurement traceability underpins confidence in conformity assessment by linking each measurement result to a recognized reference through a documented, unbroken hierarchy of calibrations with stated uncertainties. This article synthesizes practical guidance from accreditation and metrology practice to define metrological traceability (per BIPM VIM3), describe how it is realized and verified in accordance with ILAC and ISO/IEC 17025 principles, and assess its advantages and challenges for laboratories, regulators, and industry.

Terminology and Definitions

This terminology is consistent with VIM 3, the SI Brochure (post 2019), ISO/IEC 17025, and ILAC P10.

Metrological traceability: Metrological traceability is the property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty (VIM3: JCGM 200:2012). Notes to this definition also emphasize the need for an established calibration hierarchy, a clear specification of the reference (including time), and the traceability of all input quantities in a measurement model, as spelled out in ILAC P10:07/2020 document.

Reference: Basis against which a measurement result is related, such as a measurement standard, measurement procedure, or defining constant.

SI unit: Measurement unit defined by the International System of Units, based on fixed numerical values of defining constants.

Realization of an SI unit: Practical implementation of an SI unit definition using a primary measurement method, producing a quantity value with stated uncertainty.

Primary measurement method: Measurement method that realizes an SI unit directly from its definition without reference to a higher level standard.

Primary standard: Measurement standard obtained by a primary measurement method and having the highest metrological quality.

Reference standard: Measurement standard designated for the calibration of other standards within an organization.

Working standard: Measurement standard used routinely to calibrate or verify measuring instruments.

Measurement uncertainty: Non-negative parameter characterizing the dispersion of values attributed to the measurand, including residual systematic effects.

Dissemination of units: Process of transferring an SI unit value from higher to lower levels of the calibration hierarchy.

Measurement assurance: Systematic activities ensuring the ongoing validity of the measurement process and the accuracy of the standard used. As a fundamental requirement of metrology and conformity assessment, metrological traceability establishes and demonstrates the position of a measurement result within an unbroken and documented chain of calibrations, each contributing to the stated measurement uncertainty, and linking the result to appropriate national or international standards.

Traceability also provides the evidence that the unit of measure is embodied in relation to the measured quantity trail, measuring standard, measuring instrument or system, environment, method, operator, and all other components involved in the measurement process. It characterizes the overall measurement activity in a testing or calibration laboratory and, together with measurement uncertainty, indicates the laboratory's technical level in terms of equipment, personnel competence, and measurement capabilities.

The need for parts interchangeability—nationally and internationally—makes traceability to national standards, and ultimately to the International System of Units (SI), indispensable. To ensure compatibility, suppliers and end users must apply the same measurement system.

The *International Vocabulary of Metrology (VIM3)* further cautions that the term "traceability" is often used loosely for document or sample histories; when precision is required, the full-term *metrological traceability* should be used.

Traceability Chain	Evidence / Records (what to show)
Measurement Result (point of use) Application	Defined measurand / method Reported result + units Decision rule (if applicable)
Measuring Instrument Equipment	Calibration certificate Uncertainty (k, U) + conditions Instrument history / drift
Working Standard Lab standard	Certificate + unique ID Interval rationale Checks / control chart
Reference Standard Higher-level standard	Accredited provider scope Uncertainty & CMC evidence Intercomparisons / PT
Primary Standard (NMI) Top-level reference	NMI realization route Reference to SI definition Statement of traceability
SI Units Stated reference	Stated reference (SI) VIM3 terminology Traceability claim wording

Figure 1. Traceability Evidence Package (ISO/IEC 17025 + ILAC P10)

This text-only figure links the traceability chain to the minimum evidence typically reviewed during assessments (e.g., traceability statement, uncertainty, conditions, competence, and records control).

Note: If any element is missing (uncertainty, conditions, competence, or documentation), traceability is compromised.

Traceability implies uniform measurements: all measurements of the same quantity refer to the same measuring unit, verifying measuring instruments against established standards.

Measurement uniformity is realized by comparing the indications of a measuring instrument directly with the indication of an instrument that embodies the particular measuring unit (a reference standard) in accordance with its definition.

Traceability—also called the dissemination of measuring units—is the backbone of trustworthy measurement. It is the unbroken chain of comparisons that links any result back to a common standard, national or international. That chain can be traversed in both directions. It may begin at the point of use—an application on the factory floor or in a clinic—and ascend, step by hierarchical step, until it meets the national (primary) standard. Or it may be verified top-down, from the national standard through successive comparisons to the instrument that makes the application-level measurement.

Core Elements of Metrological Traceability

At each step in a traceability chain, measurement uncertainty must be evaluated and stated. Building on international consensus models, seven core elements are generally recognized as necessary to establish and maintain metrological traceability.

Unbroken chain of comparisons. A documented system of comparisons going back to a standard acceptable to the parties, usually a national or international standard. Each link in the chain compares an instrument or standard to a higher-level standard, continuing stepwise until reaching a national, international, or otherwise agreed reference. The relationship between successive links must be explicit, with no missing or assumed steps. In practice, this appears as a calibration hierarchy: working instruments → in-house standards → reference standards → national or international standards. Each calibration certificate in that chain must be available to demonstrate how the final result is connected back to the reference.

Measurement uncertainty. For each calibration step, uncertainty must be evaluated using recognized methods and reported together with the measurement result. These stepwise uncertainties combine to form the overall uncertainty associated with the lowest-level measurement in the traceability chain. Laboratories must maintain uncertainty budgets for their calibration services and ensure that the uncertainties from upstream calibrations are correctly imported and propagated. This allows end users to evaluate fitness for use and compliance with specifications.

Documentation. Implying complete, controlled records that describe the calibration or measurement process, conditions, and results. Every link in the traceability chain must be supported by documented and generally accepted procedures, as well as calibration reports that record what was done, who performed it, which equipment was used, environmental conditions, results, and associated uncertainties. Calibration certificates, standard operating procedures (SOPs), equipment records, and quality system documents form the documentary evidence of traceability. These records are reviewed during audits, accreditation assessments, and technical reviews.

Competence. Demonstrated ability of personnel and organizations to perform specific calibration or measurement tasks correctly and reliably. Technical competence includes qualified staff, appropriate facilities, properly maintained equipment, validated methods, and effective quality controls. It provides assurance that the documented procedures are actually implemented as intended. Evidence of competence may include staff training records, participation in interlaboratory comparisons or proficiency testing, and accreditation to relevant standards. Users rely on this evidence when selecting laboratories to support their traceability needs.

Realization of SI Units. The establishment of primary standards that embody the definitions of the SI units and serve as the ultimate references for the traceability chain. At the top of the chain, national metrology institutes or equivalent bodies realize SI units directly from physical phenomena or agreed realizations. These primary standards anchor the traceability chain and ensure global consistency of measurements. Calibration laboratories derive their reference standards from these primary realizations, either directly or via recognized reference laboratories. End users thereby obtain results that are compatible with the SI and comparable across borders and sectors

Periodic recalibration. Calibrations of standards (and equipment where appropriate) must be repeated at established and appropriate intervals to preserve the traceability of the standard over time and use. Calibration intervals are determined based on factors such as drift behavior, frequency and severity of use, environmental conditions, criticality of the measurement, and historical performance data. Regular recalibration confirms that measurement performance and uncertainty remain within acceptable limits. Laboratories establish and periodically review a calibration interval policy using a measurement assurance system. Records of recalibration, trends, and adjustments support decisions to tighten or extend intervals and are often examined during accreditation assessments or customer audits.

Measurement assurance. A systematic set of activities designed to ensure the ongoing validity of the measurement process and the reliability of reported results. A measurement assurance program must be established to ensure the validity of the measurement process and the accuracy of standard used.

Each comparison relies on valid calibration procedures and recorded results that show how the work was done, who performed it, the conditions of measurement, and the uncertainties achieved. Technical competence—qualified personnel, appropriate facilities, maintained equipment, and sound methods—is assuring that the written procedures are executed as intended. Typical tools include check standards, control charts, replicate measurements, interlaboratory comparisons, and proficiency testing that monitor bias, drift, and variability. A robust measurement assurance program allows early detection of problems that could affect traceability, such as unexpected bias or equipment malfunction. It supports decision-making about recalibration, method improvement, and corrective actions, and demonstrates that the laboratory maintains metrological traceability in day-to-day operation, not just on the calibration date. Every standard and instrument must have determined an interval of re-calibration that reflects drift behavior, usage, criticality, and historical performance. Those calibration intervals ensure that uncertainties remain within permissible bounds over time rather than only at the time of calibration.

Practical guidance extends these elements to include maximum permissible error/limits for application, the comparison method, and the expanded uncertainty of the comparison itself.

Because measurements ultimately express quantities in the International System of Units (SI), traceability also demands a clear realization of SI units at the top of the chain and consistent unit handling all the way down.

To ensure greater stability, universality, and to improve measurements, without changing the actual size of the units themselves, the International System of Units (SI) was redefined by no longer relying on physical artifacts defining all seven base units (second, meter, kilogram, ampere, kelvin, mole, candela) by fixed, fundamental physical constants, like the speed of light for length and Planck's constant for mass, effective May 20, 2019.

Another indispensable document for laboratory accreditation is ILAC-P10:07/2020 describing metrological traceability and providing consistent worldwide application.

Differences between national traceability documents and ILAC P10:07/2020

- Compared with ILAC P10, the International Vocabulary of Metrology (VIM, JCGM 200) is primarily terminological and conceptual: it defines metrological traceability as a property of a measurement result and introduces related concepts (e.g., traceability chain), but it does not prescribe acceptable traceability routes or the evidence an accreditation body should require.
- ISO/IEC 17025:2017 (Clause 6.5) elevates traceability to a competence requirement, yet it remains deliberately high-level about the practical hierarchy. ILAC P10 therefore acts as the operational bridge: it converts the concept into an accreditation policy by detailing acceptable routes (e.g., CIPM MRA-linked NMIs and ILAC MRA-accredited calibration laboratories), clarifying how uncertainty and capabilities are evaluated for fitness-for-purpose, and updating expectations for metrological traceability achieved through reference materials in line with developments in ISO 17034 accreditation of reference material producers.

National accreditation-body documents often adopt ILAC P10 as the technical baseline but diverge by adding economy-specific governance and assessment mechanics. For example, NIST's policy and FAQ (Frequently Asked Questions) are not an accreditation policy; they focus on how NIST measurement services support traceability claims and caution against the informal label "NIST-traceable," a provider-centric scope that is narrower than ILAC P10's harmonized accreditation intent. In contrast, UKAS TPS 41, IAS/TL/025, NATA's metrological traceability policy, Cofrac GEN REF 10, CLAS requirements, and similar AB policies largely mirror ILAC P10's routing logic, yet expand the practical "how" of demonstrating conformity: they specify certificate contents and review checks (e.g., stated uncertainty, reference standards, scope/CMC match), introduce additional expectations for calibration intervals and intermediate checks, and may explicitly couple traceability control with measurement uncertainty governance for testing laboratories.

Several policies extend beyond ILAC P10's generic, cross-economy framing by embedding traceability within national legal-metrology architectures or sector-specific guidance. Armenia's ARMNAB policy makes traceability elements explicit and defines internal calibration as a controlled activity that cannot be marketed as an accredited service, while Romania's RENAR P-05 tightens national context via Romanian-language controls and links to national metrology infrastructure. Russia's Rosaccreditation traceability policy, together with the measurement-uniformity framework in Federal Law No. 102-FZ and the national recommendation R 50.1.108-2016, introduces compliance layers largely absent from ILAC P10 (e.g., alignment to state-regulated measurement uniformity and national terminology/controls), thereby treating traceability simultaneously as an accreditation requirement and a state-governed metrological obligation. Elsewhere, policy emphasis can be purposefully tailored: SAC-SINGLAS 006 explicitly anchors reference material traceability to ISO 17034 and scheme documents; SAAC A-04-05 frames the objective as traceability to "international units"; and CNAS GL033 provides prescriptive, equipment-level traceability guidance for construction engineering that goes beyond ILAC P10's general policy scope.

We can also describe the continuous chain of traceability by identifying organized structure of levels of standards. The number of levels is not exhaustive and depends on the application.

Here is an example:

- *Level 0* are SI units defined by fixed numerical values of fundamental constants. Measurement uncertainty at this level is zero.
- *Level 1* is the national primary standard: the artifact, device, or realization with the highest metrological qualities in its field, based level zero materialization.
- *Level 2* holds the secondary standards, established by direct comparison with the primary. When a secondary is used to calibrate lower-order standards, it functions as a reference standard.
- *Level 3* contains third-order working standards, obtained by comparison with those reference standards. Working standards at this level verify ordinary instruments of lower accuracy or calibrate other working standards; when they do, they are treated as reference standards and conserved so that their comparisons back to Level 2 need not be frequent.
- *Level 4* comprises the broader population of working standards, themselves maintained by comparison to Level 3.

A good traceability chart makes this structure transparent. It identifies the standards at each level, documents their sources and certificates, and states the uncertainties—specifically the limits on freedom from bias, (the residual systematic error that may still be present) —that must not be exceeded as results are disseminated downward or verified upward. When the chart is combined with competent practice, scheduled re-calibrations, robust documentation, and a functioning measurement assurance program, the result is a measurement system whose numbers can be trusted—because they can be traced.

Why Traceability Matters in Conformity Assessment

As the "backbone" of a measuring system, traceability ensures uniform measurement across applications and markets and enabling acceptance of results beyond organizational or national borders. In practice, it functions as the unit's "genealogy" or "chain of custody," ending at the point of application in manufacturing, services, and legal metrology.

Within laboratory accreditation and certification ecosystems, traceability is an expectation under ISO/IEC 17025 and related schemes, and is intertwined with competence, suitable procedures, uncertainty, and periodic reassessment—key features of robust accreditation processes.

The following figure illustrates how these principles come together in practice by showing a typical mass traceability hierarchy, including levels of standards, comparison methods, uncertainties, and calibration intervals.

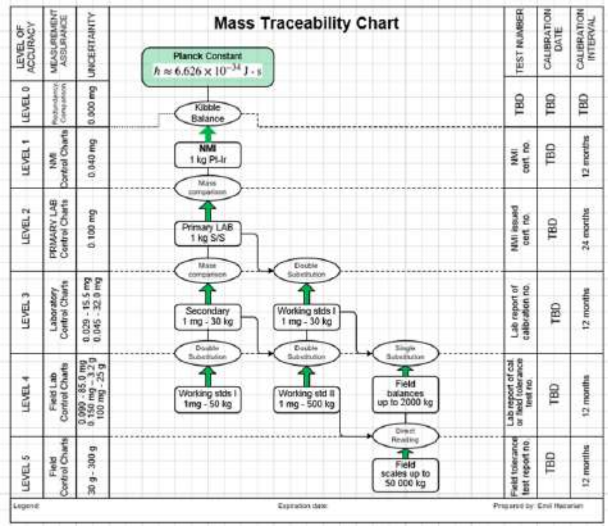

Figure 2. A proposed traceability chart satisfying quality, technical and accreditation requirements.

Note: Following the 2019 redefinition of the SI, the kilogram is defined by the fixed numerical value of the Planck constant (h) and realized through primary methods such as the Kibble balance. The International Prototype of the Kilogram (IPK) is no longer the defining reference and is retained solely for historical continuity and comparison.

Calibration Hierarchies and Charting Traceability

A **calibration hierarchy** (or *traceability chain*) typically flows from primary standards (Level 1), to secondary/reference standards (Level 2), to working standards (Level 3–4), and then to ordinary instruments at the application level. Effective charts document standards used, uncertainty budgets, measurement assurance, and calibration intervals at each level.

References and dissemination

Traceability may start "from the top down" (primary to application) or be verified "from the bottom up" (application to national standard). In all cases, adjacent elements and associated uncertainties must be identified and quantified.

Documentation and responsibilities

Calibration providers must supply traceability statements and uncertainty in reports; users must critically assess claims (e.g., by evaluating certificates, scopes, and competence). "Official test numbers" alone do not prove traceability; uncertainty and the documented chain do.

Provider. Providing support for the claim of traceability of the result of a measurement or value of a standard is the responsibility of the calibration provider. Calibration reports and certificates must contain a traceability statement.

User. Assessing the validity of a claim of traceability is the responsibility of the user of that result or value. Verifying claims of traceability often includes obtaining a calibration directly from a national metrology institute or another laboratory that has achieved recognition or accreditation through a recognized accrediting body.

Use of, or reference to, official test numbers of a national metrology institute. Having an authentic test number does not provide assurance or evidence that the measurement value provided by another organization is traceable. Not only must there be an unbroken chain of comparisons, but each measurement must be accompanied by a statement of uncertainty associated with the value. Test report numbers should not be used nor required as proof of the adequacy or traceability of a test or measurement. National and international standards dealing with test and measurement quality requirements, such as ANSI/NCSL Z 540-1, ISO 10012, ISO/IEC 17025 and the ISO 9000 series do not require the use or reporting of specific test numbers to establish traceability.

Relationship to Accreditation and Recognition

Accreditation bodies (e.g., NVLAP, IAS, ANAB, A2LA, UKAS) evaluate laboratory compliance against ISO/IEC 17025 and related standards; traceability is a foundational requirement embedded in those criteria. Transparent accreditation processes, proficiency testing, and surveillance support ongoing confidence and reduce barriers to acceptance of results across borders.

Advantages and Challenges of Traceability

Traceability offers significant benefits for organizations and laboratories, but it also introduces challenges that require planning, resources, and ongoing technical competence.

Advantages

Global acceptance of results: Facilitates conformity assessment, procurement, and regulatory compliance through mutual recognition and common references.

Decision confidence: Known uncertainty lets decision-makers align risk and guard banding with specifications.

Process comparability and uniform measurements: Enables consistent measurements across time, sites, and organizations.

Quality assurance leverage: Integrates naturally with measurement assurance programs and management systems.

Challenges

Cost and administrative burden: Periodic calibration, documentation, and accreditation/recognition activities consume time and resources.

Complexity: Branched hierarchies (multi-input models) require careful uncertainty propagation and parallel traceability of inputs.

False confidence risks: Traceability does **not** guarantee that the uncertainty is adequate or that mistakes are absent; competence and fit-for-purpose evaluation remain essential.

Good Practices for Laboratories and Assessors

Maintain explicit traceability charts for each quantity (length, mass, temperature, pressure, electrical, time/frequency), recording standards, uncertainty, and intervals.

Verify provider competence (accreditation status/scope, participation in intercomparisons) rather than relying on test numbers.

Ensure SI realization linkage to current definitions; for evolving realizations (e.g., post-IPK frameworks), manage transitions with documented corrections/uncertainty.

Integrate with management systems (QMS) to join technical traceability with process controls and continual improvement.

Human Factors

Traceability is ultimately delivered by people: clear procedures, training, attention to environmental influences, and correct use of instruments are as important as the references themselves. Visual tools—pyramids, flow charts, and completed traceability charts—help technicians, engineers, and assessors reach a shared understanding of *where* the number comes from and *how confident* we can be in it.

Conclusions

Metrological traceability, as defined in VIM3, is the structured pathway by which measurement results are anchored to recognized references through a documented hierarchy of calibrations that each contribute to uncertainty. In conformity assessment, this pathway enables global acceptance and meaningful, risk-aware decisions—provided laboratories demonstrate the full set of traceability elements (chain, uncertainty, documentation, competence, SI realization, intervals, measurement assurance) and maintain transparent charts and records. Thoughtful management of costs and complexity, coupled with robust measurement assurance and clear communication, turns traceability from an obligation into a strategic capability for trusted measurements.

List of Abbreviations

AB	Accreditation Body
ARMNAB	Armenian National Accreditation Body
BIPM	Bureau International des Poids et Mesures (International Bureau of Weights and Measures)
CIPM	Comité International des Poids et Mesures (International Committee for Weights and Measures)
CLAS	Canadian Laboratory Accreditation Service
CNAS	China National Accreditation Service for Conformity Assessment
Cofrac	Comité Français d'Accréditation (French Accreditation Committee)
EAS	Ethiopian Accreditation Service
IAS	International Accreditation Service
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
JAB	Japan Accreditation Board
JAS	Jordanian Accreditation Unit
MRA	Mutual Recognition Arrangement
NABL	National Accreditation Board for Testing and Calibration Laboratories (India)
NATA	National Association of Testing Authorities (Australia)
NIST	National Institute of Standards and Technology (USA)
NMI	National Metrology Institute
NRC	National Research Council (Canada)
PT	Proficiency Testing
QMS	Quality Management System
RENAR	Romanian Accreditation Association
Rosaccreditation	Federal Service for Accreditation (Russian Federation)
SAAC	Saudi Accreditation Center
SAC-SINGLAS	Singapore Accreditation Council – Singapore Laboratory Accreditation Scheme
SADCAS	Southern African Development Community Accreditation Service
SI	Système International d'Unités (International System of Units)
SNAS	Slovak National Accreditation Service
SOP	Standard Operating Procedure
TN	Technical Note (NIST designation)
TPS	Technical Policy Statement (UKAS designation)
UKAS	United Kingdom Accreditation Service
VIM	International Vocabulary of Metrology (JCGM 200:2012)

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Proficiency Testing and Interlaboratory Comparisons in Calibration Laboratories: Implications of ISO/IEC 17043:2023 and ILAC-P9:01/2024

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ABSTRACT

Proficiency testing (PT) and interlaboratory comparisons (ILC) are essential tools for demonstrating and maintaining technical competence in accredited calibration laboratories. Recent revisions to ISO/IEC 17043:2023 and ILAC-P9:01/2024 introduce more explicit and risk-based expectations for PT and ILC participation, evaluation, and documentation. This article clarifies the distinction between proficiency testing and other forms of interlaboratory comparison, outlines applicable accreditation requirements, and examines implications for participation planning, performance evaluation, and continual improvement. Particular attention is given to the suitability of statistical evaluation methods in calibration contexts, including the use of En values, and to the integration of PT and ILC outcomes into laboratory quality management systems to support confidence in measurement results.

1. Introduction

Proficiency testing and interlaboratory comparisons are widely used to support confidence in measurement results and to demonstrate technical competence in accredited calibration laboratories. Through comparison with other laboratories, PT and ILC activities provide external evidence that measurement processes, uncertainty estimates, and technical practices are performing as intended.

Recent revisions to ISO/IEC 17043:2023 and ILAC-P9:01/2024 have significantly strengthened expectations related to PT and ILC participation. These updates introduce more explicit requirements for risk-based planning, documented justification, and evaluation of results across the accredited scope. As a result, calibration laboratories are expected not only to participate in appropriate comparison activities, but also to demonstrate informed selection, interpretation, and effective use of outcomes within their quality management systems.

This article examines the implications of these developments for calibration laboratories. It clarifies the distinction between proficiency testing and other forms of interlaboratory comparison, outlines relevant accreditation requirements, and discusses considerations related to participation planning, performance evaluation, and continual improvement. By situating PT and ILC participation within a risk-based conformity assessment framework, the article aims to support laboratories in meeting evolving accreditation expectations while strengthening confidence in measurement results.

2. Definitions and Scope: Proficiency Testing and Interlaboratory Comparisons

Recent revisions to international standards and accreditation policies have renewed focus on the distinction between proficiency testing (PT) and other forms of interlaboratory comparison (ILC). Although the terms are sometimes used interchangeably in practice, their differentiation is essential for accreditation purposes and for demonstrating technical competence.

ISO/IEC 17043:2023 defines proficiency testing as the evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons. This definition makes clear that PT is characterized not only by participation in a comparison exercise, but by the formal evaluation of results against defined acceptance criteria. Participation in an interlaboratory comparison alone does not constitute proficiency testing unless performance evaluation is an explicit component of the scheme.

In contrast, ISO/IEC 17043:2023 defines an interlaboratory comparison as the design,

performance, and evaluation of measurements or tests on the same or similar items by two or more laboratories under predetermined conditions. This broader definition encompasses a wide range of comparison activities, many of which serve purposes other than formal assessment of laboratory competence.

The relationship between PT and ILC can therefore be described as hierarchical: all proficiency testing schemes are interlaboratory comparisons, but not all interlaboratory comparisons qualify as proficiency testing. Proficiency testing is distinguished by predefined performance criteria, formal evaluation mechanisms, and structured reporting of results. Other ILCs may be exploratory, developmental, or collaborative in nature and may not result in a classification of participant performance.

From an accreditation perspective, this distinction has practical consequences. Participation in proficiency testing is treated by accreditation bodies as direct evidence of technical competence. Other interlaboratory comparisons may support method development, validation, or internal benchmarking, but do not automatically satisfy accreditation requirements unless performance evaluation and acceptance criteria are clearly defined and documented.

Examples of non-PT interlaboratory comparisons include collaborative studies for method development, value assignment exercises for reference materials, and key or supplementary comparisons conducted among National Metrology Institutes. In such cases, the primary objective is often to establish reference values or demonstrate equivalence among expert laboratories rather than to assess individual laboratory competence against predefined criteria.

For calibration laboratories, it is therefore essential to define and document the intended purpose of each comparison activity. While non-PT ILCs may provide valuable technical insight and support internal quality assurance, they do not replace proficiency testing requirements unless their suitability is justified through a documented, risk-based rationale.

3. Accreditation Requirements Governing PT and ILC Participation

Accreditation requirements governing proficiency testing and interlaboratory comparison participation are defined through a combination of international standards and accreditation body policies. ISO/IEC 17025 establishes general principles related to monitoring the validity of results, while ILAC policies provide additional clarification on how these principles are to be applied and assessed in practice. Together, these documents form the framework within which calibration laboratories plan, implement, and evaluate PT and ILC activities.

Understanding the respective roles of ISO/IEC 17025 and ILAC-P9 is essential for interpreting accreditation expectations. While ISO/IEC 17025 emphasizes flexibility and outcome-based compliance, ILAC-P9 introduces more explicit, risk-based requirements intended to ensure consistent application across accreditation bodies. The following sections outline these requirements and their implications for calibration laboratories.

3.1 ISO/IEC 17025:2017 — General Requirements

ISO/IEC 17025:2017 establishes the foundational requirement for laboratories to monitor the validity of their results through comparison with other laboratories when such activities are available and appropriate. Clause 7.7.2 identifies participation in proficiency testing as one possible means of fulfilling this requirement, while allowing flexibility in how laboratories demonstrate ongoing confidence in their results.

This principle-based approach recognizes that suitable proficiency testing schemes may not be available for all calibration activities. However, ISO/IEC 17025 places clear responsibility on laboratories to evaluate the outcomes of any comparison activities undertaken. Clause 7.7.3 requires that results from proficiency testing or interlaboratory comparisons be reviewed and that corrective actions be initiated when performance is unsatisfactory.

Together, these clauses emphasize that participation alone is insufficient. Laboratories must actively assess comparison results, investigate deviations, and document actions taken. The standard therefore supports flexibility in participation while maintaining a strong expectation for technical evaluation and continual improvement.

3.2 ILAC-P9:01/2024 — Policy Clarification and Reinforcement

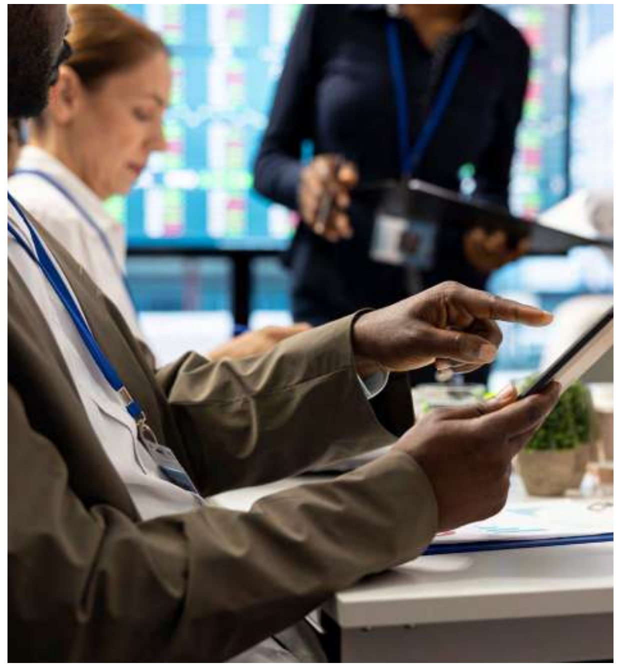
ILAC-P9:01/2024 builds upon the general requirements of ISO/IEC 17025 by introducing explicit, enforceable expectations for proficiency testing and interlaboratory comparison participation. While ISO/IEC 17025 defines what laboratories must achieve, ILAC-P9 clarifies how accreditation bodies are to assess compliance in practice.

Under ILAC-P9, participation in PT or suitable ILCs is mandatory when such activities are available, appropriate, and necessary. Laboratories are required to conduct and document a risk-based assessment to justify decisions regarding participation, including the selection of activities and the frequency of participation. This represents a shift from discretionary participation toward a structured, planned approach integrated into the quality management system.

A central requirement of ILAC-P9 is the development and maintenance of a documented PT/ILC participation plan. This plan must exist prior to accreditation and be maintained throughout the accreditation cycle. It is expected to define the scope of coverage, participation strategy, technical justification, and actions to be taken in response to unsatisfactory results.

ILAC-P9 also emphasizes the concepts of availability and appropriateness. A PT scheme may be available but technically unsuitable due to mismatches in measurand, uncertainty level, scope coverage, or evaluation method. In such cases, laboratories are expected to document technical justification for alternative approaches rather than rely on generalized statements of non-availability.

Accreditation bodies are required to review PT/ILC participation plans during accreditation and surveillance activities. This reinforces the expectation that laboratories demonstrate not only participation, but also informed planning, technical understanding, and effective use of comparison results.



4. Implications of ISO/IEC 17043:2023 for Calibration Laboratories

ISO/IEC 17043:2023 introduces substantive revisions to the standard governing the competence of proficiency testing providers. Although directed primarily at PT providers, these changes have important implications for calibration laboratories that rely on PT results as evidence of competence.

One significant development is the alignment of ISO/IEC 17043:2023 with the structure and principles of ISO/IEC 17025:2017. The revised standard emphasizes impartiality, competence, confidentiality, and consistent operations, contributing to a more coherent conformity assessment framework. For calibration laboratories, this alignment supports greater transparency and consistency in how PT schemes are designed, operated, and evaluated.

ISO/IEC 17043:2023 also reinforces harmonization with ISO 13528:2022, which provides statistical guidance for proficiency testing by interlaboratory comparison. The revised standard places greater emphasis on the use of technically valid statistical methods for determining assigned values, evaluating participant performance, and reporting results. As a result, calibration laboratories should expect PT reports to include more explicit information regarding evaluation criteria, uncertainty treatment, and performance thresholds.

The revised standard strengthens requirements related to impartiality and consistency in PT provision. PT providers must demonstrate that evaluation methods are applied objectively and without bias, reinforcing confidence in the technical validity of PT outcomes. However, accreditation of the PT provider does not transfer responsibility to the participant laboratory. Calibration laboratories remain responsible for understanding how results were evaluated and for determining whether the evaluation methods are appropriate for their scope and claimed measurement uncertainties.

In practice, this requires laboratories to review PT documentation critically and to assess the suitability of evaluation methods, particularly in calibration contexts where uncertainty plays a central role. Where PT schemes apply evaluation approaches that do not adequately account for measurement uncertainty, laboratories may need to document their assessment and consider supplementary or alternative comparison activities.

5. Risk-Based Planning for PT and ILC Participation

Recent revisions to ILAC-P9 emphasize that participation in proficiency testing and interlaboratory comparisons must be planned strategically rather than approached as isolated or periodic activities. For calibration laboratories, this represents a transition toward structured, risk-based planning integrated into the quality management system.

ILAC-P9 requires laboratories to establish and maintain a documented PT/ILC participation plan covering the full accredited scope. The purpose of this plan is not only to demonstrate compliance, but to provide a technically justified framework for selecting comparison activities, defining participation frequency, and ensuring that results are used effectively to support confidence in measurement results.

5.1 Mandatory Participation and Risk Assessment

Participation in PT or suitable ILCs is mandatory when such activities are available, appropriate, and necessary. Laboratories must conduct a documented risk assessment to justify decisions regarding participation strategy, including activity selection and frequency.

This approach aligns with the risk-based thinking introduced in ISO/IEC 17025:2017. Rather than applying uniform participation intervals, laboratories are expected to consider technical and operational factors such as measurement complexity, uncertainty levels, historical performance, stability of reference standards, personnel changes, and potential impact on customers or regulators.

By linking participation decisions to risk, ILAC-P9 encourages laboratories to focus resources where the consequences of measurement error are greatest, while maintaining appropriate coverage of the accredited scope.

5.2 Documented PT/ILC Participation Plans

The PT/ILC participation plan must define how the laboratory intends to address its entire accredited scope over the accreditation cycle. At a minimum, the plan should identify technical disciplines covered, the type of comparison activity selected, participation frequency, and the technical justification for each decision. It should also describe actions to be taken in response to unsatisfactory results, including investigation, corrective action, and verification of effectiveness.

The plan is intended to function as a living document within the quality management system. It should be reviewed periodically, typically as part of management review, and updated to reflect changes in scope, measurement capability, equipment, personnel, or external requirements.

5.3 Availability, Appropriateness, and Scope Coverage

ILAC-P9 draws a clear distinction between availability and appropriateness of PT schemes. Availability refers to whether a scheme exists and is accessible, while appropriateness requires technical alignment with the laboratory's scope, uncertainty levels, and measurement methods.

When formal PT schemes are unavailable or inappropriate, laboratories may rely on alternative interlaboratory comparisons, provided that their selection is justified and documented. Searches for available schemes, technical justification for alternatives, and periodic reassessment are essential elements of this process.

For laboratories with broad scopes, risk-based planning should ensure representative coverage of all significant technical disciplines over time. Grouping of activities may be used where equivalence can be demonstrated, but this approach must be documented and defensible. Failure to demonstrate adequate scope coverage may raise concerns during accreditation assessments, regardless of individual comparison outcomes.

6. Performance Evaluation and Statistical Considerations in PT and ILC

Performance evaluation is a defining element of proficiency testing and a primary means by which PT and ILC participation provides objective evidence of technical competence. For calibration laboratories, understanding how performance is evaluated — and whether the evaluation method is technically appropriate — is essential for interpreting results and supporting accreditation decisions.

ISO/IEC 17043:2023 reinforces the importance of transparent and technically justified performance evaluation by aligning PT provider requirements with ISO 13528:2022, which specifies statistical methods for proficiency testing by interlaboratory comparison. Although ISO 13528 is primarily directed at PT providers, its principles are directly relevant to participant laboratories, as PT outcomes are evaluated and accepted on the basis of these methods.

6.1 Purpose of Performance Evaluation in Proficiency Testing

The purpose of performance evaluation is to assess participant results relative to an assigned value using predefined criteria, enabling meaningful comparison among laboratories. Through this process, PT schemes convert reported measurement results into standardized indicators of performance that can be interpreted by laboratories and accreditation bodies.

For calibration laboratories, performance evaluation supports validation of measurement accuracy and claimed uncertainty. Unsatisfactory results may indicate issues related to measurement procedures, reference standards, environmental conditions, or uncertainty estimation and therefore require investigation and documented follow-up. Even satisfactory results contribute evidence supporting the reliability and consistency of measurement processes.

6.2 Common Performance Metrics Used in PT and ILC

ISO 13528 describes several statistical metrics commonly used to evaluate participant performance, including z-scores, z'-scores, and En values. Each metric is based on different assumptions regarding uncertainty and reference values, and their suitability depends on the context of the comparison.

The z-score expresses the difference between a participant's result and the assigned value, normalized by a standard deviation for proficiency assessment. It is widely used in testing contexts where the uncertainty of the assigned value is considered negligible. The z'-score extends this approach by incorporating the uncertainty of the assigned value, providing a more conservative assessment when reference uncertainty cannot be ignored.

In calibration contexts, the En value is widely regarded as the most appropriate performance metric because it explicitly incorporates both the participant's reported expanded uncertainty and the uncertainty of the assigned value. By evaluating metrological compatibility within combined uncertainties, the En value provides insight into whether a laboratory's claimed uncertainty is supported by its performance.

6.3 Selection of Appropriate Metrics for Calibration Laboratories

ISO 13528 emphasizes that statistical evaluation methods must be appropriate for the objectives of the comparison and the characteristics of the data. This principle is particularly important for calibration laboratories, where uncertainty is a fundamental component of demonstrating competence.

Use of z-based metrics alone may be misleading when uncertainty plays a central role in performance assessment. In such cases, evaluation methods that do not account for participant uncertainty may fail to reflect whether reported results are metrologically compatible with the assigned value. For this reason, calibration laboratories should understand which evaluation metric is applied and assess its suitability for their scope and claimed measurement capabilities.

Even when participating in PT schemes operated by accredited providers, laboratories retain responsibility for reviewing evaluation methods and documenting their assessment of technical appropriateness. Accreditation of the PT provider does not remove this responsibility.

6.4 Assigned Values, Uncertainty, and Sample Size Considerations

The determination of the assigned value is a critical component of performance evaluation. ISO 13528 describes multiple approaches for establishing assigned values, including the use of reference laboratories, certified reference materials, or robust statistical methods applied to participant results. The suitability of each approach depends on factors such as the number of participants and the availability of independent references.

Calibration comparisons often involve limited numbers of participants, including bilateral or small-group ILCs. In such cases, meaningful performance evaluation remains possible when assigned values and associated uncertainties are well characterized and acceptance criteria are defined in advance. ISO 13528 also cautions against drawing performance conclusions when assigned-value uncertainty is too large to support meaningful assessment.

7. Use of Interlaboratory Comparisons Other Than Proficiency Testing

Although proficiency testing is a primary mechanism for demonstrating laboratory competence, formal PT schemes are not always available or technically appropriate for all calibration activities. Accreditation frameworks therefore allow the use of interlaboratory comparisons other than proficiency testing, provided their selection and implementation are justified and documented.

ILAC-P9 explicitly recognizes that suitable PT schemes may not exist for certain measurands or scopes. In such cases, laboratories may rely on alternative ILCs to support monitoring of measurement validity, provided these activities are planned, technically sound, and aligned with accreditation expectations.

7.1 Conditions for Acceptance of Non-PT ILCs

Unlike formal PT schemes, alternative ILCs may not include standardized scoring or classification of participant performance. Nevertheless, they must be designed to provide meaningful evidence of technical competence. Key considerations include the establishment of an assigned value, definition of acceptance criteria, and evaluation of results relative to measurement uncertainty.

Accreditation bodies expect laboratories to justify the use of non-PT ILCs on a technical basis. This justification should be specific to the measurand and scope involved and should explain why formal PT is unavailable or inappropriate. General statements regarding lack of PT availability are insufficient without supporting evidence.

7.2 Evaluation and Documentation Requirements

For non-PT ILCs to be acceptable, laboratories must document how results were evaluated and how conclusions were reached. Even when

formal PT performance scores are not applied, the principles of metrological compatibility remain relevant. Results should be assessed to determine whether they are consistent within combined uncertainties and whether any observed discrepancies warrant investigation.

Documentation should include evidence of searches for available PT schemes, description of the comparison design, identification of assigned values and associated uncertainties, evaluation criteria, and interpretation of results. Where non-PT ILCs are used on a recurring basis, laboratories should periodically reassess whether formal PT schemes have become available or whether changes in scope or capability affect the suitability of the approach.

7.3 Role of Non-PT ILCs Within a Risk-Based Framework

Alternative interlaboratory comparisons should be integrated into the laboratory's overall risk-based PT/ILC participation strategy rather than treated as ad hoc substitutes. When selected deliberately and documented appropriately, they can support validation of measurement uncertainty and provide supplementary evidence of technical competence.

However, reliance on non-PT ILCs does not eliminate the obligation to participate in formal PT schemes when they become available and appropriate. Laboratories are expected to remain aware of PT availability and to update participation plans accordingly. Within this framework, non-PT ILCs function as complementary tools rather than permanent replacements for proficiency testing.

8. Use of PT and ILC Results for Continual Improvement

Beyond their role in demonstrating compliance with accreditation requirements, proficiency testing and interlaboratory comparison results provide valuable input for continual improvement within calibration laboratories. When reviewed and used systematically, PT and ILC outcomes support technical decision-making, reinforce confidence in measurement results, and contribute to the ongoing evaluation of laboratory competence.

ISO/IEC 17025 requires laboratories not only to participate in appropriate comparison activities, but also to evaluate results and take action when performance is unsatisfactory. ILAC-P9 reinforces this expectation by emphasizing that PT and ILC participation should be embedded within a broader, risk-based quality management framework. The value of these activities is therefore realized through interpretation, follow-up, and integration into routine quality processes.

8.1 Interpretation of Results and Corrective Action

When PT or ILC results indicate unsatisfactory performance, laboratories are expected to initiate investigation and corrective action in accordance with their quality management procedures. This process may involve review of measurement methods, reference standards, environmental conditions, personnel competence, or uncertainty estimation. Corrective actions should be proportionate to the identified risk and supported by documented evidence.

Even when results are satisfactory, laboratories may identify opportunities for improvement. Marginal results, emerging trends, or inconsistencies across similar activities may warrant additional review. In calibration contexts, particular attention is often given to the consistency between reported uncertainties and observed performance.

8.2 Trend Analysis and Longitudinal Review

Individual comparison results provide limited insight into long-term performance. When reviewed collectively over time, however, PT and ILC outcomes can reveal trends that may not be apparent from isolated events. Longitudinal review supports identification of systematic bias, drift, or instability in measurement processes or reference standards.

Tracking performance indicators across multiple comparison rounds enables laboratories to assess the robustness and consistency of measurement results. Incorporating trend analysis into routine quality activities supports proactive risk management and aligns with the intent of risk-based thinking in ISO/IEC 17025 and ILAC-P9.

8.3 Integration with Management Review and Risk Assessment

PT and ILC outcomes should be reviewed as part of the laboratory's management review process, alongside other indicators of performance and risk. This integration ensures that comparison results inform strategic decisions related to scope, resources, training, equipment maintenance, and uncertainty budgets.

By linking PT and ILC results to risk assessment, laboratories can adjust participation strategies, refine measurement capabilities, and prioritize improvement actions. This approach reinforces the role of PT and ILC activities as tools for continual improvement rather than isolated compliance exercises.

8.4 Supporting Confidence in Measurement Results

When PT and ILC participation is planned strategically, evaluated appropriately, and integrated into quality management activities, comparison outcomes strengthen confidence in reported calibration results. By demonstrating consistency, compatibility, and transparency in measurement performance, laboratories provide assurance to customers, regulators, and accreditation bodies that results are technically valid and reliable.

9. Conclusion

Recent revisions to ISO/IEC 17043:2023 and ILAC-P9:01/2024 reinforce the central role of proficiency testing and interlaboratory comparisons in demonstrating and maintaining competence in calibration laboratories. These updates place increased emphasis on structured planning, technical justification, and informed interpretation of results, moving PT and ILC participation beyond periodic compliance activities toward integrated elements of laboratory risk management and quality assurance.

For calibration laboratories, the implications are multifaceted. Clear distinction between PT and other forms of ILC is essential for meeting accreditation requirements and avoiding misinterpretation of comparison activities. Risk-based participation planning, supported by documented justification and periodic review, is now a fundamental expectation. In addition, laboratories must understand and critically evaluate performance assessment methods, particularly with respect to the treatment of measurement uncertainty and the suitability of evaluation metrics such as En values.

When PT and ILC outcomes are used effectively, they support not only accreditation compliance but also continual improvement. Trend analysis, management review, and integration with risk assessment enable laboratories to identify emerging issues, validate uncertainty estimates, and strengthen confidence in reported results. Within this framework, PT and ILC participation contributes to sustained technical competence and transparency across the calibration community.

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EA-4/18 [latest edition], *Guidance on the level and frequency of proficiency testing participation*

EA-4/21 [latest edition], *Guidance on the evaluation of PT and ILC results*

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The Role of External Quality Assessment (EQA) in Laboratory Services

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GENERAL INFORMATION

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ABSTRACT

External quality assessment (EQA) is an important tool in laboratory services, ensuring the accuracy, reliability, and consistency of diagnostic test results. In an EQA program, an external body distributes unknown samples to participating laboratories, which analyze them and report their results for comparison with those of peer institutions. This process enables laboratories to identify errors, monitor performance trends, and implement corrective measures. This article outlines the concept, process, importance, and challenges of EQA and highlights its role in supporting patient safety and healthcare quality.

INTRODUCTION

External quality assessment (EQA) in laboratory services was first introduced in the 1950s and 1960s, in response to the growing need for independent verification of test accuracy and reliability [1]. Unlike internal quality control (IQC), which relies on internal checks, EQA — also known as proficiency testing (PT) - provides an objective external benchmark against a wider peer group [2]. Globally, several organizations coordinate EQA schemes, including the World Health Organization (WHO), the College of American Pathologists (CAP), and the United Kingdom National External Quality Assessment Service (UK NEQAS) [3–5]. In addition, numerous national and regional programs support laboratories in monitoring performance across diverse healthcare settings. Over time, EQA schemes have expanded beyond core chemistry and hematology testing to include molecular diagnostics, microbiology, and point-of-care testing (POCT), reflecting the increasing complexity of laboratory services.

Laboratory testing forms the backbone of modern healthcare, guiding diagnosis, treatment, and disease monitoring. Ensuring the accuracy, reliability, and consistency of test results is therefore essential for safe and effective patient care. While IQC is routinely used to monitor day-to-day analytical performance, independent external evaluation through EQA provides an important complementary benchmark for validating results and identifying performance gaps [2].

In an EQA program, an external body distributes unknown samples to participating laboratories, which analyze them under routine conditions and submit results for comparison with those of peer institutions. The primary purposes of EQA are to ensure reliable test results, monitor laboratory performance, and promote patient safety by minimizing diagnostic errors and supporting appropriate clinical decision-making. This article highlights the role of EQA in supporting staff competency, fostering confidence in laboratory results, and maintaining high-quality laboratory services.

How EQA Works

The external quality assessment process follows a structured, step-by-step workflow designed to evaluate laboratory performance under routine testing conditions [6]. The typical EQA process begins with the distribution of unknown samples, whereby participating laboratories receive characterized specimens from the EQA provider. These samples are analyzed under routine laboratory conditions, in the same manner as patient specimens. After testing, laboratories submit their results to the EQA provider for comparison with those of peer laboratories and for statistical analysis.

Based on this evaluation, participating laboratories receive a detailed performance report that highlights errors, performance trends, and areas for improvement, along with recommendations where appropriate [7]. Commonly assessed parameters include accuracy, which measures how close results are to the assigned value; precision, which assesses repeatability; and consistency with

Table 1: External Quality Assessment (EQA), Workflow and Key Features

Step	Description	Parameters Assessed	Benefits
Sample Distribution	Participating Laboratories receive unknown samples from the EQA or PT provider.	–	Standardized starting point for testing.
Laboratory Testing	Participating laboratories analyze samples under routine conditions.	Accuracy, Precision.	Ensures consistent methodology.
Result Submission	Participating laboratories report results to the EQA or PT provider.	–	Centralized data collection.
Performance Evaluation	Comparison with wider peer laboratories; statistical analysis.	Accuracy, Precision, Peer consistency.	Detects deviations and errors.
Feedback and Recommendations	Participating laboratories receive a performance report highlighting trends and areas for improvement.	–	Enables corrective measures and staff training if required.

Table 2: Major EQA and PT Programs Worldwide

Program	Region/Scope	Key Features
College of American Pathologists (CAP)	USA and international participants.	Offers EQA programs in clinical chemistry, hematology, microbiology, immunology, molecular diagnostics, and more. CAP programs are widely recognized for accreditation purposes.
UK National External Quality Assessment Service (UK NEQAS)	United Kingdom and international participants	Covers clinical pathology, transfusion medicine, virology, microbiology, and specialized fields. Provides detailed performance reports and corrective guidance.
World Health Organization (WHO) EQA Programs	Global, with focus on low- and middle-income countries	Supports laboratories in infectious diseases, immunology, and molecular diagnostics. Focuses on strengthening public health laboratory capacity.
Royal College of Pathologists of Australasia Quality Assurance Programs (RCPAQAP)	Australia & Asia-Pacific	Provides EQA schemes in pathology disciplines, including clinical chemistry, microbiology, molecular testing, and POCT.
European Union Reference Laboratories (EURLs)	Europe	Focuses on food safety, microbiology, and public health. Offers standardized EQA programs to promote consistency across EU laboratories.
National EQA Programs	Various countries (India, South Africa, Brazil, etc.)	Tailored to national public health priorities and local laboratory capacities. Often coordinated by government health authorities or national professional bodies.

peer results, which reflects overall reliability. By providing actionable feedback, EQA participation helps laboratories identify both random and systematic errors and implement corrective measures to improve testing quality.

As summarized in Table 1, the EQA workflow comprises a sequence of five steps that collectively support the accuracy and reliability of laboratory testing.

Major EQA Programs Worldwide

Several international, regional, and national organizations offer structured EQA or proficiency testing (PT) programs to support laboratories in maintaining high-quality testing standards. These programs enable laboratories to compare their performance with peer institutions, identify errors, and implement corrective actions. Some major EQA and PT programs are summarized in Table 2.

Participation in these EQA or PT programs not only allows testing laboratories to benchmark results at regional and international levels but also supports compliance with accreditation requirements, such as ISO 15189. In addition, participation promotes professional development, strengthens confidence in clinical decision-making, and contributes to improved patient safety. Building on this global framework, India has developed its own network of accredited EQA or PT providers to ensure laboratory quality at the national level.

EQA and PT Programs in India

In India, the accreditation and provision of EQA and PT schemes are overseen by the National

Accreditation Board for Testing and Calibration Laboratories (NABL), which is responsible for ensuring that laboratories meet international standards under ISO/IEC 17043 [8]. NABL accredits a range of proficiency testing providers (PTPs) that offer EQA schemes across medical testing disciplines, supporting laboratories in meeting quality assurance requirements and ISO 15189 accreditation.

Accredited PT providers in India include both national and regional organizations offering schemes in clinical chemistry, hematology, microbiology, histopathology, molecular diagnostics, and other specialized fields [8]. Among these is Chimera Translational Research Fraternity Pvt. Ltd., which is ISO 17043:2023 accredited to provide proficiency testing services in hematology, immunohematology, and molecular testing from its facility in Delhi, known as Chimera® EQA Service. It is India's first and only NABL-accredited EQA service in transplant immunology and immunophenotyping [9]. This reflects the active participation of Indian institutions in EQA programs and contributes to strengthening laboratory quality within the national testing landscape.

The practical impact of such EQA participation is illustrated by experiences from accredited programs in India, including the CHIMERA® EQA program in transplant immunology and immunophenotyping. During routine EQA cycles, participating laboratories identified analytical variations in selected parameters when compared with peer laboratories. Review of EQA feedback prompted root-cause analyses (RCA), commonly involving evaluation of reagent performance, calibration practices, and adherence to standard operating procedures (SOPs). Corrective actions — such as instrument recalibration, reagent verification, and targeted staff retraining — were subsequently implemented. In following EQA cycles, laboratories demonstrated improved agreement with assigned values and peer results, reflecting measurable improvements in analytical performance. This example highlights how structured EQA participation supports continuous quality improvement and strengthens confidence in routine laboratory testing.

Importance of EQA in Laboratory Services

External quality assessment (EQA) plays a vital role in laboratory quality management (QM) by improving accuracy, reliability, and consistency of test results. Comparisons with peer laboratories enable deviations to be identified and corrected in a timely manner. Participation in EQA also supports compliance with international standards, such as ISO 15189, as well as national accreditation requirements [2, 10].

Beyond compliance, EQA promotes patient safety by helping prevent misdiagnoses and inappropriate treatment decisions through more accurate and consistent testing. Participation in EQA programs also supports continuous education by highlighting knowledge gaps and technical errors, thereby fostering staff training and professional development. In addition, laboratories can benchmark performance against peers over time, allowing trends to be monitored and areas for improvement to be identified

Challenges in Implementing EQA Schemes

Despite its many advantages, implementing an EQA program presents several challenges. Participation fees can be a significant barrier, particularly for small or resource-limited laboratories, limiting access to quality assurance programs. In addition, logistical challenges — such as transporting samples to remote locations or maintaining the integrity of temperature-sensitive materials — can pose difficulties for EQA providers [11].

Effective participation in EQA also requires trained personnel to interpret performance reports and implement corrective actions, resources that may not be consistently available across all laboratories. In some cases, resistance to change may further hinder adoption, particularly when laboratories are hesitant to modify established practices or acknowledge performance gaps. To address these challenges, regional or domestic EQA programs, digital reporting systems, and targeted staff training initiatives can help improve access, efficiency, and participation in EQA schemes [11].

Future Directions

EQA and proficiency testing programs continue to evolve alongside advances in laboratory technology, improving both efficiency and the scope of laboratory services. The integration of digital reporting systems, automation, and laboratory information systems (LIS) enables faster data submission, real-time feedback, and more detailed performance trend analysis.

At the same time, EQA programs are expanding into new diagnostic areas, including molecular testing, genetic screening, and point-of-care testing (POCT). In parallel, global collaboration through cross-border EQA initiatives is increasing, supporting greater standardization of laboratory performance and promoting consistency and quality in diagnostic testing across regions.

Conclusion

External quality assessment plays an essential role in maintaining high standards in laboratory testing services by providing independent evaluation, identifying errors, and promoting continuous quality improvement. Through these mechanisms, EQA contributes directly to improved patient safety and overall healthcare quality.

Despite challenges related to cost, logistics, and resource availability, participation in EQA or proficiency testing programs remains crucial for laboratories seeking accreditation, improving diagnostic accuracy, and maintaining professional standards. Continued expansion of EQA programs, along with increased integration of digital platforms, is expected to further strengthen quality management in the future.

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The Critical Role of Metrology in Conformity Assessment

By **KT Noushad**,CEO, CATIIS Laboratories; Lead and Technical Assessor, IAS

GENERAL INFORMATION

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Keywords: *Metrology; Conformity assessment; Measurement traceability; Measurement uncertainty; ISO/IEC 17000 series; Accreditation; Quality infrastructure*

ABSTRACT

Metrology — the science of accurate and traceable measurement — is fundamental to all conformity assessment activities. Testing, calibration, inspection, and certification rely on metrological principles to ensure accuracy, traceability, and comparability of results. This article explores the role of metrology as the foundation of conformity assessment, examining its historical development, relevance in everyday applications, and function across the ISO/IEC 17000 series, including ISO/IEC 17025, 17020, 17065, 17024, 17021, 17043, and 17034. Practical examples from healthcare, aviation, environmental monitoring, and manufacturing illustrate how measurement integrity underpins quality, safety, regulatory compliance, and global trade. The article also highlights emerging challenges and trends, including increasing measurement complexity, digital metrology, and the growing need for global harmonization.

INTRODUCTION

Metrology — the science of accurate and traceable measurement — has shaped human progress since ancient civilizations. Early societies understood that measurement was essential for fairness, trade, and construction. In ancient Egypt (c. 3000–30 BCE), the royal cubit enabled the construction of monumental pyramids and temples, while standardized weights and measures regulated trade and agriculture. Around the same time, in Mesopotamia (c. 2000–539 BCE), the Babylonians developed precise weights and a sexagesimal numerical system to facilitate commerce, land surveying, and astronomical observations.

In the Indus Valley Civilization of India (c. 2600–1900 BCE), cities such as Harappa and Mohenjo-daro employed standardized weights for trade, uniform bricks for construction, and carefully calibrated instruments for craft and commerce. Across ancient China (c. 2000 BCE onward), rulers implemented standardized units of length, weight, and volume for taxation, trade, and large-scale construction, while sophisticated instruments such as water clocks and measuring rods supported astronomical studies.

In ancient North America (c. 1000 BCE–1500 CE), civilizations such as the Maya and the mound-building cultures of Cahokia applied careful measurement for urban planning, land division, construction, and astronomical observations, demonstrating that sophisticated metrological practices were a global phenomenon, independent of the Old World.

Later, in Greece (c. 800–146 BCE), standardized lengths, areas, and volumes were applied in architecture, engineering, trade, and early science, with mathematicians such as Euclid and Archimedes formalizing principles still studied today. Rome (753 BCE–476 CE) expanded on these foundations, creating uniform units for length, area, and volume, regulating coinage, and using surveying tools such as the groma and chorobates to construct roads, aqueducts, and monumental buildings with remarkable precision.

Despite these early advancements across continents, it was not until the French Revolution that a unified global system of measurement emerged, with the introduction of the metric system in 1799. This effort toward standardization was further strengthened by the Metre Convention of 1875, which established the International Bureau of Weights and Measures (BIPM) and laid the foundation for the modern, globally harmonized metrology that underpins science, industry, and daily life today.

Today, metrology influences almost every aspect of modern life — whether visible or invisible. It ensures accurate dosing of medicines, fair trade at fuel stations, safe airline operations, reliable medical diagnostics, and consistent food quality. In essence, metrology builds trust in every measurement that affects health, safety, and daily life.

Conformity assessment — the process of verifying that products, services, or systems meet specified requirements — depends entirely on this trust in measurement. Without reliable measurements, conformity assessment would lack technical credibility and global recognition. Whether applied in testing, calibration, inspection, certification, or accreditation, metrology provides the scientific foundation that ensures confidence, comparability, and consistency in conformity assessment outcomes across sectors and borders.

Purpose and Thesis

This article examines the critical role of metrology as the scientific foundation of conformity assessment. It outlines how accurate, traceable, and reliable measurements support testing, calibration, inspection, and certification activities across the ISO/IEC 17000 series. By linking historical context with practical application, the article demonstrates how metrology underpins confidence in conformity assessment outcomes, supports international trade, protects consumers, and enables regulatory compliance in modern industry.

Understanding Metrology and Its Framework

Metrology is commonly divided into three interconnected domains, each serving a distinct but complementary role in ensuring reliable and meaningful measurement:

- **Scientific metrology:** Establishes and maintains national and international measurement standards based on fundamental physical constants. This domain provides the highest level of measurement accuracy and forms the basis of global measurement systems.
- **Industrial metrology:** Ensures the accuracy and reliability of measurements used in manufacturing, production, testing, and quality control. It supports process efficiency, product consistency, and compliance with technical requirements.
- **Legal metrology:** Governs measurements used in trade, safety, health, and environmental protection to ensure fairness, consumer protection, and regulatory compliance.

The unifying principle across all three domains is **measurement traceability**. Traceability means that any measurement result can be related to an appropriate reference — typically national or international standards — through an unbroken chain of calibrations, each contributing to the overall measurement uncertainty. This traceability framework ensures that measurement results are comparable, credible, and defensible, regardless of where or by whom they are produced.

Everyday Life Examples of Metrology in Action

Metrology touches nearly every aspect of daily life, often in ways that go unnoticed. Accurate and traceable measurements provide the foundation for safety, fairness, and reliability across a wide range of everyday activities, ensuring that products and services perform as expected and meet regulatory requirements.

Examples include:

- **Healthcare:** The accuracy of thermometers, blood pressure monitors, and diagnostic

instruments is essential for correct diagnosis, treatment decisions, and patient safety.

- **Food safety:** Temperature and humidity controls in storage facilities, ovens, and refrigerators rely on traceably calibrated sensors to prevent spoilage and ensure food quality.
- **Consumer protection:** Fuel dispensers, weighing scales, and grocery scanners are regulated and calibrated under legal metrology frameworks to ensure fair and transparent transactions.
- **Aviation:** Aircraft depend on precise altimeters, airspeed indicators, fuel flow meters, and pressure sensors. These instruments must be calibrated and traceable to international standards, as even minor measurement errors can affect flight safety.
- **Environmental monitoring:** Calibrated air and water quality instruments support compliance with environmental regulations and help protect public health.
- **Energy and utilities**: Smart meters and power analyzers enable accurate billing, energy management, and regulatory reporting.

Together, these examples illustrate that metrology is not confined to laboratories. It operates continuously behind the scenes, safeguarding lives, enabling trade, and maintaining trust in modern society.

Metrology as the Backbone of Conformity Assessment

Metrology is the invisible thread that connects all conformity assessment activities. Whether applied in testing, calibration, inspection, or certification, measurement traceability and an understanding of measurement uncertainty ensure that results are meaningful, comparable, and defensible.

The ISO/IEC 17000 series of standards provides a common framework for competence, impartiality, and consistency across conformity assessment activities. Metrology underpins each of these standards, ensuring that compliance decisions are based on objective and scientifically valid measurement evidence.

The following sections illustrate how metrological principles support specific conformity assessment activities across the ISO/IEC 17000 series.

The Role of Metrology in Each Conformity Assessment Activity

The role of metrology varies across conformity assessment activities, but in every case, it provides the measurement confidence required to support reliable decisions. The following examples illustrate how metrological principles are applied across key conformity assessment functions within the ISO/IEC 17000 series.

a. ISO/IEC 17025 – Testing Laboratories

Testing laboratories determine the properties or performance of materials and products. Metrology ensures that test results are accurate, traceable, and associated with a known level of measurement uncertainty, allowing results to be compared reliably across laboratories and over time.

Examples include:

- In food testing laboratories, calibration of balances, incubators, and pipettes ensures accuracy in chemical and microbiological analyses.
- In environmental testing, metrology supports traceability in measurements such as temperature, flow rate, and pollutant concentration.

Without a robust metrological foundation, test results could vary significantly between laboratories, leading to inconsistent outcomes and unreliable compliance decisions.

b. ISO/IEC 17025 – Calibration Laboratories

Calibration laboratories establish and maintain the link between measurement instruments and national or international measurement standards. Through the application of metrological principles, calibration laboratories ensure that instruments used in industry, testing, and inspection produce accurate and traceable results.

Examples include:

- A temperature calibration laboratory calibrates thermometers against a reference platinum resistance thermometer traceable to SI units.
- A pressure calibration laboratory ensures that pressure gauges used in aviation or oil and gas applications produce precise and consistent measurements.

Calibration laboratories are central to the metrology infrastructure, providing the critical link between national metrology institutes and practical measurement use in industry.

c. ISO/IEC 17020 – Inspection Bodies

Inspection bodies assess the safety, quality, or compliance of products, processes, and installations. Metrology ensures that inspection activities are supported by accurate and traceable measurements, allowing inspection results to be objective, repeatable, and technically defensible.

Examples include:

- In pre-shipment inspection of commodities such as rice and edible oil, weighing balances, moisture meters, flow meters, and densitometers must be calibrated and traceable to verify weight, quantity, moisture content, and purity before shipment.
- In vehicle inspection programs, emissions analyzers and brake testers rely on accurate calibration to support regulatory compliance and public safety.

By applying metrological principles, inspection bodies can produce consistent and reliable results that support regulatory decisions and stakeholder confidence.

d. ISO/IEC 17065 – Product Certification Bodies

Product certification bodies verify that products meet specified technical, safety, and performance requirements. Metrology supports product certification by ensuring that the measurements used during evaluation and testing are accurate, traceable, and fit for purpose.

Examples include:

- For electrical products, measurements of voltage, current, and insulation resistance must be traceable to ensure compliance with applicable safety standards.
- For automotive components, assessments of dimensional accuracy and material strength rely on calibrated measurement systems to confirm product performance.

Through the application of metrological principles, product certification results are scientifically sound, comparable across schemes, and suitable for international acceptance.

e. ISO/IEC 17024 – Personnel Certification Bodies

Personnel certification bodies assess individual competence based on objective performance criteria and measurable outcomes. Metrology supports these assessments by ensuring that measurements used during practical examinations and evaluations are accurate, traceable, and consistent.

Examples include:

- In welder certification, calibrated equipment is used to measure weld dimensions and assess mechanical strength.
- In laboratory analyst certification, practical assessments rely on traceably calibrated pipettes and balances to evaluate technical competence.

By relying on validated measurement systems, personnel certification bodies can demonstrate that certification decisions are based on reliable and impartial evidence.

f. ISO/IEC 17021 – Management System Certification Bodies

Management system certification bodies (e.g., ISO 9001, ISO 14001, ISO 45001) evaluate organizational processes, controls, and performance against defined management system requirements. Metrology supports these evaluations by ensuring that monitoring and measurement data used to assess system effectiveness are accurate, traceable, and reliable.

Examples include:

- In quality management systems, Clause 7.1.5 of ISO 9001 requires organizations to control and calibrate monitoring and measuring resources.
- In environmental management systems,

traceable measurements of emissions, energy use, and waste levels support compliance, performance evaluation, and reporting.

By enabling accurate data collection and analysis, metrology provides a sound basis for performance evaluation, continual improvement, and compliance verification within management systems.

g. ISO/IEC 17043 – Proficiency Testing Providers

Proficiency testing providers evaluate laboratory performance by comparing results obtained from identical or comparable test items. Metrology ensures that assigned values and evaluation criteria are based on traceable and reliable measurements, allowing meaningful comparison of participant results.

Examples include:

- A proficiency testing provider distributing water samples for heavy metal analysis must assign reference values that are traceable to SI units.
- A temperature proficiency test relies on reference thermometers with traceable calibration to establish valid comparison results.

By applying robust metrological principles, proficiency testing providers can support objective performance evaluation and promote confidence in laboratory competence.

h. ISO/IEC 17034 – Reference Material Producers

Reference Material Producers (RMPs) develop materials with well-characterized and traceable property values that are used to calibrate instruments, validate test methods, and support quality control activities. Metrology ensures that these materials have assigned values with known uncertainties, providing a reliable basis for measurement accuracy.

Examples include:

- A pH buffer solution with a certified value used to ensure consistent calibration of pH meters.
- A reference material for lead in water used to support traceable and comparable measurements in environmental laboratories.

By providing reference materials with clearly defined values and uncertainties, RMPs form a critical foundation for reliable measurement and conformity assessment.

Global Harmonization and Trade

Metrology supports conformity assessment by enabling the international recognition of measurement results. Mutual Recognition Arrangements (MRAs) established through organizations such as ILAC, IAF, and BIPM help ensure that calibration and test results produced in one country are accepted in another.

This global harmonization reduces duplication of testing and calibration activities, lowers costs for manufacturers and laboratories, and facilitates smoother international trade. It is particularly important for regulated products such as medical devices, electrical equipment, and vehicles, where consistent measurement and conformity assessment practices are essential for market access and regulatory acceptance.

By supporting comparability and confidence in measurement results across borders, metrology plays a critical role in strengthening international supply chains and promoting trust in global markets.

Current Challenges, Gaps, and Emerging Trends in Metrology for Conformity Assessment

Despite its central role in conformity assessment, metrology faces several ongoing challenges. One significant gap is inconsistent calibration practice, particularly among small and medium-sized laboratories, where limited resources may restrict access to accredited calibration services. This can affect measurement consistency and, in turn, confidence in conformity assessment results.

Another challenge is the increasing complexity of measurements driven by advanced technologies such as smart sensors, automated inspection systems, and digital testing platforms. These developments require new calibration methodologies and more sophisticated approaches to evaluating measurement uncertainty.

At the same time, several emerging trends are shaping the future of metrology in conformity assessment. Digital metrology is gaining prominence, with electronic calibration certificates (DCCs), data integrity, and cybersecurity becoming increasingly important considerations. In parallel, globalized supply chains and regulatory harmonization are increasing the demand for international measurement equivalence, placing greater emphasis on traceability to SI units through recognized national metrology institutes.

Addressing these challenges and trends is essential to maintaining confidence in conformity assessment outcomes and ensuring that measurement results remain reliable, comparable, and fit for purpose in modern industry.

Conclusion

From ancient measurement systems carved into stone to the quantum-level precision of modern laboratories, metrology has evolved into a foundational element of global quality and safety assurance. Across industries and regions, it ensures that conformity assessment results — whether from testing, calibration, inspection, or certification — are scientifically valid, comparable, and trusted.

By embedding metrological principles throughout the ISO/IEC 17000 series of standards, conformity assessment systems are able to base decisions on objective measurement evidence rather than assumption or approximation. This integration supports regulatory oversight, facilitates international recognition, and strengthens confidence in products, services, and systems.

Ultimately, metrology safeguards trade, technology, and everyday life alike — from the fuel we purchase and the food we consume to the aircraft we board and the medicines we rely on. In this sense, without metrology, there can be no true conformity.

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Conformity Assessment in Sports: Ensuring Safety, Fairness, and Excellence

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OPINION ARTICLE

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Keywords: *conformity assessment; sports safety; accreditation; ISO standards; testing laboratories; anti-doping; equipment certification; sports facilities; ISO/IEC 17025; quality assurance*

ABSTRACT

Conformity assessment plays a crucial role in sports by ensuring that equipment, facilities, and procedures meet established safety and performance standards. From testing athletic equipment to certifying sports facilities and validating anti-doping procedures, conformity assessment bodies help maintain integrity in sports while protecting athletes and spectators. This article explores key applications, including equipment testing, facility certification, and the role of accredited laboratories in supporting fair play.

The Critical Role of Conformity Assessment in Sports

Sports represent one of humanity's most celebrated activities, bringing together millions of athletes and billions of spectators worldwide. Behind every competition, from local tournaments to the Olympic Games, lies a complex system of standards, testing, and certification processes that ensure safety, fairness, and excellence. Conformity assessment serves as the backbone of this system, providing the technical expertise and independent verification necessary to maintain trust in sporting competitions.

Equipment Safety and Performance Standards

Athletic equipment undergoes rigorous testing to meet international safety and performance standards. Helmets used in cycling, football, and hockey must pass impact resistance tests conducted by accredited testing laboratories. These facilities evaluate products against standards such as ASTM, EN, and ISO, ensuring that protective gear can withstand the forces encountered during competition.

Similarly, sports surfaces require certification to help prevent injuries and ensure consistent performance. Track and field facilities must meet International Association of Athletics Federations (IAAF) standards for shock absorption, friction, and weather resistance. Swimming pools undergo testing for water quality, lane dimensions, and timing system accuracy. Tennis courts are evaluated for ball bounce consistency and surface grip characteristics.

Facility Certification and Management Systems

Sports venues implement management systems certified to ISO standards to ensure operational excellence. ISO 9001 quality management systems help facilities maintain consistent service delivery, while ISO 14001 environmental management systems ensure sustainable operations. ISO 45001 occupational health and safety management systems protect both athletes and staff from workplace hazards.

Major sporting venues often pursue specialized certifications, such as environmental sustainability and accessibility certifications, to ensure inclusive access for all participants and spectators.

Anti-Doping and Laboratory Accreditation

Perhaps nowhere is conformity assessment more critical than in anti-doping efforts. World Anti-Doping Agency (WADA)-accredited laboratories must meet ISO/IEC 17025 requirements for testing and calibration laboratories, ensuring the accuracy and reliability of drug testing results. These facilities undergo regular surveillance assessments to maintain their accreditation, with assessors evaluating everything from analytical procedures to data integrity protocols.

The chain of custody procedures, sample handling protocols, and analytical methods used in anti-doping testing all require strict adherence to established standards. Any deviation can compromise the validity of test results and potentially affect an athlete's career or even a country's reputation.

Technology and Innovation

Modern sports increasingly rely on technology for performance measurement. Electronic timing systems, as well as technologies such as VAR, goal-line systems in football, and Hawk-Eye in tennis, all require calibration and validation by accredited laboratories. These systems must demonstrate accuracy, reliability, and consistency under various environmental conditions.

Wearable technology used by athletes for performance monitoring also undergoes conformity assessment to ensure data accuracy and device safety during use.

Future Developments

As sports continue to evolve, conformity assessment will adapt to address new challenges. Virtual and augmented reality training systems, advanced materials in equipment design, and emerging sports disciplines will require new standards and testing methodologies. The integration of artificial intelligence in officiating and performance analysis will also demand robust validation procedures.

The continued role of conformity assessment in sports ensures that, as competition intensifies and technology advances, the fundamental principles of safety, fairness, and excellence remain paramount.

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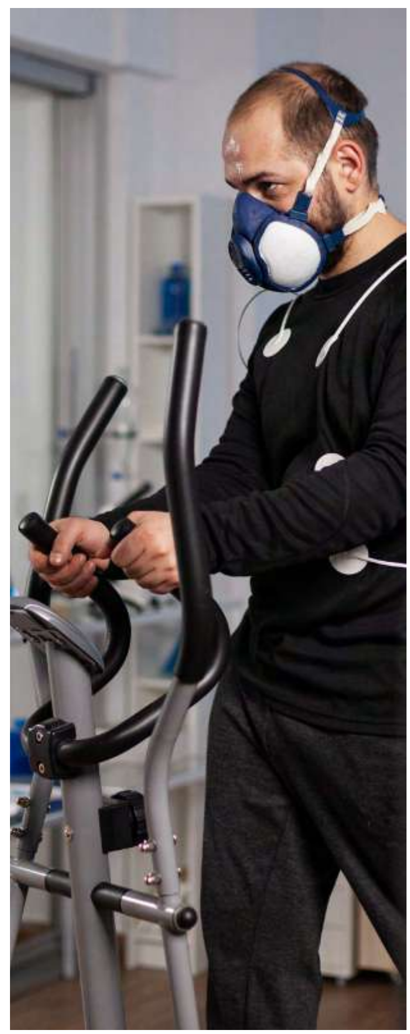

SDGs and Standards

By **Anil Jauhri**, Former CEO of the National Accreditation Board for Certification Bodies (NABCB) India

OPINION ARTICLE

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The United Nations adopted the Sustainable Development Goals (SDGSs) in 2015 to address poverty, inequality and environmental challenges by 2030.

The 17 SDGs are adopted by 193 countries as part of the agenda for sustainable development and officially came into force on 1 January 2016.

It may be desirable to list the 17 Goals:

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy?
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and economies
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnership for the goal

They provide a comprehensive framework for member countries to align their policies and strategies with the objectives in view and ensure that all members work towards the same goals.

Where do standards fit into this framework if at all?

Each of the goals needs actionable methodologies, roadmap and milestones.

It has to be understood that many of these goals may need regulations in each economy which given the urgency of sustainable development, are likely to rise further. For example, SDG 3 on Health obviously lends itself to regulation of both products and services– be it food or drugs or medical devices or medical labs or hospitals. The SDG13 on Climate action has lately become a priority and India is responding to it by developing the Carbon Credit Trading Scheme which has a mandatory compliance mechanism and targets for emission reduction for specific sectors of industry. Not only India but many developing economies are now developing national regulations relating to emission reduction besides adhering to the provisions of the Paris Agreement signed in 2015.

Standards are an excellent tool to support both regulations and voluntary action in meeting the SDGs.

Standards provide a sound basis for such regulations– from organizational quantification (ISO 14064-1) to emission reduction projects (ISO 14064-2) to methodology for validation and verification (ISO 14064-3) to requirements for GHG validation and verification bodies (ISO 17029 read with ISO 14065). Standards also provide platform for promoting voluntary action for example in SDG 7 on Clean energy through its work on renewable energy– from photovoltaic modules (IS 14286 in parts) to power inverters (IS 16221 in parts) to domestic water heating systems (ISO 9459 in parts).

The global market is increasingly concerned with social issues like child labour, fair wages and workplace safety and is increasingly demanding action beyond regulations. Which has led to rise of social responsibility standards like ISO 26000 and even in private space like SA 8000 by the Social Accountability Institute in USA or FSSC 24000 by the FSSC Foundation in Netherlands which in turn have secured global acceptance and have become a prerequisite for access to the market.

Another set of standards which supports achievement of SDGs is what is called the Management Systems (MS) Standards– pioneered by ISO 9001 for Quality Management Systems published in 1987 which is arguably the world's largest certified standard. It has led to a series of MS standards which support various SDGs– ISO 14001 (environment), ISO 37001 (antibribery), ISO 45001 (workplace safety), ISO 50001 (energy) et. Al. A complete list of MS standards can be seen at https://www.iso.org/management-system-standards-list.html

Which brings us to another aspect– the demonstration of compliance to such standards– called conformity assessment comprising such methods as testing, inspection and certification (TIC).

Be it regulations or voluntary standards, credible and reliable conformity assessment is a necessary adjunct. Here also standards play an important role. How do I trust a test report or organic certification?

Standards have stepped in here too by providing common global standards for what are called conformity assessment bodies– ISO 17020 for inspection bodies, ISO 17025 for testing laboratories and ISO 17065 for product or process certification to name a few of them.

These not only provide confidence in conformity assessment but also, through a system of accreditation of such bodies, promote global acceptance of test or inspection reports or certifications.

Courtesy:

(i) SDG SAMVAAD Issue 14 published by CSSA, GIM
(ii) Green Bridge Issue 2 published by SEPC, GOI

The Recent Incorporation of the Global Accreditation Cooperation (Global ACI)

By **Greg West** and **Karthik Easwar**

GENERAL INFORMATION

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In a press release the Global Accreditation Cooperation Incorporated (Global ACI) announced the official start-off of this recently established organization that will replace the International Accreditation Forum (IAF) and the International Laboratory Accreditation Cooperation (ILAC) whose memberships decided unanimously to operate as a single organization. The official commencement of its full operations, including the launch of its own Multilateral Recognition Arrangement (MRA), has been in effect as of 01 January 2026.

IAS, a signatory of both legacy organizations, will continue to be a full member of the new Global Accreditation Cooperation Incorporated without changing its signatory status in all recognized disciplines and areas covered by its current conformity assessment scopes.

Under the ILAC MRA, IAS had been recognized to provide accreditation services providing its clientele with acceptance of testing, calibration, medical testing, proficiency testing provider and inspection results worldwide. While the IAF MLA has enabled international acceptance of IAS accredited certification of management systems, products, processes, and persons.

To continue with the same structure of governance the Global ACI, would continue relying on recognized regional accreditation groups, such as APAC to be integral parts of the global architecture under the Cooperation.

Why the IAF/ILAC replacement matters

For governments, regulators, industry and consumers, accredited conformity assessment results and certificates must be trusted and accepted across borders, "bringing global trust for a better world".

By replacing ILAC and IAF with a single organisation, the global accreditation system that underpins trade, safety and consumer confidence will become simpler, more efficient and easier to trust. The formation of Global Accreditation Cooperation Incorporated will reduce duplication of efforts, harmonise accreditation policies and procedures and enable more consistent application of standards across sectors and borders.

What is changing

One organisation, one governance framework. While the governance and organisational structure of IAF and ILAC are evolving through the formation of the Global Accreditation Cooperation Incorporated, continuity is being maintained in scopes of accreditation and membership. The new organisation will bring a more unified framework without changing the trusted relationships or recognitions that regulators, industry, consumers and the conformity assessment community rely on.

One global Cooperation, one MRA. The Global Accreditation Cooperation Incorporated's MRA will cover the scopes previously recognised under the ILAC Mutual Recognition Arrangement and the IAF Multilateral Recognition Arrangement, providing a single, clearer pathway for mutual recognition of accredited conformity assessment results.

What isn't changing

Continuity of recognition. Existing accreditations issued under the ILAC MRA and/or IAF MLA will continue to be recognised as arrangements transition to the Global Accreditation Cooperation Incorporated MRA.

No service interruptions. Accreditation bodies (ABs), conformity assessment bodies (CABs), scheme owners and regional groups will continue operating as normal through the transition.

Existing marks remain valid during transition. The IAF MLA and ILAC MRA marks will remain valid for as long as required until full adoption of the Global Accreditation Cooperation Incorporated new mark.

How the global system continues to work

Proven regional machinery remains in place. Regional Cooperation Bodies (AFRAC, APAC, ARAC, EA, IAAC, SADCA) will continue to support peer evaluations and regional coordination that feed the global MRA.

Confidence through peer evaluation. As with ILAC and IAF, confidence is built via rigorous, standards-based peer evaluation (ISO/IEC 17011) of ABs and regions, ensuring that accreditation remains a strong enabler of mutual recognition.

What stakeholders should do now

Regulators and policymakers: Prepare to reference the Global Accreditation Cooperation Incorporated MRA in laws, regulations, specifications and schemes (with transitional recognition of ILAC/IAF marks).

CABs and scheme owners: Continue normal operations; maintain use of current ILAC/IAF marks during the transition period, then phase to the Global Accreditation Cooperation Incorporated mark once available per guidance.

International partners: Expect a single point of liaison for accreditation policy and technical input; existing MoUs will be renegotiated or transitioned to the Global Accreditation Cooperation Incorporated.

Global Accreditation Cooperation Incorporated

About Global Accreditation Cooperation Incorporated

The Global Accreditation Cooperation Incorporated is a not-for-profit Incorporated Society registered in New Zealand (6 December 2024). It brings together accreditation bodies, stakeholders and regional cooperation bodies to operate a single global Multilateral Recognition Arrangement supporting international acceptance of accredited conformity assessment results.

Official name:
Global Accreditation Cooperation Incorporated;

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TO NOTE

Email addresses: General correspondence should be sent to secretariat@global-aci.org and not the IAF or ILAC secretariat addresses.

Websites: The IAF and ILAC websites will remain available for archival/reference purposes, to allow individuals to continue accessing documents and other information. No new updates will be posted on these websites.

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