

STANDARD

METROLOGY EDITION



BY METRASLATE

THE CERTIFICATE IS THE PRODUCT

PRODUCT DOCUMENT
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METRASLATE LLC



1. Summary

A calibration laboratory takes custody of a customer's instrument, does procedural work against a standard, and issues a document the customer will rely on and an assessor will audit for the life of the instrument. Everything the laboratory is — its equipment, its standards, its people, its procedures, its customers, its prices, its schedule, its quality system — exists to produce that document and to be able to defend it years later.

Standard is a domain-agnostic record and operations platform that ships as editions. The Metrology Edition is its first, built for calibration laboratories accredited to ISO/IEC 17025, and it is the edition in which the platform's primitives were forged: an append-only record spine, a certificate sealed by a ceremony and chained by hash, document rendering that freezes every word an auditor will read, an exact-decimal numeric contract that never lets a measured value touch floating point, an uncertainty engine per JCGM 100, decision rules per ILAC-G8 and ANSI/NCSL Z540.3, and fail-closed multi-tenant isolation enforced in the database.

Around the certificate the edition runs the laboratory, department by department: Production, Quality Assurance, Sales, Customer Service, Shipping and Receiving, Dispatch, IT, and management, each opening to its own day, and the customer's portal. Work orders with custody per line. Equipment with due dates that only the calibration itself may advance. Quotes that convert to work in one transaction. Invoices that post to a double-entry ledger as they issue. Nonconformities with cause trees, corrective actions, affected-item investigations, and dispositions that carry the customer's decision and the out-of-tolerance notice. Controlled documents under revision. A schedule, a timecard, a store, a chat, a workflow engine, and Sigma Analytics — measuring the laboratory's deviation from the standard — with fifty-one shipped reports over fourteen subjects. Every screen uses the laboratory's own words.

And it answers the question no laboratory has been able to answer: what a calibration actually costs. Because procedure, datasheet revision, and service level are frozen onto every job, labour and standards time land on the job that consumed them, and cost, margin, and throughput become facts on the record rather than estimates at month end.

2. The problem

2.1 The laboratory runs on fragments

A calibration laboratory, like most companies, operates out of systems that were never one: a laboratory information system for the work, a separate accounting package for the money, a CRM for the customers, a scheduling tool for the people, a document control system for the procedures, a logistics app for the vans, email for the customer, spreadsheets for everything the systems do not hold, and paper for the assessor. Each holds a piece of the same instrument, the same customer, the same job, and none holds the whole. The certificate is produced in one, priced in another, invoiced in a third, and defended from a binder. Every hand-off between them is a place where a number is retyped, a date drifts, a decision is lost, and a person spends an afternoon reconciling what should have been one record.

Standard is one system for everything the laboratory does, on one record. The instrument that was quoted is the instrument that was received, calibrated, certified, invoiced, and recalled, and the same row carries all of it.



2.2 The document is the liability

A certificate states a measured value, its expanded uncertainty, the standards it traces to, the decision rule applied, and a statement of conformity. A customer relies on it to ship product, release a batch, or certify a system. An assessor opens it and asks for the technical record behind every number. If the record cannot reproduce the certificate exactly — the same numbers, the same words, the same standards, years later — the laboratory has a problem it cannot solve with a memo.

Laboratory software has treated the certificate as a report printed from a database, and the database as editable. A field changed after issue, a template revised, a vocabulary updated, and the certificate on the customer's wall no longer matches what the system will print today. Hash-verified certificates that cover the numbers but not the words are an inversion of what needs protecting: the auditor reads the words.

2.3 The numbers are not exact

Measured values, uncertainties, and tolerances pass through floating-point arithmetic in most laboratory systems, and a value of 1.20 becomes 1.2, or 1.1999999. A metrologist knows the difference between those. The software has not.

2.4 The laboratory does not know what a calibration costs

Labour, standards time, rework, and the difference between a service level's promise and its actual effort are not on the job. Pricing is by feel. Margin by service, by customer, by technician is unknown, and the laboratory discovers a losing contract a year after signing it.

2.5 The quality system lives in binders

Nonconformities, corrective actions, the impact of a standard found out of tolerance on the work it touched, procedure revisions, signatory authority, and the customer's decision on a failed unit are recorded in spreadsheets and paper, disconnected from the calibration events they concern, and reconstructed for the assessor's visit.

2.6 The customer is on the phone

Where is my unit, when is it back, what did it fail, what do you want me to do, where is the certificate. Every one of those is a call the laboratory answers by hand.

3. The platform

Standard is one platform that ships as editions: the substrate — records, tenancy, documents, operations, numerics, analytics — is shared, and an edition declares its subjects, its vocabulary, its numbering, its hubs and covers, its document templates, and its shipped reports in a manifest. The substrate carries no assumption about the industry it records; the Metrology Edition is the first edition and the one in which the substrate was proved.

Three design pillars govern every edition. The asset is the primary record: everything the laboratory does is to an instrument, and the instrument's record is where the history lives. The core is shared and the vertical is a configuration: what a laboratory changes is display labels, its own value-list entries, its settings, and the kinds it creates; a value's identity and a record's structure are the same for everyone, which is what makes portability possible. And the customer's vocabulary changes the words, never the structure: a laboratory that



says "Instrument" sees Instrument on every screen and every document, and the record underneath is unchanged.

4. The record model

The laboratory's records, in the laboratory's words.

Equipment. The instrument is the primary record: register, detail with tabs, add form, outside calibrations, and traceability readable in both directions — what this instrument was calibrated against, and what this standard was used to calibrate. The laboratory's own standards are equipment flagged as standards. An instrument's calibration due date has exactly one writer: the calibration event that freezes. Asset templates hold a manufacturer's model family — variants, default interval, procedure, specification bands, and instrument command rows — so a new unit inherits what its family already knows.

Customers, sites, contacts. Customer groups; per-site scope carried as a type; a contact may be invited to the portal.

Leads and opportunities. Leads on a kanban of statuses the laboratory defines, with disqualification reasons and conversion; opportunities on a draggable board by stage with outcome reasons and a funnel; a book of business per representative.

Quotes. Raised, priced from the laboratory's own price book, sent (which freezes the PDF), approved, declined, withdrawn, or revised; converted to a work order in one transaction. The customer can build and approve a quote in the portal. The decision rule that will govern the calibration is agreed at the quote, as ISO/IEC 17025 §7.8.6 requires.

Work orders. Lines of one instrument and one service; custody per line; statuses through one chokepoint using the laboratory's own value list; holds as a status; promise dates the portal can see.

Runs and calibration events. A run is the editable capture — as-found and as-left readings, environment, standards attribution, pre-flight; one in-progress run per instrument. Completion freezes the event, append-only. A correction is a new event that supersedes; nothing is edited in place. The frozen readings are the technical record.

Datasheets. The laboratory's authored test definition per make and model: formulas with a live preview, a revision lifecycle of draft, submitted, and approved, with each formula's version pinned at approval so a certificate always knows which arithmetic produced it.

Service levels. A mathematics regime, a certificate template, and a price multiplier, resolved equipment → site → customer → laboratory default, and locked at run start.

Certificates. The spine. Section 5.

Nonconformities, corrective actions, affected items, watch items, dispositions. A nonconformity the laboratory opens; its cause as a tree with evidence; its fix with an owner and a check; a standard declared out of tolerance names what it touched, with impact declarations on each affected calibration; an authored rule watches readings and raises a watch item; a disposition carries the customer's decision on a failed unit — six options — and produces the out-of-tolerance notice to the customer.

Controlled documents. Procedures, work instructions, and management-system documents with a cover, a revision log, sections, approval, and a review policy per document class.



Document templates. A visual editor with an element palette, tree, inspector, and live preview; draft → validate → publish (immutable) → activate.

Inventory, purchase orders, rentals, service catalog. The price book with mint, reprice, and retire; stock locations and receiving; rentals; purchase orders.

Invoices. Draft → issued → part-paid → paid → voided; issuing posts the journal in the same transaction; credit by receipt; month close and trial balance in the edition's own double-entry ledger.

People. Employees, roles, and seats; punches on an append-only timecard (work, meeting, training, break, out) with durations derived and never stored; N-week schedule cycles; time-off requests and approvals; a people-by-day grid.

Commitments. The promises the AI teammate makes — created, nudged, completed — never auto-completed, always on the record.

Requests, pickups, deliveries, routes, dispatch. Service requests the portal raises; logistics from requested through dispatched, picked up, under review, and converted.

Every one of these is a register with the same bar, the same lookup, the same doors, and the laboratory's own words on it.

5. The certificate

5.1 What it carries

The issue date, distinct from the calibration date, and the authorizing person. The decision rule and its guard-band basis. Per-point uncertainty with coverage factor, confidence, and effective degrees of freedom, and the reported-uncertainty floor. As-found and as-left. The standards used, each with its upstream certificate number, hash, and issuing authority. The environment as recorded. The procedure revision. The customer and instrument identity as captured. Amendment identification on any revision after the first. Signature manifestations — name, time, and meaning — for both signers. No recommended interval unless agreed.

5.2 How it is sealed

The technician signs for authorship. A quality reviewer signs for approval. The QA seal is the single event that mints the certificate number, renders the PDF, and appends the certificate to the laboratory's chain — and it is the only way a certificate can exist; the database refuses any other path. Four-eyes is enforced at review and at seal, and any override is itself audited. A seal-time drift check refuses to seal if the template, the payload, the vocabulary, or the standards moved since the review.

5.3 The chain

Every issued document is appended to a per-laboratory hash chain and signed with an Ed25519 key over the capture and the previous hash, inside a serialized append. The PDF, the canonical payload, and every consumed image are content-addressed before commit. A nightly walk re-verifies signatures, bytes, payload homes, token bindings, and mint reconciliation across the whole chain.

5.4 Every word, frozen

The capture covers the data, every display word, the final bytes, every image and appendix, and the retrieval-code binding. The exact wording shown at issue is frozen with the certificate; verification checks the



frozen wording, never current terminology. A laboratory can rename "Equipment" to "Instrument" tomorrow, and yesterday's certificate still says exactly what it said. This is the property that makes a re-render years later either identical or a verified failure, and it is the property the platform's later editions inherit as hash-verified rendering with deterministic vocabulary projection.

5.5 Revisions

Re-seal, same number and revision, reason mandatory. Amend, new revision, reason printed on the paper when bound, customer notified. Withdraw, status only, reason mandatory. Currency is derived, never a flag. An as-found declined certificate and a post-repair certificate are two histories, and the original is preserved byte-identical, as §7.8.8 requires.

5.6 Verification, labels, notices

A QR on every certificate opens an unauthenticated, throttled verification page: number, revision, issuing laboratory, instrument identity, issue date, status, and a verdict badge. A superseded certificate verifies as itself and says so. Released certificates only. Calibration labels in three sizes, per certificate or batched per work order, printed directly, carry the same verification URL. A customer notice is prepared inside the lineage lock and delivered after commit on release, amendment, and withdrawal, with every attempt recorded.

5.7 Fences

The spine is guarded by nine invariants — no certificate outside sealing; signers in scope; four-eyes; the seal matches the reviewed version; the two copies agree; revisions whole or not at all; release targets the current version; no signature on a superseded record; one lineage change at a time — and the document pipeline by thirteen more — one renderer; no raw numbers; served as captured; unknown templates rejected; every image hash-checked; numbers only from the numbering service; no free-text template logic; retrieval codes not redirectable; issued records immutable; the reproducibility checker off live settings; PDF/A independently verified in continuous integration; no notice before release; the nightly sweep. Each is a test with a planted violation.

6. The metrology engine

6.1 Exact decimal

No measured value, uncertainty, tolerance, or conversion factor is ever a floating-point number. Values are exact digits plus scale, so that 1.20 and 1.2 are different values. Rounding happens only at the certificate, at a recorded conversion, and at a policy constant. Unit conversions are exact fractions; offsets are never applied to differences. Numbers travel as text. Internal precision is 34 significant digits. A bytecode fence bans every floating-point call across the metrology module, and it has been watched to bite.

6.2 Uncertainty budgets

Per point: components with Type A or Type B evaluation; distribution — normal, rectangular, triangular, U, Student-t — with the divisor each implies; value, sensitivity, degrees of freedom, unit. Root-sum-square combination per the GUM. Effective degrees of freedom by Welch–Satterthwaite. Coverage factor from a versioned Student-t table ($\nu = 1$ to 100 and infinity) or a fixed k . Expanded uncertainty rounded to the service level's significant figures, default two, with full precision kept beside it. Default coverage 95.45 %.



6.3 Decision rules

Six rules by code: simple acceptance; ANSI/NC SL Z540.3 Method 5; ILAC-G8 guarded acceptance; ISO 14253-1 (0.83U); Z540.3 Method 6 (Dobbert, with the $\max(0, M)$ clamp); and UKAS root-sum-square. Guard-band width and per-side acceptance limits. The four ILAC zones — pass, conditional pass, conditional fail, fail — with a record of verification as a separate outcome. The default is guarded acceptance with the band equal to U, printed on the certificate, with per-customer override agreed at the quote.

6.4 Validity gates

Test uncertainty ratio as span over $2 \cdot U_{95}$, under two configurable bases. Each method's TUR window, Dobbert's TUR requirement, and the rule that tolerance half-width must be at least U are gates that pass, warn, or refuse — and a refusal blocks completion. Simple acceptance is valid only at $TUR \geq 4:1$.

6.5 Traceability

Each frozen point records the standards used with certificate number, hash, and issuing authority. Both directions are readable on the instrument. A run cannot start unless every standard it will use is itself in calibration. An instrument not flagged as a standard is refused at attribution and as scope.

6.6 Intervals

The calibration event advances the instrument's next due date — the only writer — recording the interval, the basis applied (performed, prior due, or an outside record from another laboratory's certificate), and the event that set it. A limited-scope calibration does not advance the due unless configured. A template carries the family default. Interval optimization reads the instrument's own as-found history and proposes the interval its reliability supports, so the laboratory calibrates on evidence rather than on habit.

6.7 Out of tolerance

A standard declared out of tolerance names what it touched: affected items with impact declarations on each calibration the standard was used for, so the laboratory can state, per certificate, whether the finding matters. Watch items raise when an authored rule sees readings drifting toward a limit. The disposition carries the customer's decision on a failed unit — the six options the laboratory offers — and produces the out-of-tolerance notice to the customer with the certificate it concerns. This is ISO/IEC 17025 §7.10 as records rather than as a memo.

6.8 Scope and CMC

The scope of accreditation and its calibration and measurement capabilities are records: a CMC budget builds a claim from a contributor table, a low/high pair, one k, U rounded up to two figures, and a fitted gain-and-offset line, and refuses to publish onto a standard's specification catalog any claim worse than the scope permits.

6.9 The live calculator

Quality Assurance runs a hypothetical measurement through the same evaluator a frozen record uses, so a technician can see the budget, the rule, and the zone before the run.



7. Operating the laboratory

Production. A technician opens to My Day: what is on my bench, what is due and overdue, what is blocked or waiting on me. Production carries the queue behind it.

Quality Assurance. The signatory opens to what awaits review, oldest first; what ships after signature today; which standards are due and what failed first pass. The ceremony verbs — sign, review, seal, release, re-seal, amend, withdraw — are the desk's tools, and the live calculator and the nonconformity family live here.

Management. Audit-ready or not; turnaround; who is in; what the laboratory is carrying; open nonconformities by severity; corrective actions overdue; standards out of tolerance; open affected-item investigations; procedures past review; authorized signatories. At company scope: revenue and receivables under a finance privilege, throughput across laboratories, pipeline worth, accounts at risk.

Customer Service. What is waiting on a customer; what is past promised; what is ready to ship; who is on the line. The line runs on the one chat engine, so the customer's portal message lands in a real channel with a real person, and telephony is on the same desk.

Sales. Leads on a kanban with conversion; opportunities on a board by stage with a funnel; quotes; the book of business per representative with revenue, coming due, missed revenue, and stage and source breakdowns.

Shipping and Receiving. Receiving against pickups and requests, custody on arrival, condition as received, what is ready to ship, and shipments out; every unit's stage visible to the portal.

Dispatch. Routes, stops, pickups, and deliveries over a live map, a queue sorted by when wanted, directions and best-order re-sequencing; navigation for the delivery driver, with the driver app coming soon.

IT. People, roles, and seats; modules switched on; settings by tier; integrations and the credential vault; sign-in and offboarding; the audit feed.

Schedule and timecard. Punch clock, week strip, month grid, N-week cycles, time off with approvals, a people-by-day grid.

My Metrics. Each person's own throughput, quality, and backlog over the shipped reports.

The dock. A tools tray present on every screen: notepad, calculator, the line, time, schedule, the register, the navigation band.

The store. Listings, a basket, orders approved and fulfilled from stock, for laboratories that enable it.

Chat. Channels, direct messages, threads, reactions, pins, mentions, attachments, presence, search, an audit feed, and a retention sweep. The assistant is a pinned direct message.

Workflow. Flows drawn on a canvas with branches and conditions, published as immutable versions, activated; a dry-run simulator; queues with roles and members; route boards as lane boards; notifications to the bell and to email; an automation hub with per-flow health.

Sigma Analytics. Measuring the laboratory's deviation from the standard. A composer on pickers — subject, group-by with date grain, filters, measures — publish with an audience, drill to rows, promote a list to a saved register view. Fourteen subjects: equipment, calibration events, work orders, work-order lines, opportunities, leads, receivables, QA rejections, standard usage, quotes, customers, staff presence, logistics stops, held



items. Fifty-one shipped reports seeded at birth, each with a better-is direction: throughput, first-pass yield, turnaround, service mix, rework rate, QA rejection reasons, standards due, recall due, past promised, due this week, ready to ship, overdue receivables, AR aging, revenue by month, win rate, sales cycle, and the rest.

8. Documents and reports

Every document is rendered through one renderer from a published template, captured with every word, and served as captured. The certificate, as a one-page cover — standards with traceability, procedure, received and returned condition, the decision rule, two signatures, the QR — plus data pages, in PDF/A, verified by an independent PDF/A validator in continuous integration. Labels in three sizes. Quotes frozen on send. Invoices issued, delivered as a notice, downloaded as PDF/A. Controlled documents with cover, revision log, and sections. The assessor pack: the laboratory's records exported with a cover mapping each file to the ISO/IEC 17025 clause it answers.

9. Standards

ISO/IEC 17025:2017 clause	The record that answers it
6.4 Equipment	Equipment records, flags, events, datasheet bindings
6.5 Metrological traceability	Standards as equipment flagged as standards; their calibration events; standards-used edges on every frozen point
7.2 Methods; 7.5 Technical records	Datasheets under revision; calibration events with frozen readings
7.7 Validity of results	Calibration events on the laboratory's own standards; watch items on drifting readings
7.8 Reporting — 7.8.1.1 review before release; 7.8.6 the decision rule printed and agreed at the quote; 7.8.8 amendments as new revisions with the original byte-identical	The certificate spine and its ceremony; the amendment path
7.10 Nonconforming work; 8.7 Corrective action	Nonconformities, corrective actions, affected items, impact declarations, watch items, dispositions
8.3 Control of management-system documents	Controlled documents and revisions with a review policy

Decision rules per ILAC-G8:09/2019, ANSI/NCSL Z540.3 Methods 5 and 6, ISO 14253-1, and UKAS. Uncertainty per JCGM 100. Certificates and invoices in PDF/A.



10. The portal

The laboratory's customers see their own fleet, what is due for calibration, where each unit is and when it is back, what needs their decision, and their released certificates, with the QR verification behind each. They build and approve quotes, raise service requests, schedule pickups and deliveries, and message the laboratory into a channel a person answers. The portal is a two-sided wall: portal accounts are admitted only under the portal API and refused everywhere else, with per-site scope carried as a type. A laboratory member with a preview privilege can see a customer's portal read-only.

11. Import and cutover

A laboratory brings its history in six books — equipment, customers, work orders and calibration events, certificates, standards history, and vocabulary — through a five-tier alias ladder that maps its old words to the platform's identities, with a receipt on every imported value naming its source and the rule that resolved it. Unresolved values land in a gaps inbox for a person. Cutover is by cluster of entangled records — the customers, instruments, and standards that reference each other — never by location, and never with dual writes. The certificate back-file arrives in two halves: the records, and the PDFs into a content-addressed store.

12. Tenancy and security

Every tenant-scoped table carries row-level security enabled and forced: 339 live tables, 290 carrying the tenant column, 285 with the wall enabled and forced, and every remaining tenant-bearing table handled by name. A query with no tenant predicate returns nothing. The tenant is stamped transaction-locally at connection acquire and resolved from the host alone. Large laboratories run on their own database; the long tail shares a schema behind the wall; one placement layer sits between them.

Sign-in is by an identity provider with organizations, invitations, optional multi-factor, and fail-closed matching of organization to tenant; offboarding ends access on a timer. Every mapped handler is default-deny, and 105 handlers declare the privilege they require — quote, work order, invoice, price book, settings, store, and payables writes; people management; portal preview; procedure, report, and role authoring; QA review; finance view. Modules are two-tier: the platform grants availability, the laboratory switches on. A per-tenant credential vault holds integration secrets. The AI teammate's providers sit behind an egress guard, with the model chosen server-side and three tiers from rulebook to bring-your-own-model.

13. Integrations

Identity through the provider's organizations and invitations. Mail over SMTP, Gmail, Microsoft Graph, and IMAP, with document notices and invitations. Accounting synchronization to QuickBooks and Xero. Telephony on the Customer Service line. Maps for directions and route ordering. Imports from any prior system through the six books and their CSV templates. Instrument command rows on asset templates, bound to function and band. Subscription billing to MetraSlate through the payment provider's webhooks.



14. Technology

Kotlin on the JVM with Spring Boot; sealed types for record lifecycles. Raw JDBC through a safe-SQL kit, no ORM; every query explicit and inspectable. PostgreSQL, managed, with row-level security enabled and forced, tenant-leading indexes, and tenant context through asynchronous execution. Content-addressed document storage per tenant. A React front end with an instrument aesthetic: functional-only color, tabular numerals, one register bar on every list. Continuous integration with architecture fences, lint fences, a PDF/A validator, and planted-violation receipts.

15. The platform family

Standard ships as editions on one platform. The Metrology Edition is the first. Standard with the metrology module off is Asset: the same custody, records, and documents for any organization whose work is procedural against a standard. Sigma Analytics is the analytics layer, core to every edition and never gated. The portal serves every edition's customers. The Public Safety Edition and the Traceability Edition are the second and third editions, and they inherit the certificate's discipline — every word frozen, every number exact, every decision by a rule with a guard band — as the record model for incidents and for AI inference.

16. Next

The driver app for Dispatch. The assessor pack as one click. Training-currency, internal-audit, and management-review records joining the quality family.

17. Why this works

A certificate is the hardest document in commercial software to keep: exact to the last digit, defensible for the life of an instrument, reproducible word for word, traceable through a chain of standards, and issued only by a ceremony that a database enforces. Standard was built to keep it, and the primitives that required — the append-only spine, the sealed and chained document, the frozen vocabulary, the exact-decimal contract, the uncertainty engine, the guard-banded decision rule, the fail-closed wall — turned out to be what every organization that must defend a record needs. The Metrology Edition is where they were proved, on the record that forgives the least.