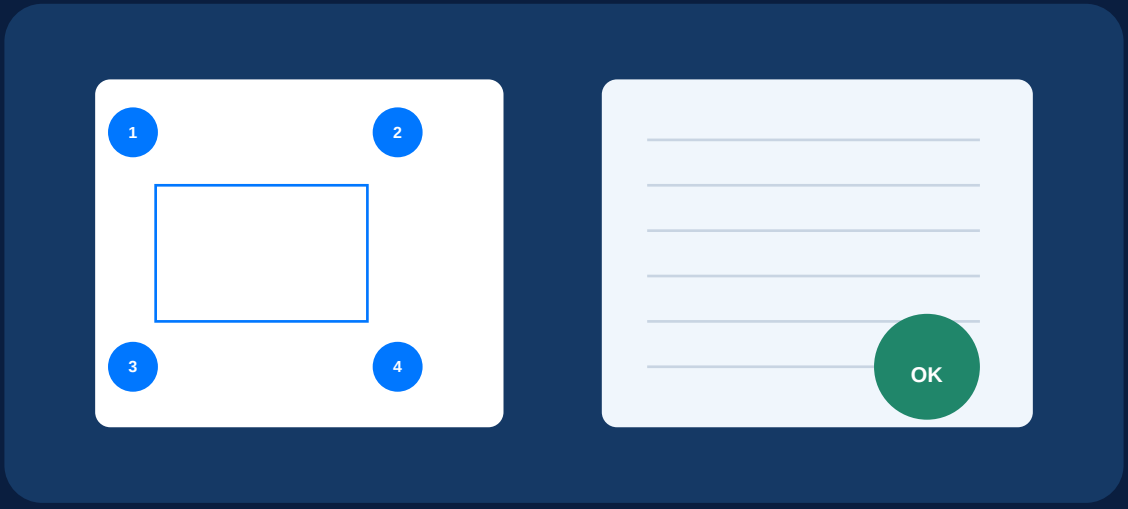
QUALITY ENGINEERING

INSPECTION & DOCUMENTATION GUIDE

Requirements | Methods | Evidence | Traceability | Release



A practical guide to defining inspection and delivering clear, traceable evidence

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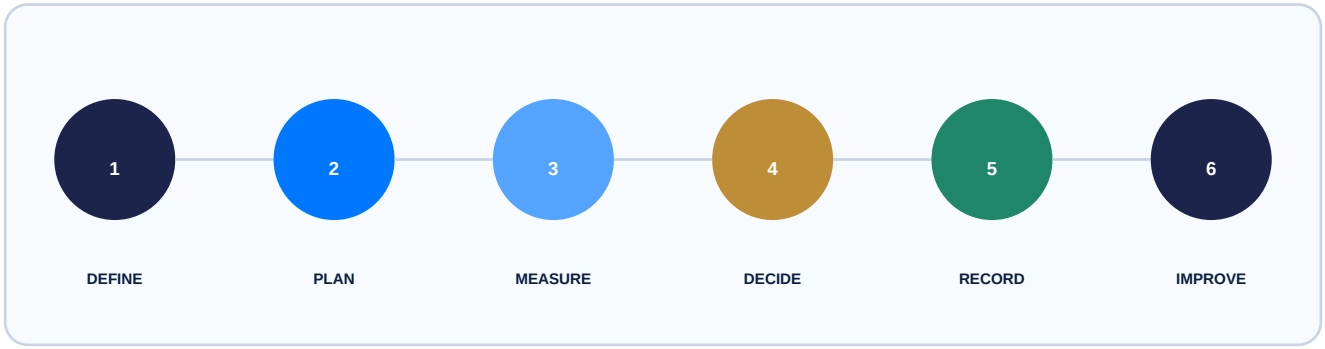
00 Build a closed inspection loop

Inspection is not a final sorting step. It converts design requirements into reliable evidence and feeds variation back into process control.



Stage	Question	Controlled output
Define	What drawing, model, specification and revision govern?	Approved product definition and requirement hierarchy
Plan	Which characteristics, risks, methods, frequency and records apply?	Inspection plan / control plan
Measure	Is the method capable, calibrated and repeatable for the tolerance?	Traceable raw result and environmental context
Decide	What rule proves conformity, especially near a limit?	Pass/fail disposition and reviewer approval
Record	Can the result be tied to part, lot, operator, equipment and date?	Inspection report and linked certificates
Improve	What does variation reveal about the process?	Corrective action, capability and revised controls

PRINCIPLE

A measurement without the requirement, method, unit, characteristic ID and product traceability is a number - not release evidence.

01 Control the product definition

Inspection begins by confirming exactly what must be built and which source wins if documents conflict.

Definition source	Control	Release check
Purchase order	Part, revision, quantity, specifications, certificates and customer flow-downs	Matches acknowledgement and traveler
2D drawing	Units, projection, datums, dimensions, notes, finish and general tolerances	Latest approved revision available
3D model / PMI	Authority, semantic PMI, derived dimensions and conflict hierarchy	Exact dataset and version identified
Material specification	Alloy, temper, product form and certification requirement	Certificate fields and traceability defined
Process specification	Heat treatment, welding, finishing, marking, cleanliness or special tests	Approved supplier/process and edition
Approved sample	Appearance, texture, color or boundary standard	Sample ID, revision, condition and retention
Deviation / waiver	Characteristic, limit, quantity, lot and expiration	Written approval linked before release

CONFLICT RULE

State whether the drawing, model or purchase order governs. Do not let inspection silently choose between inconsistent sources.

02 Translate requirements into an inspection plan

Each requirement should have an owner, method, frequency, acceptance rule and retained record before production starts.

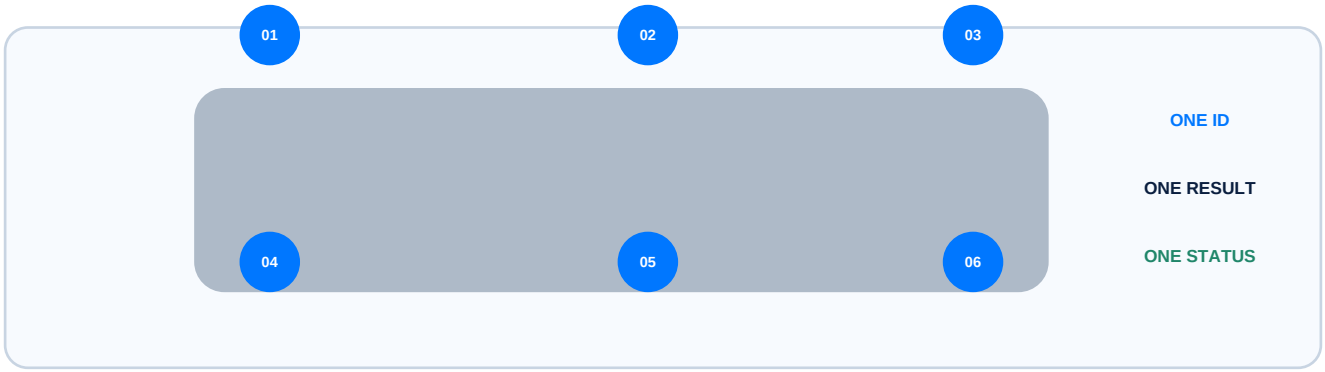
Plan field	Define	Common failure
Characteristic ID	Unique balloon/PMI identifier linked to the requirement	Results cannot be reconciled to the drawing
Requirement	Nominal, limits, GD&T; frame, note or specification clause	Ambiguous acceptance
Classification	Critical, major, minor, key or customer-specific designation	Inspection effort is not risk-based
Stage	Incoming, setup, first-off, in-process, final or pre-shipment	Defects found after value has been added
Method	Instrument, fixture, program, test procedure and environmental need	Method does not match measurand
Frequency	100%, first/last, per cavity, per setup, interval or sample plan	Coverage changes by operator
Reaction	Stop, segregate, notify, adjust, reverify and expand containment	Out-of-control product continues
Record	Report field, data system, retention and approval	Evidence cannot be retrieved

PLAN EARLY

Review measurement access, datum simulation and equipment capacity during DFM. A requirement that cannot be measured reliably is not ready for release.

03 Balloon every controlled characteristic

A ballooned drawing creates a stable key between design intent, inspection results and the final documentation package.



Characteristic type	Ballooning rule	Report entry
Size / coordinate	One ID for each separately evaluated requirement	Nominal, limits, measured value and unit
GD&T;	Keep the complete feature-control frame and datum references together	Method, result and pass/fail for the controlled characteristic
Multiple locations	Identify each location or state the quantity/position scheme	Individual values or justified summary
General note	Assign an ID when the note creates a verifiable product requirement	Objective evidence or N/A rationale
Material / finish	Balloon the controlling note or specification callout	Certificate/test reference and result
Visual / workmanship	Link to zone map, defect criteria and approved sample	Inspection condition, finding and status

NO ORPHANS

Every report line should resolve to a controlled requirement, and every applicable controlled requirement should resolve to evidence.

04 Prioritize critical characteristics

Classification should reflect product risk and process behavior, not simply how tight a tolerance looks.

Risk input	Questions	Control effect
Safety / regulation	Could failure create injury, regulatory noncompliance or mandatory reporting?	Enhanced prevention, traceability and release authority
Fit / assembly	Does the feature control interchangeability, stack-up or service access?	Functional gauging, tighter reaction and capability review
Performance	Does it affect load, seal, motion, electrical, thermal or corrosion function?	Test/measurement linked to performance need
Detection	Can the failure escape normal downstream checks?	Earlier or automated inspection
Process variation	Is the feature sensitive to tool wear, heat, fixturing, springback or coating build?	In-process frequency and trend monitoring
Customer appearance	Is the surface visible and governed by a controlled cosmetic standard?	Zone-based inspection and approved samples
Historical evidence	Have similar features generated escapes, rework or unstable capability?	Temporary containment or increased control

TIGHT IS NOT ALWAYS CRITICAL

Use functional risk to set classification. A loose-looking seal feature may be more important than a very tight nonfunctional dimension.

05 Choose a capable measurement method

Instrument resolution alone does not prove that a method is suitable for the feature, tolerance and production environment.

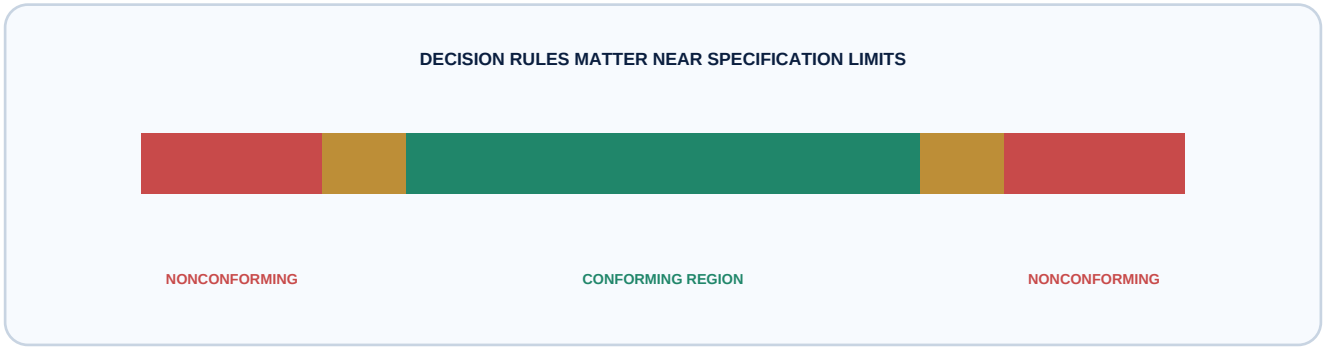
Method family	Strong fit	Watch items
Caliper / micrometer	Accessible sizes with clear contact geometry	Operator force, cosine/Abbe error, burrs and temperature
Height gauge / surface plate	Datums, steps, heights and comparative layout	Part support, datum stability and probe geometry
Bore/plug/ring/thread gauge	Fast attribute control of fits and threads	Wear, class, temperature and no numerical result
CMM	Complex geometry, datum relationships and automated reports	Alignment, probe access, strategy, filtering and program control
Optical / vision	Edges, patterns and small noncontact features	Edge threshold, lighting, focus and reflective surfaces
Surface tester	Specified profile texture parameters	Filter, evaluation length, direction and unsuitable curved zones
Coating gauge	Non-destructive thickness where substrate/method permits	Calibration standard, curvature, edge effects and coating system
Functional fixture	Assembly-like acceptance of related features	Fixture correlation, wear and hidden failure modes

CORRELATION

When supplier and customer use different methods, agree a correlation study and dispute method before production release.

06 Account for measurement uncertainty

Near a specification limit, the decision rule and uncertainty can change whether conformity is demonstrated.



Contributor	Typical source	Control
Instrument	Calibration error, resolution, repeatability and drift	Appropriate equipment, calibration and verification
Method	Probe/contact geometry, alignment, filtering and calculation	Controlled procedure and validation
Operator	Force, placement, interpretation and setup	Training, work instruction and reproducibility study
Part	Temperature, flexibility, burrs, cleanliness and surface texture	Conditioning, restraint and preparation rule
Environment	Temperature gradient, vibration, humidity and contamination	Defined inspection environment and monitoring
Sampling	Limited observations and within-lot variation	Risk-based sampling and statistical interpretation
Decision rule	Guard band or customer-specific acceptance rule	Documented agreement tied to the report

REFERENCE ISO 14253-1 addresses decision rules for verifying conformity or nonconformity while accounting for measurement uncertainty.

07 Control gauges, calibration and verification

A calibration label is only one part of metrological control; suitability, status and use conditions also matter.

Control	Minimum requirement	Evidence
Equipment ID	Unique identifier tied to records and location	Asset register and report entry
Calibration	Applicable range, interval, traceability and acceptance	Current certificate and status label/system
Intermediate check	Master, zero, reference artifact or control measurement	Recorded check at defined frequency
Suitability	Range, resolution, geometry and uncertainty appropriate to tolerance	Method review or capability study
Protection/storage	Clean, stable, damage-free storage and handling	Visual/pre-use check and controlled storage
Out-of-tolerance event	Impact assessment back to last known valid state	Affected-product review, containment and disposition
Software/program	Version, access, validation and backup	Approved program ID and change history
External laboratory	Required accreditation/scope or customer approval	Laboratory certificate and report

SCOPE MATTERS

An accredited laboratory or calibration provider must still have the relevant method, range and capability in scope for the required work.

08 Plan CMM and GD&T; verification

A CMM result is only as sound as the datum simulation, alignment, probing strategy and interpretation of the drawing standard.

Element	Define before measurement	Report / review
Governing standard	ASME Y14.5 or ISO GPS standard and exact edition	Method follows the same interpretation
Datum setup	Physical simulators, restraint, precedence and degrees of freedom	Setup description and alignment
Probe strategy	Tip, access, approach, number/distribution of points or scan path	Coverage suitable for feature form
Feature construction	Associated feature algorithm, filtering and outlier handling	Software settings/version controlled
Material condition	MMC/LMC/RFS, bonus and datum-boundary effects	Calculation shown or traceable
Composite/profile	Segments, simultaneous requirements and datum mobility	Interpretation agreed before programming
Flexible part	Free-state/restraint, supports and measurement sequence	Fixture and conditioning documented
Correlation	Alternative methods for production checks	Approved bias/repeatability evidence

PROGRAM CONTROL Tie the CMM program revision to the drawing/model revision. Revalidate affected characteristics after datum, probe, algorithm or software changes.

09 Use first article inspection correctly

FAI verifies that the released definition, planned process and inspection system can produce documented conforming output.

FAI element	Expected content	Common gap
Trigger	New part, revision, new/relocated process, new tooling or long interruption as required	Partial FAI performed without an approved basis
Production method	Representative material, tooling, setup, sequence, operator and finishing route	Prototype route does not represent production
Ballooned definition	All applicable drawing/model notes and characteristics identified	General notes, finish or material omitted
Results	Actual values where measurable; clear status and method/equipment traceability	Pass entered instead of numerical data
Certificates	Material and special-process evidence tied to the FAI part/lot	Certificate belongs to a different batch
Nonconformance	Documented disposition and customer approval where required	Rejected feature hidden by report closure
Approval	Prepared/reviewed dates and customer submission status	Internal completion confused with customer approval
Delta FAI	Only affected characteristics, with rationale and linkage to prior baseline	Change impact not evaluated

FAI IS NOT CAPABILITY

One conforming first article does not prove long-term process capability. Continue appropriate in-process control and production sampling.

10 Place inspection at the right stage

The best control point is early enough to prevent escape and late enough to reflect the delivered condition.

Stage	Typical purpose	Examples
Incoming	Verify purchased material/components before use	Alloy/temper, stock size, certificates, damage and supplier lot
Setup / first-off	Approve machine, fixture, program and offsets	Datums, tool-related CTQs, fixture seating and first piece
In-process	Detect drift before the batch is complete	Tool wear dimensions, hole location, flatness and visual conditions
Before special process	Protect characteristics that will be obscured or changed	Pre-coat dimensions, surface prep, mask zones and weld quality
After special process	Verify delivered finish and dimensional state	Coating thickness, color, adhesion, final fits and threads
Final	Confirm completeness, identity, workmanship and required results	Drawing audit, functional checks, documentation and packaging
Pre-shipment	Verify released quantity and delivery dossier	Lot match, labels, certificates, deviations and report approval

REACTION PLAN

For each in-process failure, define stop/hold boundaries, last-known-good point, expanded inspection, adjustment authority and re-verification.

11 Use sampling with a defined purpose

Sampling reduces inspection effort but accepts statistical risk; it must be tied to a lot, plan and decision rule.

Plan input	Define	Why it matters
Lot	Homogeneous product, quantity, time window, process and traceability boundary	Sampling is meaningless without a defined population
Characteristic/defect	Attribute or variable; critical/major/minor classification	Different risks need different controls
Sampling standard	Exact standard, edition, inspection level and switching rule	Avoids ad hoc sample-size selection
AQL / plan index	Contracted index used to select a plan	AQL is not a promise that every lot has that defect rate
Ac/Re or criterion	Acceptance/rejection numbers or variable-statistics rule	Makes the decision reproducible
Selection method	Random/systematic approach across the full lot	Prevents convenience sampling
Critical features	100% or prevention/capability strategy when sampling risk is unacceptable	Sampling alone may not control severe consequences
Rejected lot	Containment, review, rework/rescreen and re-submission rule	Prevents repeated presentation without control

CURRENT EDITION

ISO 2859-1:2026 replaces the withdrawn 1999 edition. Use the edition explicitly adopted by the contract and update internal plans deliberately.

12 Verify material and special-process certificates

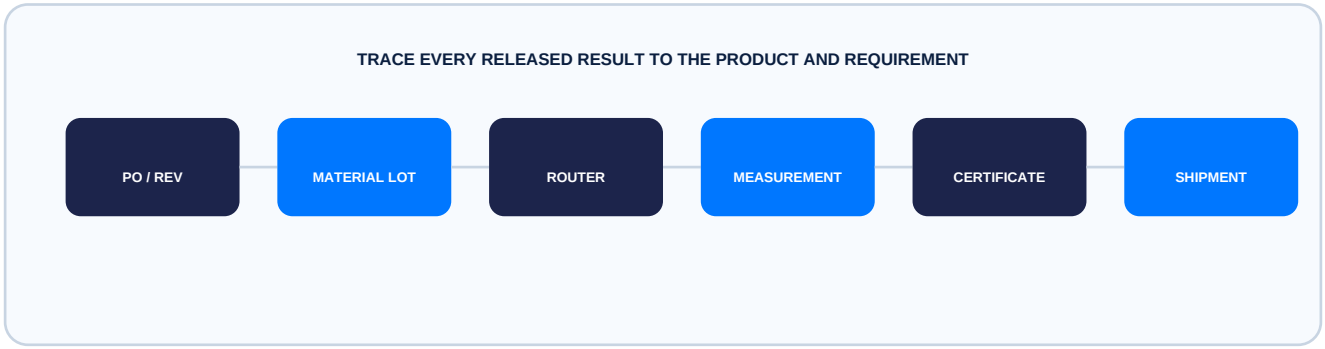
A certificate is useful only when its identity, scope and results connect to the delivered parts.

Document	Verify	Trace link
Material certificate	Alloy, temper, form, heat/lot, chemistry/properties and specification	Stock ID to traveler and finished-part lot
Heat treatment	Cycle/specification, batch, equipment, results and approval	Part/lot to furnace load
Anodize / coating	Process/class, thickness, color/seal/tests and batch	Part/lot to finishing batch and approved sample
Welding	Procedure, operator qualification, filler and inspection/test evidence	Weldment serial/lot and traveler operation
NDT / laboratory test	Method, acceptance, technician/lab qualification and results	Specimen/part identity and location
Calibration certificate	Asset, range, results, uncertainty, traceability and validity	Equipment ID used on report
Certificate of conformity	PO/part/revision/quantity/lot and authorized declaration	Shipment dossier and supporting evidence
Approved deviation	Characteristic, temporary limit, quantity/serials and expiration	Exact affected product and release

CERTIFICATE REVIEW Check content, not just presence. A certificate with the wrong specification edition, batch or process class does not support release.

13 Maintain end-to-end traceability

Traceability should allow a released part or lot to be reconstructed from order through material, process, inspection and shipment.



Trace object	Minimum link	Typical identifier
Customer order	Customer, PO, line, part, revision and quantity	PO / sales order
Material	Supplier, heat/lot, certificate and issued quantity	Heat, mill lot, extrusion lot or plate ID
Production	Traveler/router, machine/setup, operator and dates	Work order / batch
Special process	Approved processor, batch/load and certificate	Process lot / certificate number
Inspection	Characteristic results, equipment, operator and report	Inspection report / dataset ID
Nonconformance	Affected quantity/serials, disposition and re-verification	NCR / deviation / rework order
Shipment	Released quantity, package ID and delivery documents	Packing list / shipment / container ID

GRANULARITY

Choose serial, batch or lot traceability based on risk and contract. Do not claim single-part traceability when records only support a mixed batch.

14 Build a clear inspection report

A report should be independently understandable, reviewable and tied to the delivered product without hidden spreadsheets or tribal knowledge.

Report section	Include
Header	Supplier/customer, PO, part name/number, revision, lot/serials, quantity and report ID
Definition	Drawing/model/specification identifiers and editions; approved deviations
Characteristic	Balloon ID, requirement, nominal/limits, unit and classification
Result	Actual value(s), sample identity/location, status and comments
Method	Instrument/equipment ID, program/fixture/procedure and inspection stage
Environment	Temperature or conditioning when relevant to the result
Exceptions	NCR/deviation linkage, rework/reinspection and final disposition
Approval	Inspector, independent reviewer when required, dates and release status
Attachments	Ballooned definition, plots/images, certificates and referenced data files

DATA INTEGRITY Protect formulas, revisions, timestamps and approvals. If results are imported or transformed, retain the source and a controlled processing method.

15 Control nonconformance and change

A failed result must remain visible from detection through containment, disposition, rework and verified closure.

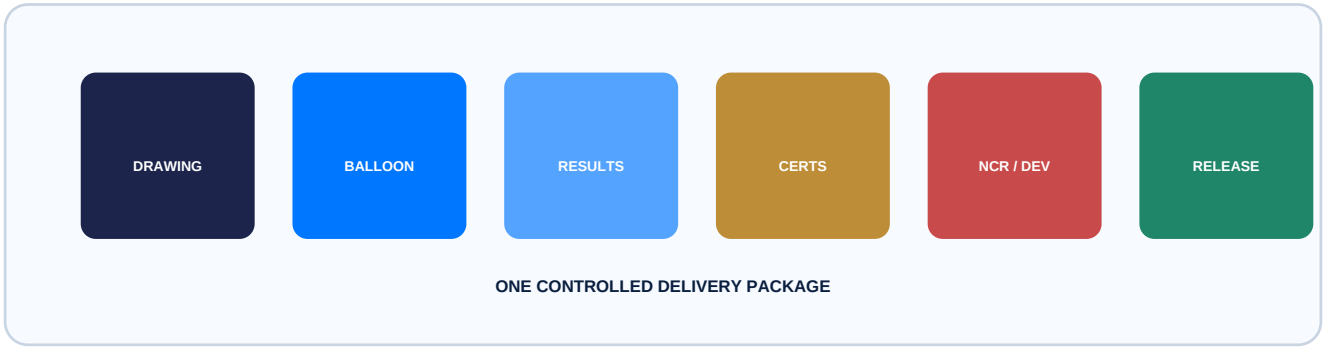
Step	Required control	Record
Identify	Part/lot, characteristic, requirement, actual result and detection stage	NCR with traceable evidence
Contain	Segregate affected and potentially affected product to a defined boundary	Hold location, quantity and status
Assess	Function, safety, assembly, downstream process and customer impact	Engineering/quality review
Disposition	Rework, repair, use-as-is, scrap or return with authorized approval	Signed disposition and customer approval when required
Execute	Controlled rework instruction and preservation of product identity	Rework traveler and operator record
Reinspect	Original failed requirement plus features affected by the rework	New results linked to the NCR
Correct	Root cause and systemic action proportional to risk/recurrence	Corrective-action record and effectiveness check
Change	Update drawing, plan, program, fixture, method and training as affected	Revision history and implementation date

NO DATA OVERWRITE

Preserve the original nonconforming result. Add reinspection as a new traceable result rather than replacing the evidence of failure.

16 RFQ and delivery-document checklist

Define documentation at quotation so inspection scope, reporting effort and approval timing are priced and planned.



Gate	Required input
Product definition	Controlled drawing/model, revision, standards, specifications and conflict hierarchy
Inspection scope	CTQs, balloon/FAI requirement, stage, method, frequency and customer source-inspection need
Acceptance	Limits, visual standard, decision rules, sampling plan and capability expectations
Metrology	Required equipment, CMM program/report, gauges, uncertainty and external-lab needs
Certificates	Material, heat treatment, finishing, welding/NDT, calibration and conformity documents
Traceability	Serial/lot level, marking, record linkage, retention and electronic format
Exceptions	Deviation authority, NCR notification, rework approval and customer response time
Delivery	Report template, language, file naming, dossier index and shipment-release approval

RFQ RESPONSE Ask the supplier to state inspection assumptions, excluded characteristics, sample basis, report format, certificate sources and non-recurring metrology cost.

Request a joint review through BAOSONG Engineering Support and Quality.

17 References and BAOSONG contact

Use the exact standard and edition adopted by the drawing, contract or quality system. Standards can be revised, replaced or supplemented by sector-specific requirements.

Reference	Guide use	Link
ISO 9001	Quality-management-system requirements; confirm the edition adopted by the organization	Official ISO page
ISO/IEC 17025:2017	Competence and consistent operation of testing and calibration laboratories	Official ISO page
ISO 2859-1:2026	AQL-indexed sampling schemes for lot-by-lot inspection by attributes	Official ISO page
ASME Y14.5-2018 (R2024)	Dimensioning and tolerancing / GD&T; interpretation	Official ASME page
ISO 1101:2017	ISO GPS language for geometrical tolerancing	Official ISO page
ISO 14253-1:2017	Decision rules for conformity/nonconformity with measurement uncertainty	Official ISO page

USE LIMITATION	Educational manufacturing guidance only. It does not replace the controlled product definition, approved inspection plan, qualified laboratory/metrology process, customer-specific requirement, applicable law or contract acceptance criteria.

REQUEST A REVIEW	Send CAD/drawing, revision, quantity, CTQs, FAI/sampling needs, required certificates, report format and delivery schedule.
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