Special Processes Institute



PRODUCTION READINESS REVIEW GUIDEBOOK



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Contents and How to Use This Guide

This guidebook helps manufacturing, quality and engineering teams decide whether a defined production system can repeatedly supply conforming product at the required rate. A Production Readiness Review (PRR) brings together design, industrialisation, supply chain, people, equipment, inspection and delivery evidence before a controlled production commitment is made.

Use the guide to plan readiness work early, challenge evidence independently and record a decision with clear limits. The strongest outcome is a production system that works reliably, rather than a complete presentation or a signed checklist. Production approval remains subject to the organisation's delegated authority and all applicable customer, contractual, statutory and regulatory requirements.

IMPORTANT This guide offers original practical guidance; it does not reproduce or replace controlled standards, customer manuals or contractual flowdown. Example gates, scores, thresholds and forms are recommendations unless adopted or flowed down as requirements.

Part	How to use it
Part A Foundations	Agree PRR purpose, applicable requirements, timing, decision authority and scope.
Part B Preparing the production system	Develop the design, configuration, route, risk controls, measurement, capacity, tooling, competence and supplier evidence.
Part C Special processes	Check validation, process qualification, customer approvals and the evidence chain through subcontract processing.
Part D Demonstrating readiness	Verify inspection, FAI, APQP, PPAP, production trials, preservation, traceability and supporting infrastructure.
Part E Conducting and sustaining PRR	Run the review, make a defensible readiness decision, close actions and use the worked example and reusable checklists.

PART A Foundations

1. Purpose and Scope of PRR

PRR is a structured, multidisciplinary assessment of whether the intended production system is ready for a specified commitment. The commitment might be a validation trial, initial production, a rate increase, work transfer or sustained serial production. Define that commitment explicitly: product and revision, site, route, equipment, suppliers, staffing, quantity, rate, delivery window and any permitted restrictions.

Review the complete value stream from requirements and purchased material to manufacture, special processing, inspection, packaging and customer delivery. Include off-site processors, shared resources, sub-tiers and digital dependencies. A local machine being ready does not establish that the end-to-end system is ready.

1.1 What the review should establish

- Requirements are understood, current, flowed down and verifiable.
- Design and production baselines are sufficiently mature for the proposed gate.
- The actual process has effective controls for safety, conformity and variation.
- People, materials, tooling, capacity and infrastructure support the commitment.
- Required approvals exist and are valid for the actual product, process and source.
- Residual risks and open actions have owners, authorised dispositions and limits.

1.2 Applicability and proportionality

Use PRR for new products, major changes, relocated work, new suppliers, new special processes and substantial rate increases. A risk assessment can also trigger re-review after repeated escapes, lengthy interruption, equipment replacement, loss of competence, approval withdrawal or a digital-system change. Established low-risk products may use a focused review if unaffected evidence remains valid and traceable.

PRR depth should increase with potential consequence, novelty, complexity, production volume and uncertainty. For low-volume aerospace manufacture, combine representative trials, process qualification, first-off verification and historical evidence from demonstrably comparable processes. Avoid presenting a few measurements as proof of long-term capability.

CORE PRINCIPAL A readiness decision applies only to the configuration, site, process, sources, rate and conditions reviewed. A material change to any of these may invalidate the decision.

1.3 Boundaries

PRR supports operational planning, production-process verification and risk control within a quality management system. It is not a universal named ceremony prescribed identically by AS9100 or ISO 9001. Customers may impose their own PRR, manufacturing readiness level, source approval or industrialisation process. Use the invoked procedure where required and map this guide to it.

2. PRR versus FAI PPAP and APQP

The methods overlap but answer different questions. Plan them together and reuse controlled evidence, while preserving the separate decision criteria and approval authorities. A single review meeting may cover several decisions only when each decision and its prerequisites are recorded distinctly.

Method	Question answered	Typical output and limit
PRR	Is the defined production system ready for the proposed commitment?	Readiness decision, scope, evidence index and actions. An internal decision does not itself authorise customer release.
FAI and FAIR	Has a representative first production article demonstrated accountability and verification of the design characteristics?	FAI is the activity; FAIR is the report and supporting evidence. One article does not establish sustained rate or long-term statistical capability.
PPAP	Does the approval evidence show that the production process can satisfy requirements under specified production conditions?	Customer approval package and approval status under the applicable scheme. Required submission content and acceptance depend on the invoked framework and customer.
APQP	Have product and process risks and deliverables been managed across development and launch?	Phased planning, deliverables, gate reviews and feedback. APQP is the lifecycle method; PPAP is a validation and approval output within it.
Qualification or validation	Does the design or process meet its intended performance or validation criteria?	Qualification or validation evidence. It may require testing beyond FAI or normal production inspection.

2.1 Aerospace & defence context

EN 9100 includes aerospace controls around operational risk, configuration, product safety, external providers and production verification. PRR is a practical way of bringing related evidence together. AS9145 provides an aerospace APQP/PPAP framework when invoked; AS9102 provides requirements for performing and documenting FAI when invoked. These are complementary activities, not interchangeable certificates.

2.2 Automotive context

Automotive customers commonly use AIAG APQP, Control Plan and PPAP with customer-specific requirements and, where applicable, IATF 16949. AIAG APQP third edition and the standalone Control Plan first edition was introduced in March 2024. A customer's adoption rules and submission instructions control implementation. Do not apply an automotive submission level to aerospace PPAP without an explicit customer agreement.

2.3 Practical sequence

Plan the product and process through APQP; review readiness before committing to the representative trial; conduct validation, FAI and required PPAP work; then review the actual results before release to the next stage. A pre-trial PRR can be Ready for Trial while remaining Not Ready for unrestricted serial production.

COMMON ERROR FAIR accepted is not the same as production ready. Check capacity, supplier continuity, operator coverage and sustained control even when first article results are satisfactory.

3. Contract Customer and Regulatory Flowdown

Begin with a requirement applicability register. Identify the source, exact revision, applicability, owner, implementation location, required evidence, approval authority and change notification rule. Include purchase orders, statements of work, drawings/models, specifications, quality clauses, customer portals and authorised correspondence. Resolve contradictory requirements with authorised parties before production.

3.1 Standards and requirement hierarchy

Record the invoked editions of EN9100, AS9145, AS9102, ISO 9001, AIAG manuals and any sector-specific or customer documents. Certification to one standard does not automatically invoke every related standard. Nor does a newer publisher edition automatically replace the edition stated in a contract. Regulatory obligations take precedence where legally applicable; contract conflicts require resolution rather than an informal local interpretation.

ISO's catalogue identifies a 2026 ISO 9001 revision in publication activity. Check its controlled publication and transition status before changing the QMS baseline. This guide uses enduring readiness concepts and does not declare that a particular organisation has transitioned. Where ISO 9001:2015 remains invoked, check applicability of its 2024 amendment.

Flowdown topic	What the PRR should confirm
Product and design	Drawings, digital definition, specifications, special requirements and authorised changes are available at the correct revision.
Quality and approvals	FAI/PPAP scope, source inspection, customer witness points, delegated authority and supplier approval rules are explicit.
Regulatory and safety	Applicable aviation, defence, product, environmental and workplace obligations have competent owners; production approvals and permits are valid.
Substances and materials	Restricted substance, material reporting, customer prohibited material and preservation requirements are addressed where applicable.
Records and access	Retention periods, formats, customer/regulator access, confidentiality, export controls and record-transfer obligations are defined.
Changes and interruptions	Customer notification, approval, revalidation and resubmission triggers are incorporated into change control.

3.2 Purchase order deployment

Flow the applicable technical and quality requirements to each supplier and sub-tier through controlled purchase documentation. State the required product/process specification, revision, approvals, certificates, traceability, record retention and notification obligations. Obtain acknowledgement and check that the supplier can comply before relying on its output.

3.3 Requirement evidence

Useful evidence includes a signed contract review, a revision-controlled applicability matrix, supplier acknowledgements, resolved technical queries, customer approval messages and a controlled list of portal documents. An email interpretation is valid only within the sender's delegated authority and agreed scope.

STOP POINT An unresolved requirement, conflicting baseline or mandatory approval gap cannot be cured by a favourable readiness score. Resolve or obtain a formally authorised disposition before the affected commitment.

4. Lifecycle Timing and Readiness Gates

Readiness develops throughout the programme. Do not leave PRR until the scheduled shipment date. Tie reviews to engineering, procurement and production decisions so that findings arrive before irreversible expenditure, processing or delivery commitments.

Recommended gate	Entry basis	Exit decision and evidence
G0 Feasibility	Customer needs, preliminary scope, rate and risk	Accept feasibility assumptions or decline/replan. Identify technical gaps, long-lead items, critical processes and initial supplier strategy.
G1 Industrialisation plan	Developing design and agreed programme requirements	Approve the production concept, APQP plan, responsibilities, resources and validation strategy. Track remaining design risks.
G2 Ready for trial	Released trial baseline and safe, controlled facilities	Authorise only the defined representative trial. Confirm materials, instructions, competent personnel, validation protocols and witness points.
G3 Ready for launch	Completed trial with reviewed results	Authorise the specified initial production scope when mandatory validation, FAI/PPAP and other approvals are satisfied. Apply defined launch controls.
G4 Ready for sustained rate	Evidence across the launch period and intended shifts	Accept the sustainable rate and remove launch containment only after agreed exit criteria are met.
G5 Change or transfer	Change impact assessment and revised plan	Reconfirm affected readiness, approvals and verification. Unaffected evidence may be reused with documented rationale.

4.1 Planning the gate

For each gate define entry criteria, required deliverables, decision authority, meeting date, evidence freeze date and escalation route. Back-plan the evidence from the trial or release date. Include external lead times for material, qualification tests, customer reviews and special-process approval. Use readiness reviews at supplier sites when those processes dominate risk.

4.2 Triggering a focused re-review

Assess changes to design, material, sources, site, route, tooling, equipment, NC programmes, inspection methods, staffing, process parameters or planned rate. Also assess degradation such as loss of an approved operator, supplier financial distress, compromised software or overdue calibration. A focused PRR must define all consequential effects, rather than review only the changed document.

4.3 Gate discipline

Record what is authorised at each stage. Where G2 permits trial manufacture before PPAP is complete, segregate trial product and prohibit unauthorised shipment. G3 cannot be assumed from a successful trial alone; it requires the approval evidence applicable to launch. G4 requires a sustainable operating system and credible evidence over the agreed exposure period.

GOOD PRACTICE Keep a gate deliverable register with planned completion, current revision, evidence link, reviewer and accepted status. Percentage complete is useful only when completeness and validity are both assessed.

5. Roles Responsibilities and Decision Authority

Appoint a PRR leader with authority to coordinate evidence and escalate gaps. The accountable production release authority owns the readiness decision, subject to delegated limits. Quality independently challenges conformity and evidence validity. Engineering remains responsible for technical interpretation and design authority interfaces.

Role	Typical responsibility and evidence ownership
Programme or project lead	Scope, schedule, customer commitments, risk register, gate plan and cross-functional actions.
Design engineering	Released definition, design maturity, DFMEA interfaces, DFM/DFA, product safety and authorised changes.
Manufacturing engineering	Process flow, route, PFMEA, tooling, NC programmes, work instructions and trial representativeness.
Quality and metrology	Control plan, MSA, inspection, calibration, capability review, FAI/PPAP coordination and independent challenge.
Operations	Staffing, demonstrated competence, capacity, maintenance, workplace controls and production execution.
Procurement and supplier quality	Source approval, flowdown, supplier/sub-tier capacity, risk, certification and contingency.
Special-process specialist	Process qualification, validation, technical approvals, critical parameters and revalidation.
Facilities EHS and IT OT	Infrastructure, permits, environment, safe operation, digital access, backup and recovery.
Logistics and planning	Material availability, packaging, storage, scheduling, transport and customer delivery interfaces.
Authorised approver and customer	Readiness release within delegation; customer approvals or witness/release decisions where required.

5.1 Responsibility assignment

Use a simple RACI matrix: one accountable owner for each deliverable or decision, named responsible contributors, consulted technical authorities and informed stakeholders. Avoid an action assigned merely to Engineering or Supplier. Identify a person and an accountable function, including deputies for absence and shift coverage.

5.2 Independent review

The preparer establishes the claim; the reviewer tests whether evidence supports it. A reviewer need not be organisationally remote but should be competent and able to challenge schedule pressure. Include appropriate specialists for safety-critical features, unusual metrology or special processes. Record dissent and unresolved technical concerns in the decision log.

5.3 Behaviour and escalation

Make missing evidence visible early. Distinguish a known nonconformance from an unanswered question. Stop the affected activity when safety, conformity or authority is uncertain. Escalate to the competent, delegated authority; a programme lead cannot grant a design concession merely because they own the schedule.

Before the meeting, agree who may authorise manufacture, who may release product, who may accept residual risk and who must provide customer consent. Retain signed or authenticated decisions with names, roles, dates and scope. Blank approval fields remain blank until the actual authorised review occurs.

PART B Preparing the Production System

6. Design Maturity and DFM

A production system cannot be made ready against an unstable or incomplete design without explicitly bounding the risk. Review drawing/model release, interfaces, tolerances, materials, process specifications, verification and validation status, outstanding changes and intended operating conditions. Identify which open design items can affect tooling, procurement, assembly, safety or acceptance.

6.1 Design evidence

Retain the released design index, review minutes, verification/validation results, interface approvals and an open design issue list. For build-to-print work, confirm customer design authority and routes for technical queries; do not assume the manufacturer owns the DFMEA or may change tolerances. For design-responsible organisations, link design risk controls to verification and manufacturing deliverables.

6.2 Design for manufacture and assembly

Review realistic process capability, datum selection, accessible inspection, tool approach, clamping distortion, burr control, surface integrity, wall thickness, distortion after heat treatment and coating allowances. Review assembly sequence, tolerance stack, orientation, error-proofing, joint access, fastening, cleanliness and serviceability. Challenge features that become inaccessible after assembly or processing.

Review question	Evidence expected
Can the intended process achieve the required definition?	Feasibility review, tolerance analysis, process knowledge and representative trial or qualification plan.
Can every required characteristic be verified?	Characteristic map, datum/measurement strategy and defined evidence for inaccessible or destructive checks.
Are interfaces and safety requirements controlled?	Interface definition, critical-item register and approved verification/validation results.
Are substitutions or design departures authorised?	Approved change or concession with scope, effectivity and authority.
Do open changes invalidate production investment?	Change forecast, impact assessment and controlled commitment limits.

6.3 Managing incomplete maturity

Where a trial intentionally supports design development, identify the development baseline and segregate its output. State which evidence will need repetition once the final definition is released. Do not use prototype success to claim readiness of a materially different serial route or configuration.

REVIEWER QUESTION What design uncertainty could change the process or its acceptance criteria after this gate? Check the issue list against the purchasing, tooling and validation plan.

The PRR result should identify released design scope, unresolved items, responsible technical authority and decision limits. A schedule assumption such as drawing update expected next week is not a controlled baseline.

7. Requirements BOM and Configuration Baseline

Create a baseline index that identifies the exact product and production configuration being reviewed. Include drawings, models, specifications, approved changes, bills of material (BOMs), software/firmware where applicable, routers, process specifications, control plans, inspection programmes and tooling revisions. Identify effectivity by serial number, lot, order, date or other controlled method.

7.1 BOM control

Reconcile engineering and manufacturing BOMs. Confirm quantities, units, make/buy status, material condition, approved alternates, consumables, fasteners, adhesives, electronic component versions and process-sensitive items. Explain legitimate differences such as phantom assemblies, kits or yield allowances. Verify that the shop and supplier BOMs implement the released product definition.

Baseline element	PRR test
Design and contractual data	Every applicable document is listed at the correct revision; superseded copies are removed or blocked.
Manufacturing and inspection data	Route, instruction, NC/CMM programme, control plan and gauge versions are compatible.
Material and bought-out items	Specification, grade, condition, supplier, substitution rules and traceability requirements agree.
Effectivity	Old and new configurations are segregated; work in progress and stock have an authorised disposition.
As-built configuration	Actual serial/lot genealogy and installed versions can be reconstructed from retained records.

7.2 Change control

Use a change board or delegated approval route with technical, quality, supply and operations input. Assess consequential effects on PFMEA, control plans, capacity, inspection, qualification, FAI, PPAP, packaging and supplier flowdown. Define customer notification and approval needs before implementing a change. Record how affected stock, work in progress and delivered product are addressed.

7.3 Digital definition

For model-based definition, confirm authoritative model identity, associated drawings/notes, translation integrity, viewing capability, coordinate systems, units and revision access at the point of use. Validate derived manufacturing or inspection data against that authority. Control exports and local copies; an unlabelled model file on a machine is not a configuration system.

7.4 Evidence acceptance

A strong baseline combines a released document index, BOM reconciliation, authorised changes and a sample point-of-use check. Select one part and trace its design revision through material purchase, route, programme and inspection record. Any inconsistency becomes a finding requiring impact analysis.

CORE PRINCIPAL Readiness is configuration specific. Approval of revision A cannot be silently carried forward to revision B, a different supplier or a different programme version.

8. Manufacturing Process Flow and Routing

Map the actual sequence from receipt to shipment, including outsourced operations, queues, storage, transport, rework loops and release points. Give operations stable identifiers that align across process flow, route, PFMEA, control plan and instructions. Identify characteristics created, modified, protected or verified at each operation.

8.1 Route completeness

Include receipt verification, material identification, cutting, machining/forming, deburring, cleaning, special processing, intermediate inspection, assembly, testing, marking, preservation and packing as applicable. Identify operations where a feature becomes inaccessible, where traceability may be lost or where processing can degrade earlier conformity.

Route review topic	Question and evidence
Sequence and dependencies	Are datum establishment, distortion-producing processes and final verification in the correct order? Review the process flow and actual traveller.
External processing	Are transport, source approval, certificates, incoming verification and returns included? Match route and purchase orders.
Hold and witness points	Can work proceed only after the required approval? Demonstrate the physical or system hold.
Rework and repair	Are methods and authorities defined and validated where necessary? Include the loops in risk analysis.
Handling and queues	Are damage, contamination, ageing and mix-up risks controlled between operations? Review storage and segregation.

Route review topic	Question and evidence
Traceability	Can split lots, scrap, merged batches and assembly consumption be reconciled? Demonstrate genealogy.

8.2 Standard work and process limits

Identify machine, fixture, tooling, programme, materials and operating windows in the route or controlled linked instructions. Specify required records for settings, environmental conditions, process cycles and inspections. Distinguish process targets from specification limits and operator adjustment authority from engineering approval.

8.3 Challenging the flow

Walk the physical route with an operator and follow an actual trial order. Compare the documented sequence with what happens at the workplace. Ask how missing paperwork, failed checks, tool breakage, machine alarms and supplier returns are handled. Review the slowest and highest-risk operations, not merely the most visible machine.

COMMON ERROR A flow diagram that omits outside processing, rework or queues understates both risk and lead time. Include the entire value stream before claiming rate readiness.

Deliver a released flow and route, a list of approved alternatives, defined hold points and a documented link to PFMEA and control-plan operation identifiers. Demonstrated execution is stronger evidence than a flowchart alone.

9. DFMEA PFMEA Risk and Product Safety

Design FMEA addresses how design functions can fail and the consequences of those failures. Process FMEA addresses how manufacturing or assembly operations can fail to achieve requirements. The interface is essential: design critical items and characteristics must become specific process controls, and manufacturing discoveries must return to design risk assessment.

9.1 PFMEA development

Use a cross-functional team with operators, manufacturing engineering, quality, maintenance and relevant suppliers. Start from the released process flow and actual work. Consider wrong material, omitted operation, incorrect setting, mix-up, wear, contamination, software version, handling damage, measurement error, human factors and loss of traceability. Include foreseeable rework, changeover and abnormal conditions. See PFMEA Guidebook

Use the customer-required FMEA method and rating criteria. Where AIAG/VDA Action Priority applies, use that method; where an RPN method is required, apply it correctly. Neither a low RPN nor a total score is a reason to ignore a high-severity safety or regulatory failure. Prioritise prevention and demonstrated controls over inspection alone.

Interface	Expected connection
Design risk to process	Critical item, failure consequence, tolerance or interface concern becomes a PFMEA input and control-plan requirement.
PFMEA to controls	Risk action identifies prevention/detection, responsible owner and measurable verification of effectiveness.
Controls to work	Parameters, measurement methods, frequency and reaction are implemented in instructions and records.
Trial feedback	Actual defects, near misses, downtime and adjustment behaviour update PFMEA and residual risk.
Change feedback	Design, route, supplier and programme changes trigger review of affected risks.

9.2 Product safety and key characteristics

Maintain an approved register of special requirements, critical items, safety-related characteristics and key characteristics, using the definitions required by the customer. These terms are related but not interchangeable. A key characteristic is associated with variation requiring control; a critical item can be a feature, process, part or other item needing management action.

Record the identification source, consequence, manufacturing operation, control method, supplier flowdown and release authority. Plan mistake-proofing, validation and escalation appropriate to the consequence. Verify that operators understand the safety reason behind critical controls and know when to stop.

9.3 Wider risks and opportunities

Maintain a programme risk register for risks not captured by PFMEA: demand, finance, obsolescence, supplier continuity, facilities and logistics. Assess likelihood, consequence, exposure and uncertainty; identify mitigation and residual-risk acceptance. Record opportunities such as fixture improvements or simplified inspection but validate them before changing the approved process.

10. Control Plans and Reaction Plans

A control plan states how the actual production process will prevent or detect nonconformity and sustain control. It should be usable at the workplace and consistent with the flow, PFMEA, characteristic register and inspection instructions. Define prototype, pre-launch, production and safe-launch controls where applicable to the customer's framework.

10.1 Minimum practical content

Identify product and revision, operation, product/process characteristic, specification or process limits, special-characteristic designation, control method, equipment, sampling/frequency, records, responsibility and reaction plan. Distinguish prevention controls, process parameter monitoring and product acceptance checks.

Operation	Characteristic and control	Reaction and retained evidence
Receipt	Material specification and lot identity; certificate and identification check for each received lot	Quarantine discrepancies; supplier-quality review; receipt record linked to material certificate.
Machining	Bore size; approved tool/offset controls and defined first-off plus in-process gauging	Stop on failure or out-of-control signal; contain since last verified good check; assess tool/offset cause; retain values and adjustment record.
Coating	Approved process parameters and product evidence to the invoked specification	Hold affected batch if parameter or test fails; processor disposition/authority; retain batch and test records.
Final release	Required characteristic evidence, traceability and approval status	Block release when evidence or approval is incomplete; retain authorised release record.

10.2 A usable reaction plan

State the trigger, immediate safe response, product containment boundary, notification, permitted adjustment, cause investigation, re-verification and restart authority. For an out-of-control process, examine potential product impact even if sampled parts meet specification. For a failed gauge check, assess whether prior measurements remain trustworthy.

Define who decides the last known good point and how product beyond that boundary is identified. Include material in transit, at suppliers, in work in progress and already shipped where applicable. A reaction plan saying inform supervisor is incomplete if it does not control product and restart.

10.3 Validation and maintenance

Observe operators using the plan during the trial. Test selected reactions safely, including a simulated missed check or gauge failure. Confirm data are recorded and reviewed. Update the plan after trial findings and approved changes; remove superseded copies and retrain affected people.

REVIEW PRINCIPAL A control-plan signature is not proof of implementation. Sample a critical characteristic from design through PFMEA, control plan, instruction, actual record and reaction evidence.

11. Measurement System Analysis and Calibration

MSA establishes whether the measurement system is fit for its intended decision. The system includes the instrument, fixture, programme, method, environment, part variation and people. Calibration demonstrates instrument performance against a reference; it does not by itself establish the capability of the complete measurement method.

11.1 Plan the study

Define the characteristic, tolerance, decision risk, resolution, range and expected production variation. Choose a suitable study: crossed gauge repeatability and reproducibility (GR&R) for repeatable non-destructive measurements, nested designs where the same part cannot be remeasured, attribute agreement for classifications, and bias/linearity/stability studies as relevant. Explain departures and limitations.

Select representative parts spanning actual process variation, operators and workplace conditions. Randomise/blind readings where feasible. Include realistic re-fixturing and datum establishment. Avoid a study that repeats a stored CMM result or uses only near-identical parts; it may measure little of the real measurement process.

Evidence item	Reviewer challenge
Study design	Are parts, operators, trials and conditions appropriate to the use and analysis method?
GR&R result	Is the percentage based on study variation or tolerance? Are calculations and acceptance criteria explicit?
Bias and linearity	Does the method agree with suitable references across the range?
Stability	Do reference checks show that performance remains credible over time?
Attribute agreement	Are known reference classifications, borderline parts and false acceptance/rejection risks covered?
Measurement uncertainty	Does uncertainty matter for the acceptance decision near a limit, and is the decision rule agreed where required?

11.2 Interpreting results

Some automotive practices use below 10% GR&R as generally acceptable, 10–30% as conditional and above 30% as problematic. These are context-dependent conventions, not universal PRR acceptance rules. State the calculation basis and apply the invoked customer/manual criteria. Consider discrimination, uncertainty, severity and intended use before accepting a borderline system.

11.3 Calibration readiness

Maintain equipment identity, range, accuracy, calibration status, traceability to appropriate standards and environmental/handling controls. Confirm calibration remains valid through the planned trial and release period. Control customer-owned gauges and reference artefacts. Define actions for overdue, damaged or out-of-tolerance equipment, including retrospective impact on accepted product.

STOP POINT Do not rely on capability or acceptance results from an inadequate measurement system. Resolve measurement credibility before using those results to justify readiness.

12. SPC and Demonstrating Process Stability

Statistical process control (SPC) uses time-ordered data to distinguish common-cause variation from signals suggesting special causes. Establish measurement credibility first, then demonstrate stability before making a predictive capability claim. Control limits describe observed process behaviour; specification limits describe product acceptance and must remain distinct.

12.1 Choosing and using charts

Select the chart based on the data and sampling design. Variables data may use X-bar/R or X-bar/S charts with rational subgroups, or individuals/moving-range charts when justified. Attribute data may use p/np or c/u charts according to whether the count is defective units or defects and whether sample size/opportunity varies. Check independence and distribution assumptions for the selected method.

Subgroups should reflect a short-term opportunity for variation; sampling across shifts, tools or machines without explanation can conceal or confuse different sources. Identify machine, cavity, tool, operator, material lot and programme where these can influence the result. Use separate analyses where processes are materially different.

SPC readiness requirement	Useful evidence
Data strategy	Characteristic, chart, subgroup size, frequency, collection method and context variables defined.
Baseline	Representative time-ordered data, documented special-cause investigation and controlled limit-setting.
Operators use	People can recognise signals, contain product and follow the reaction plan.
Management response	Assigned owners remove causes and resource preventive improvements.
Change control	Limits and control strategy are reviewed after justified process changes, without erasing adverse data.

12.2 Reaction and improvement

Define signal rules in advance. On a signal, make the operation safe, stop or contain as appropriate, protect affected product, investigate and record the disposition and restart authority. Do not continuously adjust a stable process to chase random variation; such tampering can increase variation. Conversely, do not ignore an out-of-control signal because all sampled readings are within tolerance.

Retain original data, charts, exclusions and rationale. Recalculate limits only through a controlled review based on an understood process change or a justified baseline update. Do not remove inconvenient points simply to make a chart appear stable.

12.3 Low-volume use

For short runs, consider justified family approaches, deviation-from-nominal charts, reference checks or other suitable methods with competent statistical input. Explain comparability and uncertainty. Where sample size is insufficient for a robust study, use approved alternative verification and process controls rather than inventing capability confidence.

13. Process Capability Cp Cpk Pp and Ppk

Capability/performance indices compare variation and centring with specification limits. State the data window, sample size, process conditions, measurement study, method of estimating standard deviation and distribution assumptions. Do not describe an index as proof of zero defects or of future performance under changed conditions.

13.1 Definitions and calculation

For a two-sided specification with upper limit USL, lower limit LSL and sample mean x-bar, the common normal-model formulas are:

Index	Formula	Interpretation
Cp	(USL − LSL) / (6 × sigma within)	Potential short-term spread relative to the tolerance width; ignores centring.
Cpk	min[(USL − x-bar)/(3 × sigma within), (x-bar − LSL)/(3 × sigma within)]	Within-process index accounting for the nearer specification limit.
Pp	(USL − LSL) / (6 × s overall)	Spread using overall standard deviation across the defined data window.
Ppk	min[(USL − x-bar)/(3 × s overall), (x-bar − LSL)/(3 × s overall)]	Overall performance index accounting for centring.

Cp/Cpk normally use a justified within-subgroup estimate; Pp/Ppk use the overall sample estimate. Software terminology can vary, so retain the settings and method. Use an appropriate one-sided index when only one meaningful specification limit exists. Do not fabricate the other limit.

13.2 Acceptance and limitations

Agree acceptance criteria before the study. Values such as 1.33 or 1.67 are common in some customer schemes but are not universal requirements. Customers may distinguish initial process studies from ongoing capability and require specific sampling and approval. Report confidence/uncertainty where material and avoid overstating a small study.

Check time-order stability, independence, distribution shape, subgroup logic, rounding and gauge resolution. For non-normal data, use an appropriate justified distribution, transformation or percentile-based analysis with specialist review; the normal-model six-sigma interpretation may be misleading. Do not pool different cavities or machines merely to improve an aggregate number.

13.3 Practical interpretation

A high Cp with lower Cpk suggests poor centring. A materially lower Ppk than Cpk may indicate drift or variation between subgroups; investigate the data rather than merely reporting the better index. A mean beyond a specification limit can produce a negative Cpk/Ppk and is a serious conformity concern.

GOOD PRACTICE Capability follows credible measurement and an understood, stable process. An unstable process may have a calculable Ppk, but it does not support an unqualified prediction of future conformity.

14. Capacity and Rate Readiness

Capacity readiness establishes that the complete system can meet the agreed demand profile at acceptable quality and delivery performance. Model the bottleneck, shared resources, supplier processes, inspection, changeovers, maintenance, staffing and logistics. Distinguish installed capacity, planned available capacity and demonstrated good-output capacity.

14.1 Demand and time model

Define required good units per period, product mix, batch size, shifts, demand peaks and recovery needs. Takt time is net planned production time divided by customer demand for good units in the same period. Cycle time is the measured time to complete a process or unit. State all exclusions from net time, including breaks, planned shutdowns and scheduled maintenance.

Capacity input	Evidence and challenge
Cycle time and changeover	Measured trial data at realistic load; include tool changes, setup approval, queues and handling.
Availability	Downtime records and assumptions for breakdowns, maintenance, staffing and support.
Quality yield	First-pass yield, scrap and rework exposure; distinguish produced units from releasable good units.
Shared resources	Competing products, CMMs, furnaces, cleaning, planners and inspection coverage included.
Supplier rate	Confirmed demonstrated capacity, processing slots, transport and recovery capability.
Buffer and contingency	Risk-based reserve and recovery plan without hiding the true bottleneck.

14.2 Calculation discipline

A simple planning estimate is available scheduled minutes × availability × speed factor ÷ ideal cycle minutes × good-output yield, provided the assumptions use consistent units and do not double-count losses. OEE commonly combines availability, performance and quality. Do not apply an OEE quality factor and then apply the same yield loss again.

Use measured sustained rates as the preferred basis and state the period represented. If a trial demonstrates 100 units in ideal conditions, it does not prove a week's mixed production with changeovers and supplier queues. Validate the assumptions most likely to constrain delivery and test sensitivity to demand or loss increases.

14.3 Rate commitment

Document the maximum approved rate, product mix, shifts, resource assumptions and contingency. Include training ramps and quality containment effort. Approval at one rate does not automatically approve a later increase. Re-review the bottleneck, critical controls and supplier capability before a significant increase.

COMMON ERROR A fast machining cycle does not establish delivery capability if outside processing, inspection or staffing constrains the flow. Review good output through the complete route.

15. Tooling Fixtures Gauges and Equipment

Confirm that the tools and equipment intended for production are available, identified, suitable, qualified where required and controlled. Include production tools, backup tools, fixtures, gauges, test rigs, lifting aids and customer-owned assets. Trial evidence must state the actual assets used and any difference from planned serial production.

15.1 Tool and fixture readiness

Review datum location, clamp loads, stiffness, wear, thermal effects, access, repeatability and part protection. Validate mistake-proofing features and their failure reactions. Check tool-life assumptions and availability of consumables and replacement components. Establish preventive maintenance and acceptance criteria for wear or damage.

Asset	Readiness evidence
Fixture or jig	Released design/revision, identification, fit/function verification, repeatability and representative part trials.
Cutting/forming tool	Tool specification, setup and life limits, supplier availability, replacement and inspection method.
Gauge	Fit for characteristic/range, calibration, MSA as relevant, handling and storage.
Test equipment	Qualification, verified software/limits, reference artefacts, safety interlocks and failure discrimination.
Machine	Installation/acceptance evidence, capability for intended task, maintenance, support and safe operation.
Customer-owned property	Ownership, custody, identification, status, protection and reporting obligations.

15.2 Designed and qualified tooling

Where tooling contributes to acceptance, establish what it verifies and how its suitability has been demonstrated under the invoked method. A tool must not be accepted merely because it was expensive or supplied by the customer. Confirm compatibility with the current design and the inspection decision; dimensional conformity of a fixture alone may not prove its functional adequacy.

15.3 Contingency

Identify what happens if a fixture breaks, a gauge is unavailable or a machine fails. A spare is useful only if it is compatible, accepted and ready for use. Define whether substitution requires programme changes, MSA, FAI, PPAP notification or a focused PRR. Secure approved storage and configuration identification for backups.

15.4 Evidence at the gate

Use an asset register with owner, identity, revision, location, status, acceptance evidence, calibration/maintenance due date and contingency. Walk the assets at the point of use and compare them with the route. Do not count a purchase order as evidence that a critical production tool is installed and usable.

16. Work Instructions and Operator Competence

Instructions translate the released production method into repeatable action. They must be understandable, accessible at the point of use and compatible with the route, programme, tooling and control plan. Include process limits, sequence, safety, critical characteristics, records, hold points and reaction plans.

16.1 Instruction usability

Use clear photographs or illustrations where they prevent ambiguity. Define orientation, material identity, setup, tool/fixture IDs, parameters, inspection method and acceptance criteria. Identify characteristics requiring special care, surfaces to protect, cleanliness and handling requirements. Avoid instructions that rely on undocumented personal knowledge.

Have a competent operator execute the trial using the instructions without coaching that is absent from the document. Record confusing steps, workarounds and omitted controls; correct them through controlled revision. Test access when the network or printer is unavailable and define the authorised contingency.

Competence topic	Evidence expected
Training	Controlled instruction revision, content, trainer, trainee and completion date.
Demonstrated competence	Observed performance or practical assessment for the assigned operation, including abnormal reactions.
Authorisation	Operation, equipment, process and shift limits; expiry/renewal where required.
Coverage	Competent staff and deputies on intended shifts; leave, turnover and ramp-up considered.
Special qualifications	Required process/personnel qualification and current scope, such as NDT or welding where applicable.

16.2 Competence versus attendance

A signed attendance sheet shows participation, not necessarily competence. Assess the ability to set up, execute, measure, recognise a problem, contain product and restart within authority. Include inspectors, maintenance staff, planners and supplier personnel when their actions affect conformity.

16.3 Human factors

Review fatigue, workload, repetitive tasks, language, lighting, interruption, ergonomic reach and error-prone handoffs. Use error prevention, layout and clear prompts before relying on repeated reminders. Establish a culture in which operators can stop for uncertain identity, failed checks or unsafe conditions without penalty.

16.4 Readiness evidence

Retain released instructions, a training/authorisation matrix, practical assessment results and a staffing plan. Sample one critical operation and ask the assigned operator to demonstrate its controls and reaction plan. Verify that the available workforce, rather than a small expert trial team, can execute the proposed production commitment.

17. Materials and Supply Chain Readiness

Verify that required material, bought-out parts and consumables can arrive in the correct quantity, specification, condition and timing. Account for yield, scrap, minimum order quantities, lead times and shelf-life limits. Link material availability to the approved demand and route rather than a general stock balance.

17.1 Material assurance

Confirm approved sources, specification/revision, grade, temper/condition, heat/lot identity, certificate requirements and incoming verification. Assess substitutions and alternates through the appropriate technical authority. Prevent counterfeit/suspect items through source control, traceability, risk-based verification and escalation; a certificate alone may not resolve authenticity concerns.

Supply topic	PRR evidence and control
Long-lead items	Firm orders, supplier acknowledgement, delivery dates and recovery plan.
Material condition	Certificates, identity, storage and processing restrictions linked to lot.
Shelf-life consumables	Expiry, first-expire-first-out, cold storage, thaw/open time and out-time records as applicable.
Restricted substances	Applicable customer/regulatory declarations and approved material selection.
Single-source exposure	Risk assessment, continuity plan and qualified alternatives where justified.
Obsolescence	Lifecycle status of bought-out items, forecast and approved replacement route.
Transport	Packaging, handling, transit time, customs and receiving arrangements.

17.2 Supply planning

Check inventory accuracy, allocations, safety stock assumptions and supplier delivery performance. Reconcile purchasing units with manufacturing consumption, including conversions and scrap allowances. Protect controlled material against mix-ups, damage, corrosion, contamination and unauthorised issue.

Review demand visibility across sub-tiers and processors. A supplier's promised dispatch date is not the same as usable material at the production operation. Include receipt checks, certificate review and any incoming testing or quarantine delay.

17.3 Contingency and evidence

Use a material-readiness register with part/material number, revision/specification, supplier, required quantity, need date, confirmed availability, risk and action owner. Record evidence references and the period for which supply is secure. Validate alternatives before disruption; emergency substitution can invalidate approvals and trial evidence.

STOP POINT Missing material identity; an unauthorised alternate or doubtful authenticity is a conformity concern. Hold the affected material and resolve it before production use.

18. Supplier and Sub Tier Readiness

Supplier readiness is more than a current certification or an approved-supplier-list entry. Confirm that the supplier's actual site, equipment, people, process and sub-tiers can satisfy the defined product, rate and quality requirements. Depth should reflect consequence, novelty, performance and dependency.

18.1 Supplier assessment

Review requirement acknowledgement, process capability, capacity, staffing, source approvals, special-process validation, material controls, measurement and delivery. Ask the supplier to show objective evidence from the intended route. For high-risk suppliers, conduct an on-site or remote evidence-based PRR with a representative production trial.

Assessment area	Evidence expectation
Technical feasibility	Released baseline understood; queries resolved; route and tooling feasible.
Quality controls	PFMEA/control-plan links, measurement credibility, traceability and nonconformance controls.
Rate and delivery	Demonstrated rate, shared-capacity allocation, lead-time model and logistics.
Sub-tiers	Identified critical sources, flowed requirements, approval status and change controls.
Continuity	Critical people/equipment, financial or business disruption risks and recovery plans.
Change notification	Agreed triggers before site, process, material, programme or sub-tier changes.

18.2 Sub-tier visibility

Identify who performs special processes, destructive testing, calibration and critical component manufacture. Check that customer approval applies to the actual site and scope. Flow required controls, records and change notification through the purchasing chain. A tier-one supplier remains accountable for controlled externally provided output within its responsibilities.

18.3 Acceptance and surveillance

Set the supplier decision as ready, conditional or not ready for a specified scope. Define required FAI/PPAP evidence and customer approval interfaces. Use risk-based launch surveillance, source inspection, first-off approval or certificate verification where needed. Do not use added inspection to silently bypass mandatory source qualification.

Escalate adverse trends such as recurrent escapes, late delivery, approval expiry or unexplained sub-tier substitutions. Reassess readiness when the basis changes. Share forecast/rate changes early so that supplier capacity assumptions remain valid.

18.4 Practical gate output

Retain the supplier readiness matrix, audit/review reports, trial data, approval verification, flowdown acknowledgements and a consolidated action register. Define the period and volume covered by conditional acceptance and what happens when an action is overdue. Include customer consent where contractually required.

PART C Special Processes

19. Special Process Validation and Approvals

Processes whose outputs cannot be fully verified by subsequent monitoring or measurement need appropriate validation and process control. Determine applicability using the product, process and invoked requirements; do not classify a process solely

from its name. Identify critical variables, qualification needs, monitoring, acceptance evidence and revalidation triggers. See Special Processes Guidebook.

19.1 Evidence chain

Link the design/process requirement to the production route and supplier purchase order, the approved processor/site, procedure and personnel qualification, equipment status, actual batch parameters, test results and release certificate. Each link must apply to the same product configuration and lot. A certificate saying processed to drawing may leave important requirements unproven.

Control	PRR challenge
Technical requirement	Are specification, revision, class/type, material and acceptance tests explicit?
Validation or qualification	Does it represent the actual materials, geometry, equipment and approved operating window?
Process resources	Are personnel, equipment, consumables and environment qualified and current?
Execution	Are actual parameters, deviations and inspections retained and traceable?
Approvals	Are customer and third-party approvals valid for the site, scope and processing date?
Revalidation	Are changes, interruptions, failures and approval expiry controlled?

19.2 Nadcap and customer approval

Nadcap is an industry-managed accreditation programme administered by PRI for critical aerospace processes and products. It applies where required by the customer or other invoked arrangement. Confirm the actual site, commodity, scope, limitations and status using controlled approval information. Accreditation does not automatically equal customer approval; verify the customer's separate authorisation requirements.

19.3 Release discipline

An ISO/AS quality-system certificate, Nadcap accreditation, technical process approval and lot conformity certificate serve different purposes. Verify each required element. A satisfactory coupon result cannot compensate for an unauthorised source where approved-source use is mandatory.

Define hold points before irreversible processing and before release to the next operation. For expiry or suspension, establish the validity of processing already performed and the authority required for any disposition. Do not retrospectively claim approval without evidence.

CORE PRINCIPLE Validate the process and sustain its controls. Final inspection alone cannot verify all properties affected by a special process.

20. Special Process Readiness by Process Family

Use process-specific specialists and the invoked technical specifications to determine the actual evidence. The examples below are planning prompts, not substitute process parameters or universal acceptance criteria. Review both supplier controls and the manufacturer's verification on receipt.

Process family	Readiness questions and typical evidence
Heat treatment	Qualified furnace/process scope, material and loading rules, required pyrometry, sensor/control status, cycle records, quench controls and specified hardness/mechanical/metallurgical results. Identify applicable AMS or customer pyrometry requirements where invoked.
Chemical processing and coatings	Approved sequence, bath chemistry, time/temperature, surface preparation, masking, thickness, adhesion/corrosion tests where required, hydrogen-embrittlement relief requirements and traceable batch certification.
NDT	Approved technique and acceptance criteria, personnel certification/authorisation, equipment checks, reference standards, consumables/environment, coverage, interpretation and traceable results. Confirm the invoked personnel scheme, such as EN 4179 or NAS 410 where required.
Welding and brazing	Qualified procedure and personnel/operator scope as required, joint preparation, consumable identity, parameters, atmosphere, inspection/test requirements and repair authority.
Adhesive bonding and composites	Material shelf/out life, storage/thaw control, surface preparation, environmental conditions, lay-up/bond procedure, mix/cure records, pressure/temperature control and required test/inspection evidence.
Additive manufacture	Feedstock/reuse control, machine and parameter baseline, build orientation, monitoring, post-processing, material qualification, inspection and traceable build genealogy.
Electronics processes	Applicable workmanship/process standard, soldering or other process qualification, profiles, materials, ESD, cleanliness, moisture sensitivity, inspection/test and rework controls.

20.1 Interfaces that commonly fail

Check material condition before processing, cleaning before bonding/coating, distortion after thermal processes, machining/coating allowance, masking/plugging, NDT stage and marking preservation. Confirm whether outsourced tests and laboratory approval are separately controlled. Include the transport and storage risks between operations.

20.2 Process control at production rate

A qualified procedure must also be executable at the intended load and mix. Challenge rack/furnace loading, bath throughput, cure capacity, inspection coverage and personnel availability. Confirm production volume will not push the process outside its validated operating window. Trial records should reflect serial conditions rather than specially protected laboratory batches.

20.3 Gate evidence

Retain a process approval register, validation index, critical-variable/control matrix, sample batch record, certificate review and revalidation plan. Assign a competent technical owner for each process family. Record any limitation by material, thickness, geometry, equipment, site or parameter range.

PART D Demonstrating Readiness

21. Inspection Test Planning and Product Release

Plan verification against every applicable product requirement, including drawing/model characteristics, notes, material, marking, workmanship, special-process and functional requirements. Link the plan to the route so that required checks occur before features become inaccessible or before irreversible value is added.

21.1 Verification strategy

Create a characteristic/evidence map with a unique identifier, source/revision, requirement, tolerance, operation, method, equipment/programme, sampling, record and acceptance authority. Identify destructive tests, witness points, source inspection and customer-mandated sampling. Distinguish design qualification, process validation and routine product acceptance.

Planning topic	What must be established
Method suitability	The method resolves the required characteristic and datum system with credible accuracy and uncertainty.
Coverage	Dimensions, GD&T, notes, materials, special processes, marking and functional requirements are accounted for.
Sampling	Plan, lot definition, acceptance/rejection rule and customer applicability are justified; no unauthorised reduction.
Test system	Known-good/known-fail checks, verified limits, programme revision, interlocks and failure response.
Inaccessible features	Verification before assembly/processing or another specifically approved method.
Release	Authorised person/system confirms all planned checks and mandatory approvals before dispatch.

21.2 Acceptance decisions

Record actual variable results where required or useful, with units, characteristic identity and traceability. Use unambiguous attribute results when appropriate. Define the decision rule near specification limits where uncertainty matters. Avoid blanket PASS statements that conceal whether each required characteristic was assessed.

Verify test fixtures can discriminate failures; a passing functional test may not reveal a mis-wired circuit, wrong firmware or latent process defect. Validate inspection programmes and data transfer. Protect raw data and prevent post-test edits from hiding failures.

21.3 Release controls

Check completion of the route, all hold/witness points, nonconformance dispositions, certificates, traceability, FAI/PPAP/customer status and shipping documents. An ERP status must reflect those controls rather than merely order completion. Demonstrate that missing evidence prevents unauthorised release.

GOOD PRACTICE Test one deliberately incomplete record through the release workflow in a safe test environment. Readiness includes the ability to block release as well as to process a good part.

22. FAI and AS9102 Readiness

First Article Inspection verifies a representative first production article and provides documented accountability for the design requirements. The FAIR is the report and supporting evidence. Where AS9102 is invoked, use its controlled edition, applicable forms and customer instructions. AS9102C was revised in June 2023. See FAI Guidebook

22.1 Planning FAI

Determine the trigger, scope, required timing, full/partial basis, customer submission and approval requirements. Plan the representative production route, inaccessible characteristics, material/process certification, digital definition and suitable verification methods. Identify the part, assembly/detail scope and required sub-tier FAIR interfaces.

FAIR area	PRR review intent
Part accountability	Part/drawing revision, serial/lot, assembly/detail identity, baseline and reason/scope are clear.
Product accountability	Material, special-process and functional-test evidence is correct, approved where required and traceable.
Characteristic accountability	Every applicable requirement is uniquely mapped to a result and supporting verification evidence.
Nonconformance and completion	Actual failures, dispositions, correction and completion status are accurate under the invoked requirements.

22.2 Change and partial FAI

Assess design, process, source, location, tooling, programme and other changes for their effect on the established baseline. Apply the actual re-accomplishment rules, including lapse-in-production rules, from the invoked standard/customer. A partial FAI must identify its baseline and cover all affected and consequential characteristics. Do not invent a universal interval or assume only the changed dimension is affected.

22.3 Readiness interpretation

Review whether the article used the intended production materials, route, equipment, tooling, programme and personnel. Record departures and their effect on representativeness. FAI does not replace routine inspection, statistical process control, capacity validation or special-process qualification.

A completed FAIR can support G3 but cannot alone establish sustainable production. Conversely, a successful rate trial does not replace characteristic accountability. Keep the FAI status, customer acceptance where required, PPAP status and internal PRR result separately visible.

COMMON ERROR A concession may permit a defined use of nonconforming product, but it does not make the measured result conforming. Preserve the result, disposition and FAIR completion status accurately.

22.4 Gate evidence

Retain the FAI plan, baseline, characteristic map, reviewed FAIR, source certificates, raw inspection evidence, nonconformance links and customer approval/status where required. Use the SPI FAI guidebook as a companion resource where available, while treating the invoked standard and contract as the authority.

23. APQP Phases and Deliverables

APQP is a phased approach to planning and managing product and process quality from concept through use and feedback. Phases overlap and develop iteratively; they are not permission to postpone risk control until the final phase. Agree the applicable aerospace or automotive framework and customer deliverables at programme start.

Phase	Aerospace planning emphasis	Typical PRR evidence
1 Planning	Translate needs into a feasible programme and product/process objectives.	Requirement review, feasibility, sourcing strategy, initial risks, team, schedule and deliverable/gate plan.
2 Product design and development	Develop and verify the product definition and its interfaces.	Released definition, design reviews, DFMEA where applicable, critical items, DFM/DFA and verification/validation planning.
3 Process design and development	Develop the production and verification system.	Flow/route, PFMEA, control plan, tooling, instructions, MSA plan, supplier and capacity plans.
4 Product and process validation	Demonstrate the actual production system against requirements and demand.	Representative trial, inspection/test results, FAI where required, measurement/capability evidence, capacity evidence and applicable PPAP package.
5 Ongoing production use and feedback	Maintain controls and learn from production and service.	KPIs, defect/escape feedback, corrective action, change control, continuous improvement and readiness re-review.

23.1 Aerospace and automotive naming

AS9145 and IAQG guidance provide the aerospace context. Automotive APQP commonly describes plan and define programme; product design and development; process design and development; product and process validation; and feedback, assessment and corrective action. Use the terminology and required deliverables of the invoked framework rather than substituting labels casually.

AIAG APQP third edition strengthens topics including sourcing, changes, risk and gated management. Control Plan is now a separate first-edition manual. These publication facts do not imply that every organisation or contract has adopted the same edition.

23.2 Managing deliverables

Create a deliverable register with applicability, planned date, owner, controlled revision, review status and evidence link. Assess maturity and dependencies, not just completion percentage. A PFMEA marked complete while the route is still changing may need significant revision before G2.

23.3 Integrating PRR

Use early PRRs to challenge feasibility and process planning; G2 checks the trial system; G3 checks validation/approval evidence; G4 checks sustained control. Maintain one coherent evidence chain across APQP and PRR. Customer forms and phase-gate requirements remain controlling where invoked.

24. PPAP Framework and Submission Levels

PPAP provides approval evidence for the intended production process. Determine the invoked scheme, submission reason, part/process scope, representative run conditions, required deliverables, customer submission method and approval authority. Use customer instructions for notification, retention, interim approval and resubmission.

24.1 Aerospace PPAP

Where AS9145 is invoked, use its aerospace PPAP requirements and customer tailoring. Agree the deliverables and approval status in advance. The package may draw on design/process risk, flow, control, measurement, capability, FAI and capacity evidence as required. Do not assume an AIAG Part Submission Warrant or automotive level is required for every aerospace submission.

24.2 Automotive submission levels

The following is a short orientation to the commonly used AIAG structure. The controlled manual and customer-specific submission/retention matrix determine the exact required content. A lower submission level reduces what is sent; it does not automatically remove the obligation to develop and retain applicable evidence.

Level	Common submission approach in summary
1	Part Submission Warrant; appearance approval information also where applicable.
2	Warrant, sample parts and selected supporting evidence.
3	Warrant, sample parts and a comprehensive supporting evidence package.
4	Warrant with the other requirements specified by the customer.
5	Warrant, sample parts and comprehensive evidence made available for review at the manufacturing location.

24.3 Approval status

Record approved, interim/conditional or rejected status using the customer's actual terminology. Interim approval is valid only within its authorised quantity, time and conditions. It is not unrestricted serial approval. Keep approval expiry and resubmission triggers visible in production planning and release controls.

24.4 Run conditions and changes

Agree representative run duration, quantity, rate, tools, cavities, equipment, operators and sampling according to the invoked requirements. Do not treat a familiar number of parts or hours as a universal PRR rule. Evaluate site/process/material/tooling changes and other notification triggers before implementation; the customer may require new evidence or approval.

STOP POINT Internal PRR acceptance does not authorise shipment when mandatory PPAP or other customer approval is missing. Record the actual customer status, not merely submitted.

25. PPAP Evidence Elements

For automotive PPAP, the commonly recognised evidence areas below support package planning. They are brief descriptions, not reproduced manual content or a substitute for its applicability, submission and retention rules. Customer-specific requirements determine exceptions, additions and exact forms. Aerospace packages must use the invoked AS9145/customer deliverables rather than this automotive list by default.

Evidence area	Practical review focus
1 Design records	Controlled definition of the part and applicable requirements.
2 Authorised engineering changes	Approved changes affecting the submitted configuration.
3 Customer engineering approval	Required technical acceptance is present and within scope.
4 Design FMEA	Design risk evidence where the organisation has the relevant design responsibility.
5 Process flow	Actual production sequence, including external operations.
6 Process FMEA	Risks and controls for the intended production route.
7 Control plan	Defined controls and reactions implemented at production.
8 Measurement system studies	Credibility of methods used for acceptance and process studies.
9 Dimensional results	Complete requirement coverage and traceable results.
10 Material and performance tests	Evidence that specified material/performance requirements are met.
11 Initial process studies	Variation evidence analysed under the invoked study criteria.
12 Qualified laboratory evidence	Laboratory competence/scope meets the applicable requirements.
13 Appearance approval	Required appearance approval where applicable.
14 Sample production parts	Representative parts provided as instructed.
15 Master sample	Controlled reference sample and retention where required.
16 Checking aids	Suitable, identified and controlled fixtures/gauges where applicable.
17 Customer-specific requirements	Additional requirements, declarations, portals and approvals are complete.
18 Part Submission Warrant	Correct part, reason, level, declaration and authorised submission.

25.1 Reviewing package coherence

Use one configuration index across the package. Match design revision, tool/cavity, production site, run dates, material lots and programme versions. Check that PFMEA risks appear in the control plan and that measurement studies support the dimensional/capability results. Do not accept individually plausible documents that describe different production systems.

25.2 Submission discipline

Assign a package owner, independent reviewer and customer interface. Verify portal/file conventions, approval status and retained originals. Record which elements are not applicable and the authorised basis; absence without explanation is not tailoring. Identify resubmission obligations and keep the approved package linked to change control.

26. Production Trial and Run at Rate

A production trial demonstrates the intended system under defined conditions. Run-at-rate emphasises whether good output can meet demand; the trial also tests controls, traceability, measurement, staffing and handling. Use the customer's protocol when invoked and agree acceptance criteria before running.

26.1 Trial protocol

Define product/revision, site, route, equipment, tools/cavities, programmes, suppliers, material lots, staff/shifts, run duration, quantity, rate, mix and sampling. Record permitted deviations from serial conditions and their effect on the claim. Include planned checks, stop criteria, safety controls, customer witnesses and disposition of trial product.

Trial record	Why it matters
Start and end conditions	Baseline, setup release, shift, environment and actual run exposure are known.
Time and losses	Cycle, changeover, downtime, queue, staffing and interruption data support the rate assessment.
Good output and defects	Counts reconcile produced, first-pass good, reworked, scrapped, held and releasable units.
Process and inspection data	Critical parameters, measurements, SPC/MSA and test results support conformity/control.
Traceability and certificates	Actual material/process records link to trial units and suppliers.
Abnormal reactions	Tool/gauge failure, alarms or simulated challenges show containment and restart control.
Lessons and deviations	Workarounds, expert assistance and missing evidence are recorded rather than hidden.

26.2 Representativeness

Use production equipment and realistic staffing, material, sequence, loads and shifts. Where this is not possible, state the limitation and define what remains unproven. A trial completed using engineering experts and manually expedited suppliers may not demonstrate normal production. Consider additional exposure across intended shifts, lots or changeovers when risk demands it.

26.3 Acceptance and failed trials

Compare actual results with pre-agreed quality, rate, control and approval criteria. Investigate failures and update PFMEA/control plans. Repeat affected validation after corrective action where needed. A successful repeat must identify the changed baseline and retain the failed-run evidence and its disposition.

26.4 Product disposition

Segregate trial output until authorised acceptance and release requirements are met. Record whether it is retained for testing, scrapped, reworked or released under an approved scope. Meeting rate does not override missing validation, nonconformance or customer approval.

27. Packaging Handling Storage and Delivery

Readiness extends to delivery in the required condition. Plan preservation from incoming receipt through production, external processing, storage and shipment. Consider damage, corrosion, contamination, FOD, ESD, moisture, temperature, shock, shelf life and identity loss as applicable.

27.1 Packaging and storage

Use approved packaging specifications and customer requirements. Define part orientation, separation, cushioning, protective films/caps, corrosion protection, cleanliness, labels and traceability. Validate that packing does not damage critical surfaces or create contamination. Assess transport and stacking conditions using a justified trial or qualification where required.

Topic	Readiness evidence
Workplace handling	Suitable racks, containers, lifting aids, protection and operator instructions.
Storage	Location/status control, environmental limits, shelf life and segregation.
Packaging	Released pack specification, representative packed sample and damage/preservation assessment.
Labels and documentation	Part/revision, quantity, lot/serial, destination and customer format are correct.
Shipment	Carrier, collection window, customs/export requirements, transport time and delivery interface.
Receipt at customer	Receiving constraints, electronic notices and required release documents are understood.

27.2 Logistics readiness

Check planning systems, inventory accuracy, lead times, dispatch capacity and delivery schedule. Define authorised shipping documents, certificate content, customer portal or advance shipping notice requirements. Review customer calendars, delivery slots, returnable packaging and responsibilities for transport damage.

Include external-process logistics in the route and capacity model. Confirm custody and status when parts leave the site and return. Protect lot identity on individual containers and prevent unverified returns from being treated as released stock.

27.3 Contingency

Plan response to carrier failure, border delay, package damage, storage alarm and missing paperwork. Any alternate packaging or carrier must remain suitable and meet applicable approval needs. Emergency delivery pressure cannot justify mixing revisions, losing traceability or releasing held product.

REVIEWER QUESTION Can a released unit be traced through packing and delivery, and will it reach the customer in the same conforming condition? Examine an actual packed trial sample and its documents.

The gate output should include a preservation/pack plan, logistics route, verified labels, delivery responsibilities and evidence of the customer's receipt requirements. Review return and recall interfaces where product risk warrants them.

28. Traceability Nonconformance and Concessions

Define the required traceability level from the contract, product risk and process requirements. Link raw material heat/lot, bought-out parts, process batches, operators, equipment/programmes, inspection and assembly genealogy to the finished lot or serial. Account for splits, merges, scrap and rework without breaking identity.

28.1 Traceability demonstration

Select a finished trial unit and trace it backwards to the source material and process records, then select a material/process lot and trace it forwards to all affected output. Reconcile quantities and status. Challenge marking removal during processing, relabelling, split containers and digital transactions.

Control point	Expected behaviour
Identification	Part, revision, lot/serial and acceptance status remain unambiguous.
Segregation	Nonconforming or uncertain product is physically/systemically blocked from use and release.
Disposition	Only authorised personnel make use-as-is, repair, rework or scrap decisions within delegation.
Concession/deviation	Approval states requirement, affected scope, quantity/time, conditions, customer/design authority and expiry.
Re-verification	Reworked/repaired product is checked against the authorised acceptance requirements.
Escape	Affected delivered product is assessed, contained and notified through the required authority/timing.

28.2 Nonconformance at PRR

Record actual results and NCR references. Assess the cause, scope and potential recurrence. Separate an isolated, authorised product disposition from a process readiness issue. A recurring defect may show that the process is not ready even when individual concessions have been accepted.

28.3 Concession discipline

Use customer/contract terminology for concession, deviation permit and repair approval. Do not assume local quality staff can accept design departures. Confirm effectivity and release conditions and prevent expired permissions from being reused. A concession cannot waive a regulatory obligation unless the relevant authority explicitly permits that action.

28.4 PRR evidence

Retain the traceability procedure and successful challenge record, NCR register, disposition authority matrix, approved concessions and product-impact assessment. Ensure held trial units, supplier returns and launch containment are reflected in inventory and capacity calculations.

CORE PRINCIPLE No status, certificate or signature should conceal a known failure. Preserve the technical fact, authorised disposition and remaining risk.

29. Corrective Action and 8D

Corrective action removes causes and prevents recurrence; correction fixes the immediate defect. Containment protects potentially affected product while the cause is investigated. Use a method proportional to risk, such as 8D for significant, repeated or customer-impacting problems, and follow customer-specific reporting rules where invoked. See 8D RCCA Problem Solving Guidebook.

8D stage	Practical readiness output
D1 Team	Competent cross-functional team and accountable lead.
D2 Problem definition	Specific what, where, when, extent, requirement and actual failure, using facts.
D3 Interim containment	Affected scope, controls, effectiveness check and customer protection.
D4 Cause analysis	Verified occurrence cause and escape cause, plus relevant system weaknesses.
D5 Select permanent action	Action chosen and verified against the cause, with unintended effects assessed.
D6 Implement and validate	Controlled change, retraining and evidence that the action works in production.
D7 Prevent recurrence	PFMEA, control plan, instructions, similar products/processes and system controls updated.
D8 Closure and recognition	Authorised closure with evidence, lessons shared and team contribution acknowledged.

29.1 Cause quality

Use tools such as 5 Why, cause-and-effect analysis, data stratification and designed experiments where appropriate. Verify hypotheses with evidence; do not stop at operator error, retrain staff or supplier issue without determining why the system allowed the error and failed to detect it. Distinguish occurrence cause from escape cause.

29.2 Effectiveness

Set measurable effectiveness criteria before closure: defined defect/rate exposure, shifts/lots, control adherence and absence of recurrence. A newly issued instruction is implementation evidence, not proof that the problem has been prevented. Confirm effectiveness under the actual production conditions and assess related products and sub-tiers.

29.3 Linking to readiness

An open critical corrective action may block G3 or G4. Define whether interim containment is sufficient for the proposed limited scope and who may accept the residual risk. Include containment labour, inspection and scrap in capacity planning. Remove containment only when agreed exit criteria are met, not merely when the action report is submitted.

COMMON ERROR Closing an action because a document was revised leaves effectiveness unproven. Require reviewed production evidence before closure where recurrence risk matters.

Retain the original issue, containment boundaries, verified causes, approved actions, validation results, updated risk/control documents and authorised closure. Keep customer acceptance separate where it is required.

30. Maintenance Facilities and Environment

Production readiness depends on reliable, safe infrastructure and equipment throughout the intended operating period. Review preventive maintenance, utilities, workplace environment, process monitoring, permits, emergency response and continuity. Include shared plant services and specialist contractor support.

30.1 Maintenance readiness

Define equipment-specific preventive maintenance and condition checks based on risk, manufacturer information, process qualification and operating history. Include critical spares, consumables, service capability, response time and equipment recovery. Review overdue work, breakdown history and the effect of maintenance on process qualification or calibration.

Area	Evidence and readiness challenge
Equipment maintenance	Released plan, completion/status records, critical spares and breakdown/recovery plan.
Utilities	Power, compressed air, gases, water, extraction and network meet process needs at intended load.
Environment	Temperature, humidity, cleanliness, vibration, lighting or other required conditions are controlled and recorded.
Safety and permits	Risk assessments, guarding/interlocks, hazardous-material controls, competence and required permits are in place.
FOD and ESD	Relevant workplace zones, housekeeping, equipment checks, behaviours and records are implemented.
Continuity	Safe shutdown, outage response, product disposition, restart checks and contingency capacity are defined.

30.2 Environmental qualification

Confirm the actual environment used for MSA, process validation and trials represent serial production. Establish alarms, escalation, containment and recovery where an environmental deviation can affect conformity. Validate cold storage and other critical conditions using the applicable criteria; an unexplained excursion requires product-impact assessment.

30.3 Safe production

Involve competent EHS personnel. Verify safe loading, handling, chemical exposure controls, pressure/thermal hazards, fire protection and emergency arrangements as applicable. Readiness cannot be claimed for an unsafe operation while safety actions are deferred. Check that planned production volume does not exceed facilities or permit limits.

30.4 Restart after disturbance

Define re-verification after maintenance, repair, relocation, power loss, software recovery or environmental failure. This may include reference checks, first-off inspection, process qualification, programme verification or a focused PRR. Avoid assuming a machine is ready simply because it powers on.

GOOD PRACTICE Review the highest-consequence failure of each critical resource and demonstrate that the recovery plan preserves product status and the approved production baseline.

31. Software Digital Manufacturing and Cybersecurity

Digital systems can determine product conformity as directly as physical tooling. Control NC programmes, post-processors, CMM/test software, recipes, PLC logic, firmware, models and MES/ERP data that affect manufacture or release. Define version, approval, access, backup, validation and change-impact rules.

31.1 Programme validation

Verify the programme against the released definition, intended machine/controller, tooling, fixture, datum system and units. Use simulation where helpful, followed by appropriate physical verification. Check safe toolpaths, offsets, probing, compensation, alarm handling and programme restart behaviour. Retain first-off/validation evidence and approved version identity.

Digital control	PRR evidence
Baseline and access	Approved versions, restricted editing, point-of-use identity and removal of obsolete copies.
Transfer integrity	Checksums or other appropriate verification, controlled transfers and confirmation on the actual equipment.
Data integrity	Traceable records, audit history where needed, authenticated approvals and protection against loss or unauthorised edits.
Interfaces	Validated units, rounding, identifiers, status, limits and transactions between systems.
Recovery	Backups include programmes, recipes, settings and records; restoration is tested and revalidated before release.
Change impact	Updates to controller/software/post-processor/logic receive risk assessment and relevant re-verification.

31.2 Production-relevant cybersecurity

Identify operational technology assets and dependencies. Apply risk-based access control, network segmentation, approved remote access, removable-media controls, monitoring and incident response. Coordinate patching and security changes with process safety, reliability and validation; an untested update can disrupt a qualified process. NIST SP 800-82 Rev 3 provides OT guidance; it is guidance unless imposed by an applicable arrangement.

Assess ransomware, unauthorised programme changes, loss of recipe data, compromised measurement/release records and loss of scheduling systems. Define safe shutdown, isolation, product containment, recovery authority and confirmation that restored data remain correct. Respect contract confidentiality, export restrictions and any invoked security requirements.

31.3 Automation and AI

Validate automated extraction, inspection or decision tools for their intended use. Require competent review of outputs and protect controlled customer data. An automated pass must remain explainable and traceable to approved acceptance rules. Do not permit an unvalidated model or spreadsheet macro to bypass product release controls.

STOP POINT Unknown or unauthorised programme/recipe versions invalidate the claimed baseline. Stop affected use and establish configuration and product impact before restart.

32. Quality Records KPIs and Readiness Metrics

The evidence system must preserve a usable record of what was required, what was done, what resulted and who authorised the decision. Define record owners, retention, storage, access, backup, retrieval, authenticity and disposition. Apply contract/customer/regulatory retention periods; do not assume one universal duration.

32.1 Evidence index

Each PRR evidence entry should identify claim/topic, requirement source, product/site/rate scope, document/record ID and revision, date, owner, reviewer, result, applicability limits and secure location. Link raw data to the analysis and decision. A screen capture without identity, revision or provenance may be insufficient.

Metric	Definition or interpretation
Validated evidence coverage	Accepted applicable evidence items ÷ applicable items; report critical gaps separately.
Open critical blockers	Count with owner, age and affected commitment; target zero before the blocked release.
Action closure performance	Verified closure by due date; distinguish submitted from accepted closure.
First-pass yield	Units conforming without rework ÷ units processed over the defined route/period.
Capability and stability	Characteristic-specific studies with method/window/limits, not an unexplained average Cpk.
Rate margin	Demonstrated sustainable good-output capacity relative to agreed demand.
Supplier readiness	Risk-weighted approval/evidence status, late actions and critical-source exposure.
Delivery and escapes	On-time delivery and defects/escapes using defined denominators and time periods.
Competence and assets	Required operation/shift coverage, overdue critical calibration and maintenance.

32.2 Avoiding misleading metrics

Do not let completion percentages hide mandatory missing evidence. Define denominators and justified exclusions. Treat not applicable items as approved exclusions rather than favourable scores. Show trends and exposure period. A zero-defect trial of very few parts does not prove a low escape rate at serial volume.

32.3 Management use

Use a concise dashboard with readiness scope, gate, blocker list, evidence maturity, quality/rate trends, supplier risks and next decision. Link every headline to underlying records. Set thresholds and escalation rules in advance and review them after learning, without changing them simply to pass a gate.

REVIEW PRINCIPAL Evidence must be identifiable, applicable, current, technically credible, representative, complete and authorised where required. Presence is not validity.

PART E Conducting and Sustaining PRR

33. PRR Agenda and Review Method

The PRR meeting decides using reviewed evidence; it should not be the first time reviewers see the package. Issue the scope, criteria, evidence index, risk summary and open actions in advance. Complete specialist pre-reviews and a workplace walk before the decision meeting where practical.

Illustrative agenda	Duration	Review purpose
Scope and authority	10 min	Confirm product, baseline, site, rate, gate, decision sought and mandatory criteria.
Requirements and design	15 min	Resolve applicability, maturity, critical items and baseline concerns.
Process and special processes	25 min	Challenge route, PFMEA/control-plan chain, approvals and qualification.
Measurement validation and quality	20 min	Review MSA, inspection, FAI/PPAP, capability and actual trial results.
Rate suppliers and infrastructure	20 min	Review bottleneck, people, supply, maintenance, digital and delivery evidence.
Risks blockers and decision	20 min	Agree status, limits, actions, authority and escalation.

33.1 Seven-stage review

- Confirm the exact commitment and current baseline; resolve contradictions first.
- Check entry criteria, contractual flowdown and approval prerequisites.
- Review design/critical-item risks and the flow–PFMEA–control-plan–instruction links.
- Validate measurement, process qualification, trial, FAI and PPAP evidence.
- Challenge sustainable rate, supplier/sub-tier readiness, people and support resources.
- Evaluate nonconformances, residual risk, exclusions and proposed conditions.
- Record the authorised decision, limits, dissent, actions and re-review triggers.

33.2 Evidence sampling

Select a safety/critical characteristic, a special-process batch, a supplier item and a finished trial unit. Trace each from requirement to actual record and approval. Sample point-of-use documents and demonstrate hold/release controls. Increase review depth when sampled evidence is inconsistent; do not assume a sample proves the whole package.

33.3 Meeting output

Record attendees/roles, baseline, gate criteria, evidence reviewed, findings, risk acceptance, decision/status, permitted scope, restrictions, action owners/dates, customer interfaces and signatures/authenticated approvals. Specify who communicates the decision to planning, operations, suppliers and customers where required.

REVIEWER MINDSET Ask what the evidence proves and what it leaves unproven. A confident presentation or complete checklist cannot substitute for traceable production evidence.

34. Scoring and Readiness Status

Use a scoring system to organise judgement, not to override mandatory requirements. The recommended method below separates evidence maturity from the final release decision. Adopt or tailor it before the review and identify the governing customer rules.

Evidence score	Meaning
0 Missing or invalid	No credible applicable evidence, or a known failed requirement.
1 Planned	Owner and plan exist, but implementation/validation is not demonstrated.
2 Implemented with gap	Controls exist, but verification, representativeness or coverage is incomplete.
3 Verified for gate	Evidence is reviewed and meets the agreed criterion for this gate and scope.
N A	Not applicable with recorded rationale and reviewer approval; excluded from the denominator.

If a percentage is useful, calculate sum of scores ÷ (3 × number of applicable scored items) × 100. Freeze the item set before scoring and show domain scores and all blockers separately. Optional risk weighting must be declared in advance; do not change weights to improve the result.

Decision	Recommended rule and permitted commitment
Ready	All mandatory/critical criteria verified; applicable evidence accepted for the gate; no open readiness gaps that invalidate the scope. Permit only the recorded baseline/rate/conditions.
Ready with Actions	No unresolved mandatory or safety/conformity blocker for the permitted scope. Remaining gaps are bounded, with effective controls, named owners, dates, limits and authorised residual-risk acceptance.
Not Ready	A mandatory criterion is unmet, critical evidence is missing/invalid, risk is unacceptable, rate is unsupported or conditions cannot be enforced. Do not permit the affected commitment.

34.1 Blocking criteria

Define gate-specific blockers before the review. Examples are unsafe operation; unresolved requirement/baseline; unauthorised special-process source; inadequate measurement for release; failed critical validation; missing mandatory FAI/PPAP/customer approval; uncontrolled nonconformance; or inability to meet the committed rate. Not all criteria apply at every gate, but the proposed commitment must be explicit.

34.2 Conditional approval

State exactly what can proceed, at what rate/volume, until when and under what controls. Include expiry, stop conditions, action verification and authority. Conditional trial approval is different from conditional serial delivery. Obtain customer consent wherever the contract requires it.

CORE PRINCIPAL A high average never cancels a blocker. An excellent capacity score cannot compensate for an unapproved special process or an unresolved product-safety risk.

35. Action Closure Launch Control and Re Review

Make actions specific enough to close objectively. Each action should state the requirement/gap, affected scope, containment, correction or preventive action, owner, due date, evidence expected verifier and closure authority. Identify dependencies and whether the action blocks a commitment.

Action field	Example of useful content
Gap	WI-020 Rev B omits the approved tool-life limit required by control plan CP-01 Rev C.
Containment	Supervisor verifies recorded tool use at each setup; affected lots remain on defined hold.
Action	Revise WI-020, deploy to both shifts and verify execution during the next representative trial.
Owner and date	Named manufacturing engineer; completion date and escalation route.
Closure evidence	Approved instruction, obsolete-copy withdrawal, competence checks and trial records.
Verification	Independent quality reviewer confirms implementation/effectiveness and signs closure.

35.1 Closure discipline

Review submitted evidence against the original criterion. Check applicability to the approved baseline and whether implementation created new risks. Reopen the action when evidence is weak, the scope changed or the result failed. Keep actual completion date, verifier and supporting records; do not delete overdue history.

35.2 Launch containment

Define temporary increased verification, audits, first-off checks or other controls appropriate to risk and customer requirements. Include the staffing and capacity cost. Set exit criteria such as verified corrective-action effectiveness,

demonstrated stable control and agreed exposure across shifts/lots. Customer approval may be needed before removing mandated launch controls.

35.3 Handover to operations

Transfer the approved baseline, controls, evidence locations, training, capacity limits, unresolved actions and escalation rules. Confirm planning and release systems reflect restrictions and expiry. Assign an owner for G4 surveillance and recurring performance review.

35.4 Re-review triggers

Reassess after changes in design, route, source, site, equipment, programme, material, staffing or rate, and after repeated failures or loss of approval/control. Record a change-impact decision showing what remains valid and what must be repeated. A mature system treats readiness as a maintained state rather than a one-time signature.

STOP CONDITION If a conditional approval expires or a required control fails, stop the affected commitment and escalate. Silence or an overdue action is not an extension of authority.

36. Worked PRR Example and Initial Decision

This fictional training example concerns aluminium mounting bracket MB-120 Rev C at Site A, with controlled machining, deburring, cleaning, outsourced anodising and final inspection. The proposed G3 commitment is 400 good parts per week on one shift. All names, identifiers, data and customer rules in the example are illustrative; they are not valid production approvals.

36.1 Baseline and agreed criteria

The example customer requires AS9102C FAI, an agreed aerospace PPAP package, an approved anodising source and a validated bore-measurement method. The programme's agreed bore-study criterion is Cpk and Ppk at least 1.33 using the defined method, with stability assessed. This is an example contractual criterion, not a universal requirement.

Evidence topic	Initial finding	Score and consequence
Design/baseline	Drawing, BOM, route and programme versions agree; design queries closed.	3 Verified.
Process controls	PFMEA/control plan link exists, but tool-life instruction is incomplete.	2 Gap with potential recurring size risk.
Measurement/study	Approved MSA and stable time-ordered bore data; study results meet the example criterion.	3 Verified for represented conditions.
Special process	Correct certificate, but actual processor site lacks required customer approval.	0 Mandatory blocker.
Rate	Bottleneck model supports fewer than 400 good parts/week before improvements.	0 Rate commitment unsupported.
FAI/PPAP	FAIR under review; PPAP submitted but required customer approval not yet received.	2 Launch approval incomplete.

36.2 Initial decision

The decision is Not Ready for the proposed 400-part/week launch. The special process approval, required customer package approval and rate evidence are blockers. A high score elsewhere cannot change this. Further trial work may proceed only under a separate authorised G2 scope that controls source use and product disposition.

36.3 Actions

- Supplier quality confirms the customer-approved processor/site and obtains valid approval before required processing; review affected trial material disposition.
- Manufacturing engineering updates the tool-life instruction, deploys it and verifies execution.
- Operations resolves the demonstrated bottleneck and repeats a representative rate trial.
- Quality closes FAIR findings and obtains the required PPAP/customer approval status.

The action register records evidence, owners, deadlines, containment and independent verification. The next page shows the numerical basis and final decision after verified closure.

37. Worked Example Calculations and Final Decision

The following values continue the fictional example. Data represent the defined trial configuration; they do not prove all future operating conditions. Raw data, chart analysis, MSA and the detailed trial log would be retained in a real evidence package.

37.1 Bore study

The bore specification is 8.00 ±0.05 mm, so LSL = 7.95 and USL = 8.05 mm. A 125-reading study over 25 rational subgroups reports mean 8.010 mm, within estimate 0.008 mm and overall standard deviation 0.009 mm. The measurement study is accepted under the example plan; time-ordered charts show no unresolved instability.

Index	Calculation	Result
Cp	0.100 ÷ (6 × 0.008)	2.08
Cpk	min(0.040, 0.060) ÷ (3 × 0.008)	1.67
Pp	0.100 ÷ (6 × 0.009)	1.85
Ppk	min(0.040, 0.060) ÷ (3 × 0.009)	1.48

These point estimates exceed the example's 1.33 criterion. Centring and the difference between within/overall variation still warrant monitoring. The study claim is limited to its represented machine, programme, material and operating conditions; sample uncertainty and longer-term shift/lot coverage remain part of G4 surveillance.

37.2 Capacity calculation

Net planned time is 2,100 minutes/week. Initial bottleneck cycle time is 4.5 minutes/part, with availability 0.85 and good-output yield 0.96. With no separate speed loss, estimated good capacity is 2,100 × 0.85 ÷ 4.5 × 0.96 = 381 parts/week. That fails the proposed 400-part commitment.

After a controlled fixture/changeover improvement, verified cycle time is 4.0 minutes/part, availability 0.90 and yield 0.98. Estimated good capacity becomes 463 parts/week. A representative trial and supplier/inspection review support a conservative approved rate of 400, providing an estimated 15.8% margin to demand. The bottleneck and losses remain monitored.

37.3 Final decision

After required source approval, tool-life implementation, accepted FAIR and required customer PPAP approval, G3 is Ready with Actions for 400 good parts/week, MB-120 Rev C, Site A, the reviewed route and approved sources. The remaining action is longer-term G4 evidence across the intended shifts/lots. All G3 mandatory criteria are verified; no mandatory approval is being deferred.

The recorded condition requires agreed launch monitoring, weekly review and a defined G4 due date. Any critical control failure, adverse capability trend or baseline change triggers containment and re-review. This decision grants only the stated scope and expires or escalates under the recorded conditions.

38. Practical Objective Evidence Checklist

Use the following checklist with the reusable record pages that follow. For each item record applicability, criterion/source, evidence ID/revision, score, reviewer, status and action. Split broad topics into specific items where risk or customer requirements demand it. An unchecked box or statement of completion is not objective evidence.

Topic	Minimum practical evidence to challenge
Requirements	Contract/applicability register, resolved queries, customer flowdown and approval rules.
Design and configuration	Released design/BOM index, maturity issues, effectivity and controlled programmes.
Safety and characteristics	Critical/special/key register, safety controls and downstream links.
Manufacturing route	Actual flow/routing, external operations, hold points and rework controls.
Risk and control	DFMEA interface, PFMEA, actions, control plan and implemented reactions.
Measurement	Suitable methods, MSA, calibration and programme/test validation.
Statistics	Raw time-ordered data, stability assessment, justified capability/performance analysis.
Capacity	Demand/mix, bottleneck, actual losses, good-output rate and recovery margin.
Tools and people	Accepted assets, tool life, instructions, competence and shift/deputy coverage.
Supply chain	Material availability, flowdown, approved suppliers/sub-tiers and continuity.
Special processes	Approvals, qualification/validation, parameters, certificates and revalidation.
Verification and approval	Inspection/test plan, FAI/FAIR, applicable PPAP and customer status.
Trial	Protocol, actual configuration, quality/rate results, deviations and product disposition.
Preservation and logistics	Handling/storage, pack validation, labels and delivery interfaces.
Traceability and NCRs	Genealogy challenge, segregation, authorised concessions and impact.

Topic	Minimum practical evidence to challenge
Corrective action	Verified causes, containment, effectiveness and updated controls.
Support systems	Maintenance, environment/utilities, software/OT controls and recovery.
Records and governance	Evidence index, retention/retrieval, KPIs, authority, decision and action closure.

38.1 Reviewer final check

Confirm the exact gate and scope, mandatory criteria, evidence validity, exclusions, dissent, residual-risk authority and enforceable limits. Verify that customer approvals are accepted rather than merely submitted. Ensure every blocking finding prevents the affected commitment and that operations receive the decision.

GOOD PRACTICE Keep the checklist concise at the decision level, with links to detailed technical reviews. Add depth for high-consequence items rather than creating many unreviewed ticks.

38.2 Reusable PRR Scope and Evidence Record

Copy and complete this record for each review. Blank fields require actual programme information; they are not approvals. Attach the customer's mandated forms where applicable.

Scope field	Programme entry
PRR reference gate and review date	_____
Product family part numbers and design revisions	_____
Site route revision and external processors	_____
Equipment tooling and programme baseline	_____
Customer contract and applicable standards/manual revisions	_____
Decision sought quantity rate mix shifts and period	_____
Evidence freeze date and index location	_____
Required customer/regulatory approvals and status	_____
PRR leader accountable approver and independent reviewers	_____
Change triggers prior baseline and affected scope	_____

38.3 Evidence review record

Use one row per criterion. The table can be extended in Word. Record a precise evidence reference and the review result; link additional technical records rather than compressing findings into a vague word.

Criterion and source	Evidence ID revision and scope	Score status and reviewer
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

38.4 Applicability and exclusions

For each exclusion, record the item, reason, risk basis, authority and confirmation that no customer/contract/regulatory requirement is being omitted. An unsupported N A is a finding.

Excluded item	Rationale and approval
_____	_____
_____	_____

RECORD RULE Keep the completed record under configuration and retention control with the evidence package. Preserve actual review dates, authors and authenticated approvals.

38.5 Reusable Decision and Action Record

Complete the decision only after the evidence review. Identify the actual authorised decisionmaker and delegation. Use the customer's required approval workflow where applicable.

Decision field	Entry
PRR reference and reviewed baseline	_____
Status Ready with Actions or Not Ready	_____
Permitted commitment and rate quantity period	_____
Mandatory criteria and approval status	_____
Blockers and prohibited affected commitments	_____
Conditions containment stop rules and expiry	_____
Residual risks and authorised acceptance	_____
Dissent or unresolved technical concerns	_____
Approver role authority signature and date	_____
Customer approval reference where required	_____
Communication and next review date	_____

38.6 Action register

Use a separate detailed action sheet where necessary. Each closure must link to reviewed evidence and, where relevant, effectiveness results.

ID gap and affected scope	Owner due date and containment	Closure evidence verifier and status
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

38.7 Closure verification

- Does the evidence satisfy the original criterion for the reviewed baseline?
- Has implementation reached suppliers, all intended shifts and point-of-use systems?
- Are effectiveness and product-impact checks complete where required?
- Have risks, control plans, instructions and training been updated?
- Has the appropriate authority accepted closure and any customer interface?

AUTHORITY RULE A blank signature, an assigned action or a passed score is not an approval. Release only within actual delegated and customer authority.

39. Common Failure Modes and Maturity Model

Use failures as prompts for better planning and evidence review. Repeated findings usually indicate a system weakness such as unclear ownership, poor change control or incentives that reward schedule over valid evidence.

Failure mode	Practical prevention
PRR held just before shipment	Back-plan gates and evidence; challenge readiness before major commitments.
Mixed revisions across package	Single baseline index and point-of-use reconciliation.
FAIR used as sole readiness proof	Separate quality verification, capacity, approval and sustained-control criteria.
PFMEA and control plan copied generically	Use the actual route, operator input and critical-characteristic links.
Capability reported without MSA/stability	Review method, raw data, assumptions and time-order evidence.
Trial run with special expert support	Use representative people/resources or state and close the limitation.
Supplier promise treated as approval	Verify actual site/scope, rate and current authorisation.
Conditional approval without limits	Specify quantity/time, containment, expiry and stop conditions.
Action closed on document issue	Verify implementation and effectiveness in production.
Excellent average hides blocker	Show critical gaps separately and apply override rules.

39.1 PRR maturity model

This illustrative model assesses system maturity, not contractual acceptance. Evaluate each domain separately and use evidence rather than self-rated confidence.

Level	Observable behaviour
1 Reactive	Late reviews, informal baselines, missing evidence and repeat escapes.
2 Controlled	Defined forms, owners, requirement review and basic records; implementation remains uneven.
3 Planned	Readiness integrated with APQP/gates; route-risk-control links and representative trials routinely used.
4 Predictable	Stable controls, validated measurement, credible sustainable rates and risk-based supplier oversight.
5 Learning	Closed-loop production/service feedback, effective prevention, disciplined digital evidence and rapid controlled re-readiness after changes.

39.2 Improvement plan

Choose a small number of measurable improvements: earlier requirement resolution, stronger special-process approval checks, better MSA coverage, shorter verified action closure or more representative rate trials. Assign owners and review results through management processes. Use maturity progression to improve reliability, while retaining the same mandatory release discipline at every level.

39.3 Local PRR procedure

An organisation implementing this guide should issue a controlled procedure defining triggers, gates, scope, evidence criteria, decision authority, customer interfaces, readiness statuses, conditional limits, action closure and re-review. Adopt forms only after checking their compatibility with the QMS and contracts.

Implementation task	Recommended output
Define applicability	Approved programme/contract requirement matrix.
Assign governance	PRR leader, functional owners, independent reviewers and delegation.
Integrate lifecycle	APQP/gate plan and evidence dates tied to production commitments.
Pilot the process	Representative product review with lessons and revised procedure.
Train the team	Competence in evidence challenge, safety, scope and approval boundaries.
Monitor effectiveness	Escapes, rate performance, repeat findings and verified action closure.

39.4 Maintaining technical accuracy

Assign a document owner to monitor publisher changes, customer manuals, regulatory applicability and lessons learned. Review this guide after relevant changes and at an organisation-defined interval. Record change impact before adopting a new standard edition or altering a production baseline.

LEARNING PRINCIPAL Tools support decisions; they do not make requirements disappear. Learn why each evidence item matters so that tailoring remains technically defensible.

40. Document Revision Control

Rev	Date	Change	Author
1	1 Nov 2026	Initial issue Production Readiness Review Guidebook	D. Egan

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