# Sampling Inspection: Securing Quality Selectively but Robustly

Sampling inspection is a quality inspection method in which conclusions about the quality of an entire quantity are drawn from a subset of a delivery or production batch. It is the practical backbone of goods receipt and ongoing production control, because 100 per cent inspection is often too expensive or technically impossible. For buyers, the correct design of the sample determines whether delivery defects are detected early or only end up in complaint management.

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### Key facts at a glance

01 Sampling inspection evaluates a subset and draws conclusions about the entire quantity with defined statistical confidence.

02 Typical systems are based on AQL values (Acceptable Quality Limit), frequently between 0.65 and 2.5 depending on the criticality of the characteristic.

03 In goods receipt, it is closely linked to material classification: safety-critical parts require a greater inspection depth.

04 Results feed into the supplier scorecard and influence supplier selection and the Preferred Supplier Programme.

05 Where findings are conspicuous, escalation to 100 per cent inspection or containment measures is common.

06 Sampling plans should be bindingly agreed in the quality assurance management agreement or framework supply plan.

## Definition: sampling inspection

Sampling inspection is an inspection concept in which not every unit of a delivery or batch is inspected, but rather a subset selected according to statistical rules. From the inspection result of the sample, conclusions are drawn about the quality of the entire quantity with a defined probability. It thereby deliberately replaces full inspection and accepts a residual, quantifiable risk.

### Distinction from 100 per cent inspection

In full inspection, every part is examined; sorting out defective units is maximally reliable, provided the inspection itself works flawlessly. Sampling inspection, by contrast, accepts a residual risk but significantly reduces inspection costs and throughput time. In practice, inspection is often layered: critical characteristics are inspected in full, less critical characteristics by sampling.

### Legal and contractual classification

Sampling inspection is a recognised instrument of quality management, but it does not release the buyer from their warranty rights in respect of defects discovered later. Agreements on inspection scope, AQL values and inspection methods should be recorded in the framework agreement, the quality assurance management agreement or the framework supply plan. Details such as warranty or place of jurisdiction must be examined legally on a case-by-case basis.

## Methods and procedure of sampling inspection

The procedure follows a fixed sequence: defining the inspection characteristic, determining the sample size, randomly selecting the items to be inspected, inspection and assessment against predefined acceptance and rejection criteria. The basis in industry is typically numerical sampling systems in accordance with DIN ISO 2859-1 or its English-language counterpart ANSI/ASQ Z1.4.

### AQL and sampling systems

The Acceptable Quality Limit (AQL) defines the quality limit that the buyer considers acceptable. In practice, an AQL of 1.0 means that a sampling system is designed so that batches with up to 1 per cent defective units are accepted in the majority of cases. Each AQL is associated with sample sizes depending on lot size as well as acceptance (Ac) and rejection numbers (Re).

### Attribute and variables inspection

In attribute inspection, only good/bad is assessed, for example whether a dimension is within tolerance. Variables inspection uses measurable characteristic values and determines statistical quantities such as mean and variation; it achieves comparable confidence with smaller samples. Which method is suitable depends on the characteristic, inspection time and measuring technology.

### Sample selection and sampling

Only a random selection, distributed as widely as possible across the entire delivery, produces meaningful results. Taking samples exclusively from the top layer of boxes distorts the picture, as damage due to transport risk or storage often occurs layer-specifically. For multi-part deliveries, sampling per partial delivery is recommended.

## Areas of application: goods receipt, production and supplier management

Sampling inspection is used at several points along the supply chain. Its scope should be guided by material classification and the supplier's track record, not by a blanket rule for all parts.

### Incoming goods inspection

In goods receipt, the sample serves as a fast filter between delivery and stock entry. If the criteria are met, the batch is released and posted to the asset accounts; typically the PO flip is then triggered, converting the purchase order into an invoice. If a complaint is raised, defective part management or a containment measure at the supplier is initiated.

### Process inspection in production

In ongoing production processes, samples are taken at fixed intervals to detect process drift early, for example in injection moulding or machining. Statistical process control and sampling inspection complement each other here: SPC monitors trends, while the sample decides on acceptance or rework.

### Supplier evaluation

Systematically documented sampling results feed the supplier scorecard and provide objective data alongside on-time delivery and fill rate. If the error rate deteriorates permanently, measures can range from downgrading in the Preferred Supplier Programme to re-including the item in competitive tendering.

## Key KPIs and measures for sampling inspection

KPIs make quality assurance measurable and comparable. They should be evaluated by material class and supplier and regularly discussed within the supplier portfolio.

### Error rate and reject rate

The central measure is the number of rejected units in relation to inspected units, often additionally broken down by characteristic and severity level. The reference matters: an error rate of 0.5 per cent is uncritical for standard screws, yet unacceptable for safety-relevant components.

### First acceptance rate and inspection costs

The first acceptance rate (First Pass Yield at delivery level) shows the proportion of inspected batches that pass without complaint. In addition, inspection costs per unit should be recorded, as they support the economic trade-off between sampling and full inspection, or between inspection and shifting responsibility to supplier certificates.

## Risks, limitations and controls

Sampling inspection is a compromise: it saves effort but can overlook faults in the uninspected quantity. Those who use it should consciously manage residual risks and not rely on a single method.

### Statistical residual risk and incorrect decisions

Every sample can decide incorrectly: good batches are rejected without justification (producer's risk) or poor ones accepted without justification (consumer's risk). Both risks can be controlled via sample size and AQL, but can never be reduced to zero. Where the potential damage is high, therefore, extended inspection depth or full inspection is required.

### Latent defects and transport influences

Some faults only appear later, such as fatigue cracks or ageing of plastics; they cannot be reliably detected in goods receipt, even by sampling. Here, incoming accompanying long-term tests on prototypes and suitable packaging specifications help to minimise transport risk.

### Organisational controls

Effective controls include trained inspection staff, calibrated measuring equipment, documented inspection instructions and complete traceability of inspection results to the batch. Results belong in complaint management so that patterns across suppliers and parts become recognisable. In supplier risk management, frequent sampling rejections serve as an early indicator of financial or process-related difficulties at the supplier.

## Current developments: automation, AI and sustainability inspection

Sampling inspection is increasingly moving into automated and data-based environments. At the same time, the concept of inspection is expanding beyond purely technical characteristics.

### Automated optical and metrological inspection

Image processing systems and measuring machines today typically inspect significantly more units than manual sampling, at comparable costs per unit. This brings sampling and 100 per cent inspection economically closer together; the decision should be reassessed for each part.

### Data-driven control of inspection depth

Digital quality data from the supplier scorecard allow dynamic control of inspection depth: proven suppliers are moved to reduced inspection levels, conspicuous ones to tightened levels. This logic can be well integrated with a Preferred Supplier Programme and the category governance of the respective goods purchasing function.

### Sustainability and compliance in the sample

Sampling inspection is not limited to dimensions and materials: supporting documents, marking and occasionally material properties in the context of Life Cycle Assessment (LCA) are also checked by sampling. Against the background of supply chain laws such as the Corporate Sustainability Due Diligence Directive (CSDDD), the random checking of supplier statements is gaining in importance; the specific obligations must be examined legally on a case-by-case basis.

## Typical metrics

| Metric | Typical value |
|---|---|
| **Sample error rate** | typically < 1 %<br>*depending on material class and agreed AQL* |
| **First acceptance rate (batches)** | > 95 %<br>*proportion of lots released without complaint* |
| **Inspection costs per inspected unit** | process-dependent, variable<br>*governs the trade-off between sampling and full inspection* |
| **Rejected batches per supplier** | trend: declining<br>*feeds into the supplier scorecard* |

## Practical example

A medium-sized mechanical engineering company sourced castings from several suppliers and had previously inspected every delivery with uniform effort. Introducing risk-based sampling inspection relieved the goods receipt department and reduced customer complaints.

- Material classification of all components by criticality, with AQL 0.65 for safety-relevant and AQL 2.5 for standard parts
- Dynamic reduction of inspection depth for suppliers with at least six months of fault-free history, documented in the supplier scorecard
- Binding agreement on sampling systems and sampling rules with each supplier in the framework supply plan
- Immediate containment request to the supplier in the event of a sample finding, with escalation via complaint management

## Conclusion

Sampling inspection is a proven instrument for safeguarding quality economically without having to inspect every unit. Its value depends entirely on sound statistical design, risk-oriented inspection depth and consistent documentation of results. Anyone who systematically feeds sampling data into supplier

evaluation gains, alongside quality assurance, a reliable basis for decisions on the supplier portfolio. In view of automated inspection technology and growing verification obligations along the supply chain, the method remains current, but is shifting from individual measurement to data-driven control. Buyers are well advised to bind inspection scope and AQL contractually and to regularly adapt inspection depth to the consequences of failure and supplier performance.

## Frequently asked questions

### ? What is sampling inspection in simple terms?

In sampling inspection, only part of a delivery or batch is inspected, for example 50 out of 5,000 parts. The result is used to draw conclusions about the quality of the entire quantity. This saves time and costs but carries a statistical residual risk, which is controlled via AQL values and sample size.

### ? Which sampling systems and standards are there?

Widely used in industry are attribute sampling in accordance with DIN ISO 2859-1 or ANSI/ASQ Z1.4 as well as procedures for variables inspection in accordance with DIN ISO 3951. They define sample size and acceptance and rejection numbers depending on lot size and AQL. Alternatively, industry-specific special provisions exist, for example in the automotive or medical technology sectors.

### ? How large must a sample be?

The size results from the lot size, the chosen AQL, the inspection severity and the level of risk tolerance; in the standards mentioned, it is tabulated. In practice, goods receipt samples are typically between 8 and 315 units depending on lot size. Safety-critical characteristics require larger samples or a full inspection.

### ? When is sampling inspection not sufficient?

Where faults could have consequences for life and health, where the characteristic can be inspected with very little effort, or where the risk of latent defects is high, 100 per cent inspection is frequently performed. Increased inspection depth is also appropriate for new suppliers, after waves of complaints, or for processes with known instability. The decision should be made on a risk-based basis and documented.

### ? Who bears the costs of sampling inspection?

As a general rule, the buyer bears the costs of the customary incoming inspection. If the sample reveals defects, inspection costs and additional expenses can be claimed against the supplier within the scope of warranty or defect rights. The specific contractual provision, for example in the quality assurance management agreement, must be examined legally on a case-by-case basis.

### ? What does AQL mean in sampling inspection?

AQL stands for Acceptable Quality Limit, i.e. the maximum tolerated error rate in per cent. An AQL of 1.0 means that the sampling system is designed to accept, in the majority of cases, batches with

an error rate of up to around 1 per cent. More critical characteristics are assigned lower AQL values and thus stricter acceptance criteria.


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