QUALITY MANAGEMENT & ENGINEERING

The Comprehensive Guide to AQL Sampling Tables: Mastering JIS Z 9015 and ISO 2859-1 for Industrial Quality Control

Published: April 30, 2026 | Index ID: #178

In the high-stakes environment of global manufacturing and supply chain management, ensuring product quality while maintaining cost-efficiency is a delicate balancing act. It is physically and economically impossible to inspect every single unit in a mass-production run of millions. To solve this, quality engineers and procurement specialists rely on statistical methodologies known as **Acceptance Sampling**. Central to this practice is the **Acceptable Quality Level (AQL)**, specifically as defined by international standards such as **ISO 2859-1** and its Japanese equivalent, **JIS Z 9015**.

This technical guide provides an exhaustive analysis of the AQL sampling framework, exploring the mathematical foundations, procedural execution, and strategic implementation of JIS Z 9015. By the end of this article, quality professionals will possess the depth of knowledge required to implement, audit, and optimize sampling plans across diverse industrial sectors.

Understanding the Theoretical Framework of AQL

What is Acceptable Quality Level (AQL)?

The **Acceptable Quality Level (AQL)**is formally defined as the maximum percent defective (or the maximum number of defects per hundred units) that, for the purpose of sampling inspection, can be considered satisfactory as a process average. It is a critical threshold used by both manufacturers (the producers) and buyers (the consumers) to agree on the quality standards of a shipment.

It is a common misconception that an AQL of 1.0 means the manufacturer is allowed to produce 1% defective goods. Rather, AQL is a **statistical boundary**. It represents the quality level that the sampling plan will accept the majority of the time. If the actual quality level of the lot is at or better than the AQL, the probability of acceptance (Pa) is high (typically around 95% to 99%).

The Evolution of Standards: From MIL-STD-105E to JIS Z 9015

The history of AQL sampling is rooted in military necessity. During World War II, the United States military developed **MIL-STD-105** to standardize the inspection of munitions and equipment. This standard evolved through several iterations until MIL-STD-105E. Eventually, these principles were adopted by international bodies, leading to the creation of **ISO 2859-1**. The Japanese Industrial Standards committee subsequently established **JIS Z 9015**, which is technically aligned with the ISO standard, ensuring that global supply chains speak the same statistical language.

Core Mechanics of the AQL Sampling Plan

Operating a sampling plan under JIS Z 9015 requires navigating a series of interrelated tables and parameters. The primary components include inspection levels, lot sizes, sample size code letters, and the AQL values themselves.

1. Inspection Levels: General vs. Special

JIS Z 9015 classifies inspection into two categories, each containing sub-levels that determine the relationship between the **Lot Size** and the **Sample Size**.

- General Inspection Levels (I, II, III): These are the standard levels used for most industrial products. Level II is the default and most widely used. Level I requires about 40% of the sample size of Level II, used when less discrimination is needed. Level III requires about 160% of Level II, used when higher confidence is required or the supplier has a history of poor quality.
- Special Inspection Levels (S-1, S-2, S-3, S-4): These levels are used when the sample size must be kept very small. This is common for destructive testing (e.g., stress testing a component until it breaks) or when the inspection is extremely expensive and time-consuming.

2. Sample Size Code Letters

To determine the actual number of units to be pulled from a lot, we first identify a **Sample Size Code Letter**. This letter is found by cross-referencing the total lot size with the chosen inspection level in the Master Table. The letters range from A to R, with 'A' representing the smallest sample sizes and 'R' the largest.

3. Acceptance (Ac) and Rejection (Re) Numbers

Once the sample size is determined, the AQL table provides two critical integers:**Ac (Acceptance Number):** The maximum number of defects allowed in the sample for the lot to be accepted.**Re (Rejection Number):**The minimum number of defects found in the sample that will cause the entire lot to be rejected.

Technical Analysis: The Single Sampling Plan for Normal Inspection

The most common application of JIS Z 9015 is the **Single Sampling Plan**. Under this plan, the results of a single sample set determine the fate of the entire lot. Below is a structural representation of how these metrics align.

Lot Size (Units)	Inspection Level I	Inspection Level II (Default)	Inspection Level III
2 to 8	A	A	B
9 to 15	A	A	C
16 to 25	A	B	D
26 to 50	B	C	E
51 to 90	C	D	F
91 to 150	C	E	G
151 to 280	D	F	H
281 to 500	E	G	J
501 to 1200	F	H	K
1201 to 3200	G	J	L
3201 to 10000	H	K	M
10001 to 35000	J	L	N

After identifying the letter (e.g., 'J' for a lot of 2,000 units at Level II), the technician moves to the **Master Table for Single Sampling Plans**. If the AQL is set at 1.0, the table might specify a sample size of 80 units, with an Ac of 2 and an Re of 3. If the inspector finds 2 defects, the lot passes. If they find 3, the lot fails.

The Mathematical Foundations: Probability and OC Curves

The effectiveness of an AQL plan is visualized through the **Operating Characteristic (OC) Curve**. An OC curve plots the probability of acceptance (Pa) against the actual percent defective in the lot.

Producer's Risk vs. Consumer's Risk

In any sampling plan, there are two types of statistical errors:

1. Type I Error (Producer's Risk - ; “ The risk that a "good" lot (at or better than the AQL) is rejected. JIS Z 9015 is designed to keep this risk low, usually between 1% and 5%.
2. Type II Error (Consumer's Risk - ;"“ The risk that a "bad" lot (worse than the AQL) is accepted. This is also known as the Limiting Quality (LQ) or Lot Tolerance Percent Defective (LTPD).

Mathematically, these probabilities are often calculated using the **Poisson Distribution** for defects per unit or the **Binomial Distribution** for percent defective. The formula for the probability of acceptance is: *Pa = " [(e^-;^{2} ¢ »^k) / k!]* for k from 0 to Ac, where ;^{2} —2 F†R Pxpected number of defects (sample size * defect rate).

The Switching Rules: Ensuring Dynamic Quality Control

One of the most powerful features of JIS Z 9015 and ISO 2859-1 is the system of **Switching Rules**. These rules allow the inspection severity to adjust based on the supplier's historical performance. This creates an incentive for suppliers to maintain high quality and allows buyers to save costs when quality is consistently high.

1. Normal to Tightened Inspection

If 2 out of 5 consecutive lots are rejected under Normal inspection, the system must switch to **Tightened Inspection**. Tightened inspection maintains the same sample size but reduces the Acceptance number (Ac), making it harder for a lot to pass.

2. Tightened to Normal Inspection

To return to Normal inspection, the supplier must demonstrate 5 consecutive lots accepted on the first attempt under Tightened inspection. This ensures the improvement in quality is not a fluke.

3. Normal to Reduced Inspection

If quality is consistently high (e.g., 10 consecutive lots accepted), and the total number of defectives found is below a specific limit set by the tables, the buyer may switch to **Reduced Inspection**. Reduced inspection uses smaller sample sizes, significantly lowering inspection costs.

4. Discontinuation of Inspection

If a supplier remains on Tightened inspection for more than 10 consecutive lots without returning to Normal, the standard recommends **discontinuing inspection**altogether and seeking a new supplier, as the current production process is demonstrably incapable of meeting the AQL.

Classifying Defects: Critical, Major, and Minor

Not all defects are created equal. A successful AQL strategy requires a **Defect Classification List**. Each category usually carries a different AQL value.

Defect Category	Description	Typical AQL Value
Critical	Potential to cause injury, fail safety regulations, or render the product completely unusable.	0.0 (or 0.010)
Major	Likely to result in product failure or reduced usability; significant aesthetic flaws that deter purchase.	1.0 or 1.5
Minor	Departures from specifications that do not affect function or significantly impact salability.	2.5 or 4.0

Practical Implementation Guide: A Step-by-Step Workflow

Executing an inspection using JIS Z 9015 requires a disciplined approach. Follow these steps for an audit-ready process:

Step 1: Define Parameters

Establish the AQL for each defect class (Critical, Major, Minor) in the purchase agreement or Quality Statement of Work (SOW). Decide on the Inspection Level (defaulting to G-II).

Step 2: Determine Lot Size

Identify the total number of units in the specific shipment or production batch. This is the 'N' in your calculations.

Step 3: Select the Sample Code Letter

Use the JIS Z 9015 Table A (Sample Size Code Letters) to find the intersection of your lot size and inspection level.

Step 4: Identify Sample Size and Ac/Re

Consult Table B (Single Sampling Plans for Normal Inspection). Locate your code letter in the left column and the AQL value at the top. The intersection gives you the sample size (n) and the Ac/Re values.

Step 5: Random Sampling

This is the most critical physical step. Samples must be selected **randomly**. If units are selected from the top of the box only, the data is invalid. Use a random number generator or a systematic skip-interval method.

Step 6: Inspection and Tally

Inspect the units against the specification. Categorize each found defect as Critical, Major, or Minor.

Step 7: Decision Rule

Compare the totals for each category against their respective Ac/Re limits. **Crucially:**If a lot fails on any one of the three AQL categories, the entire lot is rejected.

Case Study: Electronic Component Sourcing

Imagine a manufacturer sourcing 5,000 units of a specific PCB (Printed Circuit Board). The agreement specifies General Inspection Level II, with AQLs of 0 for Critical, 0.65 for Major, and 2.5 for Minor.

- Lot Size: 5,000

- Code Letter (Level II): 'L'
- Sample Size for Letter L: 200 units
- AQL 0.65 (Major): Ac 3, Re 4
- AQL 2.5 (Minor): Ac 10, Re 11

The inspector pulls 200 units. They find 2 Major defects and 12 Minor defects. **Result:** Even though the Major defects were within the limit (2 < 3), the Minor defects exceeded the limit (12 > 10). The entire lot of 5,000 units is **Rejected**.

Strategic Implications of AQL in Modern Industry

Beyond simple pass/fail metrics, AQL tables serve as a strategic tool for continuous improvement. By tracking AQL results over time (Trend Analysis), companies can identify "drifting" quality before it results in a lot rejection. This is a move toward **Preventative Quality Management**.

Furthermore, in the era of Industry 4.0, AQL data is increasingly integrated into **Enterprise Resource Planning (ERP)**systems. Automated AQL calculators and digital inspection tools reduce human error in reading tables and ensure that switching rules are applied strictly. This transparency fosters trust between international partners, as the criteria for acceptance are objective, mathematically sound, and globally recognized.

Conclusion: The Future of Attribute Sampling

While the rise of automated optical inspection (AOI) and 100% sensor-based monitoring is changing the landscape, the AQL sampling tables of JIS Z 9015 remain the foundational legal and technical standard for acceptance in international trade. They provide a predictable, fair, and statistically robust framework that protects both the buyer and the seller. Mastery of these tables is not merely a technical requirement for quality inspectors—it is a strategic competency for any organization aiming for operational excellence in the global marketplace.

Tags: #AQL Sampling #JIS Z 9015 #ISO 2859 1 #Quality Control #Industrial Inspection #Statistical Sampling