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Standard Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection[1]

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INTRODUCTION

Throughout this guide the terms *detection* and *prevention* apply to quality control systems. A brief description of both is provided to assist the purchaser in the application of this guide.

The *detection system* relies on inspection as the primary means of controlling the quality of furnished material. Methods include in-process and final inspection. In-process inspection is typically performed by the individual performing the process and generally includes a first-piece inspection by someone other than the operator. Quality-control inspection may perform audit inspections on the process output during the course of the production run. In addition, a final inspection is performed by quality control inspectors according to a prescribed sample plan. The other sample plans utilize zero defects as their acceptance criteria.

The *prevention system* uses advanced quality planning in addition to many of the techniques used in the detection system. Quality planning incorporates a systems approach to quality control that focuses on defect prevention and continual improvement. In addition, Statistical Process Control (SPC) is usually applied to control the process, thereby reducing the variability of the output.

The ISO 9000 and/or the ANSI/ASQC Q9000 quality system standards are models that may be used in establishing a prevention-based quality systems.

1. Scope

1.1 This guide provides sampling methods for determining how many fasteners to include in a random sample in order to determine the acceptability of a given lot of fasteners.

1.2 This guide is for mechanical properties, physical properties, coating requirements, and other quality requirements specified in the standards of ASTM Committee F-16. Dimensional and thread criteria sampling plans are the responsibility of ASME Committee B18. Therefore, unless otherwise specified in this guide, dimensional and thread fit sampling shall be in accordance with ANSI/ASME B18.18.3M.

1.3 This guide provides for two sampling plans: one designated the "detection process," as described in 3.1.3, and one designated the "prevention process," as described in 3.1.8.

2. Referenced Documents

2.1 *ANSI Standards:*

ASME/ANSI B18.18.2M Inspection and Quality Assurance for High-Volume Machine Assembly[2]

ASME/ANSI B18.18.3M Inspection and Quality Assurance for Special Purpose Fasteners[2]

ASME-FAP-1 Quality Assurance Program Requirements for Fastener Manufacturers and Distributors[2]

ANSI/ASQC Q9000 Quality Management and Quality Assurance Standards—Guidelines for Selection and Use[2]

ANSI/ASQC Q9001 Quality Systems—Model for Quality Assurance in Design/Development, Production, Installation, and Servicing[2]

ANSI/ASQC Q9002 Quality Systems—Model for Quality Assurance in Production and Installation[2]

ANSI/ASQC Q9003 Quality Systems—Model for Quality Assurance in Final Inspection and Test[2]

ANSI/ASQC Q9004 Quality Management and Quality System Elements—Guidelines[2]

2.2 *ISO Standards:*

ISO 9000 Quality Management and Quality Assurance Standards—Guidelines for Selection and Use[2]

ISO 9001 Quality Systems—Model for Quality Assurance in Design/Development, Production, Installation and Servicing[2]

ISO 9002 Quality Systems—Model for Quality Assurance

[1] This guide is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.93 on Quality Assurance Provisions for Fasteners.

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[2] Available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

in Production and Installation[2]
ISO 9003 Quality Systems—Model for Quality Assurance in Final Inspection and Test[2]
ISO 9004 Quality Management and Quality System Elements—Guidelines[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *assembly lot*—an assembly lot may consist of a combination of different products. As long as the products that make up the assembly are in accordance with 3.1.6, the quantity of assemblies determine the sample size. Example: ten assemblies consisting of a bolt, nut, and a washer would have a lot size of ten if the bolts, nuts, and washers meet the criteria of 3.1.6. However, if any of the components in the assembly are not in accordance with 3.1.6 then the ten assemblies will have to be separated into lots that meet all the requirements of 3.1.6.

3.1.2 *common cause*—common cause variation affects all the individual values of the process output being studied. In control chart analysis, it appears as part of the random process variation.

3.1.3 *detection process*—a past-oriented strategy of quality control that attempts to identify the nonconforming product after it has been produced, and then to separate it from the conforming product.

3.1.4 *in-process sampling inspection*—a random sample of product drawn from prescribed points of the processing stream (usually characteristic sensitive) and performing specific inspections and tests to determine conformance of the product at that point of the processing stream.

3.1.5 *inspection*—process of measuring, examining, testing, gaging, or using other procedures to ascertain the quality or state of, detect errors or defects in, or otherwise appraise materials, products, services, systems, or environments to a preestablished standard.

3.1.6 *lot*—a quantity of product of one part number that has been processed essentially under the same conditions from the same heat treatment lot and produced from one mill heat of material and submitted for inspection at one time.

3.1.7 *lot sampling inspection*—a random sample drawn from a lot and performing specified inspections and tests to determine the acceptability of the lot.

3.1.8 *prevention process*—a future-oriented strategy that, through analysis and action toward correcting the process itself, enriches quality through continuous improvement activities.

3.1.9 *process flow*—the current or anticipated sequential process steps required to produce a fastener.

3.1.10 *random sampling*—when every fastener in the lot has an equal and independent chance of being chosen as the sample. The sample may be returned to the lot if it has not been altered or destroyed during the inspection/test upon completion of sampling.

3.1.11 *special cause*—special cause variation is intermittent, unpredictable and unstable. In control chart analysis, it is signaled by a point beyond the control limits, a run, or some other nonrandom pattern of points within the control limits.

3.1.12 *statistical control*—exists when all special causes of variation have been eliminated from a process and only common causes remain.

3.1.13 *test*—an element of inspection that generally denotes the determination by technical means of the properties or elements of supplies, or components thereof and involves the application of established scientific principles and procedures.

4. Significance and Use

4.1 Sampling shall be selected in a random manner, ensuring that any unit in the lot has an equal chance of being chosen. Sampling should not be localized by selections being taken from the top of a container or from only one container of multicontainer lots.

4.2 The purchaser should be aware of the supplier's quality assurance system. This can be accomplished by auditing the supplier's quality system, if qualified auditors are available, or by third-party assessment certification, such as provided by ASME's Fastener Accreditation Program (FAP), QS 9000, or ISO 9000.

5. Ordering Information

5.1 The purchaser shall specify at the time of order inquiry, the specification number, the issue date and the sampling plan (detection process or prevention process) required from the supplier.

5.2 Guidelines for sampling plan selection are provided in Section 6.

6. Selection of Sampling Plans

6.1 Except as specified in 6.2, the detection process sampling level in accordance with Table 1 shall be applied.

6.2 If the purchaser knows through documented evidence that his supplier conforms with ASME/ANSI B18.18.3M, ANSI/ ASQC Q9000, Q9001, Q9002, or Q9003, or ISO 9000, 9001, 9002, or 9003, the purchaser may specify the prevention process in accordance with Table 2.

7. Acceptance Criteria

7.1 The acceptance criteria for Table 3 is to accept the lot if zero nonconforming parts are detected, and reject the lot if at least one nonconforming part is detected.

8. Disposition of Nonconforming Lots

8.1 *Supplier's Options*—The supplier has the following options in dispositioning nonconforming lots:

8.1.1 Lots may be scrapped.

8.1.2 Lots may be 100 % sorted and all nonconforming parts removed.

8.1.3 Lots may be reworked or reprocessed to correct the nonconforming characteristic(s), if permitted by specification. See 8.3.

8.1.4 Lots may be "used-as-is" providing the purchaser is informed of the rejectable items and written approval is obtained. This disposition shall be documented with each shipment, including appropriate signatures and dates authorizing the release.

NOTE 1—Caution should be exercised when applying the option to "use-as-is." In the interest of safety and quality, all "use-as-is" conditions should have no effect on the fastener's intended application or end use.

TABLE 1 Sampling Level for the Detection Process

NOTE 1—Legend: WA—Where Applicable.
NA—Not Applicable.

Characteristic	Description of Control				
	Sample Level[A]	Internally Threaded Parts	Externally Threaded Parts	Non-threaded	Washers
Adhesion (coating)	C	WA	WA	WA	WA
Assembly tension test	B	NA	WA	NA	NA
Bend, body (nails)	A	NA	NA	WA	NA
Bend, notched (bolts)	B	NA	WA	NA	NA
Bend, body (track spikes)	C	NA	NA	WA	NA
Breaking strength (eyebolts)	C	NA	WA	NA	NA
Carbide precipitation	C	WA	WA	WA	WA
Case depth/decarburization	C	WA	WA	WA	WA
Chemistry[B]	—	WA	WA	WA	WA
Compression (washer direct tension)	A	NA	NA	NA	WA
Cone proof	C	WA	NA	NA	NA
Drive test	A	WA	WA	NA	NA
Elongation—Machined specimen	C	NA	WA	WA	NA
Extension at failure	C	NA	WA	WA	NA
Grain size[C]	—	WA	WA	WA	WA
Hardness[D]	B	WA	WA	WA	WA
Bend, head (track spikes)	C	NA	NA	WA	NA
Humidity	B	WA	WA	WA	WA
Hydrogen embrittlement	B	WA	WA	WA	WA
Impact	C	NA	WA	WA	NA
Lubrication	B	WA	WA	WA	WA
Magnetic permeability	B	WA	WA	WA	WA
Packaging[E]	—	WA	WA	WA	WA
Plating/coating thickness (weight)	A	WA	WA	WA	WA
Product identification marking[F]	—	WA	WA	WA	WA
Proof load—Full size	C	WA	WA	NA	NA
Reduction of area—Machined specimen	C	NA	WA	WA	NA
Bend, rivet	B	NA	NA	WA	NA
Flattening, rivet	B	NA	NA	WA	NA
Rotational capacity	C	WA	WA	NA	WA
Salt spray[G]	B	WA	WA	WA	WA
Shear strength	C	NA	WA	WA	NA
Stress corrosion	B	WA	WA	WA	WA
Surface discontinuities	B	WA	WA	WA	WA
Surface roughness	B	WA	WA	WA	WA
Tensile strength—Full size[H]	C	NA	WA	WA	NA
Tensile strength—Machined specimen	C	NA	WA	WA	NA
Torque[I] (prevailing)	C	WA	WA	NA	NA
Torque (torsional strength)	C	WA	WA	NA	NA
Yield strength—Full size	C	NA	WA	NA	NA
Yield strength—Machined specimen	C	NA	WA	NA	NA

[A] Quantity of samples is in Table 3, Sample Size.
[B] A certified copy of the material's chemical or product analysis shall be furnished with each shipping lot, and the shipping lot shall have documentation providing traceability to this chemical analysis. It is required that the purchaser of the raw material (used to manufacture) shall verify that the material is the material specified on the purchase order.
[C] The steel producer shall provide the steel making practice (course or fine grain) on their certification. The steel producer may specify grain size at their option.
[D] Surface or core, or both, as applicable.
[E] All packaging requirements shall be in conformance with the applicable packaging standard.
[F] Visual inspection for conformance.
[G] Continuous monitoring of salt spray performance in accordance with the recommendation of Table B in Appendix 1 of ASME/ANSI B18.18.2M constitutes compliance with the requirements for salt spray testing outlined in this table.
[H] Wedge angle or axial test as applicable.
[I] Prevailing torque test includes thread start, all specified torque requirements, and retention of locking feature, when applicable.

8.2 *Purchaser's Options*—The purchaser has the following options in dispositioning nonconforming lots:

8.2.1 Lots may be rejected and returned to the supplier.

8.2.2 Lots may be accepted. If nonconforming lots are accepted, the responsibility for the lot is borne by the purchaser, provided the purchaser issues a written deviation to the supplier relieving him of responsibility for the nonconforming product.

8.3 *Reinspection*—When rework or reprocessing is performed to correct a nonconforming item, that lot shall be reinspected on completion of all rework or processing, using the same sample plan as used in detecting the nonconformance. The sample shall be inspected for the corrected criteria and any other criteria affected by the rework. The acceptance level shall be in accordance with 7.1.

9. Control of Measuring and Test Equipment

9.1 Control should be maintained over all measuring and test equipment to provide confidence in decisions or actions based on measurement or test data. As a minimum, these

TABLE 2 Sampling Level for the Prevention Process

NOTE 1—Legend: WA—Where Applicable.
NA—Not Applicable.

Characteristic	Description of Control				
	Sample Level[A,B]	Internally Threaded Parts	Externally Threaded Parts	Non-threaded	Washers
Adhesion (coating)	D	WA	WA	WA	WA
Assembly tension test	C	NA	WA	NA	NA
Bend, body (nails)	B	NA	NA	WA	NA
Bend, notched (bolts)	C	NA	WA	NA	NA
Bend, body (track spikes)	D	NA	NA	WA	NA
Breaking strength (eyebolts)	D	NA	WA	NA	NA
Carbide precipitation	D	WA	WA	WA	WA
Case depth/decarburization	D	WA	WA	WA	WA
Chemistry[C]	—	WA	WA	WA	WA
Compression (washer direct tension)	B	NA	NA	NA	WA
Cone proof	D	WA	NA	NA	NA
Drive test	B	WA	WA	NA	NA
Elongation—Machined specimen	D	NA	WA	WA	NA
Extension at failure	D	NA	WA	WA	NA
Grain size[D]	—	WA	WA	WA	WA
Hardness[E]	C	WA	WA	WA	WA
Bend, head (track spikes)	D	NA	NA	WA	NA
Humidity	C	WA	WA	WA	WA
Hydrogen embrittlement	C	WA	WA	WA	WA
Impact	D	NA	WA	WA	NA
Lubrication	C	WA	WA	WA	WA
Magnetic permeability	C	WA	WA	WA	WA
Packaging[F]	—	WA	WA	WA	WA
Plating/coating thickness (weight)	B	WA	WA	WA	WA
Product identification marking[G]	—	WA	WA	WA	WA
Proof load—Full size	D	WA	WA	NA	NA
Reduction of area—Machined specimen	D	NA	WA	WA	NA
Bend, rivet	C	NA	NA	WA	NA
Flattening, rivet	C	NA	NA	WA	NA
Rotational capacity	D	WA	WA	NA	WA
Salt spray[H]	C	WA	WA	WA	WA
Shear strength	D	NA	WA	WA	NA
Stress corrosion	C	WA	WA	WA	WA
Surface discontinuities	C	WA	WA	WA	WA
Surface roughness	C	WA	WA	WA	WA
Tensile strength—Full size[I]	D	NA	WA	WA	NA
Tensile strength—Machined specimen	D	NA	WA	WA	NA
Torque[J] (prevailing)	D	WA	WA	NA	NA
Torque (torsional strength)	D	WA	WA	NA	NA
Yield strength—Full size	D	NA	WA	NA	NA
Yield strength—Machined specimen	D	NA	WA	NA	NA

[A] Final inspection of a characteristic may be carried out at any stage of manufacture, provided the characteristic is not subject to change in any further manufacturing or processing operation. Therefore, the testing of those samples may be deducted from the sample level specified.

[B] Quantity of samples is in Table 3, Sample Size.

[C] A certified copy of the material's chemical or product analysis shall be furnished with each shipping lot, and the shipping lot shall have documentation providing traceability to this chemical analysis. It is required that the purchaser of the raw material (used to manufacture) shall verify that the material is the material specified on the purchase order.

[D] Steel making practice (course or fine grain) shall be included with the material producer's chemical analysis report.

[E] Surface, core, or both, as applicable.

[F] All packaging requirements shall be in conformance with the applicable packaging standard.

[G] Visual inspection for conformance.

[H] Continuous monitoring of salt spray performance in accordance with the recommendation of Table B in Appendix 1 of ASME/ANSI B18.18.2M constitutes compliance with the requirements for salt spray testing outlined in this table.

[I] Wedge angle or axial test as applicable.

[J] Prevailing torque test includes thread start, all specified torque requirements, and retention of locking feature, when applicable.

TABLE 3 Sample Size

NOTE 1—The acceptance number in all cases is zero defects.

Lot Size	Sample Size			
	A	B	C	D
2 to 15	3	2	1	[A]
16 to 25	4	3	1	[A]
26 to 50	5	4	1	[A]
51 to 90	6	5	2	1
91 to 150	7	6	2	1
151 to 280	10	7	2	1
281 to 500	11	9	3	2
501 to 1200	15	11	3	2
1201 to 3200	18	13	3	2
3201 to 10 000	22	15	4	3
10001 to 35 000	29	15	4	3
35001 to 150 000	29	15	5	3
150001 to 500 000	29	15	6	4
500001 and over	29	15	7	5

[A] Suppliers shall furnish certified test results from which the shipping lots originated. If certified test reports are not available, then the supplier must default to Sample Size C and conduct the tests required.

controls shall follow the guidelines provided in ISO 9004, or ANSI/ASQC Q9004, on the portion that details the control of measuring and test equipment.

10. Keywords

10.1 detection systems; fasteners; inspection for mechanical properties; performance requirements; prevention systems; quality requirements; sampling plans; selection and size; statistical process control