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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~~ 9000, QS 9000, and the ~~ANSI/ASQC Q9000~~ ASQ Q9000, quality system standards, or a combination thereof, are models that may be used in establishing a prevention-based quality system~~s~~.

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 or disposition 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.~~ B18.

1.3 This guide provides for two sampling plans: one designated the "detection process," as described in ~~3.1.3,~~ Terminology F 1789, and one designated the "prevention process," as described in ~~3.1.8.~~ Terminology F 1789.

2. Referenced Documents

2.1 ~~*ANSI*~~*ASTM Standards:*

~~ASME/ANSI B18.18.3M Inspection and Quality Assurance~~

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

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F 1789 Terminology for ~~Special Purpose~~ F16 Mechanical Fasteners[2]
~~ASME/ANSI B18.18.5M Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls[2]~~
~~ASME/ANSI B18.18.6M Quality Assurance Plan for Fasteners Produced in Third Party Accreditation System[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 Q9004 Quality Management and Quality System Elements—Guidelines[2]~~
~~QS 9004 Quality System Requirements[3]~~
2.2 *ASME Standards:*
ASME B18.18.2M Inspection and Quality Assurance for High-Volume Machine Assembly Fasterners
ASME B18.18.3M Inspection and Quality Assurance for Special Purpose Fasteners[3]

~~[2] Available from the American National~~
[2] *Annual Book of ASTM Standards ~~Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.~~*, Vol 01.08.
[3] Available from ~~Automotive Industry Action Group (AIAG), 26200 Lahser Road, Suite 2000, Southfield, MI 48034-9738.~~ the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

ASME B18.18.5M Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls[3]
ASME B18.18.6M Quality Assurance Plan for Fasteners Produced in Third Party Accreditation System[3]
2.3 *ASQ Standards:*
ASQ Q9000 Quality Management and Quality Assurance Standards—Guidelines for Selection and Use[3]
ASQ Q9001 Quality Management Systems[3]
ASQ Q9002 Quality Systems—Model for Quality Assurance in Production and Installation[3]
ASQ Q9004 Quality Management and Quality System Elements—Guidelines for Quality Improvement[3]
2.4 *AIAG Standards:*
QS 9000 Quality System Requirements[4]
2.5 *ISO Standards:*
ISO 9000 Quality Management ~~and~~ Systems[3]
ISO 9001 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]~~
Management Systems Requirements[3]
ISO 9002 Quality Systems—Model for Quality Assurance in Production and Installation[3]
ISO 9004 Quality Management ~~and Quality System Elements—Guidelines[2]~~ Systems—Guidelines for Improvements[3]

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~~

3.1 Terms shall be defined 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*~~ *Terminology F 1789.*

3.2 ~~—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.~~ *Definitions:*

3.2.1 ~~*inspection*—process~~material review, *n*—an evaluation by a team of ~~measuring, examining, testing, gaging, or using other procedures~~ fastener experts to ~~ascertain~~ determine the ~~quality or state of, detect errors or defects in, or otherwise appraise materials, products, services, systems, or environments~~ fastener's nonconformance with respect to ~~a preestablished standard.~~ fitness for general use, fitness for intended use, or fitness for specified use.

~~3.2.2 *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*~~*random sampling, n*—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~~

3.2.3 *test, n*—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.

3.2.4 *zero defects, n*—zero defects applies only to the random sample. It gives a 95% confidence level that the shipping lot is free from defects.

[4] Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Ste. 2000, Southfield, MI 48034–9738.

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, ASQ 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 manufacturer's quality system conforms with ~~ASME/ANSI~~ ASME B18.18.5M, B18.18.6M, ~~ASME-FAP-1,~~ QS 9000, ~~ANSI/ASQC~~ ASQ Q9001, Q9002 (up until the year 2003), ISO 9001, or ISO 9002 (up until the year 2003), the manufacturer shall be permitted to choose between the Prevention or Detection process for inspection and test purposes. Purchasers shall retain the right to specify the Prevention or Detection process at the time of inquiry or order (see Table 2).

7. Acceptance Criteria

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

8. Disposition of Nonconforming Lots

8.1 ~~*Supplier's*~~*Manufacturer's Options*—The ~~supplier has~~ manufacturer shall choose one of the following options in the disposition of those fasteners that have been found to contain~~g~~ nonconformities prior to shipment. The fastener manufacturer shal~~l~~ maintain records~~:~~ of disposition.

8.1.1 ~~Lots~~They may be scrapped.

~~8.1.2 Lots~~

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

~~8.1.3 Lots~~

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

~~8.1.4 Lots~~ characteristic(s).

8.1.4 The manufacturer may ~~be "used-as-is" providing the purchaser is informed~~ make concession by use of ~~the rejectable items~~ a documented internal review procedure and ~~written approval~~ determine to ship product that is ~~obtained. This disposition~~ found to contain minor nonconformances that are not critical or key characteristics as determined by the end user. Nonconformance of critical or key characteristics shall ~~be documented with each shipment, including appropriate signatures and dates authorizing~~ need approval from the ~~release.~~

~~NOTE 1—Caution should~~ end user prior to shipment of product. (See 8.1.6.) (See QS 9000, 4.13.1.2, b.)

8.1.5 They may be ~~exercised when applying~~ regraded for alternative applications. (See QS 9000, 4.13.1.2, c.)

8.1.6 The end user may be informed of the nonconformity or nonconformities and his advice requested on their disposition. The user may consider the degree to ~~"use-as-is." In~~ which the ~~interest of safety~~ characteristic(s) deviate(s) from specified requirements and ~~quality, all "use-as-is" conditions should have no~~ the significance of the effect on the ~~fastener's intended application~~ assembly or performance of the fasteners in their service application. The user may authorize a written release of the fasteners for completion of production or for shipment, as applicable.

8.2 ~~*Purchaser's*~~*End User Options*—The ~~purchaser has~~ end user shall choose one of the following options ~~in dispositioning nonconforming lots~~:

~~8.2.1 Lots may be rejected and returned to~~ for the ~~supplier.~~

~~8.2.2 Lots may be accepted. If nonconforming~~ disposition of those fastener lots ~~are accepted,~~ that have been rejected after delivery:

8.2.1 The end user considers the ~~responsibility for~~ degree to which the ~~lot is borne by~~ characteristic(s) deviate(s) from specified requirements and the ~~purchaser, provided~~ effect on their performance in the ~~purchaser issues a written deviation to the supplier relieving him~~ intended service application. The end user may authorize release of ~~responsibility~~ the parts or fastener lots for use.

8.2.2 They may be scrapped.

8.2.3 They may be 100 % sorted and nonconforming parts removed.

8.2.4 They may be reworked or reprocessed to correct the nonconforming ~~product.~~ characteristic(s).

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.

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]
3 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
10 001 to 35 000	29	15	4	3
35001 to 150 000	29	15	5	3
150 001 to 500 000	29	15	6	4
500 001 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.

8.2.5 They may be returned.

8.3 *Distributor Options*—The distributor shall choose one of the following options for the disposition of those fastener lots that have been rejected after delivery.

8.3.1 They may be scrapped.

8.3.2 They may be 100 % sorted, and nonconforming parts may be removed with the written agreement of the manufacturer.[5]

8.3.3 They may be reworked or reprocessed to correct the nonconforming characteristic(s) with the written agreement of the manufacturer.[5]

8.3.4 They may be returned.[5]

8.4 *Reinspection*—~~W~~All fastener lots that have been sorted, reworked, or ~~reprocessing is performed to correct~~ reprocessed, or a ~~nonconforming item, that lot~~ combination thereof, under the jurisdiction of the manufacturer or distributor shall be reinspected ~~on completion of~~ for the characteristic(s) found nonconforming and all other characteristics that would be affected by the reworking or reprocessing operation(s). If no parts inspected are found nonconforming, the fastener lots may be approved for delivery or use, as applicable. Reinspection shall be performed using the same or a more stringent sample plan that was used in detecting the original 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 controls shall follow the guidelines provided in ISO 9004, or ~~ANSI/ASQC~~ ASQ 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

[5] In general, product standards specify requirements for manufacturers' markings. Lot control, invoice information, and packaging may be another source of identification of the manufacturer.