MIL-STD-1916 – DoD Preferred Methods for Acceptance of Product

Subject/Scope:

The purpose of this standard is to encourage defense contractors and other commercial organizations supplying goods and services to the U.S. Government to submit efficient and effective process control (prevention) procedures in place of prescribed sampling requirements. The goal is to support the movement away from an AQL-based inspection (detection) strategy to implementation of an effective prevention-based strategy including a comprehensive quality system, continuous improvement and a partnership with the Government. The underlying theme is a partnership between DoD and the defense supplier, with the requisite competence of both parties, and a clear mutual benefit from processes capable of consistently high quality products and services. The objective is to create an atmosphere where every noncompliance is an opportunity for corrective action and improvement rather than one where acceptable quality levels are the contractually sufficient goals.

Keywords:

Sampling, quality, inspection, process, acceptance, requirement, government, procedure, attribute, acceptability, criterion, method, evidence, condition, characteristic, DoD, method, accept, submit, identification, inspect, prevention, ANSI, percent, performance, random, implementation, DoDiss, analysis, defense, measurement, special, military, contract, nonconformance, controlled, technical, inspections, approved, defective

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Text in blue boxes such as this one is instructional and is intended to assist you in understanding the document.

Text in red boxes such as this explains changes made to the document by The Wooden Crates Organization.

Red text has been added to the document or modifies the document since its final version was officially published.

Soft Conversion of Imperial to Metric

Conversions, when made, consider materials that are available in metric or imperial sizes rather than converting sizes exactly. For example: Panelboard (plywood) in the US is typically 4 feet X 8 feet (1220 x 2440 mm) while panelboard in metric countries is typically 1200 X 2400 mm. Since the standard was developed based on readily available materials these variations in material sizes could not have been practically considered.

The content of the document below has not been modified.

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MIL-STD-1916
1 April 1996

DEPARTMENT OF DEFENSE TEST METHOD STANDARD

DOD PREFERRED METHODS FOR ACCEPTANCE OF PRODUCT

AMSC N/A AREA QCIC

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F O R E W O R D

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense (DoD).

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Armament Research, Development and Engineering Center, ATTN: AMSTA-AR-EDE-S, Picatinny Arsenal, NJ 07806-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. DoD procurement practices encourage industry innovation and provide flexibility to achieve the benefits of continuous improvement.

4. There is an evolving industrial product quality philosophy that recognizes the need for quality policy changes that will provide defense contractors with opportunities and incentives toward improvement of product quality and cooperative relationships between the contractor and the Government.

5. Process controls and statistical control methods are the preferable means of preventing nonconformances, controlling quality, and generating information for improvement. An effective process control system may also be used to provide information to assess the quality of deliverables submitted for acceptance. Suppliers are encouraged to use process control and statistical control procedures for their internal control and to submit effective process control procedures in lieu of prescribed sampling requirements to the Government for approval.

6. Sampling inspection by itself is an inefficient industrial practice for demonstrating conformance to the requirements of a contract and its technical data package. The application of sampling plans for acceptance involves both consumer and producer risks; and increased sampling is one way of reducing these risks, but it also increases costs. Suppliers can reduce risks by employing efficient processes with appropriate process controls. To the extent that such practices are employed and are effective, risk is controlled and, consequently, inspection and testing can be reduced.

7. The following points provide the basis for this standard:

a. Contractors are required to submit deliverables that conform to requirements and to generate and maintain sufficient evidence of conformance.

b. Contractors are responsible for establishing their own manufacturing and process controls to produce results in accordance with requirements.

c. Contractors are expected to use recognized prevention practices such as process controls and statistical techniques.

8. This standard also provides a set of sampling plans and procedures for planning and conducting inspections to assess quality and conformance to contract requirements. This standard complies with the DoD policy of eliminating acceptable quality levels (AQL's) and associated practices within specifications.

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C O N T E N T S

MIL-STD-1916

1. SCOPE

1.1 Scope. The purpose of this standard is to encourage defense contractors and other commercial organizations supplying goods and services to the U.S. Government to submit efficient and effective process control (prevention) procedures in place of prescribed sampling requirements. The goal is to support the movement away from an AQL-based inspection (detection) strategy to implementation of an effective prevention-based strategy including a comprehensive quality system, continuous improvement and a partnership with the Government. The underlying theme is a partnership between DoD and the defense supplier, with the requisite competence of both parties, and a clear mutual benefit from processes capable of consistently high quality products and services. The objective is to create an atmosphere where every noncompliance is an opportunity for corrective action and improvement rather than one where acceptable quality levels are the contractually sufficient goals.

1.2 Applicability. This standard, when referenced in the contract, specification, or purchase order, is applicable to the prime contractor, and should be extended to subcontractors or vendor facilities. The quality plans are to be applied as specified in the contract documents, and deliverables may be submitted for acceptance if the requirements of this standard have been met.

1.3 Applications. Quality plans and procedures in this standard may be used when appropriate to assess conformance to requirements of the following:

a. End items
b. Components or basic materials
c. Operations or services
d. Materials in process
e. Supplies in storage
f. Maintenance operations
g. Data or records
h. Administrative procedures

Note, use of the word "product" throughout this standard also refers to services and other deliverables.

1.4 Product requirements. The contractor is required to submit product that meets all contract and specification requirements. The application of the quality plans or procedures of this standard does not relieve the contractor of responsibility for meeting all contract product requirements. The contractor’s quality system, including manufacturing processes and quality control measures, will be established and operated to consistently produce products that meet all requirements. Absence of any inspection or process control requirement in the contract does not

relieve the contractor of responsibility for assuring that all products or supplies submitted to the Government for acceptance conform to all requirements of the contract.

1.5 Limitations. The sampling plans and procedures of this standard are not intended for use with destructive tests or where product screening is not feasible or desirable. In such cases, the sampling plans to be used will be specified in the contract or product specifications.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE/AMERICAN SOCIETY FOR QUALITY CONTROL (ANSI/ASQC)

ANSI Z1.1/ASQC B1	-	Guide for Quality Control Charts.
ANSI Z1.2/ASQC B2	-	Control Chart Methods of Analyzing Data.
ANSI Z1.3/ASQC B3	-	Control Chart Method of Controlling Quality During Production.
ANSI/ASQC Q9000	-	Quality Management and Quality Assurance Standards Guidelines for Selection and Use.
ANSI/ASQC Q9004	-	Quality Management and Quality System Elements Guidelines.

INTERNATIONAL ORGANIZATION OF STANDARDS (ISO)

ISO 8402	-	Quality - Vocabulary.
ISO 9000	-	Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.
ISO 9004	-	Quality Management and Quality System Elements - Guidelines.

(Copies of DoD adopted non-Government Standards are available to Military activities through the DoD Single Stock Point, Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Military activities may obtain copies of non-DoD adopted documents from the sponsoring Industry Association. Non-military activities may obtain copies of non-Government standards and publications from the American Society for Quality Control, PO Box 3066, Milwaukee, WI 53201-3066 and the American National Standards Institute, 1430 Broadway, New York, NY 10018, as appropriate.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Acronyms used in this standard. The acronyms used in this standard are defined as follows

a. ACO - Administrative Contracting Officer.
b. ANSI - American National Standards Institute.
c. AQL - Acceptable Quality Level.
d. ASQC - American Society for Quality Control.
e. CL - Code Letter.
f. DFARS - DoD Federal Acquisitions Regulation Supplement.
g. DoD - Department of Defense.
h. DoDISS - DoD Index of Specifications and Standards.
i. DoDSSP - DoD Single Stock Point.
j. FAR - Federal Acquisitions Regulation.
k. FMEA - Failure Modes and Effects Analysis.
l. ISO - International Organization for Standardization.
m. PCO - Procurement Contracting Officer.
n. PDCA - Plan-Do-Check-Act.
o. QAR - Quality Assurance Representative.
p. SPC - Statistical Process Control.
q. VL - Verification Level.

3.2 Acceptance. The act of an authorized representative of the Government by which the Government, for itself or as agent of another, assumes ownership of existing identified supplies tendered or approves specific services rendered as partial or complete performance of the contract. (FAR 46.101)

3.3 Contract quality requirements. The technical requirements in the contract relating to the quality of the product or service and those contract clauses prescribing inspection, and other quality controls incumbent on the contractor, to assure that the product or service conforms to the contractual requirements. (FAR 46.101)

3.4 Critical characteristic. A characteristic that judgment and experience indicate must be met to avoid hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product; or that judgment and experience indicate must be met to assure performance of the tactical function of a major item such as a ship, aircraft, tank, missile, or space vehicle.

3.5 Critical nonconforming unit. A unit of product that fails to conform to specified requirements for one or more critical characteristics.

3.6 Government contract quality assurance. The various functions, including inspection, performed by the Government to determine whether a contractor has fulfilled the contract obligations pertaining to quality and quantity. (FAR 46.101)

3.7 Inspection. Examining and testing supplies or services (including, when appropriate, raw materials, components, and intermediate assemblies) to determine whether they conform to contract requirements. (FAR 46.101)

3.8 Major characteristic. A characteristic, other than critical, that must be met to avoid failure or material reduction of usability of the unit of product for intended purpose.

3.9 Major nonconforming unit. A unit of product that fails to conform to specified requirements for one or more major characteristics, but conforms to all critical characteristics.

3.10 Minor characteristic. A characteristic, other than critical or major, whose departure from its specification requirement is not likely to reduce materially the usability of the unit of product for its intended purpose or whose departure from established standards has little bearing on the effective use or operation of the unit.

3.11 Minor nonconforming unit. A unit of product that fails to conform to specified requirements of one or more minor characteristics, but conforms to all critical and major characteristics.

3.12 Nonconformance. A departure from a specified requirement for any characteristic.

3.13 Nonconforming unit. A unit of product that has one or more nonconformances.

3.14 Production interval. A period of production under continuous sampling assumed to consist of essentially homogeneous quality. It is normally a single shift. It can be a day if it is reasonably certain that shift changes do not affect quality of product, but shall not be longer than a day.

3.15 Quality. The composite of material attributes including performance features and characteristics of a product or service to satisfy a given need. (DFARS 46.101)

3.16 Quality assurance. A planned and systematic pattern of all actions necessary to provide adequate confidence that adequate technical requirements are established; products and services conform to established technical requirements; and satisfactory performance is achieved. (DFARS 46.101)

3.17 Quality audit. A systematic examination of the acts and decisions with respect to quality in order to independently verify or evaluate the operational requirements of the quality program or the specification or contract requirements of the product or service. (DFARS 46.101)

3.18 Quality program. A program which is developed, planned, and managed to carry out cost effectively all efforts to effect the quality of materials and services from concept

through validation, full-scale development, production, deployment, and disposal. (DFARS 46.101)

3.19 Screening inspection. An inspection process whereby every unit is checked and all nonconforming units are removed; also referred to as 100 percent inspection.

3.20 Traceability. The ability to trace the history, application or location of an item or activity, or similar items or activities, by means of recorded identification. (ISO 8402)

3.21 Verification level (VL). Prescribes the level of significance or utility of a characteristic to the user. The amount of effort to assure conformance can be allocated on the basis of importance to the user. (Major characteristics will require more verification effort than minor characteristics.) VL-VII requires the highest level of effort, and the effort decreases as the VL decreases to the lowest level, VL-I.

4. GENERAL REQUIREMENTS

4.1 Acceptance by contractor-proposed provisions.

4.1.1 General.

a. This standard, when referenced in the contract or product specifications, requires the contractor to perform sampling inspection in accordance with paragraph 4.2 and the product specification. However, it is recognized that sampling inspection alone does not control or improve quality. Product quality comes from proper product and process design and process control activities. When such activities are effective, sampling inspection is a redundant effort and an unnecessary cost. Contractors that have an acceptable quality system and proven process controls on specific processes are encouraged to consider submitting alternate acceptance methods for one or more contractually specified characteristics. In addition, contractors that have a successful quality system and a history of successful process controls relevant to the products/services being procured in this contract, are encouraged to consider submitting a systemic alternate acceptance method for all the contractual sampling inspection requirements associated with paragraph 4.2.

b. Submissions shall describe the alternate acceptance methods, the sampling inspection provision to be replaced, and an evaluation of the protection provided by the alternate methods as compared with the inspection requirement to be replaced. The alternate acceptance method shall include evidence of process control and capability during production together with adequate criteria, measurement, and evaluation procedures to maintain control of the process. The acceptability of the alternate acceptance methods is dependent upon the existence of a quality system, the demonstration of its process focus, and the availability of objective evidence of effectiveness.

4.1.2 Requirements and procedures.

a. Contractors currently operating quality systems in accordance with such models as MIL-Q-9858 enhanced with Statistical Process Controls (SPC), ANSI/ASQC Q9004, or others that are deemed satisfactory to the Government representative are qualified to apply for alternate acceptance methods if demonstration of process focus and objective evidence of effectiveness exists.

b. The contractor shall include in his request for approval of an alternate acceptance method an assessment plan to periodically verify process stability, capability, and other conditions under which the alternate acceptance method was developed. The current minimum values of process capability are equivalent to a C_{pk} of 2.00 for critical characteristics, 1.33 for major characteristics, and 1.00 for minor

characteristics. Upon approval of the assessment plan, the contractor may reduce or eliminate inspection sampling when the plan criteria are met or exceeded.

4.1.3 Submission and incorporation.

4.1.3.1 Submission. There are two ways of submitting alternate acceptance methods:

a. Submission of individual alternate acceptance methods for one or more contractually specified sampling inspection requirements through the Government quality assurance representative (QAR) to the procuring contracting officer (PCO) for approval at any time during the contract period of performance.

b. Submission of a systemic alternate acceptance method to the PCO prior to contract being awarded. This pre-approval allows the contractor to adopt alternate acceptance methods throughout the length of the contract. After contract award, submissions of a systemic alternate acceptance method should be made through the administrative contracting officer (ACO) to the PCO.

4.1.3.2 Incorporation. All approved alternate acceptance methods shall be incorporated into the contractor's manufacturing and quality program plans or other vehicles acceptable to the contracting agency, as applicable.

4.1.4 Withdrawal of approval of alternates. The Government reserves the right to withdraw approval of alternate acceptance methods that are determined to provide less assurance of quality than the inspection requirements originally specified or when the inability to maintain process stability and capability over time becomes apparent.

4.2 Acceptance by tables.

4.2.1 Preferred sampling plans. This standard establishes three sets of matched sampling plans for the sampling inspection of product submitted to the Government for acceptance. These sampling plans provide for inspecting the samples from lots or batches by attributes or variables measurement and for continuous sampling by attributes measurement. The three sets of matched sampling plans are indexed by seven specified verification levels (VL) and five code letters (CL), which are determined by the lot or production interval size. The sampling plans are matched between corresponding VL and CL combinations to result in essentially similar protection. The contractor has the option to utilize the type of plan, at the same verification level, that best complements the production process.

4.2.2 Formation and identification of lots or batches. The product shall be assembled into identifiable lots, sublots, or batches, or in such other manner as may be prescribed. Each lot or batch shall, as far as practicable, consist of units of product of a single type, grade, class, size, and composition, manufactured under essentially the same conditions, and at essentially the same time. The lots or batches shall be identified by the contractor and shall be kept intact in

adequate and suitable storage space. Although lot or batch size is not used to select a continuous sampling plan, the formation of lots or batches may remain desirable for reasons of homogeneity, shipping convenience, and facilitation of payment.

4.2.3 Determination of sampling plan. A sampling plan is determined by:

a. Verification level (VL) as specified.
b. Type of sampling (attributes, variables, or continuous).
c. Lot or production interval size code letter (CL) from Table I.
d. Switching procedure (normal, tightened, reduced).

For lot acceptance situations (attributes or variables), the occurrence of one or more nonconformances shall result in withholding acceptance of the product submitted and initiation of corrective action. When continuous sampling is in effect, the occurrence of a nonconforming unit while in a sampling phase results in withholding acceptance of that unit, a return to screening, and initiation of corrective action. If a nonconforming unit is found while in a screening phase, acceptance is withheld for that unit and screening is continued until the requirements of paragraph 5.2.2.3.2 are satisfied.

4.2.4 Sampling of lots or batches.

4.2.4.1 Selection of units. Units of product drawn from a lot for a sample shall be selected at random from the lot without regard to their quality. Random sampling requires that each unit in the lot, batch, or production interval has the same probability of being selected for the sample.

4.2.4.2 Representative (stratified) sampling. When appropriate, the number of units in the sample shall be selected in proportion to the size of sublots or subbatches, or parts of the lot or batch, identified by some rational criterion. When representative sampling is used, the units from each sublot, subbatch, or part shall be selected at random.

4.2.4.3 Process of sampling. A sample may be drawn after all units comprising the lot or batch have been assembled, or sample units may be drawn during assembly of the lot or batch, in which case the size of the lot or batch shall be determined before samples are drawn. When the lot or batch passes the sampling plan, such lots or batches are acceptable and may be submitted to the Government.

4.2.4.4 Non-conforming product. When sample units are drawn during lot or batch assembly and nonconforming units are found, the contractor shall withhold from acceptance that portion of the lot completed and all additional production occurring prior to the initiation and verification of corrective action. For lots or batches withheld from acceptance, the contractor shall take the following actions:

a. Screen the lots or batches and dispose of all nonconforming units in accordance with paragraph 4.3.

b. Determine the cause of the nonconformances and implement appropriate process changes.

c. Initiate the switching requirements of paragraph 5.2.1.3.

d. Advise the Government representative of actions taken and resubmit the screened lot or batches to the Government for evaluation/consideration.

4.3 Disposition of nonconforming product. All units of product found to be nonconforming by the contractor shall be removed and kept apart from the flow of production or otherwise identified or segregated to preclude submission to the Government. The contractor may rework or repair these units unless the contract excludes such activities. Corrected product shall be screened by the contractor and resubmitted to the Government apart from the regular flow of the product.

4.4 Critical characteristics. Unless otherwise specified in the contract or product specifications, the contractor is required for each critical characteristic to implement an automated screening or a fail safe manufacturing operation and apply sampling plan VL-VII to verify the performance of the screening operation. The occurrence of one or more critical nonconformances requires corrective action as specified in paragraph 4.5.

4.5 Special reservations for critical nonconformance. When a critical nonconformance is discovered at any phase of production or during any inspection, the following immediate actions are required:

a. Prevent delivery of critical nonconforming units to the Government.

b. **N**otify the Government representative.

c. Identify the cause.

d. Take corrective action.

e. Screen all available units

Records of corrective actions shall be maintained and made available to the Government representative.

5. DETAILED REQUIREMENTS

5.1 Acceptance by contractor-proposed provisions. In order for an alternate acceptance method to be considered, the contractor shall establish and implement an internal prevention-based quality system as a means of ensuring that all products conform to requirements specified by the contract and associated specifications and standards. The acceptability of the quality system as part of the request for alternate acceptance method(s) is dependent on its compliance with an industry-accepted quality system model, demonstration of its process focus, and the availability of objective evidence of its implementation and effectiveness.

5.1.1 Quality system plan. The quality system shall be documented and shall be subject to on-site Government review throughout the contract. It shall include, at a minimum, a description of the organizational structure, responsibilities, procedures, processes, and resources. Such documentation is hereinafter called the quality system plan. The contractor shall maintain, disseminate, update, and improve the quality system plan in order to ensure its continued use and accuracy. The design and documentation of the quality system plan shall allow for ease of use, review, and audit by internal as well as Government personnel.

5.1.2 Prevention-based quality system. The quality system shall be prevention-based. Common quality system models that reflect this philosophy include the ISO 9000 series, MIL-Q-9858 enhanced with SPC, and many industry specific total quality standards and programs. The quality system shall also reflect additional needs in accordance with the requirements of this standard. Regardless of the model chosen, the quality system shall demonstrate its prevention-based outlook by meeting the following objectives throughout all areas of contract performance:

a. The quality system is understood and executed by all personnel having any influence on product or process quality.

b. Products and services meet or exceed customer requirements.

c. Quality is deliberately and economically controlled.

d. Emphasis is on the prevention of process discrepancies and product nonconformances.

e. Discrepancies and nonconformances that do occur are readily detected, and root cause corrective actions are taken and verified.

f. Sound problem solving and statistical methods are employed to continuously reduce process variability and, in turn, improve process capability and product quality.

g. Records are maintained and indicate implementation of the quality plan and effectiveness of the control procedures.

5.1.3 Process focus of quality system. To demonstrate a process focus, the contractor shall demonstrate that the manufacturing process and its related processes have been studied and are understood, controlled, and documented to show that they are:

a. Consistently producing conforming product.

b. Controlled as far upstream as possible.

c. Robust to variation in equipment, raw materials, and other process inputs, and designed to yield a quality product.

d. Operated with the intent to constantly strive to reduce process/product variability.

e. Designed to utilize manufacturing equipment with objectives of minimum variability around targeted values.

f. Managed for continuous improvement.

g. Designed and controlled using a combination of manufacturing practices and statistical methods in order to ensure defect prevention and process improvement.

5.1.4 Objective evidence of quality system implementation and effectiveness.

5.1.4.1 Examples of evidence regarding process improvement.

a. Process flow charts showing the key control points where action is taken to prevent the production of defective product.

b. Identification of process improvement techniques and tools used, e.g., Plan-Do-Check-Act (PDCA) cycle, Failure Modes and Effects Analysis (FMEA), Pareto Analysis, and Cause and Effect Analysis.

c. Identification of the measures used, e.g., trend analysis, cost of quality, cycle time reduction, defect rates, 6-sigma capability.

d. Results of the improvements from the use of these process improvement tools.

e. Results of properly planned experiments that led to reduced common cause variability of a process and improved productivity

5.1.4.2 Examples of evidence regarding process control.

a. Identification of the scope of use of process control techniques, e.g., SPC, automation, gages, set-up verification, preventative maintenance, visual inspection.

b. Process control plans, including the improvement goals and statements of management commitment to SPC.

c. Approaches and supporting data used to determine if suppliers have adequate controls to assure defective product is not produced and delivered.

d. Descriptions of the required training in SPC and/or continuous improvement, i.e., the number of courses and their content, courses required for personnel at each organizational level and function associated with the quality plan, the qualifications of the instructors or trainers for SPC classes, support by management to attend such courses, and information demonstrating the effectiveness of the training.

e. Identification and definition of the interrelations of all departments (e.g., production, engineering, purchasing, marketing, administration, etc.) involved in SPC and quality improvement, their responsibilities, and the use of teams.

f. When applying control charts, the reasoning behind establishing rational subgroups and sampling frequency; the procedures for determining and updating control limits; and the criteria for determining out-of-control conditions.

g. Identification of key parameters used in lieu of one or more specified characteristics, verification of the correlation of such parameters to those characteristics, and description of the manufacturing process steps responsible for these parameters.

h. Identification of personnel responsible for process-related corrective action.

i. Proper gage measurement studies showing measurement variations relative to the total variation.

j. Traceability of the product and process corrective action(s) taken when the process went out of statistical control, showing how the root cause was identified and eliminated.

5.1.4.3 Examples of evidence regarding product conformance.

a. Control charts showing the process in statistical control in accordance with the criteria asked for in paragraph 5.1.4.2.f.

b. Records of product and process corrective action(s) taken when nonconformances occur.

c. Process capability studies consisting of the correct calculation and interpretation of indices, such as C_p and C_{pk}.

d. History of product inspection results reinforced by statistical data and analysis.

e. Results from in-process control methods, such as 100 percent automated assembly and/or inspection.

5.2 Acceptance by tables.

5.2.1 Sampling inspection. When acceptance is to be accomplished using the sampling tables provided in this document, the following considerations apply.

5.2.1.1 Verification level specification. The VL's are specified in the contract or product specifications. A VL may be specified for individual characteristics, for a group of characteristics, or for subgroups of characteristics within the group. The VL and code letter (CL) from Table I determine the sampling plan required to assess product compliance to contract and specification requirements. Contractors are expected to produce and submit product in full conformance to all requirements. Lots, batches, or production intervals of product that consistently meet or exceed all requirements will be accepted by the sampling plans of this standard and will result in qualifying for reduced sampling levels.

TABLE I. Code letters (CL) for entry into the sampling tables

Lot or production interval size	Verification levels						
	VII	VI	V	IV	III	II	I
2–170	A	A	A	A	A	A	A
171–288	A	A	A	A	A	A	B
289–544	A	A	A	A	A	B	C
545–960	A	A	A	A	B	C	D
961–1632	A	A	A	B	C	D	E
1633–3072	A	A	B	C	D	E	E
3073–5440	A	B	C	D	E	E	E
5441–9216	B	C	D	E	E	E	E
9217–17408	C	D	E	E	E	E	E
17409–30720	D	E	E	E	E	E	E
30721 and larger	E	E	E	E	E	E	E

5.2.1.2 Sampling procedures. Sampling is performed at one of three stages called normal, tightened, and reduced. Unless otherwise specified, the VL stated in the contract shall be considered the normal stage of inspection and shall be used at the start of inspection. The tightened and the reduced stages are then defined as the stages to the immediate left and right, respectively, of the initial stage. The sampling inspection stage in effect shall continue unchanged for each group of characteristics or individual characteristic except where the switching procedures given in paragraph 5.2.1.3 require change. The switching procedures shall be applied to each group of characteristics or to individual characteristics.

5.2.1.3 Switching procedures. The procedures for switching among normal, tightened, and reduced inspection are given as Note (2) in Tables II, III, and IV.

The switching procedures are independent of the results of any remedial action, such as screening, additional samples, etc., resulting from the occurrence of sample nonconformances and withholding of acceptance.

Some Table IV switching criteria depend upon a corresponding Table II entry. These entries have been denoted by $n_a(N)$ and $n_a(T)$ in the descriptions that follow. $n_a(N)$ represents the Table II sample size used for normal sampling at the VL and CL currently in effect. Likewise, $n_a(T)$ represents the tightened sample size.

5.2.1.3.1 Normal to tightened**.** When normal inspection is in effect, tightened inspection shall be instituted when one of the following conditions occurs, depending on the type of sampling plan being used:

Lot or batch sampling (Tables II and III):

2 lots or batches have been withheld from acceptance within the last 5 or fewer lots or batches.

Continuous sampling (Table IV):

2 nonconforming units are found within a period of inspections (whether on sampling or screening) totaling no more than 5 times n_a(N).

5.2.1.3.2 Tightened to normal. When tightened inspection is in effect, normal inspection may be instituted when the following conditions are both satisfied:

a. The cause for producing the nonconformances is corrected.

b. Lot or batch sampling (Tables II and III):

5 consecutive lots/batches are accepted.

Continuous sampling (Table IV):

No nonconforming units have been found within a period of inspections (whether on sampling or screening) totaling at least 5 times n_a(T) units.

5.2.1.3.3 Normal to reduced. When normal inspection is in effect, reduced inspection may be instituted when the following conditions are all satisfied:

a. Lot or batch sampling (Tables II and III):

10 consecutive lots/batches are accepted while on normal inspection.

Continuous sampling (Table IV):

No nonconforming units have been found within a period of inspections (whether on sampling or screening) totaling at least 10 times n_a(N) units .

b. Production is at a steady rate.

c. The contractor's quality system is considered satisfactory by the Government.

d. Reduced inspection is considered desirable by the Government.

5.2.1.3.4 Reduced to normal. When reduced inspection is in effect, normal inspection shall be instituted when one of the following conditions occur.

a. Lot or batch sampling (Tables II and III):

A lot/batch is withheld from acceptance.

Continuous sampling (Table IV):

A nonconforming unit is found.

b. Production becomes irregular or delayed.

c. The contractor's quality system is unsatisfactory.

d. Other conditions warrant that normal inspection be re-instituted.

5.2.1.4 Discontinuation of acceptance. If sampling inspection of lots or batches remains in tightened inspection due to discovery of nonconformances or when, on continuous sampling

plans, there are long periods of screening due to discovery of nonconformances, the Government reserves the right to discontinue acceptance of the product until the causes of nonconformances are eliminated or other means acceptable to the procuring agency have been instituted. When sampling inspection is restarted after discontinuation of acceptance, it shall be at the tightened inspection stage.

5.2.2 Preferred sampling inspection tables. See the Appendix for methods of computing sampling results, using switching rules, and determining compliance with requirements using the attributes, variables, and continuous sampling plans contained in this section.

5.2.2.1 Attributes sampling plans for lot or batch inspection. The preferred attributes sampling plans for lots or batches are described in Table II for normal, tightened, and reduced inspection.

5.2.2.1.1 Acceptability criterion. The lot or batch shall be considered acceptable only if no nonconforming units are found upon inspection of the random sample of the size listed in Table II.

TABLE II. Attributes sampling plans

Code letter	Verification levels								
	T	VII	VI	V	IV	III	II	I	R
	Sample size (n_a)								
A	3072	1280	512	192	80	32	12	5	3
B	4096	1536	640	256	96	40	16	6	3
C	5120	2048	768	320	128	48	20	8	3
D	6144	2560	1024	384	160	64	24	10	4
E	8192	3072	1280	512	192	80	32	12	5

NOTES:

(1) When the lot size is less than or equal to the sample size, 100 percent attributes inspection is required.

(2) One verification level (VL) to the left/right of the specified normal VL is the respective tightened/reduced plan. Tightened inspection of VL-VII is T, reduced inspection of VL-I is R.

5.2.2.2 Variables sampling plans for lot or batch inspection. The preferred variables sampling plans for lots or batches are described in Table III for normal, tightened, and reduced inspection.

5.2.2.2.1 Limitations on use. Variables sampling is not to be used indiscriminately. Its use shall depend upon evidence, provided by graphical or statistical analyses, that the assumptions of independence and normality are being met. Attribute sampling shall be used whenever the evidence fails to warrant use of variables sampling.

5.2.2.2.2 Nonconforming unit. For the purposes of variables sampling, a unit of product shall be considered nonconforming if its variables measurement is outside the specified tolerance.

5.2.2.2.3 Acceptability criteria. The lot or batch shall be considered acceptable if its sample contains no nonconforming units and the applicable "k" and "F" criteria (see Table III) are met. If the sample contains any nonconforming unit, or if the sample does not meet the "k" criterion, or if the sample does not meet the "F" criterion (when applicable), the lot does not meet the acceptability criteria.

a. k criterion, single-sided specification. For a single-sided specification the quantity $\frac{|(\bar{x} - spec\ limit)|}{s}$ shall be greater than or equal to the k value specified in Table III in order to meet the "k" criterion.

b. k criterion, double-sided specification. For a double-sided specification, each of the quantities $\frac{(\bar{x} - L)}{s}$ and $\frac{(U - \bar{x})}{s}$ must be greater than or equal to the k value specified in Table III in order to meet the "k" criterion.

c. F criterion (only applicable in double-sided specifications). For a double-sided specification the quantity $\frac{s}{(U - L)}$ must be less than or equal to the specified F value in Table III in order to meet the "F" criterion.

Note: $\bar{x}$ = sample mean, s = sample standard deviation,
U = upper specification limit, L = lower specification limit.

TABLE III. Variables sampling plans

Code letter	T	Verification levels							R
		VII	VI	V	IV	III	II	I	
	Sample size (n_V)								
A	113	87	64	44	29	18	9	4	2
B	122	92	69	49	32	20	11	5	2
C	129	100	74	54	37	23	13	7	2
D	136	107	81	58	41	26	15	8	3
E	145	113	87	64	44	29	18	9	4
	k values (one- or two-sided)								
A	3.51	3.27	3.00	2.69	2.40	2.05	1.64	1.21	1.20
B	3.58	3.32	3.07	2.79	2.46	2.14	1.77	1.33	1.20
C	3.64	3.40	3.12	2.86	2.56	2.21	1.86	1.45	1.20
D	3.69	3.46	3.21	2.91	2.63	2.32	1.93	1.56	1.20
E	3.76	3.51	3.27	3.00	2.69	2.40	2.05	1.64	1.21
	F values (two-sided)								
A	.136	.145	.157	.174	.193	.222	.271	.370	.707
B	.134	.143	.154	.168	.188	.214	.253	.333	.707
C	.132	.140	.152	.165	.182	.208	.242	.301	.707
D	.130	.138	.148	.162	.177	.199	.233	.283	.435
E	.128	.136	.145	.157	.174	.193	.222	.271	.370

NOTES:

(1) When the lot size is less than or equal to the sample size, 100 percent attributes inspection is required.

(2) One verification level (VL) to the left/right of the specified normal VL is the respective tightened/reduced plan. Tightened inspection of VL-VII is T, reduced inspection of VL-I is R.

5.2.2.3 Continuous attributes sampling inspection plans. The preferred continuous sampling plans for inspection by attributes are described in Table IV for normal, tightened, and reduced inspection.

TABLE IV. Continuous sampling plans

Code letter	T	Verification levels							R
		VII	VI	V	IV	III	II	I	
	Screening phase: clearance numbers (i)								
A	3867	2207	1134	527	264	125	55	27	*NA*
B	7061	3402	1754	842	372	180	83	36	*NA*
C	11337	5609	2524	1237	572	246	116	53	*NA*
D	16827	8411	3957	1714	815	368	155	73	*NA*
E	26912	11868	5709	2605	1101	513	228	96	*NA*
	Sampling phase: frequencies (f)								
A	1/3	4/17	1/6	2/17	1/12	1/17	1/24	1/34	1/48
B	4/17	1/6	2/17	1/12	1/17	1/24	1/34	1/48	1/68
C	1/6	2/17	1/12	1/17	1/24	1/34	1/48	1/68	1/96
D	2/17	1/12	1/17	1/24	1/34	1/48	1/68	1/96	1/136
E	1/12	1/17	1/24	1/34	1/48	1/68	1/96	1/136	1/192

NOTES:

(1) Use of other i and f combinations are permitted provided they are computed in accordance with Appendix, paragraph 30.5.

(2) During the screening phase, one verification level (VL) to the left of the specified normal VL is the tightened plan. Tightened inspection of VL VII is T. There is no reduced plan while in the screening phase.

During the sampling phase, one verification level (VL) to the left/right of the specified normal VL is the respective tightened/reduced plan. Tightened inspection of VL-VII is T, reduced inspection of VL-I is R.

(3) Sample units shall be chosen with frequency (f) so as to give each unit of product an equal chance of being inspected. The inspector should allow the interval between sample units to vary somewhat rather than draw sample units according to a rigid pattern.

5.2.2.3.1 Conditions for continuous sampling procedures. The following conditions must exist before the continuous attributes sampling procedures of this section may be used for inspection.

a. Moving product.

b. Ample space, equipment, and manpower at or near the inspection station to permit 100 percent inspection when required.

c. A process that is producing or is capable of producing material whose quality is stable.

5.2.2.3.2 Continuous sampling inspection procedure. At the start of production, all units are inspected. Sampling inspection may be initiated at frequency "f" when the following conditions are satisfied:

a. All units of product are of the same configuration and produced under stable conditions.

b. At least "i" consecutive units inspected are free of nonconformances.

Sampling inspection shall be terminated and 100 percent inspection resumed if either of the following conditions occur:

a. The production process is interrupted for more than three operating days.

b. The requirement that all units of product are of the same configuration and produced under stable conditions is not satisfied.

c. A unit having any nonconformance is found during sampling.

5.2.2.3.3 Acceptability criterion. In continuous sampling, units of product are determined to be acceptable or not on essentially an individual basis. While 100 percent inspection is being performed, each unit is individually inspected and categorized as a conforming or a nonconforming unit and accepted or not accepted accordingly. While inspection is being performed on a sampling basis, each unit that is inspected is categorized as acceptable or not acceptable depending on whether it is found to be conforming or nonconforming and each unit not inspected is considered to be conforming and hence accepted. (See "Special reservation for critical nonconforming unit", paragraph 5.2.2.3.3.1.)

5.2.2.3.3.1 Special reservation for critical nonconforming unit. In addition to the provisions of paragraph 4.5, if a critical nonconforming unit is found while on sample inspection, all product since the last conforming unit was found shall be inspected.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory).

6.1 Intended use. This document is intended for use in contracts in place of AQL-based sampling documents.

6.2 Issue of DoDISS. When this standard is used in acquisition, the applicable issue of the DoDISS must be cited in the solicitation (see 2.2).

6.3 Supersession data. The following military standards are planned to be canceled when this standard is approved:

a. MIL-STD-414 - Sampling Procedures and Tables for Inspection by Variables for Percent Defective

b. MIL-STD-1235 - Single-and Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes

6.4 Subject term (keyword listing).

Attributes
Continuous
Control
Process
Sampling
Statistical
Variables
Verification

APPENDIX

EXAMPLES OF SAMPLING PLAN USE

10. SCOPE

10.1 General. This Appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

10.2 Purpose. This Appendix illustrates how to implement the three types of sampling plans described in paragraphs 4 and 5 of this standard. The examples explain how to use the four tables, how to apply the switching rules, and how to do some of the requisite calculations. In addition, this Appendix explains how the contractor can modify Table IV to some extent by calculating and using other "i" and "f" values.

20. APPLICABLE DOCUMENTS. This section is not applicable to this Appendix.

30. EXAMPLES

30.1 Attributes sampling. Wing nuts are to be inspected for missing thread. A verification level IV (VL-IV) has been specified. The producer chooses to use attributes

Lot #	Lot Size	Code Letter	Sample Size	Non-conform-ances	Lot Disposition	Stage T/N/R	Action
1	5000	D	160	2	Withhold Acceptance	N	Begin with normal sampling, VL-IV.
2	900	A	80	0	Accept	N	
3	3000	C	128	1	Withhold Acceptance	N	2 lots out of 5 fail to pass. Switch to tightened VL-IV. Check process.
4	1000	B	256	0	Accept	T	
5	1000	B	256	0	Accept	T	
6	900	A	192	0	Accept	T	
7	2000	C	320	0	Accept	T	
8	2500	C	320	0	Accept	T	Process corrected and 5 consecutive lots accepted. Switch to normal VL-IV.
9	3000	C	128	0	Accept	N	
10	5000	D	160	0	Accept	N	

FIGURE 1. Attributes sampling inspection log.

sampling plans from Table II. Lot sizes may vary as a result of production decisions. A segment of the producer's experience is shown in figure 1.

30.2 Variables sampling (single-sided specification limit case). The maximum temperature of operation for a certain device is specified as 209 (measured in degrees F). Verification level I (VL-I) has been specified. A lot of 40 items is submitted for inspection in accordance with variables sampling. Table III requires a sample size of $n_V = 4$ for code letter A. Suppose the measurements obtained are as follows: 197, 188, 184, and 205; and compliance

Line	Information Needed	Symbol	Formula	Result	Explanation
1	Sample size	n_v		4	See Table III
2	Sum of measurements		$\sum x$	774	
3	Sum of squared measurements		$\sum x^2$	150034	
4	Correction factor	CF	$(\sum x)^2 / n_v$	149769	$(774)^2 / 4$
5	Corrected sum of squares	SS	$\sum x^2 - CF$	265	150034-149769
6	Sample variance	V	$SS / (n_v - 1)$	88.333	265/3
7	Sample standard deviation	s	$\sqrt{V}$	9.399	$\sqrt{88.333}$
8	Sample mean	$\overline{x}$	$\sum x / n_v$	193.500	774/4
9	Lower specification limit Upper specification limit	L U		Not applicable 209	
10	Lower quality index Upper quality index Quality Index	Q_L Q_U Q	$(\overline{x} - L) / s$ $(U - \overline{x}) / s$ $min(Q_L, Q_U)$	Not applicable 1.649 1.649	 (209-193.5)/9.399
11	Sample F value	$\hat{F}$	$s / (U - L)$	Not applicable	
12	Number of nonconformances k value F value	C k F		0 1.210 Not applicable	 See Table III See Table III
13	C acceptability criterion k acceptability criterion F acceptability criterion		$C = 0$? $Q \geq k$? $\hat{F} \leq F$?	Yes Yes Not applicable	 1.649 ≥ 1.21
NOTES: The k value is the minimum allowable value for the quality index, Q. The F value is the maximum allowable value for the sample F value, $\hat{F}$.					

FIGURE 2. Computations for single specification limit case.

with the acceptability criteria is to be determined. Computations are shown in figure 2. The lot is accepted since it meets all applicable acceptability criteria.

30.3 Variables sampling (double-sided specification limit case). The minimum temperature of operation for a certain device is specified as 180 (measured in degrees F). The maximum is 209. Verification level I (VL-I) has been specified. A lot of 40 items is submitted for inspection in accordance with variables sampling. Table III requires a sample of size $n_V = 4$ for code letter A (CL-A). Suppose the measurements obtained are as follows: 197, 188, 184 and 205; and compliance with the acceptability criteria is to be determined. Computations are shown in figure 3. The lot is accepted since it meets all applicable acceptability criteria.

Line	Information Needed	Symbol	Formula	Result	Explanation
1	Sample size	n_v		4	See Table III
2	Sum of measurements		$\sum x$	774	
3	Sum of squared measurements		$\sum x^2$	150034	
4	Correction factor	CF	$(\sum x)^2 / n_v$	149769	$(774)^2 / 4$
5	Corrected sum of squares	SS	$\sum x^2 - CF$	265	150034-149769
6	Sample variance	V	$SS / (n_v - 1)$	88.333	265/3
7	Sample standard deviation	s	$\sqrt{V}$	9.399	$\sqrt{88.333}$
8	Sample mean	$\overline{x}$	$\sum x / n_v$	193.500	774/4
9	Lower specification limit Upper specification limit	L U		180 209	
10	Lower quality index Upper quality index Quality Index	Q_L Q_U Q	$(\overline{x} - L) / s$ $(U - \overline{x}) / s$ $min(Q_L, Q_U)$	1.436 1.649 1.436	(193.5-180)/9.399 (209-193.5)/9.399
11	Sample F value	$\hat{F}$	$s / (U - L)$	0.324	9.399/(209-180)
12	Number of nonconformances k value F value	C k F		0 1.210 0.370	 See Table III See Table III
13	C acceptability criterion k acceptability criterion F acceptability criterion		$C = 0$? $Q \geq k$? $\hat{F} \leq F$?	Yes Yes Yes	 $1.436 \geq 1.210$ $0.324 \leq 0.370$
NOTES: The k value is the minimum allowable value for the quality index, Q. The F value is the maximum allowable value for the sample F value, $\hat{F}$.					

FIGURE 3. Computations for double specification limit case.

30.4 Continuous sampling. A visual inspection of stamped metal parts for the presence of a spot weld will be performed immediately after units pass through a spot welding station. Verification level II (VL-II) has been specified. The product will be submitted for continuous attributes sampling inspection. The production interval size is an 8-hour shift, which initially will consist of between 700 to 800 welded parts. With VL-II and code letter C (CL-C) from Table I, the "i" and "f" values (Table IV) are found to be 116 and 1/48, respectively. A segment of sampling experience is shown in figure 4.

Product Item Number	Code Letter	Frequency or 100%	Stage T/N/R	Event/Action
1	C	100%	N	Start production: Begin screening phase with i = 116.
8	C	100%	N	Find a defective unit: Reset counter.
124	C	100%	N	i =116 consecutive conforming units cleared: Begin sampling phase with f = 1/48.
170	C	1/48	N	First random sample selected: Found it to conform.
9697	C	1/48	N	200 consecutive conforming sampled units observed: Switch to reduced inspection with f = 1/68. Here, 200 equals 10 times the Table II sample size entry for CL-C and VL-II.
9769	C	1/68	R	Next sample randomly selected with f = 1/68.
13982	C	1/68	R	Production interval size tripled (2100 to 2400 units): End CL-C and begin CL-E sampling phase, f = 1/136, since VL-II and reduced sampling inspection are in effect.
14121	E	1/136	R	First random sample taken with new f = 1/136: Found it to conform. Continue random sampling.
16290	E	1/136	R	A nonconforming unit observed: Switch to normal inspection. Initiate screening phase with i = 228, since CL-E and VL-II are in effect.
16518	E	100%	N	i = 228 consecutive conforming units cleared: Begin sampling phase with f = 1/96.

FIGURE 4. Continuous sampling inspection log.

30.5 Continuous sampling - plan tailoring. The producer may opt to use another continuous sampling plan instead of the one specified in Table IV. The only restrictions are that such a change is not allowed while inside a screening sequence and that the new plan be derived in accordance with the procedure described below.

Certain circumstances make such choices desirable. Sometimes the selection of a clearance number or frequency is application dependent, e.g., if it matters that i or 1/f be a

multiple of pallet size. Availability and capability of screening and sampling crews are yet further considerations.

The plan cited in Table IV consists of the largest i number and the smallest f number combination. Plans whose i is larger than the tabulated i, or whose f is smaller than the tabulated f, are not permitted. Producers willing to sample at rates larger than f can reduce i substantially.

The procedure that allows choice is presented by way of the preceding continuous sampling example situation as initially described, subject to one modification: the producer prefers to start with a plan having an i of 50 instead of the 116 specified. The procedure to determine a valid f is as shown in figure 5.

Line	Information Needed	Symbol	Formula	Result	Explanation
1	Clearance number	i		116	Table IV
2	Target i number	i_t	$i_t < i$?	Yes	50 < 116
3	Attribute sample size	n_a		20	Table II, same VL, CL
4	Compute f_0:				
	Step 1	S_1	$(n_a+1)(1+1/n_a)^{n_a}$	55.7193	
	Step 2	S_2	$(i_t+1)(1+1/i_t)^{i_t}$	137.2710	
	Step 3	S_3	$[S_1/(S_1-1)]^{i_t}$	2.4732	
	Step 4	f_0	$(S_1-1)/[(S_2)(S_3)]$	0.1612	
5	Valid f		*Any* $f > f_0$	1/6	1/6 > 0.1612

FIGURE 5. Procedure to determine a valid f.

Therefore, an i of 50 may be used in lieu of 116 if f is increased from 1/48 to 1/6.

If it is f that is preselected, the corresponding i may be found by trial and error, that is, by iterative implementation of the procedure described.

The printed numerical results have been rounded to 4-decimal accuracy. However, use of the procedure requires that all calculations be performed with at least 6-digit precision. Evidence supporting the validity of numerical results shall be maintained and be available for review upon request. Proper execution of the procedure ensures Tables IV and II are comparable with respect to the average fraction inspected and the average outgoing quality limit.

CONCLUDING MATERIAL

Custodians:
Army - AR
Navy - OS
Air Force - 05
DLA - DH

Preparing activity:
Army - AR

Review activities:
Army - AT, AV, CR, EA, GL, ME, MI, MR
Navy - AP, AS, CH, EC, NM, NW, SA, SH, YD-1
Air Force - 10, 11, 13, 17, 19, 70, 71, 80, 82, 84
DLA - ES

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