



AEROSPACE STANDARD

AS13002

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Requirements for Developing and Qualifying Alternate Inspection Frequency Plans

RATIONALE

Aero-engine companies currently have their own requirements for Inspection Frequency which are very similar. A single standard would be more efficient for suppliers. The following standard is a consolidation of these methods to allow for a singular standard for Developing Inspection plans other than 100% inspection of all features.

1. SCOPE

This document covers the process to be applied to design characteristics (as defined in AS9102), parts or inspection processes as defined by the purchaser. Design characteristics not included within the scope include electronic, electromechanical or mechanical systems where alternative means of acceptance are approved such as through acceptance test procedures (ATPs). This document does not define processes for identifying or communicating the classification of the parts or design characteristics.

This document does not define the procedure to qualify a supplier to undertake these requirements. It is expected that each purchaser will have a procedure to manage the flow-down of these requirements.

This document applies to suppliers that demonstrate adequate proficiency in applicable process control methods as determined by the purchaser.

1.1 Purpose

The purpose of this document is to provide common requirements for developing and qualifying an alternate inspection frequency plan where characteristics are not inspected 100% of the time.

2. REFERENCE DOCUMENTS

The following documents provide useful guidance when implementing the requirements of this standard:

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS9100	Quality Management Systems - Requirements for Aviation, Space and Defense Organizations
AS9102	Aerospace First Article Inspection Requirement
AS9103	Aerospace Series - Quality Management Systems - Variation Management of Key Characteristics
AS13000	Problem Solving Requirements for Suppliers
AS13003	Requirements for MSA & Measurement Systems Analysis

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2.2 Other Publications

Advanced Product Quality Planning (APQP), Automotive Industry Action Group (AIAG), ISBN 1605341371

Statistical Process Control (SPC), Automotive Industry Action Group (AIAG), ISBN 1605341088

2.3 Definitions

100% INSPECTION: Inspection of all instances of each design characteristic on the drawing on every component within the batch/lot.

50% RULE: 50% of the drawing tolerance, centered about the middle of the tolerance band.

70% RULE: 70% of the drawing tolerance, centered about the middle of the tolerance band.

ALTERNATE INSPECTION FREQUENCY PLAN: The alternative to the 100% inspection plan where one or more characteristics are inspected at a frequency less than 100%.

BATCH / LOT: A definite quantity of some product manufactured under conditions of production that are considered uniform.

CAPABLE PROCESS: A production process which consistently performs its function to the specified standards.

CONTROLLED CHARACTERISTIC: A design characteristic which is not 100% inspected and conformance is confirmed by a technical justification defining its relationship to either a controlling characteristic or other process parameter.

CONTROLLING CHARACTERISTIC: A design or process characteristic that is monitored and/or inspected to verify the conformity of a controlled design characteristic.

NOTE: A design characteristic could be a diameter turned within the same operation. A process characteristic could be a speed and feed rate on a milling machine used to control surface finish.

C_p: A capability index. Compares the process variation to the maximum allowable variation as indicated by the tolerance. Process variation is derived from the within subgroup range (sometimes referred to as short term). C_p does not consider process location.

Calculated as follows:

$$C_p = \frac{USL - LSL}{6\hat{\sigma}}$$

where:

$$\hat{\sigma} = \frac{\bar{R}}{d_2}$$

$\bar{R}$ = Mean of several ranges as used in control chart to assess stability

n = Number of samples

d_2 = Statistical constant used in the estimation of standard deviation from ranges

USL / LSL = Upper and Lower Specification Limits

$\bar{X}$ = Average of n samples

Cpk: A Capability index. Takes into account process location as well as process variation. Process variation is derived from the within subgroup range (sometimes referred to as short term).

Cpk: Calculated as minimum of C_{pu} or C_{pl} where:

$$C_{pu} = \frac{USL - \bar{\bar{X}}}{3\hat{\sigma}} \quad C_{pl} = \frac{\bar{\bar{X}} - LSL}{3\hat{\sigma}}$$

DATA PACK: The appropriate technical justification for the alternate inspection frequency plan with appropriate evidence.

DESIGN CHARACTERISTIC: Those dimensional, visual, functional, mechanical, and material features or properties, which describe and constitute the design of the article as specified by drawing requirements. These characteristics can be measured, inspected, tested, or verified to determine conformance to the design requirements.

DESIGN CHARACTERISTIC CLASSIFICATION: A designation given to characteristics to differentiate between characteristics of different importance to the design (e.g., Key Characteristic, Critical, Major, Minor).

FORM TOOL: Any tool whose form is directly replicated on the part (e.g., a tool-radius on a milling cutter insert or a shaped knife for stamping of rubber blanks from sheet).

FORMED CHARACTERISTICS: A characteristic created by a form tool that defines the characteristics of a product. For example a press tool, casting mold or a form tool milling cutter.

IDENTICAL CHARACTERISTICS: Design characteristics produced within the same operation that occur at more than one location (e.g., four places) but are established by a single set of drawing requirements (e.g., rivet hole size, dovetail slots, corner radii, chemical milling pocket thickness).

INACCESSIBLE CHARACTERISTIC: Those characteristics that can only be verified by destructive testing or those Characteristics not readily measurable with agreed production inspection methods.

INSPECTION PLAN A document which defines the design characteristics to be inspected, the inspection method and equipment, sequence, inspection frequency and who can undertake the inspection.

MEASUREMENT SYSTEM ANALYSIS (MSA): The process of evaluating the fitness for purpose of a measurement system, including tools such as Gauge R&R, Attribute Agreement Analysis, etc.

OPERATING LIMITS: Criteria applied to measurements taken from characteristics which when met will result in verification of characteristics operating an alternative inspection plan.

PART FAMILY: A group of parts with similar processes, materials, complex form, and tolerances, which have been produced by similar manufacturing methods.

Pp: A process performance index. Compares the process variation to the maximum allowable variation as indicated by the tolerance. Process variation is derived from the process standard deviation (sometimes referred to as 'overall' or 'long-term'). Pp does not consider process location.

$$P_p = \frac{USL - LSL}{6s}$$

where:

$$s = \sqrt{\frac{\sum(\bar{X} - X_i)^2}{n-1}}$$

Ppk: A process performance index. Takes into account process location as well as process variation. Process variation is derived from the process standard deviation (sometimes referred to as 'overall' or 'long-term').

Ppk: Calculated as minimum of P_{pu} or P_{pl} where:

$$P_{pu} = \frac{USL - \bar{X}}{3s} \quad P_{pl} = \frac{\bar{X} - LSL}{3s}$$

NOTE: Differences in company terminology and definitions for process capability indices may lead to differences in interpretation of the capability requirements in this standard. Within the scope of application of this standard the above definitions apply. Ppk used in this document is the overall/long term definition as described above.

PROCESS CONTROL: The method for keeping a process within boundaries; the act of minimizing variation of a process

PROCESS CHARACTERISTIC: The specific process inputs that have an effect on design characteristics.

PROCESS MONITORING: Measuring and recording process inputs and/or outputs against process operating limits to verify that process stability has not significantly changed.

PURCHASER: The customer issuing the purchase order for the part subject to the alternate inspection frequency plan.

REDUCED INSPECTION: A type of alternate frequency inspection plan where less than 100% inspection of selected characteristics within a group of characteristics on a single part, however, all parts are inspected. The group of characteristics are created by the same process and the conformity of un-inspected characteristics within the group is inferred by the inspected characteristics within the same group.

SAMPLE INSPECTION: A type of alternate frequency inspection plan. The inspection of selected characteristics on sampled parts from which the conformity of the same characteristics on other parts is inferred.

SPECIFICATION LIMITS: The acceptable limits which a design characteristic can vary within (e.g., the tolerance on a drawing/print).

SUPPLIER: The organization/vendor receiving the purchase order and responsible for the manufacture and inspection of the part(s) subject to these requirements.

3. TRAINING

3.1 Suppliers applying these requirements are assumed to be competent in quality management methods and statistical techniques such as Statistical Process Control and Measurement Systems Analysis.

3.2 The supplier shall determine and document specific training requirements relevant to their organization appropriate to operate this process. Minimum elements of this training are subject to purchaser approval.

4. OVERVIEW OF INSPECTION FREQUENCY REQUIREMENTS

This standard defines the requirements to implement an alternate inspection frequency plan. The steps to implement these requirements are as follows:

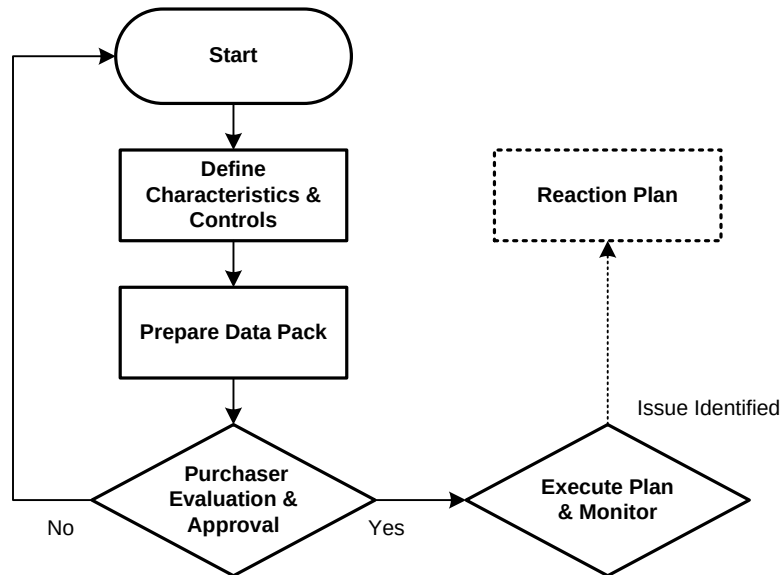


Figure 1 - Process flow

Start, The launch point at which a number of pre-requisites are expected to be in place. Typically the supplier will enter into a discussion with the purchaser at this stage to agree to a broad approach.

Define Characteristics and Controls, The supplier determines the characteristics within scope of the alternate inspection frequency plan and the appropriate control types.

Prepare Data Pack, The activity a supplier undertakes to gather the data to substantiate the proposed alternate inspection frequency plan.

Purchaser Evaluation and Approval, The evaluation by the purchaser of the proposed alternate inspection frequency plan and its subsequent approval or rejection.

Execute Plan and Monitor, Once a plan is approved the supplier will begin to operate the plan and monitor as required.

Reaction Plan, Following identification of an issue a reaction plan shall be enacted to contain the issue and return to the alternate inspection frequency plan.

5. INSPECTION FREQUENCY PROCESS

5.1 Prerequisites

5.1.1 The supplier shall have a documented process within its own quality system to control inspection which meets the requirements set forth by the purchaser. The process shall be fully implemented and subject to audit by the supplier and the purchaser.

5.1.2 The documented inspection frequency process shall describe the training requirements for practitioners.

5.1.3 A full first article inspection for the part(s) shall be in place in accordance with the purchaser requirements.

- 5.1.4 The purchaser shall formally communicate the design characteristics, their classification and extent to which the application of this process may or may not be permitted.

NOTE: This is typically communicated through the characteristics and their classification defined on the drawing/print. For example a purchaser may not permit less than 100% inspection on certain characteristics, yet allow for others. Where multiple specifications define requirements for less than 100% inspection the purchaser will determine the order of precedence.

NOTE: Some parts (e.g., standard high volume fasteners) are covered by specifications which define sampling regimes. In this case the purchaser would need to clarify which specification applies.

- 5.1.5 The production measurement systems used for all design characteristics subject to the alternate inspection frequency plan shall be proven capable in accordance with purchaser requirements.

NOTE: Typically through the use of MSA or appropriate technical justification.

5.2 Define Characteristics and Controls

- 5.2.1 The supplier shall define the characteristics which are subject to the alternate inspection frequency plan and the associated controls to ensure continued conformance.

- 5.2.2 The controls and subsequent process monitoring plan shall conform to the requirements of one of the five types described below in Table 1 and in Section 7.

Table 1 - Control types

Control Type	When to use
Statistical Process Control	When a process is in statistical process control, characterized through measurement of the output characteristic and controlled through application of predefined limits.
Software Numerical Control	When a fixed tool-path is used with a direct relationship between the conformity of one characteristic and another.
Die/Mold and form tool control	When the design characteristic is a direct output of the shape of a mold or tool and it can be proven that the shape of the tool directly correlates to a conforming design characteristic.
Die/Mold and form tool control – Complex Structural Castings	Where complex, low production volume castings require specific rules in addition to Die/Mold and form tool control.
Process Parameter Control	For special processes where the process output is entirely controlled by the process inputs such as heat-treatment, surface coating, etc. Typically controlled by a specification referenced on the drawing.

5.2.3 Where controlling and controlled characteristics are used, the supplier shall provide a technical justification and evidence for the relationship between the controlling and controlled characteristics.

5.3 Prepare the Data Pack

5.3.1 The supplier shall prepare a data pack and submit to the purchaser for evaluation.

5.3.2 The data pack shall be accompanied by a submission form in a format agreed with the purchaser (paper, electronic, etc.) which meets the intent of the sample form in Section 6.

5.3.3 Data packs shall be prepared at part number, part family or manufacturing process level as agreed between the supplier and the purchaser.

5.3.4 The data pack shall incorporate statistical data and/or appropriate technical justification to demonstrate the alternate inspection frequency plan can assure product conformance.

5.3.5 The data pack shall contain a process monitoring plan which defines activity to verify the specified controls on the process.

5.3.6 The data pack shall contain a reaction plan which defines the required actions that shall be undertaken after identifying an issue (e.g., where operating limits/criteria are not met).

5.3.7 The data pack shall as a minimum contain a list of the design characteristics relevant to the alternate inspection frequency plan together with:

- Reference to the design characteristic (e.g., drawing grid reference or balloon number)
- Design characteristic classification (Key Characteristic, Critical, Major, Minor, etc.)
- Inspection method sequence and equipment
- Authorized personnel to perform inspection and ongoing monitoring
- The proposed control type (see Section 7)
- The proposed inspection frequency
- Batch/lot size
- Supporting evidence

5.4 Purchaser Evaluation and Approval

5.4.1 The purchaser shall review the data pack and assess the risk associated with the proposed alternate inspection frequency plan.

5.4.2 The purchaser shall approve or reject and formally communicate this decision to the supplier.

5.4.3 A record of the approval of the proposed alternate inspection frequency plan shall be retained in accordance with the purchaser's requirements.