

EIFI

European Industrial Fasteners Institute



MECHANICAL FASTENERS QUALITY OF TECHNICAL CHARACTERISTICS

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1. Scope

Mechanical fasteners (bolts, nuts, screws, washers, cold/hot headed parts and blanked parts that are used to join two or more elements) are widely used in many industrial sections. In many cases they are used in functionally important or safety related applications. In these cases, therefore, the fulfilment of the necessary functional requirements is essential in many cases of application.

The manufacturers combined in the member associations of EIFI European Industrial Fasteners Institute are committed to meet the requirements of quality and performance laid down in International Standards and applicable customer specific requirements.

EIFI fastener manufacturers are committed to follow the Zero Defect strategy for their products

Nevertheless, the complexity of the manufacturing processes in some cases may create unsystematic deviations which can not be prevented under the present technological conditions.

In other cases the specific manufacturing conditions and logistical aspects create some kind of misunderstanding which lead to time and cost consuming discussions between manufacturers and customers.

The goal of this document is to compile the technical background of all important correlations, to create clear technically based rules for the applications of the Zero Defect strategy and statistical methods (random sampling, Process Control (SPC) and others) to prevent such discussions in the common interest of manufacturers and customers.

Furthermore, the interactions between manufacturers and customers in relation to technical, logistical and quality aspects are based on a large variety of different systems. In this age of globalization, where cost efficiency is one of the major challenges, the unification of those systems gives a major potential for cost reduction.

It should be clearly stated, that the achievement of the requirements of quality is not only in the responsibility of the fastener manufacturer. The customer shall provide all the necessary input data for the field of application of the product, the quantified technical requirements and the important characteristics. In case of dispute it is in the customer's duties to provide the rejected parts and the traceability of the assembly process.

Note: This document does not describe the evaluation of logistical aspects. The applicable methods shall be worked out and agreed between manufacturer and customer prior to the contract. It is generally not possible to transfer the ppm-evaluation to those processes.

2. Effects of production methods

The general production process is described in the following:

The first stage of manufacturing for most products is cold forging. The results of this mostly multi station forging process are single products. This stage is followed mostly by processes of mass production, with a major potential for mixing products of different manufacturing lots.

Those process stages are for example:

- Thread rolling
- Heat treatment
- Surface coating
- Discharging and recharging of containers
- Internal transport
- Dispatch and warehouse processes

Regarding washers or similar parts, the first stage of manufacturing for most products is blanking followed by deburring. The further stages are the same as for fasteners.

In addition external transport and conditions in the subcontractor's or customer's location may contribute as sources of mixing or other contamination.

The overall effect of this is, that even with continuous improvement of processes there is still a probability that due to unsystematic events there will be nonconforming products within a manufacturing lot.

Therefore, in many cases the manufacturing process is finished by a manual or automatic sorting process, which minimizes the number of parts with deviations. But, in the most cases mechanical properties can be checked only by destructive test methods. This means there is only the possibility of using statistical control methods.

It is **in** the responsibility of a high level quality manufacturer to establish sophisticated, experienced and reliable processes at all stages. The basic rules for these processes are described in the International Standards

ISO 9001 Quality management systems - Requirements

ISO TS 16949 Quality management systems - Particular requirements for the application of ISO 9001 for automotive production and relevant service part organizations

EN ISO 16426 Fasteners - Quality assurance system

3. Requirements

In general a standardized mechanical fastener is described by about 10-15 geometrical and just as many mechanical characteristics laid down in international or national standards.

Those products have to fulfil acceptance tests according ISO 3269 – Acceptance inspection. This standard contains sampling plans and statistically based acceptance quality levels (AQL) for the acceptance of a manufacturing lot.

Fasteners for special applications or markets (e.g. automotive, electronics) made to drawing for highly sophisticated or safety critical applications may have additional requirements and the requested quality level is much more demanding. It is measured by parts per million (ppm).

Concerning this value some misinterpretation may arise. The requests sometimes have no technical and no economical background.

To fulfil those requests it is necessary to install automatic sorting processes. Also here a wide field of misunderstanding and time consuming discussion exists.

As mentioned above, high level and stable quality of the products implies controlled processes. In some cases this may be verified by c_{pk} - or c_{mk} -figures, when statistical rules apply.

Many customers include ppm-requirements in logistical or commercial aspects. This is basically different from the technical definition of ppm-values, and outside the scope of this document!

4. Basic Arguments

4.1 General

- Zero Defect Strategy is a common (manufacturer and customer) goal. It does not mean that ppm = 0 can be achieved.
- Agreements related to design and quality of mechanical fasteners should be worked out in a close cooperation within the concept phase of the final product. The cooperation shall include the exchange of all the necessary information concerning the function and assembly of the fastener.
- Also, in case of detected deviations there shall be a close cooperation to minimize time and costs of preventing and corrective actions.
- The state-of-the-art sorting technologies or machines are not able to sort all sizes of diameters, lengths or other simple characteristics of the products.

4.2 Technical aspects

4.2.1 ppm-requests

- ppm-values shall be related to one or more agreed characteristics of a product with influence on function or assembly of the final product. The technical responsibility of the manufacturer shall be limited to the end of the assembly. The agreement should include the appropriate method of detection. The agreement shall be worked out at the time of the order.
- General requests for ppm-values of manufacturing lots are technically without any basis.
- The evaluation of ppm-values is most suitable for the control of unsystematic processes or events
- In most cases ppm-requests will require more expensive automatic sorting processes. Therefore, there should be a detailed cost assessment
- ppm-requests should be based on a specified period of time, they should not be applied for the acceptance of one single lot
- ppm-requests are not suitable for characteristics which use destructive test methods, e.g.
 - tensile strength
 - hardness
 - surface discontinuities
 - decarburization
 - impact strength
 - metallographic structure
 - others
- There are a number of characteristics where because a processing operation applies to an entire quantity of products the quality of the entire batch will be influenced. Those characteristics shall not be included in the ppm-evaluation. Examples are:
 - Corrosion resistance
 - Appearance
 - Coefficients of friction
 - Coating thickness
- State of the art for control processes of one characteristic for forged products is :
 - Unsorted: 200 ppm
 - Manually sorted: 100 ppm
 - Automatically sorted: 10 ppm
- Characteristics suitable for automatic sorting:

Dimension	Shape	Others
Length	Existence of the thread	Foreign parts
Thread length	Existence of the internal driving feature	Bursts (cracks) in the head
Diameter of the thread	Existence of the external driving feature	Bursts (cracks) in the flange
Diameter of the flange	Existence of the prevailing torque feature of a nut	
Diameter of the head	Existence of the bolt point	
Diameter of the shank	Existence of the preassembled washer	
Height of the bolt head	Existence of the microencapsulated adhesive	
Height of the nut		
Minor diameter of the nut thread		
Depth of the internal driving feature		
Pitch of the thread		
Height of the external driving feature		
Width across flats		
Inside/outside diameter and thickness for washers		

- In regard to cost efficiency the customer shall select only characteristic for sorting which are essential to the assembly or function of the final product.
- Experiences also show that during a sorting process the corrosion resistance of the products can sometimes be impaired

4.2.2 Statistical process control (SPC)

- SPC is only suitable for those characteristics which can be influenced by the operator and or equipment during the production process
- While unsystematic non-conformities cannot be recognized by statistical process control (SPC), systematic nonconformities can usually be limited by the application of SPC (ISO 16426).
- In addition for a single characteristic, if the process is exactly centred and stable ($C_{pk} = C_p$) and if a C_{pk} value of 1,33 is assumed, it means more than 63 ppm of fasteners are outside the tolerance limits (ISO 16426).
This value of ppm decreases for higher values of C_{pk} and/or C_p .
- There are a number of parameters or specified processes which are not suitable to be controlled by SPC, for example:

Category	Characteristics
Not controllable, depending on tool behaviour	Radii
	Angles
	Thread dimensions
	Forged shank diameters
	Width across flats by trimmed process
	Tolerances of shape and positions
Characteristics manufactured in a single, separated and closed process	Weight of the surface coating layer
	Corrosion resistance
	Hardness (heat treatment in a chamber furnace)
	Strength (heat treatment in a chamber furnace)
	Chemical parameters of the material
	Coefficients of friction
	Gaugeability of threads
Characteristics with special non-centrally tolerance positions	Thread forming torques
	Strength (continuous furnaces)
	Hardness (continuous furnaces)
Characteristics with small tolerance where the precision of the gauges is unreliable	Thread diameters
	Fit diameter for coated fit bolts
Characteristics manufactured with automatic adjustment) or with slow trend	Coating thicknesses
Multi-part assembly processes	
Processes with different inhomogeneous materials	

For more detailed information contact the expert of your EIFI fastener manufacturer or see:

- ISO standard 16426: Fastening elements – Quality assurance system, (Jan 2003)
- AFFIX Reference guide for quality rules and practices for fastening products, (2nd edition, Oct 2006)
- ICS Guideline – Delivery Quality of fastener, (Nov 1996)

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