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INTRODUCTORY NOTES
FASTENER QUALITY ASSURANCE

Because of the introduction of substandard fasteners into the stream of Commerce of the United States during the late 1970's, consumers, domestic fastener manufacturers and distributors initiated serious efforts to restore responsibility, accountability and traceability. Coupled with these efforts was the Fastener Quality Act signed into Law by President Bush on November 16, 1990. These efforts brought significant and lasting changes which have greatly enhanced quality in the product produced by the North American fastener industry.

The Law has encountered serious difficulties, which at the time of this writing have prevented its implementation. However, voluntary efforts in the fastener industry have brought about important changes in manufacturing controls which have produced a significant reduction in the number of nonconformances found in current production. These control concepts may be clearly understood by examining each of the quality assurance plans set forth in this section. Current state-of-the-art has reduced the nonconformances per million pieces produced from 10,000 PPM in the early 60's to a PPM level approaching 100 or even less in the mid 90's. Continuous improvement will surely continue this endless progression toward the ultimate goal of zero PPM.

The quality of a fastener is its conformance to its specification for dimensions, mechanical properties, and performance requirements. Quality is not a measure of precision. Any fastener manufactured completely within its specified limits, regardless of how narrow or broad, is a "quality" fastener. Tightening specification limits reduces variation and increases precision; it does not increase quality.

Inspection of a fastener determines if its various characteristics and attributes are in conformance. Inspection plans are a schedule of inspection and testing frequencies, intensity, and acceptance criteria. Quality assurance is the selection of an inspection plan and its employment to determine the level of conformance of a quantity of fasteners.

A single quality assurance approach for all fasteners as used in a full range of service applications is impractical. For relatively unimportant connections, possibly installed by hand, lowest fastener cost may be the prime consideration. Automatic and semiautomatic installation methods usually need fasteners which are more closely controlled in their manufacture, and consequently, require more detailed inspection. For applications where fastener failure could result in costly equipment and production loss or possible personal injury, additional inspection attention is most prudent coupled with a system to identify, isolate, and permit traceability of nonconforming fasteners to their manufacturing source. Cost and technical realities dictate that quality assurance relates directly to service expectations.

Identifying the performance expected of a fastener in its service application is the responsibility of the engineer or designer. He knows the conditions of the application, the severity of the environmental exposure, its safety factor, installation method, and expected service life. He is responsible for fastener selection. It logically follows that he must also accept responsibility for determining the level of quality assurance he needs to give him confidence the delivered fasteners conform to their specified requirements and, consequently, are suitable for use in their intended application.

Until about 30 years ago, fasteners were inspected, almost universally, using acceptable quality level (AQL) techniques with lot sizes, sample sizes, and acceptance/rejection numbers based on plans detailed in MIL-STD-105.

While AQL plans are statistically sound, in the late 1960's many large volume fastener

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users became uncomfortable with the AQL concept. The basic concern was that AQL plans recognize the possible existence of nonconforming parts within an inspection lot and condone their presence if specified numerical limits are not exceeded. This led to the introduction of the "zero acceptance" concept.

Simply stated, the "zero acceptance" concept is based on selecting a number of sample parts from a lot submitted for inspection, inspecting those parts, and basing lot acceptance on finding zero defects. The concept assumes the chosen-at-random sample parts are representative of the entire lot and if the samples are found conforming it is reasonable to suppose the other parts in the same lot are similarly conforming.

As an interesting side note, a quality assurance plan for metric fasteners was developed by ISO/TC2, the technical committee on fasteners within the International Organization for Standardization. By majority vote, the TC2 member countries structured this plan on AQL statistical concepts. When the project was first initiated, the USA delegates cautioned TC2 that this approach was no longer favored by many major fastener using industries. They further predicted that USA would not support an ISO standard resulting from this effort. The ISO effort went forward; USA has yet to endorse it.

In recent years, quality assurance practices have taken another step forward through the introduction of statistical process control (SPC). In this practice, fasteners are periodically inspected during their manufacturing operations. The hard number measurements are then statistically evaluated to determine the probability of the process remaining under or drifting out of control. When the evaluation indicates a trend toward out of control — that is, toward nonconformance of the products being manufactured — corrective adjustment of the process is made.

In 1971, the ANSI/OMFS Committee recognized that growing North American interest in metric fasteners presented industry with a unique and timely opportunity. The Committee felt that if a comprehensive quality assurance plan could be designed for metric fasteners it could become a true national standard which would benefit both fastener manufacturers and fastener using industries. More importantly, the Committee anticipated that if the plan was so designed to be equally applicable to inch series fasteners it would provide the needed alternative to discourage introduction of new and different plans and also help unify the many individual plans then in existence. The Committee prepared detailed recommendations. In 1978, these recommendations were accepted by ASME Standards Committee B18 and used as the basis for a series of ASME/ANSI quality assurance standards for metric fasteners. The B18 effort was completed in 1982 and four separate standards published. In 1987, these same four documents were revised and reissued with the only change being a broadening of their scope to include inch series fasteners. The standards are—

ASME/ANSI B18.18.1M — *Inspection and Quality Assurance for General Purpose Fasteners*

ASME/ANSI B18.18.2M — *Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners*

ASME/ANSI B18.18.3M — *Inspection and Quality Assurance for Special Purpose Fasteners*

ASME/ANSI B18.18.4M — *Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications*

Table 1 describes the basic features of the four plans. Each plan is technically valid and, within its own parameters, gives adequate assurance of product suitability. As the plans progress from .1M thru .4M, the inspection in-

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Table 1 Comparison of the First Four ANSI Quality Assurance Plans

ASME/ANSI B18.18.1M	ASME/ANSI B18.18.2M	ASME/ANSI B18.18.3M	ASME/ANSI B18.18.4M
General Purpose Fasteners	**Fasteners for High Volume Machine Assembly**	**Fasteners for Special Purpose Applications Requiring In-Process Controls**	**Fasteners for Highly Specialized Engineered Applications Produced Consecutively from a Single Mill Heat with In-Process Control and Lot Traceability**
Manufacturing Inspection at Producer's Discretion	Raw Material Checks and Records for Each Mill Heat (Batch, Cast, Melt, etc.) Used	Raw Material Checks and Records for Each Mill Heat (Batch, Cast, Melt, etc.) Used	Raw Material Checks and Records of Each Coil Produced from a Single Mill Heat (Batch, Cast, Melt, etc.)
Shipment			Produced Consecutively at the Initial Forming Operation
	In-Process Control and Inspection at Producer's Discretion	Fabrication: In-Process Inspection Plan	Fabrication: In-Process Inspection Plan
		Heat Treatment: Where Applicable In-Process Inspection Plan	Heat Treatment: Where Applicable In-Process Inspection Plan
Inspection Applied if Lot Compliance Questioned After Shipment	Final Inspection	Final Inspection Verification Sample	Final Inspection Verification Sample
	Records of Final Inspection Maintained for a Minimum of One Year as Objective Evidence of Conformance	Records of Inspection Maintained for a Minimum of One Year as Objective Evidence of Conformance	Records Maintained for a Minimum of One Year Traceable by Lot Number from Raw Material to Shipment Including Destination
Maximum Lot Size: 250,000 Pieces	Maximum Lot Size: 250,000 Pieces	Maximum Lot Size: 250,000 Pieces	Maximum Lot Size: 250,000 Pieces

tensity, record keeping, and acceptability criteria become considerably more severe. Obviously, there's an ascending cost factor. The greater the inspection effort, the higher its cost. Cost effectiveness is maximized when the designer or engineer specifies a level of quality assurance no higher than that necessary to provide confidence the delivered fasteners are acceptable for their service use.

It is important to note that B18.18.1M addresses the resolution of nonconforming material detected during receiving inspection. B18.18.2M, .3M and .4M are for use by the fastener manufacturer. While each provides for

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in-process inspection, they are based on the concept of a final inspection.

On March 15, 1987 the International Organization for Standardization (ISO) issued a series of documents which address quality management and quality systems. These documents, identified as ISO 9000 thru ISO 9004, became the focal point for quality as manufacturing began to globalize. Beginning in February of 1993 and continuing well into 1994, the automobile industry in the United States issued a series of documents which establish an orderly procedure for implementation of what is identified as QS 9000. This program utilizes a base of ISO 9000, but adds specific customer based requirements and sector-specific requirements.

As these efforts were moving forward, ASME's Standardization Committee for Fasteners initiated its effort to reflect through the consensus standards process the continuing evolution of quality assurance for fasteners. This effort produced in 1990 the publication by ASME of the only third party accreditation plan specifically for fasteners which has ever been written (FAP-1). Applicable to both fastener manufacturing and distribution, it offers a significant solution to fastener quality assurance. This plan also includes all of the requirements of ISO-9001 and adds other requirements as well. In 1993, ASTM issued F1470 which is a sampling guide for specified mechanical and performance inspection. Many ASTM F16 standards will eventually reference this document for inspection purposes.

In 1998, B18 issued three new standards including:

— B18.18.5M – *Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls*

— B18.18.6M – *Quality Assurance Plan for Fasteners Produced in a Third Party Accreditation System*

— B18.18.7M – *Quality Assurance Plan for Fasteners Produced in a Customer Approved Control Plan*

B18.18.5M, .6M, and .7M represent current thinking in quality systems. Each is based on the concept of process control and in-process inspection. None of the three provides for final inspection.

The following pages present the documents previously highlighted. The purchasers should always specify one of these documents at the time of order to assure that his expectations of quality are fully met.