AN AMERICAN NATIONAL STANDARD

Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications

ASME/ANSI B18.18.4M-1987

REAFFIRMED 1999

FOR CURRENT COMMITTEE PERSONNEL
PLEASE SEE ASME MANUAL AS-11

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda or written interpretations of the requirements of this Standard issued to this Edition.

FOREWORD

(This Foreword is not part of ASME/ANSI B18.18.4M-1987.)

American National Standards Committee B18 for the standardization of bolts, screws, nuts, rivets, and similar fasteners was organized in March 1922 as Sectional Committee B18 under the aegis of the American Engineering Standards Committee (later the American Standards Association, then the United States of America Standards Institute and, as of October 6, 1969, the American National Standards Institute, Inc.) with the Society of Automotive Engineers and the American Society of Mechanical Engineers as joint sponsors.

Subcommittee 18 of Committee B18 was established in September 1978 to develop a document to cover the quality assurance provisions for internally and externally threaded metric fasteners and accessories or associated parts.

At the March 1979 meeting of Subcommittee 18, it was agreed that the quality assurance document should be circulated for subcommittee consideration as a proposed standard. Subcommittee acceptance of the content ensued and the document was approved by letter ballot to the American National Standards Committee B18 on March 21, 1980.

The standard was subsequently approved by the Secretariat and submitted to the American National Standards Institute for designation as an American National Standard; it was designated ANSI B18.18.4M-1982 and approved on September 14, 1982.

A periodic review of the standard, undertaken by the Subcommittee in 1985, resulted in agreement that the document be revised to allow it to be used for inch as well as metric products. This was done by deleting the word "metric" from the title as well as from each place in the standard where it would inhibit the use of the document for inch as well as metric products. By retaining the "M" in the designator, the standard can be used for both inch and metric products without having to change any references made. A proposal containing these changes, as well as editorial corrections, was prepared and balloted by letter ballot to ASME Committee B18. Following approval by ASME, the proposal was submitted to the American National Standards Institute and designated an American National Standard on January 16, 1987.

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Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners

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INSPECTION AND QUALITY ASSURANCE FOR FASTENERS FOR HIGHLY SPECIALIZED ENGINEERED APPLICATIONS

1 GENERAL INFORMATION

1.1 Basic Plan Structure

This Standard outlines a Quality Assurance Plan for internally and externally threaded fasteners and accessories or associated parts. Provisions are included for sampling plans, inspection frequencies, control procedures, and record keeping. The basic structure of this plan outlines the quality assurance provisions for fasteners for special purpose applications requiring in-process controls. Included are fasteners produced by one manufacturing practice requiring records of in-process and final inspection which are maintained by the producer.

This Standard will be used in conjunction with other accepted standards for product, testing, gaging, and material and, therefore, those provisions as well as packaging are not included herein.

1.2 Inspection Levels

The substantial difference in importance to the user of various characteristics and the dissimilar degrees of control in manufacture make impractical the subjecting of all characteristics to the same degree of inspection. Therefore, four inspection levels have been provided.

Any additional characteristics deemed applicable by the user that do not appear in the plan shall be explicitly designated by the user, preferably on engineering drawings and related specifications, by the appropriate code letter at the time of ordering (see Appendix II). To assist in arriving at the most appropriate inspection level, the Decision Table included in Appendix I is recommended for guidance.

1.3 Lot Sizes

When the acceptance number for sampling by attributes is fixed, variation in sample size results in variation of acceptable quality. Therefore, to avoid this inconsistency, fixed sample sizes are applied for the greatest range of lot size. Lot sizes are restricted to a maximum of 250,000 pieces.

1.4 Measuring and Testing Equipment

All measuring instruments, gages, and testing equipment used to inspect incoming materials and parts in process and in final inspection shall be calibrated at planned intervals to National Bureau of Standards (NBS) or other equivalent National Standards where applicable. The dates of calibration and fixture checks shall be recorded. Inspection records shall be kept for a minimum of 1 year.

1.5 Basic Plan Outline

The basic plan outline as shown in Fig. 1 is included to enhance understanding and use.

2 FASTENERS

2.1 Scope

The plan in this Section is based on the concept of quality assurance through in-process control. It establishes specific inspection functions that must be performed during each process and at each operation involving the production of fasteners, with the objective of producing finished fasteners that shall conform to all customer requirements as specified in engineering drawings, related standards, and/or specifications.

The general plan presents a uniform control procedure that is intended to be applicable to all important characteristics used in the manufacture of fasteners. Adherence to the characteristic requirements of this plan does not release the contractor from the responsibility of exercising due care in the production of all parts to ensure that the requirements established for all characteristics shown on engineering drawings and

related specifications have been met. This plan requires that records of verification of material analysis, in-process inspection, and testing, as well as final inspection, all traceable to restricted size lots and shipping destination, be maintained.

2.2 Applicable Characteristics

Applicable characteristics include all characteristics of a part that are described by engineering drawings and related specifications (Tables 5 and 6). Applicable characteristics also include those transitional characteristics of a part that are present in some intermediate stage in the manufacture of the part (Tables 1 and 2). As-quenched hardness is an example of a transitional characteristic. Four levels of inspection — A, B, C, and D — are provided in the plan. Each characteristic has been assigned an appropriate level.

Any additional characteristics deemed applicable by the user and not appearing in the general plan, or characteristics for which the user requires a nonstandard inspection level, shall be designated by the user, preferably on drawings or specifications, by the appropriate code letter at the time of ordering. Refer to the Decision Table in Appendix I for guidance in establishing these nonstandard levels.

2.3 Lot Definition

A *lot* is a quantity of product of one part number produced consecutively at the initial forming operation from a single mill heat of material and subsequently submitted for final inspection at one time. Maximum lot size traceable to final inspection shall be no larger than 250,000 pieces.

2.4 Lot Identification

Each lot of material shall be identified by lot number. The lot number used prior to submittal of the lot for final inspection shall be the supplier's choice. When a log passes final inspection, it shall be assigned a six-digit lot number. The first two digits shall represent the calendar month of the year in which final inspection is made. The middle two digits shall represent the day of the month. The last two digits shall represent the order in which the lot was inspected in relation to other lots also passing final inspection on the same day. Thus, 051893 would be the lot number assigned to the ninety-third lot passing final inspection on May 18, regardless of part number. This final lot number shall appear on each shipping container.

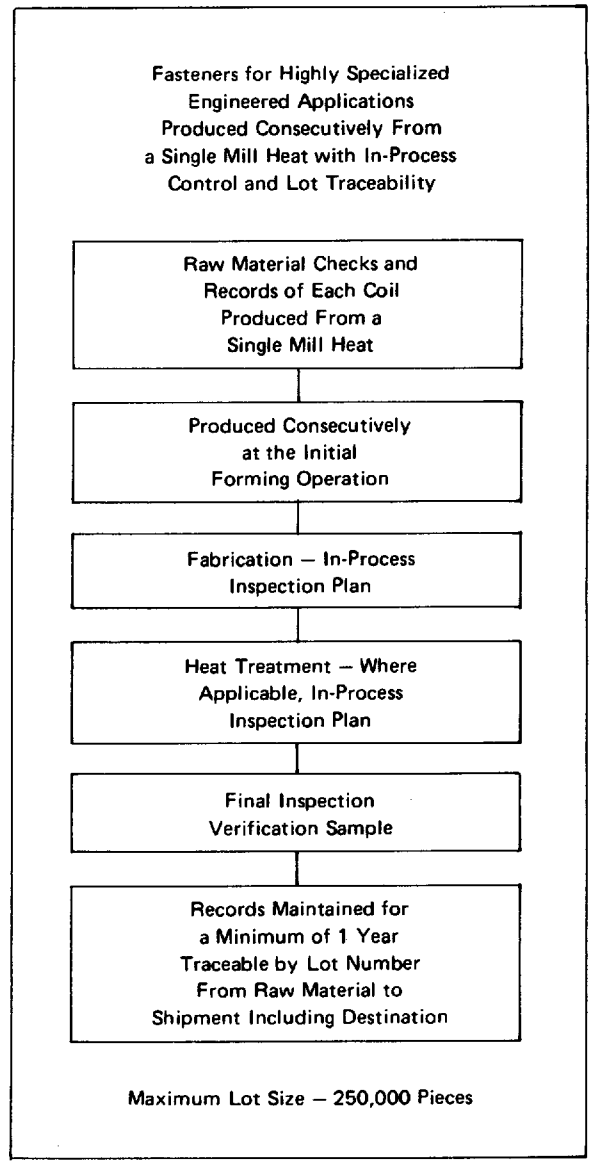


FIG. 1 BASIC PLAN OUTLINE

2.5 Records

The contractor shall maintain logs and records of inspection and tests as required by this plan. Such records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities of material or parts approved and rejected, and the nature of the corrective action taken. Records shall also include the disposition of rejected parts. All records shall be traceable from the final lot number — from raw material through part for shipment, including destination — and be maintained for a minimum of 1 year from date of shipment.

TABLE 1 IN-PROCESS — NONDESTRUCTIVE

	Characteristic	Inspection Level	Internally Threaded Parts	Externally Threaded Parts
	Forming Process			
1	Shank diameter (body)	C	WA	WA
2	Length	B	WA	WA
3	Width across flats	B	WA	WA
4	Width across corners	C	WA	WA
5	Head or nut thickness	C	WA	WA
6	Wrenching height	C	WA	WA
7	Angularity of bearing surface	C	NA	WA
8	Bearing surface diameter	D	WA	WA
9	Head diameter	C	NA	WA
10	Flange diameter	C	WA	WA
11	Flange thickness	C	WA	WA
12	Recess penetration	B	NA	WA
13	Point diameter	C	NA	WA
14	Countersink diameter and depth	D	WA	NA
15	Grade and source	D	WA	WA
16	Head and/or flange concentricity	C	WA	WA
17	Flange flatness	C	WA	WA
18	Radius under head	D	WA	WA
19	Diameter of undercut	B	NA	WA
20	Depth of undercut	D	NA	WA
21	Eccentricity of recess	C	NA	WA
22	Concentricity of hole	C	WA	NA
23	Visual inspection [Note (1)]	A	WA	WA
24	Thread acceptability [Note (2)]	B/C/D	WA	WA
25	Total thread length	B	NA	WA
26	Grip length	B	NA	WA
27	Angularity of tapping	C	WA	NA
28	Visual inspection [Note (1)]	A	WA	WA
	Slotting			
29	Slot width	C	WA	WA
30	Slot depth	B	WA	WA
31	Slot alignments and location	C	WA	WA
32	Visual inspection [Note (1)]	A	WA	WA
	Prevailing Torque Feature			
33	Width across flats	C	WA	NA
34	Thread start	A	WA	WA
35	Visual inspection [Note (1)]	A	WA	WA
	Washer for Assemblies			
36	Type of washers	D	WA	WA
37	Washer O.D.	D	WA	WA
38	Washer I.D.	D	WA	WA
39	Washer thickness	D	WA	WA
40	Visual inspection [Note (1)]	A	WA	WA

GENERAL NOTES:
(a) Legend: WA — when applicable
NA — not applicable
(b) Refer to para. 2.10 for acceptance criteria. Refer to Fig. 2 for frequency of testing.

NOTES:
(1) Visual inspection for presence of plating, duds, surface discontinuities, head style, type of recess, type of nut, type of washer, presence of locking feature, finish, and general workmanship. Those characteristics previously subjected to inspection do not require reinspection.
(2) ANSI/ASME B1.3M or other applicable standards and at the appropriate inspection level (B, C, or D).

TABLE 2 IN-PROCESS — DESTRUCTIVE

	Characteristic	Description of Control: Inspection Level	Internally Threaded Parts	Externally Threaded Parts	Heat Treated Parts
1	Tensile strength (wedge or axial)	C	NA	WA	WA
2	As-quenched hardness center [Note (1)]	B	WA	WA	WA
3	Hardness [Note (2)]	A	WA	WA	WA
4	Case depth	B	NA	WA	WA
5	Decarburization	C	WA	WA	WA
6	Torsional strength	B	NA	WA	WA
7	Washer hardness	B	NA	WA	WA
8	Plating thickness	C	WA	WA	WA
9	Corrosion resistance [Notes (3), (4)]	C	WA	WA	WA
10	Hydrogen embrittlement	A	WA	WA	WA

GENERAL NOTE:
Legend: WA — when applicable
NA — not applicable

NOTES:
(1) As-quenched hardness is checked following heating and quenching prior to tempering.
(2) Surface, core, or both, as applicable.
(3) Continuous monitoring of salt spray performance in accordance with the recommendation of Table C in Appendix I constitutes compliance with requirements for salt spray testing outlined in this table.
(4) Includes salt spray and other corrosion resisting tests.

2.6 Purchased Accessories and Parts

Accessories, services, and partially fabricated parts (e.g., washers, nuts, blanks, plating, heat treating, etc.) may be purchased by the prime contractor from other suppliers for use in the production of fasteners, provided the following conditions and requirements are met.

(*a*) The prime contractor shall be completely responsible to the user for the quality of the final product.

(*b*) The prime contractor shall be responsible for the implementation of all requirements of this plan, including records. The prime contractor shall include the requirements of this plan in the purchase order to the subcontractor.

(*c*) When the accessory, partially fabricated part, or treatment is processed by a subcontractor, the prime contractor shall so identify the subcontractor(s) of the parts and designate the process performed in his records.

(*d*) All lots that are heat treated and/or finished by a subcontractor and all lots that are processed by a subcontractor following heat treatment and/or finishing operations shall undergo inspection by the prime contractor. Final inspection may be conducted by the subcontractor upon prior written approval of the customer. The subcontractor shall send the inspection records to the prime contractor with the parts that he has processed and shall retain a copy for his records.

2.7 Raw Material

2.7.1 General. Raw material (rod, wire, or bar) shall be inspected prior to release for fabrication to verify that it conforms to the material requirements specified. Raw material shall be inspected to determine that each coil or bundle has a mill identification and that each heat (batch, cast, melt, etc.) is accompanied by a mill certification of analysis.

2.7.2 Material Specifications. Each coil or bundle of material used to produce parts shall have its suitability verified by chemical analysis or hardenability. With permission of the purchaser, a sample from one coil of steel from each mill heat shall be analyzed to verify that it conforms to the material requirements specified. All other coils shall be checked by spark testing to ensure that they are from the same mill heat, using the sample from the analyzed coil as a reference master. Cold drawn, stress relieved bars or coils, such as those used for U-bolts, shall also be checked for tensile strength to verify suitability.

For bundles of material, chemical analysis or hardenability checks shall be performed at the following frequency.

Number of Bars/Bundle	Number of Bars to Be Inspected
Up to 25	2
26 to 50	3
51 to 90	5
Over 90	8

In addition, all bars shall be checked by spark testing or other nondestructive testing method to ensure that all bars are of the same composition.

2.8 In-Process Inspection

A minimum of five fasteners, taken at random from each coil of rod or wire or from each bundle of bars, shall be visually inspected to verify the general quality of the raw material and its condition following the forming process. The part shall be examined for evidence of pipe, cracks, seams, and other surface discontinuities according to applicable specifications.

At each machine or processing station the part shall be checked during production for designated characteristics imparted to it by that machine or processing station. Since it is not essential that destructive tests be conducted at the time test samples are selected, the producer may elect to accumulate test samples taken in process for testing at one time. This provides uniform sampling as intended by in-process inspection.

2.8.1 Fabricating Operations. Table 1 lists most dimensional characteristics of fasteners covered in this plan with designated inspection levels. General inspection procedures have been established on the basis of engineering and manufacturing experience with regard to the effect of setup, tooling, operator, and machine operation on each characteristic at each processing station.

The minimum in-process requirements at each machine or processing station shall be as follows.

(*a*) At the start of each production run, five pieces of the part shall be sampled and then checked in accordance with Table 4 for all designated characteristics imparted to it by that machine or processing station.

(*b*) At the start of each new shift, five pieces of the part shall be sampled and then checked in accordance with Table 4 for all designated characteristics imparted to it by that machine or processing station.

(*c*) When a tool is changed or when an adjustment in machine setup is made, five pieces of the part shall be sampled and then checked in accordance with Table 4 for all designated characteristics affected by the new tool or by the setup adjustment.

(*d*) During the production run, the part shall be checked for all designated characteristics imparted to it by that machine or processing station in accordance with Tables 1 and 2 at a frequency determined from Fig. 2 and Table 3.

(*e*) At the completion of each production run, the last piece shall be completely checked for all characteristics imparted to it by that machine or processing station.

TABLE 3 FREQUENCY OF DESTRUCTIVE TESTING

Inspection Level	Continuous Equipment 3 at Start of Run +	Batch Equipment
A	3 per hr	3 per batch
B	1 per hr	1 per batch
C	1 per 4 hr per lot	1 per batch
D	1 per lot	1 per batch

TABLE 4 IN-PROCESS TESTING FREQUENCY

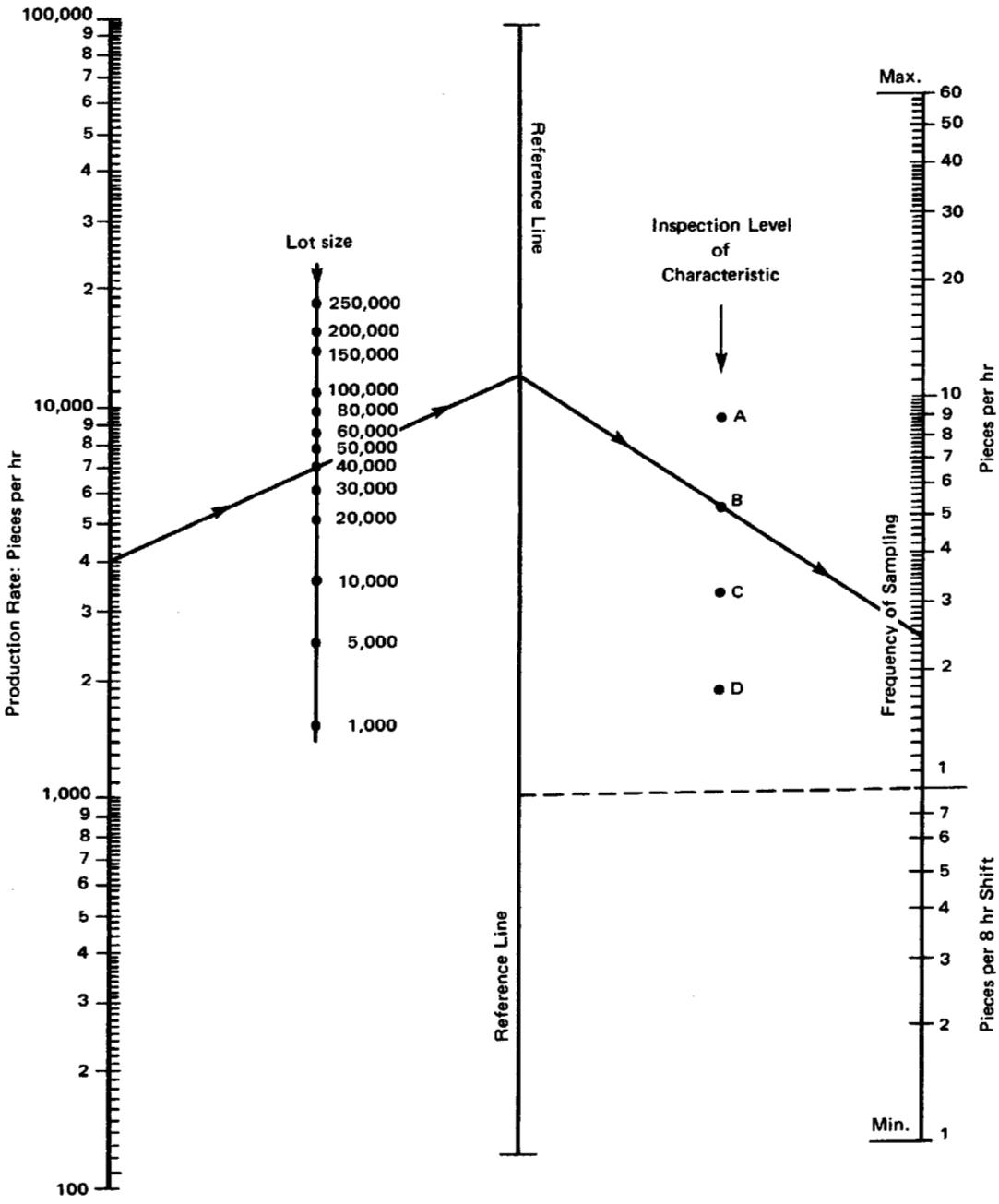
Level of Characteristics	Number of Checks
A	5
B	3
C	2
D	1

2.8.2 In-Process Controls. The inspection level shall be in accordance with Tables 1 and 2 for nondestructive and destructive testing, respectively. The frequency of testing associated with each code letter may be determined from the nomograph of Fig. 2 and is a function of production rate and lot size. Frequency of destructive testing is contained in Table 3.

When the frequency of sampling is less than one piece per hour, the time interval between sampling shall be evenly spaced throughout the shift to the degree practicable.

Checks made at the start of the shift or the production run, or following tool change or machine adjustment, may contribute to the specified checks under para. 2.8.1(d) within the following hour only.

Visual examination of general workmanship shall include inspection for surface discontinuities, legibility of identification markings, duds, and general appearance.



GENERAL NOTE:

USE: Starting at left-hand axis of production rate, set rate of operation and from this point draw a straight line through corresponding lot size to the reference line. From the reference point, draw a straight line through point for required inspection level and extend to right-hand axis of sampling frequency.

EXAMPLE: For production rate of 4,000 pcs/hr lot size 40,000 Level B, required sampling frequency = 3 pcs/hr

FIG. 2 IN-PROCESS SAMPLING FREQUENCY (NONDESTRUCTIVE)

TABLE 5 FINAL INSPECTION — NONDESTRUCTIVE

	Characteristic	Description of Control: Inspection Level	Internally Threaded Parts	Externally Threaded Parts
1	Body diameter	C	NA	WA
2	Length	B	NA	WA
3	Width across flats	B	WA	WA
4	Wrench height, min.	D	WA	NA
5	Nut thickness	B	WA	NA
6	Head diameter	B	NA	WA
7	Head style	D	NA	WA
8	Angularity of bearing surface	A	WA	WA
9	Flange diameter	C	WA	WA
10	Thread acceptability [Note (1)]	B/C/D	WA	WA
11	Flange dimensions	D	WA	WA
12	Presence of locking feature	A	WA	WA
13	Visual inspection [Note (2)]	A	WA	WA

GENERAL NOTE:
Legend: WA — when applicable
NA — not applicable

NOTES:
(1) ANSI/ASME B1.3M or other applicable standards and at the appropriate inspection level (B, C, or D).
(2) Visual inspection for grade and source identification, presence of finish, duds, surface discontinuities, type of recess, type of washer, type of nut, finish, radius under head, thread chamfer, cleanliness, lubrication, and general workmanship. Refer to Table 7 for sample size.

2.8.3 Heat Treatment

(*a*) *Process and Equipment.* All heat treating processes (including stress relief) and heat treatment equipment shall be regularly monitored to ensure process control and proper functioning of equipment. The furnace and processing control checks and the minimum frequency with which they should be made and recorded are included in Table B in Appendix I.

(*b*) *Inspection of Heat Treated Fasteners.* Heat treated fasteners are fasteners that have been subjected to one or more heat treatment operations. Heat treated fasteners shall be inspected after all intermediate and final heat treatment stages. The characteristics of the various types of fasteners and the minimum frequency of their inspection are detailed in Tables 2 and 3.

(*c*) *Records.* Records shall be maintained in accordance with para. 2.5.

2.8.4 Finishing Operations

(*a*) *Processing and Equipment.* All plating, coating, and postlubrication processes and equipment shall be regularly monitored to ensure process control and proper functioning of equipment. Suggested process control checks and the frequency with which they should be made and recorded are included in Table C in Appendix I.

(*b*) *Inspection of Finished Fasteners.* Plating thickness and/or coating weight, hydrogen embrittlement, and corrosion resistance of plated or coated fasteners shall be checked and recorded in accordance with Tables 2, 5, and 6.

2.9 Final Inspection

Each lot of fasteners shall be subject to final inspection. The final inspection is intended to verify that the lot consists of the ordered parts, to check for mixed stock, and to reinspect certain functionally important characteristics that may have been altered during heat treatment and/or finishing operations. Final inspection shall also include examination of any applicable characteristics not inspected in process. Final inspection records shall be maintained in accordance with para. 2.5.

The nondestructive inspection requirements are given in Table 5. The destructive test requirements are given in Table 6. Sample sizes are then determined from Table 7.

TABLE 6 FINAL INSPECTION — DESTRUCTIVE

	Characteristic	Description of Control: Inspection Level	Internally Threaded Parts	Externally Threaded Parts
1	Proof load — externally threaded	D	NA	WA
2	Proof load — internally threaded	B	WA	NA
3	Tensile strength (wedge or axial)	C	NA	WA
4	Hardness [Note (1)]	B	WA	WA
5	Washer hardness	B	WA	NA
6	Drive test	B	NA	WA
7	Prevailing torque [Note (2)]	A	WA	WA
8	Ductility	B	WA	WA
9	Plating thickness	B	WA	WA
10	Salt spray	B	WA	WA

GENERAL NOTE:
Legend: WA — when applicable
NA — not applicable

NOTES:
(1) Surface, core, or both, as appropriate.
(2) Prevailing torque test includes thread start, all specified torque requirements, and retention of locking feature, when applicable. Refer to Table 7 for sample size.

TABLE 7 FINAL INSPECTION — SAMPLE SIZE

Inspection Level	Nondestructive Tests [Note (1)]	Destructive Tests
A	25	8
B	9	4
C	3	2
D	1	1

GENERAL NOTE:
Quench cracking observed in a single piece renders the lot subject to rejection.

NOTE:
(1) When sample size exceeds lot size, 100% inspection is to be applied.

2.10 Acceptance and Rejection

2.10.1 Basis of Rejection. Any coil of rod or wire or bundle of bars failing to meet the requirements of para. 2.7 shall be held for disposition.

If any parts are found to be nonconforming during any in-process inspection at any fabricating, heat treatment, or finishing operation, all parts produced since the last inspection of the characteristic(s) found nonconforming shall be removed from further processing and held for disposition.

2.10.2 Acceptance Criterion. The acceptance criterion for final inspection is zero discrepancies for nondestructive and destructive tests.

2.10.3 Customer Inspection. If on receipt of the material the user discovers a single nonconforming part that would function defectively, he may reject the lot. The manufacturer will be notified.

2.11 Disposition of Nonconforming Materials or Parts

Records of disposition shall be maintained in accordance with para. 2.5.

2.11.1 Manufacturer's Options. The manufacturer has the choice of the following options in the disposition of those parts that have been found to contain discrepancies within his plant.

(*a*) They may be scrapped.

(*b*) They may be 100% sorted and all nonconforming parts removed.

(*c*) They may be used for another application.

(*d*) They may be reworked or reprocessed to correct the nonconforming characteristic(s).

(*e*) The customer may be informed of the rejectable items and his advice requested on their disposition. If the customer considers that the degree to which the characteristic(s) deviates from specified requirements will have no significant effect on the performance of the parts in their service application, the customer may authorize release of the parts or materials for completion of production or for shipment as applicable.

2.11.2 Customer's Options. The customer shall establish agreement with the manufacturer on one of the following options for the disposition of those materials or parts that have been found rejectable after receipt from the manufacturer.

(*a*) They may be scrapped.

(*b*) They may be 100% sorted and all defective parts removed.

(*c*) They may be reworked or reprocessed to correct the nonconforming characteristic(s).

(*d*) If the customer considers that the degree to which the characteristic(s) deviates from specified requirements will have no significant effect on the performance of the parts in their service application, the customer may authorize release of the parts or materials for use and advise the manufacturer.

(*e*) They all may be returned.

2.12 Reinspection

All pieces that have been sorted and/or reworked in accordance with para. 2.11.1 or para. 2.11.2 shall be resubmitted for lot sampling and inspection of the characteristic(s) found nonconforming and all other characteristics that would be affected by the repair or reprocessing operation(s) at an inspection level four times the size of the original final acceptance sample.

If no parts in the sample inspected are found defective, the material may reenter the production flow or may be approved for delivery or use, as applicable. A new lot number shall be assigned in accordance with para. 2.4 for the new suitable material, which is traceable to the original lot number.

APPENDIX I

TABLE A INSPECTION LEVEL DECISION TABLE

(This Appendix is not part of ASME/ANSI B18.18.4M-1987, and is included here for information purposes only.)

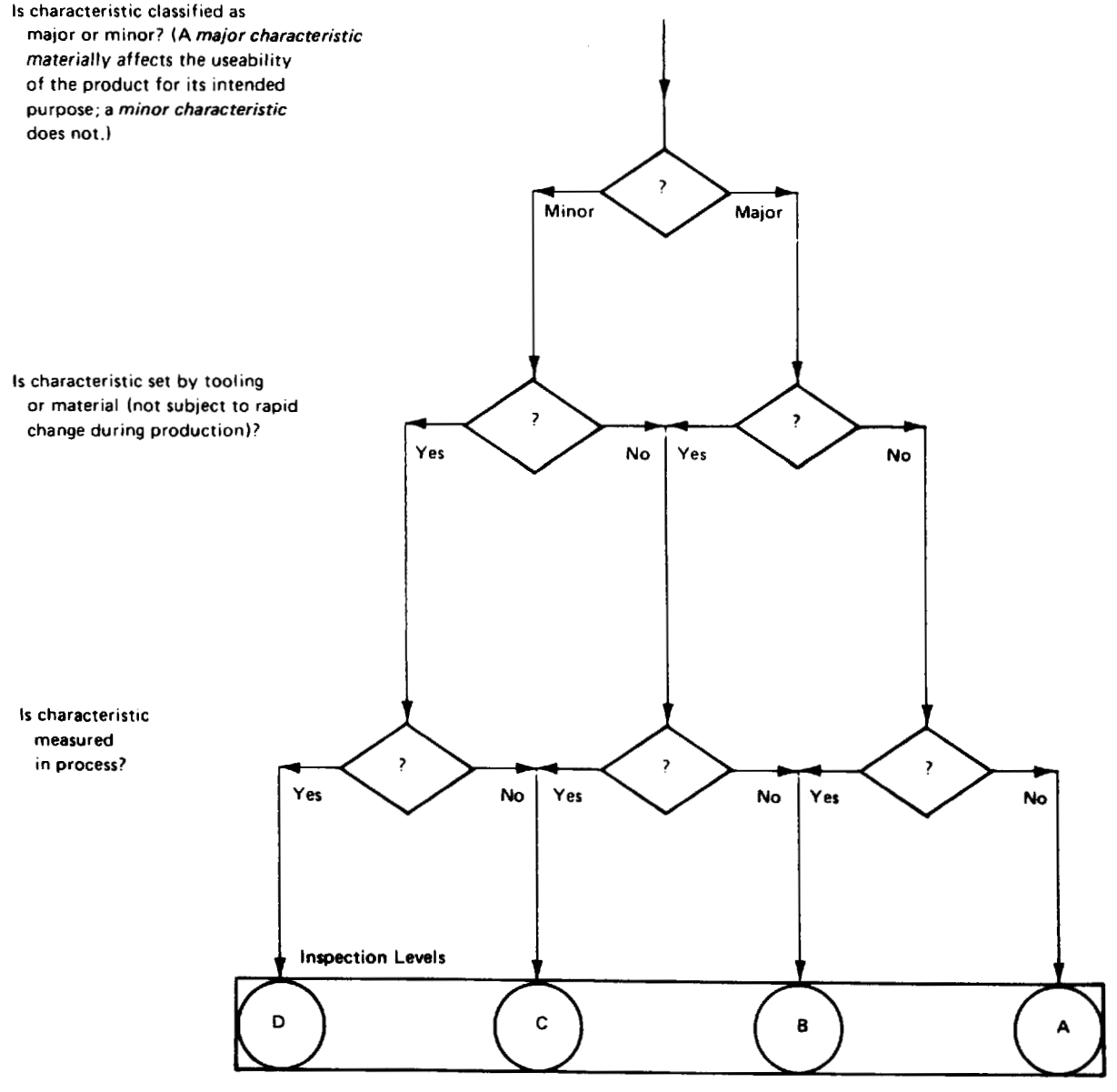


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TABLE B SUGGESTED EQUIPMENT AND PROCESSING CONTROL CHECKS

Heat Treatment Process	Control Check															
	Check Indicated Temperature — Log	Check Dew Point, CO_2, or CH_4 — Log	Check Atmosphere Gas Flows — Log	Standardize Temperature Control Instrumentation — Log	Calibrate Thermocouple Change as Required — Log	Atmosphere Purging Req'd When Process Gas Changed	Carbon Potential Check — Log	Check Furnace Pressure, Air or Gas Leaks, Radiant Tubes, etc. — Log	Check Condition of Quench Oil — Log	Check Air/Gas Ratio, Refrig. Temp., Cooling Water Temp., and Pressures — Log	Analysis of Gas Atmosphere — Log	Check Time in Continuous-Type Furnace — Log	Check Time at Heat in Batch-Type Furnace — Log	Temperature of Quench Medium — Log	Quench Medium Circulation — Log	Visual Check of Furnace Loading — Log
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Hardening furnace atmosphere quench — continuous	Each lot	4 hr [Note (1)]	Each lot	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	Each lot	NA	Each lot	Start of each shift	FSTDC
2 Hardening furnace atmosphere quench — batch type	Each batch	Each batch or 4 hr [Note (1)]	Each batch	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	NA	NA refer to col. 1	Each batch	Each batch	FSTDC
3 Carburizing furnace quench — continuous	Each lot	4 hr [Note (1)]	Each lot	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	Each lot	NA	Each lot	Start of each shift	FSTDC
4 Carburizing furnace quench — batch type	Each batch	Each batch or 4 hr [Note (1)]	Each batch	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	NA	NA refer to col. 1	Each batch	Each batch	FSTDC
5 Carbonitriding furnace quench — continuous	Each lot	4 hr [Note (1)]	Each lot	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	Each lot	NA	Each lot	Start of each shift	FSTDC
6 Carbonitriding furnace quench — batch type	Each batch	Each batch or 4 hr [Note (1)]	Each batch	Daily	Monthly	[Note (2)]	FSTDC	6 months max. and as req'd	FSTDC	NA	NA refer to col. 2	NA	NA refer to col. 1	Each batch	Each batch	FSTDC
7 Annealing furnace atmosphere — continuous	Each lot	4 hr [Note (1)]	Each lot	Daily	Monthly	[Note (1)]	FSTDC	6 months max. and as req'd	NA	4 hr	FSTDC	Each lot	NA	NA	NA	FSTDC

TABLE B SUGGESTED EQUIPMENT AND PROCESSING CONTROL CHECKS (CONT'D)

Heat Treatment Process	Control Check															
	Check Indicated Temperature — Log	Check Dew Point, CO_2, or CH_4 — Log	Check Atmosphere Gas Flows — Log	Standardize Temperature Control Instrumentation — Log	Calibrate Thermocouple Change as Required — Log	Atmosphere Purging Req'd When Process Gas Changed	Carbon Potential Check — Log	Check Furnace Pressure, Air or Gas Leaks, Radiant Tubes, etc. — Log	Check Condition of Quench Oil — Log	Check Air/Gas Ratio, Refrig. Temp., Cooling Water Temp., and Pressures — Log	Analysis of Gas Atmosphere — Log	Check Time in Continuous-Type Furnace — Log	Check Time at Heat in Batch-Type Furnace — Log	Temperature of Quench Medium — Log	Quench Medium Circulation — Log	Visual Check of Furnace Loading — Log
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
8 Annealing furnace atmosphere — batch type	Each charge by cyle	Each charge	Each charge	Daily	Calibrat. unnecessary; change only as req'd	Each charge (controlled by dew point)	FSTDC	FSTDC	NA	NA	NA	NA	Each charge by cycle	NA	NA	NA
9 Tempering and stress relieving furnaces	Each lot or batch	NA	NA	Daily	Monthly	NA	NA	NA	NA	NA	NA	Monthly	Each lot or batch	NA	NA	NA
10 Endothermic gas generator	Start of each shift	4 hr	NA	Daily	Monthly	NA	NA	NA	NA	Daily	FSTDC	NA	NA	NA	NA	NA
11 Nitrogen generators	NA	FSTDC	NA	NA	NA	NA	NA	NA	NA	8 hr	FSTDC	NA	NA	NA	NA	NA
12 Ammonia dissociators	Start of each shift	FSTDC	4 hr	Daily	Monthly	NA	NA	NA	NA	NA	FSTDC	NA	NA	NA	NA	NA

GENERAL NOTE:
Legend: NA — not applicable
FSTDC — frequency sufficient to demonstrate control

NOTES:
(1) This check may be omitted if furnace is under automatic atmosphere control; however, a daily calibration check of atmosphere instrument should be made and logged.
(2) When process gas in a furnace is changed (for example, carburizing to hardening), the correct furnace atmosphere required for the new process should be fully developed within the furnace as established by CO_2 or dew point analysis before the new production parts can be started in the furnace. When changing over a furnace atmosphere from one utilizing ammonia to one in which no ammonia is to be used, the ammonia supply line should be *physically disconnected* from the furnace (to avoid any possibility of shut-off valve leakage).

TABLE C SUGGESTED EQUIPMENT AND PROCESSING CONTROL CHECKS

Finishing Operation	Control Check																	
	Analysis of Alkali Clean Tank — Log	Analysis of Acid Clean Tank — Log	Analysis of Cyanide Rinse — Log	Ratio of Soluble Oil to Water — Log	Analysis of Chromic Acid Rinse — Log	Analysis of Reverse Current Alkali Solution — Log	Plating Bath Analysis — Log	Analysis of Chromate Finish Solution — Log	Chemical Additives to All Solution Baths — Log	Filtering of Baths — Log	Check for Proper Elec. Contact — Log	Plating Bath Temperatures — Log	Clean Rinse Tanks — Log	Clean and Recharge All Process Tanks — Log	Time Interval Before Baking, Time and Temp. of Bake — Log	Analysis of Lubrication Bath — Log	Coating Weight and/or Thickness — Log	Salt Spray Test — Log
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Zinc electrodeposited plating	Daily	Daily	FSTDC	NA	NA	Daily	Daily	Daily	As added to each tank	FSTDC	Daily	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (1)]	2 pieces per line per shift
2 Cadmium electrodeposited plating	Daily	Daily	FSTDC	NA	NA	NA	Daily	Daily	As added to each tank	FSTDC	Daily	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (1)]	2 pieces per line per shift
3 Copper electrodeposited plating	Daily	Daily	NA	NA	NA	Every 2 days	Daily	NA	As added to each tank	FSTDC	Daily	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (1)]	NA
4 Nickel electrodeposited plating	NA	Daily	NA	NA	NA	NA	Daily	NA	As added to each tank	FSTDC	Daily	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (1)]	WA 2 pieces per line per shift
5 Chrome electrodeposited plating	NA	Daily	NA	NA	NA	NA	Daily	NA	As added to each tank	FSTDC	Daily	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (1)]	WA 2 pieces per line per shift
6 Zinc phosphate coating	Daily	Daily	NA	Daily	Daily	NA	Each shift	NA	As added to each tank	NA	NA	Daily	FSTDC	As req'd based on analysis	WA each lot	NA	[Note (2)]	2 pieces per line per shift
7 Post plating lubrication	NA	NA	NA	NA	NA	NA	NA	NA	As added to each tank	NA	NA	Daily	NA	As req'd based on analysis	NA	Daily	NA	NA

GENERAL NOTE:
Legend: WA — when applicable
NA — not applicable
FSTDC — frequency sufficient to demonstrate control

NOTES:
(1) For hand line operations, one piece per barrel; for automatic line operations, five pieces at start of each lot.
(2) Check daily coating weight only.

APPENDIX II
ORDERING INFORMATION

(This Appendix is not part of ASME/ANSI B18.18.4M-1987, and is included here for information purposes only.)

Specifications

(*a*) Number and title of document
(*b*) Exceptions

Example

(*a*) ASME/ANSI B18.18.4M, Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications.

(*b*) Thread acceptability shall be based on the thread acceptability paragraph in ANSI/ASME B1.3M with an A inspection level.

AMERICAN NATIONAL STANDARDS FOR BOLTS, NUTS, RIVETS, SCREWS, WASHERS, AND SIMILAR FASTENERS

Small Solid Rivets B18.1.1-1972 (R1983)
Large Rivets B18.1.2-1972 (R1983)
Metric Small Solid Rivets B18.1.3M-1983
Square and Hex Bolts and Screws — Inch Series B18.2.1-1981
Square and Hex Nuts B18.2.2-1972 (R1983)
Metric Hex Cap Screws B18.2.3.1M-1979
Metric Formed Hex Screws B18.2.3.2M-1979
Metric Heavy Hex Screws B18.2.3.3M-1979
Metric Hex Flange Screws B18.2.3.4M-1984
Metric Hex Bolts B18.2.3.5M-1979
Metric Heavy Hex Bolts B18.2.3.6M-1979
Metric Heavy Hex Structural Bolts B18.2.3.7M-1979
Metric Hex Lag Screws B18.2.3.8M-1981
Metric Heavy Hex Flange Screws B18.2.3.9M-1984
Metric Hex Nuts, Style 1 . . . . . B18.2.4.1M-1979
Metric Hex Nuts, Style 2 . . . . . B18.2.4.2M-1979
Metric Slotted Hex Nuts B18.2.4.3M-1979
Metric Hex Flange Nuts B18.2.4.4M-1982
Metric Hex Jam Nuts B18.2.4.5M-1979
Metric Heavy Hex Nuts B18.2.4.6M-1979
Socket Cap, Shoulder and Set Screws (Inch Series) B18.3-1986
Socket Head Cap Screws (Metric Series) B18.3.1M-1986
Metric Series Hexagon Keys and Bits B18.3.2M-1979 (R1986)
Hexagon Socket Head Shoulder Screws (Metric Series) B18.3.3M-1986
Hexagon Socket Button Head Cap Screws (Metric Series) B18.3.4M-1986
Hexagon Socket Flat Countersunk Head Cap Screws (Metric Series) B18.3.5M-1986
Metric Series Socket Set Screws B18.3.6M-1986
Round Head Bolts (Inch Series) B18.5-1978
Metric Round Head Short Square Neck Bolts B18.5.2.1M-1981
Metric Round Head Square Neck Bolts B18.5.2.2M-1982
Wood Screws B18.6.1-1981
Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws B18.6.2-1972 (R1983)
Machine Screws and Machine Screw Nuts B18.6.3-1972 (R1983)
Metric Thread Forming and Thread Cutting Tapping Screws B18.6.5M-1986
Metric Machine Screws B18.6.7M-1985
Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series) B18.6.4-1981
General Purpose Semi-Tubular Rivets, Full Tubular Rivets, Split Rivets and Rivet Caps B18.7-1972 (R1980)
Metric General Purpose Semi-Tubular Rivets B18.7.1M-1984
Clevis Pins and Cotter Pins B18.8.1-1972 (R1983)
Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series) B18.8.2-1978
Plow Bolts B18.9-1958 (R1977)
Track Bolts and Nuts B18.10-1982
Miniature Screws B18.11-1961 (R1983)
Glossary of Terms for Mechanical Fasteners B18.12-1962 (R1981)
Screw and Washer Assemblies — Sems B18.13-1965 (R1983)
Forged Eyebolts B18.15-1985
Mechanical and Performance Requirements for Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts B18.16.1M-1979 (R1986)
Torque-Tension Test Requirements for Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts B18.16.2M-1979 (R1986)
Dimensional Requirements for Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts B18.16.3M-1982
Wing Nuts, Thumb Screws, and Wing Screws B18.17-1968 (R1983)
Inspection and Quality Assurance for General Purpose Fasteners B18.18.1M-1987
Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners B18.18.2M-1987
Inspection and Quality Assurance for Special Purpose Fasteners B18.18.3M-1987
Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications B18.18.4M-1987
Lock Washers B18.21.1-1972 (R1983)
Metric Plain Washers B18.22M-1981
Plain Washers B18.22.1-1965 (R1981)
Beveled Washers B18.23.1-1967 (R1975)

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