

INCH POUND

MIL-STD-866C (USAF)

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SUPERSEDING

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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

GRINDING OF CHROME PLATED STEEL AND STEEL PARTS
HEAT TREATED TO 180,000 PSI OR OVER



This document is inactive for new design.

AMSC: N/A

AREA: MFFP

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FOREWORD

1. This military standard is approved for use by 309MXSG/MXRL, Department of the Air Force, and is available for use by all departments and agencies of the Department of Defense.
2. This standard establishes the requirements for grinding of martensitic high strength steel, heat treated to 180,000 pounds per square inch, ultimate tensile strength and above and for grinding of chromium plating applied to such steel when such parts are intended for use in components for man-rated flight hardware.
3. Beneficial comments, recommendations, additions, deletions, and any pertinent data, which may be of use in improving this document, should be addressed to 309MXSG/MXRL, Hill AFB, UT 84056-2609 or 309MXSG/MXRL@hill.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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1. SCOPE

1.1 Scope. This standard establishes the requirements for grinding of martensitic high strength steel heat-treated to 180,000 pounds per square inch (psi), ultimate tensile strength (uts) and above, and the grinding of chromium plating applied to such high strength steel, when such parts are intended for use in components for man-rated flight hardware.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 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 the specified requirements of the documents cited in this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-867
(Inactive)

Temper Etch Inspection

(Copies of these documents are available online at <http://assist.daps.dla.mil/online/start/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government standards and publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE-AMS-H-6875

Heat Treatment of Steel Raw Materials

SAE-AMS-2644

Inspection Materials, Penetrant

(Copies of these documents are available online at www.sae.org or from the Society of Automotive Engineers International, 400 Commonwealth Drive, Warrendale, PA 15096-1001.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E-1444

Standard Practices for Magnetic
Particle Inspection

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ASTM E-1417

Practice for Liquid Penetrant Examination

(Copies of these documents are available at www.astm.org or ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 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 Not applicable.

4. GENERAL REQUIREMENTS

4.1 Material and equipment

4.1.1 Materials.

a. Grinding Coolant. A suitable coolant shall be used, which does not have an adverse effect on the part being ground. Re-circulated coolants shall be either gravity separated or contaminants or continuously filtered to minimize re-cycling grinding residue. A coolant nozzle sufficiently wide to flood the entire width of the wheel interface area shall be used.

b. Grinding wheel. Grinding wheels shall be labeled or numbered as to abrasive type, grit size, grade, structure, bond type, and maximum operating speed. Unless otherwise specified, aluminum oxide vitrified bonded, grinding wheels shall be used.

4.1.2 Equipment.

a. Grinding equipment. Grinding equipment shall be capable of maintaining grinding speed, work speed (spindle or traverse), cross feed and down feed in increments necessary to avoid surface degradation of the part. Provisions shall be made to supply a constant application of coolant to the working surface of the wheel.

b. Ovens. Ovens used for baking and stress relieving shall be controlled in accordance with SAE-AMS-H-6875.

4.2 Processing.

4.2.1 Grinding process. The grinding process shall be performed in accordance with *Table I* to result in metallurgical sound parts. All feeds, speeds, and stock removal parameters are actual and not necessarily machine or indicator readings.

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TABLE 1. Grinding parameters.

Variables such as part configuration and the particular operation to be performed may require compromise in the selection of deviation from the parameters listed in the following chart. These parameters do not preclude the need for experimentation and selection of specific values to be reflected in in-house documents.

GRINDING METHOD	RECOMMENDED GRINDING WHEEL CHARACTERISTICS		MAX WHEEL SPEEDS S.F.M.	WORK SPEED RANGE S.F.M.	CROSS FEED OR TRANSVERSE WHEEL WIDTH	MAXIMUM DOWN (IN) FEED		MIN. STOCK LEFT FOR FINISH
	GRIT Al ₂ O ₃	GRADE STRUCTURE**				ROUGH	FINISH	
SURFACE (FLAT) BARE STEEL	46/80	G - K 6 - 12	6500	30 - 100	1/8 - 1/2	.001"	.0005"	.003"
CYLINDRICAL BARE STEEL	46/80	G - K 6 - 12	6500	30 - 100	1/8 - 1/4*	.001"	.0005"	.003"
INTERNAL BARE STEEL	46/80	G - K 6 - 12	6500	30 - 200	1/8 - 1/4*	.0005"	.0002"	.001"
SURFACE (FLAT) CHROME PLATED	46/90	G - K 6 - 12	6500	30 - 200	1/8 - 1/4	.0005"	.0002"	.001"
CYLINDRICAL CHROME PLATED	46/120	G - K 6 - 12	6500	30 - 200	1/8 - 1/4*	.0005"	.0002"	.001"
INTERNAL CHROME	46/120	G - K 6 - 12	12000	30 - 300	1/8 - 1/4	.0005"	.0002"	.001"

THESE CHARACTERISTICS REFER TO THE INDUSTRY STANDARD DESIGNATORS FOR GRINDING WHEELS.

Examples: 32** Type Abrasive A Abrasive Grain Size 100 H Grade Structure 9** Bond Type 30** Bond Type

* Per Part Revolution

** May vary with manufacturer (code symbol not standardized)

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4.2.2 Cleaning. Protective coatings and other foreign materials shall be removed from parts prior to grinding to preclude contamination of coolant and wheels. Coolant and grinding residuals that have a deleterious effect on the part shall be removed after grinding. Cleaning materials shall not corrode or otherwise degrade the surfaces of the part. Where process delay time is such that corrosion might occur, parts shall be adequately protected after cleaning.

5. DETAILED REQUIREMENTS

5.1 General. The contractor shall maintain in-house documents designed to establish control of inspection procedures to assure that parts produced are within acceptable design criteria. The contractor shall be able to demonstrate that he is applying such controls.

5.2 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specific herein. Except as otherwise specified in the contract, the contractor may utilize his own or any other facilities suitable for performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this standard where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

5.3 Inspection requirements and procedures.

5.3.1 Ground surface inspection. All ground surfaces shall be visually inspected without magnification for evidence of overheating, cracks, tears and cold flow. Ground surfaces shall be checked for surface finish.

5.3.2 Magnetic particle inspection. All ground surfaces (excluding ground holes) shall be inspected by magnetic particle in accordance with ASME E-1444 or approved alternate procedure (see 5.3.4).

5.3.3 Nital etch inspection. All ground surfaces (excluding ground holes and chromium plate) shall be inspected by nital etches in accordance with MIL-STD-867 or approved alternated procedure (see 5.3.4 and 5.3.5). Water may be used as an alternate solvent for the nital etch solution. After nital etching, parts shall be baked at 375°F for four (4) hours.

5.3.4 Ground holes. All ground holes shall be treated as ground surfaces unless engineering requirements, size, shape or location make magnetic particle or nital etch impossible or impracticable. When ground holes are not inspectable by magnetic particles or nital etch, approved alternate procedures or parametric study data shall be used to establish that the surface has not been degraded (see 5.4.2).

5.3.5 Chromium plate. After final grinding of chromium plated parts, the parts shall be inspected for grinding – induced damage to the chromium plate and base metal as well as base metal cracking. Penetrant inspection shall be used for the detection of plate and base metal damage and magnetic particle inspection will be used for the detection of base metal cracking for chromium plate thicknesses less than 0.004 inch per surface, penetrant inspection shall be used for detection of plate and base metal

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damage. Parts shall be stripped if evidence of plate or base metal damage is found during the penetrant inspection. Re-inspect base metal in accordance with 5.3.2 and 5.3.3.

5.3.6 Penetrant inspection. Penetrant materials with SAE-AMS-2644, Level 3 sensitivity shall be used in accordance with ASTM E1417. Penetrant, emulsifier (if used) and developer dwell time shall be used that produce light background fluorescence from the chromium plate micro-cracking. Anodic etching of the chromium plate (0.0001 inch plate removal) is recommended as the preparation of the surface for inspection. Indications of damage include spiraling, chattering and coarse “mud-flat” cracking. The inspection procedures developed shall include photographs for inspection reference of all rejectable conditions as well as acceptable conditions.

5.3.7 Magnetic particle inspection. Wet, continuous, fluorescent methods in accordance with ASTM E-1444 shall be used. Magnetizing currents and methods shall be used that provide adequate field strength in the part, yet do not cause burning. Because of the poor adherence of particle indications to the smooth chromium surface, the procedures developed shall minimize the chances of indication “wash-off.”

5.4 Grinding practices. The grinding practices set forth in these paragraphs are recommended for optimum results under variety of, but not all, conditions. Such practices are not intended to restrict the contractor from developing technology or methodology other than that described herein provided the resulting part meets prescribed criteria.

5.4.1 In-house control document. In-house control documents are those documents used by each contractor to control part configuration and quality. They include engineering drawings, engineering process specifications, manufacturing process specifications, inspection procedures and any other documents designed to control manufacturing and inspection techniques. Such documents are to be based upon proven techniques derived from parametric studies, experience, and tests.

5.4.2 Parametric studies. Parametric studies refer to the techniques used by the contractor for the purpose of the initial establishment of grinding practices and inspection procedures that will consistently produce parts within the design criteria. The equipment, grinding wheels, coolant, material, heat treat, and prior processing, feeds, speeds, shall simulate the production techniques used as closely as is reasonably possible. The number of samples used shall be a matter of the contractor's judgment but shall be sufficient to prove the practice and inspection procedure.

5.4.3 Grinding practice guidelines. Grinding practices include control of all the following factors. Lack of control or improper selection of any of these factors can cause decrease in structural integrity.

5.4.3.1 Grinding equipment. The grinding equipment shall be capable of operating in the required wheel speed, feed rate, and work speed ranges, and shall have adequate horsepower to maintain required wheel speed and shall be in good mechanical condition (spindle and bearings).

5.4.3.2 Grinding wheel characteristics. Grinding wheel (normally friable or semi-friable aluminum oxide) in a relatively soft grade normal to open structure, and

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vitrified bond are recommended in the largest grit size that will produce the required finish. Hard, dense wheels in fine grit size are most likely to cause problems and their use should be avoided. This same philosophy also applies to coated abrasives.

5.4.3.3 Coolants. Copious quantity should be delivered to the part at the working surface of the grinding wheel. Dry grinding should be avoided whenever possible.

5.4.3.4 Wheel dressing. Wheels should be dressed frequently and before the start of final grinding passes to prevent grinding with a dull or loaded wheel. Dressing should produce a sharp, open wheel.

5.4.3.5 Wheel speed. Excessive wheel speeds may cause overheating and damage to the part and should be avoided.

5.4.3.6 Work speed. Generally, high work speeds are recommended. A rotating wheel (non-traversing) should never contact a stationary part.

5.4.3.7 Cross-feed. Reduced cross-feed rates are recommended for finish grinding.

5.4.3.8 Down-feed/in-feed. Reduced feed rates and spark-out are recommended for finish grinding. When plunge grinding, allowing each down-feed/in-feed to spark-out, may be beneficial.

5.4.3.9 Grinding with the side of the wheel. Extreme caution should be exercised when grinding with the side of the wheel. Large contact areas and heat input can result. This practice should be avoided if at all possible.

5.4.3.10 Chrome plate. Caution should be exercised when grinding chrome plate since it is possible to cause damage in the substrate. Damage is difficult to detect through the chrome plate.

6. NOTES

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

6.1 Intended use. The intent of this document is to establish requirements for controls to prevent overheating, cracking, and other metallurgical change, which decrease structural integrity of parts.

6.2 Subject term (key word) listing.

Grinding
Heat-treat
Inspection

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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CONCLUDING MATERIAL

Custodian:
Air Force – 70

Preparing Activity:
Air Force – 70

(Project MFFP-0724-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using ASSIST Online database at <http://assist.daps.dla.mil>.