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MIL-STD-866B(USAF)
28 June 1978

SUPERSEDING
MIL-STD-866A(USAF)
31 December 1970 and
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6 May 1976

MILITARY STANDARD

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

FSC MFFP

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DEPARTMENT OF THE AIR FORCE

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

MIL-STD-866B(USAF)

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2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Air Force Materials Laboratory, MXA, Wright-Patterson Air Force Base, Ohio 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWORD

The purpose of this standard is to establish the requirements for grinding of martensitic high strength steel, heat-treated to 180,000 pounds per square inch, ultimate tensile strength 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.

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MILITARY STANDARD

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

1. SCOPE

1.1 Purpose. This standard covers 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.

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

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-I-6866	Inspection, Penetrant Method of
MIL-I-6868	Inspection Process, Magnetic Particles
MIL-H-6875	Heat Treatment of Steels (Aircraft Practice), Process For
MIL-I-25135	Inspection Material, Penetrant

STANDARDS

MILITARY

MIL-STD-867	Temper Etch Inspection

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(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS (Not Applicable)

4. GENERAL REQUIREMENTS

4.1 Equipment and supplies

4.1.1 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.

4.1.2 Grinding wheels. 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.

4.1.3 Grinding coolants. A suitable coolant shall be used which does not have an adverse effect on the part being ground. Recirculated coolants shall be either gravity separated or contaminants or continuously filtered to minimize recycling grinding residue. A coolant nozzle sufficiently wide to flood the entire width of the wheel interface area shall be used.

4.2 Ovens. Ovens used for baking and stress relieving shall be controlled in accordance with MIL-H-6875.

4.3 Processing

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

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TABLE I. 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	WORK SPEED RANGE	CROSS FEED OR TRANSVERSE	MAXIMUM DOWN (IN) FEED		MIN. STOCK LEFT FOR FINISH
	GRIT Al_2O_3	GRADE	** STRUCTURE	S.F.M.	S.F.M.	WHEEL WIDTH	ROUGH	FINISH	(PER SURFACE)
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**	A	100	H	9**	V	BG**
	Type Abrasive	Abrasive	Grain Size	Grade	Structure	Bond (Vitrified)	Bond Type

* Per Part Revolution

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

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4.3.2 Cleaning. Protective coatings and other foreign materials shall be removed from parts prior to grinding to preclude contamination of coolant and wheels. Coolants 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 specified herein. Except as otherwise specified in the contract, the contractor may utilize his own or any other facilities suitable for the 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 MIL-I-6868 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 etch 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 hours.

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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 6.3).

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. For chromium plate thicknesses greater than 0.004 inch per surface, penetrant inspection shall be used for detection of plate and base metal damage. Parts shall be stripped if evidence of plate or base metal damage is found during the penetrant inspection. Reinspect base metal in accordance with 5.3.2 and 5.3.3.

5.3.6 Penetrant inspection. Penetrant materials with a MIL-I-25135, Group VI sensitivity shall be used in accordance with MIL-I-6866. Penetrant, emulsifier (if used), and developer dwell time shall be used that produce a light background fluorescense from the chromium plate micro-cracking. Anodic etching of the chromium plate (0.0001 inch plate removal) is recommended as of 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 MIL-I-6868 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".

6. NOTES

6.1 Intended use. The procedures set forth in this section for grinding practices are recommended for optimum results under a variety of, but not all, conditions. Such procedures are not intended to restrict the contractor from developing technology or methodology other than described herein provided the resulting part meets prescribed criteria.

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6.2 In-house control documents. 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.

6.3 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 and 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.

6.4 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.

6.4.1 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).

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

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

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

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

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

6.4.7 Crossfeed. Reduced crossfeed rates are recommended for finish grinding.

6.4.8 Downfeed/infeed. Reduced feed rates and sparkout are recommended for finish grinding. When plunge grinding, allowing each downfeed/infeed to sparkout, may be beneficial.

6.4.9 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.

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

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Air Force - 11, 99

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