AEROSPACE MATERIAL SPECIFICATION

AMS2453™

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Low Stress Grinding of Steel Parts Heat Treated to 180 ksi or Over, and Low Stress Grinding of Chrome Plating Applied to Steel Parts Heat Treated to 180 ksi or Over

RATIONALE

AMS2453 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Purpose

The purpose of this specification is to establish requirements of a grinding method and to provide grinding parameters that will eliminate or minimize overheating, cracking, high residual tensile stresses, and/or other metallurgical changes that decrease structural integrity of steel parts or chrome plated steel parts (See 8.2). This standard establishes requirements for low stress grinding of martensitic high strength steel heat-treated to 180 ksi (1241 MPa) minimum ultimate tensile strength (UTS) and above, and requirements for low stress grinding of chromium plating applied to such high strength steel.

1.2 Application

This process has been used typically to grind chrome plating on high strength steel and high strength steel parts heat treated to 180 ksi (1241 MPa) ultimate tensile strength and above for applications requiring wear, heat, and corrosion resistance or dimensional restoration, such as aircraft landing gear and hydraulic actuator components. However, usage is not limited to such applications (See 8.3).

1.3 Safety – Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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For more information on this standard, visit
https://www.sae.org/standards/content/AMS2453

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2440 Inspection of Ground, Chromium Plated Steel Parts

AMS2442 Magnetic Particle Acceptance Criteria for Parts

AMS2644 Inspection Materials, Penetrant

AMS2649 Etch Inspection of High Strength Steel Parts

AMS2759, /1, /2, /9, /11 Heat Treatment of Steel Parts

ARP4462 Barkhausen Noise Inspection for Detecting Grinding Burns in High Strength Steel Parts

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 1417 Liquid Penetrant Testing

ASTM E 1444 Magnetic Particle Testing

ASTM B 214 Sieve Analysis of Metal Powders (See 8.5.7)

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI B7.1 Safety Requirements for the Use, Care and Protection of Abrasive Wheels

ANSI B74.13 Markings for Identifying Grinding Wheels and Other Bonded Abrasives

2.4 Department of Defense Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-867 Temper Etch Inspection

3. TECHNICAL REQUIREMENTS

3.1 Materials and Equipment

3.1.1 Materials

3.1.1.1 Cutting Fluids (Coolants)

A suitable cutting fluid that does not have an adverse effect on the part being ground shall be used.

3.1.1.2 Grinding Wheels

Grinding wheels shall be labeled with the complete grinding wheel specification including abrasive type, grit size, grade, structure, bond type, and maximum operating speed in accordance with ANSI B74.13. Unless otherwise specified, aluminum oxide vitrified bonded, grinding wheels shall be used. Care and protection of grinding wheels, including proper storage, handling and mounting, shall be in accordance with ANSI B7.1.

3.1.2 Equipment

3.1.2.1 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 cutting fluid (coolant) to the working surface of the wheel at the grinding zone interface. Unless otherwise specified, a filter mesh size of 40 microns or better shall be used. A coolant nozzle sufficiently wide to flood the entire width of the grinding wheel shall be used. Unless otherwise specified, coolant supply equipment for grinding shall be capable of continuously supplying coolant to the work piece at a minimum rate of 2 gallons per minute per inch (4 liters per minute per 25.4 mm) of wheel width. The equipment shall be capable of gravity separation of contaminants from coolant before recirculation, or a suitable continuous filter shall be provided to minimize recirculation of grinding residue and swarf. Coolant supply flow rates less than the minimum specified above shall be acceptable for use provided the requirements of 3.4 are met.

3.1.2.2 Furnaces

Furnaces (ovens) shall be controlled in accordance with AMS2759 as applicable when used for baking (/9) and stress relieving (/2 or /1 or /11).

3.2 Processing

3.2.1 Cleaning

Protective coatings (other than chrome plating) and other foreign materials shall be removed from parts prior to grinding to preclude contamination of cutting fluids and wheels. Cutting fluids (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 surface of the part. Where process delay time is such that corrosion might occur, parts shall be adequately protected after cleaning.

3.2.2 Grinding Process Control

3.2.2.1 For a list of representative alloys that require low stress grinding see Table 1. Parts made from steels other than those specified in Table 1, or parts heat treated to less than 180 ksi (i.e., AISI 4130 HT to 125 ksi (862 MPa)) may be ground in accordance with the applicable requirements using processing parameters listed in Tables 2 or 3, or other processing parameters recommended by the material producer, unless otherwise specified by purchaser. The grinding process shall be performed in accordance with Tables 2 or 3, as applicable, and Figure 1 or equivalent, to result in metallurgically sound parts. All feeds, speeds, and stock removal parameters are actual and not necessarily machine or indicator readings (See 8.4.5). Prior to grinding, clean all surfaces to be ground in accordance with 3.2.1. Prior to grinding, locate high spots on chrome plating in order to avoid accidental or excessive infeed during the grinding process. Caution should be exercised when grinding chrome plate since it is possible to cause damage in the substrate (See 8.2). Damage is difficult to detect through the chrome plate.

3.2.2.2 The processor shall maintain in-house documents designed to establish control of the grinding process and inspection procedures used (grinding process control sheets, part-specific inspection technique sheets, etc.) to assure that parts produced are within acceptable design criteria. Grinding process control shall be documented and shall be used for processing of parts. Grinding Process Control Sheet (Figure 1) provides an example for process control documentation. The processor shall be able to demonstrate that they are applying such controls. In-house control documents are those documents used by each processor to control part configuration and quality. They include engineering drawings, engineering process specifications, process orders, manufacturing process specifications, inspection procedures, grinding process control sheets, part-specific inspection technique sheets, and any other documents designed to control manufacturing and inspection techniques. Such documents are to be based upon proven techniques (See 3.4).

3.2.2.3 Practices defined in this specification are not intended to restrict the processor from developing technology or methodology other than described herein provided the resulting part meets prescribed criteria (See 3.4) when approved by Cognizant Engineering Organization.

3.2.2.4 Balance the grinding wheel assembly at the time the wheel is mounted. If the grinding wheel remains on the machine arbor it will not need to be balanced again. If the grinding wheel is removed from the machine/arbor it shall be re-balanced at the next mounting. True the wheel face so that it is geometrically correct for the application and runs concentric with the centerline of the arbor assembly.

3.2.2.5 Flood the entire width of the grinding wheel at the wheel-work interface with a clean continuous flow of cutting fluid. Coolant concentration shall be maintained in accordance with the manufacturer's instructions. A coolant nozzle sufficiently wide to flood the entire width of the grinding wheel shall be used. Unless otherwise specified, minimum cutting fluid flow rate shall be 2 gallons per minute per inch (7.6 liters per minute per 25.4 mm) of wheel width. Cutting fluid shall be liberally applied by flooding the wheel surface during all grinding passes, including the final "clean-up" or "spark out" passes. Never use a dry "spark out" pass during grinding of any heat treated steel or chromium plated steel surface. Coolant supply flow rates less than the minimum specified above shall be acceptable for use provided the requirements of 3.4 are met.

3.2.2.6 Wheel Dressing

Dress the grinding wheel as required during use to keep the wheel open with sharp grit exposed to freely cut the work material and to prevent grinding with a dull or "loaded" wheel that causes smearing or glazing of metal and generates a large amount of frictional heat. Dress the wheel at a minimum frequency of 0.010 inch (0.254 mm) maximum of stock removal. Wheels should be dressed frequently and before the start of the final grinding passes to prevent grinding with a dull or loaded wheel. During grinding, constantly observe cutting action of the abrasive wheels. Chatter, smearing, glazing, high part surface temperatures, excessive coolant vaporization, and higher than normal spindle amperage are good indications that grinding wheels require redressing (See 8.4.3).

3.2.2.7 Wheel Speed

During grinding operations, the processor shall not exceed the manufacturer's maximum rated speed for any grinding wheel (refer to ANSI B7.1), or those in accordance with Tables 2 or 3, whichever is less (See 8.4.4). Some precipitation hardened alloys (e.g., Ferrium S53, AerMet 100, AerMet 310, AerMet 340, A-286, Custom 455, Custom 465, MLX-17, AF1410 and others, including the majority of PH stainless grades) may achieve high integrity ground surfaces using wheel speeds other than those listed in Tables 2 or 3 (e.g., 6500 SFPM) and shall be acceptable for use provided it does not exceed the manufacturer's maximum rated speed for the grinding wheel being used and the requirements of 3.4 are met.

3.2.2.8 Work Speed

Work speeds shall be in accordance with Tables 2 or 3, as applicable. A rotating wheel (non-traversing) shall never contact a stationary part.

3.2.2.9 Down-feed/In-feed for Plunge Grinding

When plunge grinding, allowing each down-feed/in-feed of the grinding wheel to spark-out completely is required prior to applying next down-feed/in-feed increment.

3.2.2.10 Grinding With the Side of the Wheel

Grinding of parts with the side of the wheel is prohibited unless authorized in writing by the cognizant engineering organization (See 8.4.7). When grinding with the side of the wheel is authorized, coolant application requirements per 3.2.2.5 shall be applied to the surface area of the side of the grinding wheel being used in contact with the workpiece.

3.3 Inspection Requirements and Procedures

3.3.1 Ground Surface Inspection

All ground surfaces shall be visually inspected without magnification for evidence of overheating (discoloration), cracks, and tears. Ground surfaces shall be checked for surface finish. Specific surface finish requirements shall be specified by the cognizant engineering organization.

3.3.2 Visual Inspection of Chromium Plate

All ground chrome plate shall be visually examined for linear and mud cracking. Cracking in the chrome plate that can be seen with the unaided eye (corrected vision is acceptable) at a distance of 14 to 18 inches (356 to 457 mm) shall be cause for rejection.

3.3.3 Penetrant Inspection of Ground Chromium Plated Surfaces

All ground chrome plated surfaces shall be inspected in accordance with AMS2440.

3.3.4 Rework of Rejected Ground Chrome Plate

If the plated surface is rejected due to abusive grinding indications, the surface may be polished using 400 grit or finer silicon carbide abrasive paper, cloth, or aluminum oxide hone. The surface shall be penetrant inspected again following any indication clearing operation(s). If the abusive grinding indications are not repeated, the ground surface is acceptable. Barkhausen Noise Inspection (BNI) per ARP4462 shall be performed to ensure that grinding of the chrome did not cause damage to the base metal.

If the indications are still present the ground chrome plate shall be completely stripped. After stripping, the base metal surface shall be verified to be free of abusive grinding indications and cracks by inspecting in accordance with 3.3.5 and 3.3.6 prior to replating. After chrome plating has been removed, the base metal surface shall pass Barkhausen Noise Inspection per ARP4462 or be re-shot peened prior to replating (See 8.4.8).

3.3.5 Magnetic Particle Inspection

All ground base metal surfaces (except see 3.3.7 for ground holes) shall be inspected by magnetic particle in accordance with ASTM E 1444 or approved alternate procedure. Alternate procedure shall be approved by the cognizant engineering organization. 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. Inspect parts using accept/reject criteria per AMS2442.

3.3.6 Nital Etch Inspection

All quenched and tempered steel (e.g., 4340, 4330V, 9310, 300M, etc.) ground base metal surfaces [excluding ground holes (See 3.3.7), chromium plate and all precipitation hardened alloys (e.g., Ferrium S53, AerMet 100, A-286, Custom 455, MLX-17, etc.) shall be subjected to nital etch inspection in accordance with AMS2649 or approved alternate procedure. Alternate procedure shall be approved by the cognizant engineering organization. After nital etching, parts shall be baked in accordance with AMS2759/9. Inspect using accept/reject criteria per AMS2649.

3.3.7 Ground Holes

Ground holes for the purposes of this specification are considered to be 1/2 inch (12.7 mm) diameter and less. 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 process validation data shall be used to establish that the surface has not been degraded (See 3.4).

3.4 Process Validation Methods

Process Validation Methods refer to the techniques used by the processor for the purpose of the initial establishment of grinding practices and inspection procedures that will consistently produce parts that meet the requirements defined herein. The equipment, grinding wheels, feeds, speeds, cutting fluid application and flow rates, material, heat treat, prior processing, and inspection procedures shall simulate the production techniques. The number of samples used shall be sufficient to prove the grinding practice and inspection procedures consistently produce parts that meet the requirements defined herein.

4. QUALITY ASSURANCE

4.1 Monitoring of the process and examination of the finished items shall meet the requirements of this specification.

4.2 First Article Inspection shall include Barkhausen Noise Inspection for Detecting Grinding Burns in High Strength Steel Parts.

This recommended practice (ARP4462) covers the procedures and method for establishing acceptance criteria when performing Barkhausen noise testing of surface-hardened steel components to detect grinding burns (metallurgical damage caused by over-heating) in bare or chromium-plated parts. All ground surfaces of the First Article Inspection component shall be subjected to Barkhausen Noise Inspection in accordance with ARP4462 or approved alternate procedure. Alternate procedure shall be approved by the cognizant engineering organization (See 8.5.3).

4.3 Process Approval

4.3.1 The process description and control factors shall be documented on a Grinding Process Control Sheet in accordance with Figure 1, or equivalent, prior to commencement of production grinding. The operator shall be knowledgeable of and trained on the potential effects of uncontrolled (abusive) grinding and the training shall be documented.

4.3.2 The processor of parts ground in accordance with this specification shall make no significant change to the process description, or to the materials, processes, or controls referenced in the process description (See Figure 1) unless the change is approved by the cognizant engineering organization. A significant change is one that deviates more than plus or minus ten percent of the approved baseline. A significant change to the approved baseline requires a new Process Control Sheet (Figure 1, or equivalent) and a new First Article Inspection.

4.4 If the results of any inspection fail to meet the specified requirements, the process is nonconforming. No additional parts shall be processed until the process is corrected and new specimens are coated and ground. Results of all tests shall be recorded and when requested, reported. Purchaser shall be notified of all parts ground since the last successful inspection.

4.5 Reports

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, this AMS specification number and its revision letter, part number, lot identification, and quantity.

5. PREPARATION FOR DELIVERY:

5.1 Finish ground parts shall be handled and preserved and packaged to ensure that the required physical characteristics and properties of the ground surfaces are preserved as defined by the purchaser.

5.2 Packages of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

Processor shall include this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts, that have non-compliant surface finishes that do not conform to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES

8.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 Additional information regarding the purpose of low stress grinding

This specification establishes the low stress grinding procedures and requirements necessary to (a) avoid grinding cracks or burns, that can cause catastrophic failure by sudden fracture of a steel part in service, (b) reduce grinding manufacturing losses, (c) grind high strength steels and chromium plate to achieve high integrity ground surfaces and (d) reduce residual stresses in critical or highly loaded components that results in an increased fatigue life (enables a lower value of fatigue debit at the start of service, as compared to the condition of higher residual tensile stresses at the surface imparted by conventional or other grinding methods). Caution should be exercised when grinding chrome plate applied to high strength steel since it is possible to cause damage by sudden overheating in the steel substrate. Damage (e.g., loss of compressive stress from pre-plating shot peening; loss of strength properties from over-tempering or over-aging; forming brittle phase such as untempered martensite – all of these are referred to as “burn” incidents) is difficult to detect through the chrome plate. Avoid use of a rapid or accelerated grinding rate to remove small protruding nodules or “trees” of chrome plating that are often present at the ends of a plated region. Intense thermal heating and a “burn” of the steel near-surface beneath the chrome nodules will occur if the nodules are removed by rapid grinding rate. A local burn area in the steel substrate is subject to crack formation and sudden fracture of the part later in service when operating at normal design stresses. Table 1 provides a representative listing of alloys that require low stress grinding.

TABLE 1 - REPRESENTATIVE LIST OF ALLOYS THAT REQUIRE LOW STRESS GRINDING

Low Alloy High Strength Martensitic Steels and Martensitic Stainless Steels That Require Low Stress Grinding Heat Treated to HRC 40 and above (180 KSI UTS and above)		
AISI 1090	AISI 8630	AISI 9310 (Case Hardened)
AISI 1095	AISI 8740	17-22A (AMS6304)
AISI 4130	300M	Pyrowear® 53 (AMS6308)
AISI 4140	AF 1410	A-286
4330 V (Mod)	AISI 52100	Maraging types 250/280/300
AISI 4340	D6AC	Hy-Tuf
AerMet® 100	PH 13-8Mo®	Nitralloy 135 Mod (Nitrided)
AerMet® 310	15-5PH®	Tool Steels (H-11, D-2, M-50, etc.)
AerMet® 340	17-4PH®	Ferrium® S53™ (AMS5922)
Custom 455®	Custom 465®	MLX-17 (AMS5937)

Aermet, Custom 455, Custom 465 and Pyrowear are registered trade names of Carpenter Technology
Ferrium® is a registered trade name of Questek Innovations LLC
17-4PH, 15-5PH, PH13-8Mo are registered trade names of AK Steel

8.4 Additional Information for the Application of Low Stress Grinding

The low stress grinding procedures of this specification apply when grinding high strength steel parts heat treated to 180 ksi (1241 MPa) ultimate tensile strength and above or chromium plating applied to such high strength steel. This specification covers the special combination of grinding parameters that reduce the heat shock and plastic deformation inherent in grinding operations. The term “low stress grinding” or “LSG” is used to cover all of the considerations necessary for the production of damage-free, high-integrity workpiece surfaces.

8.5 Additional Reference Material on Low Stress Grinding

Low Stress Grinding (For Quality Production), Machinability Data Center, Metcut Research Associates, Inc., 3980 Rosslyn Drive, Cincinnati, OH, 45209. (First Edition 1978. Second Edition 1983).

8.5.1 *The Machining Data Handbook* is a good resource reference for establishing initial machining parameters such as speed, feed, depth of cut, tool material and geometry, cutting fluid and other variables.

8.5.2 Low Stress Grinding (LSG) is a grinding process that utilizes specially selected operating parameters that produce surfaces with high integrity. These surfaces are essentially damage free (no changes in near-surface metallurgical condition caused by overheating the steel) and generally achieve low compressive residual stresses. The “low stress” characterization of LSG has become recognized through long usage (since 1970s) and is associated with the generally compressive, low magnitude, residual stress profiles in contrast with the higher residual tensile stress profiles produced by conventional grinding. Low Stress Grinding produces workpiece surfaces with excellent dimensional tolerances, fine surface finish, a minimum of residual stress and low distortion.

8.5.3 Grinding wheel dressing technique is consistently found to be the parameter with the greatest impact on both fatigue strength and residual stress, being 2 to 3 times more critical than other parameters. The dressing should be frequent and be of a coarse nature to yield good sharpness. Good, sharp cutting action at all times from each grit with no rubbing or plowing is the prime objective. Coarse dressing produces a wheel surface that is open and free cutting. Intense thermal heating can result from grinding with a dull or loaded wheel that causes smearing or glazing of metal due to rubbing or plowing of dull or loaded grits. This intense thermal heating can cause a “burn” event in the steel near-surface (or beneath the chrome plating). In service, a local burn area in the steel substrate is subject to crack formation and sudden fracture of the part later when operating under normal design stresses. Causing a burn by grinding with dull or “loaded” wheels must be prevented by careful attention to avoid a later (in-service), sudden catastrophic failure of the steel part.

8.5.4 Peripheral wheel speed is the second most important parameter influencing fatigue strength. Excessive wheel speeds (higher than those listed in Tables 2 or 3) may cause overheating and damage to the part and should be avoided, especially for quenched and tempered martensitic alloys sensitive to grinding burn (such as 4130, 4140, 4330 V-mod, 4340, 9310, 300M, etc.).

8.5.5 The actual value of the stock removal parameters (i.e., wheel speed, traverse rate, etc.) should be verified on a periodic basis using appropriate calibrated equipment.

8.5.6 Grinding wheel (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. Use of grinding wheels with a structure (also known as density or porosity) of less than 6 should be avoided.

8.5.7 Extreme caution should be exercised when grinding with the side of the wheel. Large contact areas can result in extreme heat input. This practice should be avoided if at all possible to prevent degradation of properties of the steel in the near-surface zone (See 8.2). Refer to ANSI B7.1 for safety requirements for the use of grinding wheels.

8.5.8 If BNI is not used to detect possible shot peen stress relaxation due to thermal input from grinding, then re-shot peening is required prior to re-plating. The grinding that forms the surface of the part might not be sufficient to cause nital etch to reveal over-tempering, but the thermal input from grinding can be high enough to reduce the compressive effects from shot peening.

8.6 Terms used in AMS are clarified in ARP1917 and as follows:

8.6.1 Balance (Dynamic)

Dynamic balance is the balancing of the complete rotating assembly; grinding wheel, mounting arbor, and the machine spindle. Depending on the balancing machine, the balance condition is measured and corrected at wheel speed.

8.6.2 Balance (Static)

Static balance is the balance of the grinding wheel mounted on an arbor, typically balanced on a pair of knife-edges.

8.6.3 Barkhausen Noise (“Rollscan”) Inspection (BNI)

Barkhausen noise inspection detects changes in magnetic domains within the material when subjected to an alternating magnetic field, applied by a probe at the surface. This technique is very sensitive to localized changes in microstructure and residual stress gradients. BNI is primarily used for nondestructive testing of heat treated, high strength low-alloy steel parts that have been ground, in accordance with MIL-STD-866, commercial standard, or this specification, before or after chromium plating. This test method may be used as an independent test or to confirm grinding damage detected in accordance with AMS2440 (Inspection of Ground, Chromium Plated Steel Parts) or MIL-STD-867/AMS2649 (Temper Etch Inspection) of bare unplated components.

8.6.4 Coolant

Coolant is a fluid that is directed onto the workpiece and tool to dissipate heat, to provide lubrication for the cutting process (machining process), and to carry away chips and debris from the cutting zone. Coolant is the industry standard term used to describe water-based cutting fluids. The coolant (cutting fluid) not only cools; it also lubricates and washes away chips and debris.

8.6.5 Cutting Fluid

Cutting fluid is the fluid used to cool, lubricate, and wash clean a machining process. Cutting fluids may be oils, soluble oils, or water-based synthetic. Oil based products are commonly referred to as cutting fluids. The industry standard and widely accepted term commonly used to describe water-based cutting fluids is coolant.

8.6.6 Dressing

Dressing is the process of removing bond material from around the cutting grains or diamonds in order to expose new, sharp cutting edges and to provide chip clearance for the material removal process.

8.6.7 Grade

The grade of a grinding wheel usually refers to the hardness of the bond system. This is determined by the size, type, and amount of filler materials incorporated in the plastic binder material. For the standard code for grinding wheel grades refer to ANSI B74.13.

8.6.8 Grain Size

The grain size refers to a number that corresponds to the U.S. Standard wire mesh size screen used for sizing the abrasive grain. This size is also defined by average particle diameter in accordance with ASTM B 214.

8.6.9 Grit Size

Another term for abrasive grain size.

8.6.10 High Strength Steel

The term “high strength steel” as used in this specification includes low alloy steels, alloy steels, carburizing steels, and tool steels heat treated to an ultimate tensile strength of 180 ksi or higher.

8.6.11 High Strength Stainless Steels

The term “high strength stainless steel,” as used in this specification, covers all of the 400 series martensitic stainless steels and all of the precipitation hardening stainless steels, e.g., Type 15-5PH, 17-4PH and PH13-8Mo.

8.6.12 Infeed

The infeed or down-feed is the feed motion of the grinding wheel into the workpiece.

8.6.13 Low Stress Grinding (LSG)

A special combination of grinding parameters that reduces the heat shock and plastic deformation inherent in grinding operations and promotes the production of defect-free, high-integrity workpiece surfaces. LSG minimizes metallurgical change in the near-surface of the part that could be caused from sudden heating above critical temperatures of the hardening heat treatment or of detrimental changes to the controlled residual stress pattern (e.g., shot peened condition underneath chrome plating) imparted by conventional or other grinding methods.

8.6.14 Low Stressed Surface

A low stressed surface is one containing a residual stress less than 20 ksi (138 MPa) or 10% of the yield strength, whichever is lower, at depths greater than 0.001 inch (0.025 mm) below the surface.

8.6.15 Residual Stress

Residual stress is defined as those stresses that remain in a material after all externally applied stresses or influences have been removed.

8.6.16 Spark-out

This is the grinding of a workpiece at the end of the stock removal cycle without engaging any further downfeed (infeed). The grinding forces are allowed to subside with time, ensuring a precision surface.