JOHN DEERE

John Deere Standard

APPROVED FOR SUPPLIER DISTRIBUTION

JDV 22

Quality Requirements for Induction Hardened Steel and Cast Iron Components

Table of Contents

List of Tables

List of Figures

1 Scope

1.1 JDV 22 covers specifications and methods for determining the quality and acceptability of induction heated and quenched steel or cast iron components. JDV 22 applies to components manufactured by John Deere and to components purchased from external suppliers.

1.2 Specifically, JDV 22 applies to processes that heat by induction and quench as defined in JDV 2. The quality requirements included are: surface hardness, hardness depth, microstructure, general metallurgical and process considerations, and quality control. The documents, standards, and testing methods to be followed are referenced. Any specific part drawing requirements supersede the specifications described in this standard.

1.3 The processes described in this standard may involve hazardous materials, operations, and equipment. This standard does not purport to address any of the safety issues associated with its use. It is the responsibility of the user to establish appropriate safety, health, and environment practices and to determine the applicability of any regulatory limitations.

2 Terms and Definitions

2.1 Banding

The segregation of elements (for example carbon and manganese) in steel that produces a microstructure with parallel bands of ferrite and pearlite. This may result in non-uniform hardness patterns after induction hardening. See JDV 22X5 for photographic examples.

2.2 Hardness Abbreviations

The following are hardness notation abbreviations:

- HRC is hardness Rockwell C
- HBW is hardness Brinell
- HV is hardness Vickers

2.3 Hardness Equivalence

When it is not possible to test material under the conditions specified on the part drawing, an alternative hardness scale may be used to produce an approximate equivalent hardness value. Discretion should be used in the selection and application of that substitution. For example 513 HV and 50 HRC are considered to represent equivalent hardness. See ISO 18265 or ASTM E140 for conversion tables; contact John Deere if more information is required.

2.4 Heat Affected Zone (HAZ)

The depth below the hardened surface which exhibits the last microstructural evidence of having exceeded the lower critical temperature (A_{C1}).

2.5 Induction Hardening Process

See JDV 2, JDV 13, SAE ARP4715, and DIN 17022-5.

2.6 Intermediate Transformation Products (ITP)

A non-martensitic microstructure obtained during quenching. Typically, the ITP structure resembles bainite and/or pearlite. This is also referred to as secondary transformation products or high temperature transformation products.

2.7 John Deere Personnel

John Deere materials engineering or quality engineering employee responsible for the heat treatment facility or external supplier heat treatment facility.

2.8 Mottled Microstructure

A mottled microstructure is observed when the time at temperature is not sufficient to transform completely the initial microstructure to austenite with uniformly distributed carbon prior to quenching. This produces a hardened structure that is blotchy in appearance from a mixture of ferrite and martensite or areas of high and low carbon martensite.

2.9 Pattern Boundaries

A part drawing specification will usually define the areas or boundaries to be induction hardened. See clause 4.3 and Figure 1.

2.10 Design, Process, and Assembly Review (DPAR)

A meeting of persons involved in the design, manufacture, or procurement of a component. This meeting is of high importance. The purpose of a DPAR is in part to:

- Ensure an understanding of part function and manufacturing process.
- Confirm and identify key part product and process characteristics.
- Establish measurement methods and inspection procedures to verify required specifications.
- Identify and assign corrective action for potential problems.
- For purchased parts, review quality requirements of JDS-G223.
- Review and understand applicable standards and specifications.

2.11 Spline Runout

The portion of the shaft between the point where the spline cutter radius is tangent to the spline root and the cutter breaks out onto the shaft outside dimension (OD).

2.12 Induction Hardened Depth (Subsurface Hardness Depth)

For the specified induction hardened area, the component shall meet the specified hardness and microstructural requirements at specified depths below the surface. This will be referred to as the induction hardened depth or subsurface hardness depth. See clause 4.5.2 for further definition. The induction hardened depth defines a critical strength profile by specifying hardness at specific locations below the surface.

2.13 Tempering

Reheating a hardened part to achieve a specified hardness or to stabilize as-quenched martensitic structures. This heating is to be done by a furnace operation unless otherwise specified. Induction tempering, self-tempering, or other methods of tempering shall be verified by lab fatigue testing and documented on the part drawing, in a unit standard, or in other documentation approved by John Deere personnel.

3 Quality Assurance Requirements for Purchased Components

3.1 The supplier shall pursue a program for continuous improvement with the goal of process capability as outlined in the JDS-G223. John Deere personnel may periodically evaluate the program. All test data and pertinent process control information shall be retained in a readily retrievable format for a minimum of 3 years and be accessible to John Deere personnel during that time period. The suppliers shall be responsible to ensure that all parts shipped to John Deere units meet all specifications. The heat treating facility shall have trained personnel capable of understanding the requirements of this standard and knowledgeable in the operation of heat treating equipment and measurement methods to consistently comply with this standard. If problems are found, the supplier shall contact the appropriate John Deere personnel. Parts not meeting specifications may not be used without an explicit and written deviation from John Deere. All requests for deviations shall be made through appropriate John Deere personnel. Some examples of what a request should contain are: the part number, the number of parts, what is discrepant about the parts, information about the scope and location of the problem, and what corrective action has been taken. Suppliers shall not ship parts that do not meet specification without an approved deviation from John Deere.

3.2 The material, heat treatment notes, and related standards shall be reviewed and approved in a Design, Process and Assembly Review or Production Part Approval Process with John Deere personnel and the supplier. Part conformance to drawing requirements and standards shall be documented in an Initial Sample Inspection Report. Test standards, methods, and procedures shall be reviewed and agreed to during the DPAR. This might include but is not limited to surface and subsurface hardness test methods, microstructure requirements, and other particulars.

4 Heat Treatment Process Designations, Specifications on Part Drawings, and Explanations

4.1 Induction Hardening Heat Treatment Process Designations

See JDV 2 for John Deere standard heat treatment designations and descriptions of heat treatment processes. Table 1 shows the JDV 2 designations and descriptions for induction hardening heat treatment processes covered by this standard.

Table 1 JDV 2 Induction Hardening Heat Treatment Designations and Descriptions

JDV 2 Designation	Heat Treatment Process
HT30	Heat by induction and quench
HT31	Preheat, heat by induction and quench
HT32	Through heat by induction, quench and heat by induction
HT9–30	Carburize, air cool, heat by induction, and quench
T	Temper (furnace)

4.2 Specifications on Part Drawings and Explanations of Heat Treatment Notes

4.2.1 The heat treatment process designation and specification for an individual part or assembly can be found in a note, which is normally located in the lower right quadrant of the drawing.

4.2.2 An example of a heat treatment note is shown in Table 2. Explanations of the heat treatment note are shown in Table 3. Notes on part drawings from a specific John Deere design control unit may be different. Contact John Deere personnel for any additional explanation required.

4.2.3 To apply the requirements of JDV 22 to a part, the following shall be included in the part drawing heat treatment note. (JDV 22 INSPECTION) shall follow the heat treatment designation. See Table 3. If a drawing calls for the application of RES 10419, then JDV 22 supersedes RES 10419.

4.2.4 If there are exceptions to specific requirements in this standard they may be noted on the part drawing. For example, the surface hardness shall apply, but the microstructural requirements are waived.

Table 2 Example of a Heat Treatment Note

HEAT TREATMENT
JDV 2 – HT30T PORTION (A) (JDV 22 INSPECTION)
48-56 HRC SURFACE HARDNESS PORTION (A)
45 HRC MIN AT 3 DEPTH PORTION (B)
25 HRC MAX AT 8 DEPTH PORTION (B)
12 MAX HAZ DEPTH

Table 3 Explanation of Heat Treatment Notes

Heat Treatment Note	**Explanation (not shown on part drawing)**
HEAT TREATMENT	
JDV 2 – HT30T PORTION (A)	See JDV 2 for description of HT30T. Heat treatment applied to the portion of the component labeled (A) on the drawing.
(JDV 22 INSPECTION)	Inclusion of (JDV 22 INSPECTION) indicates that the requirements and specifications of JDV 22 apply. If a class is specified, then indicate it as: (JDV 22 – CLASS 1 INSPECTION).
48-56 HRC SURFACE HARDNESS PORTION (A)	Surface hardness specification for area to be induction hardened labeled portion (A). Hardness may be called out using another test method such as Vickers (HV).
45 HRC MIN AT 3 DEPTH PORTION (B)	Induction hardened depth specification is 45 HRC minimum at a depth of 3 mm for area labeled portion (B) on the drawing. Other methods may be used to indicate the hardened depth.
25 HRC MAX AT 8 DEPTH PORTION (B)	Induction hardened depth specification is 25 HRC maximum at a depth of 8 mm for area labeled portion (B) on the drawing.
12 MAX HAZ DEPTH	Maximum depth of the heat affected zone for the area labeled portion (A) on the drawing.

4.3 Induction Hardening Drawing Specification Contents

4.3.1 The extent of the induction hardening pattern should be fully defined on the drawing. The definition may include but is not limited to the following. The induction hardening pattern and metallurgical features should be reviewed and agreed during the DPAR.

4.3.2 The drawing should indicate the zone or area to be induction hardened with both surface area and depth of hardening indicated. It can be indicated by maximum and minimum lengths, widths, or by other features. Geometric features such as fillets, keyways, and snap ring grooves may require special notation on the drawing. The induction pattern is expected to be continuous and uniform unless interrupted by geometry or other component feature.

4.3.3 The hardness specification for the surface and induction hardened (subsurface hardness) depth should be specified for the areas indicated. The depth of the heat affected zone should be indicated to control the depth of heating.

4.3.4 An example a drawing format is shown in Figure 1. Various techniques may be used to indicate induction hardened areas. Nomenclature used at some John Deere units may be different.

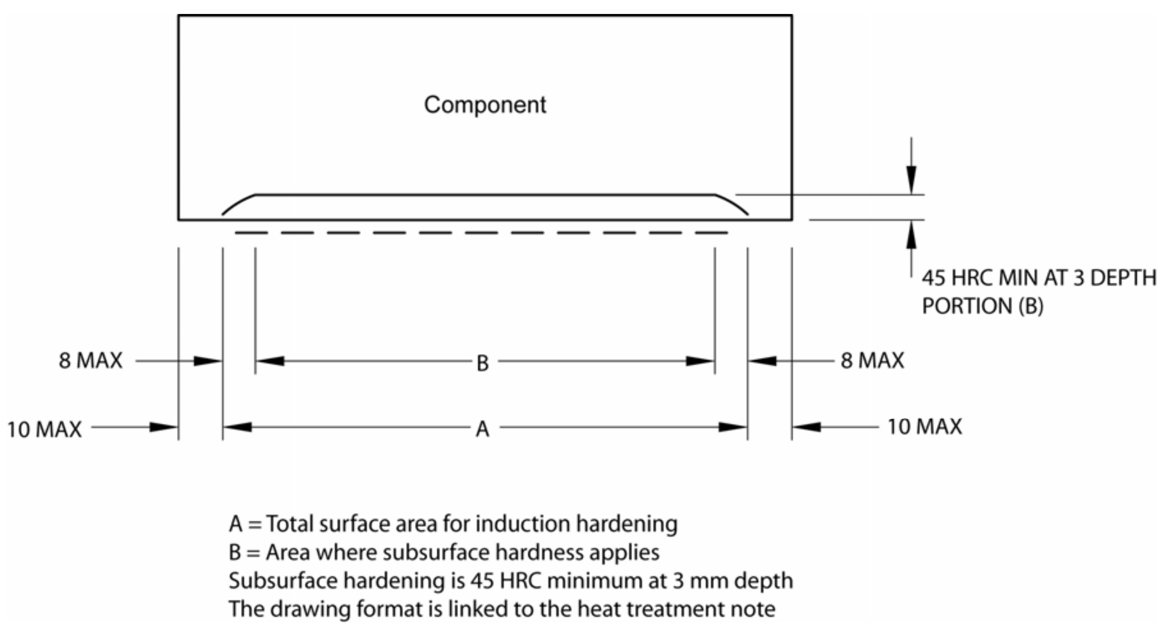

Figure 1 Drawing Format Example

4.4 Tempering Guidelines

4.4.1 In order to maintain consistency in processing, the following tempering guidelines shall be followed.

4.4.2 See Table 6 for hardness testing procedures.

4.4.3 Unless otherwise noted on the part drawing, tempering shall be done by a furnace operation and shall be carried out with the shortest practicable delay (a maximum delay of 8 hours).

4.4.4 Parts shall be tempered at temperatures sufficient to produce the hardness specified. The minimum temperature for demonstration of compliance to the tempering specification (T) is 150 °C (300 °F). Consult John Deere materials engineering personnel concerning tempering guidelines.

4.4.5 After the surface has reached the required temperature, parts are to be tempered for a minimum of one hour at the appropriate temperature.

4.4.6 If induction tempering, self tempering, or other tempering methods are utilized, this shall be noted on the part drawing, in a unit standard, or by a documented agreement between the John Deere manufacturing unit and the supplier. Methods of tempering other than by furnace shall be verified by fatigue testing.

4.4.7 If there is any deviation from these tempering guidelines or any concerns, contact John Deere materials engineering personnel.

4.5 Induction Hardened Depth (Subsurface Hardness Depth) Guidelines

4.5.1 If a part does not have an induction hardened (subsurface hardness) depth specification shown on the part drawing, then the part shall conform to an induction hardening practice that has been verified by documentation to produce an adequate hardness pattern and hardened depth. Clause 4.5.2 describes an adequate induction hardness depth. This requirement does not apply to ductile cast iron (also called spheroidal graphite or nodular cast iron) components.

4.5.2 Generally, an adequate induction hardening practice for steel components will produce a minimum induction hardened depth (or subsurface hardness depth) of 1.0 mm. The hardened depth criterion is defined as the point, when measured perpendicular from the surface, which is 10 HRC units (or equivalent) less than the minimum specified surface hardness. For example, a part with a surface hardness specification of 50 to 55 HRC shall exhibit a subsurface hardness ≥40 HRC at a depth of 1.0 mm. See SAE J423 for the hardness traverse test procedure. This subsurface hardness specification applies to the surface area of the specified pattern except for the 10% of the surface area at the end boundaries of the pattern (with a maximum of 8 mm). This is the area where the pattern tapers out to the surface. See JDV 22X2 for further details defining this requirement. The actual induction pattern shall be documented by a photograph or other method.

4.5.3 An alternate evaluation method defines the induction hardened depth (or subsurface hardness depth) as the point that exhibits a microstructure of ≥90% martensite at 1.0 mm depth. The specified surface hardness shall be met. If radio frequency equipment is used, contact John Deere personnel for guidelines regarding subsurface hardness requirements.

4.6 Heat Affected Zone (HAZ)

4.6.1 As a general rule, radio frequency induction heating equipment is not utilized to produce parts for John Deere without prior approval. Therefore, a typical heat affected zone (HAZ) depth would be 3 mm minimum depending on component geometry and processing equipment unless otherwise specified.

4.6.2 In most cases, the HAZ should not exceed 50% of the distance from the surface to the midpoint of the geometric section being hardened, regardless of the frequency of the equipment used. (HT32 is an exception.) Excessive depth of hardness can cause unfavorable residual stresses. Other exceptions should be reviewed by John Deere personnel.

4.7 Preparatory Conditioning

Components shall be free of residue, scale, shot, rust, oil, or other contaminants, which would interfere with the heat treatment procedure.

5 Metallurgical and Process Specifications and Features

5.1 Table 4 presents the specifications that apply to metallurgical features of two classes of induction hardened components. Class 1 includes general components. Class 2 includes axle shafts, bearing surfaces, splines, sprockets, gears, and similar components.

5.2 Components shall meet Class 2 requirements unless otherwise specified.

Table 4 Metallurgical and Processing Features and Specifications for Induction Hardened Components

Metallurgical or Process Feature	Class 1 General Components	Class 2 Axle Shafts, Bearing Surfaces, Splines, Sprockets, and Gears
Service Application	Moderate strength.	High strength and moderate wear.
Prior Grain Size	Fine grain, size 5 or finer according to ASTM E112.	Fine grain, size 5 or finer per ASTM E112.
Prior Structure	Ductile Iron: 40% minimum pearlite. Steel: If banding is observed see clause 7.8.	Ductile Iron: 65% minimum pearlite. Steel: If banding is observed see clause 7.8.
Surface Hardness	As specified.	As specified.
Induction Hardened Depth[1]	As specified.	As specified or clause 4.5.
Surface Microstructure for steel components	Predominately martensite with no free ferrite. Surface hardness shall be met.	Fully martensitic. Surface hardness shall be met.
Subsurface Microstructure[1] in hardened area for steel components	Subsurface hardness shall be met.	Free from ferrite or mottled structures. Gear tip and root circle area fully austenitized prior to quenching with no blocky ferrite. Subsurface hardness shall be met.
Tempering	Recommended for Carbon $>$ 0.35%.	Required
Intermediate Transformation Products at surface[2] for steel components	Surface hardness shall be met.	Surface fully martensitic. In medium carbon steels a microstructure with 5% or less intermediate transformation products in the roots of splines or gears is permitted.
Surface Cracks	Not permitted.	Not permitted.
Over Heating, Grain Coarsening, Melting	Melting unacceptable.	Melting unacceptable and grain growth minimal.
Magnetic Particle Inspection — ASTM E1444 and ASTM E709	1. To release production lot setup. 2. Each production lot per quality plan.	1. To release production lot setup. 2. Each production lot per quality plan.

[1] Area defined on part drawing or clause 4.5. If banding or other microstructural problems are evidence, see clause 7.8.

[2] Special part drawing notations may indicate the acceptance of surface intermediate transformation products as illustrated in the following example: (90% MARTENSITIC TRANSFORMATION IN GEAR ROOT PERMISSIBLE). This indicates intermediate transformation products may be present in that portion.

6 Metallurgical Examination and Other Considerations

6.1 Reasons for Metallurgical Examination

6.1.1 A metallurgical examination, as defined during the DPAR, is performed during the Production Part Approval Process (PPAP) and the submission of Initial Sample Inspection Report (ISIR) parts to ensure that satisfactory components are being produced. The parts shall be in the finished condition when evaluated. Set-up parts and audit parts may be taken at various stages of manufacturing. Those examinations shall take into account the effects of prior and subsequent processing.

6.1.2 Contact John Deere personnel if there are any questions regarding examination locations or procedures.

6.2 Recommended Locations for Examination

Locations for metallurgical examination shall be agreed to during the DPAR. In general, examination locations shall be selected which will represent an evaluation of the intended induction pattern including surface area and hardened depth. Induction area, pattern, and lengths shall be documented by a photograph or other method. If there are questions regarding this procedure, contact John Deere Materials Engineering. Recommended locations are shown in Table 5.

Table 5 Recommended Locations for Metallurgical Examinations

Geometric Feature	**Specimen Location**	**Surface Hardness Location**	**Subsurface Hardness Location**	**Core Hardness Location**
Gear	Cross section of 2 teeth and root at mid point, longitudinal section through root full length	Tooth tip, center of face, root if possible	Determine at DPAR	Neutral axis at root circle
External spline	Cross section of spline, spline run out	Spline tip and root diameter	Determine at DPAR	Neutral axis at root circle
Round Section	Mid point of most massive area; section size changes	OD surface	Perpendicular to OD in area specified	Center of geometric feature
General	Cross section of special geometric features	Surface	Perpendicular to surface in area specified	Center of geometric feature

7 Microstructure Interpretation and Other Specifications

7.1 Surface Microstructure

The hardened microstructure shall be fully austenitized and quenched martensite unless otherwise noted. See Table 4 for details.

7.2 Retained Austenite

For carburized and induction hardened (HT9, HT30T) components retained austenite is acceptable only in amounts not to exceed 25% by visual examination at 400X magnification. See JDV 21 for further details.

7.3 Intermediate Transformation Products (ITP)

Intermediate transformation products at the surface are generally unacceptable unless otherwise noted. If the surface hardness is maintained, a small amount (≤5%) of intermediate transformation products is permitted in the roots of medium carbon steel components with gear or spline geometric features. See Table 4 for details.

7.4 Grain Coarsening

Overheating that produces grain coarsening should be avoided. If the visual grain size is coarser than size 5 according to ASTM E112, contact John Deere personnel.

7.5 Surface Melting

Melting in any degree shall be unacceptable.

7.6 Component Heat Pattern

The induction heat treatment pattern shall be continuous and uniform unless interrupted by geometry or other component feature.

7.7 Gear Tooth Heat Pattern

The tip and root circle area of a gear tooth shall be fully austenitized prior to quenching with no free ferrite unless otherwise noted. Contact John Deere personnel if further clarification is required.

7.8 Banding in the Microstructure

If microstructural problems such as banding are observed in the steel, then a subsurface hardness test should be performed to verify that the subsurface hardness requirements are fully met. The test shall be a microhardness survey (or equivalent) at sufficient intervals to ensure that variations in hardness due to chemical segregation are discovered. If the variation is greater than 4 HRC units (or equivalent), contact John Deere. Results shall be reviewed, documented, and dispositioned with John Deere personnel. See JDV 22X5 for photographic examples.

7.9 Microcracks

This requirement applies to carburized and induction hardened (HT9, HT30T) components. See JDV 21 for details. Microcracks are not permitted to any degree when parts are treated per JDT 59.

7.10 Post Heat Treatment Process Cracks and Effects

Quench cracks, straightening cracks, and grinding process cracks are not permitted. Any reaustenitizing of the surface by post heat treatment operations is not permitted. Temper back from post heat treatment operations is not permitted.

7.11 Induction Process Troubleshooting

JDV 22X3 provides a guide for trouble shooting problems with the induction hardening process. Contact John Deere materials engineering personnel for assistance and details.

7.12 Edge or Crack Protection

Prior to induction hardening, it may be necessary to prevent overheating or quenching in specific areas. This may be done by fitting suitable copper or wooden inserts into holes, slots, undercuts, or other features. Caution should be noted when using copper plugs. Melting of the copper may cause liquid metal embrittlement and subsequent cracking. Adequate deburring of holes (particularly of inclined holes in crankshafts) in required prior to induction hardening.

8 Metallurgical and Process Data to be Reported and Retained

8.1 Metallographic Data to be Reported and Retained

The following metallographic data shall be reported and retained in a readily retrievable format for each heat treatment control lot as specified in the JDS-G223. A data sheet shall be completed for each specimen examined. The data reported shall be based on a visual examination using accepted metallographic practices (ASTM E3) at a minimum of 100X magnification. (See JDV 22X4 for evaluation form.)

- Surface microstructure including percent retained austenite, depth of austenite penetration, percent intermediate transformation products, mottled structures, or other constituents
- Depth to 5% intermediate transformation products
- Depth to 50% martensite
- Heat affected zone depth
- Core microstructure
- Anomalies observed such as temper back, decarburization, two phase structures (martensite plus ferrite) at gear tips or roots, carbides, intergranular oxides (IGO), grain coarsening, non-metallic inclusions, microcracks, quench cracks
- Heat pattern documentation such as a photograph of the induction pattern

8.2 Hardness Data to be Reported and Retained

The following hardness data shall be reported and retained in a readily retrievable format for each heat treatment control lot as specified in the JDS-G223. A data sheet shall be completed for each specimen examined. (See JDV 22X4 for evaluation form.)

- Surface hardness at boundaries and in center of specified pattern
- Induction hardened (subsurface hardness) depth survey in applicable areas (see JDV 22X2)
- For gears, the core hardness at the neutral axis root diameter mid width (see JDV 22X1)

8.3 Induction Hardening Process Documentation

Induction hardening heat treatment shall be performed in accordance with an established, documented, and reproducible procedure. At a minimum, the following information shall be documented and available for review by John Deere personnel.

- Surface hardness at boundaries and in center of specified pattern
- Surface hardness at boundaries and in center of specified pattern
- John Deere part number
- Coil or inductor identification, auxiliary equipment identification
- Induction machine identification, frequency, and power level
- Power setting(s), scan speed(s), and cycle time for part processing
- Coil, fixturing, machine, and work-piece settings
- Quench media and parameters (concentration, pressure, flow, etc.)
- Temper method and parameters

9 Alternative Test Methods

Known alternative test methods are shown in Table 6. Regional or national adoptions of one of the standards shown in Table 6 are considered to be equivalent to the original standard. Other test methods may be used when agreed between the supplier and purchasing John Deere unit.

Table 6 Alternative Test Methods

	Standards Designation						
Property	**AGMA**	**ASTM**	**DIN**	**IS**	**ISO**	**JIS**	**SAE**
Preparation of Metallographic Specimens		E3	50602	7739			
Brinell Hardness		E10		1500	6506-1	Z2243	
Rockwell Hardness		E18		1586	6508-1	Z2245	
Vickers Hardness		E92 E384		1501	6507-1	Z2244	
Grain Size in Steels		E112		2853	643	G0551	
Hardness Conversion Tables		E140		4258	18265		J417
Magnetic Particle Inspection		E709 E1444				G0565	
Induction Hardened Depth					3754	G0559	J423
Surface Hardness by File Test							J864
Acid Etch after Grinding	2007				14104		
Mechanical Properties		A370			6892	Z2241	

- Standards designated IS are published by BIS.
- Standards designated JIS are published by JSA.

10 References

For undated references, the latest edition of the referenced document (including any amendments) applies.

10.1 AGMA Standards

AGMA 2007	Surface Temper Etch After Grind

10.2 ASTM Standards

ASTM A370	Test Method and Definitions for Mechanical Testing of Steel Products
ASTM E3	Guide for Preparation of Metallographic Specimens
ASTN E10	Test Method for Brinell Hardness of Metallic Materials
ASTM E18	Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E92	Test Method for Vickers Hardness of Metallic Materials
ASTM E112	Test Method for Determining Average Grain Size
ASTM E140	Hardness Conversion Tables
ASTM E384	Test Method for Microindentation Hardness of Materials
ASTM E709	Guide for Magnetic Particle Inspection
ASTM E1444	Practice for Magnetic Particle Examination

10.3 BIS Standards

IS 1500	Method for Brinell Hardness Tests for Metallic Materials
IS 1501	Method for Vickers Hardness Tests for Metallic Materials
IS 1586	Method for Rockwell Hardness Tests for Metallic Materials
IS 2853	Method for Determining Austenitic Grain Size in Materials
IS 4258	Hardness Conversion Tables for Metallic Materials
IS 7739	Code for Preparation of Metallographic Specimens

10.4 DIN Standards

DIN 17022-5	Heat Treatment of Ferrous Products: Surface Hardening
DIN 50602	Metallographic Examination

10.5 ISO Standards

ISO 643	Steels — Micrographic determination of the apparent grain size
ISO 3754	Determination of effective depth of hardening after flame or induction hardening
ISO 6336	Calculation of load capacity of spur and helical gears
ISO 6506-1	Metallic materials — Brinell hardness testing
ISO 6507-1	Metallic materials — Vickers hardness testing
ISO 6508-1	Metallic materials — Rockwell hardness testing
ISO 6892	Metallic materials — Tensile testing at ambient temperature
ISO 14104	Gears — Surface temper etch inspection after grinding
ISO 18265	Metallic materials — Conversion of hardness values

10.6 John Deere Standards

JDM A0	Specification for JDM Carbon, Alloy, and Stainless Steels
JDV 2	Heat Treating Numbers and Descriptions
JDV 13	Fundamentals of Induction Heating
JDV 21	Quality Requirements for Case Hardened Steel Components
JDS-G223	Supplier Quality Manual

10.7 JSA Standards

JIS G0551	Steel — Micrographic Determination of the Apparent Grain Size
JIS G0559	Methods of Measuring Case Depth of Steel Hardened by Flame or Induction Hardening Process
JIS G0565	Methods for Magnetic Particle Testing of Ferromagnetic Materials and Classification of Magnetic Particle Indication
JIS Z2241	Method of Tensile Test for Metallic materials
JIS Z2243	Brinell Hardness Test — Test Method
JIS Z2244	Vickers Hardness Test — Test Method
JIS Z2245	Rockwell Hardness Test —Test Method

10.8 SAE Standards

SAE J417	Hardness Tests and Hardness Number Conversions
SAE J423	Methods of Measuring Case Depth
SAE J864	Surface Hardness Testing with Files
SAE AMS2745	Induction Hardening of Steel Parts
SAE ARP4715	Induction Hardening of Steel Components