MERITOR®
2135 West Maple Road
Troy, MI 48084-7121

# Process Specification

**Specification:** 400
**Revision Date:** 05/10/2017
**Revision Level:** Q

## GENERAL SPECIFICATION FOR INDUCTION HARDENING SPECIFICATIONS 400 TO 499

1. **Scope:**

Description of metallurgical requirements and code development for specifications of the induction hardening process.

2. **General Specifications:**

Process Parameters shall be controlled per P.S. No. 1.

2.1 **Induction Hardening Equipment:**

For all applications, the induction hardening frequencies and parameters must be approved by Meritor Materials Engineering – Troy. The table below lists the recommended induction hardening frequencies for certain applications, prior approval is still required. When applicable, the specific process specification supersedes these recommendations.

| Components | Recommended Target Frequency | Recommended Minimum Power Supply (per Coil) |
|---|---|---|
| Axle Shafts | 1 KHz | 250 kilowatts |
| On-Highway Spindles | 3 KHz | 150 kilowatts |
| Input Shafts | 3 KHz | 150 kilowatts |

3. **The induction hardening codes:** The codes consist of a maximum of 5 positions, the definition of which are described below.

First Position

The number four in the first position describes the induction hardening processes.

Second and Third Positions

These two numbers define the minimum case depth in hundredths of an inch up to a maximum 0.49 inch. All process specifications from 450 to 499 are product oriented induction hardening specifications and are found on individual sheets.

Case depth is measured in the as quenched condition. Case depth is defined as that distance perpendicular to the surface which has been hardened to greater than HRC 40. If core hardness is greater than HRC 40 due to pretreatment, case depth is defined as the distance which has been hardened to Rockwell HRC 50. Where splines are hardened, case depth is to be measured at the spline root.

Hardness shall be determined by the Standard Brinell (3000 kg load) or Rockwell HRC (150 kg load) procedure. Where part size limitations prohibit the use of these standard loads, conversion to the lighter loads in accordance with the recommended SAE procedure is acceptable.

Surface hardness shall be determined within dimensional limit of case depth pattern shown on print. The feathered "fade out" portion of the pattern will not be adequate for valid hardness results unless otherwise specified. Recommended ranges for corresponding case depths are given below. Recommended ranges are intended to be in uniform section areas. Shoulders, undercuts, and other section changes can have significantly deeper hardening depth but in no case should they be below the required minimum case depth.

| Minimum Case Depth (inch) | Recommended Range (inch) |
|---|---|
| 0.010 to 0.060 | 0.030 |
| 0.070 to 0.100 | 0.040 |
| 0.100 to 0.200 | 0.060 |
| > 0.200 | As specified |

Surfaces to be File Hard: No.65 file per SAE J864 unless otherwise specified.

Fourth position.

A letter in the fourth position can be used as a guideline to define the hardness as shown below.

| Letter | Surface Hardness (HRC) |
|---|---|
| A | 60 minimum |
| B | 58 minimum |
| C | 55-60 |
| D | 52-57 |
| E | 50-55 |
| F | 47-54 |
| G | 45-52 |
| H | 43-48 |
| I | 40-45 |
| J | As shown on the print |

Fifth Position.

Non-standard processes or special requirements are indicated by any number in the Fifth position of the code.

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## 4. Pre-treatment:

When pretreatment is needed on any part it will be specified per Process Specification 15. Pretreated microstructure shall not exhibit greater than 10% spheroidized structure.

## 5. Quenching Media:

Appropriate quenching media such as water, oil, or synthetic will be used. Splines, keyways, lock ring grooves, sharp corners, and small radii are prone to cracking during the quench. Sufficient magnetic particle inspection should be performed to assure freedom from cracking. When required, the severity of the water quench can be reduced by the use of Polyvinyl Alcohol, Soluble oil, or a suitable Glycol Solution.

Quench temperature and concentration should be monitored and regulated within an appropriate range to achieve consistent surface hardness, depth of hardening, and to eliminate quench cracks. The temperature should be continuously monitored or checked on a hourly basis. Concentration should be checked twice per shift.

## 6. Microstructure

Grain growth, due to induction hardening, is limited to ASTM #3 or finer, provided components meet the performance requirements. Any defects associated with overheating and / or excessive grain growth are unacceptable.

## 7. Tempering

Parts shall be furnace stress relieved for one hour at temperature (325°F minimum) unless otherwise specified.

## 8. Salvage Procedure

Re-induction hardening components with high surface hardness can cause distortion and cracking upon re-induction hardening and quenching. These cracks can be subsurface in many cases and may go undetected, therefore, one of the following precautions should be taken.

Before re-induction hardening a component, perform one of the following:

1.) Normalize
2.) Re-quench and temper
3.) Induction Temper
4.) Furnace Temper*

*A minimum temperature of 800°F should be used.

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The procedure of choice will be dictated by previous heat treatments and surface condition, i.e. ground, as forged, etc.

| Date | Change |
|---|---|
| 05/10/2017 Level Q PR-06600 | Added Surfaces to be File Hard: No.65 file per SAE J864 unless otherwise specified, to section 3. |
| 8/5/2009 Level P Request 30272-126 | Added Section 2.1 for recommended induction hardening frequencies and parameters. |
| 7/5/2005 Level N Request 24715-2 | Added Section 6 on microstructure. |
| 10/5/2004 Level M Request 24715-1 | Revised the definition of the fourth position in the induction hardening code by adding the phrase "can be used as a guideline to". |
| 6/15/2001 Level L Request 21206-74 | Removed the index 1 "NOTE". Transferred the specifications from Table 1 to individual documents. |
| 2/15/2000 Level K Request 19687-1 | 412-G-1 added to Matrix. Specification was not released into IMS when approved 2/27/98 |
| 9/15/99 Level J Requests 18748-1,-2 | Added 410-J |
| 2/27/98 | Added 412-G-1 |
| 4/15/96 Level H | Added temper to achieve surface hardness: in 423-G. |
| 11/15/95 Level G | 412-E-1: Case depth was 0.125", in Sect. 6, added "for one hour in the furnace". |
| 3/15/95 Level F | Added 406-E-2 |
| 10/15/94 Level E | Section 4 - Added "pretreated microstructure...than 10% spheroidized structure". |
| 7/15/93 Level D | Added 416-D |
| 4/15/93 Level C | Added max. on core hardness on 423-G |
| 12/15/92 Level B | Issued 405-D-1 |
| 8/15/92 Level A | Issued 403-E-3, 412-E-1, 416-E-1 |
| 8/15/91 | Added requirement on quench temp. and conc. Added paragraph 7, Salvage Procedure on re-induction hardening parts. |
| 5/15/91 | Added 406-I-1 |
| 7/15/90 | List of possible specification numbers to be avoided were added to Table 1. |
| 8/15/89 | Added 402-F-1, 403-B-1, 404-C |

Approved By: Kenneth Yu
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