

Process Specification

Specification: 100
Revision Date: 07/27/2018
Revision Level: M

GENERAL SPECIFICATION FOR CARBURIZING PROCESSES- SPECIFICATIONS 100-299

1. General Specifications

Process Specification 1. All the requirements for the general specification apply unless superseded by the requirements within this specification.

2. Scope

Description of the metallurgical requirements and code development for specification of the carburizing process. Processes using ammonia are covered in Process Specification 300. The carburizing code consists of a maximum of 5 positions, the definition of which is described below:

3. First Position

The number in the first position describes the method of case depth measurement. The number 1 defines "total case depth measurement" and the number 2 defines measurement of "effective case depth" to a hardness of HRC 50.

Note: Prints with a total case measurement specification may be inspected with an effective case measurement. In case of any dispute with total case results, an effective case depth measurement will be used by Meritor as the settlement method. The equivalent effective case depth requirement would be 0.007 inch less than the specified total case requirement. The range would remain the same as specified in the Fourth Position.

Table 1. Equivalent Effective Case Depth Examples.

Meritor Process Specification (Total Case Spec)	Specification Total Case Range (inches)	Equivalent Effective Case Range at HRC 50 (inches)
135-C	0.035 - 0.050	0.028 - 0.043
150-D	0.050 - 0.070	0.043 - 0.063

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4. Second and Third Positions

These two numbers define the minimum case depth in thousandths of an inch.

5. Fourth Position

A letter in the fourth position defines the case depth range. The 6 specified ranges currently in use and their associated designations are listed below:

The letter (A) defines a case depth range of 0.005 inch (0.127mm)

The letter (B) defines a case depth range of 0.010 inch (0.254mm)

The letter (C) defines a case depth range of 0.015 inch (0.381mm)

The letter (D) defines a case depth range of 0.020 inch (0.508mm)

The letter (E) defines a case depth range of 0.025 inch (0.635mm)

The letter (F) defines a case depth range of 0.030 inch (0.762mm)

6. Fifth Position

Non-standard processes or special requirements are indicated by any number in the fifth position of the code and signifies that a separate process sheet is available in the body of the process specification book.

Example

Specification 150-D-1 defines a carburized case requirement measured by the total case method (First position "1") of a minimum case depth of 0.050" (Second and Third positions "50") with a range of 0.020" from 0.050-0.070" (Fourth position "D") and contains process modifications explained in individual sheets (Fifth position "1").

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7. Surface Hardness

Surfaces to be file hard, unless otherwise specified.
File Hard: No.65 file per SAE J864 (1993-05).
Surface hardness must be within the hardness range of 57-65 HRC unless otherwise specified. See ASTM E18-16(2016) for appropriate hardness scale/case depth relationships. (Note: Universal Joint components are carburized to a surface hardness of 58-64 HRC).

8. Core Hardness

The core hardness requirements for finished gears are listed in Table 1. The location for hardness measurements is shown in Figure 3 unless otherwise noted below.

Table 2. Gear core hardness requirements in HRC

Applications	Core - mid tooth/pitchline	Core - root
Hypoid and spiral bevel Pinions	38-45	28-40
Hypoid and spiral bevel Gears	38-45	28-40
Carrier - spur and helical*	34-45	25-40
T-case - spur and helical	34-45	28-40
Straight bevel differential and planetary (wheelend) gears	34-45	28-40
Cylindrical planetary and others	38-45	28-40

* The carrier spur and helical gears for core hardness check can be cut either parallel to the end/edge or perpendicular to the tooth flank surface and top land for core hardness measurements. The end/edge cut must be at a minimum of 0.75 in. from the end/edge to avoid end quench effects.

9. Case Depth

- Both effective and total case depth on gears and pinions will be inspected at the pitch line. Both forms of case depth measurement are described in SAE J423 (1998-02).
- Case depth measurement is performed on the finished component unless otherwise specified.
- For non-gearing components, the case depth location to be specified on the drawing; otherwise, it should be inspected at a ground surface and/or at the largest cross section.

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10. Microstructure

10.1 Carbides:

- No network carbides are acceptable at any location.
- Discrete pepper carbides are acceptable; however, the presence of discrete carbides is an indication that the carbon potential of the furnace atmosphere is near unacceptably high levels.
- Evaluation is to be conducted at 500X magnification.

10.2 Retained Austenite:

- Must meet an "aim" of 10-30% in the carburized case.
- Retained austenite levels exceeding 30% shall require approval by Meritor Materials Engineering.
- Evaluation to be conducted visually at 400X magnification with comparison made to martensite/austenite rating chart.

10.3 Intergranular Oxidation:

- Normal IGO consisting of finger appearing oxidation extending from the surface is acceptable to 0.0015" deep.

10.4 Grain Size:

- Average ASTM #5 and finer in case and core. No duplex grains permitted in the carburized case. If any duplex grains in the core, individual grains are not to exceed ASTM #4 in grain size.

10.5 Microcracks:

- No microcracks allowed.
 - View with a light 2% Nital etch.
 - Samples should be viewed immediately after etching as microcracks can develop due to delayed manner after etching.

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10.6 Bainite/Pearlite:

- Surface
 - Non-continuous is allowed on unground surfaces up to 0.0012 inch (0.03mm) deep, see Figure 1. Part must be File Hard 65 unless specified on the drawing.
 - Continuous layer of surface bainite is allowed in deep pockets, such as a gear tooth root, up to 0.0008 inch and pending successful functional testing. Grain boundary bainite below the continuous surface layer is permitted up to 0.0015 inch deep from the surface.
- Subsurface
 - Trace (<5%) allowed between 0.0012 inch (0.03mm) and 25% of minimum case depth specification, see Figure 2. View with a light 2% Nital etch.

Acceptable



Borderline

(almost continuous and maximum depth)



Rejectable



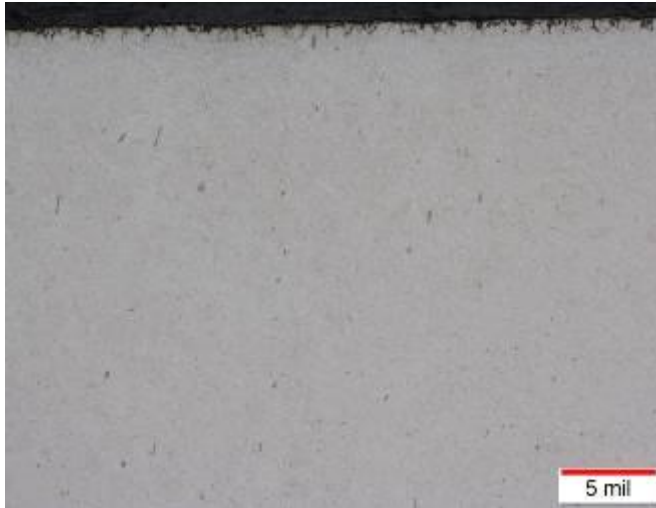
Figure 1. As-carburized surface bainite / Pearlite (500X magnification).

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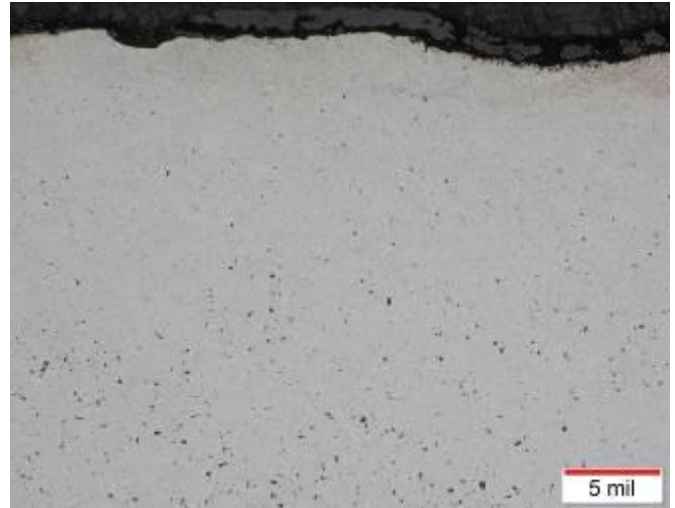
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Acceptable



Borderline (5% bainite)



Rejectable

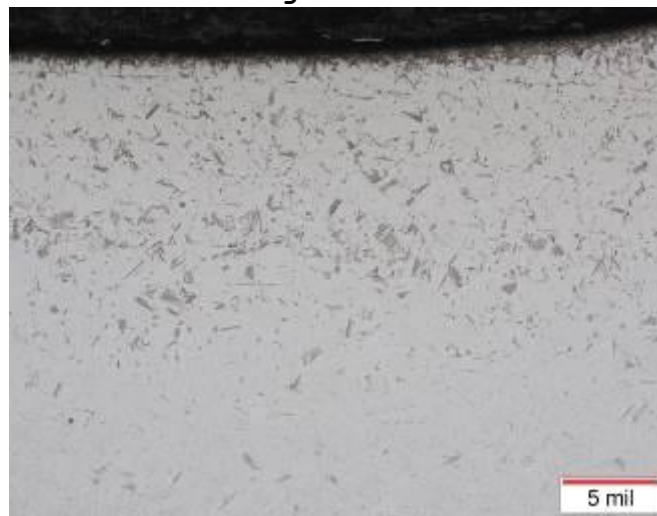


Figure 2. Subsurface Bainite / Pearlite (100X magnification).

Note: Borderline, as shown in Figures 1 and 2, means marginally acceptable for production. PPAP submissions and continued production at this level are unacceptable. The supplier shall bring the microstructure within "Acceptable" range and either resubmit PPAP (if initial PPAP submission) or perform additional auditing (if in production) until capability is proven.

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11. Stress Relieve

All carburized parts shall be stress relieved at a minimum temperature of 300°F unless otherwise specified.

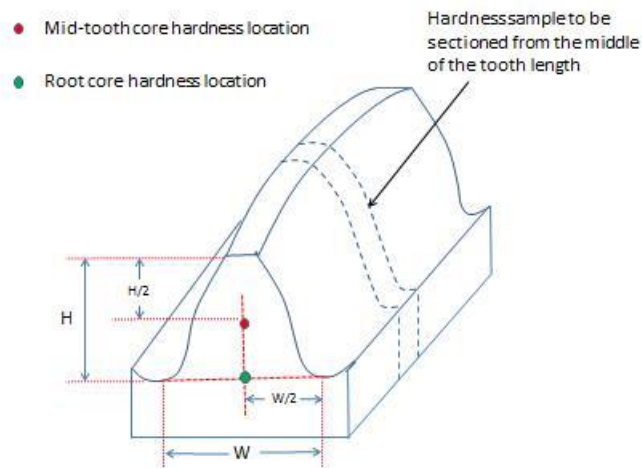


Figure 3. Schematic of tooth profile showing the locations of the core hardness measurements. The cut section shall be nearly perpendicular to the tooth flank surface and top land.

12. Reference Specifications

Industry Affiliation	Standard Number and Revision Date	Title of Standard
ASTM	E18-16 (2016)	Standard Test Methods for Rockwell Hardness of Metallic Materials
SAE	J423 (1998-02)	Methods of Measuring Case Depth
SAE	J864 (1993-05)	Surface Hardness Testing With Files
Meritor	1	Control of Heat Treating Processes, Furnaces, and Auxiliary Equipment
Meritor	300	General Specification for Wear Resistant Heat Treatment

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Date	Change
07/27/2018 Level M PR-12389	Added total case depth dispute and effective case depth equivalent note to Section 3 First Position. Added Table 1 to Section 3 and renumbered subsequent table. Added "Continuous layer of bainite..." bullet and "Borderline" note to section 10.6.
11/29/2017 Level L PR-06220	Added "For non-gearing components..." case depth locations to Section 9 Case Depth. Added Grain Size, Microcracks, and Bainite/Pearlite requirements with micrographs (Figure 1 and Figure 2) to Section 10 Microstructure. The Tooth Profile photo was Figure 1. Added Section 12 Reference Specifications.
02/08/2017 Level K PR-05384	Added Table 1 and alternate cutting locations for carrier spur & helical gears. Mid-tooth/pitch and root core hardness were HRC 38-45 and 28-40, respectively for all gears. Added Figure 1.
10/05/2010 Level J Request 30272-73	Added Section 8 "Core Hardness", Re-numbered remaining sections
09/05/2008 Level H Request 30469-2	Added "E" and "F" in section 5.
02/05/2007 Level G Request 26736-1	Removed reference to transmission gears in microstructure, section 6. Added "aim" to retained austenite requirement. Added bullets to section 6.
6/15/2001 Level F Request 21206-39	Removed the opening "Note" and number 8, (Table 1, The Index of Carburizing Specifications).
6/25/99 Level E Requests 18520-1 & 18527-1	Issued 145-C-4 as replacement for old P.S. 249; issued 255-C
11/15/96 Level D	Updated table 1- Added 125-B, 125-C, 125-C-3, 135-B, 145-B, 225-C, 230-C, 230-C-8, 230-D, 235-B, 235-D, 240-B, 245-C, 260-C, 260-C-1, 260-C-2, 270-D
3/15/95 Level C	Added PS - 140-D-5
4/15/93 Level B	Added 6. Microstructure requirement, Level B and 160-D, 160-D-1, 215-B-1
8/15/92 Level A	Added 199-D-1, 230-C-7 to Table

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4/15/92	Added 125-C-2, 145-D-1, 145-D-2
5/15/91	Deleted reference to 30% retained austenite in case depth. Added P.S. 230-D-2 to the Table 1t
7/15/90	Added specs P.S. 140-C-3, 150-D-4, 225-C-2 to the Table 1

Approved By: Kenneth Yu
Sr. Chief Engineer - Materials Engineering

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