

1.0 SCOPE

This specification covers a direct hardening and tempering treatment and is further qualified by 1E2617. This is a multiple variation specification based on different quenching requirements. (See Articles 2.0 and 3.0.).

2.0 APPLICATION

2.1 1E0106A - Intended for ferrous parts requiring a quench and temper treatment which achieves a **uniform** martensitic microstructure commensurate with the material and section size.

2.2 1E0106B - Intended for parts that require a quench and temper treatment either to improve mechanical properties or enhance further processing (such as induction hardening) but do not necessarily require an optimum microstructure.

3.0 PROCESSING PROCEDURE

3.1 Heat Treating Operations

3.1.1 Austenitize by any method of through heating (furnace, liquid bath, induction, etc.) which produces a homogeneous solution throughout the section without harmful decarburization, grain growth or excessive distortion.

3.1.2 Quench per the appropriate suffix designation as described below:

3.1.2.1 1E0106 - (Fulfilled by 1E0106A).

3.1.2.2 1E0106A - Parts shall be quenched with the maximum possible severity that can be achieved without quench cracking, to produce the maximum expected as-quenched surface hardness and depth of hardening. A uniform martensitic structure shall be produced on all surfaces, below the MAD, to a depth commensurate with material hardenability and section size. Spotty hardening shall not be permitted and is evidence of insufficient quench flow velocity (Figure 1 gives a schematic of spotty hardening shown by a mixture of light and dark etching at the part surface, and a uniform martensitic structure shown by light etching at the part surface).

3.1.2.2.1 Achieving this microstructure specification typically requires an impingement quench flow velocity on the entire surface of a part in excess of 0.76 m/s (2.5 ft/sec) for water and 1.07 m/s (3.5 ft/sec) for oil.

THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

HEAT TREATMENT – DIRECT HARDENING

DATE
08 JUL 2011

CHG NO
14

NUMBER
1E0106

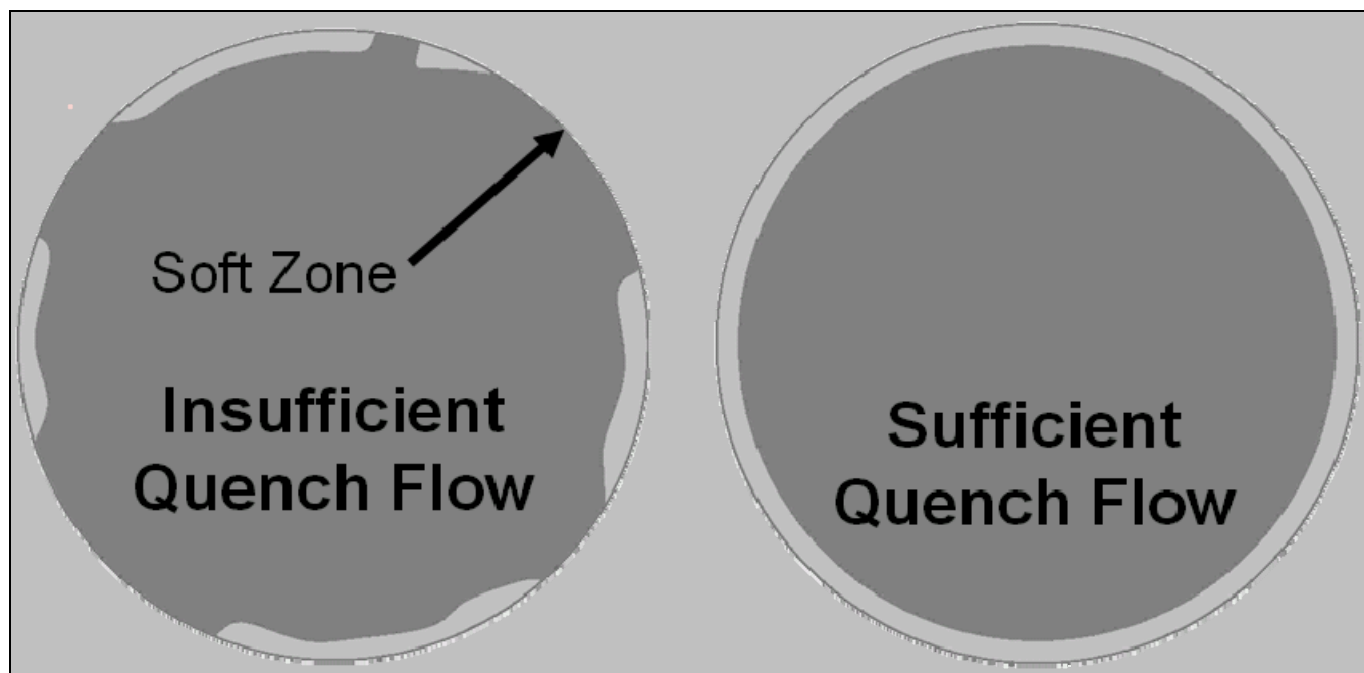


Figure 1 - Schematic of "Spotty Hardening" On a Cut Section from a Standard Test Bar

3.1.2.2.2 To assure process control, as quenched surface hardness and tempering temperature should remain constant for a specified material and section size from batch to batch. For parts heat treated at Caterpillar facilities, consult Caterpillar Manufacturing Practice ME4000 for relationships between material, as quenched surface hardness and tempering temperature. Non-Caterpillar facilities performing this heat treatment should contact the purchasing facility of the requisitioning plant to get this information from the appropriate metallurgical or heat treat personnel.

3.1.2.3 1E0106B - Quench by any means sufficient to provide the properties specified on the part number drawing after accounting for the effects of the tempering procedure described below.

3.1.3 Temper to the specified hardness by reheating for a sufficient length of time to permit temperature equalization in all sections. Care should be exercised to avoid tempering in the brittle temperature range of the material. The minimum tempering temperature is 150°C.

3.2 Machining Operations - The degree of hardness determines when machining is to be performed.

3.2.1 In the machinable hardness range the normal sequence is to complete the machining operations after direct hardening.

THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

HEAT TREATMENT – DIRECT HARDENING

DATE
08 JUL 2011

CHG NO
14

NUMBER
1E0106

3.2.2 Any machining prior to hardening shall leave the minimum amount of material necessary to complete the operations after hardening.

3.2.3 On barstock components' exterior dimensions, when the part number drawing does not specify stock size in the material block, not more than 3 mm per surface shall be machined from the maximum section after heat treatment. Stock removal on castings, forgings, and internal diameters shall be commensurate with engineering requirements specified on the drawing.

4.0 METALLURGICAL REQUIREMENTS

4.1 The hardened and tempered part shall exhibit proper heat treatment as indicated by the following:

4.1.1 Microstructure

4.1.1.1 1E0106A - The microstructure of 1E0106A treated parts shall produce a uniform martensitic structure on all surfaces, below the MAD, to a depth commensurate with material hardenability and section size. Spotty hardening shall not be permitted and is evidence of insufficient quench velocity. There shall be no evidence of incomplete austenization.

4.1.1.2 1E0106B - The microstructure of 1E0106B treated parts is subordinate to attainment of specified hardness and cannot be cause for rejection.

4.1.2 Quality of tempering shall be determined by reheating the parts to the original tempering temperature and holding at temperature for 1 hr. A maximum decrease in surface or cross-sectional hardness of 3 Rockwell C points is permissible.

5.0 QUENCH SEVERITY EVALUATION

5.1 An individual quench tank shall be evaluated in the following manner:

5.1.1 Test Pieces

5.1.1.1 Whenever possible, the actual piece part should be evaluated. The part shall be sectioned in all areas of interest, i.e., critical functional surfaces which must be consistently hardened.

5.1.1.2 For initial screening of a supplier, or in cases where sectioning the actual part is not possible, a standard sample may be used to characterize the quench (ability to break the vapor blanket).

THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.			
HEAT TREATMENT – DIRECT HARDENING	DATE 08 JUL 2011	CHG NO 14	NUMBER 1E0106

5.1.1.2.1 100 ±2 mm diameter by 300 mm long is the standard sample (SAE 1045).

5.1.1.2.2 1E0106 evaluations may use a hot rolled bar at least 1 mm machined from surface prior to heat treat to remove mill scale.

5.1.2 Use of a standard test bar in lieu of the actual part requires written approval from Caterpillar.

5.1.3 1E0106A Test Procedure

5.1.3.1 Austenitize and quench the sample (actual part or test bar).

5.1.3.2 For actual parts, cut 13 mm to 25 mm thick cross-sections through all critical areas. Shot blasting will often reveal soft areas to assist selection of test locations. For test bars, cut two 13 mm to 25 mm thick discs one-half bar diameter in from each end.

5.1.3.3 Grind the section flat, then fine grind (400-grit wet grind or equivalent) and macroetch the section to confirm uniform hardening.

5.1.3.4 Photograph each sample to document uniform hardening.

5.1.3.5 Report no less than four equally spaced hardness traverses for each sample (i.e., 0°, 90°, 180°, 270°).

5.1.4 1E0106B Test Procedure

5.1.4.1 Austenitize, quench, and temper the sample (actual part or test bar) as detailed in this specification.

5.1.4.2 Verify that the sample meets all hardness requirements on the print.

6.0 REFERENCES

Caterpillar Specifications	1E2617
Caterpillar Manufacturing Practices	ME4000
SAE	1045

THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

HEAT TREATMENT – DIRECT HARDENING

DATE
08 JUL 2011

CHG NO
14

NUMBER
1E0106