

1.0 SCOPE

This specification describes the requirements of an acid etch procedure for detecting thermal damage caused by grinding (“grinder burn”, “tempering”, or “grind checking”) on hardened steel parts. A system for classifying the severity of grinder damage and piece part quality requirements are also specified. This is a multiple variation specification.

2.0 APPLICATION

2.1 This specification is applicable to hardened steel parts with a hardness of RKW C40 or greater with various heat treatments (direct hardened, carburized, nitride, induction hardened) with machining after heat treatment. It is not applicable to stainless steels or non-ferrous alloys.

2.1.1 1E2317A Insp – Applies to critical ground surfaces which are highly susceptible to grinding damage. 100% acid etch inspection is required.

2.1.2 1E2317B Insp – Applies to ground surfaces which require periodic inspection to ensure conformance to the required quality level. If no inspection frequency is specified, 1E2317B shall apply

3.0 DRAWING DESIGNATIONS

3.1 Drawings showing former designations shall be manufactured in accordance with current designations.

Drawing Designation	Former Designation
1E2317A	1E2317 INSP Type A
1E2317B	1E2317 INSP Type B

4.0 ETCHING REQUIREMENTS

4.1 Etching shall be in performed in accordance with the 1E2317 type 1 or type 2 etch procedure detailed in Articles 14.3 and 14.4 of this specification or the appropriate procedure for the material being etched, listed in one of the following standards: ANSI/AGMA 2007-C00, ISO 14104, SAE/AMS 2649, or MIL-STD-867.

4.1.1 The type 1 etch procedure with immersion described in this specification shall be the arbitration method used to identify the presence and/or severity of burn. Type 1 etching is preferred because of robustness and less opportunity for error.

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.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

4.2 Etching by immersion is the preferred method for applying the reagents and shall be used when etching parts with complex geometries like gears.

4.2.1 Parts that cannot be immersed may be etched using squirt bottles to flood the surface being checked with the reagent, using the same solutions and procedures described in the appropriate standard.

4.2.2 Swabbing is only acceptable with written approval from the Caterpillar Design Control owner of the part.

4.3 Development of etching procedure

4.3.1 The chosen etching procedure shall be developed in such a manner as to generate the maximum amount of contrast between burned and unburned areas. This shall include but is not limited to; heating of the parts prior to etching, adjusting the acid concentration within the specified limits, adjusting the etch or bleach times, and/or requiring the etched surface to be viewed wet.

4.3.2 Development and validation of the etching procedure details (including time, concentration, and contrast levels) shall be done with sample parts known to have both thermal damage (tempered or burned areas) and areas without thermal damage or the Caterpillar developed acid etch inspection sample, part number HTE11596.

4.3.3 A range of etch times shall be tested from very light etch to very dark etch and compared to identify the best contrast. The preferred time and acid concentration shall be documented in the work instructions.

4.3.4 If a bleach step is used in the selected process a range of bleach times and concentrations shall be tested and compared to identify the best results. The preferred time and acid concentration shall be documented in the work instructions.

4.3.5 Etched sample pieces or high-quality photographs (that accurately represent the etched parts) showing appropriate contrast shall be available to inspectors for reference. If piece parts are used for reference, the etched surfaces shall be protected by a clear lacquer or similar coating that does not obstruct or change the appearance of the etch but will provide protection from corrosion.

4.3.6 Documentation of the etch development and validation, process and photographs of the results, shall be available to Caterpillar and be submitted as part of any PPAP submission.

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.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

5.0 QUALIFICATION OF PERSONNEL

5.1 All personnel performing etch inspection shall be trained and certified in accordance with SAE ARP1923.

5.1.1 Records shall be maintained documenting the training and certification for each person performing inspections.

5.1.2 This requirement is effective January 2, 2019

6.0 QUALITY REQUIREMENTS

6.1 All surfaces designated for 1E2317 inspection shall be visually inspected immediately after proper etching. Acceptable quality levels for gears are defined in Figure 1 using Figure 2 classification. Any part exceeding the allowable classification is non-conforming. All ground surfaces on the part shall be examined (e.g., each gear tooth, bores, faces, diameters).

Surface	Acceptable Quality Level
Tooth Flank & Root	FA
Bore & Web - rolling element or sleeve bearings	FB1
Bore - pressed in bearing races	NB2
End Face – thrust washer surface	FB1
End Face – Non-functional	NB2
Ground journals or ground outer diameters	NB2

Figure 1 - Gear Quality levels

6.2 Inspection after acid etch shall be done in a well-lit area with an intensity of not less than 300 foot-candles (3200 lx) at the surface of the part. When inspecting bores or other difficult to see areas a secondary hand-held light of at least 200 foot-candles shall be used to eliminate any shadows caused by indirect lighting.

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317

PREFIX CODE		
F	Functional Surfaces - flanks, ground roots, bearing journals, and other areas as specified	
N	Non-Functional Surfaces - ground areas deemed non-functional by Caterpillar	
CLASS CODE		
(Measured on a single surface, e.g. single tooth flank)		
Class	Description	Visual Appearance, Worst Area
A	No Thermal Damage	Uniform grey in color
B	Light Thermal Damage	Narrow/dark grey indications (discontinuous streaks)
D	Heavy Thermal Damage	Large dark or black indications
E	Severe Thermal Damage (Re-hardening)	White areas surrounded by black indications
SUFFIX CODE		
(not applicable to Class A)		
Level	MAXIMUM Percentage of surface area affected measured on a single surface, e.g. single tooth flank.	
1	10%	
2	25%	
3	Unrestricted	

Figure 2 - Surface Temper Indication Appearance & Classification System

6.3 The inspector shall ensure the sample is etched sufficiently either by comparing with a standard sample or a target range on a suitable gray scale card (such as Tiffen G13 or G14). If the part is not the correct shade of gray after etching, the etching process shall be reviewed and corrected such that the correct shade of gray and appropriate level of contrast are achieved.

6.4 Extraneous indications – etch surfaces with fingerprints, spots, un-etched areas, or any other extraneous indications are not acceptable and should be cleaned, re-etched, and re-inspected in accordance with Article 9.0.

6.5 Parts referencing this specification that do not have an assigned classification shall meet the **FA/NB2** classification. Gear surfaces classifications are listed in Figure 1.

6.5.1 FA means no thermal damage indications are allowed on any functional surfaces

6.5.2 NB2 means light thermal damage up to 25% of the area of the worst single non-functional surface is permitted.

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.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

6.5.3 Any part having non-functional surfaces with class D or E indications or Class B light thermal damage over more than 25% of the surface (Level 2) are non-conforming.

6.5.3.1 Any part exhibiting Class B indications shall be subsequently inspected for cracks via dye penetrant or magnetic particle inspection, even if the burn is on a non-functional surface.

6.5.4 If a non-conforming surface is found all prior production shall be inspected for both thermal damage and cracking back to the last known conforming material (last piece with conforming etch results).

6.6 Cracked parts shall be rejected.

7.0 INSPECTION METHODS OTHER THAN ETCHING.

7.1 Other inspection methods (e.g., Barkhausen, eddy current, resonant frequency, monitoring of grinding parameters, metallographic examination, alternative etching methods) do not determine conformance, but may be used to determine the nature and extent of thermal damage.

8.0 INSPECTION FREQUENCY

8.1 The frequency of acid etch inspection for 1E2317 type B parts shall be sufficient to ensure non-conforming parts are identified and scrapped.

8.2 Inspection is required at the start of a production run after the initial setup of the grinder(s). Production shall not proceed until acid etch inspection confirms conforming parts are being produced.

8.3 Inspections are required after any process change or adjustment including but not limited to; part number changeovers, wheel change, feed or speed adjustment, change in coolant pressure or location, change to a different heat treat lot or heat of steel.

8.4 A detailed process FMEA using AIAG recommended rating criteria is the preferred method to determine inspection frequency.

8.5 Inspection on a fixed frequency (such as every two hours or every 10 parts), is also an acceptable control frequency if the requirements of 8.2 and 8.3 are met.

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.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

8.6 For multiple step / multi-pass grinding – When the grinding process consists of multiple passes, particularly on different machines, parts shall be etched after each step to increase the likelihood of detection and proper corrective actions.

8.7 When there is significant risk for incoming part geometric variability (i.e., gear tooth grinding of parts with significant heat treat distortion, machining variability, changes in rough stock size), or if a large amount of total stock removal is expected (greater than 0.2 mm) on the ground face, multiple etching inspections are recommended at intermediate stages of stock removal.

9.0 RESPONSE TO DEFECTS

9.1 False indications caused by uneven cleaning, smears, stains, rust or other differences in surface condition shall be cleaned and retested. Parts shall be cleaned with a Scotch-Brite® scouring pad or similar type product before retesting.

9.1.1 Retests of functional surfaces shall be limited so that dimensions and/or surface finish are not comprised or out of conformance.

9.2 Detection of defects shall result in re-inspection of previous product back to the last known good production.

9.3 Detection of defects shall trigger 100% inspection until conforming product is produced.

9.4 Salvage or rework is prohibited - Salvage of non-conforming parts by any method is prohibited. Rejectable surface thermal damage indications may not be removed by reworking (for example via regrinding, refinishing, grit blasting, shot peening, etc.).

10.0 USAGE OF PARTS AFTER ACID ETCHING

10.1 Any part exhibiting rejectable indications is non-conforming and shall not be used.

10.2 Discoloration from 1E2317 etching is typically considered cosmetic, with no detrimental effects upon operation if nitric acid concentration is kept low (approximately <6%). If etching is performed in baths with high target concentrations (generally >6%), the etch test is considered destructive.

10.3 Etching of parts via 1E2317 can result in some metal removal if parts are repeatedly etched. Approximately 0.003 mm of stock is per surface is removed by etching each time this process is performed.

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317

10.3.1 If re-use is desired, parts with close dimensional or surface finish tolerances shall be verified to meet specifications after etching.

10.3.2 Areas with close tolerances which do not require etch inspection may be suitably masked to avoid stock removal.

10.4 Hydrogen embrittlement relief (baking) of etched parts is not required unless specified on the part number drawing or other applicable specification.

11.0 DOCUMENTATION OF INSPECTION

11.1 PPAP lots - PPAP documentation shall include evidence of thermal damage testing and auditing frequency. Conformance of the PPAP lot (initial production lot) shall be documented. PPAP shall include evidence of etch process development as defined in 4.3

11.2 Ongoing production - Thermal damage inspection frequency and response to indications shall be documented in the control plan.

11.2.1 Inspection results for ongoing production shall be recorded.

12.0 CLEANING AND PRE-HEATING PRIOR TO ETCHING

12.1 Parts shall be cleaned thoroughly to remove all surface contamination (oil, wax, grease, dirt, rust preventive, quench oil, surface oxides, metal working fluid) prior to etching.

12.1.1 Cleaning sequence shall be chosen by the manufacturer, and depends on the contaminants that require removal. Acceptable cleaning may consist of one or more of the following: vapor degreasing, solvent cleaning, or alkaline cleaning. Multiple cleaning steps may be required to remove excessive dirt and oil.

12.1.2 Parts shall not touch one another during cleaning, and contact with racking and other material handling equipment shall be minimized.

12.2 After cleaning, parts shall have a water break free surface.

12.2.1 A water break free surface is one which maintains a continuous water film (no "breaks") when held vertically for 15 seconds after immersion in clean water below 40°C (104°F).

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317

12.3 Cleaned parts shall be etched immediately after cleaning, and care shall be taken to prevent re-contamination of cleaned surfaces prior to etching.

12.4 Parts should be heated by immersion in a bath heated to 57 – 70°C prior to all etching steps. The part should reach a minimum of 57 °C, typically 3 minutes or longer is needed to ensure heating.

13.0 ETCHING PROCEDURES - CATERPILLAR RECOMMENDED ETCH PROCEDURE

13.1 Articles 14.3 and 14.4 define the type 1 and type 2 etch as used at Caterpillar. The etch process shall develop adequate contrast to detect damage. If contrast is not adequate, chemicals, times or process shall be adjusted to create adequate results before further inspections.

The etch procedures in Figures 3 and 4 are provided as a general guide. Exact etching times and solutions may be varied to produce adequate contrast for a given part and conditions. Further guidance is available in MH1027 1E2317 TYPE 1 ACID ETCHING PRACTICE.

13.1.1 The etch process shall be qualified daily or prior to use by etching a sample part with a known unacceptable condition. The Caterpillar validation test sample (drawing HTE11596) may be used to satisfy this requirement.

13.1.2 Gray scale masters may be used to establish etching response as described in ISO 14104.

13.2 Control of etching chemicals

13.2.1 All chemicals shall be technical grade or better.

13.2.2 Regular checks shall be made (titrations, for example) to control tank concentrations and constituents.

13.2.3 Recycled or reused chemicals from other processes are not permitted.

14.0 ETCHING PROCESS REQUIREMENTS

14.1 Parts shall be moved between tanks quickly, and drying or blow off between etching steps should be avoided.

14.1.1 If drying or blow off steps are utilized, they shall not create staining on the part.

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.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

14.2 During the etching process, agitation of the part or bath is required to avoid spotty etching as well as to accomplish complete neutralization.

14.3 1E2317 Type 1 Etching -

Step	Process	Solution	Time	Comments
1	Pre-Cleaning	See Article 12	As required	Part shall be water break free after this step
2	Pre-Heating	Hot Water Rinse (57-70°C)	3 minutes MIN	Required. Part shall reach a minimum of 57°C
3	Nitric Acid Etch	- Nitric Acid 1.5-5% (vol/vol) in water solution with -De-smutting agent at 2-4% (per AMS2649, type 1)	30-60 seconds	Time shall be established per the requirements of this specification.
4 Optional	Dry	Contaminant free air blast dry	As required	Reduces carryover of acid into rinse
5	Rinse	Ambient temperature water rinse	As required	Removes any remaining acid
6	Rust Prevention	-Water- based alkaline rust prevention with pH of 8 or higher OR -Water-displacing oil	As required	Prevents corrosion and aids color contrast

Figure 3 – 1E2317 Type 1 etching

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317

14.4 1E2317 Type 2 Etching -

Step	Process	Solution	Time	Comments
1	Pre-Cleaning	See Article 12	As required	Part shall be water break free.
2	Pre-Heating	Hot Water Rinse (57-70°C)	3 minutes MIN	Required. Part shall reach a 57°C minimum.
3	Nitric Acid Etch	- Nitric Acid 3-10% (vol/vol) in methanol or ethanol solution	30-60 seconds	Time established per the requirements of this specification.
4	Rinse	Hot Water Rinse (57-70°C)	As required	To remove acid.
5	Alcohol Dip	Methanol or Ethanol	As required	To remove water.
6	Bleach	Hydrochloric Acid, 2-6% by volume in ethanol or methanol, solution	30 seconds MAX	Time established per the requirements of this specification.
7	Rinse	Water	As required	Removes any remaining acid.
8	Neutralize	Alkaline solution with pH \geq 10	10-60 seconds	Not required if final step uses water-based alkaline rust preventative of pH 8 or higher. Optional if parts scrapped after etching.
9	Rinse	Water	As required	To remove caustic. Optional if neutralize is unnecessary.
10 Optional	Dip & Dry	Alcohol dip, contaminant-free air blast dry	>1-minute dip, dry immediately	Optional. To remove water.
11	Rust Prevention	-Water displacing oil or -Suitable alkaline water-based rust preventative, pH \geq 8 ⁽¹⁾	As required	Prevents corrosion and aids color contrast.

Figure 4 - Type 2 Etching

Note: Agitate part while immersed for all steps.

Note (1): If step 11 utilizes an alkaline water-based rust preventative with pH greater than 8, then steps 8, 9, and 10 are optional.

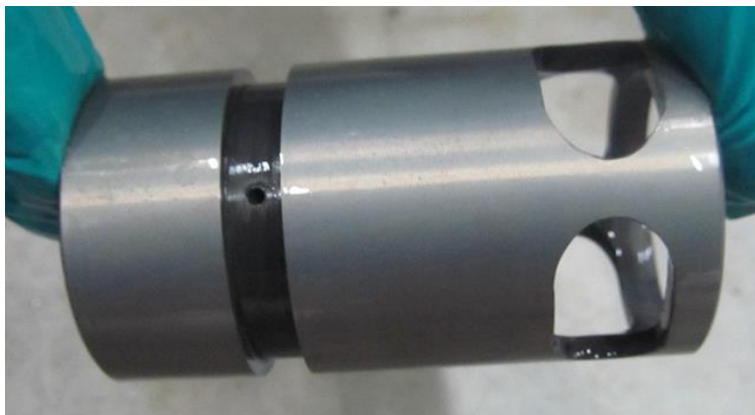
THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.			
INSPECTION – ACID ETCH	DATE 13 JUL 2018	CHG NO 06	NUMBER 1E2317

15.0 EXAMPLES OF GRINDER DAMAGE

15.1 Class A – No thermal damage



FA - ground flat face



FA - ground outer diameter



FA - ground flat face



FA - ground gear teeth



FA - ground gear teeth

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.

INSPECTION – ACID ETCH			
DATE		CHG NO	NUMBER
13 JUL 2018		06	1E2317

15.2 Class B – light thermal damage



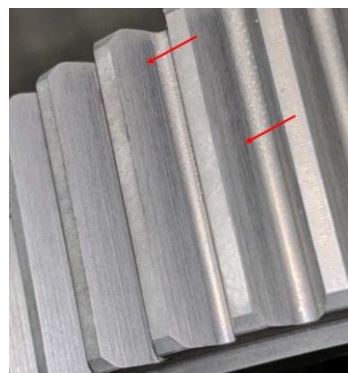
FB1 - ground face



FB1 - ground face



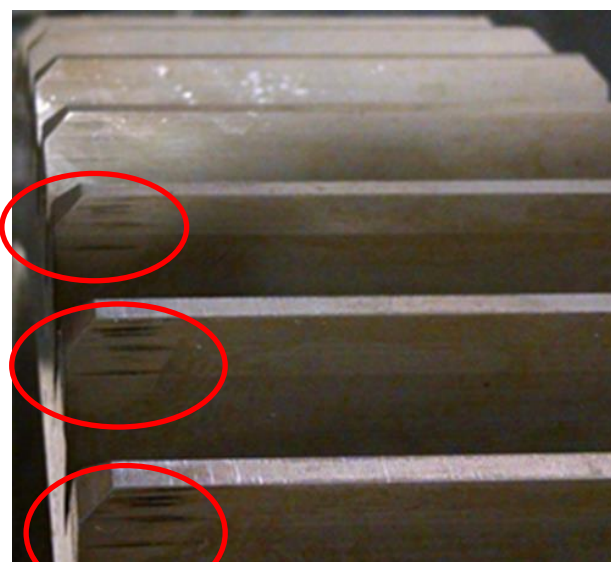
FB1 - ground face



FB1 - ground gear tooth



FB1 - ground face



FB1 - ground gear tooth

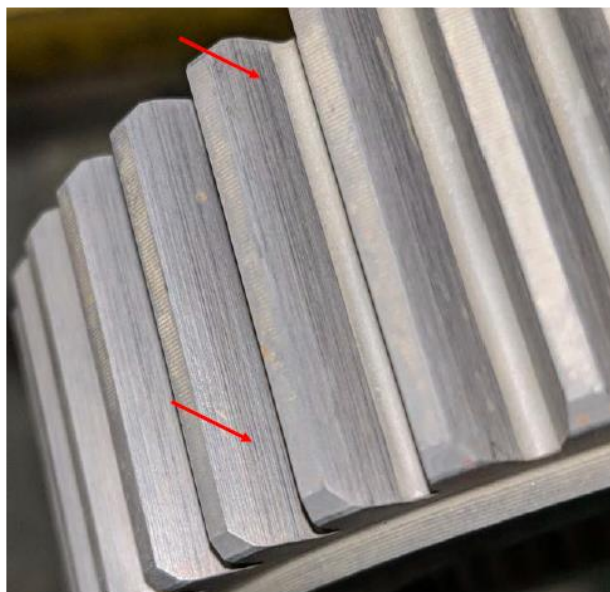
THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317



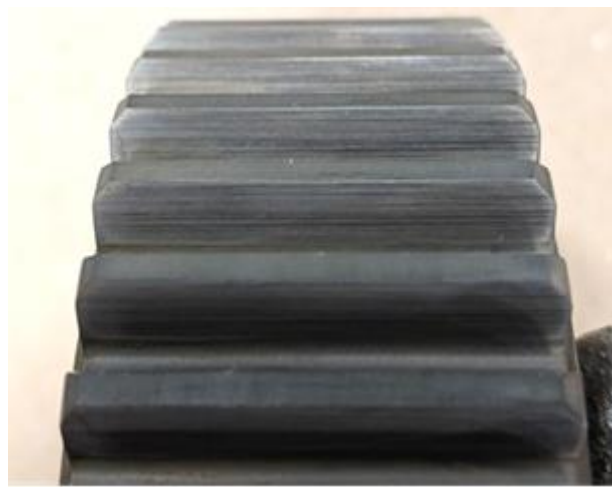
FB1 - ground gear tooth



FB1 - ground gear tooth



FB3 - ground gear tooth



FB3 - ground gear tooth

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

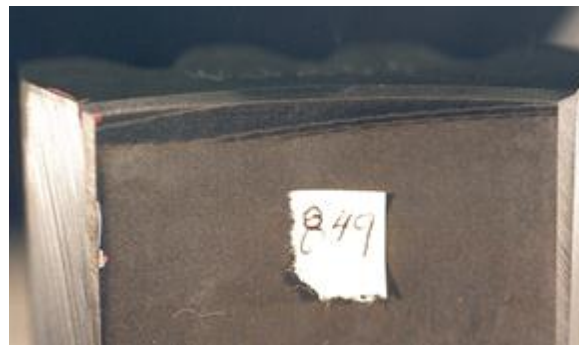
CHG NO
06

NUMBER
1E2317

15.3 Class D – heavy thermal damage (heavy, dark black temper back)



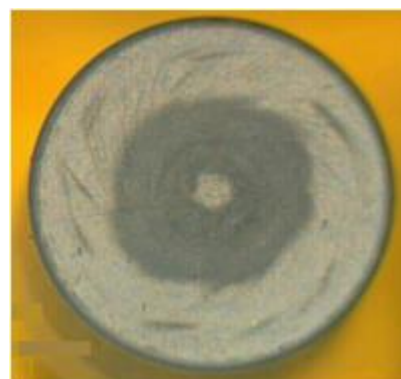
FD1 - ground gear tooth



FD1 - ground bore



FD2 - ground journal



FD3 - ground face



FD3 - ground gear tooth



FD3 - ground face

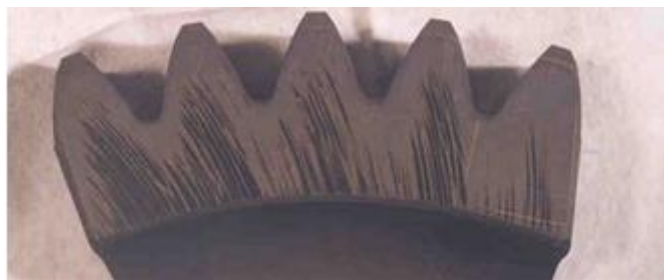
THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

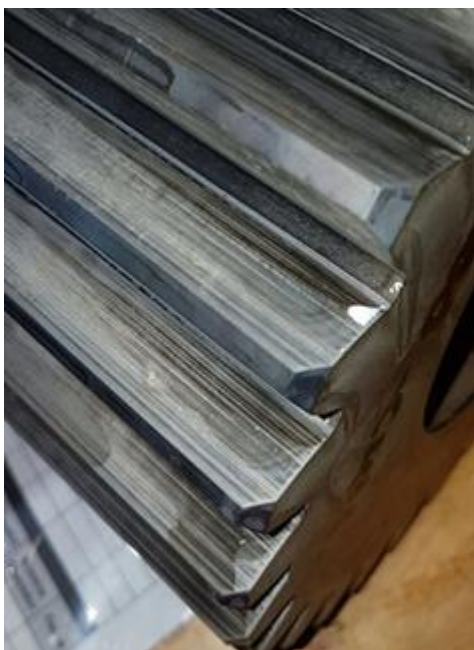
NUMBER
1E2317



FD3 - ground end face



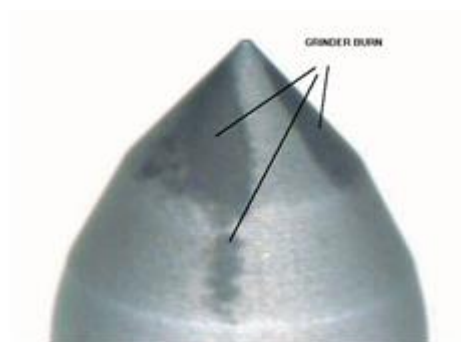
FD3 - ground face



FD3 - ground gear tooth



FD3 - ground gear tooth



FD3 - ground tip

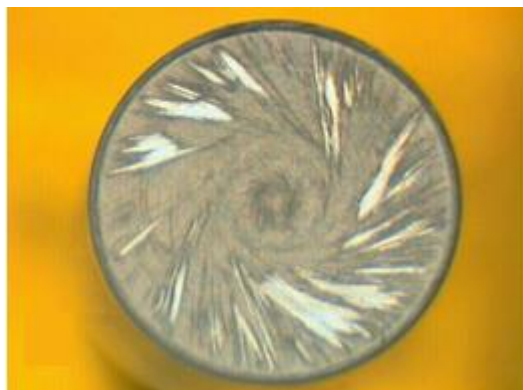
THE INFORMATION HEREON IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMITTAL TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS LOANED, IS PROHIBITED.

INSPECTION – ACID ETCH			
	DATE	CHG NO	NUMBER
	13 JUL 2018	06	1E2317

15.4 Class E – severe thermal damage (rehardening)



FE2 - ground end face



FE2 - ground end face



FE3 - ground journal



FE3 - ground end face



FE3 - ground tip

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.

INSPECTION – ACID ETCH			
	DATE	CHG NO	NUMBER
	13 JUL 2018	06	1E2317

16.0 REFERENCES

Abbreviations	1E0011
Caterpillar	MF1024, MH1027, MH1028, HTE11596 Validation Test Piece
AMS	2649
ANSI/AGMA	2007-C00
ISO	14104
SAE	ARP1923

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.

INSPECTION – ACID ETCH

DATE
13 JUL 2018

CHG NO
06

NUMBER
1E2317