

## 5 Inspection criteria

### 5.1 Visual appearance and classification

The appearance of tempering indications is described in table 4. Parts with no temper indications will be uniform gray in color when properly cleaned and etched. Localized tempered areas appear as dark gray or black areas on the etched part. Generally, the severity of temper burns increases as the color becomes darker. If sufficient heat is generated during grinding, rehardening may result. The rehardened area will contain an area of white or light colored untempered martensite, and may be surrounded by a black tempered area.

number (contact),  $\sigma_{HP}$  values for carburized surfaces with localized tempering. When possible, inspection of tempered areas should be performed using microhardness testing methods. Because of differences in hardness test methods, the equipment type, loads, and conversion charts used should be reported. There are some portable microhardness testers available that will allow hardness testing without damaging parts. However, their proper use is essential to ensure accurate hardness readings. Some difficult to reach areas may also be inaccessible to this equipment.

False indications which may be caused by smears, stains, rust, or other differences in surface conditions shall require cleaning and retesting. Since repeated etching may result in appreciable metal removal, care must be exercised to ensure that close tolerance dimensions are maintained. Stains may often be distinguished from actual temper indications since stains can be wiped off almost entirely. Temper

Any indications, especially rehardening burns, i.e., untempered martensite, may affect the durability of the part, but the part may still be functional.

It is good practice to magnetic particle inspect parts with temper indications, especially those with class D or E indications, which are more susceptible to cracking.

The classification system in table 4 should be used to develop the acceptance or rejection criteria.

It is recommended that users of this standard set their own reference standards.

### 5.2 Surface hardness effects

These etching methods detect surface hardness changes more readily than most hardness testing. Experience warrants reduction in allowable stress

indications will remain darker than the surrounding area even after wiping. It should be noted that these etching procedures may be used to discover other hardness differences such as those due to chemistry variation, spotty or non-carburized areas.

## 6 Rework of surface tempered parts

If stock permits, finish ground parts found not to be acceptable by surface temper inspection may be reworked. Permission to rework parts may be required by the customer.

Magnetic particle inspection is required before and after rework operations.

Controlled shot peening may reduce some of the detrimental effects caused by abusive grinding. Use of shot peening on surface tempered areas shall be agreed upon by the customer and supplier.

**Table 4 - Surface temper classification system**

Prefix code		
F = Functional surfaces; includes flanks, ground roots, bearing journals and, if specified, other areas. N = Non-functional surfaces; includes all other ground surfaces.		
Class code <sup>1)</sup>		
Class	Description	Visual appearance, worst area
A	No tempering	Uniform gray color
B	Light tempering	Narrow (light) indications
(C) (Obsolete class)	(Moderate tempering)	(No longer used)
D	Heavy tempering	Wide (dark) indications
E	Rehardening Severe overheating	White area surrounded by black indications
Suffix code		
Level	Maximum percentage of surface area affected <sup>1)</sup>	
1	10%	
2	25%	
3	Unrestricted	
NOTE: <sup>1)</sup> Measured on a single surface such as a tooth flank.		
Sample classification callouts are as follows: FA/NE2: No tempering is allowed on any functional surface, but light tempering on up to 25% of the area of the worst single non-functional surface, such as a shoulder, is permitted. FB1/ND2 FE2: Implies no restrictions on non-functional surfaces. FB3/FD2/ND3: Light tempering of an unrestricted amount and heavy tempering on up to 25% of the area of the worst single functional surface, such as a single tooth flank, is permitted. In addition, heavy tempering of an unrestricted amount is permitted on non-functional surfaces.		