



BSI Standards Publication

## **Gears - Surface temper etch inspection after grinding, chemical method**

---

## National foreword

This British Standard is the UK implementation of ISO 14104:2017. It supersedes BS ISO 14104:2014 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee MC/5, Gears, to Subcommittee MCE/5/-/14, Gears-materials.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2017  
Published by BSI Standards Limited 2017

ISBN 978 0 580 92853 6

ICS 21.200

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2017.

### Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

---

INTERNATIONAL  
STANDARD

**ISO**  
**14104**

Third edition  
2017-04-15

---

---

**Gears — Surface temper etch  
inspection after grinding,  
chemical method**

*Engrenages — Contrôle par attaque chimique des zones surchauffées  
lors de la rectification*



Reference number  
ISO 14104:2017(E)



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Apparatus</b> .....	<b>1</b>
4.1 Container materials.....	1
4.2 Inspection area.....	1
4.3 Cleaner.....	2
4.5 Grey scale reference.....	2
<b>5 Reagents</b> .....	<b>2</b>
<b>6 Procedure</b> .....	<b>3</b>
6.1 General.....	3
6.2 Cleaning.....	4
6.3 Etching.....	6
<b>7 Inspection criteria</b> .....	<b>7</b>
7.1 Visual appearance and classification.....	7
7.2 Surface hardness effects.....	8
<b>8 Temper etch discoloration removal</b> .....	<b>8</b>
<b>9 Rework of surface-tempered parts</b> .....	<b>8</b>
<b>10 Operator qualification</b> .....	<b>8</b>
<b>11 Maintenance and control</b> .....	<b>8</b>
<b>12 Safety and environmental precautions</b> .....	<b>14</b>
<b>13 Specifications and documentation</b> .....	<b>15</b>
13.1 Specifications.....	15
13.2 Documentation.....	15
<b>Bibliography</b> .....	<b>16</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

This third edition cancels and replaces the second edition (ISO 14104:2014), which has been technically revised. The changes of the corrected version have been incorporated as well as adoptions in the cleaning method of etching procedures shown in [Tables 2](#) and [3](#).

## Introduction

This document explains the materials and procedures necessary to determine, evaluate and describe localized overheating on ground surfaces. A system to describe and classify the indications produced during this inspection is included. However, specific acceptance or rejection criteria are not contained.

An industry-wide survey was conducted to establish common solutions in time that were acceptable to the greatest number of users. The safety and environmental precautions were included therein for those not familiar with storage, handling, use and disposal of concentrated acids, alkalis and solvents. These precautions, however, do not supersede the latest applicable requirements.





# Gears - Surface temper etch inspection after grinding, chemical method

## 1 Scope

This document specifies procedures and requirements for the detection and classification of localized overheating on ground surfaces by chemical etch methods.

The process described in this document is typically used on ground surfaces; however, it is also useful for the detection of surface anomalies that result from post-heat treatment machining such as hard turning, milling and edge breaking (deburring) processes. Surface metallurgical anomalies caused by carburization or decarburization are also readily detectable with this process.

Some methods which have been used in the past are no longer recommended. Specifications are intended to be changed to use the methods in this document. These etching methods are more sensitive to changes in surface hardness than most hardness testing methods.

This document applies to steel parts such as gears, shafts, splines and bearings. It is not applicable to nitrided parts and stainless steels.

**NOTE** This process, although at times called “nital etch”, is not intended to be confused with other processes also known as “nital etch”.

The surface temper etch procedure is performed after grinding and before additional finishing operations such as superfinishing, shot peening and honing.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

## 4 Apparatus

### 4.1 Container materials.

Container materials shall not react with the solutions contained, nor damage the parts to be processed. All containers should be labelled with the solution contained and covered when not in use. Containers should be labelled according to local regulations.

### 4.2 Inspection area.

The area to be inspected shall be sufficiently illuminated to be free of shadows and reflections. A minimum light intensity of 2 200 lx (~200 foot candles) at the inspection level is recommended.

#### 4.3 Cleaner.

An alkaline cleaner, vapour degreaser, solvent wash or equivalent cleaning process shall be used.

#### 4.4 Timing device.

A suitable timing device shall be used for the uniform processing of all parts in a group.

#### 4.5 Grey scale reference.

A suitable grey scale reference should be used, such as Tiffen Color Separation Guide and Gray Scale Q13 (small) or Q14 (large)<sup>1)</sup>.

[Figure 1](#) is an example of a suitable grey scale reference. Use of a sample part with known indications to exhibit surface tempering is also recommended.

[Figure 1](#) is an approximate reproduction of a commercially available grey scale. The reproduction shown in this image is not accurate due to variance in graphic reproduction quality and is provided for reference only. It shall not be used for inspection in conformity with this document.

The grey scale card should be replaced at regular intervals.

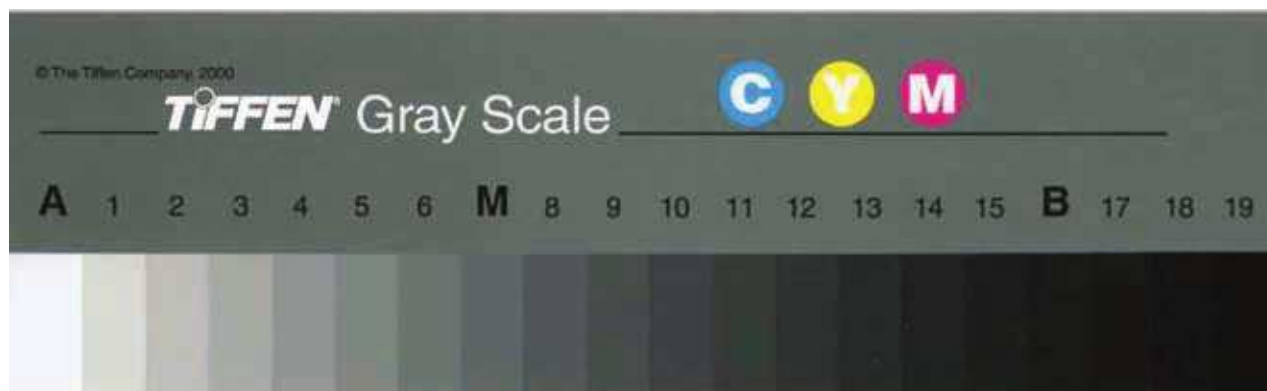


Figure 1 — Gray scale card (reprinted with the permission of The Tiffen Company)

## 5 Reagents

All chemicals shall be technical grade or better.

**5.1 Cleaning materials**, which ensure removal of all dirt, grit, grease and oil, to obtain a “water break”-free surface. A “water break”-free surface is one which maintains a continuous water film for a minimum period of 15 s after having been rinsed in clean water at a temperature below 40 °C.

**5.2 Nitric acid.**

See [Tables 2](#) and [3](#).

**5.3 Hydrochloric acid.**

See [Tables 2](#) and [3](#).

---

1) Tiffen Gray Scale is the trade name of a product supplied by Tiffen. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

**5.4 Alcohol**, methanol or denatured ethanol, clean and free of contaminants such as oil.

**5.5 Water**, clean and free of contaminants. Distilled water preferred, but not required.

**5.6 Alkaline solution**, a solution such as 4 % to 6 % sodium hydroxide in water with a minimum pH value of 10 or equivalent.

**5.7 Rust-preventive oil**, suitable for displacing water and which does not mask the results of etching.

## 6 Procedure

### 6.1 General

As shown in [Figure 2](#), clean the part first (see [6.2](#) and [Table 1](#)) then etch it using one of the procedures shown in either [Table 2](#) or [Table 3](#), whichever is appropriate for the type of steel being inspected. Unless otherwise specified, selection of the specific procedure shall be at the supplier's option.

**Table 1 — Examples of cleaning methods**

Type of contaminant	Method of cleaning
Dyes and inks	Alcohol, methyl ethyl ketone or equivalent
Oil and grease	Vapour degreasing
Soaps	Alkaline cleaner (60 °C to 80 °C) or ultrasonic cleaner

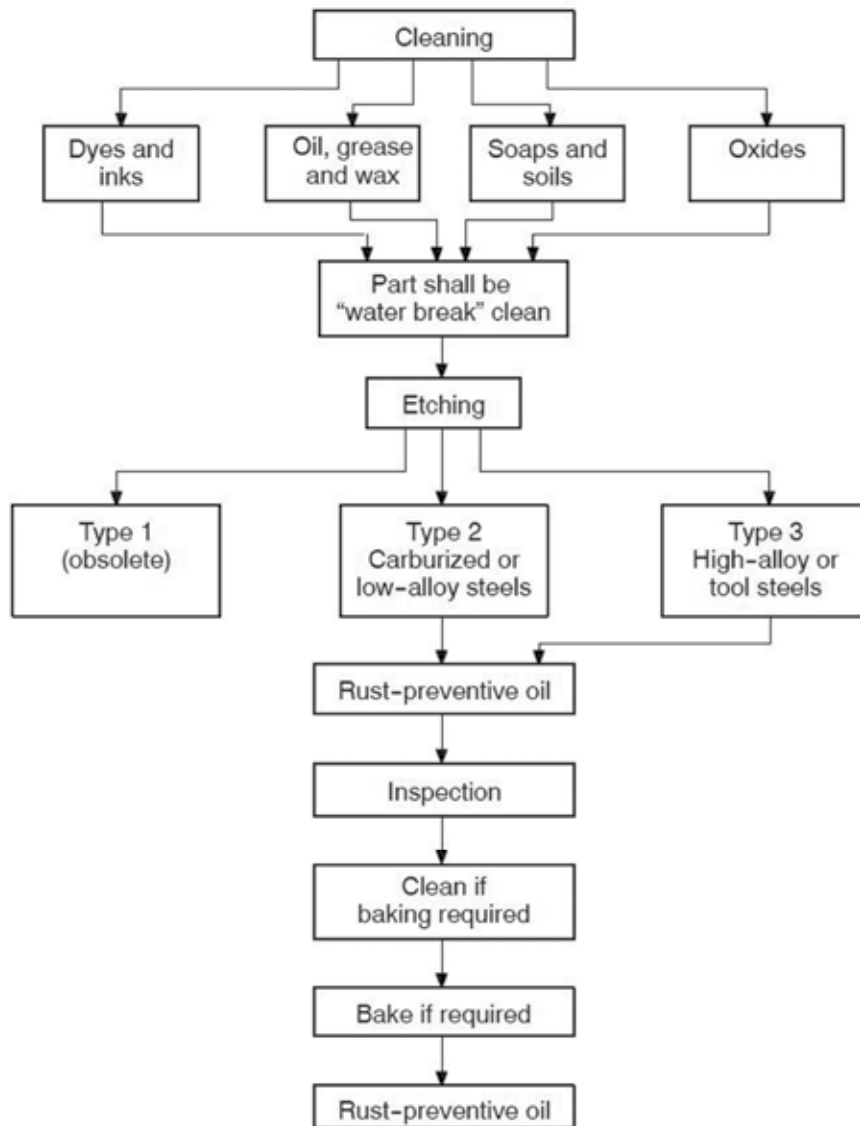


Figure 2 — Procedure flow chart

## 6.2 Cleaning

Proper cleaning is mandatory for parts to be etched and inspected. Satisfactory cleaning will be evidenced by the absence of “water breaks” on the clean parts after immersion in water. The cleaning procedure shall be chosen by the supplier. The exact method depends on the type of contaminant present. [Table 1](#) lists contaminants and corresponding methods of cleaning in common use.

Additional processes can be required to remove residues from the parts prior to etching. Thorough cleaning of parts prior to etching is imperative in order to obtain good results. Improper cleaning will result in non-uniform discoloration and staining which can lead to difficult interpretation of etching results. A typical (recommended) cleaning procedure consists of the following:

- vapour degreasing or solvent cleaning;
- abrasive cleaning: select particle size, media and blasting procedure to maintain surface finish and dimensions; avoid damage and handle parts with clean white gloves;
- alkaline or ultrasonic clean;

- rinsing in water and examining for water breaks after cleaning. If water break occurs, re-clean and re-examine for water break until water break free.

**Table 2 — Type 2 etching**

Step <sup>a</sup>	Process	Solution <sup>b</sup>	Recommended time <sup>c</sup>	Remarks
1	Nitric acid etch <sup>d</sup> Grey scale Tank 7(M) to 11, Swab 7(M) to 15	Nitric acid, 1,5 % to 5 % (by volume): — in alcohol — in water	30 s to 60 s 10 s to 30 s	Exact time to develop black oxide film will vary; time should be established and reproduced.
2	Rinse	Water or alcohol	As required	Removes acid
3	Alcohol dip <sup>e</sup>	Alcohol	Dip	Removes water
4	Bleach <sup>d</sup> Grey scale Tank 6 to 10, Swab 2 to 10	Hydrochloric acid, 2 % to 6 % (by volume): — in alcohol — in water	30 s to 60 s	Part should be immersed for a sufficient time to cause a uniform brownish-grey colour on the part; exact bleaching time should be established by test and reproduced.
5	Rinse	Water	As required	Removes acid
6	Neutralize	Alkali solution with pH of 10 minimum	10 s to 60 s	Agitate parts while immersed
7	Rinse	Water	As required	Removes caustic solvents
8	Dry <sup>f,g</sup>	Alcohol or hot water	Dip and dry	Removes water
9	Oil	Rust-preventive	As required	Prevents corrosion and aids in colour contrast

**Table 3 — Type 3 etching**

Step <sup>a</sup>	Process	Solution <sup>b</sup>	Recommended time <sup>c</sup>	Remarks
1	Hydrochloric acid clean <sup>d</sup>	Hydrochloric acid, 2 % to 6 % (by volume): — in alcohol — in water	1,5 min to 3,5 min 30 s to 60 s	Exact time to be established by test
2	Rinse	Water or alcohol	As required	Removes acid
3	Alcohol dip <sup>e</sup>	Alcohol	Dip	Removes water
4	Nitric acid etch <sup>d</sup> Grey scale 11 to 15	Nitric acid, 1,5 % to 5 % (by volume): — in alcohol — in water	1,5 min to 3,5 min 30 s to 60 s	Exact time to develop black oxide film will vary; time should be established and reproduced.
5	Rinse	Water or alcohol	As required	Removes acid
6	Alcohol dip <sup>e</sup>	Alcohol	Dip	Removes water
7	Bleach <sup>d,e</sup> Grey scale 2 to 6	Hydrochloric acid, 2 % to 6 % (by volume): — in alcohol — in water	1,5 min to 3,5 min 30 s to 60 s	Part should be immersed for a sufficient time to cause a uniform brownish-grey colour on the part; exact bleaching time should be established by test and reproduced.
8	Rinse	Water	As required	Removes acid
9	Neutralize	Alkali solution with pH of 10 minimum	10 s to 60 s	Agitate parts while immersed

Step <sup>a</sup>	Process	Solution <sup>b</sup>	Recommended time <sup>c</sup>	Remarks
10	Rinse	Water	As required	Removes caustic solvents
11	Dry <sup>f,g</sup>	Alcohol or hot water	Dip and dry	Removes water
12	Oil	Rust-preventive	As required	Prevents corrosion and aids in colour contrast

### 6.3 Etching

Use of a suitable grey scale reference is recommended to quantify the interpretation of temper indications. [Figure 1](#) is an example of a commercially available grey scale reference. Use of a sample part with known indications to exhibit surface tempering is also recommended. The use of a grey scale card is required in order to achieve the goal of improved reproducibility of results over time and between inspectors or laboratories, independent of the specific processing variations allowed by this document.

The suggested ranges for chemical concentrations, dwell times and grey shades are not mandatory for conformance with this document provided that there is evidence that the same surface temper classification (see [Table 4](#)) results as if the recommended ranges were used. Ranges for the shades of grey are suggested rather than maximums and minimums in order to avoid processing that results in shades of grey that are too light or too dark.

**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>&lt;?&gt;</sup>		
Class	Description	Visual appearance, worst area
A	No tempering	Uniform grey colour
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 <sup>&lt;?&gt;</sup>		
Level	Maximum percentage of surface area affected <sup>&lt;?&gt;</sup>	
1	10 %	
2	25 %	
3	Unrestricted	
NOTE Sample classification callouts are as follows:		
— FA/NB2: 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: Light tempering is allowed on up to 10 % of the area of the worst single functional surface. In addition, heavy tempering on up to 25 % of the area of the worst single non-functional surface, such as a shoulder, is permitted.		
— FB2: Light tempering is allowed on up to 25 % of the area of the worst single functional surface. In addition, it 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.		

The following etching techniques are effective preparation for surface temper inspection. The type of etching should be chosen based on the material to be inspected and the ease of handling.



The type 1 (hot bleach) etching method that is sometimes described in older publications is obsolete and not covered in this document.

Type 2 etching (see [Table 2](#)) is generally accepted as a good production inspection method. Type 2 is normally used for inspecting carburized steels and can also be used for surface-hardened areas of through-hardened steels. Occasionally, a part might not respond to step 1, in which case, with engineering approval, consider pre-cleaning as per [Table 3](#), steps 1 to 3.

Type 3 (see [Table 3](#)) is normally used for inspecting tool steels and alloy steels, which do not respond to simple nitric acid etching and require a pre-etch using hydrochloric acid, and can be used in place of type 2. Type 3 etching procedure should be used when grey scale level cannot be developed by nitric acid in step 1 of the type 2 procedure.

Parts which cannot be immersed in tanks can be etched using other techniques such as swabbing or spraying, using the procedures described in [Tables 2](#) or [3](#). Use of a non-immersion technique should be agreed upon by the customer and supplier.

Inspect parts immediately following the complete etch procedure. When using the swab or spray technique, there is a risk of splashing adjacent surfaces such as teeth and critical bearing journals. Therefore, appropriate protective measures should be used.

An elevated-temperature bake to relieve hydrogen embrittlement is not required by this document, but can be recommended or required to comply with other specifications. One process that can be used is SAE AMS 2759/9. If used, the maximum bake temperature shall be at least 14 °C below the final heat-treat tempering temperature in lieu of the temperatures stated in SAE AMS 2759/9.

**CAUTION — Post surface temper etch inspection bake can also serve as a post-machining stress relief prior to subsequent plating processes (such as cadmium or silver plated). In the event that a rejectable indication is detected and requires rework, the post etch bake should not be performed until an acceptable etch is achieved. Baking could make the remnant of reworked indication(s) harder to detect after the bake and rework. This can conflict with bake delay time requirements.**

## 7 Inspection criteria

### 7.1 Visual appearance and classification

The appearance of tempering indications is described in [Table 4](#). Parts with no temper indications will be uniform grey in colour when properly cleaned and etched. Localized tempered areas appear as dark grey or black areas on the etched part. Generally, the severity of temper burns increases as the colour becomes darker. If sufficient heat is generated during grinding, rehardening can result. The rehardened area will contain an area of white or light-coloured untempered martensite surrounded by a black tempered area.

False indications which can be caused by smears, stains, rust or other differences in surface conditions shall require cleaning and retesting unless it can be proven that these are false indications. Since repeated etching can result in appreciable metal removal, care shall be exercised to ensure that close tolerance dimensions are maintained. Stains can often be distinguished from actual temper indications since stains can be wiped off almost entirely. Temper indications will remain darker than the surrounding area even after wiping.

Any indications, especially rehardening burns (i.e. untempered martensite), can affect the durability of the part, but the part can 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 document establish their own reference standards. See [Clause 11](#).

## 7.2 Surface hardness effects

These etching methods can detect surface hardness changes more readily than most hardness testing. Experience can warrant reduction in allowable stress numbers (contact),  $\sigma_{H,lim}$ , values for carburized surfaces with localized tempering. When possible, inspection of areas with indications can be performed using suitable hardness testing methods to supplement surface temper etch results. Due to 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, proper use of any hardness tester is essential to ensure accurate hardness readings and that functional surfaces are not damaged. Some areas can be inaccessible to hardness testing equipment.

## 8 Temper etch discoloration removal

If desired, etch discoloration can be removed for cosmetic purposes by a standard electrolytic alkaline cleaner, vapour honing, polishing or glass-bead cleaning. The process can cause material removal or surface texture changes. Discoloration has no deleterious effects upon operation.

## 9 Rework of surface-tempered parts

If gear metallurgy, stock (case-hardened layer and tooth thickness tolerances) and design permit, finish ground parts found not to be acceptable by surface temper inspection can be reworked. Permission to rework parts can be required by the customer. After rework, parts shall be rechecked. An etching procedure is recommended.

Magnetic particle inspection is recommended before and after rework operations.

Regrinding, refinishing and controlled shot peening, singularly or in combination, can reduce some of the detrimental effects caused by grinding-induced tempering. Use of shot peening on surface-tempered areas shall be agreed upon by the customer and supplier.

## 10 Operator qualification

Test personnel should be qualified for visual testing (VT) in accordance with ISO 9712 or ASNT-TC-1A.

## 11 Maintenance and control

To check solution performance, it is recommended that parts with known temper indications be etched, as required, dependent on solution usage or when new solutions are made. After etching and inspection, the temper etch results shall be removed from the sample as indicated in [Clause 8](#). The sample should then be protected against rust. Such samples should be replaced periodically.

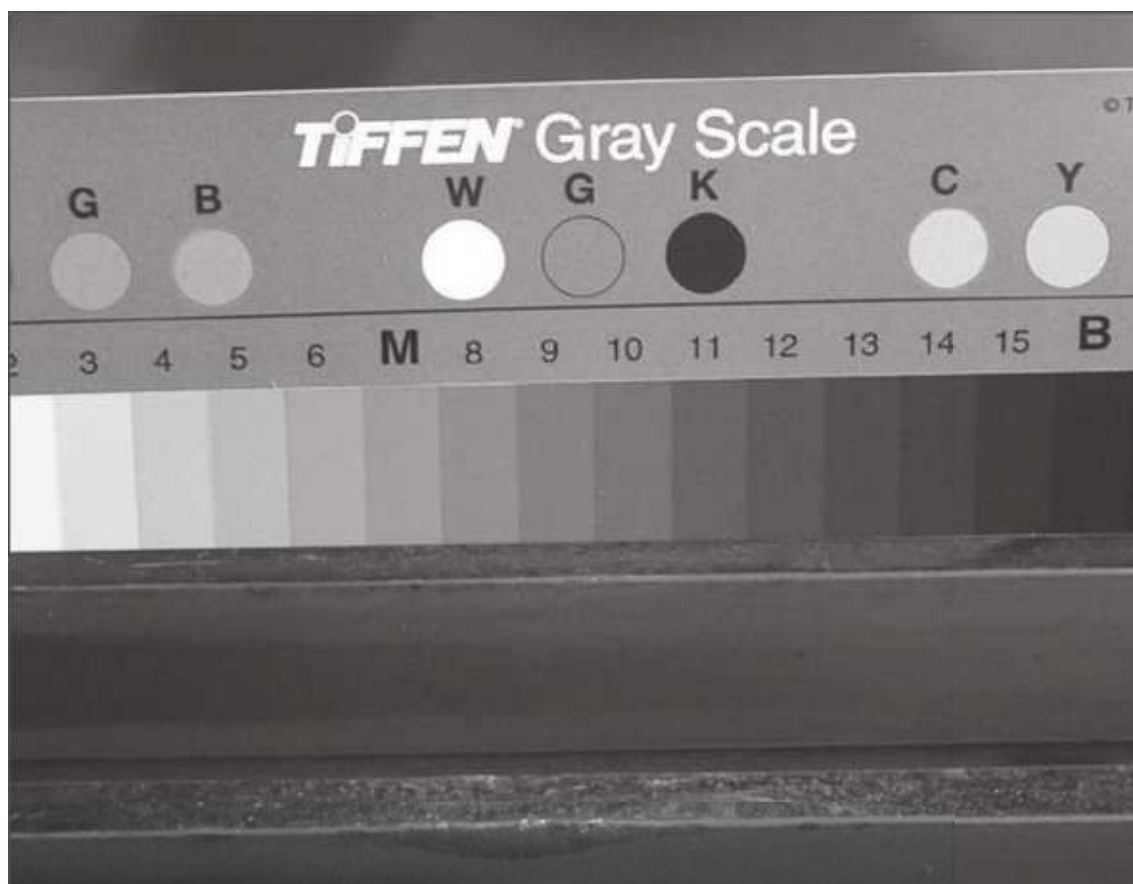
The solutions shall be checked for concentration, pH value and contamination at regular intervals, dependent on usage, and appropriately documented. The preferred method of inspecting acid solutions in alcohol is by alkali titration.

It is recommended that users of this document use a sample part with grinding temper and rehardening indications as a calibration and verification aid. The sample part should be cleaned with an abrasive pad with non-metallic fibres.

**WARNING — Abrasive pads with metallic fibres can cause corrosion.**

If the results using the same procedure are the same shade of grey as previously observed for the same part when previously etched, the operator can proceed. A photograph of the same part previously etched is a useful reference document. If there is a difference, the baths should be rechecked and corrected before the operator can proceed. See [Figures 3 to 13](#) for sample photographs.





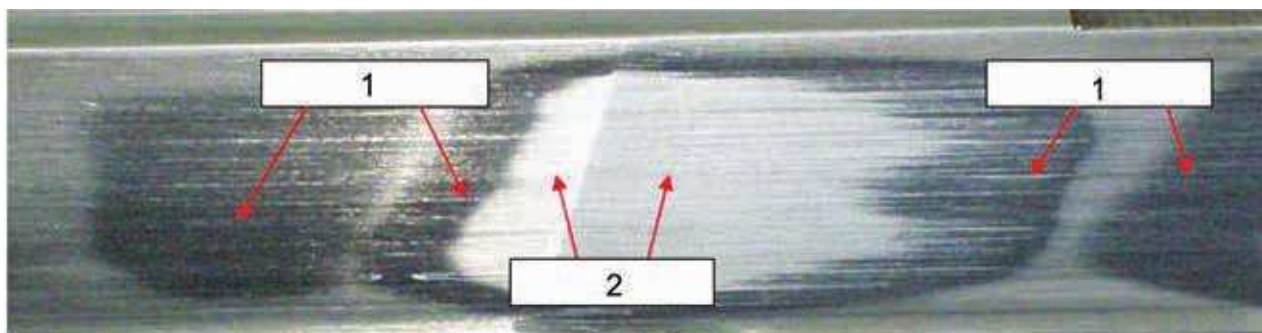
NOTE Grey scale is used for comparison of subtle colour changes across the width of the tooth from the left-hand region that is dark grey (FD) in the root area of the tooth. Surfaces not tempered appear uniform grey in colour.

**Figure 3 — Example of using grey scale for progressively heavier tempering, Class FD**



NOTE This shows progressive overheating in dedendum area near root area. Rehardened areas (FE) appear as white etching areas with dark grey etching overheated areas (FD) surrounding the white etching areas.

**Figure 4 — Progressive tempering and rehardening (severe overheating), Class FD and Class FE**



**Key**

- 1 heavy tempering
- 2 rehardening

**Figure 5 — Class FE rehardening/severe overheating with adjacent Class FD heavy tempering**



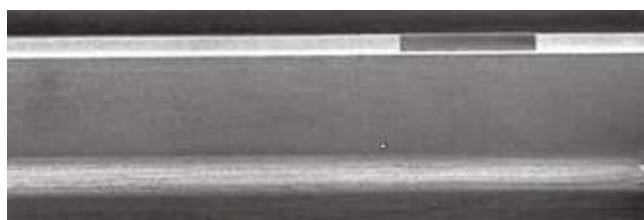
**Figure 6 — Progressively worse surface temper of teeth from left with Class FA no tempering to right with Class FE rehardening surrounded by Class FD heavy tempering on four teeth at right**



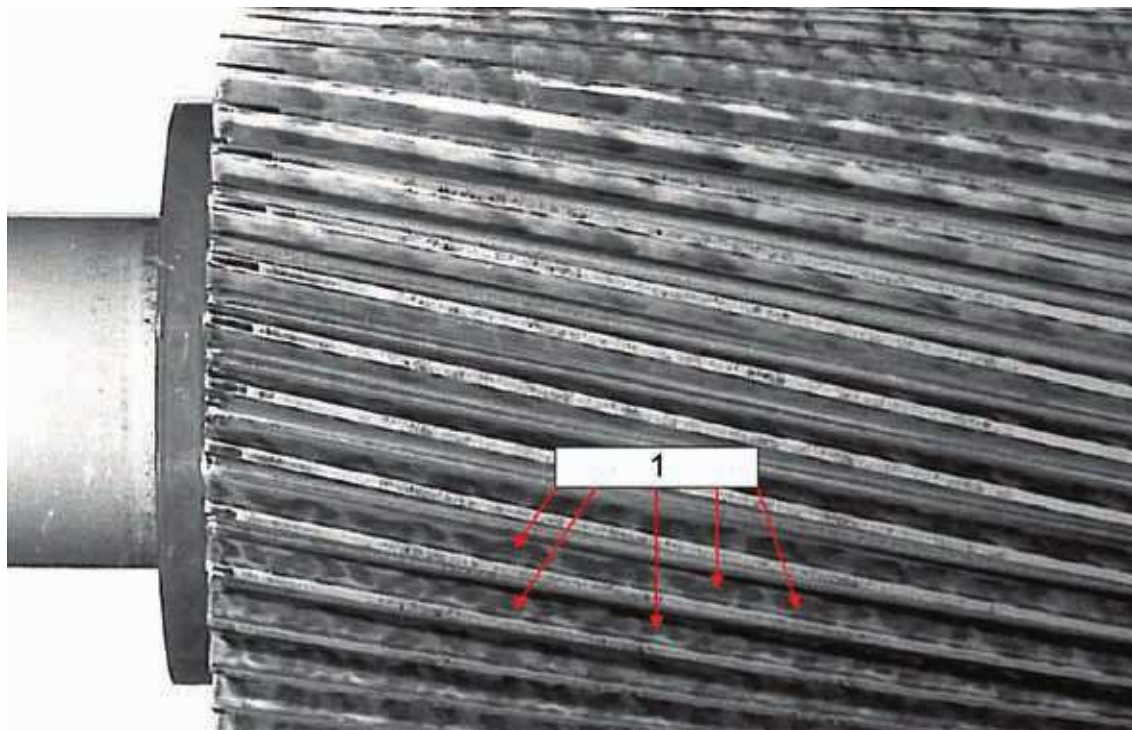
**Key**

1 heavy tempering

**Figure 7 — From Class FB to Class FD heavy tempering**

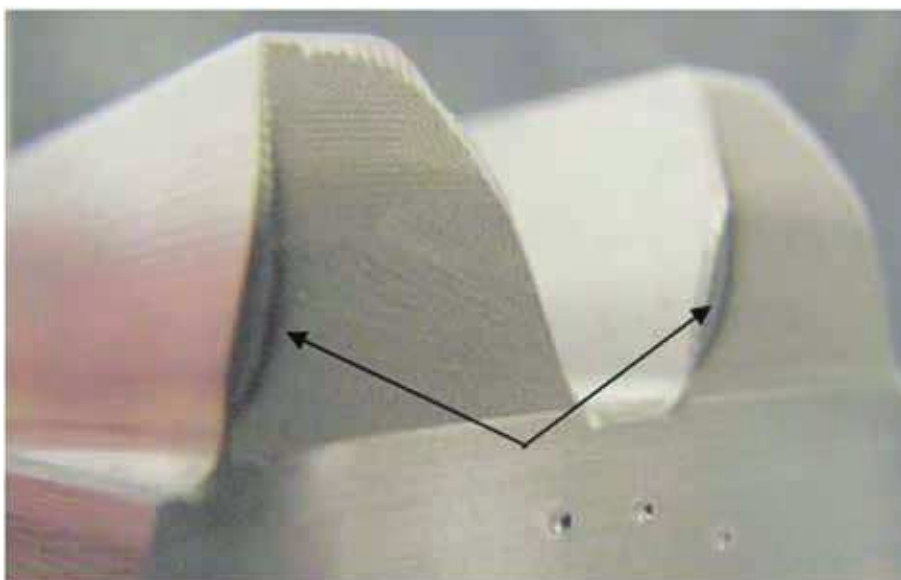


**Figure 8 — Class FA no tempering**



**Key**  
1 heavy tempering

**Figure 9 — Class FD heavy tempering**



**NOTE** Tempering bluing on a corner of a gear tooth evident before surface temper etch inspection is a visible clue that grinding is overheating the tooth.

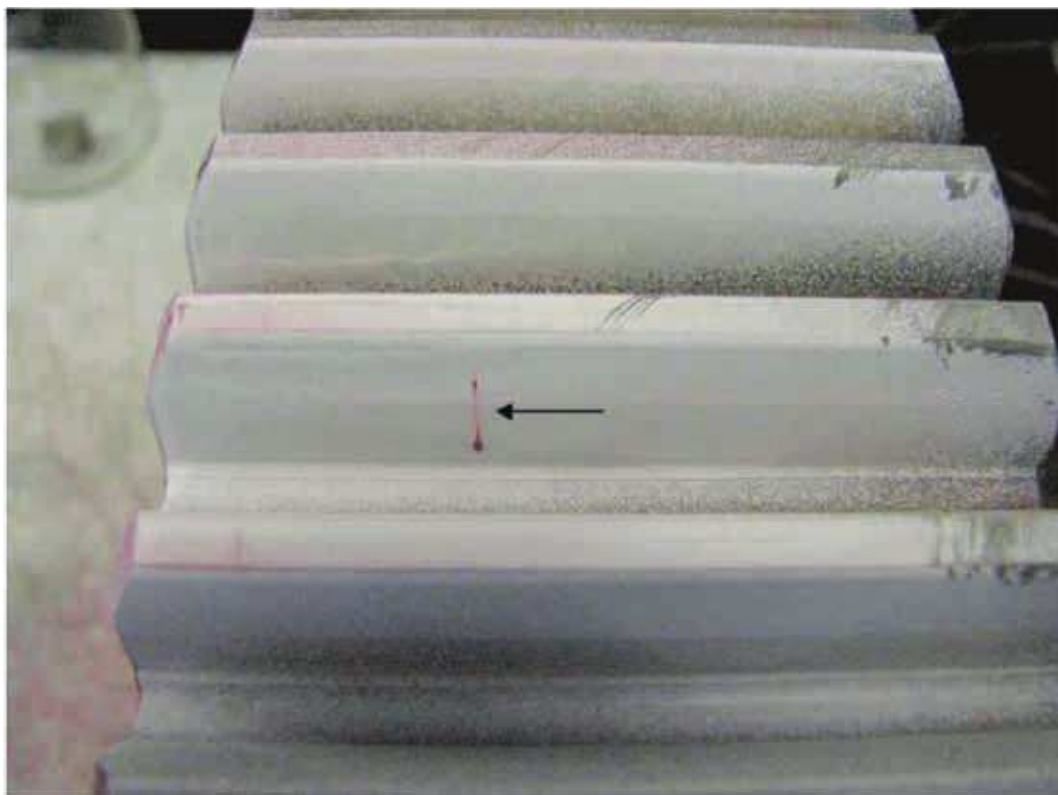
**Figure 10 — Tempering at end of tooth**



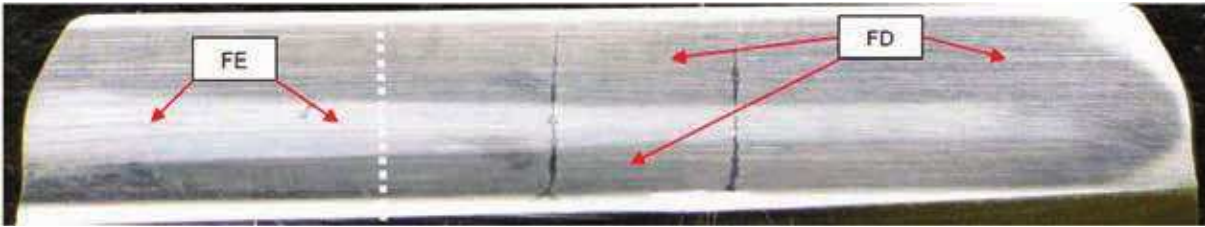


NOTE Crack is visible at arrow.

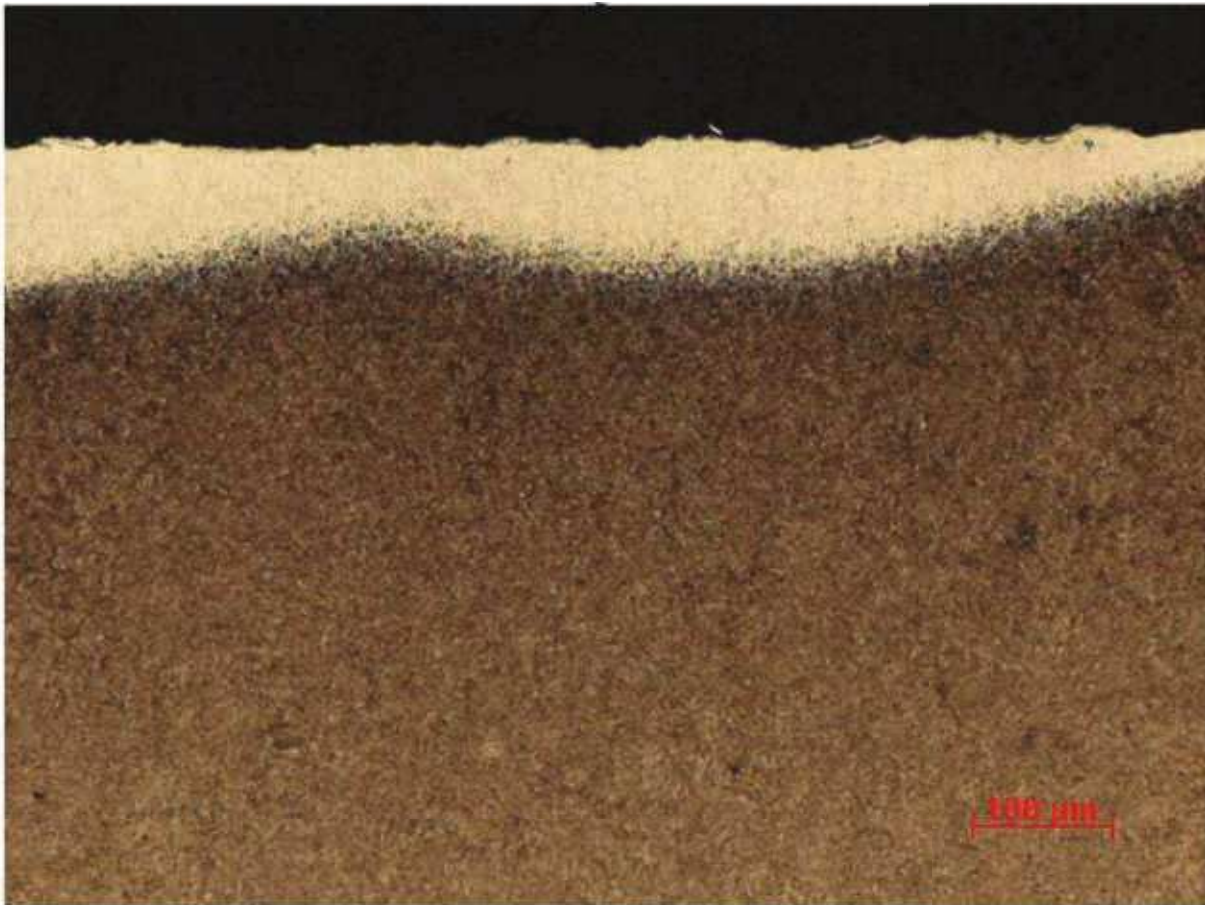
**Figure 11 — Adjacent teeth Class FD heavy tempering, one tooth with crack**



**Figure 12 — Dye penetrant inspection of teeth shown in [Figure 11](#)**



a)



b)

NOTE 1 [Figure 13](#) a): Tempered and rehardened areas revealed by surface temper etch inspection. Tooth sectioned along dotted line for microstructure.

NOTE 2 [Figure 13](#) b): Microstructure of sectioned area. White area is the rehardened microstructure at surface 75 μm deep. Mixed microstructure (white, black, blue and tan) area (approximately 250 μm) is over tempered. Tan area (below the white and mixed microstructure areas) is the original carburized case.

**Figure 13 — Tooth with rehardening (severe overheating), Class FE and Class FD**

## 12 Safety and environmental precautions

The following are recommended safety and environmental precautions.

- Concentrated and diluted acids and alkalis can be dangerous. If any contact with the body occurs, flood immediately with cold water. Seek physician for medical attention.

- Avoid contact with solvents such as methyl ethyl ketone (MEK), as serious skin “burn” can result. Use with adequate ventilation.
- Always add the acid to water or alcohol. Do not add water or alcohol to acid.
- Keep tanks covered when not in use.
- Protective gloves, face shield and apron should be worn at all times when mixing or working with acid and alkaline chemicals.
- Comply with occupational safety and health regulations covering training, material safety data sheets, storage and labelling of containers and tanks.
- Comply with regulations covering permissible exposure limits for all acids, chemicals and by-products.
- Ventilation should be in accordance with applicable regulations.
- Comply with regulations on flammable and combustible liquids, insurance and fire-protection standards covering storage and use of flammable solvents.
- Government regulations for hazardous waste and transportation of chemicals should be observed.
- Community right-to-know and reporting regulations shall be observed.

## **13 Specifications and documentation**

### **13.1 Specifications**

Specifications referring to this document should include

- defined areas to be inspected,
- acceptance criteria for these areas, and
- other applicable restrictions or requirements, such as the use of a swabbing or spraying technique or baking to prevent embrittlement.

Deviations from these requirements are acceptable only upon mutual agreement between the customer and supplier and should be referred to in any documentation provided.

### **13.2 Documentation**

Documentation that surface temper inspection has been carried out in accordance with this document shall be issued by the supplier upon request.

## Bibliography

- [1] ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*
- [2] SAE AMS 2759/9, *Hydrogen Embrittlement Relief (Baking) of Steel Parts, Rev D (5/09)*
- [3] ASNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*





# British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

## About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

## Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at [bsigroup.com/standards](http://bsigroup.com/standards) or contacting our Customer Services team or Knowledge Centre.

## Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at [bsigroup.com/shop](http://bsigroup.com/shop), where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

## Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

## Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.
- Standards purchased in hard copy format:
- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

## Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing team.

## Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to [bsigroup.com/subscriptions](http://bsigroup.com/subscriptions).

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

**PLUS** is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit [bsigroup.com/shop](http://bsigroup.com/shop).

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email [subscriptions@bsigroup.com](mailto:subscriptions@bsigroup.com).

## Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

## Useful Contacts

### Customer Services

**Tel:** +44 345 086 9001

**Email (orders):** [orders@bsigroup.com](mailto:orders@bsigroup.com)

**Email (enquiries):** [cservices@bsigroup.com](mailto:cservices@bsigroup.com)

### Subscriptions

**Tel:** +44 345 086 9001

**Email:** [subscriptions@bsigroup.com](mailto:subscriptions@bsigroup.com)

### Knowledge Centre

**Tel:** +44 20 8996 7004

**Email:** [knowledgecentre@bsigroup.com](mailto:knowledgecentre@bsigroup.com)

### Copyright & Licensing

**Tel:** +44 20 8996 7070

**Email:** [copyright@bsigroup.com](mailto:copyright@bsigroup.com)

## BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK