INTERNATIONAL STANDARD

**ISO 12686**

First edition
1999-12-01

# Metallic and other inorganic coatings — Automated controlled shot-peening of metallic articles prior to nickel, autocatalytic nickel or chromium plating, or as a final finish

*Revêtements métalliques et autres revêtements inorganiques — Grenaillage automatique de pièces métalliques avant dépôt électrolytique de nickel, dépôt autocatalytique de nickel, ou dépôt électrolytique de chrome, ou en tant que finition de surface*



Reference number
ISO 12686:1999(E)

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Printed in Switzerland

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## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12686 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 3, *Electrodeposited coatings and related finishes*.

Annexes A to F form a normative part of this International Standard. Annex G is for information only.

## Introduction

Shot-peening is a process for cold-working surfaces by bombarding the product with shot of a solid and spherical nature propelled at a relatively high velocity. In general, shot peening will increase fatigue life of a product that is subject to bending or torsional stress. It will improve resistance to stress-corrosion cracking. It can be used to form parts or correct their shapes. See annex G for additional information.

It is essential that the shot-peening process parameters be rigidly controlled to ensure repeatability from part to part and lot to lot.

This International Standard describes techniques and methods necessary for proper control of the shot peening process.

# Metallic and other inorganic coatings — Automated controlled shot-peening of metallic articles prior to nickel, autocatalytic nickel or chromium plating, or as a final finish

## 1 Scope

This International Standard describes the requirements for automated, controlled shot-peening of metallic articles prior to electrolytic or autocatalytic deposition of nickel or chromium, or as a final finish, using shot made of cast steel, conditioned cut wire, ceramic shot or glass beads. The process is applicable to those materials on which test work has shown it to be beneficial within given intensity ranges. It is usually not suitable for brittle materials. Hand-peening and rotary flap-peening are specifically excluded.

Shot-peening induces residual compressive stresses in the surface and near surface layers of metallic articles, and changes the surface microstructure (including phase transformation), thereby controlling or limiting the reduction in fatigue properties that occurs from nickel or chromium plating of the article, or increasing the fatigue properties of unplated articles.



## 2 Normative references



The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 565:1990, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings.*

ISO 2194:1991, *Industrial screens — Woven wire cloth, perforated plate and electroformed sheet — Designation and nominal sizes of openings.*

ISO 3310-1:1990, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth.*

ISO 3453:1984, *Non-destructive testing — Liquid penetrant inspection — Means of verification.*

ISO 6933:1986, *Railway rolling stock material — Magnetic particle acceptance testing.*

## 3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

**3.1**
**Almen strip**
UNS G10700 carbon steel specimens that are used to calibrate the energy of a shot-peening stream (see Figure 1)

**3.2**
**Almen strip holding fixture**
fixture for holding Almen strips in suitable locations that represent the position and angular orientation of the surfaces of a part where intensity is to be determined and verified (see Figure 2)

**3.3**
**arc height**
flat Almen strips which, when subjected to a stream of shot moving at an adequate velocity, will bend in an arc corresponding to the amount of energy transmitted by the shot stream

NOTE The height of the curved arc measured in millimetres is the arc height, measured by an Almen gauge (see Figure 3).

**3.4**
**automatic equipment**
shot-peening equipment in which parts, fixtures, nozzles and peening parameters are preset by hand or by locating fixtures and verified by inspection personnel

NOTE Peening time is monitored automatically and air pressure or wheel speed is set manually.



**3.5**
**residual compressive stresses**
layer in compression below the surface created by cold-working or stretching the surface beyond the elastic limit by shot-peening



NOTE The depth of compressive stresses is measured from the crown of the dimple to the depth.

**3.6**
**coverage**
extent of obliteration of the original surface by dimples produced by impact from individual shot particles, expressed as a percentage

NOTE 100 % coverage is defined as that leaving 2 % or less of the original surface unpeened because the estimation of coverage of the impressions is difficult when this is about 98 % of the total surface. "100 % coverage" is a theoretical limiting value. Hence, the term "complete coverage" is preferred. Usually, complete coverage requires increasing the base time, i.e. the time of peening to reach 98 % coverage, by 15 % to 20 %. Values of 200 % to 300 %, etc. are obtained by multiplying this run time by 2, 3, etc.

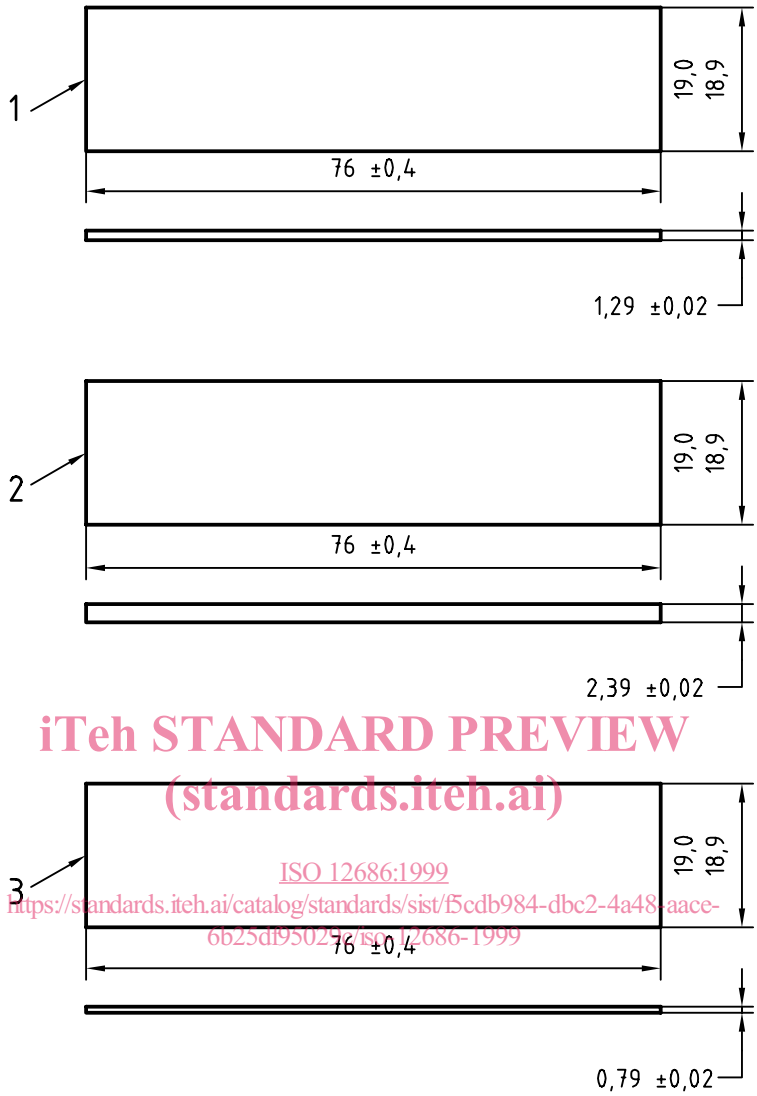
**3.7**
**depth of compressive stresses**
where the stress profile passes through zero stress

**3.8**
**shot peening intensity**
Almen strip arc height at saturation

NOTE Arc height is not correctly termed intensity unless saturation is achieved.

**3.9**
**liquid tracer system**
liquid coating material bearing a pigment that fluoresces under an ultraviolet light and is removed at a rate proportional to peening coverage

Dimensions in millimetres






**Key**

1 Test strip A
2 Test strip C
3 Test strip N

NOTES

Analysis of stock: UNS G10700

Cold-rolled spring steel

Square edge number one (on 76,2 mm edge)

Finish: blue temper (or bright)

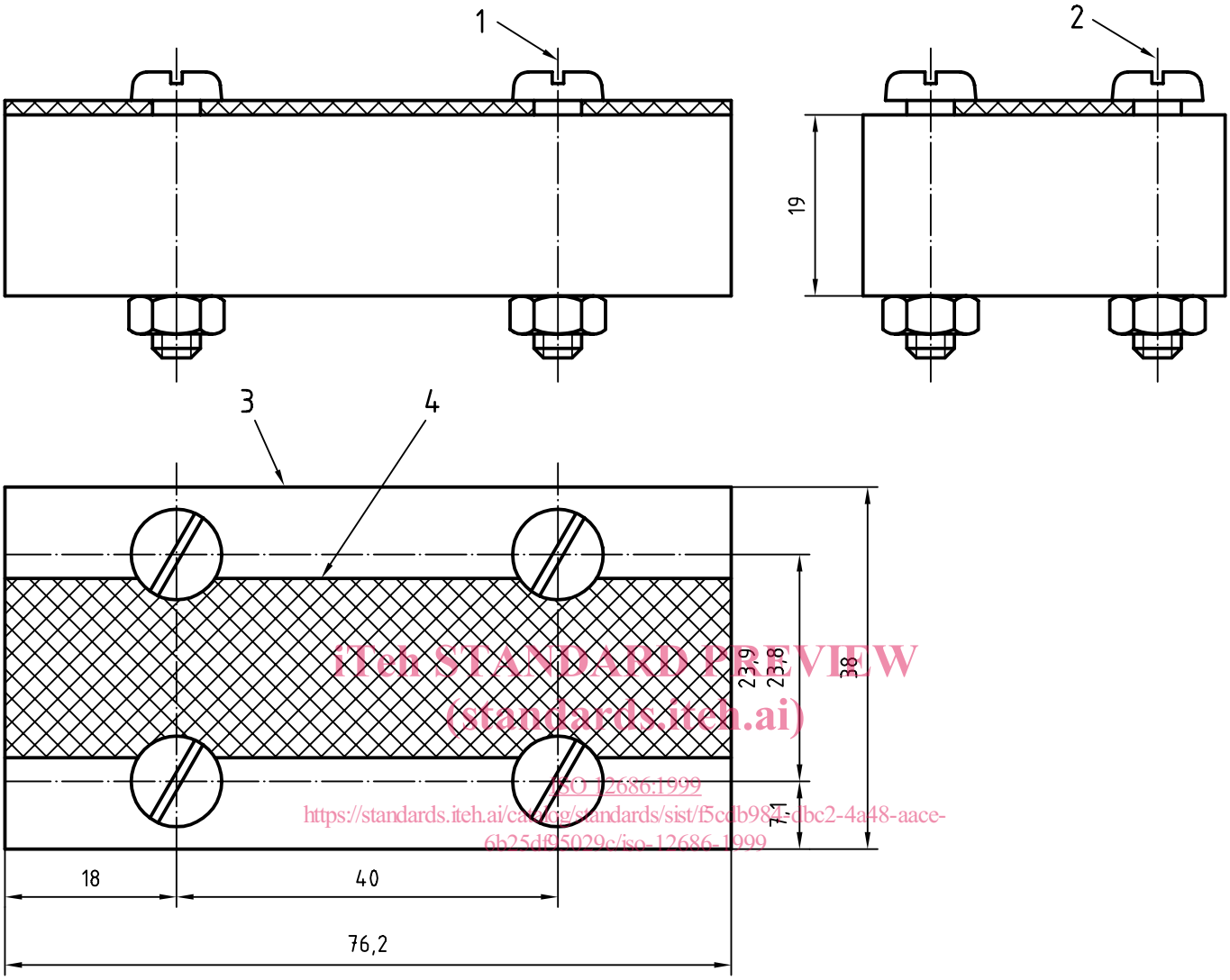
Uniformly hardened and tempered to 44 HRC to 50 HRC

Flatness C ± 0,038 mm arc height

Flatness N and A ± 0,025 mm arc height

**Figure 1 — Almen test specimen**

Dimensions in millimetres



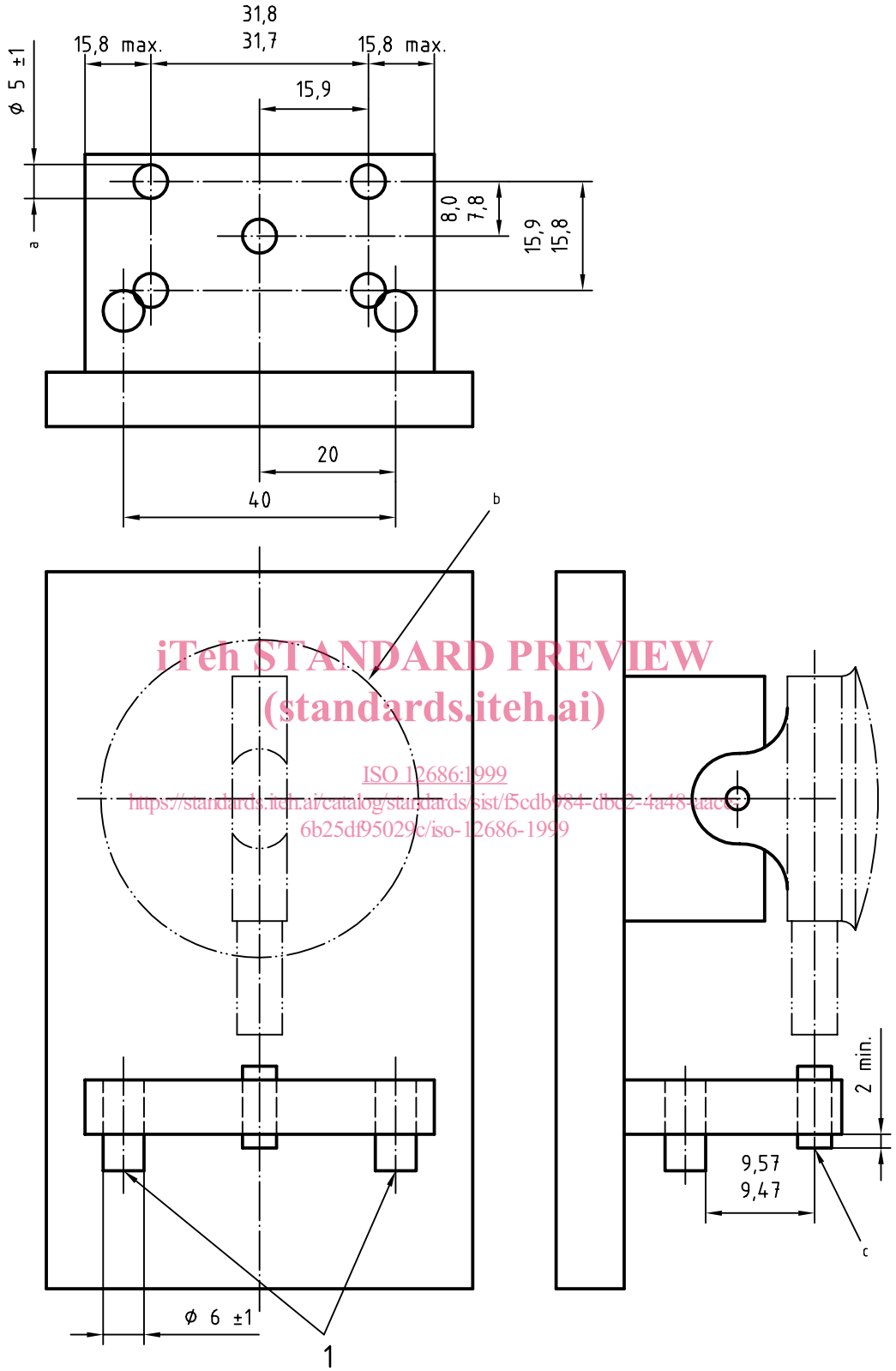



**Key**

1 Four M5 pan head machine screws with hexagonal nuts
2 Four holes of diameter 5,6 mm
3 Holder
4 Test strip (sectioned)

**Figure 2 — Assembled test strip and holder**

Dimensions in millimetres






a Four hardened steel balls

b Dial indicator to be graduated in values of 0,025 mm (0,025 4 mm permitted); maximum extension force 25 gf

c Contact surface of all balls to be in one plane ± 0,05 mm

**Key**

1 Guides

**Figure 3 — Almen gauge**

**3.10**
**microprocessor-controlled equipment**
peening equipment that has nozzle-holding fixtures and is computer-controlled for processing, monitoring and documentation of the peening parameters critical to process certification

**3.11**
**nozzle-holding fixture**
fixture that holds the nozzles at the required location, distance and angle in a locked position during the peening operation

**3.12**
**process-interrupt parameters**
for critical peening operations, parameters such as shot flow, air pressure, rotational speed of parts ($s^{-1}$), oscillation rate and cycle time that must be monitored within process requirements

**3.13**
**saturation**
minimum duration of peening necessary to achieve the desired Almen intensity which, when doubled, does not increase the Almen strip arc height by more than 10 %

**3.14**
**saturation curve**
curve that plots peening time on the Almen strip (abscissa) versus Almen strip arc height (ordinate) achieved for the peening time (see Figure 4)

**3.15**
**surface obliteration**
condition of a peened surface in which 100 % of the surface has been dimpled with shot impressions



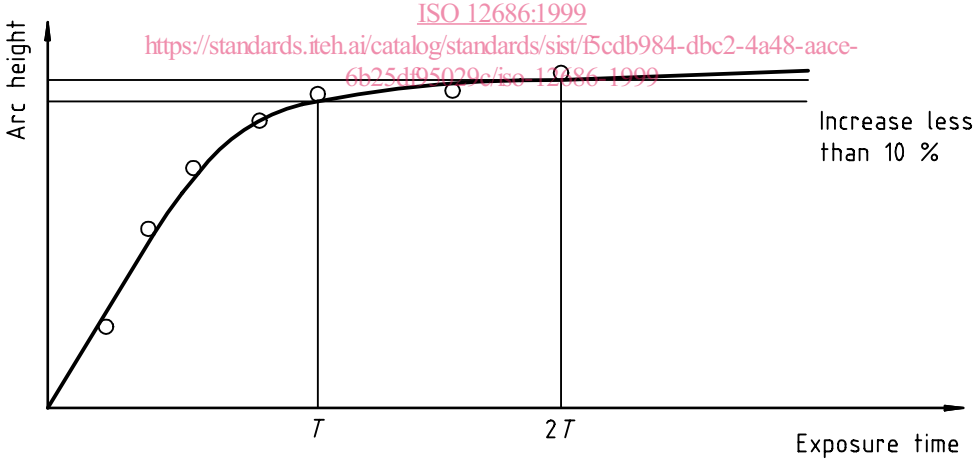



**Figure 4 — Saturation curve**

# 4 Materials and equipment

## 4.1 Shot material composition

**4.1.1 Cast steel shot,** conforming to the requirements given in annex B.

**4.1.2 Cut wire shot,** made from cold-finished, round wire, conforming to annex C.

**4.1.3 Ceramic shot (beads),** conforming to the chemical composition given in Table 1 and in annex D.

**4.1.4** Glass beads, free from lead and free silica and maintained dry and free from any surface contamination or dressings. Glass beads shall have a nominal composition of 72,5 % $SiO_2$, 9,75 % CaO, 13 % $Na_2O$, 3,3 % MgO, 0,75 % of other minor elements and a specific gravity of 2,5 g/cm$^3$.

**Table 1 — Composition of ceramic shot**

| $ZrO_2$ % | $SiO_2$ % | $Al_2O_3$ % | $Fe_2O_3$ % | Free iron % | Specific gravity g/cm$^3$ |
|---|---|---|---|---|---|
| 60 to 70 | 28 to 33 | 10 max | 0,1 max. | 0,1 max. | 3,6 to 3,95 |

## 4.2 Shot form and shape



### 4.2.1 Cast steel

Cast steel shot shall be spherical after pre-conditioning and free from sharp edges, corners and broken pieces. It shall conform to the acceptable shapes given in Figure 5. The number of nonconforming shapes (see Figure 6) shall not exceed the values given in Table 2.



**Table 2 — Maximum allowable nonconforming shapes — cast steel, cut wire and ceramic shot** (as shown in Figure 6)

| Cast steel size | Cut wire size | Ceramic size | Maximum allowable nonconforming shapes per area (1 cm X 1 cm) |
|---|---|---|---|
| 930 | | | 5 |
| 780 | | | 5 |
| 660 | CW62 | | 12 |
| 550 | CW54 | | 12 |
| 460 | CW47 | | 15 |
| 390 | CW41 | | 80 |
| | CW35 | | 80 |
| 330 | CW32 | Z850 | 80 |
| 280 | CW28 | | 80 |
| 230 | CW23 | Z600 | 80 |
| 190 | CW20 | | 80 |
| 170 | | Z425 | 80 |
| 130 | | | 480 |
| 110 | | Z300 | 640 |
| 70 | | Z210 | 640 |