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Watch cases and accessories — Tests of the resistance to wear, scratching and impacts

Boîtes de montres et leurs accessoires — Essais de résistance à l'usure, aux rayures et aux impacts

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 23160 was prepared by Technical Committee ISO/TC 114, *Horology*, Subcommittee SC 6, *Precious metal coverings*.

This first edition of ISO 23160:2011 cancels and replaces ISO 3160-3:1993, which has been technically revised.

Introduction

The quality of a watch depends on many factors. Of these, the resistance of a watch to wear, scratches and impacts is an important aspect contributing to consumer satisfaction.

This International Standard describes tests to simulate the deterioration of the aesthetic of watch cases and their accessories in wearing conditions. In addition, it describes tests for evaluating the wear resistance of surfaces. Where possible, a calibration process is described. The intention of this is to measure and adjust the strain of wear.

For instance, results that simulate a year's wear can be seen after just a few hours, allowing the resistance of decorative layers or the base material to be examined and compared.

The results are evaluated through visual observation, by comparing the parts subjected to accelerated wear tests with reference samples. Evaluation can be completed by measuring roughness and colour changes.

Watch cases and accessories — Tests of the resistance to wear, scratching and impacts

1 Scope

This International Standard specifies tests for the evaluation of the resistance of watch cases and their wristlets to wear, scratching and impacts occurring when wearing the watch.

This International Standard is applicable mainly to complete watch cases fitted with wristlets. However, certain tests can be applied to the watch case only, to the complete or partial wristlet, or to specially prepared samples.

NOTE In order to simulate the state of degradation of a worn watch, it is possible to combine all tests described in this International Standard, by agreement between the contracting parties.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion*

ISO 8251, *Anodizing of aluminium and its alloys — Measurement of abrasion resistance of anodic oxidation coatings*

ISO 11640, *Leather — Tests for colour fastness — Colour fastness to cycles of to-and-fro rubbing*

ISO 27874, *Metallic and other inorganic coatings — Electrodeposited gold and gold alloy coatings for electrical, electronic and engineering purposes — Specification and test methods*

3 Terms and definitions

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

3.1
wear
surface alteration, in particular resulting from friction against clothing

3.2
scratches
surface alterations resulting from general friction against all kinds of objects

3.3
impacts
surface alterations resulting from general shocks against hard and rough surfaces, as well as drops, when wearing the watch

4 Wear resistance

4.1 Wear test using moving ceramic chips

4.1.1 Objective

The aim of this test is to simulate general wear which results from wearing the watch.

4.1.2 Description of test

This wear test is performed using an industrial rotating or vibrating polishing machine, on which a receptacle made of a synthetic organic material is mounted, containing the tested parts and an abrasive load.

On gold plated components, one cycle corresponds to one year of effective wear. For other layers, the correspondence shall be established.

The test conditions depend on the type of machine being used. An example of the test conditions of two machines is shown in B.1.

4.1.3 Abrasive load

4.1.3.1 General

The abrasive load shall be composed of abrasive ceramic elements mixed with fresh water containing a surface tension agent.

Other abrasive elements may also be used, as long as the results remain within the agreed limits established in the calibration test, as described in 4.1.5.

4.1.3.2 Ceramic chips

It is recommended that cylindrical abrasive elements, truncated at 45° at each end and consisting of agglomerated grains of corundum, be used, in accordance with the characteristics defined in Figure 1 and Table 1.

Dimensions in millimetres

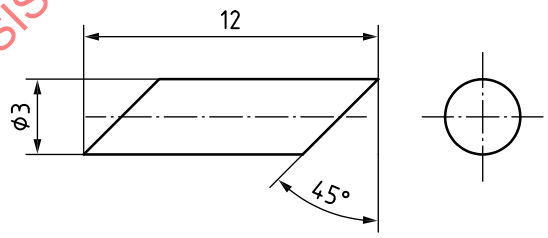


Figure 1 — Details of ceramic chips

Table 1 — Characteristics of ceramic chips

Dimensions	diameter 3 mm, length 12 mm
Indicative density	2,56 g/cm^3
Hardness	900 HV ± 100 HV
Indicative chips composition	— Al_2O_3 45 % — SiO_2 43 % — C 10 % — Na, Mg, K, Ca, Ti, Fe
Abrasive mix (indicative proportions)	— 1 l after being run in chips — 200 ml water — 6 ml concentrated surface tension agent
An example of ceramic chips is given in B.2.1.	

4.1.3.3 Ceramic balls

It is recommended that abrasive elements in the form of small balls, consisting of agglomerated grains of corundum, be used, in accordance with the characteristics defined in Table 2.

Table 2 — Characteristics of ceramic balls

Dimensions	diameter 3 mm to 4 mm
Indicative density	2,56 g/cm^3
Hardness	1 320 HV ± 25 HV
Indicative balls composition	— Al_2O_3 40 % — SiO_2 50 % — C 10 % — Na, Mg, K, Ca, Ti, Fe
Abrasive mix (indicative proportions)	— 1 kg ceramic balls — 250 ml water — 25 ml concentrated surface tension agent
An example of ceramic balls is given in B.2.2.	

4.1.4 Operating procedure

The watch case and its wristlet shall be introduced into the receptacle containing the abrasive load described in 4.1.3. They shall be examined after each cycle.

For calibration, new calibration washers shall be subjected to one wear cycle and their loss of mass measured. The chips shall be run in for at least 50 h.

The type of parts being tested determines the limit of durability of the chips. In all cases, the amount of wear should stay within the defined limits.

4.1.5 Calibration

The duration of the test to simulate the wear of watch cases and wristlets after one year's wear can be evaluated by observing the loss of mass of a standard washer in accordance with the characteristics defined in Figure 2 and Table 3. Once this loss of mass has been established, the duration of one cycle of the accelerated wear test can be determined and observed.

Loss of mass after one cycle should be 6 mg ± 2 mg, measured using a precision balance with a resolution of 0,1 mg.

Dimensions in millimetres

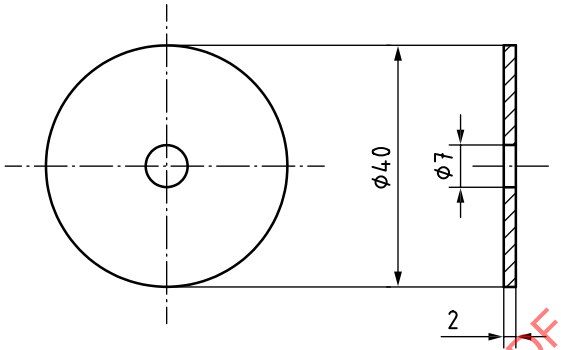


Figure 2 — Details of a standard washer

Table 3 — Characteristics of a standard washer

Material	Stainless steel 1.4435 or 1.4404
Hardness max.	210 HV1 ± 10 HV1
Roughness	N5 (Ra 0,4 µm)

4.1.6 Evaluation of results

Evaluation of wear is done principally by visual inspection and by comparison with reference samples. See Annex A.

Metallographic sections or other methods of determining the thickness of the samples or their coating(s) may be performed to assess the wear which has occurred.

In addition, a corrosion test can be carried out to reveal any possible exposure of the base material.

The limit of wear resistance shall be defined by agreement between the contracting parties.

4.2 Wear test using continuous friction against a textile belt

4.2.1 Objective

The aim of this test is to simulate mild wear resulting from friction against clothes, similar to actual watch wearing conditions.

4.2.2 Description of test

4.2.2.1 General

The test device drives a textile friction belt, applying pressure against a test sample in accordance with Figure 3.

4.2.2.2 Test conditions

The test conditions shall be as follows:

a) strain force of the textile belt: 50 N;

b) speed of the textile belt: 0,5 m/s;

c) penetration of the test sample: 15 mm;

d) test duration: 3 h.

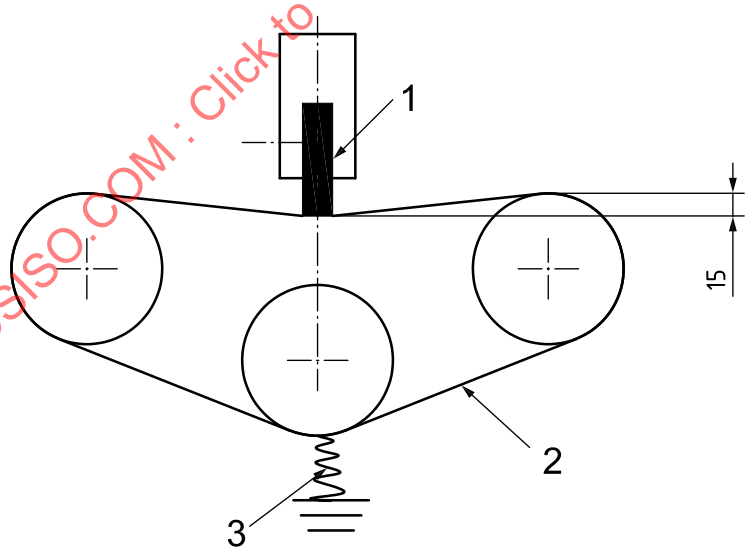
4.2.2.3 Test sample

The textile belt test can be used to test wear resistance of case coatings, wristlets and other components.

Before beginning the test, the adhesion force of the decorative coatings shall be checked, using the methods specified in ISO 2819 and ISO 27874.

The test sample shall be correctly positioned, with parallel contact to the textile belt.

Dimensions in millimetres



Key

1 sample
2 textile belt
3 tension on wheel

Figure 3 — Device for wear test using a textile belt

4.2.3 Abrasive material

The textile belt should have the characteristics shown in Table 4.

Table 4 — Characteristics of textile belt

Material	Terylene
Width	30 mm
Thickness	1,83 mm
Fabric fineness	T62 × 4 tex/W62 × 2 tex

4.2.4 Operating procedure

Prepare a sample with surface characteristics identical to the surfaces of the watch cases and accessories to be evaluated. (See Figure 4.)

The height of the test sample should be adjusted so that the textile part at the contact position can be shifted by 15 mm.

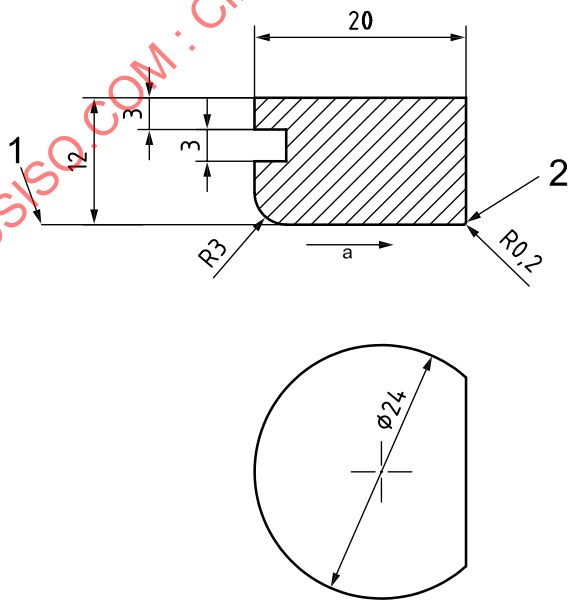
The test sample and test device shall be prepared and cleaned in the same conditions as standard parts.

The test sample shall be mounted firmly, with its surface parallel to the surface of the textile belt. The motor drives the belt in one single direction. After one cycle, or by agreement between the contracting parties, the amount of wear of the test sample is examined.

4.2.5 Calibration

The characteristics of the calibrating gauge should be in accordance with Figure 4 and Table 5.

Dimensions in millimetres



Key

1 wear surface

2 edge

[a] Direction of movement of textile belt.

Figure 4 — Calibrating gauge

Table 5 — Characteristics of calibrating gauge

Material	Stainless steel 1.4435 or 1.4404
Hardness max.	210 HV1 ± 10 HV1
Roughness	N5 (Ra 0,4 µm)

The function of the calibrating gauge is to determine the wear rate after one or several test cycles. The calibrating gauge should be positioned so that the circular part of the surface to be tested is against the direction of movement of the textile belt. The extent of wear on edge 2 can then be measured.

Most changes in test results relating to mild wear are caused by dust. Clean the gauge surface before each test cycle.

4.2.6 Evaluation of results

Evaluation of the results shall be made principally by visual observation and comparison. See Annex A.

The wear resistance of test samples should be determined by comparison with the calibrating gauge, using the equation:

$$m = \frac{q_1}{q_2}$$

where

m is the multiple of wear resistance of stainless steel;

q_1 is the amount of wear to the calibrating gauge;

q_2 is the amount of wear to the test sample.

Use a precision balance with a resolution of 0,1 mg. In some cases, it is impossible to determine mild wear using thickness and mass decreasing methods. The wear is therefore considered to be negligible.

4.3 Wear test by reciprocating movement against an abrasive surface

4.3.1 General

This test is very precise; the dust produced by the wear process does not stay on the sample as a consequence of the design of the test device.

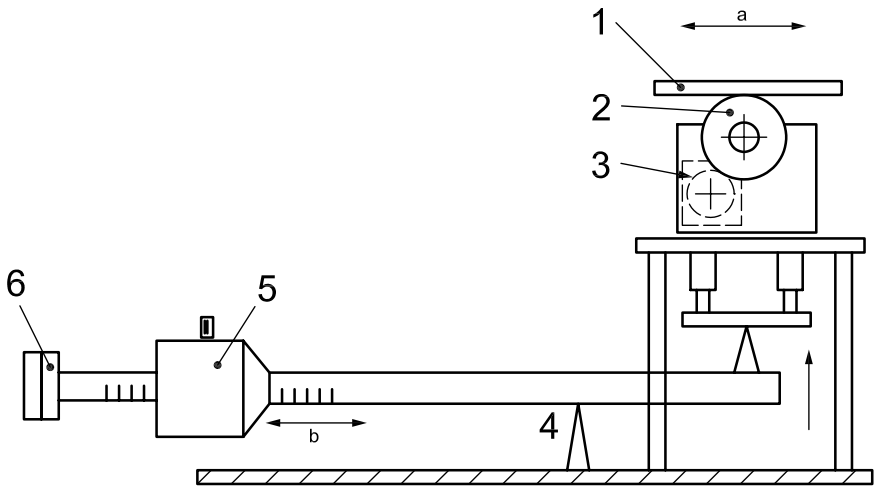
4.3.2 Objective

The aim of this test is to determine the wear resistance of base material or coatings on flat test samples, through repeated reciprocating tests.

4.3.3 Description of test

The test device comprises a carriage which moves the flat test sample back and forth. The abrasive surface exerts pressure, pushing with calibrated force against the surface of the test sample, in accordance with Figure 5 and Table 6.

The test device is general-purpose equipment complying with ISO 8251.



Key

1 sample
2 abrasive wheel
3 stepping motor
4 fulcrum
5 load variation control
6 load

[a] Reciprocating movement.
[b] Load setting scale.

Figure 5 — Example of test device for wear test using reciprocating movement

Table 6 — Characteristics of the test device

Reciprocating frequency	60 times per minute (60 DS/min)
Wear surface, mm	30 × 12 (Stroke = 30)
Abrasive wheel dimensions, mm	Diameter: 50 Width: 12 Rotation by 0,9° after each cycle of reciprocating movement
Load, N	Gold alloy coating: < 14,7 Hard coating: 14,7 to 24,5 Load shall be decided by agreement between contracting parties
Test sample dimensions, mm	Minimum: 30 × 50 Maximum: 70 × 300 Maximum thickness: 4
Number of wear cycles	Digital setting and display: 6 digits max. (0 to 999999)
Outer dimensions, cm **Mass**, kg	Main unit: 60 (length) × 32 (width) × 30 (height) Approximate mass: 20 Control unit: 31 (length) × 31 (width) × 200 (height) Approximate mass: 8

A reader fitted with an automatic stop allows cycles to be counted accurately. One cycle corresponds to one reciprocating motion and one rotation of 0,9°.

Before starting a test, adhesion of coatings may be checked using methods in accordance with ISO 2819 and ISO 27874.

4.3.4 Abrasive material

Several abrasive materials can be used, such as abrasive paper with silicon carbide (SiC), alumina, diamond, cloth and other materials, depending on the requirements.

Paper dimensions: 12 mm × 158 mm; particle size # 240 to # 2000.

Other abrasive papers may be selected by agreement between the contracting parties.

A test report should be issued specifying the type of abrasive material used, as well as load, speed, number of cycles, geometry contact, temperature and relative humidity.

4.3.5 Operating procedure

4.3.5.1 General

The test sample and the test device shall be prepared and cleaned in the same conditions as standard parts.

Test samples shall be prepared so that they have the same surface characteristics as the watch cases and accessories under consideration. The test samples shall be mounted on the machine and the defined conditions for the test shall be applied.

The test samples shall be regularly examined during the test and compared to reference samples.

4.3.5.2 Description of operating procedure

The operating procedure shall be the following:

a) Wrap the specified abrasive paper correctly and smoothly around the circumference of the wheel.

b) Put the sample in place and carry out a preliminary wear test under the defined conditions.

c) Clean the surface of the sample with a soft cloth and then measure the mass of the sample using a balance with a resolution of 0,1 mg, or measure the initial coating thickness. Carry out this wear test without changing the friction position.

d) Do not re-use the abrasive paper. The abrasive paper must be replaced after 400 cycles of reciprocating movement, i.e. one complete revolution.

e) Carry out wear test until a measurable difference in mass is reached or the substrate is exposed.

After wear tests, measure the mass of the sample according to c) or measure the thickness of the coating. If the substrate is visible after the wear test, it shall be mentioned in the test report.

4.3.6 Calibration

There is no calibration procedure.

4.3.7 Evaluation of results

Evaluation of wear is done principally by visual inspection and by comparison with reference samples of the same material (metallurgical state, coating). See Annex A.

Metallographic analysis or other methods of determining the thickness of the samples or their coating(s) may be performed to assess the wear which has occurred.

In addition, a corrosion test can be carried out to reveal possible exposure of the base material.

The limit of wear resistance shall be defined by agreement between the contracting parties.

5 Scratch resistance

5.1 Objective

The aim of this test is to rapidly determine whether watch cases and wristlets are likely to be scratched through simple transport and handling operations or by rubbing on lightly abrasive surfaces such as clothes or furniture.

5.2 Description of test

An industrial rotating polishing machine similar to that in 4.1 shall be used. The part subjected to the test shall be placed into a cylindrical container with a volume of 0,3 l (diameter: 80 mm, height: 60 mm). Its inside surfaces shall be covered with blotting paper and it shall contain a lightly abrasive material.

5.3 Abrasive load

It is recommended that a lightly abrasive load consisting of 5 to 15 pieces of felt complying with ISO 11640, and glass powder, be used. The tested part and the abrasive material shall be able to move freely in the container.

The characteristics of the glass powder consisting of angular particles are defined in Table 7.

Table 7 — Characteristics of the glass powder

Particle size	$Dv_{0,5}$ 210 µm
Indicative density	2,6 g/cm^3
Hardness	630 HV ± 100 HV
Indicative composition	— SiO_2 ≥65 % — Al_2O_3 ≤0,5 to 2,0 % — Fe_2O_3 <0,15 % — MgO ≥2,5 % — CaO ≥8,0 % — Na_2O ≥14,0 % — others ≤2,0 %
An example of glass powder is given in B.2.3.	

5.4 Operating procedure

The rotational speed of the machine being 90 r/min, a test duration of 3 min is set and the tested components are observed after 1, 2 and 3 min.

Other speeds and cycle durations can be defined by agreement between the contracting parties.

5.5 Calibration

There is no calibration procedure.

5.6 Evaluation of results

Evaluation of the scratches is done principally by visual inspection and by comparison with reference samples. Roughness measurements can be carried out to complete the evaluation. See Annex A.

6 Impact resistance

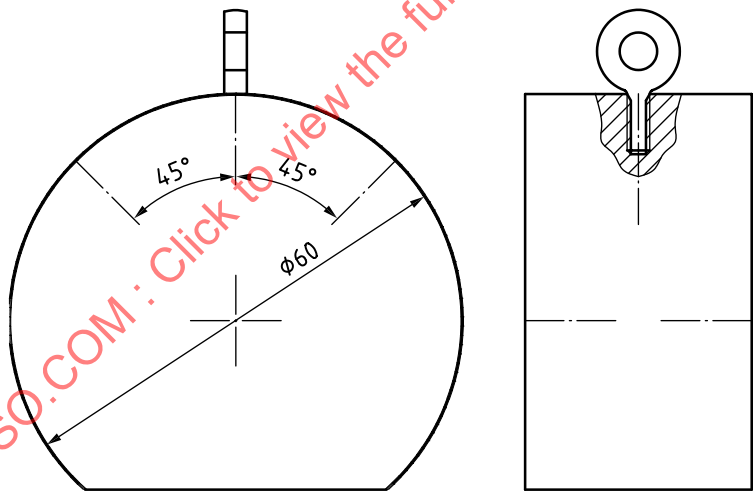
6.1 Objective

The aim of this test is to evaluate the wear resistance of a watch case and its wristlet to impacts and damage resulting from general and accidental friction against very rough and hard abrasive surfaces.

6.2 Description of test

The watch case with its wristlet and extension are mounted on a standard support adapted to the part being subjected to the test.

Dimensions in millimetres



mass 0,8 kg

Figure 6 — Standard watch support

A test device fitted with a pincer enables the watch support to be secured, positioned and released, in accordance with the drop positions given in Figure 8. The indicative height, H, of the test device shall be adjusted for a drop of 40 cm.

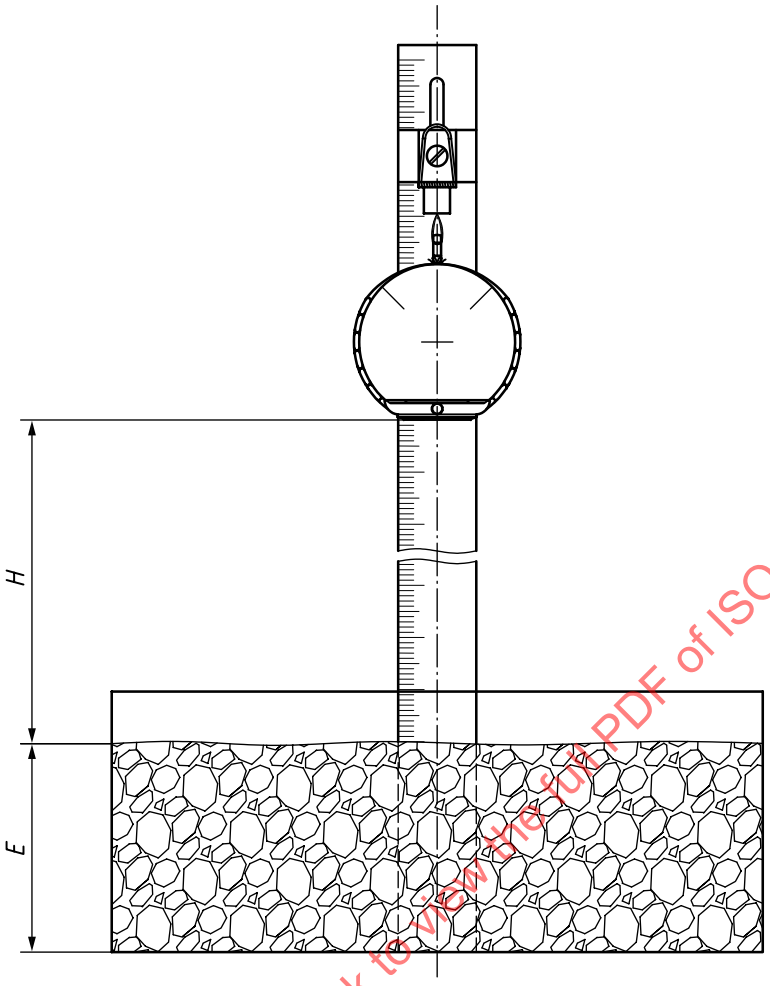


Figure 7 — Test device for drop tests

6.3 Abrasive material

A receptacle filled with ceramic chips (not run in) as described in 4.1.3.2 shall be placed under the support fixing pincer. The layer, E, of ceramic chips shall be 8 cm thick with a surface area of approximately 500 cm^2.

Other abrasive materials may also be used by agreement between the contracting parties.

6.4 Operating procedure

A drop impact test is carried out through a succession of 5 drops, each in a different position. Depending on the specifications of the parts to be tested, this test may be repeated more than once. However, it is unlikely that more than 7 repetitions will be exceeded.

Each drop is performed by fitting the support on which a watch is mounted on the pincer of the tripod in the desired position. Before releasing the support by opening the pincer, the bed of ceramic chips shall be smoothed over.

The succession of 5 drop positions is illustrated in Figure 8.

After the test, the watch case and its wristlet shall be examined.

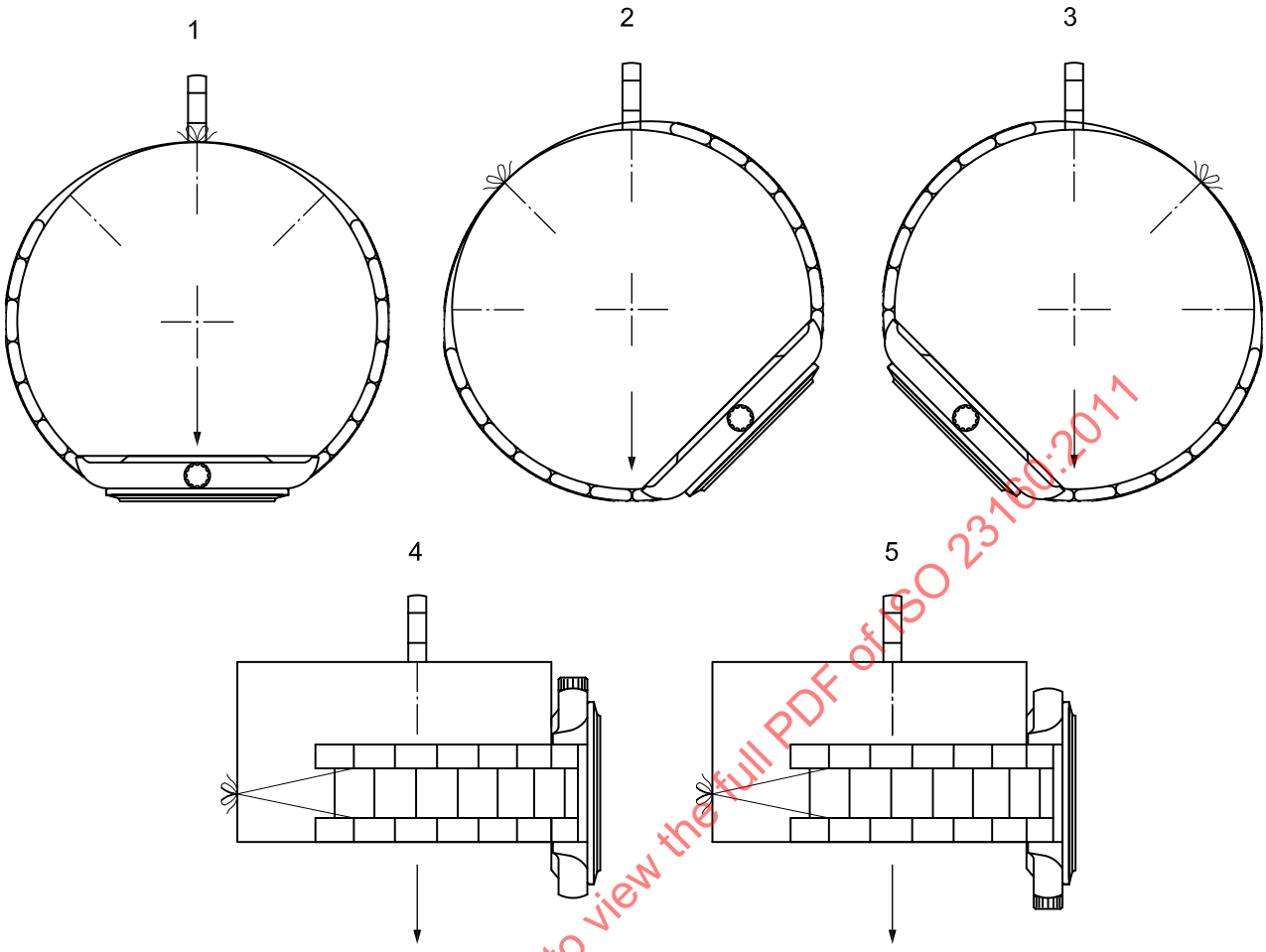


Figure 8 — Succession of drops onto ceramic chips to be performed for the complete test

6.5 Calibration

There is no calibration procedure.

6.6 Evaluation of results

Evaluation of damage is done principally by visual inspection and by comparison with reference samples. See Annex A.

After each drop impact test, the following criteria shall be observed:

— appearance after testing;

— characteristics of the abrasive damage, i.e. density, nature and position of scratches, cracking, detachment of protective layers, surface deformation, etc.;

— number of cycles after which the first damage was observed.