INTERNATIONAL STANDARD

ISO 3058

Second edition
1998-03-15

Non-destructive testing — Aids to visual inspection — Selection of low-power magnifiers

Essais non destructifs — Moyens d'examen visuel — Choix des loupes à faible grossissement

Reference number
ISO 3058:1998(E)

Foreword

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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 3058 was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 2, *Surface methods*.

This second edition cancels and replaces the first edition (ISO 3058:1974), which has been technically revised.

Annex A forms an integral part of this International Standard. Annexes B and C are for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Introduction

Experience has shown that a lack of familiarity with the principles underlying the performance, selection and use of low-power magnifiers is a cause of significant loss in terms of time and effort and is markedly detrimental to the efficiency of visual inspection.

This International Standard is intended to provide general guidance on the choice of low-power magnifiers used in the examination of metallic and other surfaces in order to detect the presence of imperfections or to assess condition and texture.

As necessary, terms of special significance in the context of this document are defined in annex A.

Non-destructive testing — Aids to visual inspection — Selection of low-power magnifiers

1 Scope

1.1 This International Standard specifies the characteristics of the following types of low-power magnifiers and gives recommendations for their selection for the inspection of surfaces.

— Single-element magnifiers of magnification typically up to ×4 (Type A).

— Multi-element magnifiers of magnification typically up to ×10 (Type B).

— Twin-system magnifiers of magnification typically up to ×15 (Type C), categorized as follows:

  a) binocular, normally with a long working distance (Type C.1);

  b) bi-ocular[1)], including those refined with stops or other attachments, for quasi-stereoscopic vision (Type C.2).

— Concave-mirror magnifiers with front-surface reflectors in powers typically up to ×6 (Type D).

1.2 This International Standard is not concerned with:

— watch-makers' loupes and spectacles;

— single-element, spherical- or cylindrical-lens magnifiers in which either the lens or the lens-mount rests on the surface of the object to be examined (this includes magnifiers provided with any form of graduated scale for the purpose of measurement);

— plastic lens sacs, liquid-filled;

— magnifiers intended for the examination of internal surfaces.

2 Description of types

2.1 In all types of magnifier an illuminator may be incorporated in the lens mount or the stand.

The stand may take the form of a distance-piece, tripod, pillar or other support.

2.2 “Reading-glass” magnifiers, Type A, shall normally be hand held. Type A and B may take the form of hand-held pocket-size magnifiers.

1) The distinction between bi-ocular viewing and stereoscopic viewing is defined in annex A.

2.3 Twin-system magnifiers, Type C.1, shall normally be mounted on a stand, but may be removed from this for use when access to the surface to be examined is difficult. Type C.2 is, of necessity, stand-mounted.

2.4 Types C.1 and D provide the viewing conditions required for binocular vision, with the accompanying extended field of view and depth of focus. The use of Type D shall be confined to small objects.

3 Magnification

3.1 Magnification shall be stated in terms of linear magnification (see annex A). Where appropriate, magnifiers of Types A and B shall have the nominal magnification permanently marked on the lens mount.

3.2 In cases where the manufacturer customarily rates lens power in dioptres, the equivalent linear magnification shall also be marked. If this is not practicable, the magnification shall be certified in a written statement.

4 Materials

These lenses shall be made from optical glass or an optically equivalent plastic material which is dimensionally stable and does not change colour with age.

5 Optical and other characteristics

5.1 Lenses shall be free from veins, striae or other manufacturing defects and also be essentially free from distortion and colour fringes over the entire viewing area.

5.2 Mounts for magnifying lenses of Types A, B and C shall give satisfactory optical performance and the mounting shall provide freedom of movement to facilitate examination of the whole surface.

5.3 The focal length or the magnification, as appropriate, shall not depart by more than 10 % from its nominal value.

6 Conditions governing the choice of magnifier

Hand-held, single- or multi-element magnifiers having a magnification of ×2 to ×4 are adequate for a wide range of industrial applications. The benefits of easy manipulation and relatively strain-free binocular vision can offset the reputed advantages of higher magnification, which may be illusory for the following reasons:

— higher magnification involves a shorter eye-to-lens distance and a shorter working distance;

— short working distances, where only one eye can be used, are a contributory cause of operator fatigue;

— the field of view is much reduced and hence the time of inspection increased;

— the depth of focus is much smaller and spatial relationships between different portions of the surface under inspection become difficult to assess.

NOTE – Attention is drawn to annex B, in which the optimum dimensions of lenses covering the range of magnification most commonly employed in visual inspection are given. Annex C gives some notes on the use of magnifiers.

7 Illumination

7.1 General

The optimum level of illumination for inspection magnification depends chiefly on the following factors:

— the relative position of the work piece, the eye and the light source, for example the ease or otherwise of access of surface to be examined;

— the nature and reflectivity of the surface;

— the direction of illumination, i.e. direct or oblique;

— light gathering and light loss in the optical system(s).

7.2 Relative position of workpiece

The ideal condition, is that in which the surface under examination, or the object, can be tilted under the light so as to enable it to be examined from more than one angle and under more than one intensity of illumination. Conversely, if the workpiece itself is immovable both the eye and the light source have to alter their positions.

7.3 Nature and reflectivity of surface

7.3.1 Whereas inspection for a crack in a steel forging or on the rippled surface of an arc weld might call for an intensity of illumination approaching 5 000 lx, a crack in a polished metal surface might be detected at a level of intensity only slightly above that of ambient lighting.

7.3.2 Freedom from glare is important and magnifiers of Type A and also some of Type B may be equipped with diffusing screens to reduce sharp variations in intensity of illumination. Separate illuminators fined with diffusers are sometimes required.

7.3.3 Where possible, other sources of sharp contrast are also to be avoided in order to minimise eye fatigue, particularly in the case of small objects which usually require a high intensity of illumination. The eye shield around the lens shall be translucent and both the object and the surface on which it is placed shall have approximately the same degree of reflectivity.

7.4 Direction of illumination

As in the case of intensity, the direction of illumination shall be dictated by reflectivity and the required purpose of the examination. The illumination shall extend to the periphery of the field of view and the variation of intensity from the middle to the outer zones shall not exceed 3:1.

7.5 Light gathering and light loss

7.5.1 Magnifiers of Type C.1 fitted with large objective lenses gather light with marked efficiency and are therefore particularly useful in situations where there is poor illumination, i.e. on site work in relatively inaccessible locations.

7.5.2 Light loss in multi-element systems can sometimes be lessened by the use of coated lenses.

Annex A
(normative)

Glossary of terms

bi-ocular viewing: The name given to an arrangement whereby the same image from a single objective lens is presented to two eye-pieces by an optical device.

NOTE – This term is not to be confused with binocular viewing.

binocular viewing: Observation of a field of view with both eyes simultaneously, using either a larger diameter lens or a binocular microscope, each eye receiving a unique image appropriate to its position relative to the field of view.

depth of focus; depth of field: The theoretical distance by which either the inspected area or the magnifier can be displaced in the direction of viewing without altering the focus of the image obtained.

dioptre: A unit employed to express the refracting power of a lens, based upon the fundamental equation for refraction at a spherical surface.

NOTE – The power of a lens expressed in dioptres should not be confused with linear magnification.

focal length: The distance between the optical centre of a lens and the image point (focus) for an infinitely distant object.

focus: The point at which parallel rays, i.e. those from a distant object, falling upon the lens are made to converge after refraction.

linear magnification or magnifying power: The increase in the apparent size of the linear dimensions of the object observed expressed by the formula

$$\mu = \frac{v}{u} = 1 + \frac{D}{f}$$

where

v is the distance, in millimetres, of the image from the lens;

u is the distance, in millimetres, of the object from the lens;

D is the distance[2)], in millimetres, of normal or corrected distinct vision;

f is the focal length, in millimetres, of the lens.

stereoscopic viewing: The coalescence of two monocular images into a single image so as to convey the impression of vision in depth.

NOTE – The quality of stereoscopic viewing depends, among other things, upon the flatness or otherwise of the surface or object observed.

working distance: The distance between the lower surface of the lens nearest the object and the surface of the object under inspection.

2) Sometimes standardized at 250 mm, but for practical purposes a more realistic value is 350 mm.

Annex B
(informative)

Optimum dimensions of lenses

The following table gives the optimum dimensions of lenses covering the range of magnification most commonly used in visual inspection.

Linear magnification	**Diameter of lens (field of view)** mm	**Working distance** (approximate) mm
×2	125	140
×4	65	62
×8	18	31
×10	14	25
×15	10	13
NOTE – The above dimensions are physically interrelated and it is therefore not possible to obtain a magnifier for use at a working distance significantly greater than that listed in the table.		

Annex C
(informative)

Notes on use of magnifiers

C.1 Regardless of the range of magnification chosen for a particular purpose, it is important to ensure that the magnification employed throughout the entire inspection process is consistent with that specified.

C.2 Where speed of inspection is required and it is necessary to handle the object, it is preferable to mount the magnifier on a pillar fitted with a means of adjustment for eye level and easy manipulation, for example a ball-and-socket clamp or “lazy tongs”. Alternatively, small objects are most easily viewed on the bench under a lens mounted on a distance piece or three-point support in which the illuminator is housed.

C.3 In cases where access to the object or surface is restricted (as in site work) and especially if good illumination is not available, a magnifier of Type C.1 may be used to advantage.

C.4 When speed of examination and depth of focus are of secondary importance, a magnification as high as ×15 may be required. For comfortable viewing in such cases, a magnifier of Type C.2 is recommended.

C.5 It is possible to modify the optical system of a bi-ocular magnifier so as to produce a quasi-stereoscopic image. With regard to stereoscopic magnifiers, the user should satisfy himself that the main purpose of the inspection warrants the choice of such equipment.

ICS 19.100

Descriptors: tests, non-destructive tests, visual inspection (testing), surface condition, test equipment, magnifiers, characteristics.

Price based on 6 pages