International Standard 6161

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Personal eye-protectors — Filters and eye-protectors against laser radiation

Protecteurs individuels de l'œil — Filtres et protecteurs de l'œil contre les rayons laser

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6161 was developed by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, and was circulated to the member bodies in July 1978.

It has been approved by the member bodies of the following countries :

Australia	Iran	Poland
Austria	Israel	Romania
Belgium	Italy	South Africa, Rep of
Denmark	Mexico	Spain
France	Netherlands	Switzerland
Germany, F. R.	New Zealand	USA
Hungary	Norway	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Czechoslovakia
United Kingdom

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0 Introduction

The work undertaken for the finalization of ISO 6161, which was staggered over several years, represents a basic study for which a majority consensus was reached at the international level. To take account of new developments and knowledge relating to lasers and of the studies undertaken within IEC/TC 76, a revision of ISO 6161 will be undertaken by the working group responsible for this work from the beginning.

1 Scope and field of application

This International Standard specifies requirements for spectacle filters and eye-protectors against laser radiation within the spectral region 0,2 to 1 000 µm.

2 References

ISO 4849, *Personal eye-protectors — Specifications.*

ISO 4854, *Personal eye-protectors — Optical test methods.*

ISO 4855, *Personal eye-protectors — Non-optical test methods.*

3 Basic considerations

In a lasing system, light is amplified by stimulated emission which produces a collimated beam of coherent electromagnetic radiation of one or more wavelengths determined by the lasing system. This characteristic radiation is of great radiant intensity and very low angular divergence. When working with lasers, personnel may therefore need to protect their eyes by filters against this radiation.

Laser filters should, especially, absorb and/or reflect a great part of the radiation of the laser wavelength to prevent any damage to the eyes. However, the transmission should be as large as possible at other wavelengths.

It is possible to produce laser radiation of many different wavelengths by choosing appropriate substances. In addition, there exist lasers which are tunable in certain wavelength ranges. Particularly dangerous are frequency-doubled lasers : in their beam the double frequency as well as the normal frequency may exist. For these reasons, it is not possible to produce only one filter type which gives sufficient protection from all kinds of lasers and laser wavelengths. Filters must therefore be used only for protection from the wavelength that is marked on them. It might even be possible that they do not give efficient protection from other wavelengths of the same laser.

Laser radiation of different spectral regions can cause different kinds of injury to the eyes :

a) Ultra-violet exposure between 200 and 380 nm produces photophobia accompanied by redness, lachrymation, conjunctival discharge, surface exfoliation and stromal haze.

b) In the spectral region from 350 to 1 400 nm, laser light can reach the retina. Since it traverses the refractive media, it becomes focused; thus, the irradiation increases considerably. Excessive exposure to radiation of this region causes above all retinal damage.

c) Between 1,4 and 1 000 µm, laser radiation traversing the various media of the eye is diminished to such an extent that the retina will be endangered only secondarily. However, injuries to the anterior parts of the eye can occur : chiefly to the cornea, the eyelid, the conjunctiva, and the skin. Since no focusing effect occurs, the permissible radiant exposure and irradiance, respectively, are considerably higher when these lasers are being used.

In these three spectral regions, the maximum permissible exposure for the eyes has been measured or calculated by different investigators. In two of these spectral regions, the maximum permissible exposure is the same. Therefore, the spectral region has been divided into two ranges :

1) 200 to 1 400 nm, where the permissible irradiance and the radiant exposure, respectively, must be very low, and

2) 1,4 to 1 000 µm, where both can be considerably higher.

The maximum permissible irradiance also depends on the duration of the laser radiation. Therefore, it is useful to distinguish whether the laser is used as a continuous-wave (CW) laser, a pulsed laser or a giant-pulse laser.

4 Spectral requirements

4.1 Spectral transmittance

The limits adopted in this International Standard correspond to the case of long exposure to CW-lasers and to the concentration of the total permissible irradiation in one pulse of a pulsed laser.

The transmittance shall be measured at an angle of incidence of 0°; for laser filters with interference layers, it shall be measured between angles of 0° and 30°, the highest of the values obtained giving the protective density.