

Recommendations for

Preparation of drawings for optical elements and systems

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- Engineering Equipment and Materials Users' Association
- Federation of Manufacturing Opticians
- Flat Glass Manufacturers' Associations
- Ministry of Defence
- Sira Limited
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Foreword

This British Standard has been prepared under the direction of the Cinematography and Photography Standards Policy Committee. It supersedes BS 4301:1982, which is withdrawn.

This standard was first published in 1968 and was revised in 1982. This second revision has been prepared as a result of a request for improved methods of describing and quantifying surface defects. Technical changes in this edition have therefore been confined to clauses **14, 15, 26, 27** and **28**, together with a minor addition to clause **32**.

BS 308, particularly Part 3, provides ample scope for the definition of complex shapes on drawings and this standard contains only directions on matters not covered or inadequately covered in BS 308. In particular, and because of the common practice in the optical industry to use angular measurements when measuring and checking optical elements and subassemblies, this standard introduces the use of angular values and fringes in the tolerance flames. This special need for optical drawings is not covered in BS 308-3, and BS 4301 should be regarded as a supplement to that standard.

The preparation of International Standards on related subjects is not sufficiently advanced to justify delaying the publication of this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. Introduction

1 Scope

These recommendations apply to the presentation, on drawings, of design and functional requirements for optical elements and systems. Sections 5, 8 and 9 include information considered necessary for the correct appreciation and application of the recommendations.

The material included is that necessary to provide a standardized method of presenting information on drawings, and is not intended to impose restrictive practices upon designers.

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Introductory notes

3.1 BS 308 methods should be used unless recommended otherwise in this standard.

3.2 The inclusion in these recommendations of the means of indicating various parameters of optical elements or systems does not imply a requirement that such information should be on a drawing. Therefore on a drawing the omission of any parameter should be taken as indicating that there is no requirement. The preferred method, however, relative to the use of defect codes (see Table 1) is to follow the index figure and oblique line by a hyphen (e.g. 5/-) as this signifies that the lack of instruction is deliberate.

Additionally, the use of the instruction “(see note)” as an alternative to the hyphen can be used to indicate the presence of a note giving further information. In this case the note should be numbered to provide easy reference (see 7.5).

In some circumstances the individual defect rating of elements is not critical within the context of the performance of the complete assembly or subassembly. In such cases there is no reason to insist on the defect rating of each element when assembled being within a stated specification, and it is recommended that the defect rating should be enclosed in brackets, thus: 5/($a \times b \times c$). This will indicate to the manufacturer of the total system that the rating is for guidance only, but should be applied to individual elements being provided as replacements in existing systems.

4 Definitions

For the purposes of this standard the definitions given below, and at the beginning of some later sections, apply.

NOTE The definitions given below are of a general nature and are therefore not included in each section. Further definitions are given in the relevant sections.

4.1

element

an optical unit that cannot be subdivided into other optical units

4.2

field stop

the aperture or any of its images limiting the extent of the object viewed

4.3

pupil

the aperture or any of its images limiting the bundle of rays entering the system from an object point at the centre of the field

NOTE 1 The entrance pupil is the pupil in the object space.

NOTE 2 The exit pupil is the pupil in the image space.

4.4

optical axis

the ray path passing through centres of pupils and field stops

4.5

test region

an optically effective surface or space, or both, that is subject to testing to ascertain defects

4.6

test field

the portion of a test region that is effective in the system at any one time

Section 2. General recommendations, methods of presentation and definition of materials for optical elements and systems

5 Types of drawing

Three types of drawing may be needed, as indicated in 5.1 to 5.3.

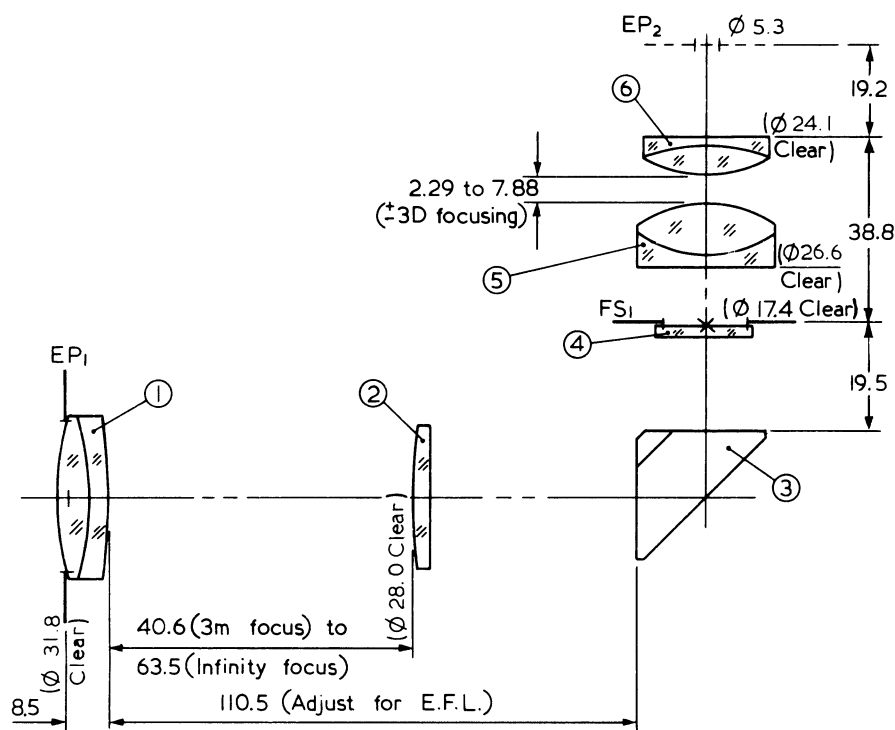
5.1 Optical arrangement. An optical arrangement drawing is only for reference and should show the relative positions of all the elements or subassemblies of a complete optical system and should specify, as appropriate, the following:

- a) element or subassembly reference part numbers (or parts-list reference numbers);
- b) separation distances;
- c) magnification and/or system equivalent focal length;
- d) magnification between consecutive image planes;
- e) true field of view;
- f) position and sizes of field stops;
- g) position and sizes of pupils;
- h) clear apertures at element or subassembly component surfaces;
- i) details of light source;
- j) special notes regarding assembly and test procedures;
- k) movements required for magnification and focus adjustment;
- l) mounting interface data.

An example is shown in Figure 1.

5.2 Optical subassembly. An optical subassembly drawing should give, as appropriate, the following:

- a) element part numbers (or parts-list reference numbers) and assemblies on which each is used;
- b) details of cement or other method of fixing (see section 7);
- c) dimensions and tolerances that are additional to those given in the detail drawings;
- d) equivalent focal length or test data;
- e) special notes regarding assembly and test procedures.



All dimensions are in millimetres unless otherwise stated.

NOTE 1 Total magnification at infinity focus $\times 6$.

NOTE 2 Eyepiece magnification $\times 10.6$.

NOTE 3 True field of view 7° .

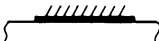
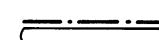
NOTE 4 Graticule is adjusted laterally to obtain correct line of sight.

Figure 1 — Optical arrangement drawing

5.3 Optical detail. An optical detail drawing should give, as appropriate, the following:

- assembly or subassembly to which the detail applies;
- material specification (see clause 9);
- codes for material defects (see sections 3, 4 and 5);
- dimensional data with tolerances (see clause 8): including centring and equivalent focal length;
- surface texture (see section 9);
- surface treatment (see section 10);
- test regions and test data (see 7.7);
- codes for surface defects (see section 8) and form errors (see section 6).
- Table 1 printed as an explanatory key.

Table 1 — Summary of defect codes and symbols

0/---	Strain birefringence		Polished, coarse
1/---	Inclusions		Polished, medium
2/---	Homogeneity		Polished, fine
 or 3/---	Surface form error		Polished, very fine
4/---	Lens centring error		Coating, first surface reflective
5/---	Surface defects		Coating, second surface reflective
	Rough, not worked		Coating, partial reflective
	Rough, working optional		Coating, anti-reflective
	Rough, working mandatory		Coating, paint

6 Orientation of drawings

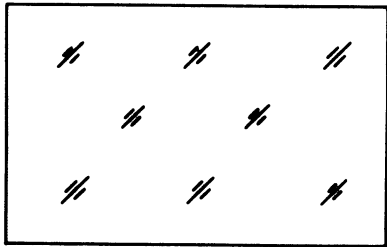
Orientation of optical arrangement drawings should be such that the ultimate receptor (e.g. the eye, projection screen, photographic plate or photoelectric cell) should appear to be on the right-hand side, unless shown otherwise on the corresponding mechanical assembly drawing. In subassembly and detail drawings, elements may be oriented with optical axes horizontal or as they appear on the optical arrangement drawing.

7 Methods of representation

7.1 Where there is a particular need to indicate optical axes they should be shown as thin chain double-dash lines, thus:

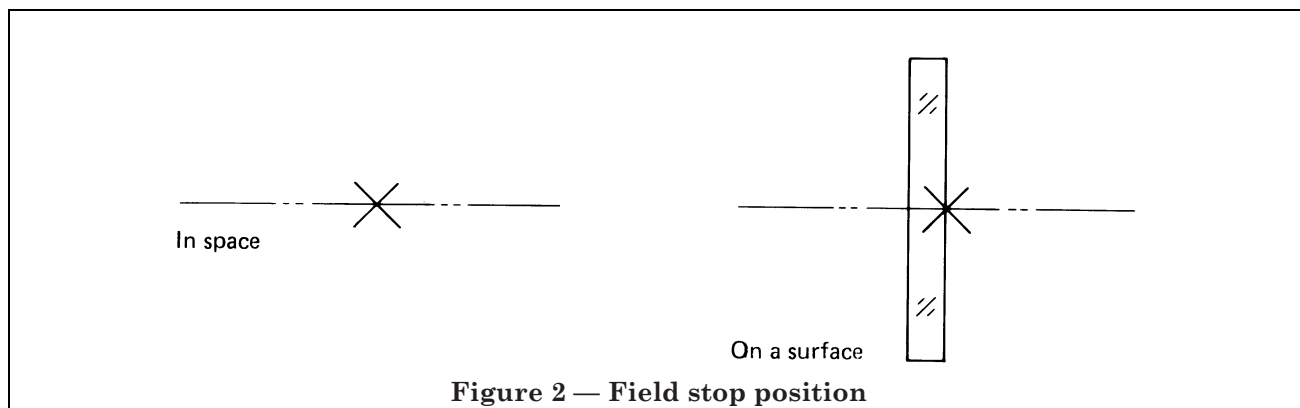


7.2 Optical materials when shown in section should use the following representation:

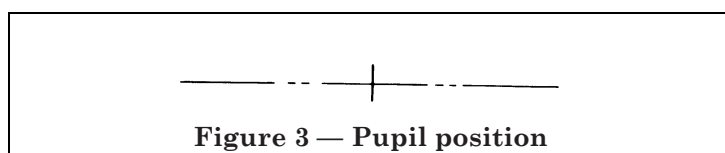


7.3 Field stops and pupils in optical arrangement drawings should be indicated as follows.

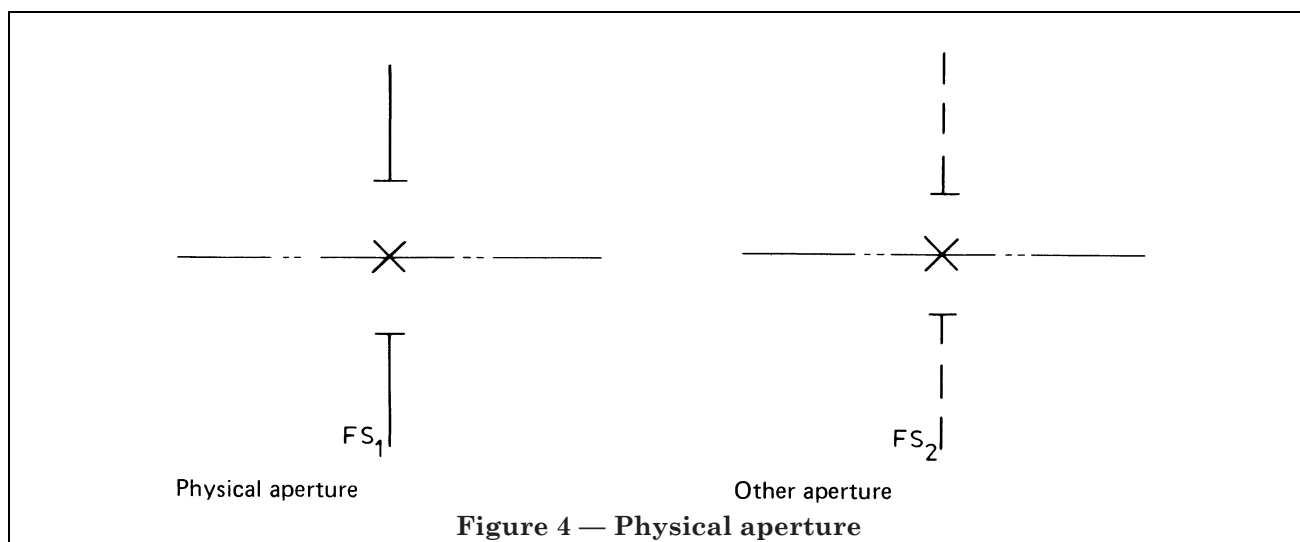
a) Position of field stop is indicated by a cross (i.e. $\times$) on the optical axis (see Figure 2).



b) Position of pupil is indicated by a short line across the optical axis (see Figure 3).



c) Physical apertures should be drawn in thick continuous lines defining position; sizes should be indicated by short cross lines. Other apertures should be drawn in a similar manner, but in thick dashed lines. When required, field stops should be marked FS_1 , FS_2 etc., following the path of the incident light (see Figure 4).



d) When required, pupils should be marked EP_1 , EP_2 , etc., following the path of the incident light (see Figure 5).