BRITISH STANDARD

BS 5225-3: 1982

Photometric data for luminaires —

Part 3: Method of photometric measurement of battery-operated emergency lighting luminaires

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Cooperating organizations

The Electrical Illumination Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

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British Glass Industry Research Association
British Railways Board
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Contents

Foreword

This Part of BS 5225 has been prepared under the direction of the Electrical Illumination Standards Committee. It describes the method of making photometric measurements on battery-operated emergency luminaires so that this may be done on a sound and reproducible basis. Utilizing this method, lighting scheme planning data may be derived for a system to meet the requirements of BS 5266-1:1975.

Much of the photometry is the same as is already specified in BS 5225-1:1975 and extensive reference is made to that publication. The main differences are in the reporting of measurement, including the calibration of polar curves and the application of correction factors, including some correction factors which are peculiar to battery-operated emergency lighting luminaires. This standard does not introduce a need for apparatus other than that called for in Part 1.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 10, 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.

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Section 1. General

1 Scope

This Part of BS 5225 details methods of photometric measurement and presentation of photometric data for battery-operated emergency lighting luminaires. It does not apply to internally illuminated exit signs which fall within the scope of BS 2560.

This Part of BS 5225 should be read in conjunction with Part 1:1975; the numbering of the clauses corresponds to Part 1.

2 References

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

3 Definitions

For the purposes of this Part of BS 5225 the definitions referred to in BS 5225-1 apply together with the following:

3.1
ballast

all the control equipment situated between the source of battery power and the lamp, including the automatic transfer switch. For incandescent lamp luminaires, the "ballast" may only be the contacts of a relay used as the automatic transfer switch

3.2
objective ballast

a ballast, giving claimed or declared characteristics. The details marked on or provided with a ballast are considered to be its declared or claimed characteristics

3.3
inverter ballast

a d.c./-a.c, inverter using semi-conductors which may include stabilizing elements for supplying power to one or more fluorescent lamps

3.4
nominal battery voltage (V_{nom})

the nominal voltage of a battery as declared by the manufacturer

NOTE Generally lead-acid systems have a nominal voltage of 2 V per cell and nickel cadmium alkaline systems a nominal voltage of 1.2 V per cell.

3.5
initial battery voltage (V_5)

the voltage of the battery as declared by the manufacturer that will occur 5 s after removal of a nominal charge that has been continuous for not less than the previous 40 h

3.6
initial light output factor (F_5)

the ratio of the light output using an objective ballast on V_5 at 5 s after switchover to the emergency mode of operation, to the stabilized light output using an objective ballast on V_{nom}, using the same lamp

3.7
end of duration battery voltage (V_{end})

the minimum voltage of the battery, as declared by the manufacturer, that will occur at the end of the rated duration at the end of the declared battery replacement interval

3.8
end of duration light output factor (F_{end})

the ratio of the stabilized light output using an objective ballast on V_{end}, to the stabilized light output using using an objective ballast on V_{nom}, using the same lamp

3.9
battery

secondary cells provided as a source of supply for use when the normal supply fails

3.10
rated duration (of a battery)

the period of time as declared by the manufacturer, during which, at a voltage not less than 85 % of the nominal output voltage, the battery will continue to supply the rated load

3.11
rated load

the maximum load that may be connected to the battery and that will be supplied for the rated duration

3.12
rated ballast voltage

the supply voltage or voltages assigned to the ballast by the manufacturer

4 Units and terminology

The provisions of clause **4** of Part 1 apply.

5 Photometric centre

The provisions of clause **5** of Part 1 apply.

6 Cut-off angle reference point (lamps)

The provisions of clause **6** of Part 1 apply.

7 Co-ordinate systems for luminaires

The provisions of clause **7** of Part 1 apply.

Section 2. Laboratory conditions and procedures

8 General

The provisions of clause **8** of Part 1 apply.

9 Laboratory measurements

The provisions of clause **9** of Part 1 apply. Additionally, the following principal measurements for emergency lighting luminaires shall be made:

Initial light output factor (F_5)

End of duration light output factor (F_{end})

For maintained and sustained luminaires, measurement of factor F_5 and factor F_{end} shall be made with the luminaire in both the maintained and the sustained modes, if the design of the luminaire permits this.

10 Laboratory facilities

The provisions of clause **10** of Part 1 apply.

11 Status of measurement

The provisions of clause **11** of Part 1 apply.

12 Electric power supply and indicating instruments

The provisions of clause **12** of Part 1 apply except that items a) and c) do not apply to the output of an inverter ballast. Additionally, the following applies.

Batteries may be disconnected and replaced by a stabilized power supply at the normal point of connection of the supply to the ballast, The power supply shall have negligible impedance at this point, and its reactance should be adjusted, if necessary, by means of suitable components such that the waveform at the input to the inverter is identical to the waveform obtained with the ballast connected to its normal battery supply. The voltage derived from the power supply shall be capable of being set to, and be stable to, within 0.2 % of the nominal voltage required.

13 Temperature control and indicating instruments

The provisions of clause **13** of Part 1 apply.

14 Photocells and associated apparatus

The provisions of clause **14** of Part 1 apply.

15 Selection of luminaires for test

The provisions of clause **15** of Part 1 apply.

16 Selection of ballasts for use with luminaires under test

The provisions of clause **16** of Part 1 apply. Additionally, for measurements to derive F_5 and F_{end}, a test ballast shall be used for which the characteristics of input current, lamp current, waveform and frequency are within ± 5 % of the values of an objective ballast.

17 Selection of ballasts for bare lamp tests

The provisions of clause **17** of Part 1 apply.

18 Selection and preparation of lamps for use with luminaires under test

The provisions of clause **18** of Part 1 apply.

19 Operation and handling of lamps

The provisions of clause **19** of Part 1 apply.

20 Standard measuring conditions for luminaires

The provisions of clause **20** of Part 1 apply, modified as given below.

Item f) 1) does not apply. Instead, the following applies.

Luminaires for incandescent lamps. The objective voltage shall be within the range 90 % to 100 % of the nominal battery voltage.

Item i) applies; however, batteries may be disconnected and replaced by a stabilized power supply as described in clause **12** of this standard.

21 Standard measuring conditions for bare lamps

The provisions of clause **21** of Part 1 apply.

22 Stabilization

The provisions of clause **22** of Part 1 apply.

23 Measuring procedure

The provisions of clause **23** of Part 1 apply.

24 Reporting of measurements

The provisions of clause **24** of Part 1 apply with the addition of the provisions given below.

For calculations in accordance with BS 5266-1, calibrated polar curves and correction factors are required. Calibrated polar curves shall be normalized to 1 000 total bare lamp lumens (see definition in **3.15** of Part 1 and Appendix K of this standard). The curves shall be prepared either by the direct method using calibrated apparatus or by relative test procedures. The latter method is preferred and is summarized in a flow chart in Appendix L.

The following correction factors shall be applied to the calibrated polar curves:

a) ballast lumen factor (BLF);

b) initial light output factor (F_5), or end of duration light output factor (F_{end}), whichever is the smaller;

c) temperature correction factor (F_t) [see **59** a) of Part 1];

d) supply voltage correction factor (F_v) [see **59** e) of Part 1].

Lamp lumens measured in accordance with the British Standard for the lamp type shall be declared at the point in the lamp life at which replacement is recommended.

Section 3. Goniophotometers

25 to 39 The provisions of clauses **25** to **39** of Part 1 apply.

Section 4. Photometric integrators for luminaires

40 to 56 The provisions of clauses **40** to **56** of Part 1 apply.

Section 5. Photometric factors

57 General

The provisions of clause **57** of Part 1 apply.

58 Measurement correction factors

The provisions of clause **58** of Part 1 apply.

59 Service correction factors

The provisions of clause **59** of Part 1 apply with the following additions.

A service correction factor is required when the light output of a lamp or luminaire at 5 s after switch-over to emergency differs from the stabilized output at rated voltage. This factor is known as F_5 and is determined by operating the test lamp on the initial battery voltage (V_5) from the instant of switch-over to emergency operation and comparing the light output at 5 s with the stabilized light output of the same luminaire operated on V_{nom}.

NOTE For some equipment it may be necessary also to determine F_5 at various ambient temperatures.

A service correction factor is required when the stabilized light output of a lamp or luminaire on minimum supply voltage differs from the stabilized light output on V_{nom}. This factor is known as F_{end} and is determined by operating the test lamp on the end of duration battery voltage (V_{end}) and comparing the stabilized output with that of the same luminaire operated on V_{nom}.

NOTE For some equipment it may be necessary also to determine F_{end} at various ambient temperatures.

60 Ballast lumen factor (BLF)

The provisions of clause **60** of Part 1 apply except for the first sentence of the second paragraph of **60.1**. In its place, the following applies.

The test lamp shall be pre-aged, if necessary, on a 50 Hz supply voltage and operated in turn on the reference ballast at 50 Hz supply voltage under the standard measuring conditions for bare lamps prescribed in clause **21**, and then on the test ballast at rated ballast voltage.

Section 6. Luminance measurements

61 to 69 The provisions of clauses **61** to **69** of Part 1 apply.

Section 7. Illuminance measurements (single luminaire)

70 General

The provisions of clause **70** of Part 1 apply.

71 Measuring apparatus

The provisions of clause **71** of Part 1 apply.

72 Selection of lamps, ballasts, luminaire

The provisions of clause **72** of Part 1 apply.

73 Measuring procedure

The provisions of clause **73** of Part 1 apply.

74 Calibration of measurements

The provisions of clause **74** of Part 1 apply.

75 Reporting of measurements

The provisions of clause **75** of Part 1 apply except that photometric data shall be reported after correction by the initial light output factor (F_5) or by the end of duration light output factor (F_{end}) whichever is the smaller.

Appendix A Light output ratios of luminaires

The provisions of Appendix A of Part 1 apply. In addition, with reference to paragraph 3, it should be noted that for LORW the ballast specifications referred to are BS 2818 for ballasts for tubular fluorescent lamps and BS 4782 for ballasts for discharge lamps. For the purpose of photometric tests all measurements are made using an objective ballast.

Appendix B Calibration of measurements

The provisions of Appendix B of Part 1 apply.

Appendix C Check of photocell linearity

The provisions of Appendix C of Part 1 apply.

Appendix D Check of photocell spectral response

The provisions of Appendix D of Part 1 apply.

Appendix E Standard mounting boards

The provisions of Appendix E of Part 1 apply.

Appendix F Commissioning of goniophotometers

The provisions of Appendix F of Part 1 apply.

Appendix G Selection of type of goniophotometer

The provisions of Appendix G of Part 1 apply.

Appendix H Initial checking of integrators

The provisions of Appendix H of Part 1 apply.

Appendix J Amalgam lamps

The provisions of Appendix J of Part 1 apply.

Appendix K Normalization of photometric data

Assuming that the luminaire has been photometrically tested in accordance with this document, a table of intensities will be available from this measurement.

The required angular spacing of the intensity values is shown on two worksheets, 1a and 1b (Figure 1 and Figure 2). Worksheet 1a is used for luminaires (typically using incandescent lamps) that have a light distribution symmetrical about the vertical axis. For these luminaires, readings are required in vertical planes at intervals of 45° in azimuth.

Worksheet 1b is used for other luminaires (typically using fluorescent lamps) that have a di-symmetric light distribution about the vertical axis with two mutually perpendicular planes of symmetry.

For these luminaires, readings are required in vertical planes at intervals of 30° in azimuth. It is normal practice to use Worksheet 1b for linear luminaires having symmetrical light distribution to produce axial and transverse polar intensity distributions, which are of use in aspect factor calculations.

Intensity values are only required at 5°, 15°, 25°, etc. in elevation for calculating zonal flux. Values of 0°, 10°, 20°, etc. to 90°, are required for all angles of azimuth shown in worksheets 1a and 1b for drawing the normalized polar curves. These additional values are, therefore, included in the tables. To enable the worksheets to be used when intensity readings are taken at equal angular intervals, spaces for the redundant readings are included in the worksheets, but are shaded.

The method of using worksheets 1a and 1b, is as follows.

Step 1. Select the relevant worksheet and enter the intensities in the appropriate rows and columns. These values are normally in arbitrary units.

Step 2. Sum the intensities along the rows and average them at the angles of elevation indicated on the worksheet. These are at 5° intervals for symmetric luminaires and at 10° intervals, starting at 5°, for di-symmetric luminaires.

Step 3. Multiply the total of column E obtained at angles of elevation 5°, 15°, 25°, etc., by the zone factors given in column F. The zonal flux so obtained is written in column G.

Step 4. Total column G from 0° to 180° with sub-total at 90°.

Step 5. Find, if necessary, LOR by using the formula given on the worksheet. Where bare lamps are tested on the goniophotometer, steps 1 to 4 will have to be repeated for each lamp to find the total bare lamp flux in arbitrary units. Alternatively, the simplified procedure for calibration given in Part 1 may be followed.

Step 6. Find the scale factor (SF) by using the appropriate formula given at the bottom of the worksheet.

Step 7. Complete column H for symmetric luminaires to find the average light distribution, or columns J and K for di-symmetric luminaires to find the average transverse and axial distributions respectively.

Worksheet 1a. Luminaires with symmetrical distribution

LUMINAIRE DESCRIPTION:

Angle of elevation (degrees)	Intensities (in arbitrary units) Angle of azimuth (degrees) 0	45	90	135	180	225	270	315	*E* Average intensity (Sum / 8)	*F* Zone factor	*G* Zonal flux *E* x *F* (arbitrary units)	*H* Average intensity SF x *E* (Cd/1000 total bare lamp lumens)
0												
5										0.095		
10												
15										0.283		
20												
25										0.463		
30												
35										0.628		
40												
45										0.774		
50												
55										0.897		
60												
65										0.993		
70												
75										1.058		
80												
85										1.091		
90												
				Flux 0° to 90° (arbitrary units) = *L* =								
95										1.091		
100												
105										1.058		
110												
115										0.993		
120												
125										0.897		
130												
135										0.774		
140												
145										0.628		
150												
155										0.463		
160												
165										0.283		
170												
175										0.095		
180												
				Total flux (arbitrary units) = *M* =								

LOR (when not already determined) = $\frac{\text{Total flux in arbitrary units } (M)}{\text{Total bare lamp flux in arbitrary units}}$ = _____

Scale factor = SF = $\frac{\text{LOR} \times 1000}{\text{Total flux in arbitrary units } (M)}$ = _____

DLOR = Flux from 0° to 90° in arbitrary units (L) x (SF/1000) = _____

ULOR = LOR - DLOR = _____

Figure 1 — Example of worksheet for luminaires with symmetrical distribution

Worksheet 1b. Luminaires with di-symmetric distribution

LUMINAIRE DESCRIPTION:

Angle of elevation (degrees)	A			B			C			D			E	F	G	J	K
	Intensities (in arbitrary units) Angles of azimuth (degrees)												Avge intensity (Sum /12)	Zone factor	Zonal flux $E \times F$ (arbitrary units)	Transverse intensity $SF \times \frac{(A+C)}{2}$ (cd/1000 total bare lamp(s) lumens)	Axial intensity $SF \times \frac{(B+D)}{2}$ (cd/1000 total bare lamp(s) lumens)
	0	30	60	90	120	150	180	210	240	270	300	330					
0																	
5														0.095			
10																	
15														0.283			
20																	
25														0.463			
30																	
35														0.628			
40																	
45														0.774			
50																	
55														0.897			
60																	
65														0.993			
70																	
75														1.058			
80																	
85														1.091			
90																	
							Flux 0° to 90° (arbitrary units) = L =										
95														1.091			
100																	
105														1.058			
110																	
115														0.993			
120																	
125														0.897			
130																	
135														0.774			
140																	
145														0.628			
150																	
155														0.463			
160																	
165														0.283			
170																	
175														0.095			
180																	
							Total flux (arbitrary units) = M =										

LOR (when not already determined) = $\frac{\text{Total flux in arbitrary units } (M)}{\text{Total bare lamp flux in arbitrary units}}$ = _____

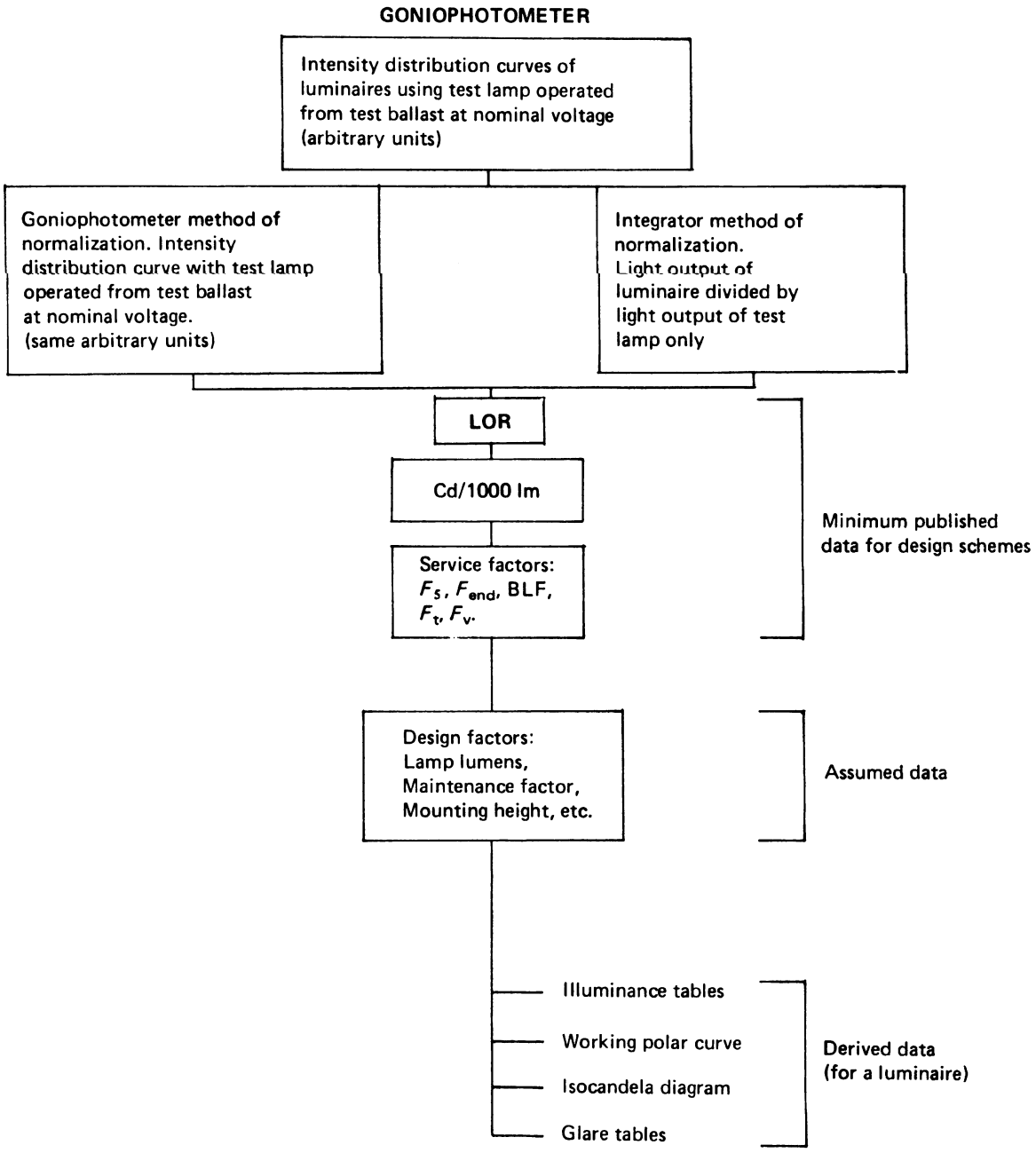
Scale factor = SF = $\frac{\text{LOR} \times 1000}{\text{Total flux in arbitrary units } (M)}$ = _____

DLOR = Flux from 0° to 90° in arbitrary units (L) × (SF/1000) = _____

ULOR = LOR – DLOR = _____

Figure 2 — Example of worksheet for luminaires with di-symmetric distribution

Appendix L Flow chart
(for preferred, i.e. relative method)



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Publications referred to

BS 2560, *Specification for exit signs (internally illuminated).*

BS 2818, *Specification for ballasts for tubular fluorescent lamps*.

BS 4782, *Ballasts for discharge lamps (excluding ballasts for tubular fluorescent lamps).*

BS 5225, *Photometric data for luminaires*.

BS 5225-1, *Photometric measurements*.

BS 5266, *Emergency lighting of buildings*.

BS 5266-1, *Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment*.

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