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IMPACT ASSESSMENT OF HARMONIZING THE IDENTIFICATION OF CORES IN CABLES AND FLEXIBLE CORDS

DRAFT AMENDMENT No 2, 2004 TO BS 7671 : 2001

1. Introduction

Proposals for changes to the cable core colours of electrical installations have been made available for public comment, in accordance with British Standards Institution procedures, in Draft for Public Comment: 03/302646DC, Project No. 2002/00768

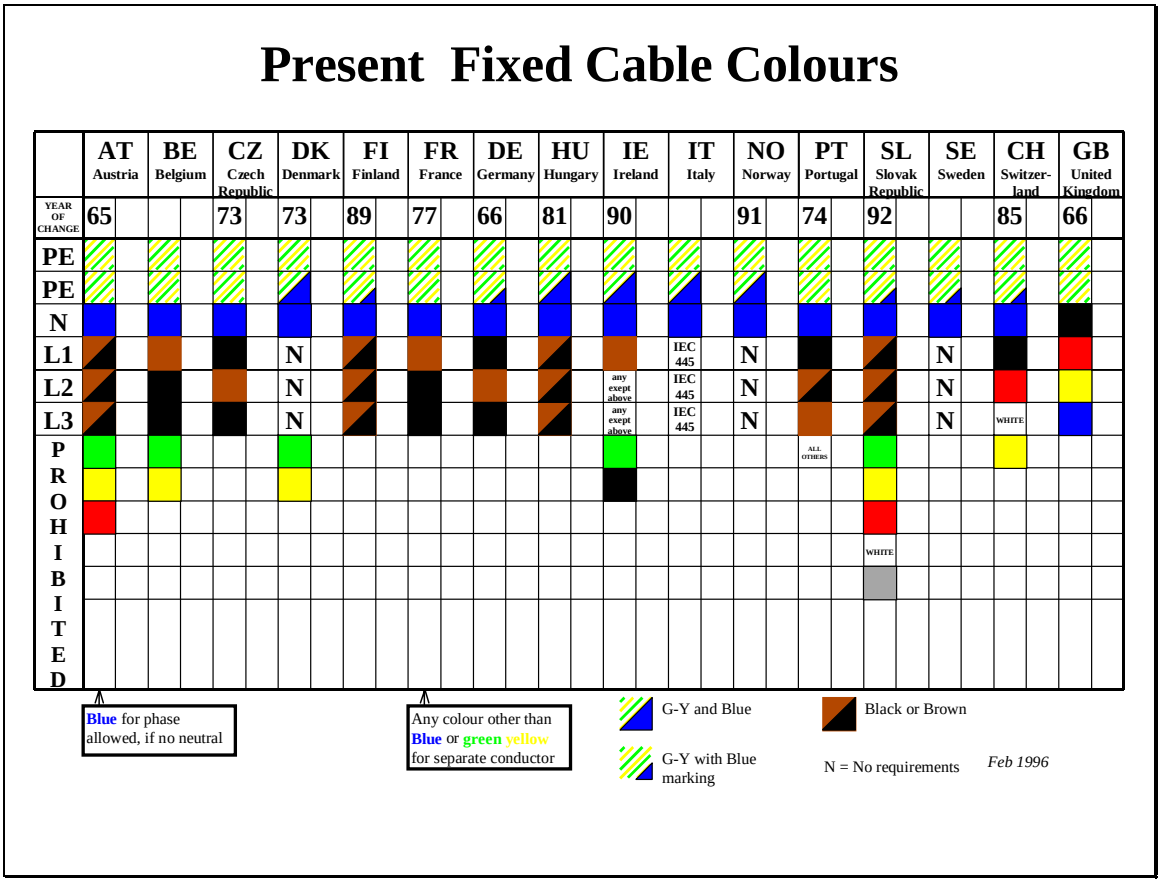
Title: BS 7671 Requirements for electrical installations Draft Amd 2 – Identification by colours
Responsible Committee: JPEL/64: Electrical Installations of Buildings Joint Committee
(Committee Secretary: Mr P R L Cook (IEE) Email: pcook@iee.org.uk).

The IEE has published the proposals in its publication Wiring Matters and on its website. Other organisations including the NICEIC and the ECA have advised of the proposals in their publications. It is anticipated that awareness of the proposal to change the standard is quite high within the trade.

2. Reasons for change

In December 1998 JPEL/64 considered that the identification of cable cores by colour should be reviewed, as HD 308 S1 was being revised by CENELEC to include rigid cables as well as flexible in its scope. Without input from the UK the phase colours would be confirmed as those for flexible cables, that is black and brown. With the exception of the UK, all countries in Europe had harmonized their cable colours in accordance with HD 324: 1976 9 and HDs 3, 4, 16, as can be seen from Figure 1.

Figure 1: CENELEC cable colours



The UK had not been obliged to adopt HD 324 by January 1977, as required by CENELEC agreements, because the IEE Wiring Regulations were not then a British Standard.

The practical consequence was that UK fixed installation cable colours of:

Protective conductor	green/yellow
Neutral	black
Phases	red, white, blue (or 3 reds)

were, and still are, in conflict with the colours adopted for equipment used in and supplied by the installations as follows:

(i) Appliance flex core colours (HD 308, latest implementation date 1 Jan 1977).
For over 30 years these have been:

Protective conductor	green/yellow
Neutral	blue
Phase	brown

These colours were introduced to the UK by the Electrical Appliance (Colour Code) Regulations 1969, statutory instrument No. 310. This, as one of the requirements of the Low Voltage Directive, has resulted in the removal of trade barriers in Europe for domestic and similar equipment.

(ii) According to HD 308 S1: 1976 Flexible cable cores are coloured:

Protective conductor	green/yellow
Neutral	blue
Phases	brown or black,

See table 51B of BS 7671.

(iii) Marking and identification of terminals of BS EN 60446:2000 *Basic and safety principles for the man-machine interface, marking and identification – Identification of colours of conductors by colours or numerals* requires:

Protective Conductor	green-and-yellow
Neutral	blue
AC-phase colours	black and brown are preferred.

Further conflict was to arise as:

(iv) BS EN 60446:2000, the official English language version of EN 60446, required conflicting national standards, including BS 7671, to be withdrawn by 1 April 2004.

(v) CENELEC committee TC 64 would prepare amendments to HD 384 (see page 7 of BS 7671) to extend the colour requirements to include line conductors as well as neutral and earth.

The situation, particularly for DIY, was a cause for concern as the brown, blue and green/yellow colours of flexible cables (including pendants), appliances and equipment conflicted with the fixed cable colours.

JPEL/64 formed a working group in December 1998 to recommend the way forward with respect to phase colours for rigid cables.

3. Cable colour working group

There was immediate agreement within the working group formed in December 1998 that, for single-phase circuits, the colours should be:

Protective conductor	bi-colour combination green-and-yellow
Neutral	blue
Phase conductor	brown

This would mean that the colours of a dwelling's fixed wiring would be the same as those of the flexible cables on appliances and lighting pendants.

In considering three phase colours the working group referred to CENELEC standard HD 384.5.51(IEC 364.5.51) published in October 1985, which required the fixed wiring conductors to be coloured as follows:

Protective conductor	bi-colour combination green and yellow
Neutral	blue
PEN conductor	green/yellow throughout its length and, in addition, light-blue markings at the termination or light blue throughout the length with, in addition, green/yellow markings at the termination.

Harmonisation document HD324 (IEC 446) specifies for phase colours any colour from the following: black, brown, red, orange, yellow, green, violet, grey, white, pink, turquoise, of which black and brown are preferred.

With respect to the phase colours, the options considered when the working group was formed were to:

(i) Make further proposals to amend HD308 to provide for three different phase colours that would be acceptable both in Europe and within the UK,

(ii) Accept the present consensus in Europe of brown and two blacks (see Fig.1),

(iii) Seek a special national condition when HD308 was amended,

(iv) Stay as we were with our present colours i.e. resisting harmonisation and accept the increasing conflict between the colours of the fixed installation and that of appliances, equipment, machinery and flexible cables.

4. The options

4.1 Make proposals to amend HD308

In December 1988 CENELEC TC 64 was considering proposals to extend the scope of HD308 to include fixed cables. At this particular time its scope included only flexible cables and the requirements are shown in Table 51B of BS 7671. The cable colours adopted by Europe for phase conductors were either black or brown and the proposal was that there should be either two browns or two blacks.

An option was that the UK could recommend to CENELEC that three different phase colours be adopted: brown, black and another colour, perhaps grey, white or pink. Should CENELEC adopt these colours, the UK would adopt them. It was clear that it would not be possible to persuade all the other countries in Europe to change their colours to suit the UK as all had harmonized their colours giving preference to brown and black. These colours had been included in HD 308 for flexible cables and the EN for machinery etc.

The intention was that the same colours would be used throughout Europe for installations in buildings and for electricity distribution. The advantage of this approach was that all the countries of Europe would be using the same colours facilitating trade in cables and installations (including erection), and providing safety benefits from the same colouring system for distribution systems as for installations. The disadvantage, as far as the UK was concerned, was that the problems associated with black as a line conductor, would need to be faced.

4.2 Accept the European consensus

As can be seen from Figure 1, all countries in Europe were showing a preference for brown and black as phase conductors and some 11 out of 14 had adopted combinations of black and brown, the balance allowing the IEC range. The proposal to amend HD 308 was to include for two browns and a black as for the flexible cables. Accepting this approach would bring the UK entirely in line with Europe. It would have the advantage with respect to our communications with other countries in Europe and would be the path of least resistance.

The disadvantage, as well as the adoption of a black line conductor, was that it would be difficult to distinguish between the three phases.

4.3 Request a special national condition

The UK could take no action and seek a special national condition allowing non-compliance with HD 308 and BS EN 60446. This would require legislation to be identified that requires the UK installer to use the UK national colours. No such legislation has been found. Cable standards committees would also have to agree to this approach otherwise the cable colours would clash with the installation colours (as they do now for flexible cables).

4.4 Resist harmonization

The UK could continue as now, ignoring deadlines on ENs, continuing with its own British Standard for cables and continuing to use the colours currently used in fixed installations.

The advantage of this would be that concerns with respect to changing the cable colours within fixed installations would not arise. The major disadvantage is that the risks associated with other colours in flexible cables, machinery, and flexes and would remain and over time become more significant. The UK government might well be challenged on this course of action.

4.5 Adopt blue neutrals only

The basic requirement of the HD 384 series for installations in buildings is that the neutrals are blue and the earth is green/yellow with a range of colours for the line conductors. Whilst particular phase colours are agreed for flexible and rigid cables, it would be quite possible to allow a range of colours for the fixed wiring. As brown and black would be adopted for cables, there would be a mix of colours in the installation.

5. The way forward

The working group was unanimous in its recommendation to JPEL/64 that the way forward should be to try to persuade the Europeans to accept three different phase colours for flexible cables, rigid cables and fixed wiring and that these colours should be compatible with those adopted for distribution cables. If the other members of CENELEC accepted the UK proposal, then the UK would adopt them. The phase colours for fixed wiring would have to include brown to align with colours for flexes and would have to include black, as had been adopted by so many countries, with a third colour suggested as being white, grey or pink.

JPEL/64 agreed with the recommendation of the working group and proposals were put in hand to seek the support of the cable committee, TC20, to change the cable colour proposals for fixed wiring. The UK representatives on the cable committees and on the electrical installation committees were successful in persuading the other European countries to withdraw from brown and two blacks, or black and two browns, and to adopt brown/black/grey. There was also intent that these colours would be used not only for installations in buildings but also for distribution cables. This move was thought to be a significant step forward for Europe with respect to safety. CENELEC has now reached agreement to adopt the fixed cable colours in HD308 and the other amendments to Chapter 51 continue to be debated. Although there is agreement on cable core colours there are other requirements within the Chapter with respect to protection against external influence that have yet to be agreed.

HD 308S2 was ratified by CENELEC in May 2001. It was accepted by CENELEC that the changes required to UK standards and practices were significant and, recognising this, the UK transition period was agreed at 5 years. All electro technical committees were advised of the content of HD 308 and asked to determine if any changes were required to the standards for which they were

responsible, and they were invited to participate in the work of BSI committee L/12, *National Umbrella Group (NSUG) to co-ordinate the change in colour identification of cores of cables (CENELEC HD 308.S2),* (see 02/206243).

The UK lately has been faced with a further decision as to whether to proceed with colour changes now or wait upon agreement within Europe with respect to all the requirements of HD384-5-51. Because of the continuing problems in respect of the man-machine interface, the committee decided that it would be appropriate for the UK to proceed. The decisions to be made were becoming generally known. Contractors and clients were asking if and when the new colours could be used in new installations, particularly those with a long construction period. The committee decided that early adoption was appropriate and that, as soon as it was practical, contractors should be allowed to use the new colours in their installations.

6. The draft for public comment

6.1 Publication

The draft for public comment 03/302 646 DC was issued on 27 March 2003. There were 29 respondents making 155 comments.

The concern of respondents not represented on the joint committee JPEL/64 was, as expected, the use of the colour black for the neutral in old installations and for a phase conductor in harmonized installations. This had also been the major concern of the committee. DC users expressed similar concerns with respect to d.c. installations.

Changes were made following the consultation. The most important are summarised below.

6.2 Use of alphanumeric marking

More prominence was given to alphanumeric marking in the text and tables of the amendment both for a.c. and d.c. as this is unambiguous with respect to colour. In the appendix alphanumeric marking was specified for the interface between new and harmonized installations.

6.3 Warning label

A warning notice is required at or near the appropriate distribution board of installations with wiring to both the old and the harmonized colours.

6.4 d.c. guidance

Specific guidance on marking dc cables has been introduced including the use of alphanumeric marking at the interface i.e. L+, L-, and M.

7. Implementation

7.1 Timing

The amendment agreed for issue on 31 March 2004 allows installations commencing on site after 31 March 2004 and before 1 April 2006 to be installed to Amendment No 2 i.e. with the harmonized colours or the old colours, but not both. After 1 April 2006 only the harmonized colours can be used.

7.2 Existing installations

There is no intention that the cable colours of existing installations should be changed to those of the new harmonized colours. Where there is an extension or alteration to an existing installation the installer may use the old cable colours until 1 April 2006 or the harmonized cable colours marked at the interface.

An Appendix had been included in the DPC and would be included in BS 7671, stating how cables at the interface should be marked. Cables in the old colours are not expected to be available after April 2006 when the old cable standards will be withdrawn.

7.3 Domestic installations

The Committee believes that benefits will accrue from the change to the new colours for domestic installations. The change from protective conductor: green/yellow, neutral: black, phase: red to green/yellow, blue and brown respectively will be beneficial. It will be particularly beneficial in the DIY sector where the cable colours will relate to those found on flexes to appliances and cabling within equipment.

7.4 Industrial installations

Industrial and commercial installations are the domain of the professional installer and problems associated with amateur work should not arise. The concern is the change from the black being used as a neutral to a black being used as a phase colour. There should be few problems with new installations, but there are concerns with respect to additions to existing installations.

When multicore cables are used there is little scope for error as the new and old cables are easily distinguishable.

For single core cables in conduit or trunking there is more concern. However if the use of phase conductors with black insulation is avoided and, say, brown insulation is used for all phases, marked L1, L2, and L3 at the terminations, problems associated with black phase conductors would be avoided.

7.5 Marking

As well as identification by colour, the amendment to the standard recognises other methods of identification including marking. It is proposed that the marking to be adopted would be L1, L2, L3 for the phase conductors, N for the neutral and P for the protective conductor. For d.c. L+, M and L- would be used. Use of this marking at the interface between old and harmonized colours is recommended in Appendix 7, as it is unambiguous.

8. Electrical accidents

Typically there are three or four fatalities each year in the UK associated with the installations of buildings (see figure 2), generally associated with householders making contact with live parts either as a result of DIY repairs or picking up severed flexible cables. This means that within electrical installations in buildings the UK is operating from a very safe base and care has to be taken to maintain this.

Figure 2: Electric shock fatalities in the home

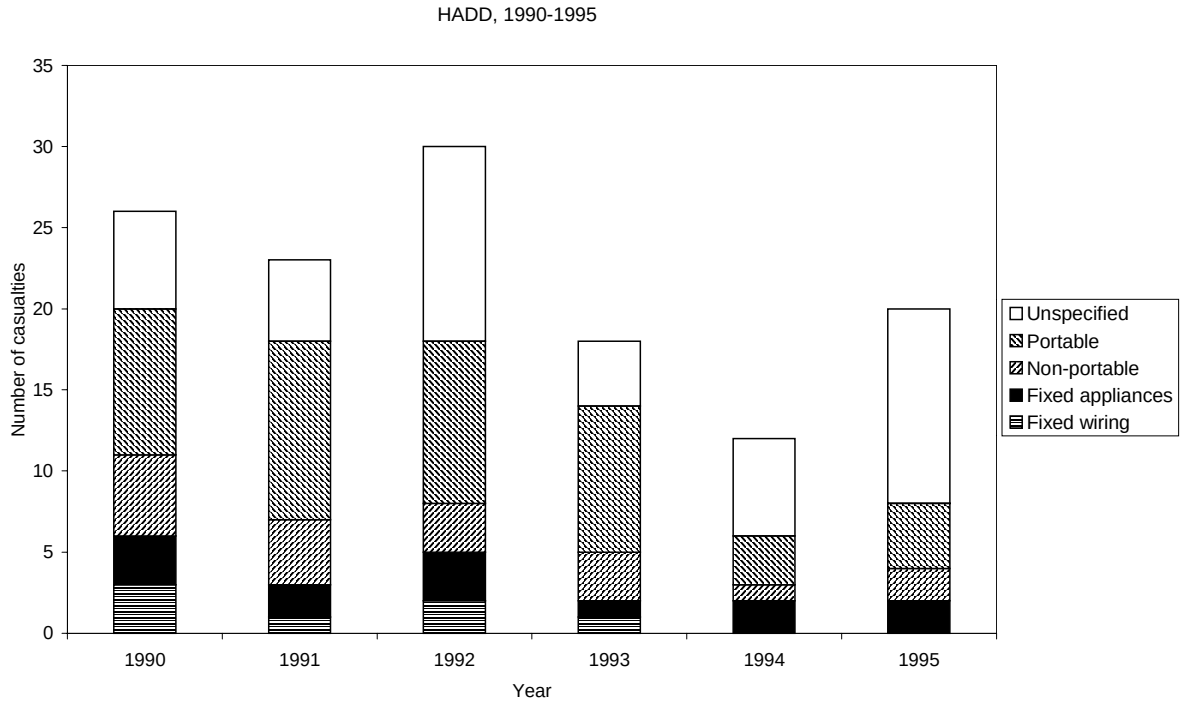


Figure 3 Accidents at work

Injuries to workers involving contact with electricity or electrical discharge as reported to HSE (see Annex 1) 1996/7 - 2000/01

	FATALITY					MAJOR INJURY					OVER 3 DAY/MINOR				
AGENT	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**
Domestic type equipment	-	1	2	2	1	21	29	26	22	17	70	62	61	55	51
Handtools or Hand Lamps	1	2	1	-	-	7	6	9	3	9	13	11	15	10	8
Industrial plant, vessels or equipment	3	1	2	2	3	31	37	40	40	34	66	58	54	55	79
Other network maintenance inc substations	1	-	-	-	-	8	13	20	16	17	23	16	15	17	19
Overhead Lines (unintentional contact)	3	5	2	6	4	6	3	1	8	5	13	5	5	3	6
Research or test equipment	-	-	-	-	-	6	6	4	3	1	3	2	4	4	4
Stimulation or stunning equipment	-	-	-	-	-	1	2	1	-	1	1	3	-	-	2
Switchboards	-	-	1	-	1	6	6	4	10	5	8	9	5	9	10
Underground Cables (unintentional contact)	1	2	1	1	-	37	33	39	36	27	53	55	37	37	22
Other	5	3	6	5	3	67	102	66	72	61	174	160	118	144	131
Grand Total	**14**	**14**	**15**	**16**	**12**	**190**	**237**	**210**	**210**	**177**	**424**	**381**	**314**	**334**	**332**

I:Keyfacts/statistics/Volt table 9601
(1) Kind = 13

Figure 3 summarises accidents at work. The level of fatalities associated with working on electrical installations, that is excluding network maintenance and unintentional contact with overhead lines, is such that the risk of an accident is low. BS 7671 requires that installations be inspected and tested during work and on completion so that wiring is proven, and that certificates are issued to the persons ordering the work.

9. Awareness

There is a need to make both the general public and the trade aware of the colour changes. The BSI and the IEE have set up a Committee L/12 to co-ordinate the requirements of the various standards committees, particularly cable committees. L12 will co-ordinate publicity to bring the change to the attention of professionals engaged in electrical installations and also to the DIY sector.

10. Costing

10.1 Existing installations

There is no intention that existing installations be rewired in the new colours. When extensions are made in the new colours there will be no additional costs associated with single-phase installations, as there is no need to mark. With respect to three-phase installations it is recommended that cables are marked at the interface and there will be some cost to this, but it is expected to be minimal and is difficult to quantify.

10.2 Cable costs

All the countries in Europe will be using cables with the same cable colours. However, this is not likely to be as beneficial as it would first appear as most countries in Europe have national cable types. For example the UK uses a national type, the flat-twin-with-earth commonly installed in domestic dwellings, and other countries do not use the steel wire armoured cable popular in the UK. Whilst BS 7671 lists the cable standards that are to be used, there is no bar to an installer selecting a suitable cable from the standard range of other countries. It is thought that as there is little commonality in cable types in Europe, (except between the UK and Ireland), in the short term there will be no saving in cable costs.

The British Cable Association (BCA) advises that the generic cable types will remain unaffected by the harmonisation. The only detailed change will be from the existing non-harmonized colours of identification for the functional aspects (earth, neutral and phase(s)) to the newly harmonized ones. Manufacturers will bear a significant once-only cost associated with the change. The ongoing effect for manufacturers on costs of producing and supplying standard cables in harmonized colours should be neutral by comparison with those of equivalent cables in non-harmonized colours. This assumes a relatively rapid changeover in the general market, and a pattern of demand for the various generic cable types that is essentially unaltered.