

PREVENTION OF PREMATURE COLLAPSE A GUIDE TO THE DESIGN, INSTALLATION AND INSPECTION OF CABLE MANAGEMENT SYSTEMS



Version 2

April 2022

ABOUT BEAMA

BEAMA is the long established and respected trade association for the electrotechnical sector. The association has a strong track record in the development and implementation of standards to promote safety and product performance for the benefit of manufacturers and their customers.

Details of other BEAMA Guides can be found on the BEAMA website
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PREMATURE COLLAPSE BEAMA CABLE MANAGEMENT TECHNICAL COMMITTEE (CMTC)

1. Introduction

Following the Grenfell Tower tragedy and the subsequent Hackitt Report, the UK Government in December 2018 issued a publication entitled 'Building A Safer Future – An Implementation Plan', whilst also approaching the electrical industry for its support to implement the recommendations contained within the report. BEAMA responded by stating that its members are committed to work with Government to achieve the recommendations and in respect of cable management systems to investigate measures that could be taken to improve the performance of cable management systems to improve fire safety.

Some work had been carried out by the IET prior to the Grenfell tragedy following another fire in a high-rise building – a fire had taken place in Shirley Towers which is a 15-storey concrete tower block of 150 apartments located in the Shirley area of Southampton. In the process of fighting the fire and attempting to clear the building two firefighters died. As an evacuation was attempted, escaping firefighters became entangled in fallen cables, both inside and outside the compartment after the heat from the fire had melted the plastic trunking, they were contained in.

Following the Coroner's inquest, recommendations were made to the UK Government to improve wiring regulations to ensure fire resistant cable support. The IET then amended the 17th Edition Wiring Regulations (BS 7671)

regulations with the publication of Amendment 3, clause 521.11.201. This requirement was subsequently further clarified in the 18th Edition of BS 7671 (521.10.202) stating that *"wiring systems shall be supported such that they will not be liable to premature collapse in the event of a fire."*

Unfortunately, the term 'premature collapse' was not defined and rather than offer clarity to installers this may have added confusion. Furthermore, the fact that there are currently no fire rating tests for the performance of cable management systems within the harmonised product standards, installers have a problem when their clients specify fire safety performance levels for installations.

BEAMA members who represent many of the leading UK cable management manufacturers have been working on further guidance in this area. In conjunction with many stakeholders, including the fire services, the following guidance has been established for installers.

BEAMA are producing a members document that defines test methods for cable management products that will aid compliance with Regulation 521.10.202. The purpose of the tests is to reduce the risk of entanglement in hanging cables caused by failure of cable containment and/or support. This risk does not apply in the case of cables installed under a floor.

See appendices B and C.

Appendix B: Examples of poor installations that could lead to disaster.

Appendix C: Images from the Shirley Towers report

2. Scope

The purpose of this Guidance document is to aid installers to select and erect Wiring Systems to prevent cables from premature collapse due to the effects of heat caused by fire.

Cable Management Systems manufactured from thermoplastic materials such as PVC-U will soften at around 80°C – 100°C and be molten from 180°C – 200°C. Therefore, the retention of cables in the event of a fire is unlikely. Systems manufactured from metallic materials with low melting points and composite materials may also be susceptible to premature collapse in the event of a fire.

To overcome this issue metallic devices may be used, internally and / or externally to the system as advised by the manufacturer.

The purpose of the document is to verify compliance with current 18th Edition IET Wiring Regulations (BS7671:2018+A2:2022) regulation 521.10.202. This guidance is to be used for all Wiring Systems (as per BS 7671 110.1.2), which includes fixed wiring for information and communication technology, signalling, cables above false ceilings, control cables and similar systems.



Construction Fixings:

Construction (substrate) fixing devices are not within the scope of this guidance document. BEAMA members do not represent fixing manufacturers so are unable to offer guidance on such devices. It is crucial that installers liaise with the manufacturers of these fixings to ensure they are suitable to enable the finished installation to meet the requirements of the Regulation.

Web: www.the-cfa.co.uk • Email: info@the-cfa.co.uk • Tel: 0116 274 7358

3. Exclusions from Scope

- 3.1** The electrical performance of wiring systems is not within the scope of this Regulation and therefore not a consideration within this guidance document. The following standards BS 8539 and BS 8519 cover these topics.
- 3.2** Cables buried in walls and floors.
- 3.3** Make-up and performance of substrate.
- 3.4** Reaction to fire and smoke emissions.
- 3.5** Fire propagation and spread of fire between compartments.
- 3.6** BS EN 61534 series Powertrack.
- 3.7** Underfloor cable management installations.
- 3.8** BS EN 61439-6 Busbar.
- 3.9** Construction (substrate) fixing devices as defined in section 4.3.

4. Definitions and Abbreviations

4.1 Cable Management System (CMS):

Assembly including different system components intended for the accommodation of insulated conductors, cables and possibly other electrical equipment in electrical and/or communication systems.

Note: Examples of cable management systems are cable tray systems, mesh cable tray systems, cable ladder systems, cable trunking systems, conduit systems, cable ducting systems, cable cleats, cable ties.

4.2 Collapse:

- (of a structure) suddenly fall down or give way.
- cause (something) to fall down or give way.
- fail suddenly and completely.
- an instance of a structure falling down or giving way.

4.3 Construction Fixing Device (CFD):

A component used to secure the CMS or a component of the CMS to the building structure (substrate).

4.4 Escape Route:

Path to follow for access to a safe area in the event of an emergency.

4.5 Horizontal Movement:

Occurs when wiring installed vertically moves away from its installed position in a horizontal direction (see Figure 2).

4.6 Load (volume):

A maximum allowable volume of cables within a CMS.

4.7 Load (mass):

A maximum allowable mass of cables within a CMS.

4.8 Looping of Wiring Systems:

Common practice where single or groups of cables are often 'looped' to provide slack within the installation. (see appendix D).

4.9 Premature:

Occurring or done before the usual or proper time; too early.

4.10 Reaction to Fire:

Response of a CMS in contributing by its own decomposition to a fire, to which it is exposed, under specified conditions.

4.11 Suspension:

The threaded rod, wire rope, channel or other bracketry system installed from the CFD to the cable management system.

4.12 Vertical Movement:

Occurs when wiring installed horizontally moves away from its installed position in a vertical direction (see Figure 2).

4.13 Wiring System:

An assembly made up of cable or busbars and parts which secure and, if necessary, enclose the cable or busbars. (BS7671:2018+A2:2022).

4.14 Wiring System Bundles:

Bundling / grouping of more than one cable together (See appendix E).

4.15 Substrate:

Building materials commonly used in the construction industry, for example; on which paint is to be applied. Usual substrates include concrete, drywall, wood and steel / metal.

5. Wiring System Zones

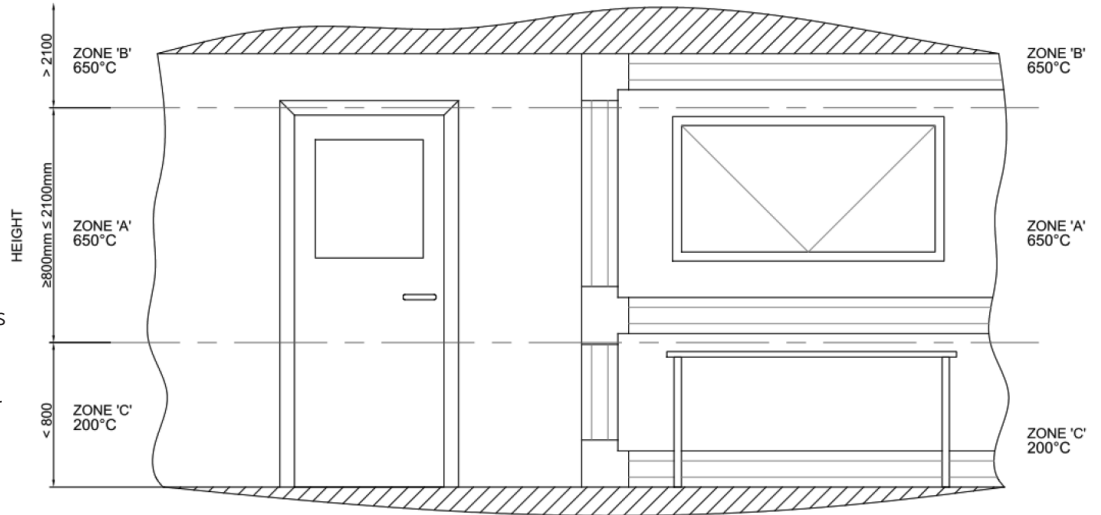
5.1 In the following table the Zones are numbered to enable specifiers, designers, and installers to understand where the requirements are to be applied, see table 1 and figures 1, 2 & 3:

Note: The zone temperatures have been advised by London Fire Brigade (LFB).

Table 1

Zone Ref	A	B	C
Height (mm)	≥800 ≤2100	>2100	<800

Figure 1



Approved Document K provides recommendations for the minimum height of windows (800 mm) above floor level and guarding for windows where they fall below these levels.

5.2 Horizontal Runs:

For horizontal runs in zones 'A' and 'C' the vertical movement as a result of fire, of the wiring system or its contents shall not be greater than **300 mm** (See figure 1, 2 and 3).



IMPORTANT: For installations in zone 'B' any movement of the wiring system or its contents should not result in any part of the installation entering zone 'A'. (See figure 1, 2 and 3)

5.3 Vertical Runs:

For vertical runs in zones 'A' and 'C' the horizontal movement, as a result of fire, of the wiring system or its contents shall not be greater than 150 mm (See figure 2).

Note: Adequate provision shall be made to allow the continued opening of a non-standard door. (See figure 4).

Note: The Wiring System in this context does not include lids, covers and sundry parts.

Figure 2

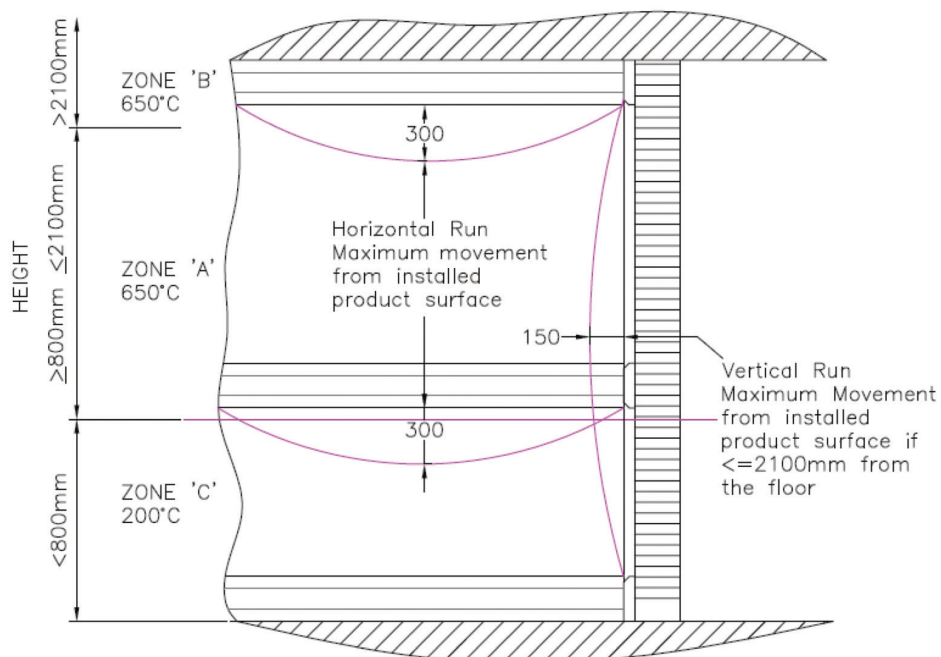
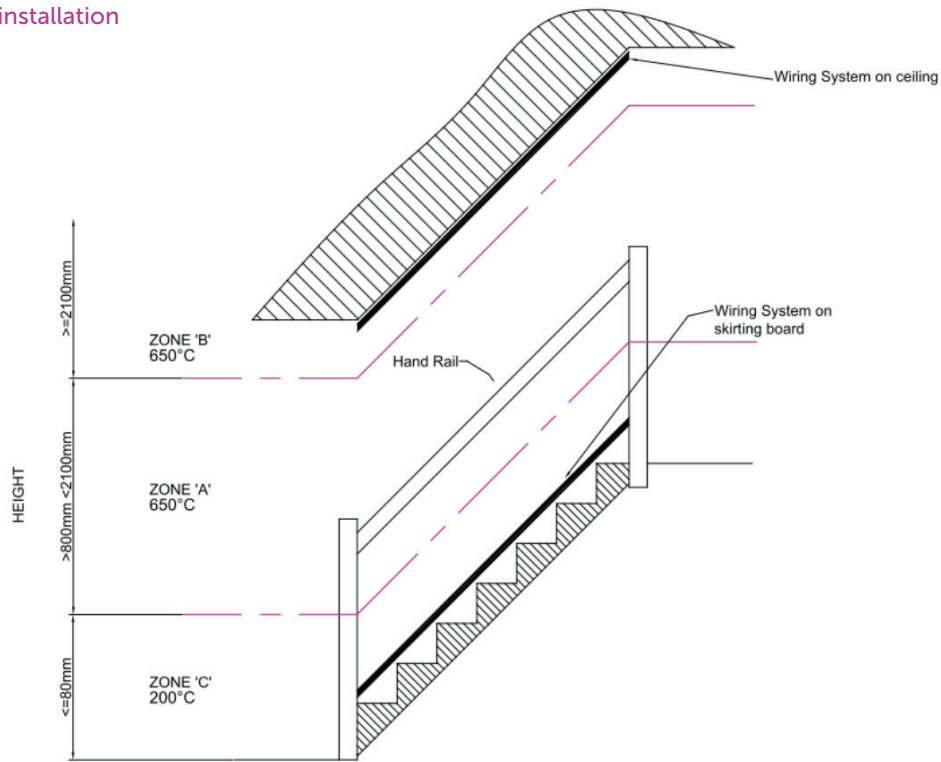


Figure 3: Stairwell installation



5.4 Exclusion Zone:

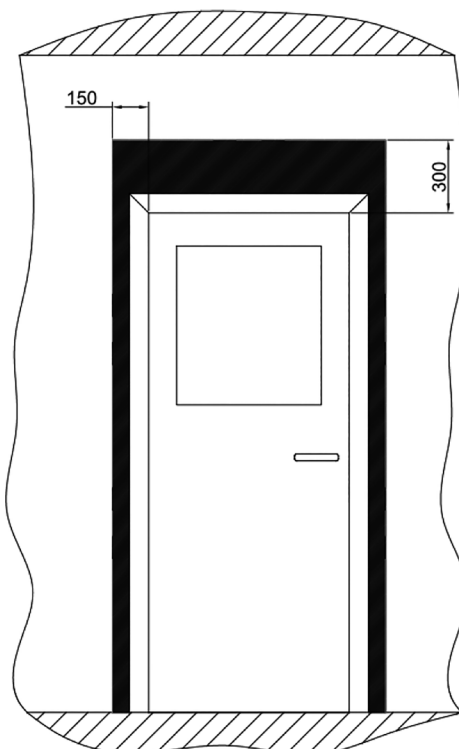
To prevent any movement of the Wiring System from obstructing a doorway in the event of a fire, no Wiring System parts shall be installed within 150 mm either side of a door opening or less than 300 mm above a door opening, see figure 5.

Where this is not possible, a risk assessment can be made and alternate materials such as metal conduit or enclosed

trunking may be used. No movement of the Wiring System or its content is allowed.

Exception: Wiring required for door connected services (i.e., alarms, sensors etc.) which must pass through the exclusion zone must be kept to a minimum and take the shortest path through the zone.

Figure 4: Solid hatch area denotes the exclusion zone



6. Spacing

6.1 Spacing of cable cleats, clips and/or ties:

The spacing of cable cleats, clips and/or ties must be in accordance with IET 'On Site Guide' Appendix D, Table D1 (see table 2 below). Supplementary or replacement heat resistant cable cleats, clips and or ties shall be used to achieve conformance with regulation 521.10.202 and section 5 of this guidance document.

Table 2: Spacings of supports for cables in accessible positions

Overall diameter of cable, d* (mm) 1	Maximum spacing of clips (mm)				Mineral insulated copper sheathed or aluminium sheathed cables	
	Non-armoured thermosetting of thermoplastic (PVC) sheathed cables		Armoured cables			
	Generally		Horizontal †	Vertical †	Horizontal †	Vertical †
	Horizontal †	Vertical †				
2	3	4	5	6	7	
$d \leq 9$	250	400	-	-	600	800
$9 < d \leq 15$	300	400	350	450	900	1200
$15 < d \leq 20$	350	450	400	550	1500	2000
$20 < d \leq 40$	400	550	450	600	-	-

Notes:

For the spacing of supports for cables having an overall diameter exceeding 40 mm, the manufacturer's recommendations should be observed.

- For flat cables taken as the dimension of the major axis.

† The spacings stated for horizontal runs may be applied also to runs at an angle of more than 30° from the vertical. For runs at an angle of 30° or less from the vertical spacings are applicable.

6.2 Trunking and conduit systems:

Trunking and conduit systems that have a melt temperature below 650°C shall have supplementary heat resistant cable cleats, clips and or ties spaced in accordance with 6.1.

Note: The design and materials from which the clip is manufactured may vary between manufacturers and may influence the required number and spacing of clips needed to support the Wiring System, always consult the installation instructions provided by the manufacturer.

7. Installation Requirements

7.1 Physical Load:

Cable Management Systems are often overflowing and over filled with cables. The maximum allowable load placed on or within the component parts of tray and basket (BS EN 61537) is to be declared in the manufacturer's instructions. For cable capacities for trunking and conduit (BS EN 50085 and BS EN 61386) the following tables from the IET On-Site Guide Appendix E should be referenced (See figures 7 – 11), or seek advice from the manufacturer.

Table 3: Cable factors for use in conduit in short straight runs

Type of conductor	Conductor cross-sectional area (mm ²)	Cable factor
Solid	1	22
	1.5	27
	2.5	39
Stranded	1.5	31
	2.5	43
	4	58
	6	88
	10	146
	16	202
	25	385

Table 4: Conduit factors for use in short straight runs

Conduit diameter (mm)	Conduit factor
16	290
20	460
25	800
32	1400
38	1900
50	3500
63	5600

Table 5: Cable factors for use in conduit in long straight runs over 3 m, or runs of any length incorporating bends

Type of conductor	Conductor cross-sectional area (mm ²)	Cable factor
Solid or Stranded	1	16
	1.5	22
	2.5	30
	4	43
	6	58
	10	105
	16	145
	25	217

Note: The inner radius of a conduit bend should be not less than 2.5 times the outside diameter of the conduit.

Table 6: Conduit factors for runs incorporating bends and long straight runs

Length of run (m)	Conduit diameter (mm)																			
	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32
	Straight				One bend				Two bends								Four bends			
1	Covered by Tables 3 and 4				188	303	543	947	177	286	514	900	158	256	463	818	130	213	388	692
1.5					182	294	528	923	167	270	487	857	143	233	422	750	111	182	333	600
2					177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529
2.5					171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474
3					167	270	487	857	143	233	422	750	111	182	333	600				
3.5	179	290	521	911	162	263	475	837	136	222	404	720	103	169	311	563				
4	177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529				
4.5	174	282	507	889	154	250	452	800	125	204	373	667	91	149	275	500				
5	171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474				
6	167	270	487	857	143	233	422	750	111	182	333	600								
7	162	263	475	837	136	222	404	720	103	169	311	563								
8	158	256	463	818	130	213	388	692	97	159	292	529								
9	154	250	452	800	125	204	373	667	91	149	275	500								
10	150	244	442	783	120	196	358	643	86	141	260	474								

Additional factors:

- For 38 mm diameter use 1.4 x (32 mm factor)
- For 50 mm diameter use 2.6 x (32 mm factor)
- For 63 mm diameter use 4.2 x (32 mm factor)

Table 7: Cable factors for trunking

Type of conductor	Conductor cross-sectional area (mm ²)	PVC BS 6004 Cable factor	Thermosetting BS 721 I Cable factor
Solid	1.5	8.0	8.6
	2.5	11.9	11.9
Stranded	1.5	8.6	9.6
	2.5	12.6	13.9
	4	16.6	18.1
	6	21.2	22.9
	10	35.3	36.3
	16	47.8	50.3
	25	73.9	75.4

Notes:

- (a) These factors are for metal trunking and may be optimistic for plastic trunking, where the cross-sectional area available may be significantly reduced from the nominal by the thickness of the wall material.
- (b) The provision of spare space is advisable: however any circuits added at a later date must take into account grouping, Regulation 523.5.

Table 8: Factors for trunking

Dimensions of trunking (mm x mm)	Factor	Dimensions of trunking (mm x mm)	Factor
50 x 38	767	200 x 100	8572
50 x 50	1037	200 x 150	13001
75 x 25	738	200 x 200	17429
75 x 38	1146	225 x 38	3474
75 x 50	1555	225 x 50	4671
75 x 75	2371	225 x 75	7167
100 x 25	993	225 x 100	9662
100 x 38	1542	225 x 150	14652
100 x 50	2091	225 x 200	19643
100 x 75	3189	225 x 225	22138
100 x 100	4252	300 x 38	4648
150 x 38	2999	300 x 50	6251
150 x 50	3091	300 x 75	9590
150 x 75	4743	300 x 100	12929
150 x 100	6394	300 x 150	19607
150 x 150	9697	300 x 200	26285
200 x 38	3082	300 x 225	29624
200 x 50	4145	300 x 300	39428
200 x 75	6359		

Note: Space factor is 45% with trunking thickness taken into account.

7.2 Looping of Wiring Systems:

The looping of cables is bad practice and should be avoided.

7.3 Wiring System Bundles:

Cable bundles must be secured in accordance with the spacings defined in Table 2 based on the diameter of the smallest cable in the bundle.

7.4 Containment of cables:

Cabling shall be installed inside the cabling area of the CMS (unless designed otherwise) and be secured as per this guidance document. For example: cables shall not be tied directly to the outside of the CMS (See Appendix F).

7.5 Additional cable installations:

Additional cable installations shall not be cable tied directly to cables in a pre-existing installation as the sole means of support.

7.6 Plastic cable ties:

Plastic cable ties are a very popular method of securing bundles of cables to cable tray and other fixings. It should be noted that these are very high-risk items and the use be limited especially in Zone A and B.

7.7 Construction Fixing Devices (CFDs):

Construction Fixing Devices (CFDs) shall be selected under the advice from the CFD manufacturer to ensure that under the conditions of this document, Wiring Systems shall not be subject premature collapse.

7.8 Suspension products:

Suspension products should be selected under the advice from the suspension manufacturer, and the installer must ensure that the suspension and its connection to the CFD and the CMS is secure and robust enough so that it shall not cause the wiring system to prematurely collapse.

7.9 Maximum limits of cable spillage:

To aid understanding of the horizontal and vertical limitations set out in sections 5 and 6 additional drawings are shown in Appendix A.

7.10 Inverted CMS:

Where CMS is used in an inverted orientation, the installation shall comply with 6.1.

Where cable tray or ladder is used in an inverted orientation, cable fixings must be used with the spacings defined in Table 2 and sub-clause 7.3.

7.11 False / Suspended Ceiling:

CMS and wiring systems shall not be secured to false or suspended ceilings.

Wiring systems shall be installed according to this document irrespective of the presence of a fire rated ceiling.



8. Conclusion

The intention of this guidance is to assist designers and installers in meeting the requirements of 521.10.202 regarding premature collapse. The guidance has been developed by BEAMA experts across the Cable Management sector and the London Fire Brigade. The team will continue this work to include the development of test methods and specifications for Cable Management products with the objective of improving installation safety.

9. Bibliography

9.1 BS 7671:2018+A2:2022

2018 Requirements for Electrical Installations. IET Wiring Regulations.

9.2 BS EN 50085 Series:

Cable trunking systems and cable ducting systems for electrical installations.

9.3 BS EN 61386 Series:

Conduit systems for cable management.

9.4 BS EN 61537:

Cable management. Cable tray systems and cable ladder systems.

9.5 BS EN 61914:

Cable cleats for electrical installations.

9.6 IEC 61084-1:

Cable trunking systems and cable ducting systems for electrical installations. General requirements.

9.7 BS EN 62275:

Cable Management Systems. Cable ties for electrical installations.

9.8 BS EN 12385-1:

The manufacture and testing of steel wire rope systems.

9.9 BS 8539:2012:

The code of practice for the selection and installation of post installed anchors in concrete and masonry.

9.10 Building Regulations (Fire Safety):

England

Approved Document B (fire safety) volume 1: Dwellings, 2019 edition incorporating 2020 amendments

Approved Document B (fire safety) volume 2: Buildings other than dwellings, 2019 edition incorporating 2020 amendments

Scotland:

Building (Scotland) Regulations 2004. Schedule 5

Wales:

Approved document part B volume 1 (dwellinghouses)

Approved document part B volume 2 (Buildings other

Northern Ireland:

Technical Booklet E (Fire Safety)

9.11 Hackitt Report:

Independent Review of Building Regulations and Fire Safety: Final Report.

<https://www.gov.uk/government/publications/independent-review-of-building-regulations-and-fire-safety-final-report>

9.12 Shirley Towers:

Report of the Hampshire Fire and Rescue Service investigation into the deaths of Firefighters Alan Bannon and James Shears in Flat 72, Shirley Towers, Church Street, Southampton, SO15 5PE, on Tuesday 6 April 2010

https://www.ife.org.uk/write/MediaUploads/Incident%20directory/Shirley%20Towers%20-%202010/Shirley_Towers_-_Final_REDACTED_FRS.pdf

9.13 BRE Test report:

A series of experiments to assess the effect of fire on a selection of electrical cable supports and fixings.

<https://www.bre.co.uk/page.jsp?id=3652>

9.14 BS 5839 series

Fire detection and fire alarm systems for buildings – Code of practice for the design, installation, commissioning and maintenance.

9.15 BS 8519:2020

Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications. Code of practice.

10. Appendices

Appendix A

The dimensions shown are the maximum limits of cable spillage or CMS movement due to increased temperature in the event of a fire.

The following diagrams show various Cable management systems and guidance on their installation in accordance with the preceding document:

Figure 10: Tray, Ladder and Basket Examples

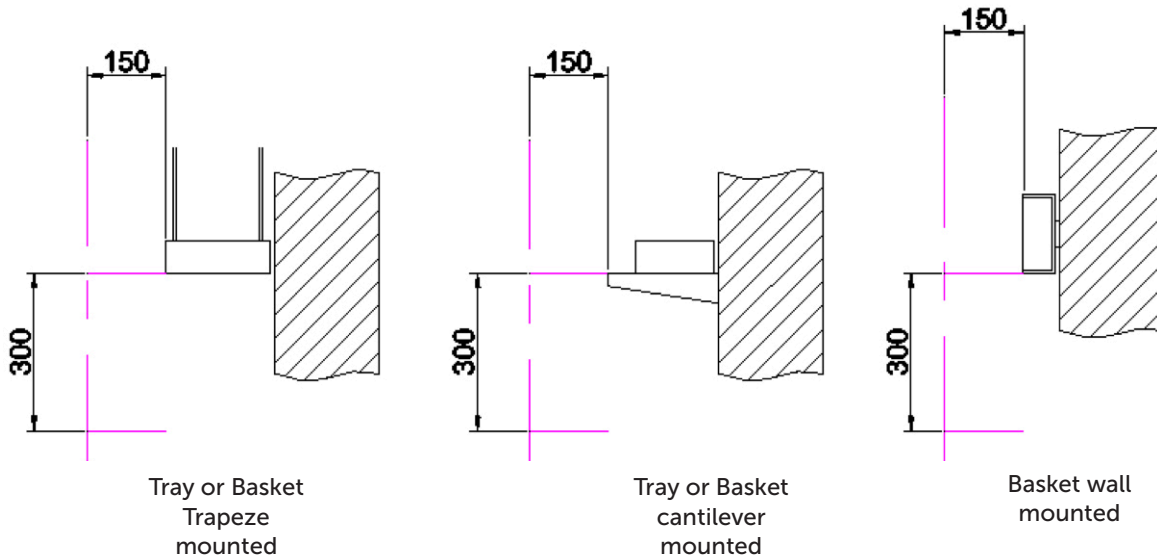


Figure 11: Trunking and Conduit – Horizontal runs on vertical face

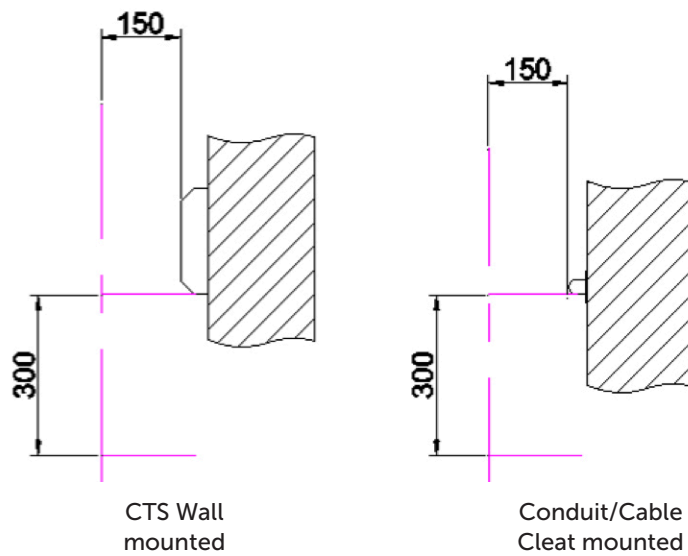


Figure 12: Trunking and Conduit – Internal Bends

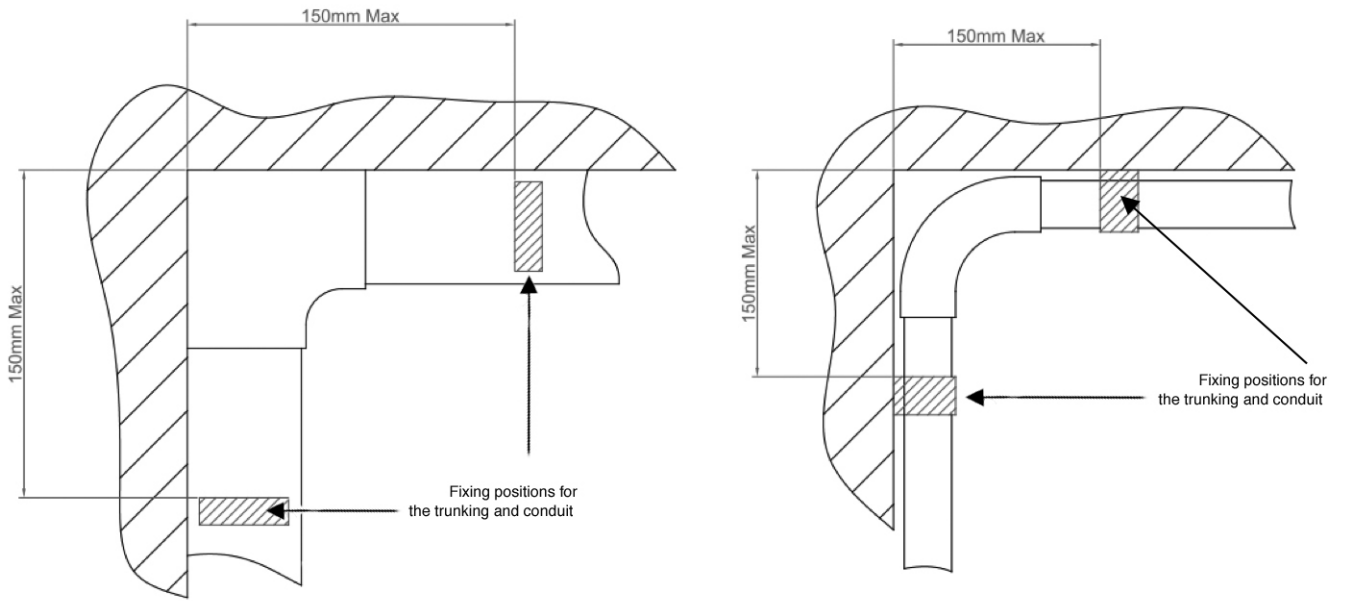
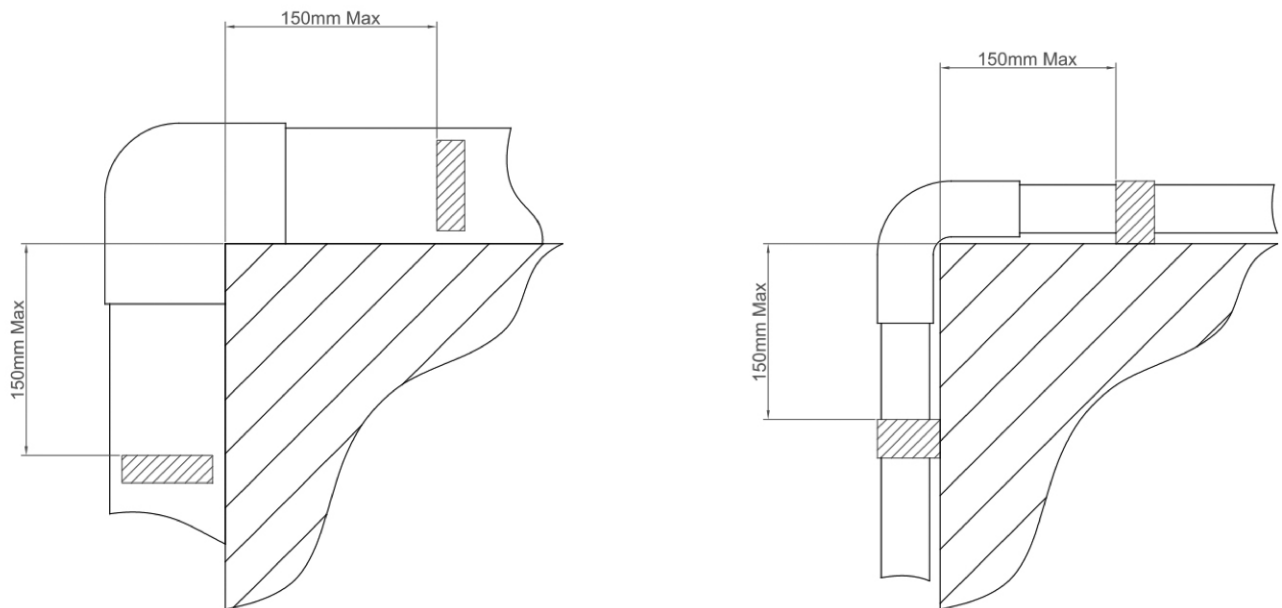


Figure 13: Trunking and Conduit – External Bends



Appendix B

The following image is an example of cabling above a suspended ceiling. Which is not in CMS and / or secured.



The following image is an example of cabling that has spilled from a trunking system and not secured to prevent 'premautre collapse' in the event of a fire.



Appendix C

The following are images from the Shirley Towers report:

Source: Hampshire Constabulary



Post-incident photograph showing conditions on the eleventh floor after the escape door from Flat 27 was left open, note the displaced cables.



Post-incident photograph of the eleventh floor landing showing displaced cables.

Source: Hampshire Constabulary

Appendix D

The image shows an example of cable looping.



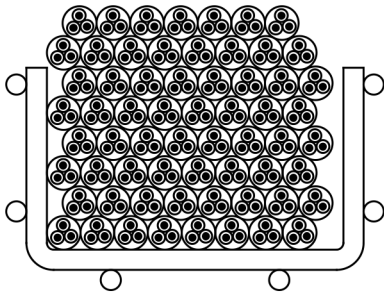
Appendix E

Example of 'bundling/grouping':



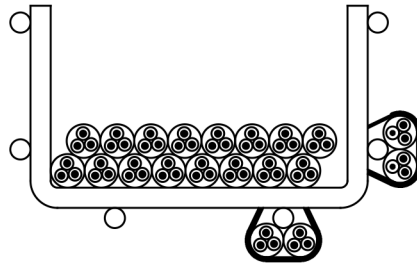
Appendix F

Examples of unacceptable loading of wiring systems:



Appendix F: Figure 1

An example of over filled cable management.



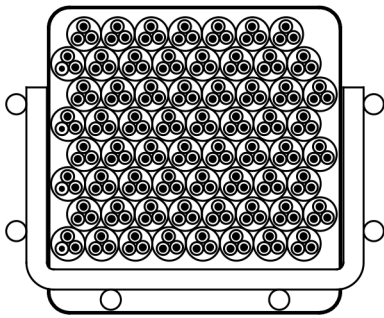
Appendix F: Figure 2

An example of cable ties or similar being used to support additional wiring.

NOT ACCEPTABLE

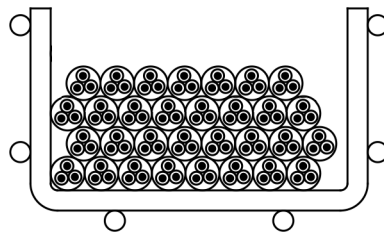


Examples of acceptable loading of wiring systems:



Appendix F: Figure 3

Stainless steel banding used to contain wiring system within and to the CMS.



Appendix F: Figure 4

No external cables to the CMS and filled below the top edge.

ACCEPTABLE

