EDITED BY DAVID LITTLEFIELD

METRIC HANDBOOK

PLANNING AND DESIGN DATA

THIRD EDITION

Architectural Press

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METRIC HANDBOOK

Preface

It is remarkable that, since the *Metric Handbook* first appeared in 1979, it has been revised just twice – in 1998 and, with this 3rd edition, in 2008. This is a testament to both its enduring popularity and the fact that compiling and updating a volume of this size is a vast undertaking. Building regulations and standards of good practice are almost constantly being updated, tightened and rewritten. Agendas also change and awareness of issues such as environmental performance and access for people with disabilities have not only changed the way architects detail buildings – they have changed the way architects think.

The *Metric Handbook* attempts to provide some steady ground on which to lay some fundamental principles. It is a sourcebook which aims to provide architects, and students of architecture, with the essential data and principles required to undertake their work professionally. It seeks to explain and present the principles and protocols of architectural design based on proven best practice and legal requirement. The *Metric Handbook* is a sourcebook to be relied on as good first place to look for data – a volume to be reached for, annotated, written on and book-marked by design teams getting a project off the ground. It is a book of many hundreds of pages but, in spite of the thousands of pieces of data it contains, it represents only a small percentage of the technical/procedural/statutory obligations that architects are expected to meet. This is a book that tells not the whole story (no book ever could) but one which acts as a companion to the wealth of documentation heavy enough to make any library shelf sag.

For the practice moving into new territory, for the student, or for the architect merely needing confirmation of a hunch, this book can be regarded as a trusty friend. There are countless specialist booklets and websites which purport to provide up-to-the-minute data on regulations, laws, products and techniques, and a book of this immensity cannot possibly attempt to compete with other resources. But it does, in a sense, bring all these resources together into a consistent and accessible format. And at every step of the way the many people who have contributed to this new edition have asked themselves the question: "is this useful for the practising architect?"

Of course, the *Metric Handbook* does not seek to guide architects in terms of aesthetics and poetics; rather it seeks to provide them with the essentials from which to undertake a design. It is a foundation only. Users of this book, who can expect it to get them off the starting blocks, would be unwise to rely on it to detail an entire building. Even if building codes don't change (and they have been changing regularly) protocols and standards of good practice are constantly evolving, and users of this book should regard it as one important resource among many.

This 3rd edition represents a major revision of the book. There are brand new chapters, covering masterplanning, whole life costing and inclusive design, while the book also recognises that computers and CAD are now part of normal life. Many chapters have been completely rewritten (such as the chapters on healthcare, laboratories and libraries); others have been significantly updated (schools, student housing and factories); others have been mildly adjusted while some have been left alone. The completed book therefore represents a balance between the time required to update the detail and the need to actually publish. It is like painting the proverbial bridge. We ask readers to forgive any omission or inaccuracy.

David Littlefield
August 2007

Acknowledgements

This update represents a considerable amount of work from a large number of architects, engineers and academics, and heartfelt thanks are due to all of them.

There are chapters within this book that are the result of a considerable team effort, while other chapters have been assembled by sole practitioners or consultants (such as Andy Thompson) who spent many days on this book when they could have been earning fees elsewhere. We are particularly grateful to them.

We also thank those organisations which have provided images to illustrate this book, including the Department of Health, the Central Office of Information, Stephen George and Partners and Hampshire County Council.

All the writers of the new and revised sections within this book are credited at the top of their chapters, but it is worth mentioning some individuals by name who deserve particular thanks – Catherine Nikolaou of Sheppard Robson; David Clarke of Clearwell Healthcare Planning; Fred Lawson; Arthur Lyons; and Norman Seward of the University of Wales.

There will inevitably be people who have helped in the creation of this book who receive no mention. We understand that no book of this size and complexity could be produced without an army of graphic designers, administrators and specialist consultants who have been prepared to fact check, answer questions, push things along and source material from deep within the archives. We thank all of them.

Contents

1 Notation, drawing office practice and dimensional coordination

CI/SfB (1976 revised) (A3t) and (F43)
UDC: 744 and 69.032

KEY POINT:
- *For clear understanding the conventions must be followed*

Contents

Updated 2007, with contribution on CAD standards by Nigel Davies, director of Evolve Consultancy

1 NOTATION

1.01 Decimal marker

The decimal marker (full stop) on the baseline is the standard decimal point in the UK; but the marker at the halfway position is also acceptable. It should be noted that Continental practice is to use the comma on the baseline.

When the value to be expressed is less than unity it should be preceded by zero (e.g. 0.6 not .6). Whole numbers may be expressed without a decimal marker. The appropriate number of decimal places should be chosen depending on the circumstances in which the resulting value is to be used.

Thousand marker

To avoid confusion with the Continental decimal marker, no thousand marker should be used. Where legibility needs to be improved a space can be left in large groups of digits at every thousand point. Where there are only four digits, a space between the first digit and the others is not desirable (e.g. 15000, 1500). (However, the comma is used in currency, e.g. £115,000.)

1.02 Symbols

1 The main symbols should be used as shown in Table I. The same symbol, i.e. m, mm, kg, should be used for singular and plural values (1 kg, 10 kg), and no full stops or other punctuation marks should be used after the symbol unless it occurs at the end of a sentence. Use a 'solidus' or sloping line as a separator between numerator and denominator, i.e. 3 kg/m^3 or 3 kg/cu m (three kilograms per cubic metre).
2 A single space should separate figures from symbols: 10 m, not 10m.
3 The unit should be written in full if there is any doubt about the symbol. For example, the recognised unit symbol l for the unit litre can be confused with the number 1 and it is less confusing to write litre in full. Also, the unit symbol t for tonne may in some circumstances be confused with the imperial ton, and the unit tonne should then be written in full.

Table I Summary of symbols and notation

Quantity	Description	Correct unit symbol	Acceptable alternatives	Incorrect use	Notes
Numerical values		0.1 0.01 0.001		.1 .01 .001	When the value is *less* than unity, the decimal point should be *preceded* by zero
Length	metre millimetre	m mm		m. M meter m.m. mm. MM M.M. milli-metre	
Area	square metre	m^2	sqm	m.sq sm sq.m sqm.	
Volume	cubic metre cubic millimetre	m^3 mm^3	cu m cumm	cu.m m.cu. cu.mm. mm.cub. mm.cu.	
	litre (liquid volume)	l, ltr		l. lit.	Preferably write *litre* in full to avoid 'l' being taken for figure 'one'
Mass (weight)	tonne	t		ton	Preferably write *tonne* in full to avoid being mistaken for imperial ton
	kilogram	kg		Kg kG kg. kilogramme	
	gram	g		g. G.	
Force	newton	N		N. n	Note that when used in written text, the unit of newton is spelled out in full and begins with a lower-case letter 'n'. When used as unit symbol, in calculation or in a formula it is then expressed as capital letter 'N'

4 When symbols are raised to various powers, it is only the symbol which is involved and not the number attached to it. Thus 3 m^3 equals $3(m)^3$ and not 3 m × 3 m × 3 m (i.e. the answer is 3 cubic metres and not 27 cubic metres).
5 Difficulty may be experienced when reproducing the squaring and cubing indices m^2 or mm^2, and m^3 or mm^3. In such cases, units may be written with the indices on the line instead of as superscripts (m2, m3). Alternatively, particularly when the general public is involved, the abbreviations 'sq' and 'cu' may be used (sqm, cu m).
6 Units should not be hyphenated (milli-metres).

1.03 Notation

1 As a rule the sizes of components should be expressed in consistent and not mixed units, e.g. 1500 mm × 600 mm × 25 mm thick and not 1.5 m × 600 mm × 25 mm thick. However, for long thin components such as timbers, it is preferable to mix the units, e.g. 100 mm × 75 mm × 10 m long.
2 It is important to distinguish clearly between the metric tonne and the imperial ton. The tonne is equivalent to 2204.6 lb while the ton is equal to 2240 lb – a difference of 1.6 per cent.
3 The interval of temperature should be referred to as degree Celsius (°C) and not as centigrade. The word centigrade is used by the Continental metric countries as a measure of plane angle and equals 1/10000th part of a right angle.

Examples

Correct use	Incorrect use
33 m	3 cm 3 mm
10.100 m	10 m 100 mm*
50.750 kg	50 kg 750 g

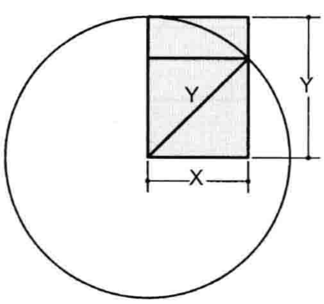
* *Note*. Some metric values are expressed differently in certain countries. The value of 10.100 m, for example, could mean ten thousand one hundred metres and not ten metres one hundred millimetres, as in the UK.

2 PAPER SIZES

The International A-series of paper sizes is used for all drawings and written material.

2.01 Sizes in the A-series

The A range is derived from a rectangle AO, **1.1**, of area 1 m^2 with sides x and y such that $x:y = 1:\sqrt{2}$ (i.e. x = 841 mm; y = 1189 mm). The other sizes in the series are derived downwards by progressively halving the size above across its larger dimension. The proportions of the sizes remain constant, **1.2**.

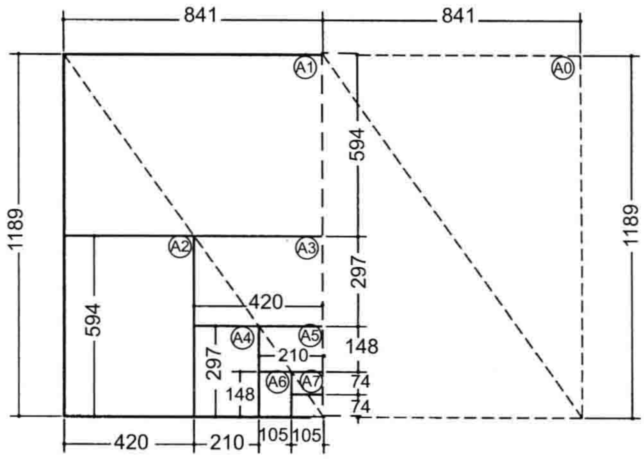


1.1 *Derivation of the rectangle AO, which has a surface area of 1m²*

2.02 Trimmed sizes and tolerances

The A formats are trimmed sizes and therefore exact; stubs of tear-off books, index tabs, etc. are always additional to the A dimensions. Printers purchase their paper in sizes allowing for the following tolerances of the trimmed sizes:

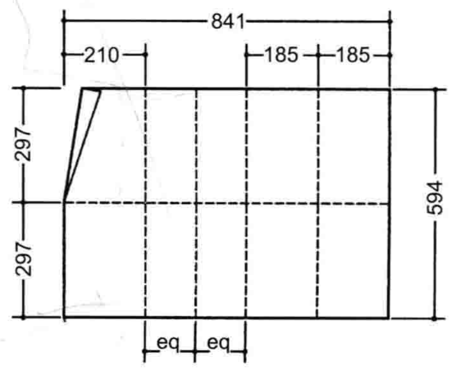
- For dimensions up to and including 150 mm, +1.5 mm
- For dimensions greater than 150 mm up to and including 600 mm, +2 mm
- For dimensions greater than 600 mm, +3 mm. Recommended methods of folding the larger A-sized prints are given in **1.3**.



1.2 *A-sizes retain the same proportion (1:√2), each size being half the size above folding A1 size*

A size	mm
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297
A5	148 × 210
A6	105 × 148
A7	74 × 105
A8	52 × 74
A9	37 × 52
A10	26 × 37

measurements represent trimmed sizes



folding A1 size

1.3 *A-series of paper sizes*

2.03 Pre-metric paper sizes

Old drawings will frequently be found in the sizes common prior to the changeover to metric. These sizes are given in Table II.

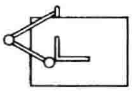
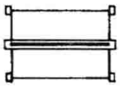
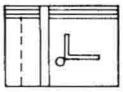
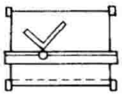
Table II Pre-metric paper and drawing board sizes

Name	Paper size	Board size
Half imperial	559 × 381	594 × 405
Imperial	762 × 559	813 × 584
Double elephant	1016 × 679	1092 × 737
Antiquarian	1346 × 787	1372 × 813

2.04 Drawing boards

Drawing boards are currently manufactured to fit A-size paper, while vertical and horizontal filing cabinets and chests have internal dimensions approximately corresponding to the board sizes listed in Table III. Boards, cabinets and chests designed for the pre-metric paper sizes are still in use.

Table III Nominal sizes of drawing boards for use with parallel motion or drafting machines attached

Type of board	Size	Width (mm)	Length (mm)
Parallel motion unit only or parallelogram type drafting machine  	A2 A1 AO 3AO	470 730 920 1250	650 920 1270 1750
Track or trolley type drafting machine requiring additional 'parking' area to one side 	A1 extended AO extended	650 620	1100 1500
Parallel motion unit with drafting head requiring additional 'parking' area at bottom of board 	A1 deep AO deep	730 1000	920 1270

3 ORDNANCE SURVEY MAPS

3.01

Ordnance Survey maps are now based completely on metric measurements and are immediately available to the following scales:

1:50 000, 1:25 000, 1:10 000, 1:25 000 and 1:1250.

However, new computer methods of storage and retrieval mean that maps can be supplied to any desired scale.

Architects and surveyors inevitably need to refer back to old maps and plans from time to time. These may have been drawn to almost any scale, but the common scales to which OS maps were drawn were as follows:

1 inch to the mile (1:63 360)
6 inches to the mile (1:10 560)
88 feet to the inch (1:1056)

Where these are stored on microfiche, etc., they can be reproduced to a scale more suited to modern use.

3.02 Bench marks and levels

Points used for measuring and marking levels are known as *bench marks*. On a particular site a temporary *bench mark* (TBM) may be established, to which all other levels on that site are referred. The level value allocated to the TBM may be to Ordnance Datum; more commonly it is given an arbitrary value. This value should be large enough not to require any negative levels (including levels of drains, etc.), as these can lead to errors. All levels in and around buildings are recommended to be given to three decimal places, although BS 1192 permits two decimal places for landscape work.

The heights of Ordnance Survey bench marks are given in Bench Mark Lists obtainable from Ordnance Survey Headquarters, Romsey Road, Maybush, Southampton SO9 4DH. Modern OS maps to the larger scales include Ordnance Bench Marks related to Newlyn Datum. Older maps may have levels to Liverpool Datum; levels on maps other than of Great Britain will be related to other datums. Where known, the datum and date of levelling should be stated.

OS maps include contours. On the 1:10 000 series the contour interval is 10 metres in the more mountainous areas and 5 metres in the remainder of the country.

4 DRAWINGS

4.01 Centimetres or millimetres

Continental building practice uses metres or centimetres depending on the particular application. In the UK, since the change to metric dictated the practice, the millimetre is used instead of the centimetre, although this does lead to a mistaken perception of the degree of accuracy.

On a drawing, either metres or millimetres should be used: these units should not be mixed. If this rule is followed, ambiguity is avoided – it is not possible to confuse which units are intended. Dimensions in metres should include either the decimal marker or the letter m: 2.0 or 2 m.

Avoid using capital M for metres. M is used to indicate the number of *modules*: e.g. where a module of 100 mm is adopted 5M means 500 mm.

4.02 Specifying both imperial and metric sizes

If work is being done on an old building that was built to imperial dimensions, and it is desired to show these on new drawings, show them in feet, inches and fractions of an inch to an accuracy of 1/16th inch, followed by the metric equivalent in brackets to the nearest millimetre. The reverse should never be required.

Imperial dimensions may be indicated by the abbreviations *ft* and *in*: 4ft–6in, or using single and double inverted commas: 4'–6". The hyphen is used as the separator.

4.03 Levels on plan

It is important to differentiate on site layout drawings between existing levels and intended levels, thus:

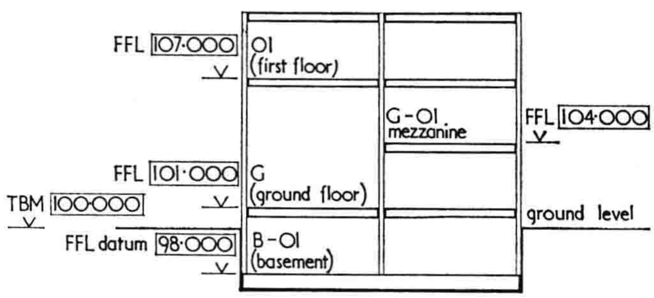
Existing level: × 58.210

Intended level: [60.255]

The exact position to which the level applies should be indicated by 'x'. Finished floor levels should be indicated by the letters FFL followed by the figures of the level, thus: FFL *12.335*.

4.04 Levels on section and elevation

The same method should be used as for levels on plan except that the level should be projected beyond the drawing with an arrowhead indicating the appropriate line, as in **1.4**.



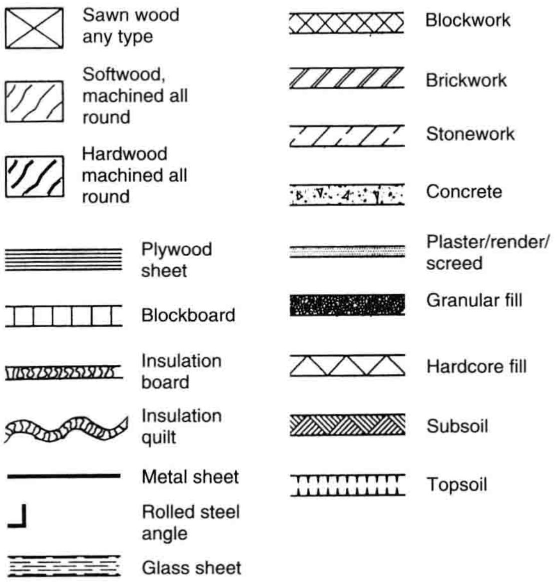
1.4 *Method of indicating levels on sections and elevations*

4.05 Conventional symbols

BS 1153 specifies certain standard symbols for use on drawings. A selection of these are given in **1.5**.

4.06 Scales

The internationally agreed and recommended range of scales for use in the construction industry is given in Table IV. The scale or scales used should be stated on each drawing; drawings that are to read by the non-specialist (e.g. sketch drawings) or that are to be microfilmed or published should have a drawn scale in addition. Where two or more scales are used on the same sheet, these should be clearly indicated. **1.6** shows some dimensions to various scales.



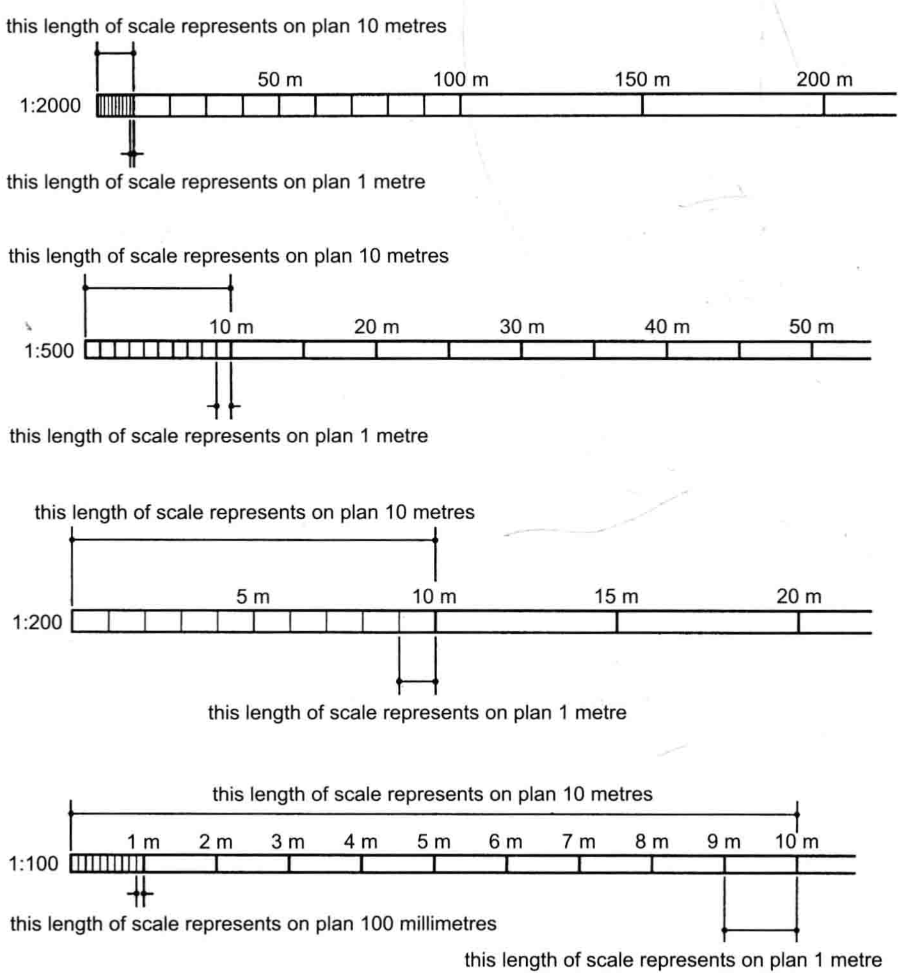
1.5 *Conventional shadings for various materials in section*

Table IV Preferred scales

Use	Scale
Maps	1:1000000
	1:500000
	1:200000
	1:100000
Town surveys	1:50000
	1:20000
	1:10000
	1:5000
	1:2500
	1:2000
Block plan	1:2500
	1:2000
	1:1250
	1:1000
Location drawings	
Site plan	1:500
	1:200
General location	1:200
	1:100
	1:50
Ranges	1:100
	1:50
	1:20
Component drawings	
Assembly	1:20
	1:10
	1:5
Details	1:10
	1:5
	1:1

4.07 Types of drawings

Types of drawings done to the most suitable scales are shown in **1.7** to **1.13**. Note that in **1.10** and **1.11** alternative dimensional units are shown for comparison. The method of expressing dimensions as shown in the shaded drawings is not recommended.



1.6 *Representations of lengths to scale. This drawing may be used to check the correct interpretation of a scale (continued over)*

Table II Selection table for a good passenger lift service

Levels served	Population per floor	Net area served (m²)	No. of lifts in group	Load (persons)	Speed (m/s)	Cost level index
4	60	2400	1	8	1.0	1.00
	69	2760	1	10		1.07
	76	3040	1	13		1.13
	147	5880	2	8		2.00
	176	7040	2	10		2.13
	202	8080	2	13		2.27
5	33	1650	1	8	1.0	1.07
	37	1850	1	10		1.13
	88	4400	2	8		2.13
	105	5250	2	10		2.27
	147	7350	2	10	1.6	2.67
	168	8400	2	13		2.80
	199	9950	2	16		2.93
6	51	3060	2	8	1.0	2.27
	58	3480	2	10		2.40
	63	3780	2	13		2.53
	86	5160	2	8	1.6	2.67
	100	6000	2	10		2.80
	109	6540	2	13		2.93
	121	7260	2	16		3.07
	151	9060	3	10		4.19
	168	10 080	3	13		4.40
	199	11 940	3	16		4.61
7	69	4830	2	10	1.6	2.93
	75	5250	2	13		3.07
	109	7630	3	10		4.40
	122	8540	3	13		4.61
	138	9660	3	16		4.80
	152	10 640	3	21		5.08
	163	11 410	4	13		6.13
	184	12 880	4	16		6.40
	207	14 490	4	21		6.78
8	51	4080	2	10	1.6	3.20
	84	6720	3	10		4.80
	94	7520	3	13		5.00
	109	8720	3	16		5.20
	119	9520	3	21		5.48
	125	10 000	4	13		6.67
	146	11 680	4	16		6.93
	165	13 200	4	21		7.31
	183	14 640	5	16		8.67
	206	16 480	5	21		9.14
9	75	6750	3	13	1.6	5.20
	85	7650	3	16		5.41
	92	8280	3	21		5.68
	100	9000	4	13		6.93
	116	10 440	4	16		7.20
	131	11 790	4	21		7.58
	146	13 140	5	16		9.00
	164	14 760	5	21		9.47
	175	15 750	6	16		10.80
	197	17 730	6	21		11.36
10	61	6100	3	13	1.6	5.41
	68	6800	3	16		5.60
	73	7300	3	21		5.88
	82	8200	4	13		7.20
	96	9600	4	16		7.47
	107	10 700	4	21		7.84
	120	12 000	5	16		9.33
	134	13 400	5	21		9.80
	144	14 400	6	16		11.20
	161	16 100	6	21		11.76
11	51	5610	3	13	1.6	5.6
	56	6160	3	16		5.8
	61	6710	3	13	2.5	7.4
	69	7590	3	16		7.8
	73	8030	3	21		8.8
	81	8910	4	13		9.9
	93	10 230	4	16		10.4
	103	11 330	4	21		11.7
	112	12 320	4	24		12.0
	129	14 190	5	21		14.7
	140	15 400	5	24		15.0
	155	17 050	6	21		17.6
	168	18 480	6	24		18.0
12	53	6360	3	13	2.5	7.6
	61	7320	3	21		9.0
	71	8520	4	13		10.1
	80	9600	4	16	10.7	
	89	10 680	4	21	12.0	
	96	11 520	4	24	12.3	
	111	13 320	5	21		15.0
	120	14 400	5	24	15.3	
	134	16 080	6	21		18.0
	144	17 280	6	24		18.4
13	46	5980	3	13	2.5	7.8
	52	6760	3	16		8.2
	61	7930	4	13		10.4
	70	9100	4	16		10.9
	77	10 010	4	21		12.3
	82	10 660	4	24		12.5
	97	12 610	5	21		15.3
	105	13 650	5	24		16.7
	116	15 080	6	21		18.4
	126	16 380	6	24		18.8
14	40	5600	3	13	2.5	8.0
	54	7560	4	13		10.7
	61	8540	4	16		11.2
	68	9520	4	21		12.5
	71	9940	4	24		12.8
	77	10 780	5	16		14.0
	85	11 900	5	21		15.7
	92	12 880	5	24		16.0
	102	14 280	6	21		18.8
	110	15 400	6	24		19.2
15	48	7200	4	13	2.5	10.9
	54	8100	4	16		11.5
	60	9000	4	21		12.8
	68	10 200	5	16		14.3
	76	11 400	5	21		16.0
	82	12 300	5	24		16.3
	91	13 650	6	21		19.2
	98	14 700	6	24		19.6
16	44	7040	4	13	2.5	11.2
	50	8000	4	16		11.7
	53	8480	4	21		13.1
	62	9920	5	16		14.7
	68	10 880	5	21		16.3
	74	11 840	5	24		16.7
	82	13 120	6	21		19.6
	89	14 240	6	24		20.0
17	40	6800	4	13	2.5	11.5
	45	7650	4	16		12.0
	47	7990	4	21		13.3
	56	9520	5	16		15.0
	62	10 540	5	21		16.7
	64	10 880	5	21	3.5	18.7
	77	13 090	6	21		22.4
18	42	7560	4	16	3.5	13.8
	45	8100	4	21		15.2
	53	9540	5	16		17.3
	59	10 620	5	21		19.0
	71	12 780	6	21		22.8

Based on the handling capacity of lift types (Table I) for typical office traffic

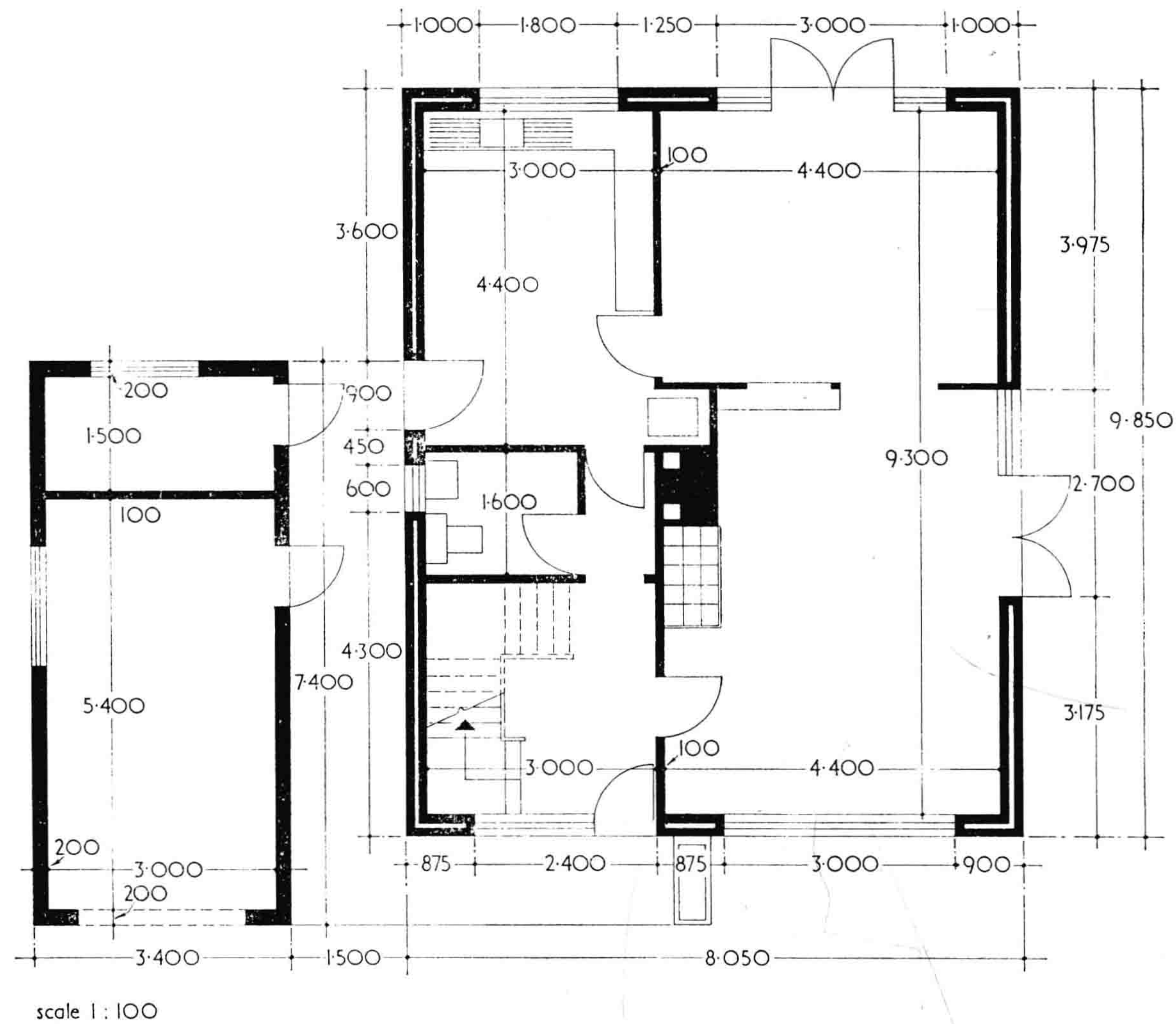
Table III Selection table for separated lifts

Levels served	Population per floor	Net area served (m²)	Load (persons)	Speed (m/s)	Cost level index
5	64	3200	8	1.60	1.27
	70	3500	10		1.33
	77	3850	13		1.40
6	40	2400	8	1.60	1.33
	44	2640	10		1.40
	47	2820	13		1.47
7	29	2030	10	1.60	1.47
	31	2170	13		1.53

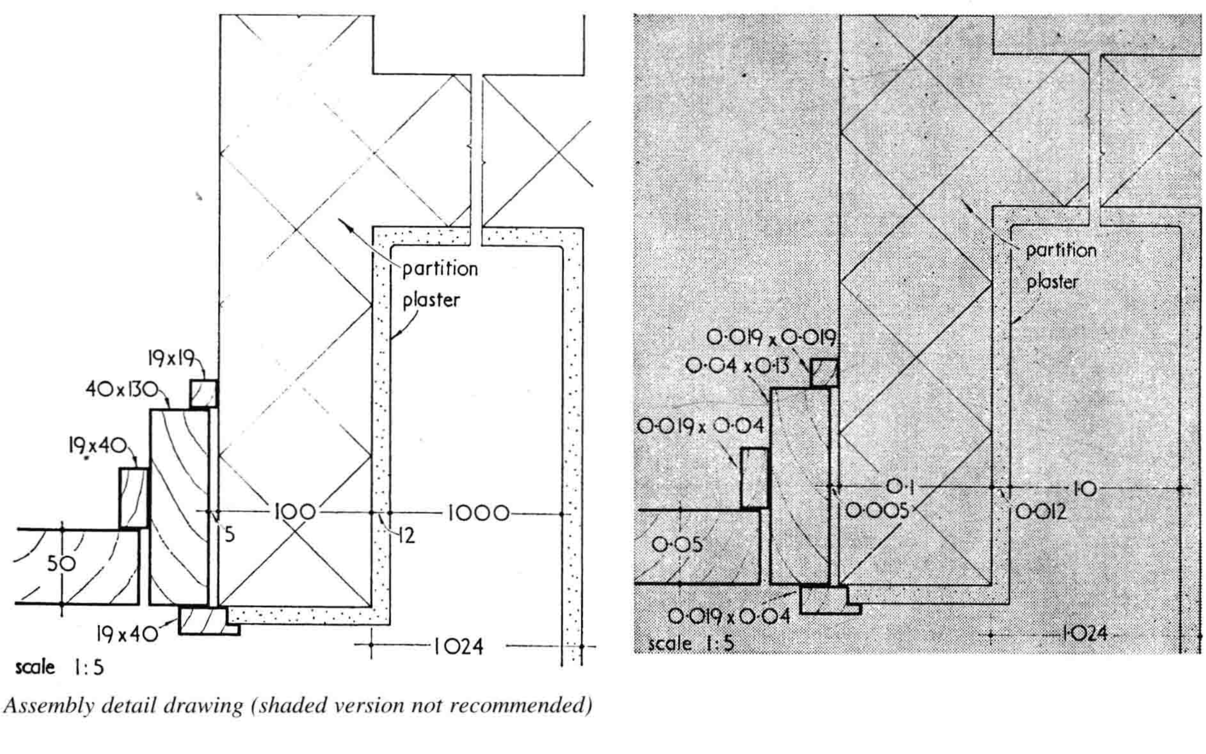
Based on estimated handling capacity of lift types 6 and 7 in Table I

regulations regarding accessibility to residential accommodation of all kinds for wheelchair users may eventually prohibit this practice.

There should be no direct lift access to enclosed underground or underdeck garage spaces for safety reasons. An open area should be provided between lift and garage. Stair access from the lift is



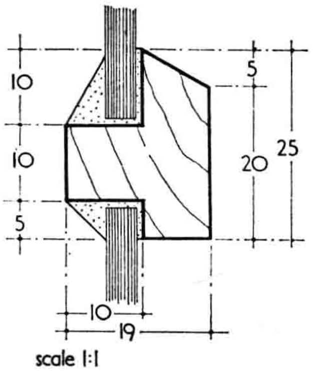
1.10 *Location drawing (sketch plan)*

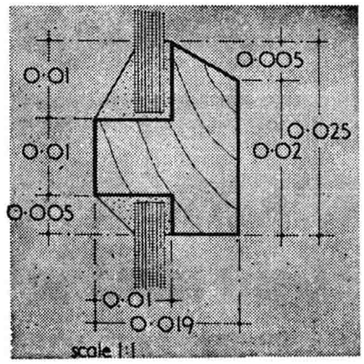


1.11 *Assembly detail drawing (shaded version not recommended)*

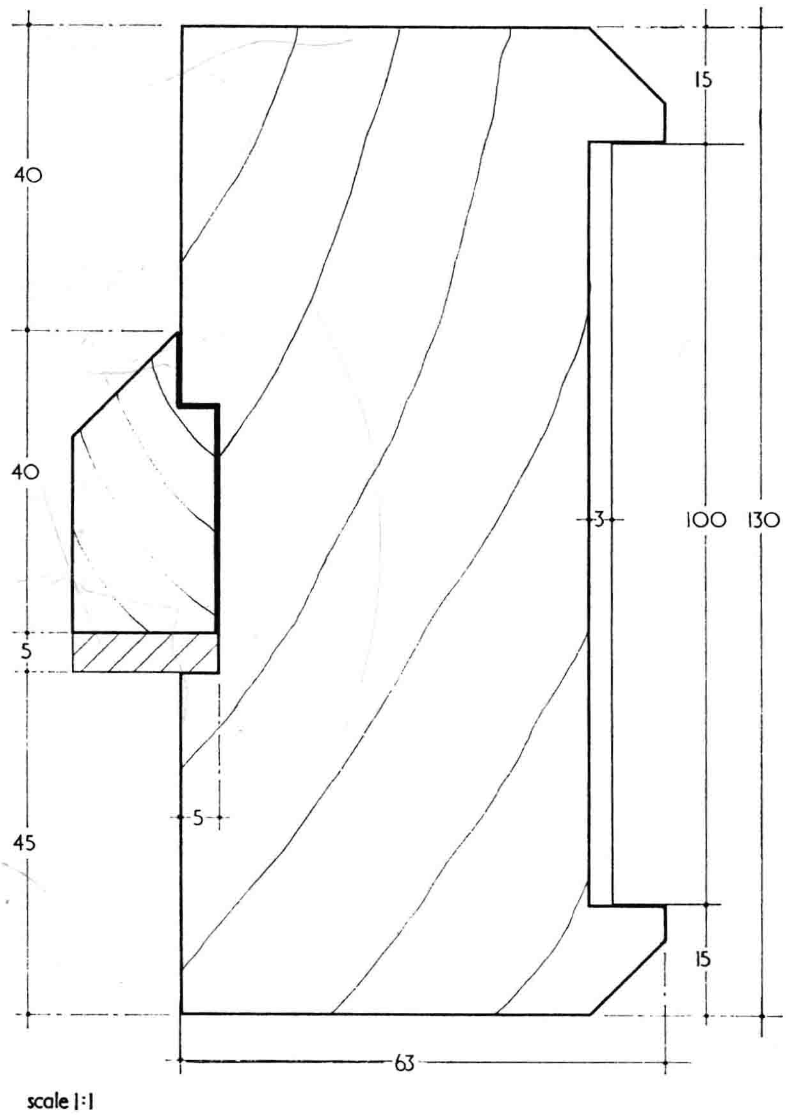
5 Annotation can destroy a legible drawing if not used carefully. Notes should never be used unless they clarify the drawing content. You should never repeat notes on two drawings as this may lead to ambiguity. If a note is repeated on two drawings, remove one or question the need for that drawing.

6 Annotation should be close to the information it relates to, but clear of linework.





1.12 *Full size detail (shaded version not recommended)*



1.13 *Full size detail*

7 The use of abbreviations should be avoided, unless space dictates otherwise.
8 Ensure any drawings is independently checked and approved before issue. One rarely sees ones own mistakes.
9 Symbols should be consistent on all drawings.
10 Certain standard notes should always be considered, including: do not scale from this drawing; all dimensions are in millimetres unless noted otherwise; all levels are in metres above ordnance datum unless noted otherwise; this drawing is to be read in conjunction with other relevant architects' and engineers' drawings and specifications; all setting out is to be confirmed on site prior to construction. Within CAD, these notes can be included as a layer within the drawing border file; if these are on by default, a conscious decision needs to be made before they are omitted.

5.03 Standard symbols

Annotation and symbols are a critical part of the language of a drawing. Symbols – in the form of blocks or cells – are used to either define specific types of annotation – such as North arrows, level markers, spot heights, door and room numbers – or to represent diagrammatically building components such as valves, manholes or insulation. Part of the role of managing an efficient CAD system is to make the use of office-specific symbols and hatching (all part of a high quality, consistent drawing set) quicker than having to redraw the required information. For insulation, this is straightforward; nobody wants to redraw the continuous repeating curve that is commonly used. Ensuring a consistency for level markers, break lines and standard brick hatching is more difficult. The CAD manager can provide all the necessary symbols and hatch patterns so that they appear by default for all users. Each CAD system has ways of enabling this.

No matter how technologically advanced the software configuration, it is useless unless the output (the drawing) is of consistent high quality. A CAD standard is useless if nobody follows it.

5.04 Layer standards

Layer standards should cover more than just layer names; they should include:

- CAD Standards (folder structures, file names, blocks and cells, text and dimension styles, etc.);
- Drawing Standards (drawing borders, layouts, annotation, drawing numbering, revision control, etc.); and
- Related procedures and processes (issue management, archiving, incoming CAD file use, etc.).

The development of layer standards should not be static, but should evolve to account for changing software, working practices and needs of the users.

5.05 Chosing a layer standard

There is a wide variety of standards to choose from, and standards change according to need and location. Indeed, the standard one chooses should be reviewed regularly. The principal layer standards comprise the following:

UK

There is an official British Standard, BS1192 pt 5, that defines the format of layer names for the distribution of digital data. It is part of the complete BS1192, most of which is now out-of-date. Part 5 itself is listed as 'withdrawn'. The codes break down into numerous fields and, consequently, are cumbersome to implement.

There are also the BAA CAD Standards, developed for all British Airports Authority projects and based on the CI/SfB classification system. This is even more comprehensive than BS1192, covering standard naming to the *n*th degree including blocks/cells and even software that can/ca not be used.

AEC (UK) CAD Standards are not actually a standard but, in fact, a ready-to-use implementation of BS1192 pt 5 using Uniclass. The committee responsible for this was made up of actual end-users (architects and engineers) who took BS1192 pt 5 and ISO 123567, bent certain rules (like fixed field lengths) and provided a standard which is free.

US

The main recognised layer structure employed in the USA is the US National CADD Standards (NCS). This is not an official standard in the same manner as an ISO or BS standard but is 'officially sanctioned' by the National Institute of Building Science (similar to the UK's Building Research Establishment) and is ISO compatible. It was put together by a committee comprising members of the American Institute of Architects, the US Corp of Engineers and the US Coast Guard. The NCS also covers other items alongside the layer standards, including drawing sets, drawing sheets, annotation standards, etc.

The layer codes, effectively a republishing of the AIA CAD Layer Conventions, work in a similar way to most of the other world layer standards in that they is broken down into fields to describe the information.

Europe

The European standard, ISO 13567 is very similar to BS1192 in that it provides a framework and guidelines rather than a single unified standard. Its fields are very similar and are just as convoluted and complex.

The trick is to identify the one which best suits your company's area of work (UK, Europe, USA, etc.) and implement it to suit your internal needs for element segregation. If you are mostly working in the USA, use the US National CADD Standards, but if you are a firm split between say, London and New York, consider the AEC (UK) CAD Standard, designed specifically to utilise the 'User Defined' field as other languages or CAD codes.

5.06 Standards for objects and 3D

There is no current standard for definition of objects, and none of the existing standards take 3D into account – simply because this was not a prevalent use of CAD systems when those standards were devised.

The International Alliance for Interoperability (IAI) was formed to tackle this issue and has provided the IFC (Industry Foundation Class) for software-independent exchange of non-graphical data. That is, the geometry of a CAD element will normally survive when translated from one format to another (e.g. DGN to DWG), but the additional intelligence that makes it an object – the material, its weight, cost, accessories, etc. – is lost. The IFC format provides a standard structure for defining and storing this data so that it can be passed from one system to another. Even with many CAD systems now supporting IFC 2.× the industry has still not taken to this approach.

Instead, the industry appears to be developing its own specialist formats for exchange of data. The appearance of, for example, the CIMsteel CIS/2 format for the exchange of steel members has transformed the steel design and fabrication chain. CIS/2 is a simple text file format that stores only what it needs to regarding a steel member, such as its start and end co-ordinates, section size and so on.

5.07 Devising a robust standard layering convention

The following 10 point plan should help a CAD manager devise a robust and standardised layering convention:

1. Refuse to pay for standards. Standards will only become standard when they are freely available and easy to implement.
2. Always opt for a recognised standard wherever possible.
3. Avoid internal standards. Even if your standard has survived for many years, consider updating it to a national system. You can still keep the layers and just apply the national codes.
4. Use only the layers you need, not all those that are available. Do not, for example, print out a list of all the available layers or classifications and tick the ones you could use. Instead, work out what distinctions you need to make and then find the layer code to suit.
5. Involve your users in all the segregation decisions.
6. Avoid superseded classification systems.
7. Avoid the optional fields, they only confuse matters and make information difficult to classify.
8. Use the CAD system to best effect. If you can add descriptions to layers do so. No one likes codes – but it does make them universally interchangeable.
9. Make sure your layer standards are software neutral (as far as is possible) and work regardless of dimension. You should not have two standards, one for 2D one for 3D (and even a third for visualisation).
10. Distribute your layer standards to all other collaborators and try to get them to do the same. Then you are in no doubt as to what and where things are. Point out non-compliance.

6 MEASURING INSTRUMENTS

The following notes are based on BS 4484.

6.01 Folding rules and rods, laths, and pocket tape rules

Lengths of instruments are as follows:

(a) Folding rules: 1 m
(b) Laths: 1 m, 1.5 m or 2 m
(c) Folding and multi-purpose rods: 2 m
(d) Pocket tape rules: 1 m, 2 m, 3 m, or 5 m.

The forms of graduation are shown in **1.14**. The instruments are graduated in millimetres along one edge with 5 m and 10 m graduation marks. Along the other edge the millimetre graduations are omitted.

6.02 Steel and synthetic tapes

Lengths are 10 m, 20 m, or 30 m long. Etched steel bands are available in 30 m and 50 m lengths.

Tapes are graduated at intervals of 100 mm, 10 mm (with the 50 mm centre graduation mark 'arrowed') and 5 mm. The first and last metre of the tape are further subdivided into minor graduation marks at 1 mm intervals (see **1.15**). Note that synthetic material tapes, however, are not subdivided into millimetres over the first and last metre.

6.03 Chains

Studded steel band chains are in lengths of 20 metres, divided by brass studs at every 200 mm position and figured at every 5 metres. The first and last metre are further divided into 10 mm intervals by smaller brass studs with a small washer or other identification at half-metre intervals. The markings appear on both sides of the band.

Land chains are also in lengths of 20 metres, made up of links, which from centre to centre of each middle connecting link measure 200 mm. Tally markers are attached to the middle connecting ring at every whole-metre position. Red markers are used for 5 m positions, with raised numerals; yellow markers of a different shape and with no markings are used for the rest, **1.16**.

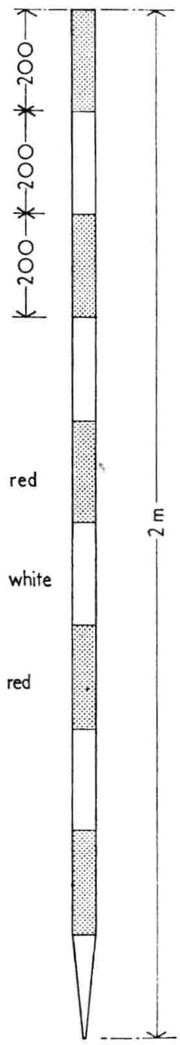
6.04 Levelling staffs

Lengths are 3 m, 4 m or 5 m long with a reading face not less than 38 mm wide. Graduation marks are 10 mm deep, spaced at 10 mm intervals. At every 100 mm the graduation marks offset to the left and right of centre, **1.17**. The outside edges of the lower three graduation marks join together to form an 'E' shape. Different colours distinguish graduation marks in alternate metres. Staffs are figured at every 100 mm interval with metre numbers (small numerals) followed by the decimal point and first decimal part of the metre (large numerals).

6.05 Ranging rods

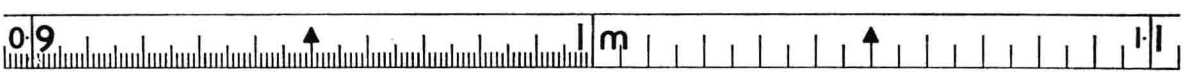
Lengths are 2 m, 2.5 m or 3 m painted in either 200 mm or 500 mm bands alternating red and white. A rod of 2 m length painted in 200 mm bands is shown in **1.18**.

1.17 *Levelling staff marked in 10 mm increments*

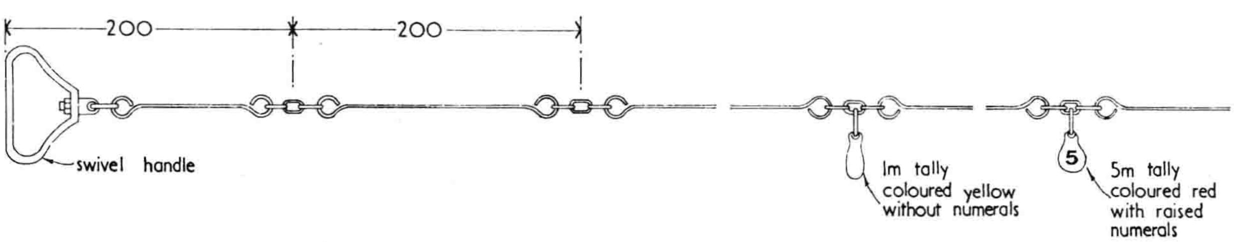


1.18 *Ranging rod*

1.14 *Graduation markings for folding rules and rods, laths and pocket tape rules*



1.15 *Graduation markings for steel tapes*



1.16 *Land chain markings*