
MEASUREMENT OF ELECTRICAL SERVICES IN BUILDINGS

Onwe Friday I.

*Department of Technology and Vocational Education
Ebonyi State University, Abakaliki*

ABSTRACT

This paper deals with the measurement of electrical services in building. It identified the basic items that make up electrical installation including the procedure for their measurement in line with the relevant sections of the standards method of measurement of building works and services. The paper revealed certain vital information which must be made available to the Quantity Surveyor either directly by the consulting Services Engineers or through the Architects. The relatively simple worked example provided an insight to the subject and showed the method of measuring the electrical services to a small building in accordance with the details on drawing and the distribution sheet as shown.

Keywords: *Buildings, Electrical, Conduit, Trunking, switchgear, miniature circuit breaker, installations*

INTRODUCTION

Where electrical circuits are to be measured in detail, such as circuits other than lighting and small power, the route of the conduit and/or cable should be plotted on the plan or a tracing overlay and the number of cables indicated. This sketch will then form a record of what is measured. An isometric sketch is often useful (as with pipework) to illustrate complex runs, Seeley I.H and Roger. W. (2005). According to Murray. G. P. (1997), when plotting conduit and cables it is usual to draw runs at right angles to each other rather than running diagonally. This is usually necessary because of the nature of the structure through which the conduits and cables are passing, as for example following joists or beams. However, conduits and cables can sometimes be laid diagonally where running in floor screeds or in pitched roof voids. Once the route has been plotted and the specification fully understood, the measurement of the work is relatively straightforward, comprising enumerated items of equipment and final circuits and linear items of conduit, cable trunking, cable tray and cable on more complex systems, all measured in accordance with the rules prescribed in the standard method of measurement of builders work seventh edition (SMM7) by the Royal Institute of Chartered Surveyors (RICS, 1998). Within the constraints of this paper, the relatively simple worked example can only provide an introduction to the subject. The measurement of electrical services, as with mechanical services, requires the traditionally trained quantity surveyor to develop his knowledge of the underlying technology.

MEASUREMENT PROCEDURES

CONDUIT: As stated by the Royal Institute of chartered surveyors (1998) in Seeley et al (2005), conduit (not in final circuits) is measured in metres, distinguishing between straight and curved, giving the radii, and stating the type, external size, method of fixing and background as Y60:1.1-2.1.1-5, and particulars of materials as appropriate (Y60:S1-6). The conduit is measured over all conduit fittings and branches (Y60:M2). The conduit is deemed

to include all the labours and components described in Y60:C3. However, junction boxes and the like are enumerated as extra over the conduit in which they occur (Y60:2.1-6.1.1), RICS (1997).

A typical measured item in take off format follows:

<div style="display: flex; align-items: center; justify-content: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 100px; width: 100%;"></div> <div style="margin: 0 5px;">18.50</div> </div>	<p><u>PVC heavy gauge; push fit jts.;</u> <u>Space bas saddles at 600 ccs.</u></p> <p>Conduits</p> <p>20 dia; strt; plug'g to masonry</p> <p>Surfs.</p> <p>E.o. for</p> <p>Small circ. term. boxes</p>
<div style="display: flex; align-items: center; justify-content: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 100px; width: 100%;"></div> <div style="margin: 0 5px;">3</div> </div>	

CABLE TRUNKING AND TRAY: These are measured similarly to conduit, but in addition stating the method of jointing and spacing and method of fixing supports (Y60:5&8.1-2.1.1.), as stated by Seeley I.H. (1997).

CABLES: Seeley I.H. (1997), said that cables (not in final circuits) are measured in metres, giving the type, size, number of cores, armouring and sheathing, method of support and background as Y61.1.1.1-7.1-2, and particulars of relevant materials as Y61.S1-7.Y61:as directed by SMM7 (1998). M3 of the same edition prescribes the allowances to be made to cable lengths entering fittings and equipment.

CABLE AND CONDUIT IN FINAL CIRCUITS: According to the Civil Engineering Standard Method of Measurement Third Edition (CESMM3, 1991), these are enumerated on an enumerated points basis where they form part of a domestic or similar simple installation from distribution boards and the like (Y61:M7), as in the illustration shown in example 1. The SMM7 measurement code points out that this approach is appropriate for the majority of small power and lighting installations of a domestic or similar nature and also for the more simple installations in final circuits in other sections. Other types of final circuits are measured in detail.

Y61:P2 requires the following information to be given in connection with final circuits:

- (a) a distribution sheet setting out the number and location of all fittings and accessories; and
- (b) a location drawing showing the layout of the point.

Examples of these documents are illustrated in table 1 and on drawing 1 of this paper. The SMM7 (1998), measurement code recommends that the distribution sheet should contain information relating to the locations, number and type of lamps, the number of lighting, switch and socket points and the type of fittings, appliances and accessories, together with any information relevant to the circuit arrangement for each distribution board and the like.

Further clarification of the measurement of enumerated final circuit items contained in the SMM7 (1998), measurement code includes the following guidelines:

- (1) It is not necessary to give the size of conduit as it will be at the discretion of the contractor.
- (2) The distribution boards and the like' from which final circuits are measured include such control gear as control panels for boilers, fire alarms, or master clocks and similar items.
- (3) The clarification of points in the enumeration of final circuits relates to the terminations of the permanent wiring to switches and to outlet accessories and control gear for the connection of current using appliances or fittings.
- (4) Flexible conduits, cables and the like between appliances or fittings and the associated terminal accessories or control gear on the permanent wiring of a final circuit should be included in the description of the relevant appliance or fitting.

SWITCHGEAR AND DISTRIBUTION BOARDS : As stated by RICS (1988), these are enumerated, stating the type, size, rated capacity and method of fixing, usually with a cross reference to the specification, and giving details of fuses, supports provided with the equipment and method of fixing, and background as Y71:1-2.1.1.1-3. The SMM7 (1998), measurement code stated that fuse links and miniature circuit breakers (mcb's) supplied with the switchgear and distribution boards shall be included in the description of the control gear; whereas those supplied independently shall be measured separately.

LUMINAIRES AND ACCESSORIES FOR ELECTRICAL SERVICES: These are covered in Y73 and Y74 of SMM7 (1998). Luminaries are enumerated stating the type, size and method of fixing, often with a cross reference to the specification, and any other relevant details listed in the fourth column (Y73:2.1.1.1-13). Pendants are also enumerated, distinguishing between those a drop ≤ 1.000 and > 1.000 . Lamps may be separately enumerated, stating the type, size and rated capacity (Y73:3.1.0.0), or alternatively they can be given in the description of the luminaires (Y73:M2). Accessories, which include lighting switches, socket outlets, thermostats, telephone cord outlet points and bell pushes, are enumerated stating the type, box, method of fixing, background and rated capacity, and may provide for plugs to be provided with socket outlets (Y74:5.1.1.1-2). The description of accessories should state the number of gangs comprised in the accessory, (RICS, 1979).

TESTING AND COMMISSIONING OF ELECTRICAL SERVICES: This is given as an item, stating the installation and any other relevant requirements listed in Y81:5.1.1-2.1-2. Provision of electricity and other supplies and of test certificates is deemed to be included (Y81:CI&C2), Seeley I.H. (1997).

IDENTIFICATION OF ELECTRICAL WORK: This is enumerated, where not provided with equipment or control gear, and is categorized as to plates, discs, labels, tapes and bands,

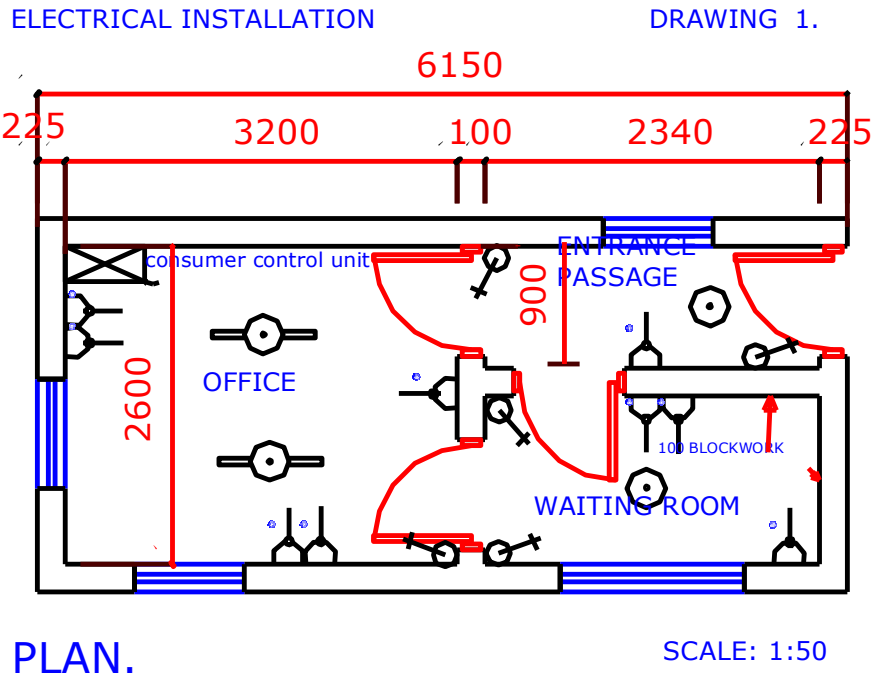
arrows, symbols, letters and numbers, and charts, giving the type, size and method of fixing (Y82:4.1-6.1.1-2), as prescribed in SMM7 (1998).

SUNDRY ITEMS: These are covered in Y89 of SMM7 (1998) For example, marking positions of holes, mortices and chases in the structure is given as an item, stating the installation as Y89:2.1.0.1. Provision of electricity and other supplies required for the temporary operation of the installation is covered by provisional sum as listed in A54 9Y89:6.1.1.1-3&M3).Preparing drawings can be included as an item, giving the details contained in Y89:7.1.1.1-2. Drawings include builder’s work, installation drawings and records or ‘as fitted’ drawings (Y89:D1), Seeley I.H. (1996).

WORKED EXAMPLE: A worked example shows the method of measuring the electrical services to a small building, in accordance with the details shown on drawing 1

Table 1: Distribution Sheet

Location	Lighting				Power			Remarks
	Circt. nr.	Fittings nr. type	Switches one gang	Switches two way	Circt. nr.	13A single SSO	13A double SSO	
Entrance Passage	1	1 100w Plain Pendant		2	2		1	
Waiting room	12	1 150w Plain pendant	2		2		1	1
Office	1	2 65w Fluor.		2	2		1	2
Totals		4	2	4			3	3



Example

Drg. 1

Conn. to. mains cable
Include the follg. defined provisional sum
for works by Electricity Authority

item

Bring'g. mains cable to bldg installg.
 meter and conn. to switchgear: #4096

Consumer unit

LV switchgear & disttn. bd

Distribution bd.

1

4 way surf. type met. clad. M.C.b.
 consumer control unit w.100 amp
 main switch; manufac's ref KM 100;
 two 5 amp & two 30 amp m.c.b.s.;
 plugd. & scrd. to masonry

General LV power

Cables and conduit in final circuits

1

Final circuits;

Cable & conduit in ring main circuit;
 Concealed installation; consistg.
 of 2.5mm² PVC insul. colour coded
 cable; drn. into black enam. heavy
 gauge m.s. conduit; in screeded flrs.;
 in circuit nr. 2, comprisg. Six s.s.0's

Accessories

soc. Outlet

3

13 amp; 3 pin shuttered flush;
 ivory plastic patt single switched,
 stl.k.O. box; plugd. & scrd. to masonry

ditto double

switched; do.

3

General Lighting

Cables and conduit in final circuits

Final circuits

1

Cable and conduit in lighting circuit;
 concealed insallatn.; consistg of
 1.00mm² PVC insul. Colour coded cable
 drn. into black enam. heavy guage m.s.
 conduit; fxd. to tbr.w.clips in circuit nr 1;
 comprisg. four lightg. pts. & two 1
 way & four 2 way switch pts.

Luminaires and lamps

Luminaires

2

Pendant fittg; comprisg. ivory plastic clg.
 rose & connector blk.; brass B.C. lampholder
 w. shade rg. & 3-core 0.75 mm² PVC insul.

Measurement Guide/Notes

The provisional sum for bringing the electric cable to the building, installation the meter and connecting to the client's switchgear, is in according with A53: 1.2.0.0, covering work by statutory undertakings and General Rules 10 of SMM7 measurement code (1998).

The description of the distribution board is to include the type, size, rated capacity, fuses, method of fixing and background as Y71:2.1.1.1-3. The reference to a manufacturer's product will ensure that all contractors tender on the same basis. The background classification is in accordance with General Rules 8.3b, whereby masonry includes concrete, brick, block and stone. M.c.b. is an abbreviation for miniature circuit breaker.

Final circuits are measured on an enumerated points basis where they form part of a domestic or similar simple installation from a distribution board or the like (Y61:M7). The description is to include the cable and conduit installation, giving the size and type of cable and conduit and description of the final circuit (Y61:19.2.1.4.). The circuit number is given for identification purposes although not specifically required by Y61:19. It is necessary to state whether the power circuit is a radial or ring main, whether attached to a surface or concealed and the number of sockets. The abbreviation s.s.o. stands for switched socket outlet.

Accessories are enumerated and contain details of the type, box, method of fixing and background as listed in Y74:5.1.1.2. Accessories include switches and socket outlets (SMM7 measurement code: Y74:5). The abbreviation k.o. refers to knock out box.

All final circuits measured on an enumerated points basis are shown on the distribution sheet (table 1) on drawing 1. The sheet sets out the number and location of all fittings and accessories, which include luminaires, lamps and lighting switches. The distribution sheet (table 1) is adequate for the purpose of Y61:P2 and must be inserted in the bill of quantities. The measurement of final circuits is prescribed in Y61:19.2.1-6.1-5. Colour coded cables must be so described (Y61:S7).

The type, size and method of fixing pendant luminaires are to be given, together with the length of drop (≤ or >1.000) and details of the ceiling rose, conduit box, connector block and lampholder as Y73:2.2.1.2,4,5,6,9 & 13. The locations of these fittings have also been included for ease of identification.

Example

	<p>& protectd flex. cable; drop ≤ 1.000, incl. 50 φ loop in conduit box, scrd.to (ext.passage tbr. & waitg.rm.</p>	
2	<p><u>Luminaires</u> Fluorescent fittg.; 1.500 lg; 65w single tube & difusser, cat. ref. UK 654; incl. conn.blk.; 50 φ loop in conduit box & one suppt bkt.; comprisg. 600 len. of 20 φ conduit & 2nr. 50 loop in boxes., one box scrd. to tbr. (office</p>	<p>Fluorescent fittings require two fixing points. One would be provided with the conduit installation and the other must be included in the description or; alternately, measured separately. The bracket is made up in conduit and screwed to a timber ceiling joist. Timber bearers may be required if the bracket does not coincide with a ceiling joist.</p>
	<p style="text-align: center;"><u>Lamps</u></p> <p>Lamps 100w B.C., G..L.S.; as specfd.</p>	<p>Lamps are enumerated stating the type, size and rated capacity (Y73:3.1.0.0) . It is common practice to take the lamps separately from the luminaires, although alternatively the lamps may be given in the description of the luminaires (Y73: M2) . Many new lamps are now on the market aimed at giving greater efficiency and longer life, such as the Ecolamp™7.9 and 11 equivalent to GLS 40, 50 and 60 W, by soalight and Greenstock’s triple life 26 000 hour fluorescent lamps.</p>
1	<p>(ext. pass</p>	
	<p>Ditto. 150w</p>	<p>Lighting switches are classified as accessories in the SMM7</p>
1	<p>(waitg. rn</p>	<p>Measurement code: Y74:5, and the descriptions are to conform to Y74:5.1.1.2. The descriptions of switches are to give the number of gangs in accordance with Y74:M3. The knock out box is included in the description. Alternatively, specific products can be specified, such as a 1 gang, 2 way stainless steel rocker switch, reference RIGTW/SS, supplied by Forbes and Lomax Ltd. As with all measurement items, work logically through the lighting switches, checking against the layout drawing and the distribution sheet. It is important to double check all quantities to ensure that they are correct.</p>
	<p><u>Lamps</u> Fluorescent tube; 1.500 lg.; 65w; 'warm white'</p>	
1	<p>(office</p>	
	<p><u>Accessories</u> <u>Lighting switches</u> 1 gang, 1 way, 5 amp; single pole silent action, flush ivory plastic plate & stl. k.o. box; plugd. & scrd.to masonry</p>	
2	<p>(waitg. rrn.</p>	<p>The sundries item for marking the position of holes, etc. is required by Y89:2.1.0.0. In large installations it is intended to apply to each installation separately, i.e. lighting and power. These have been combined in this example as it is a very small project and is classified under work section V90.</p>
	<p>1 gang, 2 way ditto (ext. pass</p>	
	<p>(office</p>	
2	<p><u>Generally</u> Markg. the posn. of holes mors. & chases, in the structure for the general lighting & power (small scale) installtn.</p>	

Example

item		
<u>item</u>	<p><u>Installn. generally</u> Testg & commsng. as specified for general lighting & power (small scale) installn.</p>	<p>The testing and commissioning item is covered in Y81:5.11-2.1-2 and is deemed to include provision of electricity and other supplies and certificates (Y81:C18.2).</p>
1	<p><u>Identification</u> <u>Label</u> 125 x 100, white plastic; marked DIS BOARD1/4; w. list of ea. circuit beneath; plug'd & scrd. to masonry.</p> <p>(sited near (Consumer unit</p>	<p>The identification label is not provided with the control gear and so is required to be measured under Y82:4.3.1.0, stating the type, size and method of fixing.</p>
<u>item</u>	<p><u>Sundries</u> Preparg. drgs 4 copies of 'as fitted' prints showg. circuits & conduit runs & hand to maintenance engr.</p>	<p>The drawing item emanates from Y89:7.1.1.2, with one item only being required for the whole works. It is a common requirement for these drawings to be on linen and, if so, it must be stated in the description. The description is to include the number of copies and name of recipient.</p>
6	<p><u>Gen. buildrs wk.</u> Cuttg. or formg holes, mors, sinkgs. & chases for elec. Installns. Concealed m.s conduit 20 ϕ; soc. outlet pts & m/gd</p> <p>(circuit 2</p>	<p>Cutting or forming holes, mortices, sinkings and chases for electrical installations is enumerated, distinguishing between concealed and exposed conduit/cable, and stating the type giving the number of classified points and making good as P31:19.1-4,1-5,1-2, irrespective of the size, type and kind of points (P31:M10) . Associated switch points are deemed to be included (P31:C3).</p>
4	<p>luminairie pts. & m/gd.</p> <p>(circuit 1</p>	

CONCLUSION

The major problem often encountered by inexperienced Quantity Surveyors in the measurement of Electrical installation is often what to measure and not how to scale or the like. Accurate detailed and precise measurement of electrical services in buildings depends on clear understanding of a well plotted or sketched plan showing what is to be measured. This explains the distribution sheet and illustrates the isometric sketch.

Having ascertained that all the relevant drawings are available, careful study of earth drawing should be made to ensure that all the symbols used in the drawing are indicated in the legend in case there is any not reflected in the legend or vice versa, such should be referred to the Engineer for clarification. Same goes for any inconsistency discovered in the drawing or specification.

REFERENCES

Murray, G.P. (1997). *Measurement of Building Services* Macmillan.

Institution of Civil Engineers and Federation of Civil Engineering Contractors (1991). *Civil Engineering Standard Method of Measurement (CESMM3)*, Third Edition Telford.

Royal Institution of Chartered Surveyors and Building Employers Confederation of Building Works (SMM7), Seventh Edition.

Royal Institution of Chartered Surveyors (1979). *Principles of Measurement (International) for Works of Construction*.

Royal Institution of Chartered Surveyors and Building Employers Confederation (1998). *Standard Method of Measurement of Building Works (SMM7)*, Seventh Edition.

Seeley, I.H and Roger Winfield (2005). *Building Quantities Explained Fifth Edition* Creative and Design Publishers (Wales) Ebbw vale Great Britain.

Seeley, I.H. (1997). *Quantity Surveying Practice*, Second Edition Macmillan.

Seeley, I.H. (1996). *Building Economics*, Fourth Edition. Macmillan.

Seeley, I.H. (1989). *Advanced Building Measurement*, Second Edition. Macmillan.