Chapter 9
Principles of Measurement (International)[1]

In the Foreword to the 2004 reprint of POM(I), Simon Cash, chairman of the RICS Construction Faculty, remarks that measurement-based procurement is still appropriate, despite the popularity of other 'newer' approaches, because circumstances still arise where there is design certainty before the contractor is appointed and where, by implication, the advantages of bills of quantities can benefit all concerned in reducing one-sided risk and ensuring a fair and balanced contract.

Simon Cash also points out that *measurement should be undertaken at the level at which design is carried out* and makes reference to the extent to which design decisions are being passed down the supply chain as a result of non-traditional procurement arrangements. Mr Cash also pleads for consistency in measurement, whoever does it, and underlines the consequent need for standard methods of measurement and appropriate measurement skills.

Mr Cash adds, importantly, that the Principles of Measurement (International) (POM(I)) *require a detailed specification and tender drawings to be provided* but hints that it is recognised by the RICS that they also *need to be flexible in order to accommodate* [local] *variations in practice and techniques*.

9.1 Introduction

Most standard methods of measurement are sector specific, focusing on either building or civil engineering work. CESMM does have a *simple building works* class, but no method of measurement offers the range of construction work that POM(I) does.

This might be criticised as the oversimplification of complex measurement issues, but there are merits to be found in an approach that links simple item descriptions with a well-developed design and clear and unequivocal specifications and contract conditions.

Despite being over 35 years old, POM(I) is, perhaps, more suited to modern procurement methods than other more sophisticated methods of measurement of more recent origin.

Managing Measurement Risk in Building and Civil Engineering, First Edition. Peter Williams.

9.1.1 A word of warning

Users of POM(I), and especially contractors and subcontractors, should be not be misled or deceived by the simplicity of these principles of measurement.

POM(I) can be used for all sorts of building and engineering work, including demolitions, underpinning, piling, dredging, railway work and tunnelling, of any value. Because of its simplicity and brevity, however, very little provision is made for measuring, or otherwise describing, risk issues such as may be provided in other more complex methods of measurement.

For this reason, bill compilers, or contractors/subcontractors pricing bills of quantities based on POM(I), should be aware of four key provisions of Section GP: General Principles that condition the measured quantities provided:

1. POM(I) bills of quantities shall describe and represent the works to be carried out (GP2.2).
2. The principles of measurement are reliant on detailed conditions of contract, drawings and specifications being provided with the bill of quantities (Foreword and GP2.3).
3. There may be a need to provide more detailed description than is required by POM(I) in order to fully define the work to be carried out (GP1.1).
4. All BQ items shall be fully inclusive of the liabilities and obligations arising out of the contract (GP4.1).

Risk issue

Tenderers should be aware of the need to visit the site, to scrutinise the accompanying drawings and specification more carefully than ever and to fully understand the conditions of contract being used alongside POM(I).

It may be the case that risk issues not measured under POM(I), which might attract relief under other standard methods of measurement, may be provided for in the accompanying conditions of contract, but this is by no means certain.

If not, it might be necessary to turn to the common law of the land for relief in case of difficulty, but this is likely to result in a much less favourable conclusion than the provisions the JCT, ICC, FIDIC and NEC3 conditions would otherwise render.

9.1.2 POM(I) and computerised measurement

The item description requirements of POM(I) are so simple that a non-library-based software package could be used to create a bill of quantities.

There is no requirement to describe items of work in any specific way provided that the basic information required by each POM(I) clause is included. There are no additional description or supplementary information rules in POM(I), as there are in other methods of measurement.

The example shown in Figure 9.1 illustrates how easy it would be to create a library of item descriptions that can be saved as a template and then copied and exported into other projects.

It can be seen from Figure 9.1 that the software (Buildsoft Cubit) has produced a work breakdown structure, with headings referenced to POM(I) Section B: *Site Work* and Section C: *Concrete Work*. Item descriptions are simplicity itself, albeit some additional description might be thought necessary. Once the take-off has been completed, a variety of reports can be printed, such as individual trade mini-BQs or even a full bill of quantities. The software will also export the file into MS Excel for sending out trade enquiries to subcontractors who don't have Buildsoft Cubit.

Alternatively, an extensive library of standard item descriptions is available within the CATO take-off and billing software. It should be noted, however, that the authors of CATO appear to

Work breakdown structure and take-off sheet

	Description	Result	Quantity	Unit	Rate	...	Total	
1	HOLLY FARM OVER-BRIDGE							
1.1								
2	B - SITE WORK							
2.1	Trench excavation	Vo...		m3				
2.2	Disposal to tip	Vo...		m3				
2.3	Filling to excavation	Vo...		m3				
3	C - CONCRETE WORK							
3.1	Poured concrete							
3.1.1	Foundations	Vo...		m3				
3.1.2	Walls 300 mm thick	Vo...		m3				
3.2	Reinforcement							
3.2.1	10 mm mild steel	Le...		t				
3.2.2	12 mm high yield steel	Le...		t				
3.3	Shuttering							
3.3.1	Sides of foundations	Area		m2				
3.3.2	Sides of walls	Area		m2				
3.4	Prestressed concrete							
3.4.1	Bridge beams type T	C...		each				
3.4.2	Bearings	C...		each				

Figure 9.1 Bespoke POM(I) library template. Produced with Buildsoft Cubit.

have taken the view that enhanced descriptive features are needed in some circumstances but, notwithstanding this, the software allows for the creation of 'rogue' descriptions.

This means that the bill compiler is at liberty to create bespoke item descriptions as need be. The functionality of CATO is a big help to bill compilers who would otherwise need to compile their own additional descriptions.

Examples of the approach to item description taken by CATO can be seen in Figure 9.2 which shows that trial holes are measured by number rather than depth (POM(I) Clause B2.1)

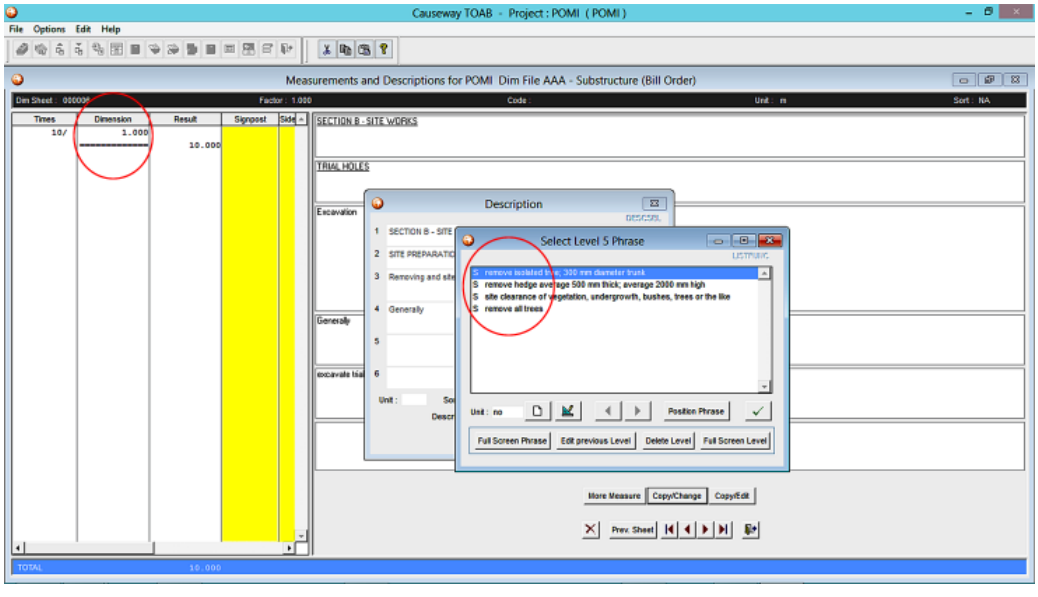


Figure 9.2 Item description – CATO.

Part 2

and that additional descriptive features are provided for tree removal and the removal of hedges which are again supplementary to POM(I) rules.

9.1.3 Structure

POM(I) consists of 20 pages of measurement rules, comprising Section GP: General Principles, Section A: General Requirements and 15 measured Work Sections (B–R) together with an Appendix.

The measured Work Sections are subdivided into:

Section	Title
B	Site Works
C	Concrete Work
D	Masonry
E	Metalwork
F	Woodwork
G	Thermal and Moisture Protection
H	Doors and Windows
J	Finishes
K	Accessories
L	Equipment
M	Furnishings
N	Special Construction
P	Conveying Systems
Q	Mechanical Engineering Installations
R	Electrical Engineering Installations

The list of work types that are covered by POM(I) is impressive, especially when drilling down into individual Work Sections. Section B: *Site Works*, for instance, covers an extensive array of building and civil engineering work, including demolitions, underpinning, dredging, railway work and tunnelling.

The Appendix allows the body responsible for preparing the quantities to state any amendments to the principles of measurement where, for instance, additional measurement rules are needed for work items not covered in the standard document or where local conditions demand that certain items of work be measured in a specific or non-standard way.

Reading through the document will reveal one or two 'glitches' in the editing that may require a second look in order to fully understand the intended meaning.

9.2 Section GP: General Principles

Section GP contains 10 sets of general principles (GP1–GP10) which overarch the measured Work Sections B–R. It should be noted that some of these principles are optional (*may*) and some are compulsory (*shall*) which indicates that some of them are rules and some are not.

In some Work Sections, certain measurement rules are stated as being *subject to* specific GP clauses which tends to indicate, in such cases, that the general principle is to be observed.

9.2.1 GP1: Principles of measurement

GP1.1 requires that additional description ***may*** be given in order *to define the precise nature and extent of the work* ***or*** *the circumstances under which* the work is to be carried out. This

is both an optional and 'either/or' clause. There is, therefore, no strict obligation to comply with it, but the bill compiler must consider whether not to do so would constitute a misrepresentation.

GP1.2 refers the bill compiler to the Appendix should it be necessary to amend the principles of measurement – that is, POM(I) – for local reasons or to include measured work not covered in the document.

GP1.3 states that the principles of measurement ***may*** *be applied equally* to the measurement of completed as well as proposed works. This contrasts with the certainty of CESMM4 that the same principles shall apply, and to the lack of any mention at all of completed work in NRM2. Certainty in a contract is to be encouraged, and an amendment to GP1.3 saying **will** could easily be listed in the Appendix, should this be desired.

9.2.2 GP2: Bills of quantities

GP2.1 simply describes the objectives of bills of quantities, and GP2.4 states that the way in which they are presented is not restricted by the headings and classifications used in POM(I).

GP2.2 is a rule – in fact, it is two rules:

- Bills of quantities *shall describe and represent the works to be carried out.*
- Work that cannot be measured accurately *shall be* either:
  - *Described as approximate.*
  - *Given in bills of approximate quantities.*

The first rule must be read in conjunction with GP1.1 which provides that more detailed information than is required by POM(I) *may be given* in order to accurately define the nature and circumstances of the work to be done.

Despite the brevity of item description required by the measurement rules, care must be taken not to misrepresent the work required by the contract, and the role of the conditions of contract, drawings and specification are of utmost importance in conveying to tenderers exactly what is required of them. POM(I) bills of quantities are reliant on these documents in the same way that a bill of quantities saying *build one house* or *construct one tunnel* would be.

It is, perhaps, tempting to assume that a document entitled *principles* of measurement contains no rules and that, therefore, there are no rules to be broken and no liability for misrepresentation can arise. This, in the author's view, would be a mistake because any principle that contains the words *shall be* can only be construed as a rule to be followed. Should the principle not be followed, therefore, a misrepresentation could occur unless supporting documents make the matter clear.

The first part of the second rule is standard practice where firm quantities cannot be given in what is otherwise a bill of firm quantities (i.e. the contract is a lump sum contract).

The second part of the second rule is less clear but, presumably, refers to situations where the entire works are to be remeasured on completion. If so, GP1.3 may need to be amended because, as it stands, there is no obligation to measure completed works in accordance with POM(I) rules. A further consideration might be that if POM(I) is used in conjunction with NEC3 ECC Option B, the complex rules for compensation events relating to differences between the estimated and final quantities would need to be pondered (ECC 60.4).

GP2.3 is a little unusual in that the conditions of contract ***shall be*** *provided with the bills of quantities* along with the drawings and specifications. Normal practice, for practical reasons as well as cost, is that the conditions of contract are either made available for inspection or a list of the clauses and amendments applicable is included in the bill of quantities with tenderers presumed to have access to the full printed conditions.

9.2.3 GP3: Measurement

GP3.1 – measurements are net fixed in position to the nearest 10 mm (except dimensions stated in descriptions).
GP3.2 – no deduction of voids of less than 1 m^2 in superficial items.
GP3.3 – voids at the edges of areas deducted irrespective of size.
GP3.4 – amendments may be made to use other units of measurement with POM(I) which, presumably, refers to imperial rather than the default (but not expressly stated) metric units.
GP3.5 – separate minor buildings/structures may be enumerated.

9.2.4 GP4: Items to be fully inclusive

GP4.1 states that all items *shall be fully inclusive of all that is necessary to fulfil liabilities and obligations arising out of the contract* including:

- Labour and oncosts.
- Materials.
- Plant.
- Temporary works.
- Establishment charges, overheads and profit.

Attention needs to be paid to this clause, especially as regards temporary works.

Risk issue

Temporary works (except earthwork support) are not measured under POM(I), and therefore, the conditions of contract will, to a large extent, determine whether or not the contractor will be reimbursed if difficulties are encountered.

The ICC – Measurement Version and NEC3 ECC include provisions for situations that could not have been anticipated by an experienced contractor but JCT 2011 SBC/Q does not. Under the JCT conditions, below-ground risk issues are dealt with by SMM7 or NRM2, but this is not the case under POM(I) which does not have any similar provisions:

- No requirements to state/assume groundwater levels or existing services.
- No requirements to provide this information on drawings.
- No measured items for excavation below groundwater level or associated earthwork support.
- No requirement to measure excavation in instable ground.
- No requirement to measure earthwork support next to buildings or roadways.
- No relief to measure steel sheet piling if it becomes necessary.

9.2.5 GP5: Description of items

Most standard methods of measurement require additional description to be given in some circumstances. In most cases, additional description 'rules' are provided that clarify what additional description shall be given and to which items.

POM(I) is different in this respect, because there are no additional description **rules**. This is not to say that there are no additional description **requirements**, though, and GP1.1 states that additional description ***may*** be given in order *to define the precise nature and extent of the work* ***or*** *the circumstances under which* the work is to be carried out.

Risk issue

In order to avoid a possible misrepresentation, the bill compiler must decide whether it is necessary to convey additional information to tenderers relating to the nature and extent of the work, or whether the conditions under which it may be carried out need to be amplified in item descriptions, but not both.

GP5 instructs how items shall be described:

GP5.1 – enumerated items *shall be fully described*.
GP5.2 – linear items *shall state* the cross-sectional size and shape, girth or ranges of girths or other appropriate information, and the diameter of pipework items shall be stated as internal or external.
GP5.3 – items measured by area *shall state* the thickness or other appropriate information.
GP5.4 – items measured by weight *shall state* the material thickness and unit weight, if appropriate.
GP5.5 – if manufacturers measure items in a customary manner, then this is acceptable under POM(I).
GP5.6 – item descriptions may refer to other documents, drawings or published information, and reference to such information shall be deemed to fulfil the requirements of POM(I).

9.2.6 GP6: Work to be executed by a specialist nominated by the employer

Should the employer wish to have certain work carried out by a nominated specialist of his own choosing, GP6.1 requires that such work *shall be given as a sum* in the bill of quantities. This provision is subject to the important caveat *unless otherwise required by the conditions of contract* whose meaning is not entirely clear.

The phrase *otherwise required by the conditions of contract* could mean that:

- Such work shall not be given as a sum in the bill of quantities but shall be given as a prime cost item or provisional sum. Under the ICC – Measurement Version, such sums of money can be expended on work to be carried out by a nominated subcontractor.
- Certain conditions of contract do not allow the nomination of specialists or nominated subcontractors. This is the case under JCT and NEC3 contracts.
- A subcontractor can be named in the contract[2] as a nominated subcontractor or can be engaged by the contractor pursuant to the expenditure of a provisional sum. These are the arrangements under the FIDIC Conditions of Contract for Construction (1999).

It would appear, therefore, that GP6.1 recognises that the nomination of specialists can only be provided for in the bill of quantities if it is permitted by the conditions of contract and then only if the procedures in the conditions are followed.

GP6.1 also requires that an item *shall be given* for the addition of contractor's profit to each sum given in the bill of quantities in respect of such work.

GP6.2 states that an item *shall be given* in each instance for *assistance by the contractor*. In POM(I), 'assistance' may be taken as a synonym for 'attendance', but care should be taken that POM(I) makes no distinction between 'general' and 'special' assistance. In fact, GP6.2 lists in its

item coverage for 'assistance' the usual 'general' items (1–6) and two items of what might be called 'special assistance' (7 and 8):

7. Scaffolding required by the specialist, *giving particulars* in the item.
8. Unloading, distributing, hoisting and placing in position items such as plant and machinery for which there is no requirement to state particulars.

Item 8 could involve considerable cost including cranes, tele-handlers, site transport and associated labour.

9.2.7 GP7: Goods, materials or services to be provided by a merchant or tradesman nominated by the employer

This is an unusual provision which does not appear in the mainstream forms of contract referred to Section 9.2.4. Under the ICC – Measurement Version, prime cost items may be used to order the supply of goods, materials or services by a nominated subcontractor, or by the contractor himself, but not by a supplier or tradesman.

It may be the case that this is an arrangement used in certain parts of the world using local conditions of contract in which case an item for profit shall be given with each such item as per GP7.1.

GP7.2 deals with the fixing of goods and materials supplied under GP7 arrangements which shall be given (i.e. measured or itemised) in accordance with the relevant section of POM(I), that is, Sections B–R. It should be noted that the item coverage for fixing includes *unloading, storing, distributing and hoisting* as well as the normal labour, plant and temporary works deemed to be included by Clause GP4.1.

9.2.8 GP8: work to be executed by a government or public authority

This is a similar arrangement to that used in GP7.1 where, *unless otherwise required by the conditions of contract*, such work *shall be given as a sum* in the bill of quantities with an accompanying item for profit.

GP8.2 adds the requirement to include an item *for assistance by the contractor* as per Clause GP6.2.

9.2.9 GP9: Dayworks

GP9 makes provision for the eventuality that some work may have to be carried out on the basis of time spent and resources used commonly known as 'daywork'. There are various ways of dealing with daywork, and POM(I) proposes two methods:

1. The provision of a sum money.
2. The provision of a schedule with provisional quantities of labour, materials and constructional plant as the case may be.

GP9.1 requires that any daywork schedule shall include *different categories of labour* with *a provisional quantity of hours for each category*. Whether a sum or schedule is given, the cost of labour is defined in GP9.2 as *wages, bonuses and all allowances to operatives* – including plant operators and drivers – *in accordance with the appropriate employment agreement or, where no such agreement exists, the actual payments made*.... GP9.7 further requires that an item shall be given for the addition of *establishment charges, overheads and profit* to the sum or schedule.

The same rules apply to the cost of materials (Clause GP9.3) and constructional plant (Clause GP9.5) except that:

- The cost of materials shall be the net invoiced price, including delivery to site (GP9.4).

- The cost of constructional plant shall include fuel, consumable stores, repairs, maintenance and insurance of plant (GP9.6).

GP9.8 defines the meaning of *establishment charges, overheads and profit* in a seven-point list which *shall include*:

1. Labour employment costs.
2. Storage, handling and (storage) waste of materials.
3. Contractor's administration.
4. Constructional plant additional to that used on dayworks.
5. Contractor's facilities.
6. Temporary works.
7. Sundry items.

This list is less than clear. There is no mention of *profit* in the list and the distinction between *establishment charges* and *overheads* is not made either – normally, they mean one and the same thing.

It is probably incorrect to assume that *overheads* are represented by item 3 because a definition of 'administrative arrangements' is given in Section A, Clause A4.1, which resembles the usual labour 'oncosts' normally associated with daywork. Items 1 and 2 would also normally be daywork 'oncosts', and items 4–7 represent the usual 'preliminaries' or 'site oncosts' added to daywork rates. Contractors and subcontractors, especially, should note these anomalies and make sure that any daywork rates they quote include all necessary oncosts and overheads and profit.

A significant feature of GP9 generally is the absence of the phrase *unless otherwise required by the conditions of contract* which is used elsewhere in POM(I) in connection with nomination and provisional sums (which is what the BQ daywork provision is).

Different forms of contract deal with the issue of 'daywork' in different ways, and the POM(I) bill compiler should be aware of potential conflict with Clause GP9:

- FIDIC only refers to the provision of a daywork schedule.
- NEC3 ECC prefers the term 'compensation event' used in conjunction with the Shorter Schedule of Cost Components.
- The ICC – Measurement Version refers to a 'daywork schedule' or, alternatively, the Schedule of Daywork Carried Out Incidental to Contract Work published by the CECA.
- JCT 2011 SBC/Q employs daywork for the valuation of variations, where appropriate, using the Definition of Prime Cost of Daywork Carried Out under a Building Contract (RICS) together with percentage additions stated in the BQ by the contractor.

9.2.10 GP10: Contingencies

GP10.1 states that, *unless otherwise required by the conditions of contract*, contingencies *shall be given as a sum* with *no item* for the addition of profit.

Once again, potential conflict with the conditions of contract arises:

- ICC and FIDIC do not use the word 'contingency' and, instead, refer to the phrase 'provisional sums'.
- Neither 'provisional sums' nor 'contingencies' feature in NEC3 contracts.
- JCT 2011 refers to defined and undefined provisional sums consistent with SMM7 and NRM2.

9.3 Section A: General requirements

This section of POM(I) provides a set of rules to enable space to be created in the bill of quantities for the employer to state the conditions of contract that shall apply to the project, any limitations and restrictions that ought to be brought to the attention of tendering contractors

and to give the contactor the chance to price the preliminaries, or general items, including facilities required for the employer or his representatives.

9.3.1 A1: Conditions of contract

POM(I) Clause A1.1 states that a schedule of contract clause headings *shall be set out in the bill of quantities*, and Clause A1.2 requires that, where there is an appendix to the conditions of contract, a schedule of the insertions made in the 'appendix' *shall be set out in the bill of quantities*.

Inexplicably, Clause A1.1 does not require a statement to be included in the bill of quantities as to which form of contract is to apply to the project, which is unusual.

As far as the appendix to the conditions of contract is concerned, tenderers need to be alerted to this important information because it has a direct impact on the tender price. In the appendix, the employer stipulates important information about the contract such as the commencement and completion dates, the rate of liquidated and ascertained damages and the rate of retention, etc. In some forms of contract, there is an appendix to the conditions, and in others, there is the equivalent but with a different name:

- ICC – Measurement Version – **Appendix Part 1**
- FIDIC (1999) Red Book – **Appendix to Tender**
- NEC3 ECC – **Contract Data Part 1**
- JCT 2011 SBC/Q – **Contract Particulars**

Notwithstanding POM(I) Clauses A1.1 and A1.2, the above information should be made clear in the bill of quantities, and it is common practice to include a completed 'appendix' with the tender documents as opposed to a *schedule of insertions*.

9.3.2 A2: Specification

Clause A2.1 refers to the relationship between the specification and POM(I) general requirements A3–A9, whereby the bill of quantities *shall make reference to* any specification clauses that are relevant to the general requirements. Such specification clauses may add detail to the general requirements that could impact on the tender price.

9.3.3 A3: Restrictions

Clause A3.1 lists five generic examples of possible restrictions that may be imposed on the contractor in the construction and completion of the contract. These include access restrictions, limitations on working space and requirements to complete the works in a specific order. The sixth item in the A3.1 list is *items of a like nature* which is an invitation for the employer/bill compiler to include any other restrictions that might be relevant to a particular project.

9.3.4 A4: Contractor's administrative arrangements

This is the first of six general requirements to be included in the bill of quantities that tenderers are likely to price. Clause A4.1 deals *inter alia* with the contractor's staffing and supervision of the project and would normally be priced in conjunction with Clauses A6 (employer's facilities) and A7 (site accommodation) as 'preliminaries'. Most contractors have a standard 'spreadsheet' for such items.

It should be carefully noted that Clause A4.1 only requires *an item* (i.e. a single item) to be given in the bill of quantities to cover all of the five items listed as 'administrative arrangements'. The words *shall include* means, in effect, that the items listed are 'understood to be included' (a POM(I) phrase) and also that it is not an exhaustive list.

Table 9.1 Contractor's administrative arrangements.

	SECTION A - GENERAL REQUIREMENTS					
	CONTRACTOR'S ADMINISTRATIVE ARRANGEMENTS					
	Generally		(NA)			
	The Contractor shall allow for all necessary administrative arrangements, including :					
A	allow for site administration	ITEM				
B	allow for site supervision	ITEM				
C	allow for site security	ITEM				
D	allow for the safety, health and welfare measures	ITEM				
E	allow for transport of workpeople	ITEM				

CATO takes the view that it is reasonable to list items 1–5 as illustrated in Table 9.1. Whilst there is a certain logic to the CATO approach, there are also some drawbacks:

- This is not what the method of measurement says.
- The bill compiler must either:
  - **a)** Select the items that he/she considers appropriate or
  - **b)** Include them all.
- There is no guarantee that tenderers will price any of the items individually and could:
  - **a)** Bracket the items and include a lump sum.
  - **b)** Write 'included' against the list.

Contractors and subcontractors will have to consider the wisdom of disaggregating these items from other preliminaries and whether or not to 'write in' to the bill of quantities item those preliminaries which are fixed and those which are time related.

Risk issue

'Writing in' additional items in the bill of quantities may constitute a tender qualification, and this would have to be checked carefully with any tendering rules that might apply.

9.3.5 A5: Constructional plant

As with Clause A4.1, Clause A5.1 requires the provision of *an item* in the bill of quantities to cover a list of widely differing items of plant that the contractor may wish to price into the tender. The list ranges from small plant and tools to cranes and lifting equipment as well as scaffolding and site transport, as illustrated in Table 9.2.

Some of these items will have fixed costs – for example, erect/dismantle mobile crane (including crane pad), erect/dismantle scaffolding – and other costs will be time related such as crane and scaffold hire.

Table 9.2 Constructional plant.

	CONSTRUCTIONAL PLANT					
	Generally		(NA)			
	The Contractor shall allow for all necessary constructional plant including:					
F	small plant and tools	ITEM				
G	scaffolding	ITEM				
H	cranes and lifting plant	ITEM				
J	site transport	ITEM				
K	plant required for specific trades	ITEM				

Risk issue

There is some danger in pricing fixed and time-related costs in a single item, particularly when the valuation of variations becomes an issue, and contractors and subcontractors may need to deal with this by 'writing in' appropriate items in the general requirements part of the bill of quantities (restrictions regarding tender qualifications permitting).

9.3.6 A6: Employer's facilities

There is no requirement in Clause A6.1 for a bill of quantities item to cover 'employer's facilities'. A6.1 simply states that *particulars shall be given* of any facilities required by the employer which *shall include* the seven items listed, such as temporary accommodation, telephones and the cost of calls which, paradoxically, *may be given as a sum*, any special requirements for programmes or progress charts and facilities such as progress photographs and signboards, etc.

The bill compiler may interpret A6.1 as meaning that a sum shall be given for these items, but if not, contractors and subcontractors should perhaps be careful to check that the employer's requirements are not hidden in a specification clause referred to in the bill of quantities pursuant to POM(I) Clause A2.1.

9.3.7 A7: Contractor's facilities

Clause A7.1 requires that *an item shall be given for facilities required by the contractor*, and a list is provided of the facilities which the item *shall include*. The list includes things like accommodation, welfare facilities, site fencing, water for the works (which might be supplied to the contractor), lighting and power, etc.

Unusually, in Clause A7.2, *particulars shall be given* if the *nature or extent* of the contractor's facilities is *not at the contractor's discretion*. In this context, *nature* may be taken to mean kind, type or sort and *extent* the amount or scope.

Table 9.3 Contractor's facilities.

					£	p
	CONTRACTOR'S FACILITIES					
	Generally		(NA)			
	The Contractor shall allow for the following Contractor's Facilities					
A	provide accommodation and buildings, including offices, compounds, stores, messrooms, laboratories and the like	ITEM				
B	provide temporary fencing, hoardings, screens, roofs, guardrails and the like	ITEM				
C	provide temporary roads, hardstandings,	ITEM				
D	provide water for the works, as specified	ITEM				
E	provide electric power for the works, as specified	ITEM				
F	provide lighting for the works	ITEM				
G	provide telephones for the works	ITEM				

Should the bill of quantities state that the *nature* of the contractor's site facilities is not at his discretion, this might be because the employer is running the site (say on a petrochemical works) and the contractor is required to use existing buildings or services provided by the employer. Alternatively, on a very large site, such facilities may be provided by a managing contractor.

Restrictions as regards the *extent* of the contractor's site facilities may be imposed should there be confined spaces on the site or limits may be imposed on the contractor's site set up under a cost reimbursement contract. In any event, the bill compiler must ensure that the contractor knows exactly what to price in order to comply with A7.2.

Sample items for 'contractor's facilities' are shown in Table 9.3 where it can be seen that CATO refers to the provision of water and power *as specified*. This may be an attempt to comply with A7.2, albeit this rule could equally apply to some of the other items billed.

9.3.8 A8: Temporary works

An item shall be given for temporary works in accordance with Clause A8.1, but in A8.2, *particulars shall be given* where the temporary works are *not at the discretion of the contractor*.

The temporary works item *shall include* any one, or more, of seven listed items such as traffic diversions, access roads, temporary bridges (e.g. Bailey bridges), cofferdams, pumping and dewatering and compressed air for tunnelling.

Table 9.4 provides an interpretation of such items where the bill compiler has taken the view that:

a) A list should be provided for tenderers to price.
b) All the items on the list in A8.1 are not relevant to the project in question.

Table 9.4 General requirements.

					£	p
	SECTION A - GENERAL REQUIREMENTS					
	TEMPORARY WORKS					
	Generally		(NA)			
	The Contractor shall allow for all necessary temporary works, including:					
A	provide bridge; temporary; two-way traffic	ITEM				
B	provide cofferdam; bridge pier A3	ITEM				
C	provide dewatering; wellpoints	ITEM				

Risk issue

Bill compliers are playing a dangerous 'game' if they try to 'second guess' how a contractor is likely to go about constructing the works.

In Table 9.4, unless the provision of a temporary bridge is *not at the discretion of the contractor*, it may be unwise to create a specific item like this as the contractor may go about solving the problem in a completely different way.

If, for instance, the only access to the site is across a watercourse, the contractor could just as easily decide to divert the watercourse, or install a temporary culvert and ramp, as build a temporary bridge.

In any event, it seems, once again, that the contractor (or subcontractor) has to interpret what is required from the tender documents, and price everything into one item, as there is no provision for fixed and time-related charges.

Clause A8.2 states that *particulars shall be given* if *the nature or extent* of the temporary works is *not at the contractor's discretion*. Such particulars might be required for similar reasons to those given under Clause A7.2.

9.3.9 A9: Sundry items

Clause A9.1 requires that an item shall be given for sundry items which shall include those listed 1–9. Despite the designation 'sundry items', the list is fairly extensive ranging from the testing of materials to the control of noise and pollution. Removal of rubbish is included as is the drying out of the works and protection from inclement weather.

Clause A9.2 again provides for circumstances where the contractor has no discretion over the *nature or extent* of sundry items, and it can only be imagined that this might be the case should the employer or a managing contractor wish to control such items. In any event, particulars *shall be given* if this is the case.

9.4 Section B: Site work

POM(I) Section B takes five pages to go from site investigation to tunnelling, and so it is no surprise that the measurement rules are very brief!

Notwithstanding this, the Foreword to POM(I) recognises that local practice and contract-specific circumstances require a flexible set of measurement principles which, in conjunction with a well-developed design and specification, can nevertheless result in a meaningful and useful bill of quantities for the financial control and management of construction projects.

Risk issue

A well-developed design and specification are crucial to POM(I) because item descriptions are so brief and, even with additional description (GP1.1), they do not approach the level of detail offered by SMM7, NRM2 or CESMM4. There are no notes for guidance to bill compilers in POM(I), and there are no additional description rules of the sort found in other methods of measurement.

In keeping with the remainder of this book, the following subsections of POM(I) Section B identify the key risk issues concerned with the billing and pricing of items related to site work.

9.4.1 B1–B3: Site investigation

Clauses B1–B3 concern matters relevant to site investigation and, despite being brief, provide suitable measured items ranging from simple trial hole work to the complex soil sampling, laboratory testing and analysis that might be required on a large project:

- **B1: Site exploration generally**
  Record keeping of various tests and observations *shall be given as an item* (refer to Clauses B1.1–B1.3). No details are stated regarding the extent of records, tests and samples that might be required, but presumably, this will be stipulated elsewhere (e.g. in the specification) or may be given in the respective items as additional description in accordance with the provisions of Clause GP1.1.
- **B2: Trial holes**
  Clause B2.1 concerns the excavation of trial holes but requires no distinction to be made as to the purpose that trial holes might be required for (e.g. to determine subsoil conditions, to locate underground services). Unusually, trials holes *shall be measured by depth* stating *the number and the maximum depth below commencing level*. It would be more normal to measure by number stating the depth, and it would also be more usual to stipulate the length (or plan area) of the trial holes required.

  B2.2 confirms that earthwork support in connection with the excavation of trial holes is not measured unless ***not*** *at the discretion of the contractor* when it shall be measured by depth.
- **B3: Boreholes**
  B3 covers both boreholes for ground investigation and for driving test wells. B3.1 requires that boreholes *shall be measured by depth* stating *the number and the maximum depth below commencing level* with raking bore holes *so described*. Borehole linings are not normally measured (B3.2), but *cappings shall be enumerated* (B3.3).

Risk issue

It should be noted that the provision of additional description is not mandatory under GP1.1 and that, where there is any question as to item coverage, the drawings, specification and conditions of contract play a crucial role under POM(I).

Notwithstanding this, trial holes to discover existing services that could be live is both a health and safety issue and a cost issue for the contractor, and the bill compiler should consider including additional description where felt necessary.

A case for additional description could also be made regarding the length or plan size of trial holes to avoid unnecessary claims from contractors.

9.4.2 B4: Site preparation

Any work needed to prepare the site, including site clearance but not demolition work, is covered by Clause B4.

B4: Site preparation

Removing *isolated* trees *shall be enumerated* (B4.1), but there is no requirement to state girth.

Removing hedges *shall be measured by length* (B4.2).

Site clearance *shall be measured by area* (B4.3), but the removal of trees and the removal of hedges are both included in the coverage of the site clearance item (B4.3) which also includes the removal of vegetation, bushes and so on.

Risk issue

In view of Clauses B4.1 and B4.2, the bill compiler will need to exercise some judgement as to when to separately measure the removal of hedges and trees and when to include this work in the general site clearance item.

It would also seem sensible to provide additional description of the diameter of trees to be removed and the width and height of hedges to be grubbed up in order to avoid possible claims (refer to Table 9.5).

Table 9.5 Site preparation.

				£	p
	SECTION B - SITE WORKS				
	SITE PREPARATION				
	Removing and site clearance		(NA)		
	Generally				
A	remove isolated tree; 300 mm diameter trunk	5	no		
B	remove hedge average 500 mm thick; average 2000 mm high	68	m		
C	site clearance of vegetation, undergrowth, bushes, trees or the like	22800	m2		

9.4.3 B5: Demolitions and alterations

Demolition and alteration work is covered by Clauses B5.2–B5.4 which include removal of fittings and fixtures, demolition of structures, cutting openings and altering existing structures. B5.2 is effectively a soft stripping item, but to make this clear, additional description needs to be given.

Risk issue

Care should be taken when reading BQ items under B5.2 as this could include the removal of engineering installations which, in some instances, could be extensive.

Demolition of structures is *given as an item*, but this may be for single structures or parts thereof or for all structures on a site.

Forming openings in structures or carrying out alterations thereto is again *given as an item*, but there is also an item coverage rule that includes *making good all work damaged*. It should be noted that there is no requirement to describe the insertion of new work such as lintols which could either be referenced to a drawing or measured in accordance with Clause C5.

With each item of demolitions and alterations, locational information shall be given (Clause B5.1), and unless otherwise stated, all materials shall be cleared away by the contractor. The provision of temporary screens and roofs shall be *given as an item*, but any shoring requirements (and, presumably, needling and propping) shall be measured as per Clause B6.

9.4.4 B6: Shoring

Shoring may be temporary or left in place and may involve simple needling and propping or the provision of complex and extensive raking or flying shores to support existing buildings or structures. POM(I) Clause B6 distinguishes between:

1. Shoring *incidental to demolitions and alterations* (B6.1).
2. Shoring not *incidental to demolitions and alterations* (B6.2).
3. Shoring where the design of the shoring is not at the discretion of the contractor (B6.3).
4. Shoring required *by the specification* to be left in position (B6.4).

In the first case, any shoring required which is part and parcel of demolitions and alterations work is not itemised in the BQ and is *understood to be included* in the measured items. In the second case, any shoring that is required, such as the provision of shoring to buildings to be retained, is measurable and *shall be given as an item*. The design of any such shoring is the contractor's responsibility, irrespective of how extensive it is, as it is not part of the permanent works.

The third case provides for the situation where the design of the shoring is *not at the contractor's discretion*, in which case *particulars shall be given* (B6.3), but this is not a measurable item. There is no indication in B6.3 where the *particulars* shall be stated – this could be on a drawing or in the BQ item for shoring.

In the fourth case, shoring required to be left in position shall be identified in the specification and *shall be so described* in the bill of quantities.

Risk issue

The issue of shoring, temporary or left in place, raises the issue of design liability and risk.

As with all temporary works, shoring is not usually identified and/or measured in the bill of quantities unless the work is of such significance that it is to be designed by the employer's engineer. In this event, design liability rests with the employer/engineer.

Under normal circumstances, the contractor would be responsible for the design of temporary works generally and shoring in particular, and its suitability in the context of his obligation to carry out and complete the works would also be down to the contractor.

However, under POM(I), all shoring, whatever the scale of work involved and whether it is a billed item or not, is the contractor's responsibility, unless otherwise stated, in which case the contractor carries the liability for the design of the shoring as well as for the installation.

Therefore, it would be dangerous to presume that design liability has shifted just because there is a billed item for the work. Design liability will only shift where clear particulars are given that *the design is not at the discretion of the contractor*, and this would have to be clear from the drawings, the specification and/or the billed item.

This important distinction is illustrated in Figure 9.3 where it is clear that, in one item description, the contractor is responsible for the design and, in the other, the shoring is 'as specified' and therefore the responsibility of the employer/engineer.

Where shoring is to be left in place – and this could be for several years – the question as to whether this is temporary or permanent works is a difficult one. Some shoring systems, such as RMD Kwikform 'Megashor' power shores,[3] are hired and therefore belong to the hire company, and it may not be feasible for the original contractor or subcontractor to remove them, maybe years later. A suitable contractual provision would have to be made for this eventuality and, perhaps, made clear in the BQ item description.

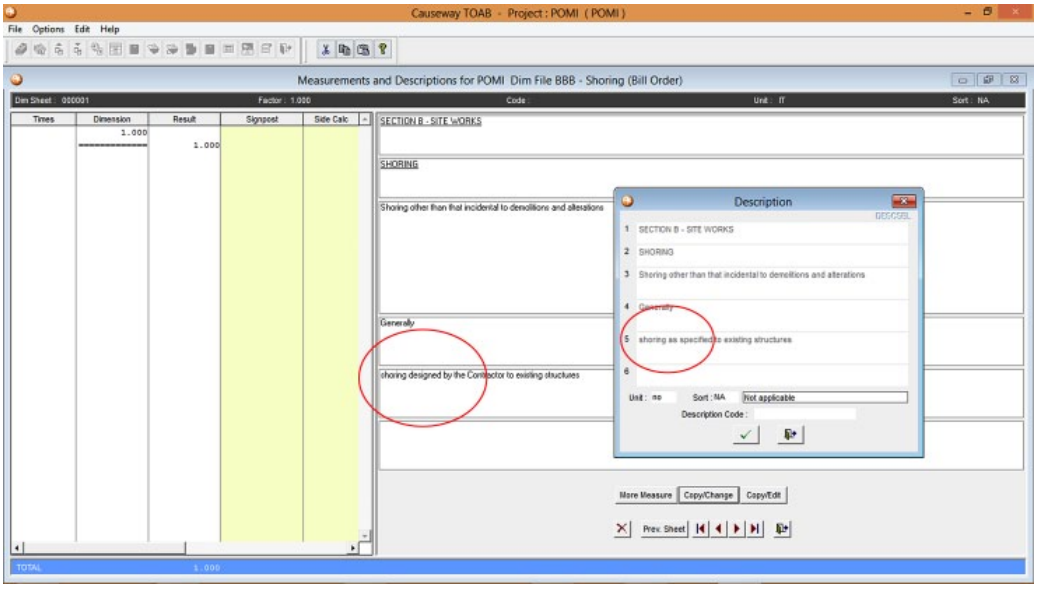


Figure 9.3 Shoring.

9.4.5 B7: Underpinning

Underpinning of existing structures can take many forms depending upon the nature of the problem, the condition of the existing building, the prevailing ground conditions and groundwater levels, access to the site, access to the interior and so on.

Anything beyond the traditional approach of excavating trenches or pits and building up walls or columns on new foundations underneath the existing foundation is likely to be specialist work because it will probably involve piling of some sort, cement–soil stabilisation (jet grouting) or resin injection, etc.

Risk issue

The treatment of underpinning in the bill of quantities would need to be considered in the light of the chosen procurement strategy and the form of contract to be used.

Traditional methods of underpinning and specialist piling work could be measured under relevant POM(I) rules (e.g. Piling B13–B15 and B18). Other methods of constructing underpinning could be measured according to other rules provided that they are stated as an amendment in the Appendix in accordance with Clause GP1.1.

Alternatively, any sort of underpinning work could be given as a sum under GP6 if a specialist contractor is to be nominated. Should the preference be for a contractor-designed solution, then a single BQ item could be given provided that the amended measurement rules applicable are stated in the Appendix (refer once again to Clause GP1.1).

POM(I) Clause B7 provides that underpinning work *shall be measured in accordance with appropriate* Work Sections (B7.2) under an *appropriate heading* that includes the location of the work (B7.1). The only measurement rules under B7 are:

- Temporary support to the existing structure *shall be given as an item* and particulars shall be given where the design of the temporary works is not at the discretion of the contractor (B7.3).
- Excavation *shall be measured by volume* (B7.4).
- Cutting away projecting foundations *shall be measured by length* (B7.5).

Clause B7.4 deserves some attention and this is dealt with as a case study in Chapter 17.

9.4.6 B8: Earthworks generally

Clause B8 deals with the general rules relating to all earthworks. This includes excavation of various sorts, dredging and tunnelling. In all cases, general rules apply that concern:

- The provision of ground information (B8.1).
- The proviso that quantities do not allow for bulking of materials (B8.2).
- That *multiple handling* is deemed included unless *required by the specification* and *described in the item of disposal* (B8.3).

There are also two measured items in B8:

1. Earthwork support which *shall be given as an item* (B8.4).
2. Rock which may be measured full value, and described as such, or extra over the excavation in which it occurs (B8.5).

In order to avoid duplication or ambiguity, B8.4 should be read in conjunction with Clause B26 (Tunnel support and stabilisation) wherein different methods of supporting tunnel excavations are measured in a variety of units.

Risk issue

The measurement of earthwork support *as an item* is a strange one.

Normally, the choice is to measure such work superficially or not at all whereupon the earthwork support is deemed to be included in the rates. Creating an item in the bill of quantities is of no help to the contractor who, of course, would have to measure the area of earthwork support himself.

Perhaps the logic of POM(I) Clause B8.4 is to create an item for the contractor to insert a method-related charge for any temporary works needed in connection with the measured excavation items.

Clause B8.6 defines 'rock' as material that *can only be removed by means of wedges, special plant or explosives*.

Risk issue

The POM(I) definition of 'rock' follows that of SMM7 and NRM2, although the latter has also included *rock hammers* in the definition. This is a very old definition and not really fit for purpose, as splitting rock with wedges is rarely seen and the term 'special plant' is not defined.

The use of the term 'rock hammers' in NRM2 signals that rock hammers are not 'special plant' which can only be taken to mean plant specially brought to site for the purpose of digging or otherwise removing rock.

Arguments over what is rock and what is special plant have been going on since time immemorial, and weak definitions such as this give plenty of scope for claims experts who are well versed in the 'delay and disruption', 'compensation event' and 'experienced contractor' clauses in contracts!

Many years ago, Seeley (1965) recommended that a definition of rock be *drawn up to suit the local geological formation.* It is hard to disagree with the soundness of his logic.

9.4.7 B9: Excavation

The POM(I) classification of excavation is very broad and includes excavation for pits and trenches through to diaphragm walls.

All excavation items are measured on the basis of the volume of the void created by the permanent construction which is borrowed from the CESMM Class E Measurement Rule. This, of course, leaves the bill compiler with the dilemma of distinguishing between different classes of excavation in the same void (e.g. foundation excavation below cuttings) which is best solved by indicating a 'payment line' on the drawings.

The one exception to measurement by volume is trench excavation for service pipes, drains, cables and the like which shall *be measured by length, stating the average depth*, and shall include disposal and filling in the item coverage.

The role of the drawings is important in POM(I) bills of quantities in that no 'commencing' or 'excavated' surfaces or 'levels' are referred to in the measurement rules. Additional description could always be included in the measured item, in accordance with GP1.1, to overcome this issue.

Apart from the removal of topsoil, excavation items are not required to state the depth as is common in other methods of measurement. Consequently, the mini-BQ shown in Table 9.6 employs the phrase *any depth* which is exactly how the CATO software operates. The phrase is included to be illustrative, but it is clear that CATO intended additional description to be included and uses the phrase *any depth* simply because there is no POM(I) depth classification available.

In this example, the earthworks balance is made up of the following.

	m^3	Total (m^3)
Excavation		
Bulk excavation	48 000	
Excavation for pile caps	43	48 043
Disposal		
Landscaping	45 600	
Off-site disposal	2 443	48 043

Table 9.6 Excavation.

	EXCAVATION				
	Generally		(NA)		
	Oversite to remove top soil				
E	150 mm average depth	6000	m3		
	Reduce levels				
F	any depth	48000	m3		
	Pits to receive foundation bases				
G	any depth	43	m3		
	DISPOSAL				
	Disposal of material arising from excavations		(NA)		
	Generally				
A	backfilled over site in making up levels and contouring	45600	m3		
B	remove from site	2443	m3		
	LANDSCAPING				
	Soiling, seeding and turfing		(NA)		
	Vegetable soil selected from spoil heaps				
C	150 mm thick and levelling	38000	m2		

Excavation, disposal and topsoiling are measured in Sections B9, B11 and B22, respectively.

At this point, it is worth mentioning items of excavation for diaphragm walls (B9.1.7) which are required to state the width of the permanent construction and the type of support fluid used.

B9.1.7 should be read in conjunction with C2.1.10, where concrete to diaphragm walls appears. This is measured, in common with other concrete items, by volume.

Risk issue

The measurement of diaphragm walls is included in POM(I) at B9.1.7 (Excavation), B11.1* (Disposal) and C2.1.10 (Concrete).

No other items are measured elsewhere for such work, and tenderers must understand that there is no definition of Commencing Surface, nor any measurement of guide walls. Disposal is measured, either on or off-site, at B11.1*.

An example of a diaphragm wall 'mini-BQ' is illustrated in Table 9.7.

Table 9.7 Diaphragm wall.

				£	p
	SECTION B - SITE WORKS				
	EXCAVATION				
	Average 8 m deep		(NA)		
	Trenches for diaphragm walls; permanent construction				
A	1500 mm wide, support fluid Bentonite	1200	m3		
	DISPOSAL				
	Disposal of material arising from excavations		(NA)		
	Generally				
B	remove from site	1200	m3		
	SECTION C - CONCRETE WORK				
	POURED CONCRETE				
	Poured concrete; Grade 45; 20 mm aggregate		(NA)		
	Diaphragm walls				
C	generally	975	m3		

9.4.8 B10: Dredging

Dredging is a special subset of earthworks that normally involves the removal and disposal of unwanted material submerged below a body of water. This may be required for a variety of reasons, including removal of silt from rivers and estuaries, cleaning of canals and ditches, the creation of trenches in the seabed to accommodate pipelines and the like and the removal of unacceptable material from within cofferdams for land reclamation and the construction of bridge piers and the like.

Dredging and land reclamation work can be carried out by a variety of means including:

- Shore-based long-reach backhoe or dragline.
- Barge or pontoon-mounted backhoe or grab.
- For large-scale works, bucket ladder, cutter suction and trailer suction hopper dredgers, etc.

Measurements can be taken from a survey launch or dredger using GPS and other horizontal positioning systems with depths measured using lead lines, echo sounding or bar sweeping (where acoustic soundings would be inaccurate). Some barges carry sophisticated equipment and hydrographic software capable of providing an accurate graphical profile of the depth of the seabed before, during and after completion of the work, and they also carry sophisticated data collecting instrumentation capable of recording, *inter alia*, cutter head coordinates and the mixture flow and density in a hydraulic dredger (Institution of Civil Engineers, 1995).

The scope of dredging and reclamation work can be relatively small scale, perhaps incidental to other civil engineering work, or it might involve extensive work at sea. Consideration, therefore, must be given to whether the work involved warrants a separate 'dredging-only' contract or whether it can be included with the civil works.

FIDIC publishes an internationally recognised standard *Form of Contract for Dredging and Reclamation Works* (2006) – the 'Dredgers Contract' or 'Blue Book' – that was developed in conjunction with the International Association of Dredging Companies (IADC). This contract can be used in conjunction with engineer-designed or contractor-designed projects, and it incorporates five different mechanisms for valuing the works according to the prevailing circumstances. The FIDIC form provides a legal framework for the specification and design of the work and for the documentation that describes and quantifies the work itself.

Issues that need to be considered when measuring and billing dredging work include:

- Method of measurement:
  - Horizontal positioning and soundings.
  - Half-sphere or centrifuge methods[4].
  - Hopper pressure method[3].
  - Tonnes of dry solids (TDS)[3].
- Calculation of volumes:
  - Average end area method.
  - Volume in barge.
  - Volume deposited as fill.
- Tolerance limits for over-depth dredging for payment purposes.
- The extent of work on side slopes or margins above or beyond the body of water.
- The presence of hard material, rock or artificial obstructions.
- Definition of rock.
- Whether blasting of hard material will be permitted for ecological or geological reasons.
- Disposal method:
  - Deposition of dredged material hydraulically, by hopper dredge or by self-dumping scow or barge.
  - Disposal in indicated fill areas.
- Responsibility for the removal of re-silting during the defects' correction period.

Other relevant issues include:

- Environmental protection limitations.
- Limitations of working hours.
- Interference with marine traffic.

POM(I) Clause B10.1 requires that dredging *shall be measured by volume* which, unless otherwise stated, will be assumed to be *taken from soundings*. Sounding is a method of determining

the depth of a given point beneath the surface of a body of water which, nowadays, is carried out using ultrasonic echo sounders.

B10.1 further requires that items for dredging shall state the location and limits of the work with disposal measured as equal to the volume excavated in accordance with Clause B11.1.

This is illustrated in Table 9.8.

Table 9.8 Dredging.

				z	p
	SECTION B - SITE WORKS				
	DREDGING				
	Generally		(NA)		
	Dredging within phase 2				
A	within zone A and B; extending 1000 m	10000	m3		
	DISPOSAL				
	Disposal of material arising from dredging		(NA)		
	Generally				
B	remove from site	10000	m3		

9.4.9 B13–B18: Piling

In the absence of method-related charges in POM(I), except for the limited A5: *Constructional plant* provisions, tenderers should be aware that the mobilisation costs associated with piling work must be allowed for somewhere in the tender.

The measurement of piling distinguishes bored, driven and sheet piling, but there is some inconsistency in the rules that apply.

Risk issue

In bored piling and sheet piling, length measurements are taken from ***the formation level of the ground*** to the bottom of the pile hole or the bottom edge of the sheet piling when driven, whereas in driven piling, measurements are taken from where *the pile point* [is] *in contact with* ***the ground*** *when pitched*.

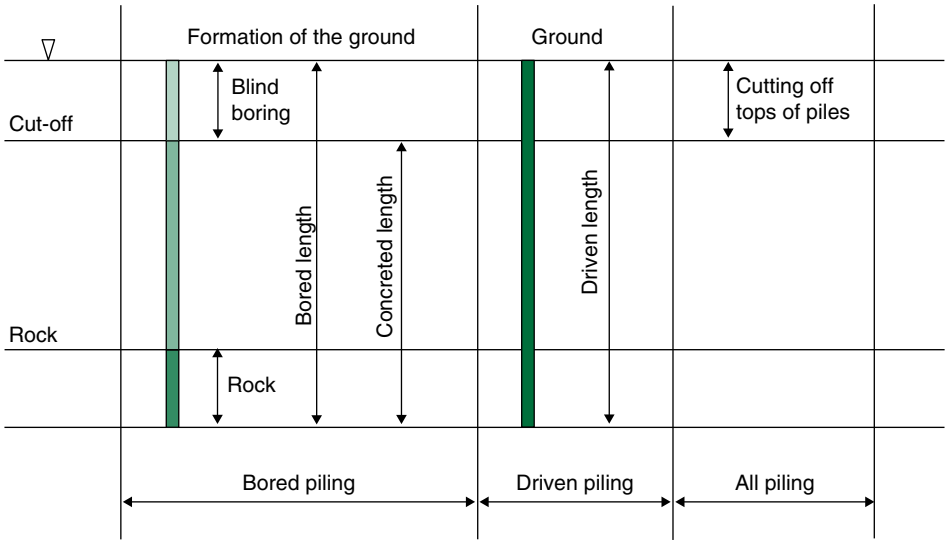
Formation level is not ground level, and a commencing surface should be identified in item descriptions.

Boring through rock is measured by length, *extra over* the boring item.

Disposal of piling arisings is measured by volume in accordance with B11. This rule, however, refers to 'volume' as being *equal to the volume of excavation*. As boring is measured by length, this makes little sense. Also, if there is the likelihood of an element of 'blind boring', perhaps for the contractor's convenience or to suit the method of working, should disposal of this element be measured or not?

CESMM deals with this issue quite simply by referencing calculations, both pre- and post-contract, to a 'Commencing Surface'.

In situ concrete is measured by volume with the piling items and not in Section C: *Concrete Work*. This is much clearer than Class P: *Piles* in CESMM4, which is, to say the least, vague about the subject of concrete in piles. On the other hand, there is no indication in POM(I) as to where the concrete is measured to and, perhaps, a cut-off level could be referred to in the item description as illustrated in Figure 9.4.



	Bored piling				
	Reinforced piling; as specified		(NA)		
	Boring for piles; 30nr				
C	450 mm diameter	360	m		
	Extra over				
D	for boring through rock	24	m		
	Disposal of material arising from excavation; Removed				
E	450 mm diameter	57	m3		
	Poured concrete 30 N/mm2; 10 aggregate, unreinforced				
F	450 mm diameter	315	m		
	Reinforcement, BS 4449: 1978, hot rolled plain round mild steel				
G	450 mm diameter	2.50	t		
	Cutting off top of pile				
H	450 mm diameter	45	m		

Figure 9.4 Piling.

Figure 9.4 demonstrates the billing of 30 nr bored piles, 450 mm diameter × 12 m long, with a cut-off level 1.5 m below Commencing Surface.

All items are measured by length in accordance with B15, with the exception of disposal, measured in accordance with B11.1, and reinforcement, which is measured by weight in accordance with Section C3. It will be noted that the number of piles is stated in the boring item (B15.1) and that the disposal item states 'removal'. This indicates removal off-site which includes providing a suitable tip (B11.1.4).

Sheet piling, conventionally measured only when expressly required in the contract, is measured in POM(I) according to the rules of B16. There is no indication of any rule as to 'if or when' sheet piling is measured, but reference to the drawings supplied with the tender documents should reveal whether such work is part of the design or not.

Supplying sheet piling is measured by area when in its final position, but unlike driving, which is measured from the 'formation level' to the bottom of the piling when driven, there is no indication of how the depth shall be determined. If sheet piling is measured in the BQ, B16.1 requires that the length is measured *along the centre line* and not along the developed length as is customary. This is illustrated in Figure 9.5.

Any strutting and walings required in connection with sheet piling is *understood to be included* according to B16.4.

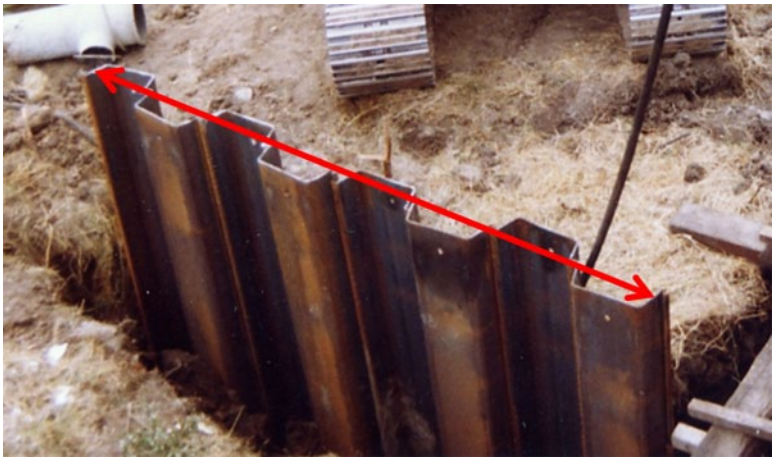


Figure 9.5 Sheet piling.

One final point about piling concerns B17: *Performance designed piling* illustrated in Table 9.9.

The method of measurement says little about this type of piling, and so it must be assumed that such piles are to be designed by the contractor in response to a performance specification provided by the employer. The inclusion of such an item in the bill of quantities indicates a partial contractor design procurement route.

Table 9.9 Performance designed piles.

	SECTION B - SITE WORKS					
	PERFORMANCE DESIGNED PILING					
	Generally		(NA)			
	Pile to carry					
A	25KN with pile top 1.50 m below formation level of the ground	30	no			

Performance designed piles are to be enumerated, with reinforcement and disposal *understood to be included* (B17.1), and details are to be provided should the tops of the piles be required to terminate below the formation level of the ground (wherever that is!).

9.4.10 B19: Drainage

Drains are measured by length, over fittings, and thus, the B19.2 requirement to group and enumerate 'fittings' is effectively an extra over item. The diameter of pipes shall be stated as 'internal' or 'external' (refer to GP5.2).

Concrete beds and coverings for drain pipes are measured separately by length, including formwork, but there is no similar requirement to measure granular beds, haunchings and surrounds.

Chambers may be enumerated or measured in detail, according to relevant section of the method of measurement.

Risk issue

Important ancillaries to drainage work, such as excavation in rock, excavation and filling of soft spots, the provision of granular beds, haunchings and surrounds, and testing requirements are not included in B19.

Some of these items might come under the heading of 'required and indispensably necessary to complete the work', and others would give rise to claims under the contract, depending upon which form of contract is used.

It is hard to argue that granular beds and haunching should not be measured when there is a measured item for concrete beds and coverings. It is also a well-understood custom and practice to measure pipe supports and protection, even in CESMM.

The question is, 'would a contractor take the gamble' and risk having to fight through the dispute resolution process for payment, or would it be more sensible to raise the issue during the tender period or, if not, qualify the tender accordingly?

9.4.11 B20–B22: External works

Paving and surfacing, kerbing, fencing and landscaping are given short shrift by POM(I).

Road kerbing and edgings (B20.3), for instance, are measured by length, with curved work so described, but no mention is made of concrete beds and backings, formwork, excavation or disposal. As *curved work shall be so described*, the implication is that this is a full-value measured item and not an 'extra over'.

Paving and surfacing is measured by area (B20.1), but no distinction is made as to the composition of the paving or surfacing. Clearly, additional description is required here, especially to clarify whether or not excavation, disposal and filling (e.g. sub-base) have been measured elsewhere in the BQ.

9.4.12 B23: Railway work

Railway ballast is measured by volume, with no deduction for sleepers, in separate items for *top* and *bottom ballast*. This is normal practice, as is the method for measuring track – length along the centre line over all fittings. Sleepers are enumerated, and switches, turnouts and different types of crossings are separately classified and also enumerated.

There is no indication that the provision and laying of track should be separately measured, as is normal practice, but this could be clarified by the provision of additional description. There is, however, no provision for additional itemisation in POM(I), but if desired, this could be overcome via an amendment in the Appendix provided with the Method of Measurement pursuant to GP1.2.

9.4.13 B24–B26: Tunnelling

The volume of excavation in tunnelling is measured as *the void which is to be occupied* including permanent linings. This includes the volume of permanent linings but not linings that would be classed as support (e.g. NATM linings). Consequently, the volume of overbreak and support linings must be allowed for in the BQ rates. Volumes may be grouped but must be separately classified as tunnels, shafts or other cavities stating whether they are straight or curved. Disposal is measured in accordance with B11: *Disposal*, and therefore, separate items must be measured both for disposal as on-site backfilling of different types and for disposal off-site to tips.

Table 9.10 Classification of tunnel linings and support and stabilisation.

Classification		Type		Unit
Linings	Lining	Poured concrete	Sprayed concrete	Area
			Cast concrete	Area
		Preformed segmental		Enumerated
	Secondary lining	Poured concrete	Sprayed concrete	Area
			Cast concrete	Area
		Preformed segmental		Enumerated
Supports and stabilisation	Timber			Volume
	Sprayed concrete			Area
	Rock bolts			Length
		Injection grout		Weight
		Face packers		Enumerated
	Metal arches			Weight

	Section B - site works					
	Tunnel excavation					
	Excavation		(NA)			
	Generally					
A	Straight shaft	348	m^3			
	Disposal		(NA)			
	Disposal of material arising from excavations					
B	Removing from site	348	m^3			
	Tunnel linings					
	Preformed segmental tunnel linings		(NA)			
	Generally					
C	1500 × 200 × 450 mm	128	no			

Figure 9.6 Pumping station.

Part 2

Tunnel *linings* and *support and stabilisation* are measured independently as summarised in Table 9.10 and typical bill items are shown in Figure 9.6. This illustrates a deep pumping station constructed of precast concrete segmental shaft rings.

It will be noted that there is no item for in-circle or cross caulking as this is not measurable in POM(I) Section B24.

9.5 Section C: Concrete work

Concrete work is the most extensive Work Section in POM(I).

General items C1.1–C1.4 establish that **reinforced** poured concrete and **plain** poured concrete shall be separately described and that horizontal surfaces are to be presumed *tamped* unless otherwise stated. Voids less than 1 m^3 shall not be deducted.

Concrete work is categorised according to Table 9.11.

Table 9.11 Concrete classification.

Reference	Subsection	Classification		Unit
C2	Poured concrete			Volume
C3		Reinforcement	Bar	Weight
			Fabric	Area
C4		Shuttering*		Area
C5	Precast concrete	Floor slabs, partitions, etc.		Area
		Lintels, sills, duct covers, etc.		Length
		Beams, stanchions and tunnel rings		Enumerated
C6	Prestressed concrete			Volume
		Reinforcement	Bar	Weight
		Shuttering*		Area
			Edges	Length
			Grooves, throats, etc.	Length
C7	Sundries	Surface finishes†		Area
		Expansion material		Area
		Designed joints		Length
		Sinkings, channels, etc.		Length
		Fixings, ties, inserts, etc.		Enumerated or by area
		Mortices, holes, etc.		Understood included

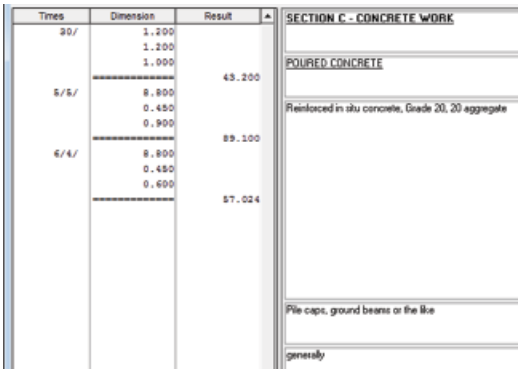
*Formwork.
†Understood included.

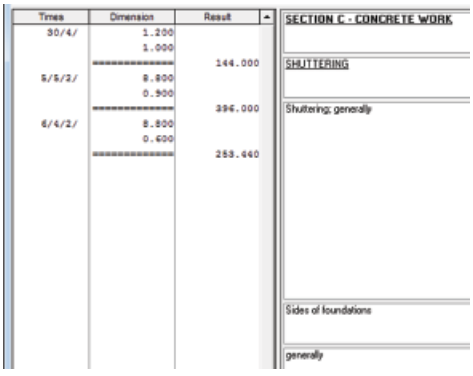
A further categorisation is provided for **poured concrete**, which shall be classified in the following groupings:

1. Foundations.
2. Pile caps.
3. Blinding.
4. Beds.
5. Suspended slabs.
6. Walls.
7. Columns.

8. Beams.
9. Staircases.
10. Diaphragm walls.
11. Other as may be appropriate.

Within each grouping of poured concrete are subsets, such that 'pile caps' include ground beams, 'beds' include roads and footpaths and 'columns' include stanchion casings. It is not clear whether the subsets of each grouping are to be separately measured, but for clarity, it would seem prudent to do so.





	SECTION C - CONCRETE WORK		
	POURED CONCRETE		
	Reinforced in situ concrete, Grade 20, 20 aggregate		(NA)
	Pile caps, ground beams or the like		
A	generally	189	m3
	SHUTTERING		
	Shuttering; generally		(NA)
	Sides of foundations		
B	generally	793	m2

Figure 9.7 Pile caps and ground beams.

Notwithstanding the general requirement to measure concrete by volume, there are cases where a thickness needs to be stated in the item descriptions, such as beds, suspended slabs and attached columns. C2.3 provides an alternative for items where the thickness is to be stated, in that similar items of different thicknesses (e.g. beds) may be grouped within a range of dimensions of different thicknesses.

As far as shuttering is concerned, it appears that all surfaces requiring support will have an associated shuttering item measured. There is no exclusion for concrete cast against the earth. Certain classes of shuttering shall be identified in item descriptions, including that required to be left in position, curved, conical or spherical shuttering and shuttering requiring a special finish.

In Figure 9.7, it can be seen that items in connection with pile caps and ground beams have been measured.

The poured concrete and associated shuttering items follow the strict wording of C2.1.2 and C4.1.4 which respectively say that *pile caps … shall include ground beams* and that *sides of foundations* include *pile caps and ground beams*. This is to be contrasted with SMM7, which measures these items separately, and NRM2, which makes no distinction.

In this particular example, the contractor has decided to use blockwork as permanent shuttering. This is not *left in position* shuttering within the meaning of C4.5 but should nevertheless be included within the interim valuation for payment as if 'normal' shuttering had been used.

9.6 Section D: Masonry

The traditional UK work classification of 'brickwork and blockwork' is termed *masonry* in POM(I).

Measurement is by area, with sloping, battered, curved and reinforced work so described. Walls are classed as:

1. Walls.
2. Walls built against other construction.
3. Cavity walls.
4. Isolated piers.

For cavity walls, each skin and the cavity may be measured by area (D2.1.3) as illustrated in Table 9.12. Strictly speaking, no extra items are measured for forming and closing cavities or cavity ties, but in this example, the software adds this as an additional description.

Table 9.12 Masonry.

	SECTION D - MASONRY					
	WALLS AND PIERS					
	Blockwork; concrete blocks; Thermalite, 440 x 215; in cement mortar(1:4)		(NA)			
	Cavity wall skins					
A	100 mm thick	1080	m2			
	Facing brickwork; Spec A; coloured cement lime mortar (1:1:6); Flemish bond; flush pointing as the work proceeds		(NA)			
	Cavity wall skins					
B	half brick thick; fair and pointed one side	1080	m2			
	Forming cavity					
C	50 mm wide including ties type A, two per m2	1080	m2			

Faced or fair faced work may be so described in the item or, alternatively, may be measured 'extra over' the work concerned.

Cavity walls may also be measured as a composite item (both skins and cavity included) if desired (refer to D2.1.3).

Cills, copings and arches are measured separately by length, and reinforcement, concrete filling to cavities, joints and air bricks are all specifically measured in the masonry section.

9.7 Section E: Metalwork

Metalwork includes structural steelwork, measured by weight, and non-structural metalwork items whose units of measurement vary.

Structural metalwork is classified as:

- Grillages.
- Beams.
- Stanchions.
- Portal frames.
- Roof trusses.
- Support steelwork.
- Other as may be appropriate.

Fittings, grouped into caps, brackets, etc., and bolts, distance pieces, etc. are measured as items under E2.2 and E2.3.

There is no separation of fabrication and erection.

Risk issue

Protective treatments are given as an item and not measured by area as is conventional.

9.8 Section F: Woodwork

Woodwork comprises work that would conventionally be classed as 'carpentry' with 'joinery' being measured in Section H: *Doors and Windows*.

Sawn timbers must be distinguished from finished timber, but there is no requirement to identify timber requiring treatment or structural grading.

Structural timbers are measured by length in a classification that separates:

1. Floors and flat roofs.
2. Pitched roofs.
3. Walls.
4. Kerbs, bearers, etc.
5. Cleats, sprockets, etc.

Strutting, and the like, is measured by length, but there is no requirement to identify different types of strutting.

Boarding to floors, walls, ceilings, roofs, etc. is measured superficially with eaves, verges, trims and the like by length.

Grounds and battens are measured by length, but framing (e.g. stud partitions) is measured by area. Framing is stated to be taken [measured] overall, presumably meaning overall openings and the like. As an alternative, framing may be measured linearly.

Composite items are enumerated. Exactly what is meant by this expression is not explained except that they may be, but not necessarily, fabricated off-site. The method of measurement makes no distinction. There is no requirement for a dimensioned diagram apart from the requirements of GP1.1 and GP2.3.

9.9 Section G: Thermal and moisture protection

This incongruously named section includes some substantial items of work including roofing, tanking and waterproof coverings.

Also included are eaves, ridges, flashings and roof lights, ventilators and special roofing sheets. Special roofing sheets, whilst not defined, may be measured 'extra over' other roof coverings.

Damp-proof courses and insulation are also measured in this section (G3), but no indication of any relationship with Section D: *Masonry* is made.

9.10 Section H: Doors and windows

Doors and windows are enumerated items, whereas jambs, mullions, transomes and the like are measured by length. Alternatively, frame and lining sets may be enumerated.

Screens are included in this section, leaving some doubt as to the meaning of 'composite items' in Section F: *Woodwork*. In Section H, it is presumed that 'screens' include entrance screens, shop fronts, etc., but there is no definition of the term. In common with Section F, there is no requirement for a dimensioned diagram, but the requirements of GP1.1 and GP2.3 nonetheless apply.

Tucked away in 'screens' is curtain walling – measured by area – and further down, in H6, patent glazing can be found, also measured by area. There is no extra detail provided on either.

Glass and glazed units appear under H5 with ironmongery in H4.

9.11 Section J: Finishes

This section makes the subtle, but important, distinction between 'finishes' and 'finishings'. Whilst not explained, it is fair to assume that 'finishes' is a collective noun that includes 'finishings'. In any event, J1.3 requires that *internal and external work shall each be so described* and, presumably, measured separately.

Section J is categorised as:

- Backgrounds (screeds).
- Finishings (floors, walls, ceilings, staircases).
- Sundries (inserts, dividing strips, mouldings, etc.).
- Suspended ceilings.
- Decorations.
- Signwriting.

Backgrounds are *floor, wall or ceiling finishes* (J2.1), and *each* [background] *shall be described*. Screeds and plasterboard backgrounds are specifically referred to in J2.2 and J2.3, respectively, but the method of measurement is silent on the subject of plastering. It is highly likely that plaster 'render' or 'backing' coats (i.e. the first of two-coat plaster work) will be included in 'backgrounds' on the simple logic that they are not 'finishings'.

J3: *Finishings* makes no reference to types of finishings, but this is likely to include skim plaster (because it is not a 'background'), floor and wall tiling and, possibly, textured coatings, for example, Artex (if not part of J6: *Decorations*).

J6: *Decorations* is non-specific but is likely to include both painting and wallpapering. There is a large classification of items given in the subsection J6.3, all of which are measured by area. This includes items that would conventionally be measured as 'narrow widths'.

Decorations to small pipes (internal diameter < 60 mm) are measured by length.

9.12 Section K: Accessories

'Accessories' includes partitions, doors and glazed units and cubicles or the like.

It is not clear how Section K relates to Section H: Doors and Windows, which includes H3: *Screens*.

9.13 Section L: Equipment

'Equipment' is defined as *specialist equipment related solely to the function of a building or department*, examples of which are provided in L1.1 (food preparation, laboratory equipment, etc.).

Such items are synonymous with 'fit-out' contracts that are normally separate from the main construction contract. However, in an international context, where the popularity of turnkey procurement is greater than in the United Kingdom, it is a sensible inclusion in this particular method of measurement.

Such items are to be itemised in the bill of quantities but will, in all probability, be given initially as a 'nominated' or 'prime cost' item.

9.14 Section M: Furnishings

The same comments as Section L apply.

9.15 Section N: Special construction

Work in this section includes *air supported or geodetic structures, prefabricated buildings or … radiation protection installations* (N1.1).

Such items shall be described as:

1. Enclosures of a specialist construction.
2. Installations of a specialist nature.

Air-supported structures would come under the first classification and radiation protection under the second.

At a more prosaic level, prefabricated buildings would also be classed as *enclosures of a specialist construction*. In view of the popularity of off-site prefabrication of bathroom pods and the like and the provision of a special Work Section 2: *Off-site manufactured materials, components or buildings* in NRM2, this is a far-seeing inclusion in a method of measurement that is some 35 years old!

9.16 Section P: Conveying systems

Section P is concerned with lifts, hoists, conveyors, escalators, etc.

Each item shall be enumerated, but separate measured items shall also be given for supports, identification, testing and commissioning, tools and spares and documents, including operation and maintenance manuals.

Incidental work – conventionally referred to as 'builder's work' – is to be provided as an item (P3.1) as is each of removing protective coverings and cleaning and polishing exposed surfaces.

9.17 Section Q: Mechanical engineering installations

A separate heading in the bill of quantities is to be given for each 'installation', classed by function, such as hot and cold water installations, heating, air conditioning and so on.

Under Q2, 'pipework and gutterwork' are measured by length which, whilst not defined, are likely to be equivalent to Work Section 33: *Drainage above ground* (NRM2) or R10: *Rainwater pipework/gutters* (SMM7).

The remainder of this section deals with the measurement of Q3: *Ductwork*, Q4: *Equipment*, Q5: *Automatic controls*, Q6: *Connections to supply mains* and Q7: *Insulation* in connection with mechanical engineering installations.

Builder's work in connection with mechanical engineering installations is measured in accordance with P2: *Sundries* in Section P: Conveying Systems (Q8.1 refers).

9.18 Section R: Electrical engineering installations

The POM(I) approach to electrical work is refreshingly pragmatic and is divided into:

- R2: *Main circuits*.
- R3: *Sub-main circuits*.
- R4: *Final sub-circuits*.

Accessories (R5), control gear (R6) and equipment (R7) are each measured separately as are R8: *Connections to supply mains* and R9: *Sundries*.

Installations are classed by function and given separately under an appropriate heading. The Section R measurement rules may be followed or the work *may be enumerated on a locational basis* (e.g. lighting installation to ground floor).

The 'main' circuit is the incoming supply to the main distribution board, and the 'sub-main' is the supply which runs from the main distribution board to a sub-main distribution board. Final sub-circuits include lighting points, socket outlets, telephone outlets and so on. Ceiling pendants, light switches and other 'final fix' items are included in 'Accessories' (see R5.1).

Builder's work in connection with electrical engineering installations is measured in accordance with P2: *Sundries* in Section P: Conveying Systems (R9.1 refers).

Notes

1. *The headings in this chapter generally follow those of POM(I).*
2. That is, in any of the various documents that make up the contract – for example, contract agreement, letter of acceptance, letter of tender, contract conditions, specification, drawings, schedules (including bills of quantities), etc.

3. http://www.rmdkwikform.com/uk?gclid=CNCa6uqL3bwCFSEHwwoda0UACg (accessed April 29, 2015).
4. Methods of payment rather than methods of measuring the absolute net volume of solids removed.

References

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