

Chapter 4

Approaches to Measurement

There is no question that bills of quantities have been the ‘big beast’ of the UK construction industry for well over a century. Whilst it is true that many projects do not merit or require such detailed measurement, it is also true that bills of quantities, in some form, have underpinned the traditional methods of procurement used in the United Kingdom both prior to and since the advent of formalised measurement in 1922 (Royal Institution of Chartered Surveyors, 1922).

History shows that bills of quantities have not, in fact, changed radically for over 500 years, and it remains true today that a contractor cannot price anything but the smallest of projects without preparing some sort of quantified ‘list’ of the work required. The supremacy of bills of quantities was challenged briefly in the 1960s, unsuccessfully as it turned out, by the operational bill, but this failed to catch on, predominantly due to the lack of computing power available at that time.

The UK industry ‘fixation’ with bills of quantities is probably due to the omnipresence of ‘formal’ bills of quantities prepared by professional quantity surveyors (PQSs) as part of the traditional tendering process. This ‘fixation’ is also the likely reason why the use of bills of quantities is reported to be in decline. Both the RICS Survey of Contracts in Use 2010 (Davis Langdon (AECOM), 2011) and the NBS National Construction Contracts and Law Survey 2013 appear to indicate that changes in procurement methods and, especially, the growth of design and build (DB) are behind this shift in emphasis, and it is also probably true that the use of activity schedules popularised by the Engineering and Construction Contract has also displaced the ‘formal’ BQ to some extent.

However, Hibberd (2014) usefully points out that the RICS survey *does not look at ‘traditional procurement’ as such but considers procurement in terms of the use of firm or approximate bills, specification and drawings, design and build, target cost, etc.* This is, therefore, more indicative of pricing mechanisms than procurement methods. Hibberd also concludes that ‘traditional procurement’ is still dominant in the marketplace if the use of firm bills of quantities and drawings and specification is assumed to represent ‘traditional procurement’. Both the RICS survey (76% of projects) and the NBS survey (72%) confirm this to be the case albeit that there has been a steady decline in traditional methods since the 90% levels reported in 1987.

It would be a mistake, however, to assume that the decline of firm bills of quantities also means a decline in the need to measure and prepare quantities. Everything that had to be measured

‘formally’ still has to be measured in order to prepare a price, and there is no ‘magic’ way around this fact of life. Drawings and specification-type contracts, for instance, need to be quantified in order to arrive at a tender price, and thus, the void caused by the decline in ‘formal’ bills of quantities has been filled by ‘informal’ bills of quantities (or similar) whether prepared by contractors, subcontractors or otherwise. This chapter focuses on the various approaches to measuring construction work available.

4.1 Measurement skills

At one time, the acquisition of measurement skills, though hard won, was a fairly straightforward process:

- Understand the technology of construction.
- Learn how to read a drawing.
- Drill yourself in the practices and conventions of the quantity surveyor.
- Acquire the ability to use a scale rule.
- The ability to write accurate and concise item descriptions would come with practice and experience.

Nowadays, the process is much more technological with the availability of digitised measurement, 2D and 3D computer-aided design, electronic drawings, BIM models and the like. Despite these advances, Lee et al. (2011) and Ostrowski (2013), amongst others, still believe that it is crucial to understand what to measure and how to measure it and to do so by grasping the basic principles of measurement in a traditional way, that is, by learning to measure using worked examples presented in 2D line drawing format and by setting out the resulting side-casts and dimensions in the traditional handwritten form.

It is hard to disagree with this point of view, but equally, computer-generated drawings and models can help to make measurement much easier, more fun and less prone to error than taking off from 2D paper-based drawings. Some design packages, for example, have the facility to remove or hide various ‘layers’ of the design in order to reveal only those items that are to be measured. In this way, internal partitions, doors, windows, plumbing appliances and the like can be visualised in isolation from the rest of the design in a way that was previously not possible with paper-based drawings.

4.2 Uses of measurement

As discussed earlier in this book, measurement is used for many purposes in the construction industry. Most people, however, would probably say that measurement is principally used as a means of quantifying the work required in a construction contract. This provides data that can be used for the pre- and post-contract administration of a project, including:

- Pricing tenders whether it be for a lump sum, measure and value contract or target-type contract.
- Preparation of the pretender programme of works.
- The valuation of work in progress for the purpose of interim payments.
- Valuation of variations and additional work.
- Remeasurement of completed work where required by the contract.

The construction industry uses a number of ways of communicating the work required in a contract according to the preferred method of procurement and the form of contract used.

Risk issue

Irrespective of the choices available, it would be unwise to enter into a contract without some sort of analysis or breakdown of the contractor's price or without a list of prices or rates.

Without such information, even for relatively small projects, the employer would be exposed to the risk of exploitation by the contractor especially as regards post-contract administration.

The choice of pricing document is a matter for the employer according to the level of detail that is thought necessary for a particular contract.

4.3 Pareto principle

The Pareto principle, or 80/20 rule, is a widely recognised rule of thumb in management and business circles, which states that:

- *For many events, roughly 80% of the effects come from 20% of the causes.*¹

A typical example is where a small painting and decorating contractor relies on subcontracts from two or three main contractors for the bulk of its work and also picks up smaller direct contracts from a number of 'one-off' clients as well as a few 'regulars'. In this case, it is probable that a significant proportion (say, 80%) of the company's turnover is generated by only 20% of its clients.

For this simple example, it would be easy to test the Pareto principle by checking how much work emanated from each client. However, generally speaking, there is no empirical evidence to support the rule which largely stems from observation rather than scientific investigation. Despite there being no strict mathematical foundation to the 80/20 rule, it has some merit, however, because it helps managers to manage by exception and to focus on those aspects of the business that have greatest impact on its success.

With regard to measurement, it has long been generally accepted that 20% of the items in bills of quantities represent 80% of the cost. This can be tested by simply counting the number of items in the bills of quantities and by establishing how many of these are high-value items. The 80/20 rule is more likely to be true in bills of quantities for building work simply because such work is conventionally measured in greater detail, and consequently, there is likely to be a high number of small-value items.

In bills of quantities for civil engineering work, it is probable that the Pareto effect will be less evident; this is because of the likelihood of a higher proportion of 'bill' items with significant quantities or high value or both due to the method of measurement adopted. In civil engineering methods of measurement, the majority of 'minor items' will be deemed included in item coverage rules and therefore not measured separately as they would be in one of the building methods of measurement.

In bidding situations where there is no bill of quantities supplied by the client/employer and the main contractor is consequently responsible for producing its own quantities, it is commonly the case that the contractor's quantity take-off will place most emphasis on the important, high-value items of work. The contractor will be less concerned with measurement precision and accuracy of the quantities than would a PQS working for the employer. The time, effort and cost of measuring 80% of the items that represent 20% of the cost is simply not viable, and in any case, the small-value items will be picked up by the estimator, or by subcontractors, who will make suitable allowances in the rates for the main work items.

4.4 Measurement documentation

Despite the pre-eminence of bills of quantities in construction, measurement information can be conveyed in several different ways according to the nature of the work involved and the type and form of contract used.

JCT contracts offer the choice of bills of quantities of different sorts as well as various schedules as a means of conveying quantity and price information, whereas the choices under the New Engineering Contract family are limited to bills of quantities, activity schedules and quantified and unquantified price lists. In the FIDIC Conditions of Contract for Construction, bills of quantities are, in fact, seen as a subset of ‘schedules’ which are defined in Clause 1.1.1.7 as documents *completed by the Contractor and submitted with the Letter of Tender* and may include *the Bill of Quantities, data, lists and schedules of rates and/or prices*.

Some construction work lends itself to the use of measured quantities and some to less detailed methods of identifying the work in a project. The choice of documentation will depend on whether a lump sum, measure and value or reimbursement contract is to be used and whether the employer or the contractor is to carry the measurement risk. The range of documents commonly used in the industry may be categorised as follows:

- Formal bills of quantities.
- Formal ‘quasi’ bills of quantities.
- Formal ‘operational’ bills of quantities.
- Informal bills of quantities.
- Activity schedules.
- Price lists and contract sum analyses.
- Schedules of actual cost:
 - Daywork schedules.
 - Schedule of cost components.

4.5 Formal bills of quantities

The decline in the use of bills of quantities over recent years has been well documented, the most cited reason being the trend towards non-traditional methods of procurement where bills of quantities are seemingly not required. Whilst there may be some truth in the suggestion that bills of quantities are no longer the *lingua franca* of the UK construction industry, they are, nevertheless, still commonly used for traditionally procured projects and also in non-traditional procurement albeit in a different guise.

Formal bills of quantities are inextricably linked with standardised measurement and with the employer-engaged PQS or ‘in-house’ specialist in measurement matters. There is good reason for this tradition because tendering contractors are able to rely upon the fact that the bill of quantities is:

- Based on clear and unequivocal rules of measurement.
- The same for each tenderer.
- Accurate in so far as the stage of design development allows.
- A contract document linked with a known method of measurement.
- A sound basis for accurate pricing.
- Subject to clear rules regarding the post-contract adjustment of quantities, errors and omissions and variations that impact on the contractor’s original level of pricing.

Formal bills of quantities based on a standard method of measurement may be:

- Firm or
- Approximate.

4.5.1 Firm bills of quantities

The adjective ‘firm’ is somewhat misleading because it gives the impression that the bill of quantities is of a stable or fixed nature where the quantities are unlikely to change. Most bills of quantities in this category are anything but ‘firm’.

Traditionally, firm bills of quantities are used mainly in building work where the design has been developed to a sufficiently detailed stage that accurate quantities can be measured and billed. In practice, it is rarely the case that designs are anywhere near complete at the tender stage, and it is well known that contracts, tendered on the basis of ‘firm’ quantities, have lots of design issues to be resolved.

Despite tendering a ‘firm price’, contractors habitually find that the contract bills contain:

- Approximate or provisional quantities.
- Errors and omissions.
- Prime cost sums for work which cannot be quantified with any accuracy.
- Provisional sums for work that has yet to be designed.
- Contingency sums for the unexpected or ‘known unknowns and unknown unknowns.’²

It is also common in bills of quantities to find that ‘firm’ measured work items are varied, added to or omitted during the course of the works due to design changes and other circumstances. This can play havoc with the contractor’s planning and programming of the works and can have a detrimental effect on profit and overhead recovery. Whilst it is reasonable to suppose that no design can ever be complete in every detail, it is, perhaps, unreasonable that ‘firm’ quantities based on a supposedly complete design should be subject to the wholesale variations commonly experienced in the UK construction industry. For this reason, it is probably the case that traditional methods of valuing variations inadequately recompense the contractor and that the system of variations based on a contractor’s quotation used in some standard contracts (e.g. JCT 2011 SBC/Q) is fairer, at least to contractors!

In any event, all standard forms of contract provide clauses for situations where variations, loss and expense/compensation events and errors in the contract documents occur and standard methods of measurement usually contain protocols that anticipate the need for flexibility in the contract bills. These protocols require, *inter alia*, that provisional quantities are clearly marked as such and the bill of quantities is appropriately structured to accommodate PC and provisional sums.

Risk issue

The so-called ‘firm’ bills of quantities that are not firm do not constitute a breach of contract because standard forms of contract anticipate a range of circumstances where uncertainty in the quantities and/or in other works required by the contract is expressly provided for in the contract terms. Provided the correct protocols are followed, there can be no breach.

In the same way, bills of quantities prepared on the basis of an incomplete design cannot be construed as not being in accordance with the standard method of measurement if the SMM in question contains protocols for the inclusion of approximate or provisional quantities, PC sums or provisional sums in the bills of quantities. Provided that the SMM rules are followed, there cannot be a breach of contract in such circumstances.

Contractors who sign up to contracts with ‘firm’ bills of quantities should be fully aware of the consequences of entering into a contractual agreement that may contain a considerable degree of uncertainty in the contract bills.

4.5.2 Approximate bills of quantities

Approximate bills of quantities might be considered to be more ‘honest’ than the so-called ‘firm’ bills of quantities because they are what they say they are – approximate. Normally employed on measure and value contracts, such bills of quantities are sometimes referred to as ‘quantified schedules of rates’.

The quantities in an approximate BQ are estimated and amount to an approximation of the amount of work that the contractor can expect when the job is started. The final ‘firm’ quantities are derived by admeasurement as the work proceeds.

There is no need to mark the quantities as ‘approximate’ in a bill of approximate quantities because the tender documents will make it clear that:

- The tender sum is simply a total of the bill of quantities which enables tenders received to be compared with each other.
- The billed quantities are subject to admeasurement.
- The contract sum will be based on the final quantities derived from the admeasurement process.

This does not necessarily imply that the final quantities can be wildly different from the approximate quantities as some standard forms of contract provide for the adjustment of the contractor’s rates when there is a significant increase or decrease in the eventual quantities:

- By providing the contract administrator with the express power to consider the impact of the quantities being greater or less than those stated in the bill of quantities; this could mean revisiting the original BQ rates with a view to deciding whether an increase or decrease is appropriate albeit at the contract administrator’s discretion.
- By an express provision in the contract that recognises the contractor’s entitlement to additional payment should the difference between the billed and admeasured quantities cause a change in unit cost.
- By an express provision in the contract for additional payment where *the final quantity × the original rate exceeds the original quantity × the original rate* by a stated factor or percentage.

In all other respects, approximate bills of quantities follow the same structure and method of measurement as ‘firm’ bills of quantities.

4.6 Formal ‘quasi’ bills of quantities

Formal ‘quasi’ bills of quantities may be taken as *resembling but not actually being*³ bills of quantities but may nevertheless be issued ‘formally’ as part of the tender documentation issued by employers to contractors or by contractors to their subcontractors.

The three main categories of formal ‘quasi’ bills of quantities are:

1. Schedules of rates.
2. Schedules of works.
3. Priced specification.

4.6.1 Schedule of rates

Schedules of rates are used where the nature of the work required is known but not the extent, and they may therefore resemble bills of quantities but do not actually quantify the work required at the tender stage. The quantities are determined when the work is carried out, and the type of contract would thus be a **measure and value contract**.

Schedules of rates are commonly used for repair and maintenance work and on measured term maintenance contracts for social housing, government buildings or highways where the contractor is appointed for a fixed period (say, 3 years) to carry out an unquantified amount of maintenance work. The work would be described in detail in the specification and in the schedule of rates so that tenderers would be aware of the 'scope' of works, but few drawings would be available other than perhaps a site plan, a general arrangement drawing and, perhaps, standard construction details.

At the tender stage, the contractor prices the contract on the basis of a general understanding of the scope and scale of the work as described in the tender documents. The contract prices may be rates per unit for the items of work listed and lump sums where appropriate or, alternatively, a percentage deduction or addition to the rates quoted in the schedule. The eventual total price for the work carried out would be calculated by measuring the quantity of work actually done multiplied by the rate in the schedule.

Types of schedules of rates

There are three types of schedules of rates in common use:

- A bill of quantities-style document, written in SMM format, without any quantities. Such schedules may be standard 'in-house' documents, or they may be produced on an *ad hoc* basis for specific projects. In both cases, the contractor prices the various items of work described, but no tender total may be determined as there are no quantities.
- A bill of quantities-style document, prepared 'in-house' or on an *ad hoc* basis and not necessarily in accordance with a standard method of measurement. Tenderers would be invited to price the scheduled work items by either:
 - Entering unit rates or lump sums (if appropriate) against each scheduled item or
 - Stating a percentage addition to or deduction from rates already entered in the schedule.
- A published schedule, such as the PSA Schedules of Rates, the M3NHF (National Housing Federation) Schedule of Rates or the National Schedules of Rates (NSR) where:
 - Rates are already pre-entered and tenderers quote a percentage addition to or deduction from the scheduled rates or
 - Scheduled items are left blank for tenderers to enter their rates.

Schedules of rates format

There are several ways that schedules of rates may be presented or formatted according to the rates and level of detail required from tenderers.

The National Schedules of Rates (NSR)

The NSR is highly detailed with rates broken down into materials, labour and plant. There is a portfolio of NSR schedules of rates for Building Works, Electrical Services, Highways Maintenance, Housing Maintenance and Mechanical Services.

Table 4.1 shows an extract from the NSR, Part A: *Contractor's General Cost Items*, to illustrate the point.

PSA Schedules of Rates

In Table 4.2, it can be seen that the layout of the PSA schedule has the look of a bill of quantities but with the additional sophistication of a spreadsheet to cater for, in this case, different rates for the removal of different sizes of window. It will be noted that the items are 'written short' in a similar way to bill of quantities format but that the unit of measurement is shown as a heading and not in a 'unit' column.

Table 4.1 National Schedules of Rates.

A: Contractor's general cost items			Mat.	Lab.	Plant	Total
			£	£	£	£
A4487						
115	5.00–6.00 m from ground level	nr			48.70	48.70
A4490	Lightweight aluminium access units – hire charge (weekly rate)					
200	Chimney scaffold unit to provide working platform to half of centre ridge stack	nr			135.00	135.00
205	Chimney scaffold unit to provide complete working platform around centre ridge stack	nr			270.00	270.00
230	Window access unit, 450 mm wide platform	nr			129.00	129.00
235	Window access unit, 600 mm wide platform	nr			129.00	129.00
240	Staircase access unit, 300–450 mm wide platform	nr			108.70	108.70
245	Staircase access unit, 600–675 mm wide platform	nr			108.70	108.70
A4491	Lightweight aluminium access units – hire charge (daily rate)					
200	Chimney scaffold unit to provide working platform to half of centre ridge stack	nr			27.00	27.00

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A different version of this format is shown in Table 4.3, which illustrates a spreadsheet layout that enables different types of roof covering to be associated with common item descriptions. Once again, the unit of measurement appears as a heading.

The M3NHF Schedule of Rates

The National Housing Federation (M3NHF) Schedule of Rates is more of a ‘family’ or suite of documents. There are five versions of the schedule which are used by over 600 organisations and 3000 contractors and direct labour organisations.

The M3NHF schedule has an extensive infrastructure of measurement rules. These comprise:

- General rules.
- Measurement rules.
- General *deemed to include* measurement preambles.
- Trade/work section *additionally deemed to include* coverage rules.

The M3NHF measurement rules are illustrated in Table 4.4.

The M3NHF measurement rules underpin the measured items in the various schedules. Additionally, however, the schedules of rates items are subject to price framework rules (see Table 4.5) which, strictly, are contractual but also act as further item coverage for the measured items in the schedules.

Measured items are generally of a ‘composite’ nature as shown in the example in Table 4.5, but the rules and measured item descriptions, despite being comprehensive, also rely on the common law understanding that items shall include for everything that is *contingently and indispensably necessary* to complete the contract work.

M3NHF Schedules of Rates are revised from time to time, some more frequently than others.

Standard contracts used with schedules of rates

Some schedules of rates, such as the M3NHF schedule, come with a bespoke set of contract conditions which are specifically designed for repair and maintenance work. M3NHF publishes

Table 4.2 PSA Schedules of Rates (1).

C90: Alterations					
Windows					
	1	2	3	4	
	Area				
Item C90	£	£	£	£	£
	Not exceeding 1.00 m²	1.00–2.00 m²	2.00–3.00 m²	additional 1.00 m²	ADD for each additional 1.00 m²
077	6.78	8.91	11.05	2.14	
078	31.00	40.26	49.88	9.62	
079	37.05	48.10	59.86	11.59	
080	7.12	9.45	11.76	2.33	

Taking out single or composite timber casement window and frame: timber surround: accessories: glass
 in conjunction with taking down wall.....
 preparatory to filling in opening: cutting out fixings.....
 preparatory to renewing window and/or frame: cutting out fixings: removing timber surround from frame.....
 Taking out single or multi-light casement frame and sashes: accessories; weights: glass
 in conjunction with taking down wall.....

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Table 4.3 PSA Schedules of Rates (2).

		FELTS – continued								
Item	Square metre	£	2	3	4	5	6	7	8	
			Bitumen felt – Each layer							
			Elastomeric bitumen polyester							
			Cap sheet							
			Venting base layer	Bottom layer polyester-based bitumen felt	Bottom layer bitumen glass fibre	Bottom or intermediate layer	Sanded finish	Granule finish	Aluminium foil faced	Copper foil faced
		£	£	£	£	£	£	£	£	
145	Roof covering horizontal or to falls, crossfalls or slopes: any width not exceeding 10° pitch	6.19	6.82	6.13	8.00	13.67	15.56	28.59	52.35	
146	Sloping 10° to 45° pitch	6.84	7.33	6.73	8.53	14.48	16.51	29.93	53.80	
147	Vertical or sloping exceeding 45° pitch	7.35	7.78	7.20	8.96	15.12	17.25	31.00	55.02	

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Table 4.4 M3NHF measurement rules.

M3NHF measurement rules	
MEASUREMENT RULES	
<p>The rules for the measurement of items included in this schedule of rates will be those detailed within the All Trade Preambles and this appendix as follows:</p>	
<p>GENERAL RULES Schedule of rates descriptions</p>	<p>1. For items in the schedule of rates which are measured (indicated in LM/SM/CM), the client will reimburse the service provider for works on the following basis. The use of an item and the usage rate is less than 1 (one), the charge shall be as for 1 (one) whole. Where, however, more than 1 (one) whole is used reimbursement shall be pro-rata the item schedule rate i.e. 1.27 LM, SM or CM = 1.27 to two decimal places, (multiplied) by the unit schedule rate.</p> <p>2. For items in the schedule of rates where the unit of measure is per no, (number) or IT (item), then the charge shall be as for 1 (one) whole multiplied by the unit schedule rate.</p> <p>3. For items in the schedule of rates where the unit of measure is per HR (hour), then the Brickwork and blockwork</p> <p>Brickwork and blockwork rates deemed to include</p> <p>A. Rates for brickwork and blockwork are additionally deemed to include as appropriate for the following:</p> <ol style="list-style-type: none"> 1. All rough and fair cutting. 2. Forming rough and fair grooves, throats, mortices, chases, rebates and holes, stops and mitres and all like labours. 3. Raking out joints and hacking faces to form key for finishings. 4. Labour in eaves filling. 5. Centering to new and rebuilt flat or cambered arches
<p>001 There are three levels of description for each schedule of rates item. Each of these, in particular, the long description set out in the scope of works envisaged for an order for that item.</p> <p>002 Each item has a six character numeric code reference and a single-character alpha priority code reference: Example:</p> <p>125001 E Chimney: Ball chimney flue, clear obstruction and IT 34.39 clean up including all associated work, and remove waste and debris, – (as an emergency priority (see the following text))</p> <p>Items are grouped in the following sections:</p> <p>MEASUREMENT PREAMBLES</p> <p>The following are provided as indicative examples only and should be reviewed and adapted as necessary by the client, prior to incorporation into any tender or other contract documentation, to ensure that they are fully compatible with the maintenance service to be provided and the particular schedule of rates with which they are to be used:</p> <p>Generally</p> <p>Generally rates deemed to include</p> <p>A. Rates for all schedule of rates items in all trades generally are deemed to include as appropriate for the following:</p> <ol style="list-style-type: none"> 1. All work that can reasonably be deemed to be included either as good workmanship, including the provision of materials and plant, or accepted practice whether or not specifically referred to in this document, the client representative's decision on this will be final. 	

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Table 4.5 Price framework rules and composite rates.

M3NHF schedule of rates			
PART 2: Price framework rules			
1	Schedule of rates items	951009 R	NO 729.49
1.1	Service provider to execute works at contract rates		
1.1.1	<p>The service provider's tendered rates include all costs required to undertake the works including the following:</p> <ul style="list-style-type: none"> • Labour and all related costs (including travel and other non-productive time); • Materials supply costs (including delivery and collection costs); • Equipment (including scaffolding up to two storeys, tools and personal protective equipment); • All waste, debris and waste disposal costs (including tipping charges, landfill tax and any similar costs) arising from materials; • All temporary works and reinstatements; • All payments to utility providers; • Supervision, transport (including parking and/or congestion charges) depot and storage costs; • Water supply for the works, including all necessary plumbing and removal of temporary facilities on the completion of void property works; • Temporary artificial lights and electrical power and/or gas facilities; • The temporary disconnection and protection of telephone installations including repositioning to maintain services releasing wires and cables before undertaking the 	<p>951011 R</p> <p>Bath: install special needs type Bath: renew bath with special needs bath with rim and internal bath seat complete with new taps and waste reconnect to existing supply pipework including any adjustments; provide new service valves if not already installed; complete with new plug and chain, plastic trap; connect to waste pipework; remove existing bath panels and framework and fix new proprietary front and end bath panels including all necessary fixings and supports; make good existing and renew glazed wall tile splashback fixed with adhesive including all rounded edges and labours, silicone sealant between splashback and bath, and crossbond; make good wall and floor finishes; and remove waste and debris.</p> <p>Bath: install special needs HIP type Bath: renew bath with special needs hip bath complete with new taps and waste reconnect to existing supply pipework including any</p>	NO 508.53

a complete set of tender documents which comprises an invitation to tender, articles of agreement, a price framework, contract details, the contract conditions, preliminaries and a key performance indicator (KPI) framework.

Alternatively, the JCT SBC/XQ 2011 ‘without quantities’ form of contract might typically be employed for repair and maintenance work, but equally, a standard form of term contract could be used such as the JCT Measured Term Contract (MTC) 2011, the NEC3 Term Services Contract (TSC) or the NEC3 Term Services Short Contract (TSSC).

In common with other NEC3 contracts, the NEC3 TSC offers an option structure, thereby facilitating different types of contractual arrangement and various means of allocating price/financial risk:

- **Option A** is a priced contract with a price list. The risk attached to the agreed prices is largely borne by the contractor.
- **Option C** is a target contract with a price list where the price risk is shared by the employer and contractor in an agreed proportion.
- **Option E** is a cost reimbursable contract where the price risk is largely carried by the employer.

The payment mechanism in the TSSC is based on agreed rates and prices.

For an MTC under the TSC, Option A (priced contract with a price list) would be used in conjunction with secondary Option X19 (Task Order). The price list could be a published or a bespoke schedule of rates. Work is instructed by the service manager on the basis of task orders which should contain a detailed description of the work required and a priced list of items, as well as details of commencement and completion dates and delay damages (if required), and so on.

4.6.2 Schedule of works

Schedules of works are, usually, unquantified lists of work to be undertaken for a building project, usually works involving demolitions, alterations or repairs. They should not be confused with:

- **Work schedules** which are more correctly associated with Gantt or bar charts and other forms of programme or visual displays of work related to time.
- **Activity schedules** which are lists of unquantified construction activities, prepared and priced by the contractor, often, but not necessarily, linked to the contractor’s programme.

Schedules of works tend to be prepared by building surveyors rather than quantity surveyors, or they might be drafted by architects as part of the service provided to clients. They will usually have a ‘preliminaries’ section and will accompany the drawings and specification which, together, will comprise the tender documentation. In its priced form, the schedule of works will be an important contract document and will be used as production information as well as for interim payments and the valuation of variations to the contract.

Schedules of works describe the work required in the form of ‘composite’ items as opposed to the individual measured items that would appear in a bill of quantities. They do not follow a particular method of measurement, and thus, the style, content and quality of the item descriptions can be very variable. **Composite items** include several work items that would normally be separated in a conventional bill of quantities.

Schedules of works usually consist of unquantified items in which case it is the tendering contractors that must judge the extent of the work required and the amounts of materials needed to complete the contract. In other words, they bear the quantity risk. In this context, it is important to read schedules of works in conjunction with any drawings available, and a site visit is indispensable to understanding what is to be priced.

Different formats are possible with schedules of works, and they can be arranged:

- Elementally (e.g. substructure, superstructure, internal finishes).
- In work packages (e.g. demolition works, groundwork, concrete works, external and internal structural walls).
- In trade or work sections (e.g. concrete work, brickwork and blockwork, drainage).
- On a room-by-room basis (e.g. entrance/reception, consulting room 1, treatment room A).

Where a schedule of works includes details of the specification for materials and the quality of workmanship, it may be referred to as a 'specified schedule of works'.

Schedules of works tend to be used on smaller projects, or for demolition and alteration work, as an alternative to bills of quantities, but it is not inconceivable that the monetary value of such projects could be significant. The main point about schedules of works is simplicity. It is probably not worthwhile measuring the individual items of work involved because the quantities are too small. It is therefore more sensible to combine several individual items in a collective item that the contractor can nonetheless price. It is unlikely that the contractor will attempt to quantify the work involved but will more likely 'spot' price the items using experience of similar work as the price database along with a 'guesstimate' of the materials required (e.g. 1 nr pack of facing bricks, 6 nr bags of multi-finish plaster, 4 nr 10 litre tubs of emulsion paint, etc.).

There are no rules governing the style or content of schedules of works, and the compiler is free to choose whatever form of presentation is preferred. Some guidance in formulating item descriptions may, nevertheless, be found in SMM7 Class C10 (demolishing structures) and Class C30 (spot items). An example of a schedule of works is shown in Table 4.6, but this is not claimed to be 'typical' or 'representative' of industry practice.

Table 4.6 Schedule of works.

Reference	Description	Price
A	Remove skirtings, take up defective flooring and lift existing floor joists and wall plates; remove debris from site; bed new 50 × 100 mm treated softwood wall plates on existing sleeper walls including polymer-based DPC; install new 50 × 150 mm treated softwood floor joists and spike to wall plates; lay new 20 mm softwood tongued and grooved floor boarding; supply and fix new softwood skirtings to match existing.	
	<i>Approximate areas:</i> Room A: 6 m × 4.5 m Room B: 4 m × 4 m Room C: 4 m × 3 m Room D: 3 m × 3 m	
B	Remove existing single flight timber staircase, balustrading and strings and remove from site; make good all plasterwork (new staircase and all decorations itemised separately).	
C	Form opening in 250 mm cavity wall faced one side; carefully cut out for and install proprietary galvanised steel boot lintel and pin to existing brickwork; quoin up jambs and point to match existing facework; make good internal plasterwork; supply and install 1200 × 1200 mm softwood casement window complete with brass casement stay and lockable window fastener; supply, cut and fit 25 × 250 mm softwood bullnose window board and plug and screw to brickwork; plugs to be pelleted and sanded flush; remove all debris from site; wall to be temporarily supported with suitable needles and propping whilst the work proceeds (decorations itemised separately).	
	Quantity: 8 nr on two floors	

Risk issue

Schedules of works place more risk on the contractor than a bill of quantities as care has to be taken to ensure that all the necessary costs have been included in the tender price despite the lack of precision in the item descriptions.

It is also much more difficult to value variations with a schedule of works than it is with either bills of quantities or schedules of rates.

Some compilers like to quantify schedules of works, and this might be done by:

- Creating a ‘quantity’ column similar to that in a bill of quantities.
- Quantifying the component parts of each item within the item itself.

Risk issue

There would seem to be little advantage to be gained from quantifying a schedule of works, the net effect of which is to transfer the quantity risk from the contractor to the employer.

This risk is compounded due to the lack of any supporting measurement rules for schedules of works. Measurement rules provide a degree of protection for the bill compiler/employer as there can be no misrepresentation of the quantities provided that the rules of measurement are followed.

If item descriptions in a schedule of works are incomplete or misleading, the employer may be faced with claims for misrepresentation.

The additional work in quantifying the schedule of works items would also increase the lead time for the preparation of the tender documents, and employers would be faced with additional costs and/or professional fees.

4.7 Formal ‘operational’ bills of quantities

Operational bills of quantities for production-orientated tendering were first developed in the 1960s at the Building Research Station (now BRE) at Garston, near Watford, United Kingdom, by senior researchers Forbes and Skoyles (1963; Skoyles, 1966, 1967). The late Edward ‘Ted’ Skoyles was quite a character (I spent the morning with him in 1972) and was someone, on a personal view, ahead of his time.

The operational bill is likened by some to the priced activity schedule used for Options A and C of the NEC Engineering and Construction Contract, but there are a number of significant differences between them:

- The operational bill was a ‘formal’ tender document prepared the employer’s QS (not by the contractor as with the NEC activity schedule).
- It attempted to quantify building work in terms of the activities or operations required and the sequence of construction.
- The operational bill was considerably bulkier even than the equivalent measured bill of quantities and much more so than an activity schedule.
- It required considerable computing power to manipulate all the data (lacking in the 1960s).
- It did not fit conventional estimating methods and databases used at that time, but activity schedules are popular and fit well with modern software.

An operational bill comprised discrete items of construction work (operations) which could be distinguished from other operations. An operation was defined as *a piece of construction work*

which can be carried out by a gang of operatives without interruption from another gang. The operational bill was supplemented by a precedence diagram which indicated the sequence and concurrency of operations one to another which could be developed by the contractor using the critical path analysis programming technique that was popular at the time.

From memory, the operational bill had a number of sections, and some of the main features included:

- Operations scheduled with materials quantities in purchasing units (e.g. rolls of damp-proof membrane, bricks per thousand).
- A global labour item with the amount of work described which the contractor would then assess.
- Separate identification of work carried out off-site, such as prefabricated components.
- Management and plant resources at the end of the bill rather than at the front as is the case with the (similar) present-day time and method-related charges.

Jaggar et al. (2002) remember that the operational bill failed for a number of reasons but especially because of design team inertia and because the industry at the time gave it a hostile reception. The researchers clearly came at the problem from the wrong angle – the design team should not be trying to anticipate how the contractor will carry out the work – and they perhaps did not appreciate the impact of the perennial problem of producing bills of quantities from an incomplete design.

NEC activity schedules are clearly related to operational bills but only distantly, so why bring up a subject that resides over 50 years in the past? The answer is BIM!

It is quite clear to this author (who might be considered by some as a heretic!) that there is a great deal of synergy between operational bills and BIM models:

- BIM models comprise objects (e.g. precast concrete wall panel).
- Operational bills comprise operations (e.g. the supply, erection and fixing of precast concrete wall panel).
- BIM objects are ‘intelligent’ and can carry all sorts of data – structural, thermal, acoustic, **time and quantity**.
- BIM data can be quickly manipulated by computer, and the 3D model can be linked to time (4D) and cost (5D).

Using BIM model data in conjunction with a type of ‘operational bill’ would encourage ‘operational estimating’ (pricing based on time and resources) rather than the conventional unit price estimating method associated with traditional bills of quantities. This would be a good fit with both activity schedules and linked bar chart software such as Asta Powerproject, Project Commander or Microsoft Project, and the entirety would fit well with a modern family of construction contracts such as the NEC.

Based on a simple method of measurement, suitably aligned with BIM output data, twenty-first century operational bills could be used both formally and informally according to the preferred procurement strategy.

4.8 Informal bills of quantities

An ‘informal’ document may be defined as being *not of a formal, official... or conventional nature... appropriate to everyday life or use ... characterized by idiom, vocabulary, etc., appropriate to everyday conversational language rather than to formal written language.*⁴

This definition is characteristic of the so-called builders’ quantities that are widely used by subcontractors, trade contractors and main contractors. Builders’ quantities are meant to be ‘internal’ documents, not seen by outsiders to the company or organisation using them.

The term ‘builders’ quantities’ is something of a colloquialism, however, which has no formal definition and yet is in common use in the construction industry. Everyone understands what it means and yet it can mean different things to different people.

At one end of the spectrum, a plastering contractor can look at a room and work out a price on the basis of one bag of multi-finish and half a day's labour. At the other end, a large contractor pricing a DB tender can produce a bill of quantities fairly quickly without worrying too much about the finer detail.

4.8.1 Builders' quantities

To an extent, there is an understanding that builders' quantities are somewhat 'rough and ready', lacking the precision of a PQS measuring to a standard method of measurement. There is also the understanding that builders' quantities are good enough to produce an estimate but not good enough as a basis for formal competitive tendering.

Whilst there is undoubtedly some truth in this, it is also true that, certainly from the writer's personal experience, builders' quantities have to be good enough for formal competitive tendering because:

- Procurement methods that aim to move the quantity risk to the tendering contractors are on the increase (all available evidence points to this).
- Contractors are increasingly asked to tender for traditional contracts on the basis of partial contractor design; this usually requires the preparation of informal detailed quantities in order to price the 'global' item(s) provided in the formal bill of quantities.
- Design and construct and drawings and specification tenders oblige contractors to produce their own quantities and take the associated risk on board.
- Contractors are comfortable with the Pareto principle that some 20% of the items measured represent 80% of cost and that the remaining 80% of items are not worth the time and effort of measurement.
- The remaining 20% of cost (80% of items) is not an entire risk because estimators habitually make allowances for the low-cost items in their pricing; this is a matter for personal judgement and can be a bit 'hit-and-miss'.
- The risk attached to builders' quantities is 'manageable' within the bidding process, but the judgements made at tender adjudication may have to be made on less precise data than for conventional tendering.

It is true, of course, that some contractors turn to QS practices who offer 'bills of quantities' services to contractors and trade contractors. By providing bills of 'principal quantities', but without detailed descriptions and without measuring the smaller, less cost-significant items, this can be done at a reasonable cost.

Care needs to be taken by estimators to appreciate which items of work have not been measured, and this is why some contractors prefer to prepare the quantities themselves 'in-house'. QS software with the capacity to measure direct from drawings makes this a much easier task than traditional paper-based 'taking-off'.

4.8.2 Uses of builders' quantities

Contractors frequently use builders' quantities 'behind the scenes'. They are used to build up the contractor's price but are not normally seen by the employer. Situations where this can happen include:

- Large contracts where the formal bill of quantities contains 'composite items' that cannot be priced without drilling down into more quantitative detail. Typical examples are where an item is provided in the bill of quantities comprising a dimensioned description of a staircase but no detailed quantities are given or when a manhole or other complex structure is

itemised but not measured in detail. In order to price the items in question, detailed quantities are needed but not necessarily in accordance with a standard method of measurement.

- ‘Drawings and specification’ tenders where no quantities are supplied by the employer. Tenderers are obliged to calculate their own quantities from the drawings supplied with the tender documents, and this enables a lump sum tender figure to be determined. Once the contractor’s tender is accepted by the employer or if the tender is of interest before formal acceptance, the contractor may be asked to provide a breakdown of the lump sum. This provides a means for the employer to both scrutinise the prices and check for errors and also value work in progress and variations to the contract once work gets underway.
- Design and build/construct contracts where tenderers not only supply a design but also assume responsibility for quantifying the design to enable a tender sum to be determined. Design and build/construct contracts may be let on either a lump sum or measure and value basis, but in both cases, it is usual for the employer to request a breakdown of the tender figure for pre- and post-contract use. The request for a breakdown may be made in the tender invitations or as a formal requirement of a contract such as the JCT 2011 DB contract.

4.8.3 Preparation of builders’ quantities

Perhaps being reflective of the varied structures of the construction industry, there are several ways that builders’ quantities can be prepared:

- *Ad hoc* methods:
 - ‘Seat of the pants’ judgement or the back of a cigarette packet (for smokers!).
 - Handwritten dimensions on drawings, scraps of paper, notepads or notebooks.
 - Handwritten dimensions, perhaps on dimension or estimating paper.
- Direct entry software:
 - Spreadsheets such as Microsoft Excel or OpenOffice.
 - Direct entry into non-SMM-based measurement software from paper-based PDF drawing files and the like.
- On-screen measurement:
 - 2D on-screen measurement from PDF or CAD files.
 - 3D on-screen measurement from CAD files.
- Quantities extracted from BIM models.

For smaller projects, perhaps where the estimator is also producing the quantities, *ad hoc* methods are fine. The estimator understands exactly what has been measured and what has not and can make appropriate allowances in the pricing to cater for smaller, less cost-significant items.

On larger projects, direct entry methods would be the minimum standard, but measurement software is much quicker than spreadsheets unless the work involved is repetitive and a spreadsheet ‘template’ could be used. The beauty of measurement software, such as Buildsoft Cubit, is that the output can be ‘dumped’ into Excel spreadsheets, retaining the formatting, which can then be shared and manipulated between members of the estimating team or sent out to subcontractors once the main cells have been locked.

On-screen measurement takes a bit of getting used to but, once mastered, is a great way of producing accurate quantities quickly. Non-SMM-based software, such as Buildsoft Cubit, is probably best because SMM-based software demands too much detail in the item descriptions albeit the less cost-significant items can be overlooked for speed and simplicity.

Irrespective of the method used, however, where there is a team of estimators, some structure to the preparation of the quantities is needed. The obvious answer is to use a familiar standard method of measurement, but this may well be too complex when time is at a premium.

Risk issue

At a time when responsibility for measurement risk is being passed down the supply chain, contractors and subcontractors need to be sure that the quantities they produce follow a structured approach which is essential to avoid costly mistakes and reduce tender risk.

An experienced individual can do this in an *ad hoc* way, but when more than one person is involved, something more formal is needed. A set of 'in-house' procedures would work but takes time and effort to establish, and so, perhaps the easiest solution is to use a recognised standard method of measurement that is not too complex or time-consuming to employ.

POM(I) offers a simple method of measurement with few rules that cover a wide range of building, civil engineering and M&E work. The downside to this method of measurement is that many of the measured items are 'composite' and require further detailed measurement; additionally, the item coverage provided lacks sufficient detail to be clear and unequivocal.

Perhaps a better bet would be to use NRM1. Admittedly, it is designed for early cost estimating and cost planning, but it could equally well be used for producing good-quality, consistent builders' quantities. The big advantage with NRM1 is that the item coverage rules are extensive and clear so that everyone involved should fully understand what is included in the BQ items with the bonus that the time and effort spent to produce the quantities would be reduced.

The advantages of using a simple, yet standard, method of measurement include:

- Subcontract/work package tenders can be invited on the basis of a consistent set of quantities giving all tenderers a 'level playing field'.
- Comparison of subcontract quotes is easier, more consistent and on a 'like-for-like' basis.
- Subcontracts can be awarded with everyone knowing what is included in the rates.
- Remeasurement and the valuation of variations are based on recognised rules that are written into the contract.

4.9 Quantities risk transfer

Where contractors undertake the risk of producing the quantities, a breakdown of the contractor's price is usually required by the employer for pre-contract checking and post-contract valuation of work in progress and variations to the contract.

Risk issue

Entering into a contract or subcontract without an accepted 'list of prices' is a known shortcut to arguments and disputes.

Very few construction projects reach a conclusion without changes being made, and some agreed basis for valuing these changes must be in place to avoid problems. A contract based on a 'fair and reasonable' valuation of changes is not advisable as each party to the contract will have a different idea as to what is 'fair' and what is 'reasonable'.

A breakdown of the contract price is also advisable for the purpose of valuing work in progress. In this regard, employers will wish to avoid the risk of overpaying, and contractors and subcontractors will want to make sure that cash inflows from the project are as positive as possible.

Most standard contracts provide a means for valuing work in progress and variations and other changes. The traditional way, of course, is to use a 'formal' bill of quantities, but where the method of procurement precludes this, another form of analysis is needed. Where the employer chooses not to issue a formal pricing document – DB tenders, drawings and specification tenders,

for example – it will be the contractor's responsibility to prepare a breakdown of the contract price or list of prices. However, most contractors would be reluctant to submit their builders' quantities for this purpose because:

- Builders' quantities are a means of pricing a tender and may contain errors, omissions or 'hidden' contingencies that the contractor would prefer to keep private.
- Contractors are generally suspicious of employers' representatives and may fear that their prices may be 'picked apart' to their disadvantage.
- Builders' quantities may be handwritten and may include pricing notes that the contractor would prefer the employer not to see.
- Builders' quantities are 'raw' documents and contractors might prefer to submit a document where the money is in all the right places to ensure the best positive cash flow for the contract.

Popular methods of achieving a breakdown of contractors' tenders appear in standard contracts such as the NEC and JCT families of contracts and include:

- Activity schedules.
- Price lists.
- Contract sum analyses.

4.10 Activity schedules

An activity schedule, or unquantified price list, is a list of activities, determined by the contractor or specified in whole or in part by the employer, wherein the contractor prices lump sums for the various activities listed in order to arrive at the contract sum or target price.

The format and content of an activity schedule will depend upon the form of contract used. In the JCT 2011 SBC/Q, for instance, activity schedules (if supplied by the contractor) are used in conjunction with bills of quantities as a means of simplifying the valuation of work in progress with little prescription as to their content. In the NEC3 ECC form, activity schedules are used 'stand-alone' as a pricing document with prescriptive rules as to how work in progress is to be valued and how activity schedules are to be used in conjunction with the contractor's programme of works.

Activity schedules are invariably prepared by the contractor and are therefore not part of the tender documentation. Once priced and accepted by the employer, however, the activity schedule will be incorporated into the contract along with the other documents supplied at the tender stage such as the drawings and specification.

Activity schedules are often linked to the contractor's programme, and sometimes, there is a contractual requirement to this effect (e.g. ECC Option A). This makes sense from the perspective of ensuring that interim payments are geared to actual progress on-site.

An extract from a simple activity schedule is illustrated in Table 4.7 from which it can be seen that:

- The item descriptions are simple and do not correspond to any specific method of measurement.
- Each activity is referenced A, B, C, etc.
- Each activity is referenced to the contractor's programme.
- A column is provided for the contractor's lump sum price for each activity.

Table 4.8 shows a slightly different presentation where the activity schedule is more detailed:

- Activity descriptions correspond exactly as per the contractor's programme (see Figure 4.1).
- The start and finish dates for each activity and group of activities are shown.
- The duration of each activity is indicated.

Table 4.7 Activity schedule v.1.

Activity schedule			
Activity reference	Activity description	Programme reference	Price, £
A	Form access and set up contractor's compound and site offices	1	
B	Excavate to remove topsoil and store in temporary spoil heaps on-site	2	
C	Excavate to reduce levels and remove spoil to tips of site	3	
D	Excavate pad foundations, remove spoil from site and prepare formation for concrete	4	
E	Supply and fix steel reinforcement cages to pad foundations	5	
F	Pour ready-mixed concrete to pad foundations against earth faces	6	
etc.			

- A payment preference column is included where the contractor can indicate how payment is required:
 - % completion in accordance with progress.
 - Monthly on completion of the activity.
 - *Pro rata* to time elapsed (e.g. for design activities or preparation of the health and safety file).

Should the programme change during the course of construction, then it makes sense that the activity schedule is changed accordingly so as to correspond to the current programme.

There might be problems under ECC Option A (priced contract with activity schedule) with the activity schedule and programme as illustrated in Table 4.8 and Figure 4.1 respectively, as the programme tasks are grouped under a 'summary' heading and could be regarded as 'grouped activities'. As a consequence:

- The contractor would only be able to apply for payment when all the activities in the group are completed satisfactorily.
- Site establishment could be included in the first valuation, but earthworks, being over 1 month's duration, would have to be deferred until the second payment application.
- Pad foundations are less than 1 month in duration but could not be included in Valuation No. 2 because the concreting would not be completed until after the end of week 8 and would therefore appear in Valuation No. 3.

It can be seen, therefore, even for a simple project, that the contractor's cash flow can quickly be eroded as a result of the provisions of ECC Option A.

'Activity schedule' should not be confused with the term 'work schedule' which is generally taken to be a list of work items related to time in the form of a Gantt or bar chart or other types of programme or visual display of work related to time. However, where a work schedule has a sum of money attached to each 'bar', then this could be an activity schedule.

Risk issue

Except for fairly small projects, it is not sensible to have a 'combined' work schedule and 'activity schedule'. The benefits of each would be compromised, and there is the added danger that the programme could be unwittingly incorporated into the contract.

Legally speaking, this would not be in the employer's interests following the decision in *Yorkshire Water Authority v Sir Alfred McAlpine & Son (Northern) Ltd* (1985).

Table 4.8 Activity schedule v.2.

Activity schedule							
Line	Name	Duration	Start	Finish	Payment preferences	Price £	p
1	Pre-start procedures	4w	01/06/2015 08:00	26/06/2015 17:00			
2	Design & planning	20w	10/06/2015 08:00	28/10/2015 17:00			
3	Health and safety file	6w	29/06/2015 08:00	07/08/2015 17:00			
4	Gantry crane	19w 3d	09/06/2015 08:00	23/10/2015 17:00			
5	Procurement	12w	09/06/2015 08:00	01/09/2015 17:00			
6	Installation and testing	2w	12/10/2015 08:00	23/10/2015 17:00			
7	Site establishment	3w	29/06/2015 08:00	17/07/2015 17:00			
8	Remedial works	2w	07/07/2015 08:00	20/07/2015 17:00			
PHASE 1							
9	Bulk excavation	4w	21/07/2015 08:00	17/08/2015 17:00			
10	Piling work	7w 4d	04/08/2015 08:00	28/09/2015 17:00			
11	Access and piling mat	1w	04/08/2015 08:00	10/08/2015 17:00			
12	Piling	3w	10/08/2015 08:00	28/08/2015 17:00			
13	Test piles	4w	01/09/2015 08:00	28/09/2015 17:00			
14	Pad foundations	5w 1d	25/08/2015 08:00	30/09/2015 17:00			
15	Trim piles	2w	25/08/2015 08:00	08/09/2015 17:00			
16	Excavation	2w	04/09/2015 08:00	17/09/2015 17:00			
17	Rebar	3w	08/09/2015 08:00	28/09/2015 17:00			
18	Concrete	2w	17/09/2015 08:00	30/09/2015 17:00			
19	Structural steelwork	5w	01/10/2015 08:00	04/11/2015 17:00			
20	Ground floor slab	7w	23/10/2015 08:00	10/12/2015 17:00			
21	Sub-base	2w	23/10/2015 08:00	05/11/2015 17:00			
22	Formwork	4w	02/11/2015 08:00	27/11/2015 17:00			

Table 4.8 (Continued)

Activity schedule							
Line	Name	Duration	Start	Finish	Payment preferences	Price £	p
23	Rebar	2w	18/11/2015 08:00	01/12/2015 17:00			
24	Concrete	2w	27/11/2015 08:00	10/12/2015 17:00			
25	Envelope	7w 2d	11/12/2015 08:00	15/02/2016 17:00			
26	Brickwork	6w	11/12/2015 08:00	04/02/2016 17:00			
27	Cladding and roofing	5w	12/01/2016 08:00	15/02/2016 17:00			
28	Services	4w 4d	03/02/2016 08:00	07/03/2016 17:00			
29	Plumbing	2w	16/02/2016 08:00	29/02/2016 17:00			
30	Electrical	3w	16/02/2016 08:00	07/03/2016 17:00			
31	HVAC	3w	03/02/2016 08:00	23/02/2016 17:00			
32	Roller shutter door	1w	16/02/2016 08:00	22/02/2016 17:00			
PHASE 2							
33	Decant existing building	1w	08/03/2016 08:00	14/03/2016 17:00			
34	Asbestos removal	3w	15/03/2016 08:00	06/04/2016 17:00			
35	Internal fit out	6w	07/04/2016 08:00	19/05/2016 17:00			
PHASE 3							
36	External works	11w 1d	16/02/2016 08:00	06/05/2016 17:00			
37	Drainage	4w	16/02/2016 08:00	14/03/2016 17:00			
38	Roadworks	6w	15/03/2016 08:00	27/04/2016 17:00			
39	Landscape	3w	15/04/2016 08:00	06/05/2016 17:00			
40	Clear site	2w	09/05/2016 08:00	20/05/2016 17:00			
41	Test and commission	2w	23/05/2016 08:00	06/06/2016 17:00			
42	Demobilise site	2w	07/06/2016 08:00	20/06/2016 17:00			
					Tender	_____	
					total £	_____	

Part 1

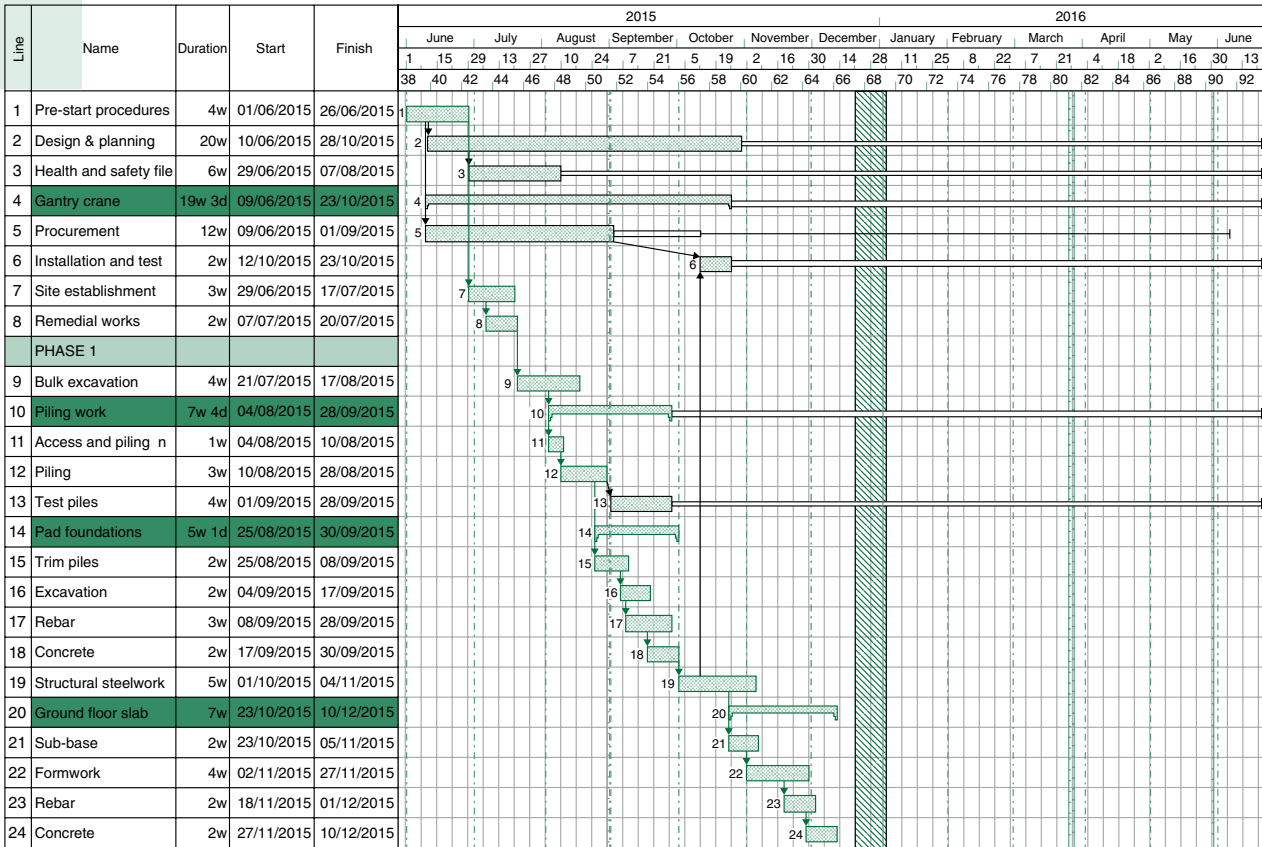


Figure 4.1 Contractor's programme.

4.10.1 Activity schedules generally

The activities appearing on an activity schedule are usually determined by the contractor, but on occasion, the employer may wish to have some input into this. This would normally be done by listing the particular activities to be included in the tender documentation. Overprescription by the employer of what should be in the activity schedule may not be wise particularly where the activity schedule is linked to the contractor's programme.

Activity schedules may equally include administrative activities as work-based construction activities. Therefore, items such as design work and preparation of the health and safety file may appear in the activity schedule alongside the likes of earthworks, drainage or the construction of a complete structure. Temporary work items such as constructing haul roads and steel sheet piling may also be listed as 'activities' as might the testing of completed work.

An activity schedule is essentially a breakdown of a lump sum tender into a series of smaller lump sums with an accompanying description of what each activity is. Activity schedules do not contain any quantities and, as such, need to be underpinned by 'base' quantities so that:

1. The estimator is able to price the work, item by item, in the usual way and can then aggregate items into the 'activities' which will appear in the activity schedule.
2. The contractor can produce a meaningful pretender programme that is based on the quantity of work to be done rather than 'guesswork'.

Just who is to be responsible for preparing the 'base' quantities is a matter for the employer to decide according to the chosen procurement strategy, and this has to be balanced with the advantages and the drawbacks of using activity schedules. Essentially, activity schedules are a means of transferring quantity risk from the employer to the contractor, but Broome (2013) suggests that some employers have found it appropriate to reduce the contractor's risk by using a variety of mechanisms whereby quantities are supplied to tenderers either by or on behalf of employers or by third parties.

4.10.2 Preparation of the 'base' quantities

The foundation to an activity schedule is the underlying or 'base' quantities which enable tenderers to both price the tender and prepare the programme that is usually linked to it. Current industry practice suggests that there are three methods of preparing the 'base' quantities:

a) Each tenderer prepares their own quantities.

This is the most obvious way to prepare the 'base' quantities and may be used for straight-forward projects and for individual 'trades' where there are relatively few items of work to measure.

For a project of any reasonable size or complexity, however, it may be costly and/or counterproductive to follow this route to quantification, especially in a competitive tendering situation. Not only is this method costly and time-consuming for tenderers, it is also wasteful of scarce industry resources when, statistically, only one contractor in five or six can prepare the 'winning' quantities in any one tender competition.

b) Tendering contractors arrange for a bill of quantities to be prepared and share the cost amongst themselves.

To some extent, this harks back to nineteenth-century contract practice where contractors tendering for lump sum contracts would each appoint their own surveyor to measure the quantities with the contractor making the most mistakes winning the tender. Mainly due to cost and the wide variation in tender prices received by employers, this system developed to the point where tenderers would jointly appoint a surveyor to prepare quantities for all of the contractors with the cost being shared.

This method is being used today, but there are dangers that such practice could contravene collusive tendering legislation.⁵

Risk issue

Contractors who jointly appoint a quantity surveyor to prepare quantities, which they each pay for and use, risk heavy fines if this is done without the knowledge or consent of the employing authority.

In such cases, it is advisable to obtain written permission in advance from the employer.

c) The employer supplies a bill of quantities when choosing to use a priced contract based on an activity schedule.

At first glance, this seems to be counterproductive as it may be thought that the employer could just as well use a bill of quantities tender arrangement and have done with it. This would, however, ignore both the benefits of using an activity schedule and the disadvantages of bills of quantities.

There appear to be three common methods in current practice:

1. Where the employer has a bill of quantities prepared in-house but the BQ is kept separate from the tender documentation. The BQ is supplied to tenderers on a 'without prejudice' basis but does not become a contract document should the tender be accepted.
2. Where the employer prepares a list of principal quantities to help tenderers with stated confidence limits \pm within which variances are at the contractor's risk. Variances of quantity outside the confidence limits would be at the employer's risk.
3. Where the employer provides the documentation necessary for a firm of quantity surveyors to prepare a bill of quantities who then sell the BQ direct to tenderers in order to recoup their costs.

Each of these methodologies has its drawbacks. Quantities prepared for or on behalf of the employer may fall foul of a claim for misrepresentation under the Misrepresentation Act 1967 should the quantities be proved to be wrong. Quantity surveying firms also risk being sued should they make mistakes that cannot be recovered under the contract.

These disadvantages may be outweighed, however, by the reduced cost to the industry of preparing several independent bills of quantities and also by the benefits of careful scrutiny of the design which emanates from the discipline of preparing detailed quantities. This scrutiny may lead to fewer errors, variations and claims as small points of detail would inevitably be unearthed during the measurement process that could be rectified before inviting tenders.

Apart from giving tenderers confidence in their own assessment of the quantities, bills of quantities supplied by the employer, or by a third party, also help to ensure consistency in the tendering process and a more balanced and closer tender competition than would otherwise be the case.

4.10.3 Advantages of activity schedules

Activity schedules avoid many of the drawbacks with bills of quantities including differences of opinion concerning provisional quantities and how 'firm' the 'firm quantities' are. The employer

is probably paying a premium for the contractor to take the ‘quantity risk’ but, conversely, is not paying quantity surveyors to prepare bills of quantities or carrying the risk that the quantities may be wrong.

Activity schedules are popular with users of the Engineering and Construction Contract, including Highways England, and have an attractive list of benefits:

- Brevity and simplicity.
- Linked to the contractor’s programme, provides a simple means of payment for work in progress directly related to actual progress.
- With payment for completed activities only, there are no arguments over what is and what is not complete.
- In the absence of unit rates, it is easier for contractors to ‘front-load’ activities to improve cash flow.
- Easy for the employer to state requirements for the inclusion of provisional sums and the like in the tender documentation or employer’s requirements.
- Employers may state what activities are to be included in the activity schedule to suit their own funding and other needs.

4.10.4 Disadvantages of activity schedules

As with all things, activity schedules have drawbacks that need to be weighed in terms of the employer’s procurement requirements and the balance of risk desired for a particular contract. With tenderers responsible for preparing them, and the underlying quantities, the use of activity schedules needs to be carefully considered. There is no doubt that the industry carries an additional burden of cost as each tenderer prepares his own submission, but this has to be balanced with the probable reduction of disputes and legal costs associated with bills of quantities and other traditional pricing documents.

The disadvantages of activity schedules include:

- Someone has to prepare the quantities upon which the activities in the activity schedule rely on – the ‘base’ quantities. This could be the contractor or the employer (see Section 4.10.2).
- Activity schedules require careful drafting, especially when linked to the contractor’s programme.
- Employers who state what activities are to be included in the activity schedule risk prejudicing the contractor’s ability to link the activity schedule to the master programme.
- Activities with a long duration (exceeding 1 month) may be problematic for payment purposes if they cannot be subdivided or apportioned, unless the contract so provides (c.f. JCT 2011 SBC/Q and NEC3 ECC).
- With no unit rates, variations are more difficult to value, and it is probably best to include a contractual provision requiring contractors to submit quotations for ordered variations.
- The employer has less idea of whether the contractor is being overpaid due to front-loading of the lump sums.
- The employer or employer’s agent may decide to ‘group’ activities for payment purposes which may disadvantage the contractor’s cash flow.
- Activities may have to be grouped in order to reduce the length and complexity of the activity schedule.
- Where the contractor decides to ‘group’ activities, payment may be on the basis of completed groups and not individual activities within the group.
- Grouped activities can lead to considerable capital lock-up in the contract which can adversely affect the contractor’s working capital requirements.
- Employer’s agents need to be ‘on the ball’ with regard to checking for defects in ‘completed’ work prior to certifying payment thereof.

4.10.5 Activity schedules under the JCT SBC/Q

The JCT 2011 SBC/Q anticipates that a priced activity schedule may be annexed to the contract should the contractor decide to supply one to the employer. Having said that, there is no reason why the employer cannot require an activity schedule from the contractor, but this would need to be prescribed in the tender documentation.

The main distinction between the use of activity schedules under the JCT contract and ECC Options A and C is that a bill of quantities forms part of the contract under the JCT contract and the activity schedule is optional, whereas under the ECC, there is no ‘formal’ bill of quantities and the submission of an activity schedule is a contractual requirement.

There is little prescription as to the form or content of activity schedules under the JCT form of contract save to say that:

- Each activity should be priced.
- The sum of the prices should equal the Contract Sum.
- The sum of prices should exclude:
 - Provisional sums.
 - PC sums and any contractor’s profit thereon.
 - The value of work for which there is an approximate quantity in the contract bills.

There is no link between the contractor’s programme and the activity schedule under the JCT contract, and the list of activities is not required to bear any relation to the operations on the programme.

Where an activity schedule is included in the contract, the JCT 2011 SBC/Q specifies that interim payment is determined by applying the proportion of work completed in an activity to the price stated for that work in the activity schedule. Again, this contrasts with the ECC approach of payment for completed activities only and raises the issue of potential disagreements as to what portion of the work has been completed and whether it has been completed properly.

The major advantage of activity schedules under the JCT contract is that there is a default priced bill of quantities to rely upon for the valuation of variations to the contract. In this sense, the JCT approach is less transparent than that of the ECC, which values compensation events (including variations) on the basis of changes in resource costs, but the upside is that contract administration is less complex under the JCT contract, especially regarding the valuation of variations.

4.10.6 Activity schedules under the ECC

The ECC has six main payment options (A–F) to choose from which determine both how the contractor will be paid under the contract and what the balance of risk will be. Activity schedules are used under Options A (priced contract) and C (target contract).

Option A provides the employer with a lump sum price and ostensibly transfers quantity risk to the contractor. Conversely, the activity schedule under Option C is used as a means of establishing target cost and the eventual pain/gain share with payment being made on the basis of actual cost (i.e. defined cost plus fee). In both cases, however, some means of establishing ‘base’ quantities is needed as activity schedules rely upon detailed measurement in order that the work can be properly priced.

The use of ECC Options A and C means that a bill of quantities is not supplied by the employer and that tenderers are required to calculate the quantities from the Works Information provided in order to calculate the contract price (Option A) or target price (Option C). Consequently, the quantity risk in the contract lies squarely with the contractor and not the employer, and adjustments to the contract price arise only when variation orders are issued or compensation events occur.

With regard to Option A activity schedules particularly, there are drawbacks which have led the industry to add a layer of complexity to their use. The plain fact of the matter is that, irrespective of how detailed the activity schedule is, quantities are needed in order to establish a price that can be broken down into priced activities as required by the contract.

The NEC3 *Guidance notes* recognise the risk, time and cost involved in preparing quantities and suggest that *employers may wish to calculate quantities before inviting tenders and then issue a copy of the quantities list to all tenderers*. The *Guidance notes* further suggest that some employers instruct tenderers to base their tenders on these quantities and agree any changes with the successful tenderer before entering into a contract.

Where this guidance is not followed, it is possible that tendering contractors may arrange for a bill of quantities to be prepared with the cost shared amongst themselves. Alternatively, the employer may supply, or arrange for a QS firm to supply, a bill of quantities when choosing the activity schedule option.

The issues associated with these arrangements are discussed in Section 4.10.2, but in any event, Broome (2013) considers that disclaimers relating to the accuracy of quantities supplied by the employer are likely to be ineffective and that employers are at risk of claims for misrepresentation when they *get the numbers wrong*.

A further downside to activity schedules under the ECC is that contractors only receive interim payment for completed activities (or groups of activities), and this has led contractors to employ strategies to protect their cash flow position, thereby encouraging the employers to do the same. Broome (2013) reports that:

- Some contractors have resorted to listing hundreds, if not thousands, of items in their activity schedules.
- This results in a programme with a huge number of operations, all of which take less than a month to complete to ensure inclusion in the monthly valuation.
- This then leads to employers imposing restrictions in the tender instructions on the number of activities that can be included in the activity schedule.
- Employers may also place limitations on the minimum value of activities in the activity schedule.

The implication is that common sense should prevail on both sides in order to sustain the principle of the ECC that all parties act *in a spirit of mutual trust and co-operation* (ECC Clause 10.1).

4.10.7 Activity schedules and the contractor's programme

Activity schedules are not necessarily linked to the contractor's programme as the provisions of the JCT 2011 SBC/Q demonstrate, but when there is no other priced document in the contract, it makes sense to synchronise the activity schedule with the programme as there are a number of benefits to be gained:

- Interim payment may be linked directly to physical progress on-site.
- Where payment is for completed activities, there is no dispute as to whether an activity is 40% complete or only 35%.
- The contractor's cash flow can be geared to the programme without resorting to inflating unit rates and front-loading preliminaries as is the case with bills of quantities.
- Post-contract administration is simplified resulting in less costs for contractors and less professional fees for employers.
- Monitoring of physical and financial progress is simplified.

When using an activity schedule in conjunction with the contractor's programme, it is important to consider the vocabulary used, especially where the Engineering and Construction Contract is concerned. Activity schedules naturally contain **activities**, but a glance at any construction

management book will reveal that the words ‘activity’ and ‘operation’ may equally be used to describe the items of work listed in the programme. Some project management software packages also refer to ‘activities’ and ‘summary activities’ (i.e. activities grouped under a heading where more/less detail can be revealed by double-clicking on the summary activity bar). This suggests that common parlance in the industry is that both words are used synonymously.

The importance of the distinction between **activities** and **operations** is made clear by referring to ECC Option A where:

- Clause 31.4 states that the *Contractor* must indicate how each **activity** on the activity schedule relates to each **operation** on the programme.
- Clause 11.2(27) states that payment for priced activities, or groups of activities, is directly linked to the completion of those activities, or groups of activities, and not to the completion of operations.

When used under the ECC contract, activity schedules usually closely mirror the operations on the contractor’s programme because of the contractual requirement to show how the activities on the activity schedule relate to the operations on the programme. This impacts on the contractor’s administrative workload because:

- Changes in the planned method of working require submission of a revised activity schedule (Clause 54.2).

Under the ECC, there is a considerable distinction to be made between ‘activity’ and ‘operation’ because payment for work done to date is on the basis of the total of the prices for:

- Each group of completed **activities**.
- Each completed **activity** which is not in a group.

The prices are the lump sums for each of the **activities** on the activity schedule, and payment is made for activities, or groups of activities, only when they are completed.

Risk issue

Payment is linked to completion of **activities** in the activity schedule and **not** completed **operations** on the contractor’s programme.

This means that ‘activities’ are not the same as ‘operations’ as far as the ECC is concerned.

Common industry practice seems to be that the contractor’s programme determines the activities on the activity schedule and not vice versa. This means that the contractor must give considerable thought to the programme at the tender stage so as to be able to produce a meaningful activity schedule as well as the quantities to back it up. Consideration must therefore to be given to:

- Choosing a sensible number of operations and grouped operations to appear on the programme.
- Ensuring that the activity schedule is not overly long.
- Making sure that the activity schedule and programme are sensibly referenced to each other even if the number of activities/operations on each is not the same (the programme may be more detailed than the activity schedule or vice versa).
- Choosing of activities/groups of activities bearing in mind that the contractor only receives payment when completion is achieved:
 - Long-duration operations/activities should be divisible into segments of 1 month or less so as to ensure regular monthly payments for work in progress.

- Operations/activities must be clearly identifiable as completed so as not to jeopardise payment and hence cash flow.
- Ensuring that subcontract operations/activities and terms of payment do not create cash flow problems for the contractor.

An issue with the ECC is that payment is for **completed** activities, or groups of activities, and thus, incomplete activities will not be included in the monthly valuation of work in progress. This is to be contrasted with the JCT contract which gears payment to the proportion of work completed in each valuation period. The JCT approach is more traditional but prone to disagreement as to the extent of ‘completeness’, whereas the ECC approach is simpler but problematic:

- Only completed activities will be included in the monthly valuation of work in progress.
- Activities started but not completed in the valuation period will leave contractors with a cash flow deficit.
- Long-term activities, including preliminaries, are not included in the valuation of work in progress until completion is reached; this could be at the end of the contract period.
- Groups of activities will only be included in the monthly valuation when all the activities in the group are complete.

In the case of long-term activities, or groups of activities, there are three options as regards the Engineering and Construction Contract:

- Subdivide the activities so that they are each capable of being completed within one month (i.e. the valuation period).
- Invite tenderers to state their ‘*stage payment requirements*’ in the tender documents (as practised by Highways England).
- Include a suitable ‘Z’ clause in the contract to permit payment for long-term activities to be included in the valuation on the basis of percentage completion.

Subdividing long-term activities will inevitably lead to a lengthy and overly complicated activity schedule which defeats the object of the exercise.

Broome (2013) identifies other problems with the ECC approach and suggests that:

- The concept of groups of activities be dropped so that activity schedules contain only ‘activities’.
- Make ‘activities’ a subset of ‘operations’ so that operations on the programme, each of which requires statements of methods and resources under ECC Clause 31.2, can be expanded into a detailed ‘list’ of activities for payment purposes.

These are sensible suggestions that not only simplify the administration of Option A contracts with activity schedules but also provide a good fit with project management software such as Asta Powerproject, Project Commander and Microsoft Project.

4.10.8 Activity schedule size and scope

Bearing in mind the wide variety, size and complexity of building and civil engineering projects conducted by the construction industry, it is difficult to generalise as to how long an activity schedule should be or what it should contain.

A bill of quantities for a typical £5 million building project for a school, leisure centre or office building could well have 200 pages or more of measured items which could amount to 1500 or more items. Based on the Pareto principle (80/20 rule), 300 or more items could be cost significant. If these items are transposed into an activity schedule format, this could result in ±15 pages of activity schedule depending upon the length of the item descriptions.

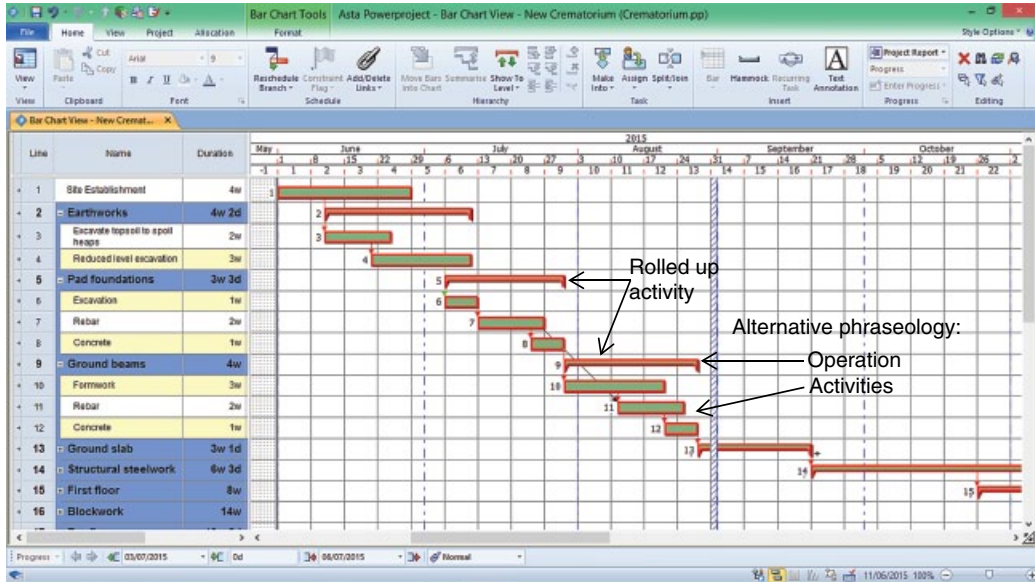


Figure 4.2 Rolled-up activities.

As far as the contractor's programme is concerned, 300 activities/operations may seem a lot but some activities/operations may be grouped under 'summary activities' which can then be scrolled up/down according to the degree of detail required.

Consideration also needs to be given to the number of subcontract packages in the contractor's programme as there could easily be 20 or more different subcontractors on such a project each conducting several different work activities/operations.

Under the Engineering and Construction Contract, a limiting factor on the number of operations on the programme, and consequently on the length of the activity schedule, is that the contractor is obliged to submit details of his working methods and resources for each operation on the programme. This would be a considerable administrative burden were the programme to contain 300 operations, but this would need to be balanced with the contractor's desire to ensure a satisfactory cash flow from the activity schedule.

Taking all these into account, Broome (2013) is most sensible in suggesting that 'operations' on the programme should be used to summarise the 'activities' contained within, as illustrated in Figure 4.2 where the ground slab, structural steelwork and first floor tasks have been summarised.

Rolled-up or summary activities could then be rolled down to reveal further detail within the summarised tasks as illustrated for the earthworks, pad foundations and ground beams tasks in Figure 4.2.

This approach would not only surmount the problem of payment for grouped activities under the ECC but would also reduce the administrative burden on contractors and help avoid the artificial dissecting of long-term activities.

4.11 Price lists

Price lists are common in all walks of life and simply consist of a list of items with an accompanying price and unit. They tend to be simple *ad hoc* documents and may be used for small-scale construction projects and work orders. An example is provided in Table 4.9.

Table 4.9 Price list.

Price list		Leave these columns blank for a lump sum contract			
		Unit	Quantity	Rate	Price
Item number	Description	Unit	Quantity	Rate	Price
A	Formwork to sides and soffits of beams	m ²	318	45.00	14 310.00
B	Formwork to square columns	m ²	144	32.00	4 608.00
C	Formwork to horizontal soffits including propping	m ²	432	75.00	32 400.00
D	Rebar as per schedule	tonne	12	1450.00	17 400.00
E	Class C30 concrete in beams	m ³	38	265.00	10 070.00
F	Class C30 concrete in square columns	m ³	10	275.00	2 750.00
G	Class C30 concrete in horizontal slabs	m ³	166	255.00	42 330.00
Total of the prices					123 868.00

A degree of ‘formality’ is given to the ‘Price List’ under NEC3 wherein they are used in the Engineering and Construction Short Contract (ECSC) and in the Engineering and Construction Short Subcontract (ECSSC).

Price lists are typically versatile within the NEC3 family:

- They may be prepared by the employer or the contractor, and this fits with Main Options A–E.
- They are intended for straightforward low-risk projects, but this does not imply any limitation on the value of the contract.
- They may be used for a lump sum contract, where the price paid is not adjusted if the quantity of work changes, by leaving the ‘quantity’, ‘unit’ and ‘rate’ columns blank.
- They may be used for measure and value contracts where the price paid is determined by the quantity of work completed multiplied by the corresponding rate.

In common with other pricing documents in the NEC family of contracts, the price list is not part of the Works Information but is an essential contract document nonetheless. The price list functions as a ‘mini-bill of quantities’ for a measure and value contract with the actual quantities of work done replacing the original quantities as appropriate. Such changes are assessed as compensation events but only to the extent of the change in quantity.

For a lump sum contract, the contractor takes on the quantity risk, and the price list will contain only lump sums that add up to the total of the prices.

There is no link between the price list and the contractor’s programme under the ECC Short Contract, and so applications for payment from the contractor follow conventional lines, that is, an assessment of work completed to date.

4.12 Contract sum analyses

In design and build contracts, it is conventional for the contractor to submit a breakdown of the contract sum in order to check prices and totals and to assist with post-contract administration.

Under the JCT 2011 DB contract, this takes the form of a Contract Sum Analysis. Along with the Employer's Requirements and the Contractor's Proposals, the Contract Sum Analysis is incorporated into the formal contract and becomes a contract document with all that this implies.

There are no similar provisions in the ICC – Design and Construct form of contract and thus the necessary checks and balances needed to administer the contract correctly would need to be incorporated into the tender documents and thence into the contract.

Risk issue

Under the JCT design and build form, there is no prescription as to the form or content of the Contract Sum Analysis. However, it might be prudent to require submission of the Contract Sum Analysis with the Contractor's Proposals and tender bid in order that the employer may be satisfied that the Contract Sum Analysis is suitably transparent before accepting the tender or entering into a formal contract.

The Contract Sum Analysis can take whatever form the contractor likes unless prescribed to the contrary in the Employer's Requirements. A bill of approximate quantities could be used or something similar to an elemental cost plan might be preferred. Unlike ECC Option A with activity schedule, there is no link between the Contract Sum Analysis and the contractor's programme in the JCT 2011 DB contract nor, indeed, is there any connection between the Contract Sum Analysis and the method of payment.

There are two methods of payment under the JCT 2011 DB contract:

- Alternative A: stage payments.
- Alternative B: periodic payments.

One or other of the alternatives should be deleted from the Contract Particulars, but if neither is selected, Alternative B is deemed to apply.

Under Alternative A, the contractor completes the list of stages, with brief descriptions, provided in the Contract Particulars along with a cumulative value for each stage or may provide this information on a separate sheet for incorporation into the contract. Applications for payment are made by the contractor according to the stage of completion reached and the relevant cumulative value stated in the list of stages.

Where Alternative B applies, interim payments are made at the dates stated in the contract, usually monthly. Applications for payment must be accompanied by such details as may be prescribed in the Employer's Requirements. Such requirements may relate to the Contract Sum Analysis but, equally, might follow an ogive curve, formula or an assessment made according to the physical progress of the works on-site relative to the contractor's programme.

4.13 Schedules of actual cost

Traditional construction contracts, such as JCT and ICE/ICC conditions, are drafted in such a way as to confer powers on the contract administrator to issue instructions to the contractor for a variety of reasons:

- Variations to the original contract.
- Postponement of work.
- Expenditure of provisional sums.
- Inspection of completed work.
- Etc.

There are several reasons for this including the need to make changes to the contract without committing a breach and the need to retain a degree of flexibility in how the project is to be completed satisfactorily.

Within the confines of this arrangement, traditional contracts also provide rules for the valuation of such eventualities, and this includes making use of the bill of quantities and the tendered rates as a means of valuing change. However, occasions arise in construction projects where work is required that does not lend itself to measurement in the normally accepted units, that is, m, m², m³, etc., examples of which include:

- The contractor is instructed to search for existing utilities that are not shown on the drawings.
- The contractor discovers an unknown sewer which has to be diverted.
- A subcontract painting and decorating firm is asked back to the site to repair finished work damaged by other trades.

In such cases, the valuation rules provide for the quantity of work undertaken to be determined by measuring the time and resources expended to do the work to which a percentage is added to cover the cost of supervision and other oncosts, overheads and profit.

Payment for work carried out on this basis might be for a complete contract or, more usually, for discrete parts of contracts where unexpected situations arise or where variations are instructed and no other means of valuation is feasible.

This method of payment is a form of cost reimbursement albeit that the costs reimbursed are not exactly the actual costs incurred by the contractor. Labour costs, for instance, are not actual wages paid but are usually determined according to a definition of prime cost to which the contractor adds a percentage. Plant is paid for on a time basis, but here again, the rates paid are not market plant hire rates but rates laid down in a standard schedule to which the contractor adds a percentage to cover his overheads and profit. Materials, on the other hand, are paid for on the basis of invoiced costs plus a percentage addition for overheads and profit.

Under NEC3 conditions, the valuation of change is approached in a completely different way to traditional contracts. Using the novel concept of **compensation events**, ECC Clause 60.1, for example, lists 19 eventualities that qualify as such, including:

- Changes to the Works Information.
- Instructions regarding objects of value or of historical or other interest discovered on-site.
- Physical conditions encountered that an experienced contractor would not have anticipated.
- An event occurs which prevents the contractor from completing the works.

It can be seen that the ambit of compensation events is very wide ranging and includes not only variations to the contract but also eventualities that would lead to a claim for additional payment or loss and expense under traditional contracts.

With this in mind, a further significant difference in approach between the NEC3 family and traditional contracts is that the valuation of compensation events does not rely on the use of bill of quantities rates as a means of valuation (unless only quantities change, and then only within certain limits stated in the ECC 'Black Book').

Part of the reasoning for this is that post-contract administration of NEC3 contracts is very much focussed on using the contractor's programme and method of working as a control tool rather than BQ rates that may have been manipulated at the tender stage for commercial advantage.

In the NEC3 suite, therefore, compensation events are valued according to changes in resources (under the full ECC) or on the basis of actual cost (short ECC), whereas the valuation of work on a 'time and cost' basis in traditional contracts is usually reserved for relatively insignificant amounts of work carried out on daywork.

In any event, express arrangements are needed in any contract for valuation on the basis of resources expended, and it is prudent to do so at the tender stage in order that competitive rates may

be obtained for such work. This has an impact on tender documentation preparation and, in particular, drafting of the bill of quantities (if one is used). There are two ways of doing this in common use:

- Daywork schedules – used under JCT and ICC conditions.
- Schedules of cost components – used with NEC3 contracts.

4.13.1 Daywork schedules

The normally accepted meaning of the term ‘daywork’ is that it is a method for measuring and valuing work on the basis of the resources expended rather than in relation to the quantities of work done. Payment for labour and plant is at an hourly rate, materials are paid for at cost and each resource attracts a percentage addition to cover overheads, profit and oncosts.

Perhaps more correctly, ‘daywork’ could be defined as a type of provisional sum (included in the bill of quantities) that allows for undefined work which will be paid for on the basis of the time spent and materials used in completing the job (Ross and Williams, 2013). In traditional forms of contract, such work would be treated as a variation to the contract, and the provisional sum would be expended by the contract administrator (if necessary) when no other means of valuing the variation would be appropriate.

Daywork is a normal, but often contentious, feature of most construction projects:

- Contractors and subcontractors are often accused of allocating their most inefficient workers to daywork tasks.
- Daywork record sheets are seen as works of pure fiction.
- Some contract administrators, contractors and, especially, subcontractors do not understand how daywork operates.
- Claims for payment on a daywork basis are made when work should actually be measured conventionally.

The truth is that daywork is a ‘necessary evil’ because occasions arise on construction projects where there is no fair way to pay for the work other than by daywork. In this regard, perhaps a better way to define ‘daywork’ is:

- A means of compensating the contractor (or subcontractor) when work is instructed by the contract administrator (or contractor) that wasn’t contemplated in the contract (or subcontract) originally and is so small or dissimilar to the measured work that there is no effective way to measure it conventionally.

Provision for daywork is traditionally made in bills of quantities by including provisional items for each class of resource. These are effectively risk allowances because such work is not planned or necessarily expected, and it might not be necessary to spend the money at all. Should the unexpected happen, however, a pot of money is built into the contract sum and is available to the contract administrator without the need to approach the employer for more budget.

The contractual mechanism for determining the daywork rates that tenderers price into the bills of quantities is provided by the **Definition of Prime Cost of Daywork for Building Work 2007** and by the **CECA Schedules of Dayworks Carried Out Incidental to Contract Work 2011** which is the equivalent schedule for civil engineering work.

A typical bill of quantities entry for daywork is illustrated in Table 4.10. This illustrates one of two options for billing daywork recognised by the industry and by the Definition of Prime Cost of Daywork for Building Work 2007 which classes this ‘traditional’ method as Option A.

Option A allows a series of provisional sums to be adjusted by tenderers according to the percentage addition required to account for any additional costs over and above the Definition of Prime Cost and for the contractor’s overheads and profit.

Table 4.10 Billing daywork v.1.

PROVISIONAL SUMS					£
Daywork					
<u>Daywork shall be valued in accordance with the Conditions of Contract and with the Definition of Prime Cost of Daywork Carried out under a Building Contract 2007 published by the BICS.</u>					
A	Allow the Provisional Sum of £5000 for the cost of Labour for work carried out on a Daywork basis.				5000.00
B	Percentage adjustment	Add/Deduct		%	
C	Allow the provisional sum of £2000 for the cost of Plant for work carried out on a Daywork basis.				2000.00
D	Percentage adjustment	Add/Deduct		%	
E	Allow the provisional sum of £3000 for the cost of Materials for work carried out on a Daywork basis.				3000.00
F	Percentage adjustment	Add/Deduct		%	
TOTAL					
NB: Rates to be inserted by the Contractor					

In Option B, provisional sums are included for plant and materials, with a place for the required percentage adjustment, whereas labour is provided for by a list of classes of labour against which tenderers quote the 'all-in' hourly rate required with no percentage adjustment, as shown in Table 4.11.

Both Options A and B are recommended good practice as they both achieve the goal of eliciting competitive daywork rates at the tender stage. This is ensured because the sums of money determined by the provisional sums and the contractor's entries will be added into the tender total which can then be compared with competing contractors.

The choice between Options A and B is a personal one, but where NRM2 is the standard method of measurement, Option B is the required choice (refer to NRM2 Paragraph 2.13.3).

Risk issue

To an extent, 'competitive' daywork rates are a fallacy.

In practice, some contractors 'load' the daywork rates and fund this by making savings in other parts of the bill of quantities.

Reducing tenders by making perceived savings on materials, subcontract quotes and errors and omissions in the BQ forms part of the contractor's 'commercial opportunity strategy' as explained by Ross and Williams (2013).

Table 4.11 Billing daywork v.2.

PROVISIONAL SUMS					£
Daywork					
<u>Daywork shall be valued in accordance with the Conditions of Contract and with the Definition of Prime Cost of Daywork Carried out under a Building Contract 2007 published by the BICS.</u>					
Allow the following Provisional Sums for the cost of Labour for work carried out on a Daywork basis:					5000.00
A	Craft operative	200 hrs			
B	Labourer	150 hrs			
C	Plant operator	50 hrs			
E	Allow the provisional sum of £2000 for the cost of Plant for work carried out on a Daywork basis.				2000.00
F	Percentage adjustment		Add/Deduct	%	
G	Allow the provisional sum of £3000 for the cost of Materials for work carried out on a Daywork basis.				3000.00
H	Percentage adjustment		Add/Deduct	%	
TOTAL					
NB: Rates to be inserted by the Contractor					

Measurement software packages do not support the concept of daywork, and thus, it is necessary to draft the Provisional Sums for Daywork pages in the BQ separately using a word processing package such as Microsoft Word or an Excel spreadsheet.

Standard methods of measurement, such as SMM7, NRM2 and CESMM4, provide sets of rules for including provisional sums for daywork in the bill of quantities, and daywork is referred to in the conditions of contract normally associated with these methods of measurement (e.g. JCT and ICE/ICC forms). The NEC3, however, does not use the term and prefers the concept of ‘defined cost’ linked to a schedule of cost components.

The various ways of calculating daywork rates and the submission of daywork sheets are beyond the scope of this book, but Ross and Williams (2013) provide a detailed explanation for the interested reader.

4.13.2 Schedule of cost components

Whilst ‘daywork’ has been used as a means of valuing variations in both the building and civil engineering sectors of the UK construction industry for many years, the approach taken under the NEC3 suite of contracts is conceptually quite different.

Firstly, the NEC3 approach has a broader ambit than ‘daywork’ which is limited to the valuation of variations when all else fails. The NEC3 suite of contracts, on the other hand, provides a measure of ‘change’, rather than focussing on the narrower theme of variations, and this is used for:

- Assessing the cost of changes to Works Information (i.e. variations).
- Assessing the cost of other compensation events (i.e. claims or loss and expense in non-NEC-speak).
- Assessing the value of work carried out under cost reimbursement contracts.

The driving force behind the NEC3 concept is the reimbursement of both the time and cost effects of contractual change through its **compensation event** procedure. It is through this mechanism that the contractor is compensated for changes in certain defined costs, to which a fee is added. The ‘defined costs’ are determined by schedules of cost components, of which there are two:

1. Schedule of Cost Components (SCC) – that is, the full schedule.
2. Shorter Schedule of Cost Components (SSCC) – that is, the shorter, less complex version.

Whilst this system of compensation is meant to be fairer and more rigorous and is based on the contractor’s programme and method of working, Broome (2013) recounts that there have been problems. The first and second editions of the ECC, for example, failed to fully recognise how contractors incur additional costs in particular circumstances or how this was reflected in the contractor’s compensation. The NEC3 is regarded as an improvement albeit that some anomalies remain.

In order to understand how the NEC3 system of compensation works, it is first necessary to appreciate that:

- ECC Options A and B are for traditional lump sum and measure and value contracts, respectively.
- ECC Options C and D are for target contracts where the contractor is paid on the basis of actual cost plus a fee but within the confines of a target ‘pain/gain’ arrangement.
- ECC Option E is for pure cost reimbursement contracts.
- Option F is for management contracts where neither of the schedules of cost components applies.
- The ECC Short Contract is a simplified contract for traditional lump sum and measure and value contracts where neither of the schedules of cost components applies.

In all cases, the concept of defined cost plus fee is used but the basis upon which it is used differs according to the contract option used. The concept of defined cost plus fee is also used under the ECC Short Contract but not in conjunction with either of the schedules of cost components. See Chapter 12 for more on this topic.

Notes

1. Wikipedia, 1 December 2012, http://en.wikipedia.org/wiki/Pareto_principle (accessed 2 April 2015).
2. Quote from Donald Rumsfeld, Former US Secretary of State for Defense, February 2002, <http://www.youtube.com/watch?v=GiPe1OiKQuk> (accessed 2 April 2015).
 - Known-unknowns = things we know we don’t know.
 - Unknown-unknowns = things we don’t know we don’t know.
3. Collins English Dictionary.
4. Paraphrased from Collins English Dictionary.
5. UK Competition Act 1998 and The Treaty of Rome.

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