DECOMMISSIONING COST ESTIMATING THE PRICE APPROACH

Roy Manning – UKAEA
Jeremy Gilmour – GLEEDS

ABSTRACT

Over the past 9 years UKAEA has developed a formalised approach to decommissioning cost estimating. The estimating methodology and computer-based application are known collectively as the PRICE system. At the heart of the system is a database (the knowledge base) which holds resource demand data on a comprehensive range of decommissioning activities. This data is used in conjunction with project specific information (the quantities of specific components) to produce decommissioning cost estimates.

PRICE is a dynamic cost-estimating tool, which can satisfy both strategic planning and project management needs. With a relatively limited analysis a basic PRICE estimate can be produced and used for the purposes of strategic planning. This same estimate can be enhanced and improved, primarily by the improvement of detail, to support sanction expenditure proposals, and also as a tender assessment and project management tool.

The PRICE system can be applied to both small and large projects and because of its hierarchical approach can be used to identify costs in key 'Areas' and also those associated with identified 'Stages' throughout a project lifetime. At the lowest level in the hierarchy are the 'components' and it is at this level that costs are attributed. The system database currently makes available 33 standard components, which may be selected by the user. For each component it is possible to select up to 15 resource based 'norm' values which are subsequently used to generate cost figures. The magnitude of the 'norm' values varies with radiological condition and task complexity.

UKAEA have been using PRICE to improve the quality of the decommissioning cost estimates on all of its nuclear licensed sites and the system has also been used to derive the decommissioning costs for the JET fusion experiment at Culham in Oxfordshire. More recently the system has been adopted by external organisations including AECL in Canada and the Danish, Riso National Laboratory. The system is currently being benchmarked by BNFL in the UK and discussions are ongoing with the UK Atomic Weapons Establishment at Aldermaston for trial usage on their decommissioning programme.

The paper will: describe the principles of the PRICE estimating system; report on the experiences of applying the system to a wide range of projects from contaminated car parks to nuclear reactors; provide information on the performance of the system in relation to historic estimates, tender bids, and outturn costs.

BACKGROUND

The United Kingdom Atomic Energy Authority (UKAEA) was formed in 1954 and pioneered the development of nuclear energy in the UK.

Today it is responsible for managing the decommissioning of the nuclear reactors and other radioactive facilities used for the nuclear research and development programme in a safe and environmentally sensitive manner.

Its mission is to restore the environment of its sites in a way which is:

- safe and secure
- environmentally responsible
- value for money
- publicly acceptable

It is also responsible for the UK's input to the European fusion research programme and for maximising the income from the land and buildings at its sites.

The programme for decommissioning and site restoration is a significant capital project which requires sanction from government bodies. The effectiveness of the project management of these activities is therefore under close scrutiny and the accuracy of UKAEA's forward cost estimating is of particular importance.

Over the past 9 years UKAEA has developed a formalised approach to decommissioning cost estimating. The estimating methodology and computer-based application are known collectively as the PRICE system. At the heart of the system is a database (the 'knowledgebase') which holds resource demand data on a comprehensive range of decommissioning activities. This data is used in conjunction with project specific information (the quantities of specific components) to produce decommissioning cost estimates.

PRICE is a dynamic cost-estimating tool, which can satisfy both strategic planning and project management needs. With a relatively limited analysis a basic PRICE estimate can be produced and used for the purposes of strategic planning. This same estimate can be enhanced and improved, primarily by the improvement of detail, to support sanction expenditure proposals, and also as a tender assessment and project management tool.

In order to widen its utilisation and help accelerate the development of the PRICE system a collaborative agreement has been set up between UKAEA and its cost and project management consultants, Gleeds. This agreement provides for the usage of the PRICE system on a number of UKAEA sites and facilities and also envisages the promotion of the PRICE system for wider industry acceptance. This will provide not only for the further establishment of the system within the decommissioning sector, but will also make available valuable data and benchmarking opportunities against other organisations' estimating systems.

This paper describes the PRICE estimating methodology and provides information on its performance, usage and plans for future development.

THE 'PRICE' ESTIMATING PROCESS

The "Level" Approach

The quality or level of confidence that can be expected from PRICE estimates is a function of:

- the quantity and quality of the project specific data input into the system; and
- the accuracy of the PRICE knowledge base.

The latter comprises data from several sources throughout the nuclear and non-nuclear industry. Administrative procedures are in place to ensure the continuous improvement of the knowledge base using information collected from ongoing decommissioning projects. The processes involved in improving the knowledge base are controlled and subject to audit.

Estimates are produced at various stages in the lifecycle of a decommissioning project and these are related to the "Level" approach adopted for their study, planning and implementation. There are four Levels, defined as follows:

- **Level 1** Project Definition and Preliminary Planning
- **Level 2** Project Initiation and Planning
- **Level 3** Prepare and Approve Business Case
- **Level 4** Project Implementation

The detail and complexity of the estimates increases from one level to the next. PRICE estimates can be considered to fall into three broad categories, which are described below.

Preliminary PRICE Cost Estimate

This is the simplest form of PRICE estimate and should be used when a basic level of cost estimating is required i.e. in support of Level 1 studies. At this level it is acceptable to: group together similar activities; identify key cost drivers; and apply broad approximation during the measurement process. Estimates at this level should consist of the smallest number of cost items commensurate with the magnitude of the project. In practice it has been found that typically as little as 20 cost items are appropriate at this level. Preliminary PRICE estimates can be expected to have a high level of uncertainty, which might be as high as ±50%.

Intermediate PRICE Cost Estimate

The intermediate form of estimate should be produced as part of a Level 2 Study exercise. At this level a more rigorous examination of the facility will need to be undertaken involving more accurate measurement. Estimates at this level typically consist of up to 5 times the number of cost items employed for Preliminary estimates. The uncertainty in these estimates will be reduced to approximately ±30% as a consequence of the more detailed attention to the estimation and the improved information available.

Detailed PRICE Cost Estimate

This level of estimate should be produced to support proposals seeking approval from funding organisations. The estimate must be based upon a well defined scope of work and facility information should be founded on a comprehensive survey and data collection exercise. Estimates at this level represent a refinement of the Intermediate estimate and it may be necessary to add additional or revise existing cost items or components. It is expected that the uncertainty associated with estimates at this level would be further reduced to approximately ±15-20%.

Consideration of Risk

It should be noted that the PRICE estimation system does not, in itself, give formal consideration to the impacts of risk.

The identification of Risk and some estimation of risk allowances are, however, required at Levels 1 and 2. For some estimates at Level 2 and for all estimates at Levels 3 and 4, risk allowances must be quantified in order to produce cost predictions at, for instance, the 50 and 90 percentile confidence levels. This will often comprise a formal qualitative and quantitative risk assessment exercise and may entail the use of external software packages such as @Risk or Predict!

The Estimating Process

The four principal steps in the production of a PRICE estimate are described below:

Step – 1 Quality First

PRICE estimates must be produced in accordance with a Quality Plan. The Quality Plan has been designed to ensure that PRICE estimates:

- are prepared by suitably qualified and experienced personnel;
- hold good provenance;
- are consistent;
- are produced in a rigorous well managed way;
- have an audit trail to show that the estimating process adopts best practice and includes appropriate supervisory, checking, and approval processes.

Individuals charged with producing PRICE estimates must be suitably qualified and experienced in the PRICE estimating methodology and in the use of the bespoke Microsoft® Access 97 database application. This is achieved by providing PRICE users with specific training in the use of the system. Training records are held by the PRICE Programme Manager. A precursor requirement is a broad understanding of nuclear decommissioning, radioactive waste management and general engineering practice.

Step – 2 Estimate Scope and Assumptions

The UKAEA Responsible Manager (RM) must make clear to the PRICE estimator the purpose of the estimate and hence the level of detail to be adopted. Also, the RM must clearly describe the scope of the estimate in terms of the end point conditions and make the estimator aware of any project, site or corporate assumptions, which need to be made as part of the estimating process.

Step – 3 Information Gathering

Before starting the estimate, the estimator must, in consultation with the RM or his representatives, identify the main sources of information that the estimator may have access to and use during the estimating process. These typically include:

- dedicated documents e.g. Level 1 Study or Decommissioning Plan;
- drawings of the facility and plant;

- Safety Cases, HP surveys and Incident Reports etc.;
- interviews with current or former employees;
- a Preliminary Visit.

This portfolio of material should be catalogued and presented to the RM as evidence that sufficient information has been collected or is available for the development of the PRICE estimate to commence. The production of the PRICE estimate should only commence when this step has been completed and verified by the RM.

Step – 4 Estimate Production

Principles

The PRICE system caters for all decommissioning activities including waste management. In essence the estimate is established through the selection of items from a coded library. Each standard library item is further defined by the application of project specific factors, such as task complexity and radiological condition. The combination of the library item and the project specific data permits the retrieval of a specific 'norm' value from the PRICE knowledge base. This 'norm' value represents the number of man-hours per measured unit of work that has been established for this particular item of work. When multiplied by the relevant man-hour rate and the measured quantity this will deliver the estimated cost of the activity.

The heart of the system is the 'norm' data and the key to its accuracy therefore lies with the collection and maintenance of these 'norm' values within the knowledge base. 'Norms' are established through the recording of decommissioning operations on site. Where available, similar operations are monitored on a number of ongoing projects and the resulting data compared to establish trends. The data is then 'conditioned' by the use of established statistical methods and where, for instance, a particular measured value is observed to be 'out of range' the particular drivers for this anomaly are investigated at project level. Additionally, there is a process of continual refreshment of aged information within the knowledge base to ensure that changing 'norms' associated with learning curve benefits and technological advancement are reflected.

'Norm' values for waste management operations are derived from observed internal waste conditioning, packaging and management activities and additionally make allowance for ultimate repository costs utilising cost information provided by the relevant national waste management organisations.

Structure

The system can be applied to both small and large projects and because of the hierarchical approach adopted can be used to identify costs in key ‘Areas’ and also those associated with identified ‘Stages’ throughout a project lifetime. An example of the hierarchical structure used by the system is shown **Fig. 1**. It is envisaged that this structure will be set up on a project to closely mimic the established Work Breakdown Structure and thereby provide levels of information which are consistent with other Project Management Systems.

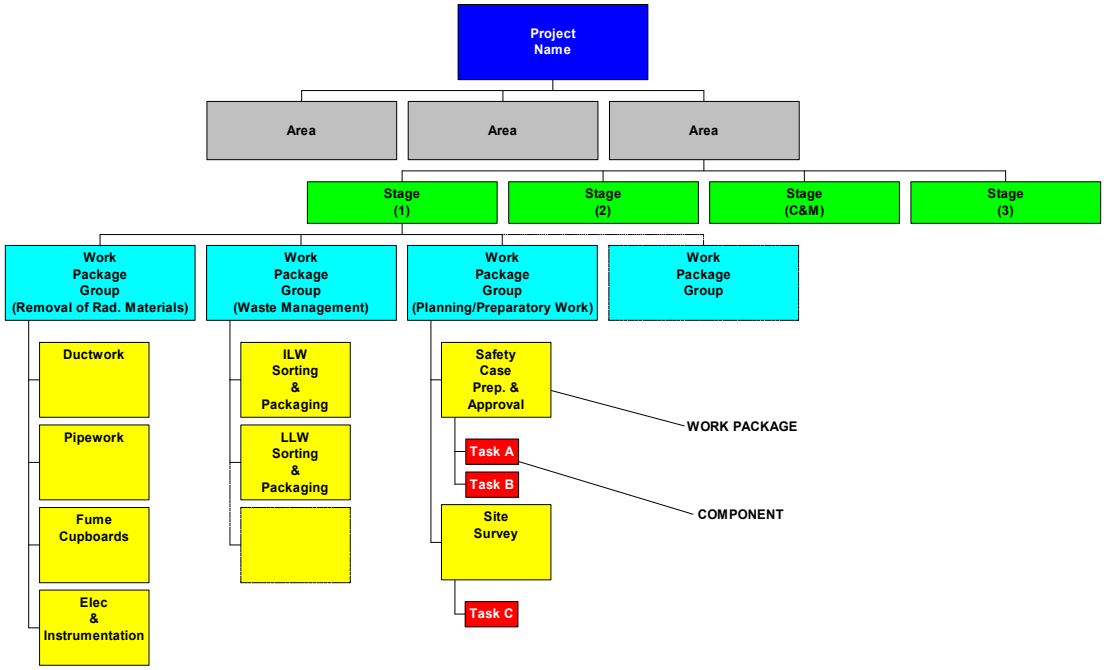


Fig. 1. PRICE Work Breakdown Structure

At the lowest level in the hierarchy are the 'components' and it is at this level that costs are attributed. The system database currently makes available 33 standard components, which may be selected by the user.

Having selected a component it is necessary to apply two factors that impact on cost: these are 'Task Type' and 'Complexity'. There is a choice of three task types (M – minimum protection, C – complex contact handleable and R – remote) for most components, which indicate the level of radiological protection that will be required when undertaking the task. These are illustrated below.

Fig. 2 PRICE Task Types

For all components there are five levels of complexity to chose from and this is generally a function of the physical size of the item being dealt with.

Components may also be described as 'User Defined' items. In this case the system knowledge base is not used and the estimator is able to input a lump sum allowance for that component.

Facility Data Collection, Assimilation and Input

The information collected during Step 3 forms the basis for estimate development and must be assimilated in an appropriate form and input into the PRICE database.

Reporting

The PRICE estimates are presented in the form of a report. The reports have the following structure, but may additionally include any other relevant project specific items.

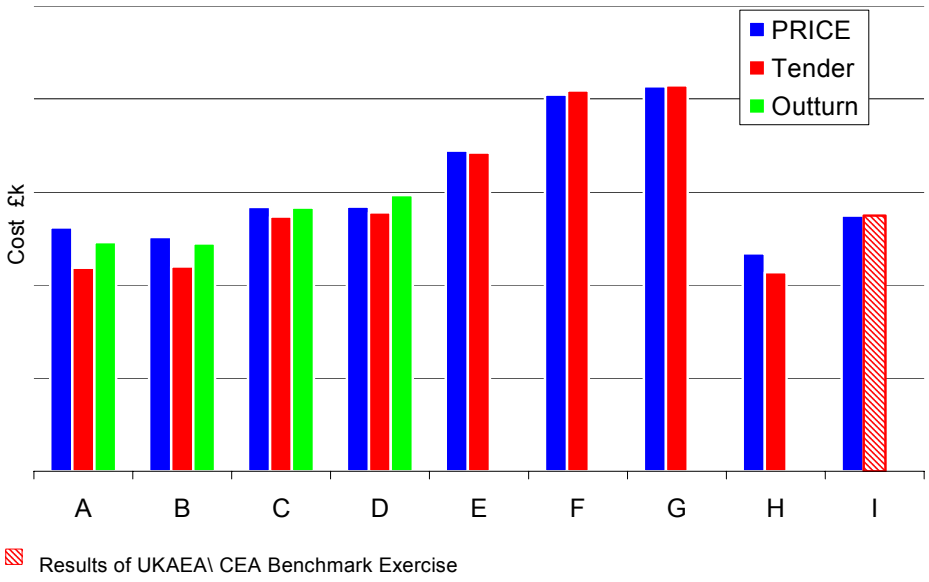
Table I. Report Structure which PRICE Estimates are Presented

Introduction	***Appendices:***
Basic Principles	***PRICE - Summary Report***
Decommissioning Sequence	***PRICE - Detail Report***
Summary of Results	***PRICE - Additional Information Report***
Discussion	***PRICE - Quality Plan***
Conclusions	
References	

The level of detail contained within the final report will vary depending on the status of the PRICE estimate i.e. it will be less detailed for a Preliminary PRICE estimate.

PERFORMANCE

The performance of PRICE estimates is analysed at two levels. At the highest level estimates are compared to winning tender prices and final outturn costs. Examples of these comparisons are shown in Figure 3.



Facility	Description
A	Beryllium handling facility (Harwell)
B	LLW Incinerator (Harwell)
C	Contaminated hard-standing (Harwell)
D	Alpha Materials Laboratory (Winfrith)
E	Prototype reactor facility (Winfrith)
F	Post Irradiated Fuel Examination Facility (Winfrith)
G	Reactor sludge tanks (Winfrith)
H	Active Laundry (Harwell)
I	Pu Hot Cells (CEA Facility - Fontenay-Aux-Roses - France)

Fig. 3. Examples of PRICE Performance

We are of course striving to improve the accuracy and confidence in the estimating process and comparison with final outturn costs is the final arbiter. In making this comparison however, it is essential that fair comparisons are made and close attention must be paid to detail and in particular work scope. In decommissioning projects the anticipated scope of work can evolve significantly as work progresses and this must be taken into account.

At a much more detailed level PRICE estimates are measured against other PRICE estimates and in particular against a set of metrics. These metrics provide a 'health check' against which the estimate can be assessed,and include:

1. Component/Value Profile
2. Task Type Allocation (value and percentage)
3. Work Package Group Usage

4. Decommissioning Stage Breakdown
5. Knowledge base vs User Defined Cost Usage

At any stage in the development of an estimate a PRICE Analysis can be automatically generated to give instant feedback to the estimator on the above metrics. As the overall portfolio of PRICE estimates increases our understanding of the values and ranges of the metrics is improving.

USAGE

UKAEA have been using PRICE to improve the quality of the decommissioning cost estimates on all of its nuclear licensed sites and the system has also been used to derive the decommissioning costs for the JET fusion experiment at Culham in Oxfordshire.

The array of projects for which the system has been used by UKAEA ranges from the removal of contaminated car parks and active laboratories and drains at Harwell in Oxfordshire, through to the full decommissioning of the Steam Generating reactor at Winfrith in Dorset and the Fast Breeder reactors at Dounreay.

At present PRICE has been used by UKAEA on more than 45 facilities for decommissioning works totalling 275 million pounds sterling (US$ 400M*)*.

More recently the system has been adopted by external organisations including AECL in Canada and the Danish, Riso National Laboratory. The system is currently being benchmarked by BNFL in the UK and discussions are ongoing with the UK Atomic Weapons Establishment at Aldermaston for trial usage on their decommissioning programme.

It is envisaged that through the collaborative agreement with Gleeds the system will be able to utilised for a widening array of project types and Client organisations.

The experience gained and data derived from these exercises is invaluable in the continuing development process for the system. Information is fed back into the PRICE knowledge base and will serve to improve its accuracy and flexibility for differing applications.

Ultimately it is envisaged that the feedback process will deliver a knowledge base which is sufficiently comprehensive to make the use of non-standard user-defined items a rarity.

THE FUTURE

The current system utilises a detailed library of activities and 'norms' to build up a decommissioning estimate from first principles. Even at the 'Preliminary Estimate' stage this process demands a high level of knowledge and a significant inventory of information regarding the facility to be decommissioned.

In order to provide a system which can be used at the very earliest stage of decommissioning planning it is planned to introduce a further module to 'PRICE'. Within this module the knowledge base will consist of high level Parametric 'norms', providing whole-facility decommissioning costs based on empirically derived costs per facility, per unit floor area, or per unit of volume as appropriate.

It is envisaged that this will permit the PRICE estimating process to be adopted from the outset of decommissioning planning to provide global feasibility information. Theconsistency of use of the system throughout the process will provide benefit in terms of standardisation of reporting and data gathering.

Furthermore, completed detailed estimates will be analysed to supply data back into the parametric estimating process, thus creating an 'improvement spiral' for the knowledge base.