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# Asset Management Summary



Dr. Tony Healy

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P.O. Box 766, Everton Park, Brisbane, Qld. Australia 4053

Ph: +61 7 3855 8964 Fax: +61 7 3855 8964

Web: [www.jahcon.com.au](http://www.jahcon.com.au)

Email: [jahcon@bigpond.com](mailto:jahcon@bigpond.com)

[Tony.healy@jahcon.com.au](mailto:Tony.healy@jahcon.com.au)

ABN 16 107639565

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## Introduction

'Asset Management' is an evolving philosophy which has become one of the major business tools available to users of capital equipment. These tools help manage the increasing pressure from legislation, ensure safety and environmental targets are met and optimise asset performance. The advantage of Asset Management over other approaches is that it recognises the asset as part of a larger system and treats the interaction between assets and systems as important considerations. In addition, decisions taken almost daily are cumulative in effect and the overall performance of the asset throughout its life is influenced by this 'decision continuum'. This simply means that a decision regarding an asset taken today is influenced by the assets history and will influence the assets future.

Using this philosophy the asset is managed over its life as part of a set of complex interactions rather than simply as a discreet item at a point in time. The operating context within which each asset and/or system operates includes business, safety, environmental and technical considerations that impact directly on asset performance and cost effectiveness and heavily influence the decision process over the life of the asset.

The Life Cycle of an asset presents many opportunities to optimise its performance while at the same time minimizing the risk/s associated with that asset - including the cost of ownership. The optimum operational and maintenance condition for the asset is achieved when the 'Maximum Sustainable Capacity' is reached and sustained at the lowest practicable cost. The sooner this desirable state is reached, during or after commissioning and the longer it is maintained, the lower the whole of life cost of the asset. In addition, this desirable state is also likely to result in fewer safety related incidents and lower environmental impact over the life of the asset.

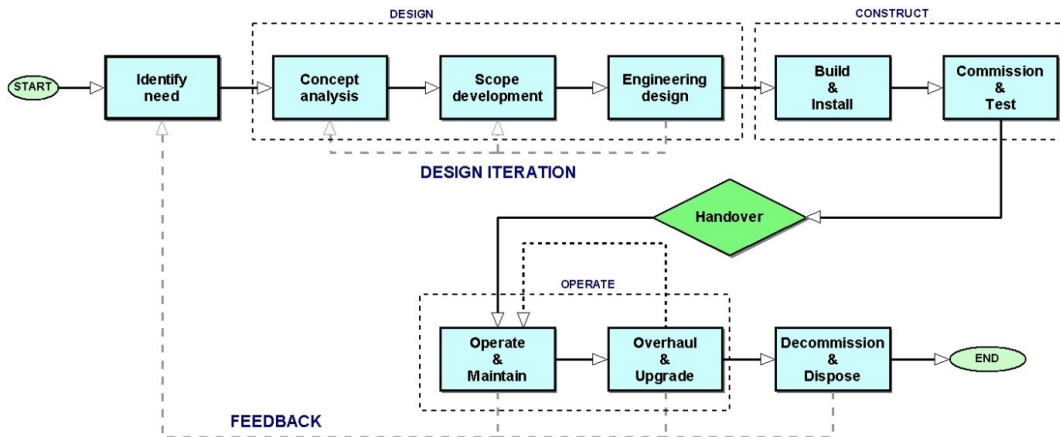
The general trend of increasing competition in the marketplace for most products and services requires that all assets forming part of the production cycle are selected and managed to optimise the manufacturing or process system as a whole. Asset Management methodologies help to achieve these aims. The primary aims of Asset Management are to achieve maximum sustainable performance from the available assets while minimising risks and costs. JAHCon has the skills and experience to assist organisations find the optimum balance between these sometimes competing aims. JAHCon will work closely with in-house personnel to identify ways to minimize operating and maintenance costs and minimise safety and environmental risks while achieving business targets in a sustained way.

Modern manufacturing and process plants operate best when the optimum balance is achieved between asset reliability and process reliability. Asset reliability is fairly easy to appreciate in that it relates directly to how well the installed equipment meets its design targets. In practice this is often measured in terms of Reliability and Availability. Process reliability on the other hand can be difficult to measure except in coarse financial terms and careful study is required to identify opportunities for improvement. The link between asset and process reliabilities adds a complex interaction that requires understanding and effective management in a modern plant. Only when both asset

reliability and process reliability are matched and optimised does the plant operate sustainably at peak performance.

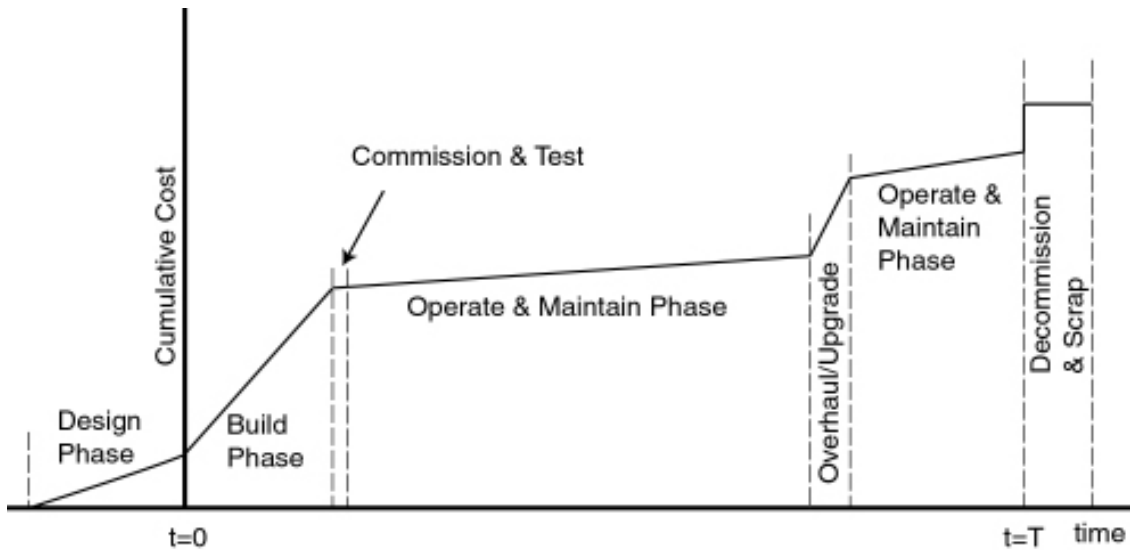
### Start

This marks the starting boundary of the Asset Management cycle and hence is important in understanding what 'triggers' the process as well as what is outside the boundaries of the process.



### End

This marks the end of the Asset Management cycle and helps to identify when all stages of the process are completed.



## Needs Analysis

The ability to recognise the need for new or additional assets is a basic requirement of any organisation as it operates within the normal constraints of its business environment. Failure to recognise the need to upgrade or replace assets at the appropriate time can place the organisation at a significant commercial disadvantage and over time can lead to failure of the business. Reluctance to replace aging assets at the right time can lead to the organisation continuing to operate obsolete assets that inflate operating costs, compromise product quality and restrict output. Control of the rebuild/renew decision process is crucial especially when any rebuild has a significant financial cost with respect to the new cost of a similar or improved asset.

The need for a new or additional asset can arise from one or more of the following reasons.

- Existing assets are at the end of their economic life and require replacing.
- Existing assets are at the end of their 'technological life' and need to be replaced for the organisation to remain competitive.
- Existing assets do not have sufficient capacity to meet current needs and need to be replaced with an asset having greater capacity.
- Existing assets do not have sufficient capacity and need to be supplemented with additional, similar assets to meet the increased demand.
- Existing assets cannot continue to be operated due to unacceptable safety or environmental problems associated with the asset.

Most modern organisations have developed procedures to identify the need for new or supplementary assets and manage the assessment of these needs.

## Safety or environmental obsolescence

A variation on the economic and/or technological end of life replacement is encountered when an asset needs to be replaced or upgraded for reasons other than economic or technical. An increasing influence on asset retirement decisions in modern industry is seen when it becomes impossible to achieve mandated safety or environmental targets using existing assets.

Before a point is reached where the asset cannot meet these targets in an acceptable fashion, it is likely that the asset will be operating for some time at an increased cost that eventually reached unacceptable or un-sustainable levels and the decision is taken to upgrade or replace the asset. The current debate on replacing or upgrading existing power stations to reduce emissions is one example of functioning assets being made redundant or obsolete by environmental policy.

## Concept Analysis

When the need for a new or upgraded asset is recognised, it is necessary to map out a detailed description of the operational requirements of the proposed new or upgraded asset or plant. This is often the root cause of problems experienced later with many projects as failure to provide clear guidelines leave different groups with competing or conflicting aims and objectives.

The concept analysis phase explores how the asset will be utilised by operations and what features are 'must-have' and which are 'nice-to-have'. Failure to consider the true and complete operational requirements can lead to a poor choice of asset or a sub-optimal combination of features. Failure to get agreement on the operating requirements at the outset can lead to changes being required during the project leading to escalating costs.

Ultimately, failure to get agreement on the operating requirements at the outset can lead to inappropriate assets being bought for the application. If appropriate assets are not available to meet the operational scope of the project it may be necessary to have an asset custom built in whole or in part to meet the organisations needs. It is very important to ensure that any customising is truly justified as any customising will almost inevitably lead to higher acquisition costs and most likely to higher through life costs. It is often wiser to reduce the operating scope to something that can be met by a standard asset whenever possible rather than rely on a customised asset that may be difficult to support over the life of the plant, especially after the warranty period expires.

## Scope Development

Having established the need for a new or upgraded asset and identifying the basic operating concept to be used, it is necessary to convert the operating concept into practical assets and systems. These must be able to meet the operating requirements at the lowest overall cost. Failure to properly determine the real needs of the organisation can lead to poor asset selection and subsequent failure of the asset to meet the business needs when in service. The scope development phase considers how to meet the operating scope and whether suitable equipment, systems and software are available to meet these requirements. The process usually begins by breaking down the operating scope into manageable sections and identifying established engineering solutions where available.

Traditionally, the operations group determines the operational requirements and the engineering (or projects) department decide how to meet these requirements. The engineering department selects, sources, builds and commissions the project according to the operating scope provided by operations and the engineering design prepared by engineering and accepted by operations. In recent years, the need to optimise the engineering designs available from suppliers has become increasingly important as the whole of life cost becomes a major Asset Management consideration. Before appropriate assets can be selected to meet the operations scope, it is important to have a good understanding of how operations and maintenance practices can affect the overall performance of the asset before specific asset types are considered for the application. Inherent in all asset designs are particular constraints and limitations that affect the overall performance of the asset and stay with it throughout its operating life. These constraints or limitations can relate to an asset type or class or to specific brands or models of a particular asset type. The manner in which individual manufacturers implement their design for a particular asset type (e.g. pumps from different manufacturers can have different design features) can significantly influence the operational behaviour of the asset and also the ease and cost of performing routine and repair maintenance.

It is at the scope development phase where choices are made as to the asset type to be used to meet the operations scope and therefore these characteristics are 'frozen' into the design at this stage. Any need for design changes at a later stage will inevitably be more expensive than if optimum selections were made at this stage.

Only when maintenance and operations practices reach world's best practice (wbp) will it be possible to reach and sustain the inherent capacity and Reliability of the plant. It should be understood that this is a difficult goal to achieve on a long-term basis especially if the asset is marginal in design or specification for the application and the resulting 'temperamental' nature of the asset can make it very difficult to keep it at this performance level. Specific asset types, as well as specific assets, will have operating and maintenance requirements that have to be met through its operating life and both operations and maintenance must perform their tasks and duties at the highest level of proficiency if the maximum performance of the asset is to be realised at the lowest cost.

## Engineering Design

Having finalised the Concept Analysis and Scope Development phases, the next stage is to carry out a detailed engineering design for the proposed plant. The Engineering Design phase is the point at which specific equipment makes and models are selected, detailed drawings prepared for installation purposes and purchase orders raised to buy the necessary equipment.

Many significant decisions made during this stage include the optimum brand and model for a specific application, the layout or orientation of different equipment and space for access to individual equipment for operations and maintenance. It is at this stage that the final design takes shape and design decisions are 'locked in'. After this stage, it becomes extremely difficult to make changes to the design without significant additional cost being incurred.

## Equipment make and model

Equipment brands and models are often decided by adhering to the organisations purchasing policy, which may stipulate which brands are acceptable and even the model to be used. This is an important consideration as the established population of a specific brand or model of equipment on site helps to ensure manufacturers support as well as optimise spare parts holdings by sharing the cost of spares and equipment across a number of similar equipment.

Project teams sometimes purchase different brands and sizes of equipment to that already on site either because they are familiar with particular makes or because the alternatives have a lower upfront cost and this helps keep the project budget under control. This can be a shortsighted policy as the new, unfamiliar equipment brings with it additional costs for training and spares, which can outweigh the savings made on the purchase price.

A counter argument is the need to keep up-to-date technology on site to ensure support from manufacturers and to take advantage of any technological improvements that may have been made since existing models were installed.

## Plant layout issues

The layout or spatial organisation of the different pieces of equipment that make up the new plant is an important consideration as two competing aims are at play. On the one hand, it is necessary to minimise travelling time for operations staff as they carry out their normal duties and to reduce the cost of land taken up by the plant. This is especially important in older plants as the site becomes congested and additional land may not be available to use or purchase. On the other hand, sufficient space must be provided between individual machines to allow safe and efficient access for operators and maintenance staff carrying out their normal duties.

Operations staff usually have a lower space requirement than maintenance staff as access to equipment will, in most cases be on foot and therefore a normal walkways will meet their needs for access.

Maintenance staff often require sufficient access to be able to use small cranes and scaffolding etc. around individual equipment and this can increase the space required around individual machines. Only by careful analysis of the operations and maintenance requirements of each machine can the access needs be identified and optimised.

## Build and Install

Once the final engineering design has been agreed, the approved assets are purchased and installation commences according to the engineering plan. From this point onwards there should be no need to make design changes if the planning has been effective and all stake holders have had appropriate input to the decision process. Any requests for changes during the build and install phase should be subject to rigorous examination and only if it can be clearly demonstrated that it is to the organisations advantage, or that the change is unavoidable, should it be undertaken. It is during the build and install phase that any shortcomings in the project planning will become obvious and inevitably lead to cost and time overrun. Changes at this stage (variations) are a common problem in some organisations and need well designed systems and discipline in implementing these systems if costs and time lines are to remain under control.

Valid requests for changes during the build and install phase are an indication of poor or incomplete planning (not always avoidable) and should be documented for post project review and analysis. Changes made during the implementation of the project are inevitably expensive as they are by definition, alterations to what should have been a carefully considered plan and therefore, sub-optimal. The need to manage the project build and install phase is paramount if the project is to come in on time and within budget.

## Commission and Test

Once the plant has been built and installed according to the project plan, it is necessary to commission it. Commissioning controls the transition from the construct phase to the operational phase. Commissioning includes performing agreed tests to validate plant performance and ensure it meets the design performance metrics.

Failure to properly commission new or updated plant can greatly increase the time from start-up to maximum sustainable capacity and lead to considerable operating and maintenance costs as personnel try to get the plant to run correctly. It is relatively common to find that the time estimated to bring the plant fully up to maximum sustainable capacity after installation and commissioning is inadequate and sometimes, significantly so. This sometimes results from an attempt to put the best 'gloss' on the project at the proposal stage but it can also be due to a poor understanding of the difficulties in getting complex assets up to full production. This lack of understanding can also manifest itself in other areas of the project such as inadequate cost and labour estimates.

There is often a tendency for project groups to hand over a plant too early and before the plant is operating correctly as the project is coming to a close and desire to finish on time overcomes the need to get the plant running to specification. It is a common complaint of operations and maintenance staff that projects are foisted on them before they are properly finished and they are then expected to finish off the detail and provide the support functions that most would consider the responsibility of the project team.

Asset registers, equipment numbering, spare parts, documentation and training are often poorly implemented or omitted at the commissioning phase and it is left to those operating and maintaining the asset to sort these out if they want them. This is despite the fact that these support functions are normally detailed in the project scope and in most cases have been factored into the project cost.

## Handover

Once commissioning and testing have been completed and any outstanding issues have been resolved to the satisfaction of the organisation, the plant is ready to hand over to the operations and maintenance departments for ongoing operation and maintenance.

It is useful to think of the handover phase as being divided into three sections with the following focus.

1. Lead-up to the handover.
2. Handover.
3. Handover follow-up.

### 1. Lead-up to the handover

The actual handover should be preceded by appropriate training of operating and maintenance staff who will operate and service the equipment initially. Those chosen for the handover should be capable staff with experience in problem solving and who are not intimidated by the potential problems they might encounter. Responsibility for the initial operating shifts and maintenance backup teams should be assigned to clearly identified individuals and/or teams who have received appropriate training and who are prepared for the changed conditions and increased responsibility associated with the handover phase.

Operations raw materials and consumables should be on hand well before the handover to allow operators to become familiar with any new materials and their associated hazards and Material Safety Data Sheets. It is likely that blockages and other settling in problems will occur in the initial days of the new plant and extra consumables such as filters, cleaning materials etc. should be on hand to cater for this contingency.

Similarly, maintenance spare parts should be available in sufficient quantities to support any likely start-up problems and where possible, manufacturer support should be arranged for the early stages especially. Having the manufacturers available when needed will reduce the start-up time, reduce the likelihood of equipment damage, reduce any disputes over warranty or equipment problems and facilitate training for both operations and maintenance staff.

The level of pre-handover preparation will depend on the complexity of the plant and the degree to which the new plant differs from that which the operations and maintenance staff are familiar. In any event it is not appropriate to simply hand the plant over to staff after commissioning and testing and hope they muddle through eventually.

### 2. Handover

The actual handover in most cases is a milestone rather than a major event and serves to clearly mark the day/time at which responsibility is transferred from the projects group to the operations group. The main advantage of having a formal handover is that it clearly signifies when responsibility is transferred and forces the projects team to meet the design standards for the plant and prevents

the operations group from delaying handover for trivial reasons.

### 3. Handover follow-up

Following the formal handover of the plant from the projects group to the operations group, there will be a finite period when the support required by both operations and maintenance will be higher than will be the case when the plant has been operating for some time and has settled in to routine operation. Access to the project engineers and specialists and the equipment manufacturers is vital during this period as any operating and maintenance problems become apparent which might require skills not yet available in the operations or maintenance groups.

Over time, the plant can be expected to settle into a steady operating state as any early problems are sorted out and staff learns how to get the plant to operate in a sustainable way. The transition from the post handover period to normal running will, in most cases, be gradual and may not necessarily be marked by any clearly definable operating performance change or other noticeable boundary.

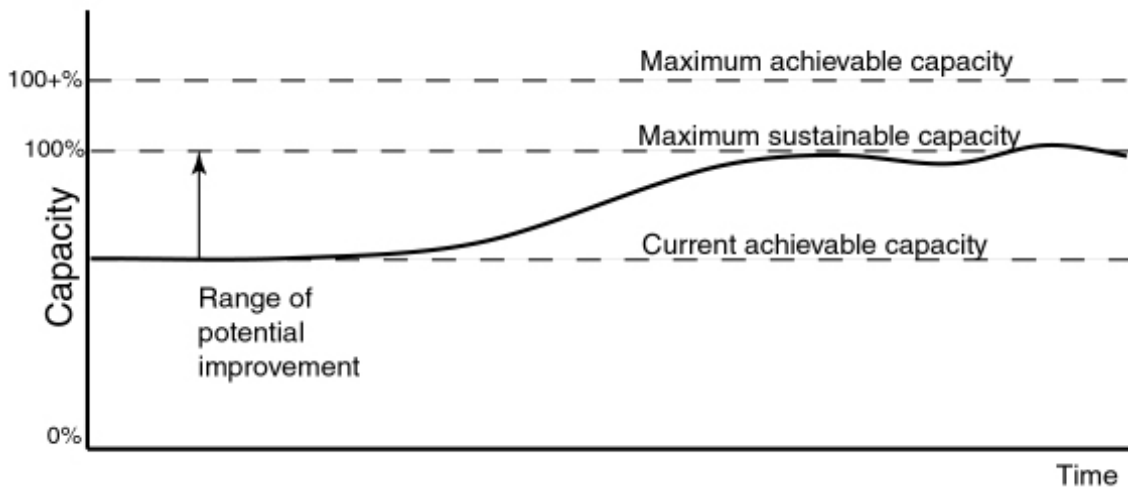
## Operate and Maintain

Most major assets are operated over many years punctuated by periodic and ad-hoc maintenance activities. The operate and maintain phase of the asset life cycle represents, in most cases, the major time component of the asset life.

In addition, a mid-life upgrade or major overhaul may also be part of effectively managing the asset over its life cycle. This cycle of operate and maintain must be optimised to maximise the useful operating time of the asset throughout its life while minimising the undesirable consequences of failing to maintain the asset in good condition. Finding this balance is one of the principal aims of AM systems and maintenance systems in particular.

The underlying aim of the Asset Management engineer in this instance is to achieve the 'Maximum Sustainable Capacity' (MSC) over the asset life cycle, as this is usually synonymous with maximum utilisation and maximum through life output. An important secondary aim is to achieve this MSC at the lowest cost, zero injuries and zero (or minimum) environmental impact.

The aim of achieving and operating stably at MSC is based on the view that the capacity of the plant (measured as output, up-time, support services etc.) is its 'reason for being' and therefore anything that we can do to maximise the output from a plant for a given investment will maximise the return on that investment.



In practice, there are operating points other than MSC with the 'Current Achievable Capacity' (CAC) being the operating mode for all plants. If the CAC differs significantly from the MSC (usually lower) the maximum utilisation of the plant is not achieved.

The capacity gap between the CAC and the MSC is an indication of the potential untapped capacity that is achievable if the plant is operated and maintained using 'Worlds Best Practice' (WBP) systems. In this case, WBP results in the MSC achievable from the existing or proposed plant or at least in closing the gap between CAC and MASC. As improvements in Asset Management and maintenance approach WBP, MSC will also improve creating a dynamic target for the Asset Management engineer.

## Overhaul and Upgrade

During the operational life of a large plant, it may be necessary to carry out overhauls and/or upgrades to ensure the products produced at the plant remain competitive in the market place. The role of Overhauls differs from that of Upgrades as their justifications and intended outcomes are different.

### Overhauls

Overhauls are carried out to restore existing assets and functions to an acceptable condition (not necessarily as-good-as-new) following deterioration and wear that has accumulated over time and use. Some failure modes occur over a long time period, are relatively slow to develop and are cumulative in nature. There may not be an effective or convenient maintenance restoration task available to prevent or reduce the impact of these failure modes. Overhauls are often required to correct these long term deterioration mechanisms such as deterioration of linings and refractory, corrosion of vessels etc. In many cases these deteriorating mechanisms do not have routine maintenance tasks assigned (except in some cases where inspections may be carried out) but which have to be restored when they have reached some unacceptable level of deterioration.

The overhaul or 'turnaround' is usually complex and expensive and involves significant planning and resourcing to minimise the cost and disruption of the overhaul. Typically, overhauls are carried out on large combinations of equipment such as power station boilers, paper machine chests, ships, locomotives, refinery vessels etc. and are often typified by limited access during normal operation and high setup and repair costs when carried out. Large overhauls attract significant planning and scheduling to ensure the work packages are delivered on time, resources are available when needed and access to parts of the plant are coordinated to prevent delays and minimise the total event duration.

### Upgrades

Unlike overhauls, which are designed to restore existing functions, upgrades are carried out to add new features or capacity to an existing plant over and above that originally designed into the plant. Upgrades are required when the need for additional functionality or increased capacity, cannot be met by limited changes to existing plant, cannot be postponed any longer and where the cost of completely replacing the asset is not justified on economic grounds.

An upgrade may be more attractive than a complete replacement when:

- The cost/benefit relationship of the upgrade is more favourable than for a complete replacement plant.
- The upgrade involves a relatively small percentage of the equipment and the rest of the plant has valuable remaining life.
- If the upgrade is relatively simple.
- The plant downtime for the upgrade is significantly shorter than for a complete replacement.
- No new technical enhancements are available or attractive.
- The projected remaining life of the overall plant is too short to support the larger investment

of a new plant.

The need for additional features or capacity can arise for similar reasons as those at the 'identify need' phase. Typical reasons for upgrades include the following.

- Existing assets are at the end of their 'technological life' and need to be upgraded for the organisation to remain competitive.
- Existing assets do not have sufficient capacity to meet current needs and need to be upgraded to increase capacity.
- Existing assets cannot continue to be operated due to unacceptable safety or environmental problems associated with the asset.

## Decommission and Dispose

An asset that has been in service for a number of years will eventually reach the end of its useful life either because it is no longer economic to continue using and maintaining it, technological changes have made it obsolete or it has some feature (or lack of a feature) that makes it no longer safe or otherwise desirable to operate it. The decommissioning and disposal phase follows the useful operate and maintain phase/s of the asset's life. The expected useful life of an asset can vary from one to two years for high stress applications (or disposable assets such as office computers) to many decades or even centuries for some major assets such as bridges, buildings, paper machines etc. Between these extremes, manufacturing and process plants can have expected lives of forty to sixty years at which time their scale, cost effectiveness or technological limitations render them no longer viable and a new, or significantly upgraded plant is required. A significant responsibility of the Asset Management group is to correctly identify the best rebuild/replace points and to effectively plan and implement these decisions to minimise the whole of life costs and minimise any disruption to operations.

The decision to decommission and dispose an existing asset gives rise to the need to manage this phase of the asset's life safely and effectively to minimise the total cost to the organisation while still meeting all safety and environmental regulations. Safe disposal of redundant assets has become an area of increasing concern in recent years and decommissioning and disposing of assets when they have reached the end of their useful life can incur significant cost and require adherence to restrictive regulations. The main area of concern to the regulators up to now has been how best to allow an organisation to dispose of an asset while minimising the environmental and safety risks associated with the disposal phase.

The economic, safety and environmental issues surrounding the retirement of an asset must be considered in detail and a clear plan developed to manage the decommissioning and disposal phase. The nature of the asset will in most cases determine the relative importance and difficulty of the tasks involved and should be laid out in a detailed plan showing timing, resources, risks, risk mitigation and costs.

The decommissioning and disposal phase can be a significant project in its own right and must be treated as such. It is not uncommon for those involved in the initial construction project to ignore the likely costs associated with decommissioning and disposal, leaving the organisation with a significant unfunded liability for the future. The project may well have been considered uneconomic at the outset if all the true costs had been identified and accounted for. Assets with significantly long life expectancies such as bridges, oil rigs etc. can have much higher decommissioning and disposal costs than might have been initially appreciated. Some of these costs may arise from changes to safety and environmental regulations and make decommissioning and disposal of these and similar assets much more costly.

Some of the important steps in the decommissioning and disposal phase planning are as follows.

- Identification of the need to retire the asset.
- Initial scoping of the project tasks involved in decommissioning and disposal.
- Research of any relevant regulations that must be followed during the decommissioning and disposal phase.
- Assess the safety and environmental risks associated with all stages of the decommissioning

and disposal project.

- Assess the financial costs associated with the decommissioning and disposal project.
- Develop a detailed project plan for the decommissioning and disposal project.
- Provide all documentation and supervisory systems demanded under any relevant regulations.