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SUSTAINABILITY OF A MATURE PROCESS PLANT
ASSET LIFETIME STUDY (a)

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1. Summary

The Asset Lifetime Study Process has evaluated the condition of the equipment at a leading manufacturer of ammonia and urea. The necessary actions and associated costs have been determined for continued operation in order to provide the business with the basis for forward planning and budgeting. The study has also identified opportunities for improvement of both equipment and equipment management systems.

The study has determined that in general the plant is well maintained by committed and enthusiastic personnel and should run satisfactorily for a further 20 years with replacement of only a relatively small fraction of the equipment.

2. Background

In today's demanding and highly competitive environment businesses are constantly being challenged to improve the reliability and operability of their assets. Against this backdrop, as the chemical industry in Europe has matured, the dependence on the extended operations of chemical plants long past their original design life expectation has become essential to the sustainability of the business. This need for sustainability of the asset requires businesses to proactively assess the integrity of their plants and put in place an asset life strategy that supports attainment of this objective.

The drive in ICI in recent years has been to achieve World-class standards of manufacturing across all aspects of its operating businesses; inherent in this drive has been the application of asset life strategies supportive of business objectives.

The need for assessing the integrity of an operating asset and the desire to extend its life beyond that for which it was originally designed first surfaced within ICI in the late 70's and early 80's. At this juncture, however, requests were sporadic and either system or equipment focused, but over time the need for a coherent methodology and the importance of developing a structured and focused approach to the issue of asset life extension became evident. Hence the "Asset Life Study" concept was conceived.

Over the last 10 years this detailed methodology has been further developed and refined by ICI, who in conducting such studies has gained considerable experience of extending the life of mature assets in a number of process technologies, including ammonia and fertilizers, petrochemicals and plastics, chlorchemicals, fine chemicals and pharmaceuticals.

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3. ABF Requirements

Although part of the global market place, each company has its own specific set of circumstances – business objectives and constraints. This is due to its own blend of process technology, plant design, plant age and condition.

ABF are an ISO 9001 accredited company (one of the first to receive this accreditation in the Petronas Group). Like all companies following the path to world-class performance, ABF have instituted a number of reliability improvement programmes. However, ABF management realised that effective and sustained improvements in reliability need to be viewed in the context of a long term asset strategy.

This is where Synetix/ABB provided help.

4. Asset Life Planning

The plants at ABF are amongst the oldest in the Petronas Group, but are not old by world standards where many ammonia and urea facilities are 20 to 30 years old. It has however reached the stage where positive management of age-related deterioration is necessary.

The standard of design and construction of the plant equipment appears to have been good and appropriate conservatism is featured in several of the items examined. Very few items are formally rated as having limited life. The documentation supplied with the original equipment is generally comprehensive and of high quality.

A fairly large number of modifications have been made to the plant, including increased production rate following the revamps. Some new equipment has been added and a few items have been renewed but most of the plant, including the main process trains, is still as originally supplied.

Obsolescence is not yet a major issue other than a few machines.

The maintenance and inspection systems necessary for ensuring the continued integrity of equipment are well focussed and effective, with pro-activity being shown. The plant team appear knowledgeable about their plant and most of the issues affecting its integrity.

Even in this environment of a well run and maintained plant the deterioration of particular equipment items will continue through age and corrosion, and with the increasing production demands other items may be operating outside their design capability. Sustaining plant operations beyond the original design requires a level of strategic reinvestment. Identifying the particular plant items which will need replacement allows the development of an Asset Life Plan and provides the framework for the determination of appropriate equipment and maintenance policies and provides the essential information needed in the normal budgetary and planning processes.

Figure 1: ABF Asset Life Study - part of long term Asset Management Strategy

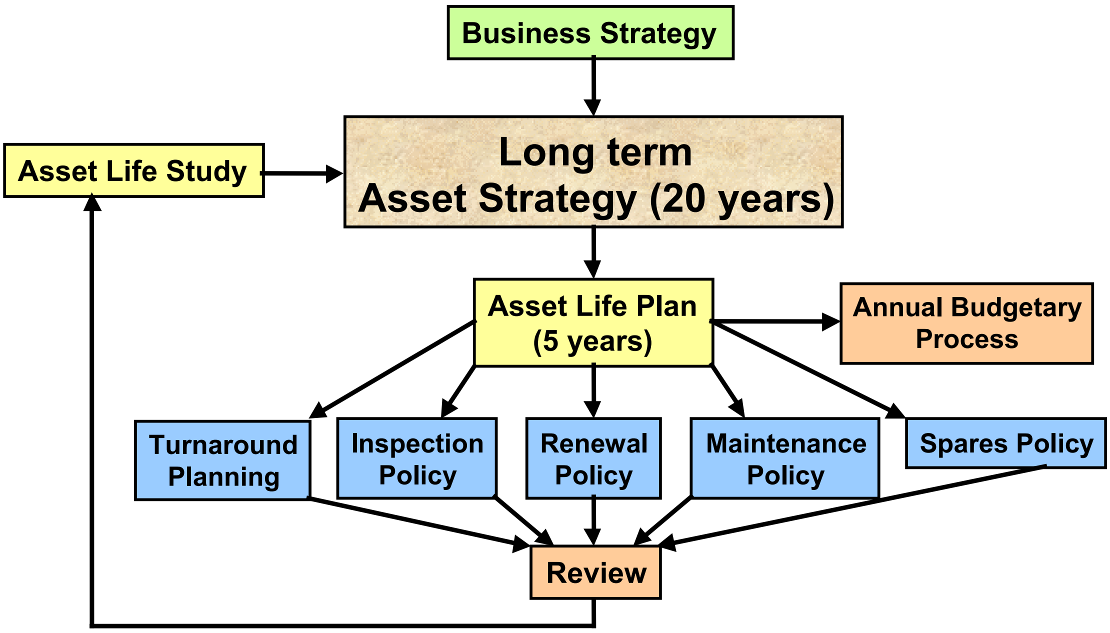


Figure 1 shows the main constituents of an Asset Strategy from ABF Asset Lifetime Study. Asset Strategy ties in with overall Business Objectives and feeds down to the essential equipment operating and maintenance policies.

Asset Life Planning is a balance between the immediate issues facing equipment and the cumulative effect of these operations.

Information need to support the generation of an Asset Life plan needs to address both the immediate and the long term issues, so providing a balanced picture of the current state on which future judgements can be made.

The process undertaken with ABF provided studies, which integrated views of current state and long term effects. The study processes Asset Care and Asset Life give this complementary view of the asset condition and, as will be described, provide both information for the current maintenance programme, as well as for long term investment planning.

5. Asset Care Philosophy

In a study of this nature it is important to include asset care practices in any equipment lifetime assessment, because such practices determine to a large extent the life and associated lifetime costs of the asset. With this in mind, the study team reviewed operating, inspection and maintenance practices as well as equipment 'hardware' issues.

In the reporting of each item the study team identified actions to ensure sustainability of operation and maintenance strategies of key items, based on normal operation. These involve changes to equipment and improvements to asset care practices. However, in a number of cases, equipment problems have been caused by abnormal operational events. These issues have been highlighted, though the investigation of solutions is outside the scope of this study.

In the course of the overall study, asset care guidance was given to ABF personnel. This was done in a number of ways to suit the particular circumstances, ranging from formal training and on-the-job training (such as for the bellows study) through to documents for guidance, and advice given informally throughout the course of the study.

6. Asset Life Study Methodology

The Asset Life Assessment is an overview process in which the construction, history and mode of operation of a large number of items of plant equipment are examined together with the ethos and practices of the organisation(s) responsible for equipment management. The assessment would typically cover the seven principal equipment groupings comprising the normal inventory of plant assets;

Piping
Vessels
Fired equipment
Instrument systems (excluding the DCS and up to the field instrument)
Electrical systems (11 kv to 110v, including the UPS)
Rotating equipment, and
Civil structures.

ICI's well proven methodology starts with a careful assessment of asset condition, its operational history and the deterioration mechanisms. Combining these with historic performance assessments reveals the extent to which the asset is suitable for its intended duty and the expected life before unacceptable performance will occur. The equipment is then categorized, to clearly highlight those items of greatest concern. Costs for anticipated changes are then calculated so that the required spend to maintain integrity over a period of time can be determined, typically over 10, 15 and 20 years.

During the study due consideration is given to:

product obsolescence
new technology development and/or enhancement
possible plant improvements, such as equipment redundancy
repair or replace options
material enhancements
turnaround effectiveness

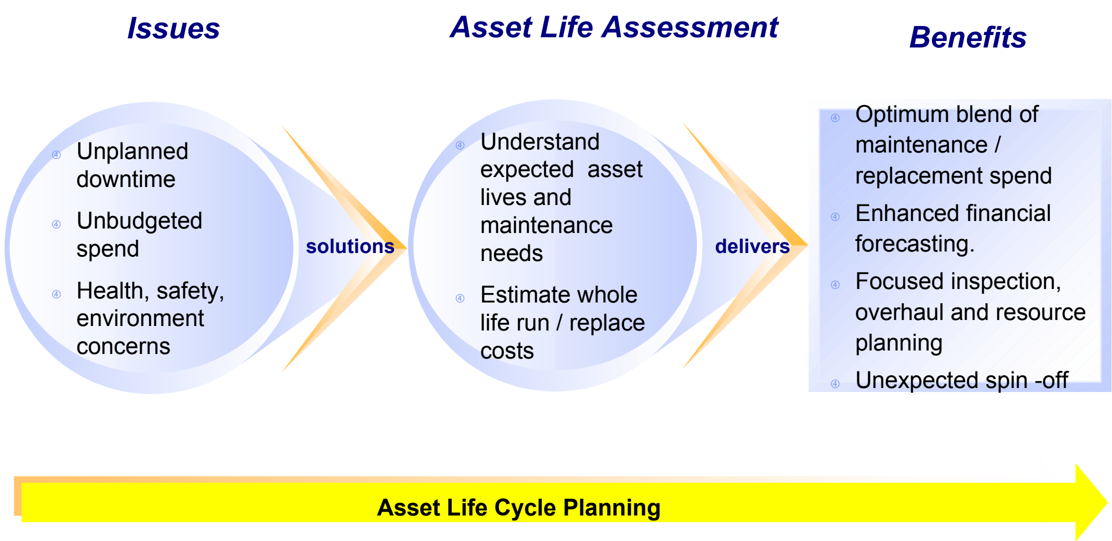
Assessment of each item is made largely on the basis of information supplied by the plant team either directly or by means of records. The process does not normally involve detailed inspection of operating equipment and judgements are made on longer-term sustainability rather than the immediate integrity or reliability status. The methodology considers the impact of equipment sustainability on operations with issues being addressed by considerations of reliability, supportability, obsolescence, and maintainability.

In conducting the study, an Asset Study team is selected based on relevant plant experience and understanding of the main specialist technologies involved, typically comprising the following:

furnace and boiler technology
vessels engineering
piping systems engineering
rotating equipment and mechanical handling technology
structural and civil engineering
control and instrumentation
electrical systems Engineering

Additional expertise is made available, as necessary, for example materials and corrosion engineering, to provide support to these functions as required.

Asset Life Study Implementation Strategy



The asset life study covered the whole plant area, namely ammonia, utility, urea and offsite plant.

The study included a detailed assessment of

asset current condition
asset construction and operating history

likely deterioration mechanisms and age-related failure of the assets

For Asset Life Study purposes the inventory of ABF equipment was divided into seven specialist study areas:

vessels
fired equipment
piping
machines & solids handling
control & instrumentation
electrical
civil and structural.

Each of these elements of the study was conducted by an engineer both specialist in the topic and with experience of ammonia plant equipment, with detailed reports presented for each topic.

A Criticality Assessment was carried out by the Asset Life Study team to provide focus for the Asset Life Study. This assessment can be used as a key input to other asset management initiatives (such as Risk Based Inspection and Spares Management).

The Asset Life Study reviewed and evaluated asset integrity and life assessment based on anticipated revamp operating conditions.

The study also addressed specific issues of concern as detailed by ABF and listed below:

Catalyst filled pressure vessels – inspection without vessel entry or shutdown
Ammonia storage tank inspection
Boiler & furnace operation, maintenance and inspection
Reformer tube life assessment and policy
Bellows – covered by separate report
Underground piping
Main machine foundations
Life expectancy of HP steam turbine components and compressor/pump components subjected to cyclic and thermal stresses
Rejuvenation of auxiliaries and accessories for main machines
Obsolescence of main machines
Ageing cables
Ageing E&I field equipment
Plant UPS
Philosophy for replacement of main electrical switchgear, etc
Life assessment on electrical switchgear
Concrete structure integrity
Corrosion under insulation

Failure of steam turbine condenser tubes

In addition, the study reviewed and incorporated findings from the turnaround in November 2001.A risk review of the Revamp 3 Project was carried out separately from the Asset Life Study.

7. Findings

This assessment has revealed that ABF assets are generally in good condition and benefit from effective asset management systems. The assets should continue to give satisfactory service for 20 years and beyond, with respect to safety and production, provided that the present inspection regime, refurbishment policy and overhaul interval continue. However, the study has identified a number of key items of equipment that are of concern in the short and long term, the most significant of which are highlighted below.

Given an appropriate level of investment the plant should run satisfactorily for a further 20 years with replacement of only a relatively small fraction of equipment.

Maintaining the plant in full effectiveness well beyond its original design life requires continuing emphasis on asset care - operating the plant within its design parameters and keeping it well maintained. This includes inspection over and above statutory requirements. A process for examining the potential for operational mishaps to damage equipment should also be developed.

There are a number of items of equipment of significant concern. These are covered in detail in the functional reports developed for the study. If these items of concern are adequately addressed, none of these are seen as fundamental to continued operation.

In order to gain maximum benefit from this study, an Asset Life Strategy and Plan should be generated. These need to incorporate the findings of this study and the Criticality Assessment.

To achieve even greater benefit, equipment management practices need to be developed further. There is a need to facilitate study of deterioration trends, as these are the best means of determining and sustaining asset life. Such measures include improved inspection techniques (to provide consistent and reliable data) and continued emphasis on improving personnel awareness and technical expertise.

7.1 The technical findings of these studies provided information in 3 categories:

7.1.1 Key items where further detailed investigation is needed

Corrosion Under Insulation

This is the most significant concern for safety and costs of the piping systems, because it has the potential to affect a large amount of piping containing ammonia gas and liquid.

Recommendations were provided to ensure that action is taken before the problem becomes widespread.

Safety Valves

A significant proportion of safety valves were identified as suffering from “jamming”, preventing operation at the required pressure. The plant relies on its safety valves, if the integrity of these cannot be assured the plant is vulnerable. A detailed study to investigate the causes of “jamming” was recommended with the appropriate integrity improvements implemented.

Storage tanks

The study revealed a range of mechanical issues with the plant’s storage tanks. Failure of these tanks would present significant consequences for production and safety/ environment. Changes were identified ranging from monitoring deterioration to extensive repairs.

7.1.2 Quick Wins – where immediate recommendations were made to allow rapid action to improve conditions:

Bellows review – identification of bellows in deteriorated condition allowing timely replacement at shutdown, avoiding failure and significant plant outage.

Electrical limitations for the revamp project.

Advice given on safety and environmental protection improvements e.g. bunding, handrails (gaps noted), air conditioning system to control room, vehicle barrier protection.

Advice given on cost effective inspection methods:

Tank settlement surveys

Inspection of piping

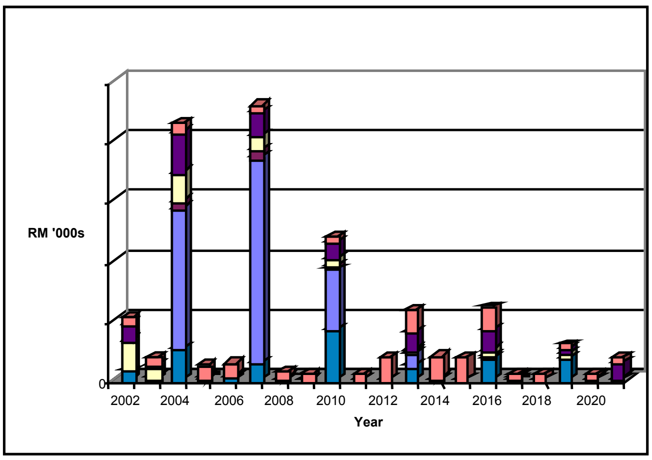
Risk-based approach to blast over-protection of buildings.

Advice given on the importance of steam trapping steam mains.

7.1.3 Technical Improvements – detailed technical comments made for future actions to avoid or reduce deterioration rates, and identify potential investments needed for sustainability

In taking a long- term view of ABF assets, it is important to consider the impact of assets owned by others that effect the operation of the plant. Such assets include the jetty and natural gas pipeline. Although these were not in the scope of this study, it is recommended that ABF satisfy themselves that active asset management systems are in place by the respective owners/operators.

Plant Life-Time Expenditure Profiles



8. Benefits to ABF of the ASSET LIFE STUDY

8.1 Management attention independent view

The Asset Lifetime Study provided a long-term view of the sustainability of the assets based on industry experience of similar plants and process operating greatly beyond their design lives.

Flexible approach

The study approach needed to adapt for logistical issues concerning both the timing of the plant shutdown and availability of key personnel.

Newly gathered information from the shutdown was introduced into the study reviews to provide ABF with a contemporary review of the current equipment condition.

By focusing on long term, eases production of annual budgets.

Captures plant history and experience of plant personnel.

Cohesive view of what the future holds
Where & why deterioration is taking place
What is needed to maintain equipment integrity

Life Cycle actions and budgetary plans – investment to prevent failure rather than as a reaction to it

Improvement of operating & maintenance practices

Demonstration of pro-active management of assets

8.2 Reduced risk of HSE incidents

Senior Management comments:

" I am very pleased with this study because it has given us exactly what we wanted. All too often when using consultants you get something you don't want."

Other comments, from participating engineers:

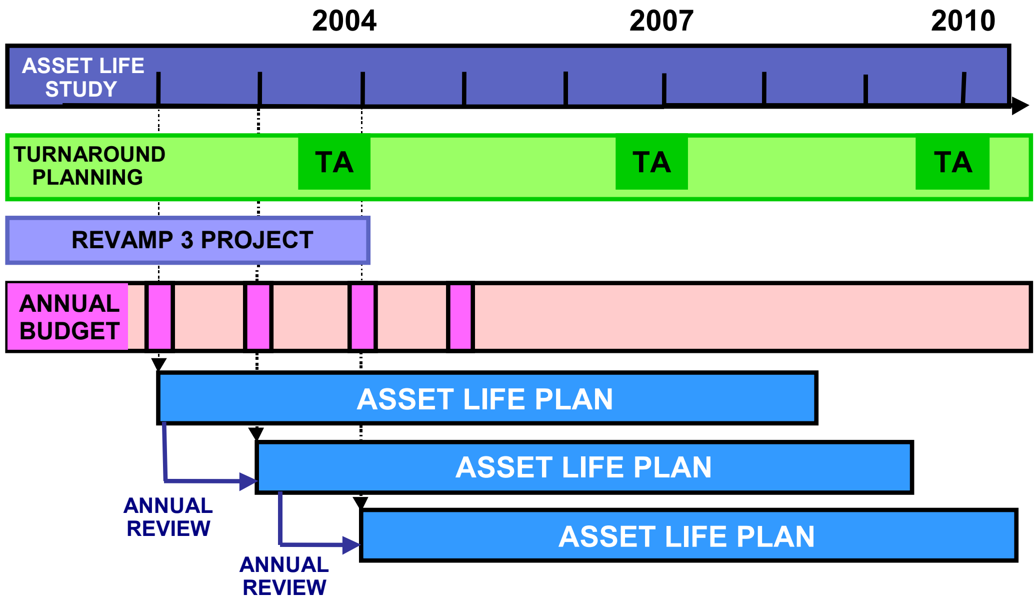
"This study has helped get management attention for the important issues, by putting things into perspective, focussing on the long term and providing an expenditure profile."

"The ALS will greatly ease the production of annual budgets in the future."

"The ALS report is a very important summary of the key issues on the plant. The ALS has turned the 'tacit knowledge' of experienced plant personnel into 'explicit knowledge' - all a new person needs to do is read the report and he will know almost as much those who have been here many years."

Next steps:
Development of Asset Life Plan – specific actions, focusing on next 6 years
Focus on specific immediate problem areas (e.g. Corrosion under insulation).

Asset Life Plan



9. Conclusions

The Asset Life Study has revealed that ABF assets are generally in good condition and benefit from effective asset management systems. The plant team are committed and enthusiastic and are knowledgeable about the plant and most of the issues that affect its integrity.

The assets should continue to give satisfactory service for 20 years and beyond, with respect to safety and production, provided that the present inspection regime, refurbishment policy and overhaul interval continue.

The study has tailored an established methodology developed by Synetix/ABB to provide a structured review of all the process and associated utilities and offsite assets. By focussing on issues that are less well known by the plant team, as well as reviewing known problem areas, the study team has carried out a specialist assessment that includes experience in the ammonia industry and wider petrochemical industry.

The study has identified a number of key items of equipment which are of concern in the short or long term. Some issues require further study in order to develop optimum solutions.

The study has identified opportunities for improvement of both equipment and equipment management systems.

The study has provided timely and valuable input to the Revamp 3 Project and the next turnaround.

The study has provided a range of deliverables including a Criticality Assessment, a bellows study, training of ABF staff and Asset Life Databases. The Criticality Assessment provides a vital foundation for a range of further Asset Care initiatives, such as Risk Based Inspection studies. The Asset Life Databases summarize all the key data used in the course of the study.

In order to gain maximum benefit from this study, an Asset Life Strategy and plan should be generated.