Methods for Life Extension Studies RAM Modelling of Capital Projects

Let a Plant Wellness Way EAM System-of-Reliability End Your Business Risks Forever

This document covers conceptual methodologies only, some of which are novel, and we accept no responsibility for any consequences of its use.

Life Extension Study (LES)

The purpose of a life extension study is to determine whether an item of production equipment is suitable for a minimum life extension of a selected number of years from present day. The methodology proposed to assess equipment capacity to both 1) safely, and 2) reliably, continue in operation for the extended period is sketched in Figure 1. Plant and equipment can fail yet still be safe. This will cause serious disruption to production but not harm life or environment. The converse, where failure leads to safety concerns, adds the possibility of death and destruction to the outcome of the incident. It is necessary to gain full appreciation of the consequences of both types of failures to make sound life extension decisions.

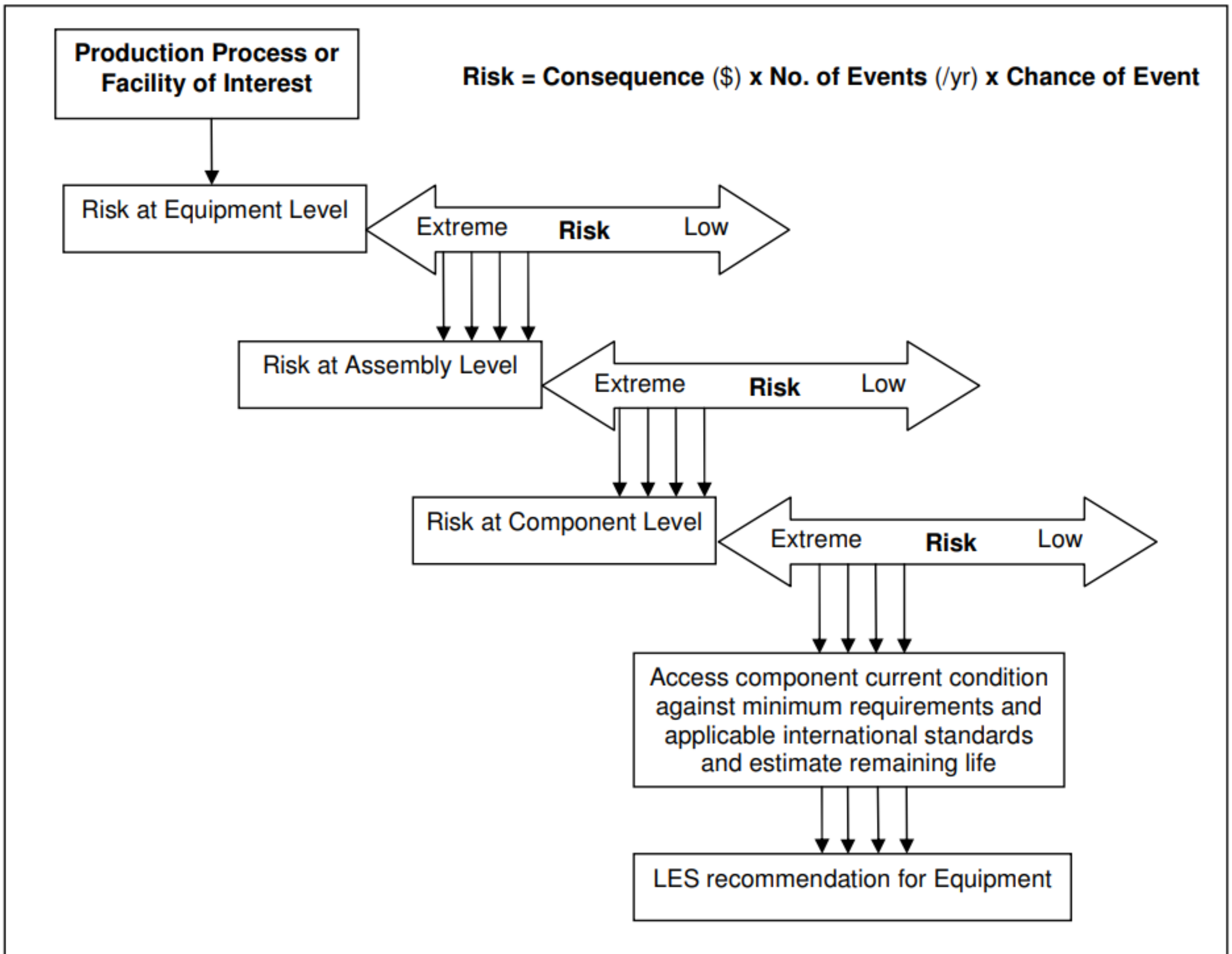

Figure 1 - Equipment Life Extension Methodology

The method involves assessing the full extent of business risk from the equipment/facility based on the total consequential costs of failure to the business and the historical incidents of failure experienced by the organisation. Costs are an accumulation of the relevant Defect and Failure True Costs (See Appendix for explanation of DAFT Costs) should a failure incident occur and are extracted from the organisation's financial systems. Frequency of failure is extracted from the equipment/facility operations and maintenance records, and if not available, then from applicable industry equipment reliability databases. The standard risk matrix is used to rank the size of the risk from 'extreme', 'high', 'medium' to 'low'.

Initially equipment by equipment in the process/facility under study is risk assessed and ranked from 'extreme' to 'low' risk. In the order of the equipment risk ranking each assembly in the equipment (e.g. for a pump set its assemblies could be piping – wet end – seal – coupling – drive – power supply) also undergo a risk ranking assessment to identify the criticality of the assembly to both 1) the safe and 2) reliable operation of the equipment. Finally, the components comprising an assembly (e.g. for a mechanical seal it maybe housing – stationary member – rotary member – compression part - seals) are risk ranked to identify their importance to on-going equipment reliability and safe operation.

For each critical component identified an assessment of its suitability for continued service and its estimated reliability is performed based on worst case, and likely case scenarios. The scenarios incorporate known failure histories of parts, possible failure mechanisms that could occur in the operation, frequency of various types of overstressing during operation, quality of maintenance and extent of maintenance, along with other factors deemed important for the study.

Assessing the integrity, serviceability and remaining service life of components / assemblies / equipment is done using accepted industry best-practice methods and standards. These applicable techniques will be identified as required during the risk analysis phase, and in all cases will be traceable to internationally recognised standards and methods.

From the risk analysis and component remaining life analysis the equipment life extension recommendation is finally proposed.

The LES methodology described above is simple yet robust, incorporating modern risk analysis practices along with industry accepted reliability and integrity assessment techniques. It makes clear where any life extension problems lay and provides reasoned and practical advice for their management and resolution.

Required Resources

The method initially consumes time developing the equipment / assembly / component financial and history data bases if none exist. If the information already resides in softcopy form within the organisation's management systems, the time is greatly reduced to downloading existing data into suitable spreadsheets. Manning depends on the size of an investigation and the complexity of equipment and processes involved. Initially manning is based on one person competent in reliability analysis and risk analysis devoted to each production process or large structure/facility. The intention being that this person becomes the 'data and analysis expert' for that facility/process.

Technical Due Diligence (TDD)

The purpose of Technical Due Diligence is to identify those technical issues unfavorably affecting asset acquisition. The method proposed is to use the intended acquisition's performance history to identify the extent of any operating under-performance and associated operating reliability problems. This is diagrammatically shown in Figure 2.

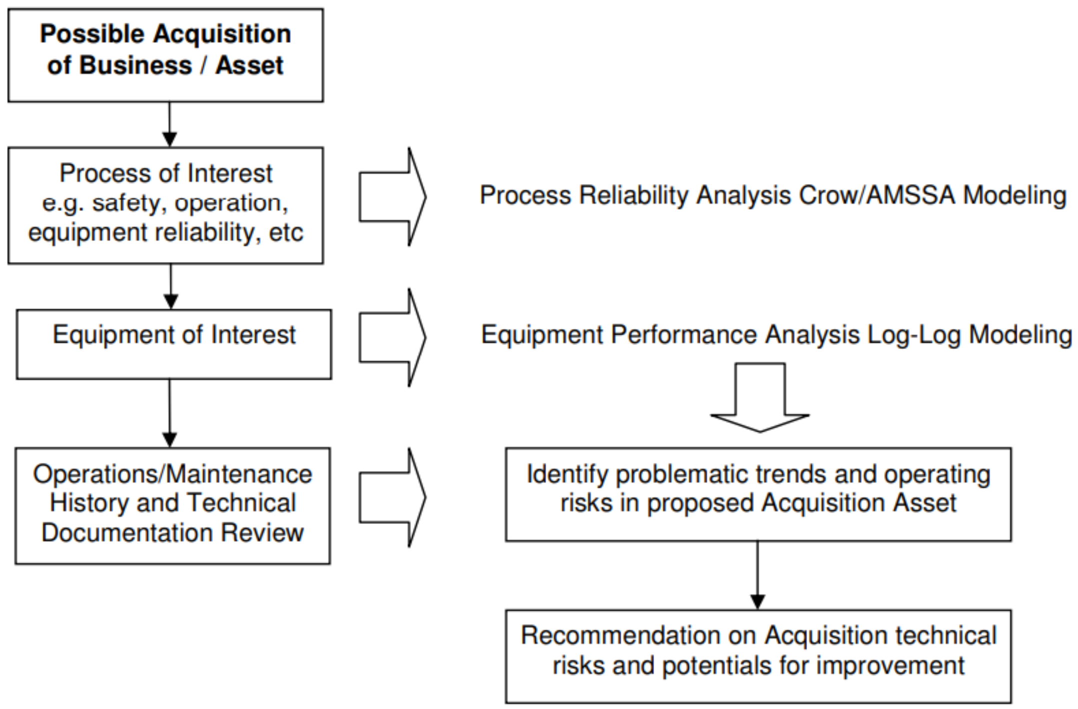

Figure 2 – Acquisition Due Diligence Methodology

Data collected from the asset's operating history, safety history, and maintenance history is used to construct a variety of process reliability growth and cost models using Crow/AMSSA software. The models indicate the future state of the asset unless changes are made to alter its performance. The Crow/AMSSA and the log-log plots developed from the historic data graphically illustrate the future financial performance capability of the asset's processes and/or equipment.

The application of Crow/AMSSA reliability growth analysis is recognised as a very robust way to forecast future asset performance. It provides clear evidence and insight on the current state of the asset and the effects of historic management and maintenance practices during its use. It clearly indicates whether the asset has been well operated or not. For those assets poorly operated it provides an indication of whether the Asset can be reinvigorated with new capital expenditure and/or with better management processes and systems.

Required Skills

Technical Due Diligence analysis requires a competent person knowledgeable in maintenance and reliability engineering basics and with basic statistical mathematics. One person would be adequate to conduct the reliability modeling for a large facility or process. The Crow/AMSSA software is available from several reputable suppliers. Though the algorithm is well understood and fully developed the software is still becoming more user-friendly with continuing improvement in screen displays and reporting functionality.

RAM Modeling of Capital Projects

The purpose of modeling the Reliability, Availability and Maintainability of capital projects is to identify opportunities to reduce operating risk and maintenance costs so that plant availability and operating profits can be maximized. The method proposed is shown in Figure 3 and is applied during both the feasibility stage and the full design stage of capital projects. Every capital project group must recognise that they are designing and building a business and not simply installing a new facility or plant. For the business to be successful its operating costs must be minimized and its operating profits maximized. This requires the project group and operations group to use technical and engineering finesse to maximizing the operating profits of the business.

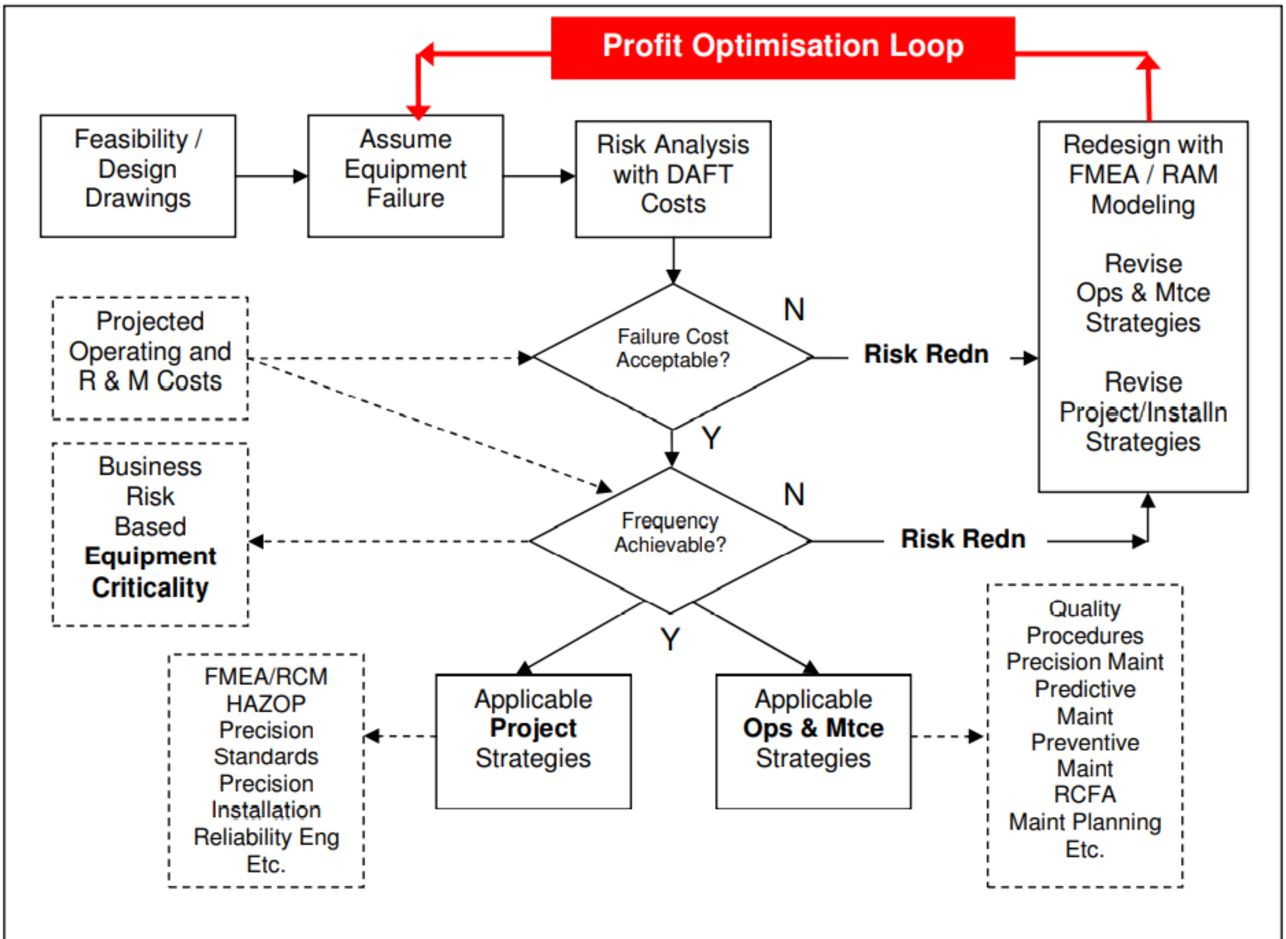

Figure 3 – Optimised Operating Profit RAM Methodology

The diagram shows the methodology for selecting appropriate project, maintenance and operating strategies matched to the size of risk carried by a business should there be a failure. The methodology known as the 'Optimised Operating Profit Method' uses the more than 60 Defect and Failure True (DAFT) Costs that could happen from a failure to determine the true cost of business risk and then matches risk reduction and risk control practices to the risk a company is willing to carry.

The proposed capital plant, equipment and processes are examined for inherent operating risk present in the business. Where the operating risk (DAFT Costs or failure frequency) is unacceptable improvements are made to design and construction quality management, the proposed operating practices or the maintenance strategies and the residual risks are then reassessed. This optimisation process continues until the operating risks are acceptable with the capital project model for operating costs. The risks are controlled by a suitable mix of good design choices, quality control during design and construction, good operating practices and good maintenance practices. RAM modeling is done on standard reliability engineering software available from several suppliers.

Required Involvement

The operating risk optimisation is performed by the project design group with relevant input from financial, operations and maintenance groups when developing the DAFT Cost data base and the historic failure frequency data base. The operations and maintenance groups are also represented at the various design reviews during which risk management strategies, such as project and construction quality control, and the future operating and maintenance practices, are decided and incorporated into the business' design.

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APPENDIX

Defect and Failure True (DAFT) Cost

Each organisation is different and each defect, error and failure it suffers has different consequences. The total cost to the organisation of a failure incident will be shared amongst the departments and people involved. The proportion of the cost each department ends up carrying depends on the extent of its involvement. The total and true costs incurred by a business from a failure event reverberate and surge throughout the organisation. The more than 60 consequential costs listed below reflect a good number of them, though there are others specific to each organisation that will need to be identified and recorded.

- Labour : both direct and indirect
  - operators
  - repairers
  - supervisory
  - management
  - engineering
  - overtime/penalty rates
- Product waste
  - scrap
  - replacement production
  - clean-up
  - reprocessing
  - lost production
  - lost spot sales
  - off-site storage
- Services
  - emergency hire
  - sub-contractors
  - traveling
  - consultants
  - utility repairs
  - temporary accommodation
- Materials
  - replacement parts
  - fabricated parts
    - materials
    - welding consumables
    - workshop hire
  - shipping
  - storage
    - space
    - handling
  - disposal
  - design changes
  - inventory replenishment
  - quality control
- Equipment
  - OEM attendance
  - energy waste
  - shutdown
  - handover
  - start-up
  - inefficiencies
  - emergency hire
  - damaged items
- Capital
  - replacement equipment
  - new insurance spares
  - buildings and storage
  - asset write-off
- Consequential
  - penalty payments
  - lost future sales
  - legal fees
  - loss of future contracts
  - environmental clean-up
  - death and injury
  - safety rectification
- Administration
  - Documents and reports
  - purchase orders
  - meetings
  - meeting rooms
  - stationary
  - planning, schedule changes
  - investigations and audits
  - invoicing and matching
- Equipment Curtailed Life
  - Life wasted in previously replaced parts
  - Labour wasted in replacing parts

The sum totals of the organisation-wide ‘instantaneous costs of failure’ are not usually considered when the cost of a failure incident is determined. This means that most companies do not fully appreciate the huge consequential costs they incur business-wide from every failure incident. Few companies would cost the time spent by the accounts clerk in matching invoices to purchase orders raised because of a failure. But the truth is the clerk would not be doing the work if there had been no failure. The cost of matching invoices to purchase orders was incurred only because the failure happened.

The same logic applies for all the costs due to a failure – if there had been no failure there would have been no costs and no waste. Prevent failures and you will make a lot more money much more easily.

The full value of all DAFT Costs from a failure incident can be calculated in a spreadsheet. Simply trace all the departments and people affected by an incident, identify all the expenditures and costs incurred throughout the company, determine the fixed and variable costs wasted, discover the consequential costs, find-out the profit from sales lost and tally them all up. It will astound people when you show them how much money was destroyed by one small equipment failure.