RAM study

As owner of an installation or system, one can generally obtain insight into that system’s capabilities; ‘what are possible causes of production losses, and what could potential system alternatives consist of?’ A RAM study (Reliability, Availability and Maintainability) assesses the production system in question, whether it is already in operation, or still in the design phase.

RAM study is well-designed and properly implemented asset optimization program that can significantly lower project costs. The results from a RAM modeling will identify possible causes of production losses and can examine possible system alternatives. The RAM study is, thus, a tool for decision-making, with additional insights for costs-versus-benefits analysis.

RAM Methodology

RAM modeling can simulate the configuration, operation, failure, repair and maintenance of equipment. The inputs for a RAM modeling will generally include items such as the physical components, equipment configuration and maintenance philosophy of a system. The outputs can help determine average production of the system over the life-span of the facility or vessel.

Firstly, the design of the installation is transferred into a Reliability Block Diagram (RBD). Component failure data, together with RBD’s form the initial input for software that employs Monte Carlo simulation to calculate system reliability and availability. Consequently, the effect of changes in the configuration of an installation, on the availability and reliability of that installation, can be made visible. This makes it possible to optimize an installation even in the design phase. The relationships between the design, the demands on performance, the FMECA, failure data, and RAM, is schematically presented in figure 1.

Figure 1: Structure of the FMECA/RAM study.

FMECA

The Failure Mode, Effect and Criticality Analysis (FMECA) is prepared using P&I’s of the Plant as a basis for the performance of an assessment. An FMECA provides insights into the most critical parts of an installation and works by evaluating the individual components against the probability of failure, the effect of failure, and the ability to detect a failure. The basic design of Plant, together with the performance requirements, form the basis for the FMECA-sheet.

A FMECA Session is conducted with the Engineering Team, with the objectives specified hereunder, in order to obtain inputs from various disciplines, and to get inputs on each component being considered for the RAM study.
- Objectives of FMECA

The objectives of the FMECA session are to gain input from experts in relation to most critical equipment, relating to:

- different failure modes regarding the Plant Facility;
- effects of failure on the Plant Facility installation: Availability, Maintainability;
- possible preventive measures (maintenance strategy);
- validation of current design measures regarding criticality of components.

- Criteria

The three criteria on which the component failure modes have been judged are:

1. frequency of component failure;
2. effects of component failure;
3. detectability of component failure.

- RAM Study Basis

A RAM analysis has been performed to determine the Availability. In this section, the RBD model and the typical results of the RAM analyses are detailed.

Reliability (Re) is defined as:

\[ Re = \frac{T_{total} - M_{repair}}{T_{total}} \]

Availability (Av) is defined as:

\[ Av = \frac{T_{total} - M_{preventive} - M_{repair}}{T_{total}} \]

where:

- \( T_{total} \) = the total number of hours in the evaluation period; this is usually one year (8760 hours) for an all-year-round operating facility;
- \( M_{preventive} \) = the total number of hours downtime of the plant for preventive maintenance in the evaluation period; this is often referred to as ‘scheduled downtime’;
- \( M_{repair} \) = the total number of hours downtime of the plant for corrective maintenance in the evaluation period; this is often referred to as ‘unscheduled downtime’ and includes detection time, response time, diagnosis, repair, testing and start-up.

- Set-up of the Reliability Block Diagram

The first step of the RAM modeling is the development of a Reliability Block Diagram (RBD). The components from the FMECA that are critical for the operation, form the basis of the RBD. The relations amongst the components are modelled and failure data related to the failure modes are included.
- **Failure data**

The major part of the Mean-Time-To-Failure data for the RAM model, is collected from the Existing Database, such as OREDA. During the FMECA session, data has already been compared with data from Existing Database.

- **Typical RAM simulation of a compressor facility**

![Pie chart showing systems contribution to Unavailability](image)

**Figure 1: Systems contribution to Unavailability**

**Conclusions**

RAM studies will generate sufficient data to form the basis for making decisions regarding possible systems changes that may increase system efficiency, with a consequent potential increase in project profitability.

Performing a RAM Study will help to address the following issues:

- detection of failures in the early stages of design;
- optimization of the maintenance schedule;
- allocation of adequate reserves in the spares inventory;
- increasing the effectiveness of logistics;
- identification of equipment priorities on failures.