HEALTH AND SAFETY INFORMATION
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QUANTIFIED RISK ASSESSMENT TECHNIQUES (PART 1)

Failure Modes and Effects Analysis – FMEA

Introduction

Previous Health and Safety Briefings have discussed risk assessment:

- Risk Assessment – Practical Application in the Workplace – (December 1997)
- Risk Assessment – Legal Position and Interpretation – (September 1997)

In this and in two subsequent Briefings, some specific risk assessment techniques will be outlined. The first technique to be covered in this way is Failure Modes and Effects Analysis – FMEA. It must be emphasised that this brief treatment is intended to be illustrative rather than definitive.

FMEA

This is an analytical technique, which explores the effects of failures or malfunctions of individual components in a system - i.e. "If this part fails, in this manner, what will be the result?" First the system under consideration must be defined, so that system boundaries are established. Thereafter the essential questions are:

1. How can each component/part fail?
2. What might cause these modes of failure?
3. What could the effects be if the failures did occur?
4. How serious are these failure modes?
5. How is each failure mode detected?

The level of risk is determined by:

Risk = probability of failure x severity category

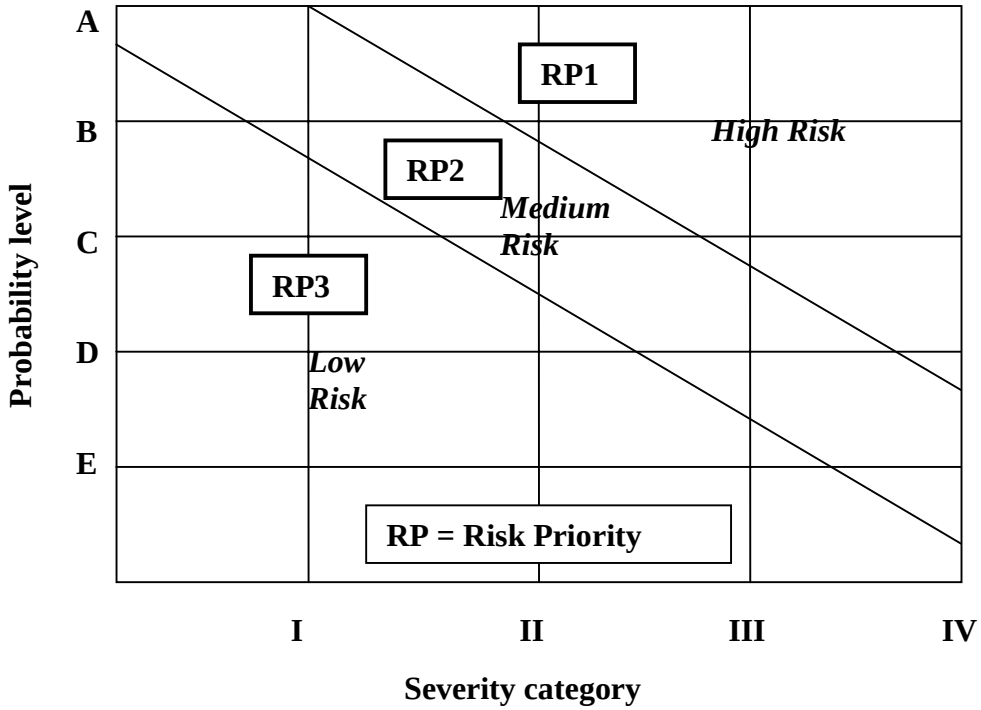
Where severity may be categorised thus:

Category	*Degree*	*Description*
I	**Minor**	Functional failure of part of machine or process – no potential for injury
II	**Critical**	Failure will probably occur without major damage to system or serious injury
III	**Major**	Major damage to system and/or potential serious injury to personnel
IV	**Catastrophic**	Failure causes complete system loss and/or potential for fatal injury

And probability may be categorised thus:

Level	*Probability*	*Description*	*Individual failure mode*
A	**10^{-1}**	**Frequent**	Likely to occur frequently
B	**10^{-2}**	**Probable**	Likely to occur several times in the life of an item
C	**10^{-3}**	**Occasional**	Likely to occur sometime in the life of an item
D	**10^{-4}**	**Remote**	Unlikely to occur but possible
E	**10^{-5}**	**Improbable**	So unlikely that occurrence may not be experienced

A risk assessment matrix may then be prepared:



Application

A practical application of the FMEA technique would involve the completion of a worksheet in which the failure modes of individual components, such as relays and switches, are identified, evaluated and risk priority codes identified. A summary sheet can then be prepared in which failure modes are listed in declining order of risk priority codes. The summary should also list the corrective measures required to reduce the frequency of failure or to mitigate the consequences. Corrective actions could include changes in design, procedures or organisational arrangements e.g. the addition of redundant features and detection methods or a change in maintenance policy may be suggested.
FMEA can be used for single point failure modes but can be extended to cover concurrent failure modes. It can be a costly and time consuming process but once completed and documented it is valuable for future reviews and as a basis for other risk assessment techniques such as Fault Tree Analysis and Event Tree Analysis.

References and Further Reading

- British Standards Institute (1988): BS 5760 Reliability, Availability, Maintainability and Failure Modes and Effects Analysis.
- US Department of Defense (1980): Military standard procedures for performing FMEA (Mil-Std-1629). Washington DC.
- IEC 812 – Procedure for FMEA
- CEI/IEC International Standard (1998): IEC 61508 - Functional Safety of Electrical/ Electronic/ Programmable Sytems. IEC Publications.