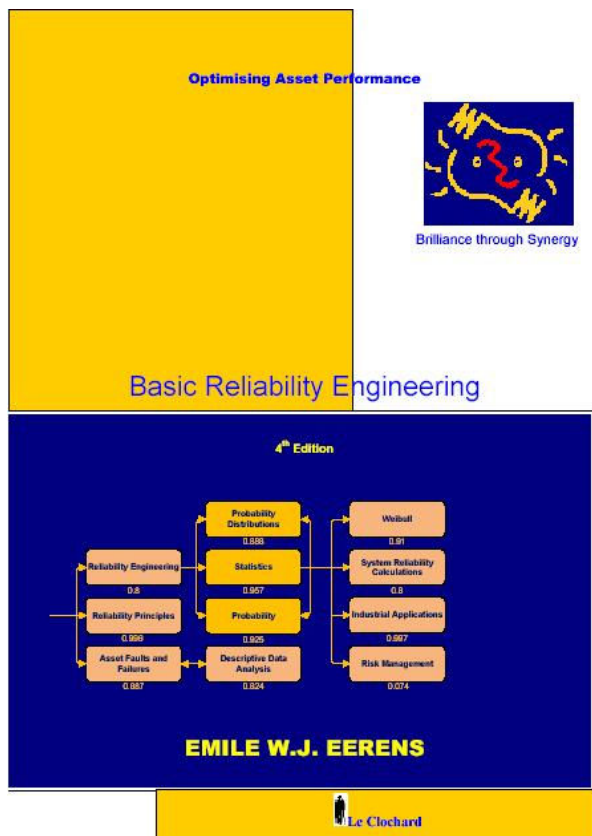




Audience Profile

The manual is suitable for everybody seeking to improve the reliability of their physical assets and who would like to be able to analyze and forecast reliability and, subsequently, forecast the relationship between investment in assets or improvement and business outcomes. The manual systematically guides you through various reliability assessment techniques and discusses risk assessment and management. In particular, Asset owners, Asset Managers, Engineers, Planners, Trades' Persons, Operators, Finance Managers, Safety Officers and all those who contribute in their roles of first-line (operators and maintainers) and second-line (engineering, designers, logistics, admin, workshops, etc.) asset managers to asset performance.



Objectives

To provide:

- the knowledge, understanding and skills to perform reliability analyses to optimize the quality and quantity of asset outputs (revenue), minimize risk and the use of inputs (costs)
- knowledge for the most effective and efficient asset design, operation and maintenance
- methods and examples to assist with the easy implementation of the various technique and achieving the changes espoused in the theory.

What makes our approach different?

We unravelled the confusing use of terms in various reliability engineering literature by providing the different names used for the same phenomenon and the different phenomena given the same name in the various literature.

We intended to explain reliability engineering concepts in simple terms and explain all mathematical concepts, so that reading this manual does not require a pre-existing working knowledge of mathematics or reliability.

We provide a practical approach and provide many examples that assist in understanding and implementing the various techniques, without covering an overwhelming variety and depth of techniques of which only a small percentage may be needed. We recommend readers to access the internet and search for solved examples of the various mathematical and reliability techniques and try solving those problems before reviewing the solution, as we found that a worked-out example is always easy to understand and makes sense, but developing a solution yourself is a lot harder.



Contents

1. Reliability Engineering Explained

Historic development of reliability engineering
What is reliability engineering?
What are the objectives and goals of reliability engineering?
How does reliability engineering link to asset management?
Definitions and acronyms
What are the benefits of applying reliability engineering?
Why should you consider using reliability engineering?
What is the reliability engineering process?
How should you implement reliability engineering?

2. What Are the Reliability Principles?

Desired learning outcomes
Introduction
How does quality or fit for purpose compare to reliability?
How does reliability link to life cycle costs?
How to design for reliability?
What are the effects of manufacturing and installation on reliability?
What are the effects of operations and operability on reliability?
What are the effects of maintenance and maintainability on reliability?
Which reliability measures are available?
Quality
Reliability, availability and maintainability

Main outcomes of Chapter Two

Exercise

3. What Are Asset Faults and Failures?

Desired learning outcomes
What are faults and failures?
What are the six patterns of failure?
What is wear-out failure?
What is the bathtub curve or hazard function?
What is slowly aging?
What is the best new failure mode?
What is random failure?
What is wear-in failure?
Common mode failures
What are characteristics of age-related failures?
What are characteristics of non-age-related failures?
Failure analysis
What data do you use in performance analysis?
What data to collect?
What is the generic parts count method?
What is the failure rate?
How to work out the mean life of items?

Main outcomes of Chapter Three

Exercise

4. How to Perform Descriptive Data Analysis?

Desired learning outcomes
What is the purpose of quantitative techniques?
What decisions do you make in maintenance?
Classification of maintenance problems
Purchasing decisions
Replacement decisions
Inspection decisions
Overhaul and repair decisions
Resourcing decisions
How to analyse failure data with descriptive statistics?
What is tabulation?
How to graphically represent data?

How to perform trend analysis?

What are failure distributions?

Comparing data to a distribution

Main outcomes of Chapter Four

5. How Do You Apply Statistics?

Desired learning outcomes
Numerical characterisation of data
What are the measures of central tendency?
What are the measures of variation?
What are populations and samples?
Six sigma
What are inferential statistics?
Main outcomes of Chapter Five
Exercise 3
6. What Is Probability?
Desired learning outcomes
Introduction
What are permutations and combinations?
What are probability and probability theorems?
What is probability?
Which symbols appear in probability theory?
What are the probability axioms and theorems?

Main outcomes of Chapter Six

Exercise 4

7. What Are the Probability Distributions?

Desired learning outcomes
General cautions
Probability distributions
What are the discrete distributions?
What are the continuous distributions?
Which distribution to choose?
How to determine confidence levels?
How to calculate confidence levels for normal distributions?
How to calculate confidence levels for log-normal distributions?
How to calculate confidence levels for negative exponential distributions?
When do you use confidence limits

Main Outcomes of Chapter Seven

Exercise 5

8. What Is the Weibull Distribution?

Desired learning outcomes
How to perform a Weibull analysis?
What is the Weibull slope or shape parameter β ?
What is the scale parameter or characteristic life η ?
What is the location parameter or minimum life γ ?
How to use Weibull graph paper?
A large sample Weibull analysis
How to deal with grouped data?
What is the plotting age for grouped data?
Large sample Weibull analysis 2
Small sample Weibull analysis
How to calculate Weibull results?
What do you do with suspended items?
Main outcomes of Chapter Eight
Exercise

9. How to Calculate System Reliability?

Desired learning outcomes
What are static reliability models?
What are functional and reliability block diagrams?



Conventions

How to solve series systems?

System reliability

The equivalent part probability P_c

Series of identical parts

Grouped parts or part families

Series systems using the failure rate λ

How to solve redundant systems?

Parallel system reliability

The MTBF for parallel systems

Availability for parallel systems.

How to solve an active parallel configuration with partial redundancy?

How to solve inactive parallel or stand-by redundancy?

What are the effects of parallel units?

How to solve parallel and series combinations?

Low level or part redundancy

High level or system redundancy

Reliability analysis with system reduction

Writing formulas

Main outcomes of Chapter Nine

Exercise

10. What Are Industrial Applications of Reliability Analysis?

Desired learning outcomes

Introduction

Reliability, availability and maintainability in an asset's life cycle

What types of reliability analyses can you use?

What are reliability audits?

What are reliability reviews?

What are reliability assessments?

Which reliability analyses techniques should you use?

What are the reliability aspects in contracting?

Accurate reliability specification

Avoid ambiguity in contracts

What is reliability testing?

Test terminates once a pre-assigned number of failures happen

Test terminated at pre-assigned time

Successive reliability testing

Testing with the Binomial Distribution

Main outcomes of Chapter Ten

11. How to Manage Risk with Reliability Tools?

Desired learning outcomes

What is risk analysis and management?

What is risk?

What is the definition and measurement of risk?

Risk statistics

What risk analysis techniques are available?

What is the probabilistic risk assessment methodology?

What are hazard & operability analyses?

Introduction

At what times do you perform hazards and operability analyses?

Site and process selection

Site layout design

Final design

Process or asset construction

Commission the process or asset

After obtaining meaningful operational experience

When considering process or asset change

How to perform the HazOps analysis?

Which HazOps analysis sheets do you use?

The standard Sheet

The extended Sheet

The final HazOps report

What are the benefits of Hazops?

What Are the Disadvantages of HazOps?

Is a HazOps Analysis Consistent?

What Are Time Sequence Models?

What Are the Gate/Logic and Event/Terminal Symbols?

What Are Fault or Success Trees?

What Are Event Trees?

What Is a Cause-Consequence Analysis?

What Are Logic Trees?

What Are Cause and Effect Diagrams?

Main Outcomes of Chapter Eleven

Exercise

Solutions to Mathematical Exercises:

Bibliography