

# Corso "How to Analyze Reliability Data"

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FIRENZE

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## Purpose.

The purpose of Reliability Engineering is to design, develop, test, manufacture, service, and manage reliable products that have long life and durability and are cost effective. Thus product reliability (i.e., life) is an important measure of quality. The purpose of this course is to advance reliability engineering and management. This advance will yield improved products and competitiveness.

## Audience.

This advanced course is designed for engineers, managers, and students concerned with product reliability. Course participants would benefit from a previous statistics course, but such a course is not required. Participants would also benefit from industrial and reliability experience.

## Benefits.

Course participants will learn to efficiently collect and analyze test lab and field data to obtain needed information for improving and managing products. In particular, they will learn the latest best practice

- to plan reliability tests and to collect valid useful product life data from field service,
- to measure product reliability and to predict warranty costs, failures, and maintenance needs,
- to verify if a product life meets reliability demonstration requirements of customers,
- to compare the life of competing product designs, components, materials, manufacturing methods, maintenance policies, etc.,
- to extract information from product repair and warranty data, which require new methods,
- to communicate resulting information to coworkers and management,
- to survey suitable computer programs for such data analyses and other sources of information.

The course methods are illustrated with reliability data from products from various industries, including automotive, computer, electronics, household appliance, electric and nuclear power.

## **Content.**

### Day One Morning

#### **1. LIFE AND STRENGTH DISTRIBUTIONS**

Basics Concepts: Exponential Distribution, importance of product reliability, cumulative distribution function (cdf), exponential distribution, locomotive fan application, exponential plotting paper, reliability function, percentiles, probability density, mean, hazard (failure rate) function, bathtub curve, special distributions.

Normal Distribution: cdf, transformer application, normal plotting paper, reliability function, probability density, percentiles, hazard function.

Weibull Distribution: cdf, windings application, Weibull paper, reliability function, probability density, percentiles, hazard function.

Lognormal Distribution: cdf, locomotive control, lognormal paper, reliability function, probability density, percentiles, hazard function, relationship with normal distribution.

Binomial Distribution: probability density, locomotive control application, cdf, normal approximation, mean, acceptance sampling.

Competing Failure Modes: series-system model, product rule, three-way bulb application.

### Day One Afternoon

#### **2. GRAPHICAL ANALYSIS OF RELIABILITY DATA**

Background: advantages of data plots, population and sample, valid data, failure and usage, types of data (complete, singly censored, multiply censored, interval, competing failure modes), information sought.

Plot Complete Data: connection strength data, plotting positions, interpretation and estimates from the plot.

Plot Singly Censored Data: electronic control data, plotting positions, interpretation and estimates from the plot.

Plot Multiply Censored Data: locomotive fan data, plotting positions, interpretation and estimates from the plot.

Plot Data with Competing Failure Modes: connection strength data, all modes acting, a single failure mode, failure modes eliminated.

### Day 2 Morning

#### **3. COMPUTER ANALYSIS OF RELIABILITY DATA**

Background: information sought, estimates, confidence limits, model checks.

Exponential Analysis: locomotive fan application.

Weibull Analysis: locomotive fan application.

Normal Analysis: connection strength application.

Lognormal Analysis: electronic control application.

Competing Failure Modes: connection strength application.

Computer Programs: a survey.

Day 2 Afternoon

**4. REPAIR DATA ANALYSIS**

Background: repair (recurrence) data, automatic transmission, information sought.

Model: history functions, mean cumulative function (MCF), recurrence rate, Poisson process.

MCF: estimate, plot, confidence limits, interpretation.

Compare MCFs: automatic and manual transmissions.

Computer programs: a survey.

**5. SURVEY OF OTHER TOPICS**

Comparisons, regression models, accelerated test models, useful references.

APPENDIX A. STATISTICAL TABLES

APPENDIX B. REFERENCES

Participants are encouraged to bring their test plans and data to the course for discussion and analysis.

**Text.**

The course uses Nelson, Wayne, *HOW TO ANALYZE RELIABILITY DATA*, booklet in The ASQC Basic References in Quality Control: Statistical Techniques, Vol.6, (Feb.1983), Amer. Soc. for Quality Control, 611 E. Wisconsin Ave, Milwaukee, WI 53201. This sold more copies than any other Basic Reference. It was translated into Italian by the Centro Tessile Cottoniero and published by Editoriale Itaca of Milan, 1991.

**Instructor.**

**Dr. Wayne Nelson** is a leading expert and private consultant and instructor on reliability data analysis and accelerated testing. For 25 years he consulted across the General Electric Co. and received the Dushman Award of the Corp. R&D for developments and applications of product reliability data analysis. He was elected a Fellow of the Amer. Statistical Assoc. (1973), the Amer. Soc. for Quality (1983), the Institute of Electrical and Electronics Engineers (1988) for his innovative developments. He was awarded the 2003 Shewhart Medal of ASQ and the 2005 Lifetime Achievement Award of IEEE for outstanding developments and reliability education. He authored three books *Applied Life Data Analysis* (Wiley 1982), *Accelerated Testing* (Wiley 1990, 2004), *Recurrent Events Data Analysis* (SIAM 2003), two ASQ booklets, and 120 journal articles. [www.members.aol.com/WNconsult](http://www.members.aol.com/WNconsult) provides more details.

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***Il corso sarà tenuto in lingua inglese***