8th Successful Run in Asia!

RELIABILITY ENGINEERING

24 – 28 JULY 2017, KUALA LUMPUR, MALAYSIA

TOPICS COVERED

- Reliability Engineering Concepts & Application
- Human Error & Reliability
- Degradation Mechanisms
- Risk Management
- Reliability Centered Maintenance (RCM)
- Risk Based Inspection (RBI)
- Instrumental Protective Functions (IPF)
- Failure Mode, Effects and Critically Analysis (FMECA)
- Fault Tree and Event Tree Analysis
- Reliability Block Diagram Modelling
- Simple and Complex Weibull Chart Exercise
- Data Sources
- Getting The Basics Right (GTBR)

Expert Course Faculty Leader

V Narayan

About the Reliability Engineering Course

The reliability of a Plant or Facility determines its performance – process safety, environmental and cost performance all depend on it. It is thus a pivotal driver, which we can use to make significant business gains. Unfortunately it is often seen as a black art, best left to mathematicians or other specialists. This practical training course will show you that it is easy to understand and explains how to use data from operating and maintenance records and get the results.

Learning Outcome

The links between maintenance and reliability, and the effect of Reliability on Process & Environmental Safety, Production volume and maintenance costs will become clear.

By attending this 5 day training course, you will acquire the following:

- Learn reliability terms, their definitions and its use.
- Practice exercises to determine e.g., MTBF, MTTR, Scale and Shape factors etc. and learn how to use these to determine maintenance strategies and operating philosophies.
- Find out how Plant availability depends on reliability and see how configuration affects the outcome.
- Study different failure distributions and see why these matter. Exercises on spares holdings will show them how to optimize these to meet service level and cost considerations.

A number of tools including RCM, RBI, FMECA, IPF, RBD, FTA, ETA, and Modelling will be covered briefly, so that you know what to use where. Failure analysis using RCA will be discussed. The Business Process to manage Reliability Improvement and a roadmap to achieve high performance will be included.

Who will benefit from this training?

Engineers from industries including Oil & Gas (Upstream and Downstream), Power Generation, Chemicals, Pharmaceuticals and Manufacturing can apply the learning to their advantage. They can be from Production, Maintenance, Projects, Design and Inventory Management teams.

For optimal results, a University degree in Science or Engineering is desirable, as some mathematical background knowledge is necessary. Managers, supervisors or support staffs from different disciplines are all suitable.


A copy of this book will be issued free to all participants at this course and will be utilised during the training conducted by the author.

This training course has a limited attendance for up to 20 participants only.

Sessions commence at 9am on all days, with short intervals at 10.30am and 3.30pm respectively.
Refreshments will be provided in the short intervals.
Lunch will be provided at 12:30pm for 1 hour. Sessions will end at 5pm on all days.
5 Days Course Outline

**DAY 1**
0830hr  Welcome, Introduction & Safety Issues
- Objectives
- Expectations from delegates
- Discussion – how good is your facility reliability?

0910hr  Reliability Engineering Concepts
- Terminology and definitions
- Probability and Likelihood of Failure
- Understanding basic statistical concepts:
  - Mean, Median, Mode, Standard Deviation, Normal Distribution
- Failure Histograms
- Class room exercise
- Failure distributions; simple analyses

0950hr  Morning Refreshment Break

1010hr  Reliability Engineering Concepts (Cont’)
- Probability Density Function, Hazard Rates
- Class room exercise
- Different Distributions
- Class room exercise
- Metrics – MTTF, MTBF, MTTR
- Relationship between Reliability, Availability & Maintainability
- The Bathtub Curve
- How to use reliability information for maintenance

1230hr  Lunch

1315hr  Reliability Engineering Application
- Tools overview; RBDs, Reliability Modelling, FTA/ETA, FMECA, RCM, RBI, RCA
- Computing value added, performance metrics
- Making a Business Case

1500hr  Afternoon Refreshment Break

1520hr  Human Error & Reliability
- People, Process and Plant; Reliability Tripod
- Human Error major contributor to unreliability
- Understanding Human Error
- Physiological & Psychological Stress
- Rule, Skill and Knowledge based errors
- Error prone situations
- Managing Error

1640hr  Homework & Close of Day 1

**DAY 2**
0830hr  Review of Day 1 & Homework

0850hr  Degradation Mechanisms
- Wear, Corrosion, Fatigue, Creep, Erosion
- Physical process – tyres & potholes, crack propagation
- What do we understand by the term Maintenance?
- Failure Patterns
- Age-related and non age-related failures
- Managing Degradation – Appropriate Tasks

1000hr  Morning Refreshment Break

1020hr  Risk Management
- What is Risk?
- Quantitative Risk
- ALARP and Residual Risk
- Qualitative Risk
- Decision Making
- Selling ideas

1115hr  Introduction to Reliability Centred Maintenance (RCM)
- Maintenance in context (includes video presentation)
- Why RCM is different
- The seven RCM questions
- The Operating Context
- Failure Mode and Effect Analysis
- Simple RCM Exercise – Kettle
- Where to use RCM
- RCM in Oil & Gas and Process Industry

1200hr  Introduction to Risk Based Inspection (RBI)
- Corrosion Circuits
- Corrosion Rates; Design & Actual
- Probability of failure, Susceptibility to failure
- Consequences; HSE, Production loss, Asset damage
- Process steps, Criticality, Confidence Rating, Inspection Interval factor, Remnant life, Next Inspection Interval
- Non Age-Related failures
- Strategy based tasks
- Where to use RBI

1230hr  Lunch
**DAY 3**

**0830hr** Review of Day 2 & Homework
- Histograms
- Probability Density Function

**0845hr** Revision of Topics To Help Us In Exercises
- Histograms
- Normalizing Histograms
- Probability Density Function, computing $F(t)$, $R(t)$, $z(t)$

**0915hr** Exercises
- Histogram plotting
- Normalizing Histograms
- Probability Density Function, computing $F(t)$, $R(t)$, $z(t)$

**1000hr** Morning Refreshment break

**1020hr** Exercises – Simple Weibull Chart
- Arranging the data set
- Distribution of rank order, Benard’s approximation
- Median ranks
- Plotting the data points, best-fit line
- Outputs: Shape and scale factors, $B_{10}$, $B_{1}$, $B_{.1}$, $B_{.01}$
- Computing the pdf chart values
- Forecasting failures
- Weibull Video

**1230hr** Lunch

**1315hr** Exercises – Reliability Block Diagrams
- Series RBD example
- Parallel RBD example
- Bridge RBD example
- Laboratory Ovens
- Nested RBDs

**1500hr** Afternoon Refreshment Break

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**1315hr** Introduction to Instrumental Protective Functions (IPF)
- IPF vs. Process Control
- Cause-Consequence charts
- Process Demand Categories
- Consequences; HSE, Production loss, Asset damage
- Safety Integrity Levels
- Implementation
- Spurious Trips/Alarms; Safe Failures
- Testing, Coverage Factor and Maintenance
- Where to use IPF

**1345hr** Introduction to Failure Mode, Effects and Critically Analysis (FMECA)
- Failure Mode and Effect Analysis
- Probability and its ranking
- Detectability of Failure and its ranking
- Consequence and its ranking
- Risk Priority Number – Criticality
- Where to use FMECA

**1415hr** Introduction to Fault Tree And Event Tree Analysis
- Terminology, Symbols, and Notation
- Logic Diagrams
- Assigning probabilities
- Incorporating Human Error
- Where to use FTA, ETA

**1445hr** Recap of RCM, RBI, IPF, FMECA, FTA, ETA

**1515hr** Afternoon Refreshment Break

**1535hr** Introduction to Reliability Block Diagrams, Modelling
- System Reliability
- Series RBDs
- Parallel RBDs
- Complex RBDs, Nested RBDs
- Bridge RBDs
- System Analysis
- System Analysis and Modeling ¬
- Analytical and Simulation Models

**1640hr** Homework & Close of Day 2
## 1520hr  Exercises – More Complex Weibull Charts
- Suspended data points
- Censoring, Effect on ranks
- The effect of preventive maintenance
- Applying Benard’s approximation to get median ranks
- Plotting Weibull chart points
- Plotting the data points, best-fit line

## 1610hr  Data Sources
- Run length data; run meters, DCS, operating logs
- CMMS; failure data, history text
- Operators and Maintainers as sources
- Publicly available sources, OREDA, IEEE
- Errors in data sources, Independent & Identical conditions

## 1625hr  Summary & Questions

## 1640hr  Homework & Close of Day 3

### DAY 4

#### 0830hr  Review of Day 3 & Homework

#### 0845hr  The Reliability Improvement Process
- An important business process
- Pre-requisites, Elements and Structure

#### 0915hr  Pre-Requisites
- Asset Register, Audits
- Data required for Reliability Improvements

#### 1000hr  Morning Refreshment Break

#### 1020hr  Managing Human Reliability
- Competence
- Motivation
- Behaviour

#### 1040hr  Getting The Basics Right (GTBR)
- OEE & TPM
- Lubrication
- Joint Tightness
- Alignment
- Balancing
- Failure Elimination Culture

#### 1230hr  Lunch

## 1315hr  Planning
- Reliability – Planning objective
- Tools and Techniques
- Top Performers and Planning

## 1400hr  Scheduling
- Scheduling objectives
- Minimizing Production Losses
- Maximizing Productivity
- Managing Work Period Timing effectively
- Managing Effective Communications

## 1440hr  Work Preparation
- The Follow-Through matters
- Infrastructure and Logistics
- Work Permits
- Equipment Readlines

## 1505hr  Afternoon Refreshment Break

## 1525hr  Condition Based Maintenance
- Technical and Business case
- Process Steps
- Application Examples
- Effectiveness & Measurement

## 1620hr  Compliance
- Definition
- Availability and Compliance

## 1640hr  Homework & Close of Day 4

### DAY 5

#### 0830hr  Review of Day 4 & Homework

#### 0845hr  Implementation of Reliability Improvements
- When & Where to apply – Selection of Projects
- Preparing the ground

#### 0855hr  Project Selection
- Knowledge of current performance
- Identify Critical Systems
- Identify Poor Performers
- Set Objectives
- Sponsor, Terms of Reference, Budget
- Socratic Method

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Your Expert Course Faculty

V. Narayan

V. Narayan retired from The Royal Dutch Shell Group of Companies in 2002, after a distinguished career in maintenance and project engineering.

As the Head of Maintenance Strategy Group, Shell UK Exploration and Production, he was involved in the following assignments:

- Created a new process and authored a standard to build in Reliability into new Projects. This process, called ‘Operations in Projects’ is now extensively used in all major Shell Projects. This clear Business Process enables Shell to maximise Life Cycle Net Present Value by designing lean Plants with high Reliability.
- Created a comprehensive Reliability Database, using failure records from 15 Offshore Platforms over a 17 year period and applying Weibull analysis. It includes a Relief Valve Database analysing some 14000 test bench records, as well as one for Gas, Heat and Smoke Detectors.
- Managed the Internal Consultancy Services and later extended it to other Shell Companies as Head of Shell’s Centre of Excellence for the E&P sector. Provided Training and Consultancy Services to Shell Companies in Brunei, Philippines, Argentina, Australia, Gabon, Nigeria and Oman.
- Was the Custodian of Shell Standards relating to Maintenance Strategy.
- Was a regular lecturer in RCM at the Shell Training Centre in Holland, conducting 14 sessions over an 8 year period.
- Carried out a Maintenance Review of Shell Gabon’s Oil Production Facilities.

As Maintenance and Reliability Adviser, Shell International, The Hague, he was involved in the following:

- Created Shell’s process and Performance Indicators, for Bench-Marking Maintenance Performance of Refineries and Gas Plants. This methodology is still in use today.
- Carried out a Maintenance Audit of Woodside Petroleum’s LNG Plant in Western Australia.
- Coordinated the Shell Group Refineries participating in the external Bench-Marking studies conducted by Solomon Associates Inc.
- Facilitated a major Root Cause Analysis at a Shell Chemical Plant in The Netherlands.
- Carried out a review of a major Shutdown execution at Pernis, the largest Shell Refinery, identifying significant improvement opportunities. Many of these are now embedded in their planning process.
- Carried out an audit of the Planning of the largest Shutdown at Shell’s Stanlow Refinery.

- Was a founder member of the Shell MERIT team, which made major improvements to Refineries’ maintenance performance. Shell now sells this process to third parties.
- Identified best practices and opportunities for business improvement in fields of reliability, maintenance, inspection and projects in Shell Refineries, and Gas Plants.
- Created and edited Shell’s Reliability Newsletter promoting best maintenance and operating practices and techniques worldwide.

He has published many articles and presented papers at International Conferences. He has worked in the upstream and downstream Oil and Gas Industry sectors, Engineering, Automobile and Pharmaceutical Industries. He has worked in several countries and cultures, including Saudi Arabia, India, Malaysia, the Netherlands, and the United Kingdom. He is currently on the faculty of Shell Open University and Robert Gordon University, Aberdeen, in their MSc programme in Asset Integrity.
# RELIABILITY ENGINEERING

**24 – 28 JULY 2017, KUALA LUMPUR, MALAYSIA**

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- By Cheque/ Bank Draft: Make Payable to PowerEdge Pte Ltd.
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All bank charges and payment in Singapore dollars (SGD) to be borne by payer. Please ensure that PowerEdge Pte Ltd receive the full invoiced amount.

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## 4 ways to Register

- Online Web Registration
  - info@poweredgeasia.com
  - (65) 6747 9927
  - (65) 67478737

## RELATED TRAINING

- Maintenance Planning and Scheduling
- Competency Management System for the Power Industry
- Fundamentals of Power Generation for Non-Technical Professionals

## ON SITE TRAINING

Can’t make it for the Course? We’ll make the course come to you!!

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