Reliability Centered Maintenance (RCM)

11th-12th May 2017, Kuala Lumpur, Malaysia

CHAIRMAN OF VIBRO-ACOUSTIC MONITORING, CO - CHAIRMAN OF THE CONDITION MONITORING TECHNICAL COMMITTEE, BRITISH INSTITUTE OF NDT

Prof Len Gelman, is an expert in maintenance planning and scheduling, preventive and predictive maintenance, vibration and condition monitoring, reliability centered maintenance (RCM).

COURSE INTRODUCTION

Reliability centered maintenance (RCM) is a corporate-level maintenance strategy that is implemented to optimize the maintenance program of a company or facility. The final result of an RCM program is the implementation of a specific maintenance strategy on each of the assets of the facility.

This course is designed to build competency in RCM and to enhance the equipment reliability and overall plant productivity. It covers all the fundamentals of RCM that a suitably qualified professional that would be expected to carry out during his duty starting with the first steps and building up to a fully functional advanced maintenance.

WHO SHOULD ATTEND

It is recommended that all maintenance, reliability, engineering and technical staff including leadership and management attend this training.

Namely: plant managers, maintenance managers, maintenance superintendents and foremen, maintenance engineers, reliability and safety engineers, operator supervisors and operators and maintenance planners and schedulers who are directly and not directly involved in the plant maintenance activities.
Course Agenda

Day One

- Introduction
- Definitions of Maintenance and Reliability Centered Maintenance
- RCM: the Main Concepts and Seven Basic Questions
- Build Systematic RCM Strategies for Your Organization:
  - Preventive/Time Based Maintenance
  - Predictive Maintenance/Condition Based Maintenance
  - Run to Failure/Breakdown Maintenance
  - Proactive Maintenance
  - Maintenance by Redundancy
  - Opportunity Maintenance
  - Opportunistic Maintenance
  - Corrective Maintenance
- Classification of Day to Day Maintenance Jobs
- The Key People in RCM: a Planner, a Maintenance Supervisor, a Craftsman, Storeroom Personnel, an Operations Superintendent and Operator
- Flow Chart of Maintenance Planning and Scheduling for RCM
- Work Orders: Top Ten Essential Estimations
- Work Orders: Industrial Case Studies
- Maintenance Planning Principles for RCM
- Maintenance Scheduling Principles for RCM
- The Key RCM Metrics: Reliability, Mean Time Between Failures, Mean Time to Failure, the Instantaneous Failure Rate, Equipment Availability and Maintainability, Mean Time to Repair
- Practical Exercises on Reliability for RCM
- Outsource RCM vs In-House RCM: What Works Best for Your Organization?
- Spare Part Management and Outsourcing for RCM
- Operations vs Maintenance: Aligning Operational Requirements with Maintenance Capabilities
- Cost Benefit Analysis for RCM
- Life Cycle Cost Analysis for RCM
- Life Cycle Cost Analysis for RCM: Industrial Case Study
- RCM: Seven Stages Process
- Functions: Primary and Secondary
- Failures: Potential and Functional
- The P-F Interval, the Net P-F Interval and Multiple P-F Intervals
- Estimation of Optimum Maintenance Interval for Predictive and Preventive Maintenance
- Estimation of Optimum Maintenance Interval for Predictive and Preventive Maintenance: Industrial Case Studies
- The Operating Context
- The Operating Context: Industrial Case Studies
- Failure Modes (outlines are on a separate sheet)
- Hidden and Evident Failures
- Failure Effects
- Failure Consequences:
  - Hidden Consequences
  - Safety and Environmental Consequences
  - Operational Consequences
  - Non-Operational Consequences

Day Two

- Principles of Root Cause Analysis of Failures for RCM; an Approach of Six Root Causes
- The Generic “Eight Disciplines Problem Solving” Technique for Root Cause Analysis
- HAZOP (Hazard and Operability Study) for Root Cause Analysis
- Root Causes of Assets Failures: Description
- Planning Industrial Root Cause Analysis for RCM: 17 Industrial Case Studies (outlines are on a separate sheet)
- Planning Failure Assessment for RCM: 9 Classical Steps
- Failure Assessment for RCM: Industrial Case Studies
- Failure Assessment Reports
- Six Patterns of the Instantaneous Failure Rate: Traditional View, Bathtub, Slow Aging, Best New, Random Failure and Worst New
- Relationship Between the Failure Rate Pattern and Maintenance Type Selection for RCM
- Failure Management for RCM: Proactive Maintenance and Default Maintenance
- Proactive Maintenance:
  - On-Condition Maintenance
  - Repair Maintenance
  - Replacement Maintenance
- Default Maintenance:
  - Failure-Finding Maintenance
  - Maintenance by Redesign
  - Run-to-Failure Maintenance
- Determining When to Prevent Failure and When to Allow Failure to Occur; Replace, Maintain or Refurbish: Optimally Planning Your Next Maintenance Action; Optimal Selection of Maintenance Type
- Logic Diagram for Optimal Selection of Maintenance Type
- Failure Mode and Effect Analysis (FMEA)
- FMEA: Ranking Criteria and Industrial Case Studies
- FMEA: Practical Session
- Failure Mode, Effect and Criticality Analysis (FMECA)
- FMECA: an Industrial Case Study

PRE-COURSE QUESTIONNAIRE

In order for this workshop to fully benefit you, a pre-course questionnaire will be sent to you in order to test the area where your training needs lies. The results from this questionnaire will ensure that this entire workshop will be delivered at the level that is catering to your needs.
Optional Part (subject to client interest)

- RCM Control: an Audit
- Risk Analysis, Hazard Analysis and Risk Based Maintenance
- Event Tree Analysis for Risk Based Maintenance

Workshop of Failure Mode and Effect Analysis (FMEA)
Workshop to undertake a FMEA of a specific machine/equipment:

- Review design and operation of chosen machine/equipment
- Review failure history and failure modes
- Review root causes of failure modes; estimate root cause occurrences
- Review failure consequences; estimate severities of consequences
- Review detection/diagnosis capabilities
- Estimate the risk priority numbers
- Assign optimised maintenance tasks/frequencies

Titles of Case Studies & Failure Modes

1. Root Causes of Failure for RCM: 17 Case Studies:
   - Maintenance of two stage vertical pumps
   - Maintenance of a vacuum exhauster
   - Maintenance of an engine turbocharger
   - Maintenance of a steam turbine
   - Maintenance of a primary air fan
   - Maintenance of two large fans
   - Maintenance of a turbine generator
   - Maintenance of a gas turbine gearbox
   - Maintenance of an oil pump bearing
   - Maintenance of a boiler fan bearing
   - Maintenance of an axial compressor
   - Maintenance of a motor bearing
   - Maintenance of a furnace
   - Maintenance of a fan
   - Maintenance of a turbine bearings
   - Maintenance of a gas turbine
   - Maintenance of a fan for power generation

2. Case Studies for Predictive RCM; Condition Monitoring of:
   - Damage in gearboxes
   - Fatigue damage in rotating units (blades, shafts, discs, etc.) of turbomachinery
   - Faults in mechanical parts of reciprocating machinery (e.g. diesels, reciprocating compressors, etc.)
   - Rolling Element Bearing Faults

3. Operating Context for RCM: 2 Case Studies:
   - Maintenance of a diesel
   - Maintenance of pumps

4. Failure modes for RCM:
   - Fatigue
   - Fracture
   - Wear
   - Creep
   - Buckling
   - Corrosion
   - Yielding

Expert Trainer Profile

Prof. Len Gelman

Prof. Len Gelman (UK) holds PhD and Dr. of Sciences (habilitaton) degrees. He has trained and consulted the industry across the world. He is the author of over 200 publications (including 17 patents, 2 books and 2 book chapters) in the areas of maintenance, condition monitoring of complex mechanical systems and root cause analysis. Prof. Gelman has over 35 years of real-life industrial experience in maintenance.

He has developed and delivered training programs worldwide for both offshore and onshore facilities, including maintenance planning and scheduling, machinery failure analysis and preventon, reliability centered maintenance, condition monitoring of machinery, risk assessment for producon and operators and problem solving and decision making.

Prof. Gelman is a Fellow of the British Institute of Non-Destructive Testing (BINDT) and UK Institute of Diagnostic Engineers, Chairman of the Condition Monitoring and Diagnostic Technology Technical Committee of the BINDT, President-Elect of the International Institute of Acoustics and Vibrations, Honorary Editor of the International Journal of Condition Monitoring and Chairman of the International Society for Condition Monitoring.


Prof. Gelman is a Chief Designer of numerous technologies and engineering prototypes for vibratoon fault detecton/diagnosis/isolation.
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