Life Cycle Engineering provides two eLearning courses that integrate relevant content and decades of best-practice benchmarking into performance-driven, self-paced online solutions.

- Create a set of standard processes and tools
- Onboard employees faster
- Reach geographically dispersed teams
- Use learning checks to validate competency
- Access the resource library containing practical tools, templates and guides

Designed by certified learning professionals who are also maintenance and reliability professionals (CMRP, CRL), and developed by a team of eLearning specialists using cutting-edge eLearning best practices and approaches.

Cost: $995
Discounted group rates available, and options for an unlimited user license hosted on your own system.

eRCM - Reliability Centered Maintenance online

eRCM integrates content from our Risk-Based Asset Management course with the prevailing Reliability Centered Maintenance standards.

- Asset hierarchy
- Asset criticality analysis
- Operational context, functions and performance standards
- Documenting the RCM analysis in an FMEA
- Selecting the right maintenance strategy
- Equipment maintenance plan (EMP)
- RCM program approach
- KPIs, metrics and continuous improvement

eMPS - Maintenance Planning and Scheduling online

eMPS transforms our most successful learning program, Maintenance Planning and Scheduling.

- Work management process overview
- Information system and equipment history
- Work order system and requesting work
- Estimating and measuring work
- Work planning
- Work scheduling
- Work execution, closeout and continuous improvement
- Work management metrics
# Table of Contents

## Training

Certification
- Maintenance Management Certification (MMC) ................................................................. 4
- Reliability Engineering Certifications (REC) ........................................................................ 5

Public Courses
- ISO55000 .................................................................................................................................. 6
- Maintenance Management Skills .............................................................................................. 7
- Maintenance Planning and Scheduling ................................................................................... 8
- Managing Planning and Scheduling ......................................................................................... 9
- Materials Management ........................................................................................................... 10
- Planning for Shutdowns and Outages ...................................................................................... 11
- Predictive Maintenance ........................................................................................................... 12
- Reliability Engineering ............................................................................................................ 13
- Reliability Excellence for Managers ......................................................................................... 14
- Risk Based Asset Management ................................................................................................. 16
- Root Cause Analysis ............................................................................................................... 17
- SMRP Body of Knowledge ....................................................................................................... 18

eLearning
- eMPS ...................................................................................................................................... 19
- eRCM ....................................................................................................................................... 20

3A Learning ................................................................................................................................ 21
- Facilitators Make the Difference ............................................................................................. 23

## Services

Asset Performance Improvement
- LCE’s Approach to Asset Performance Improvement .............................................................. 24
  - Reliability Excellence for Existing Plants and Facilities .................................................... 25
  - Strategic Alignment Workshop ............................................................................................ 26
  - Asset Management Consulting ............................................................................................ 27
  - Life Cycle Planning for Start-ups ......................................................................................... 28
  - Assessments .......................................................................................................................... 29
  - Risk-Based Asset Management ............................................................................................ 30
  - Machine Design FMEA ......................................................................................................... 31
  - RAM Analysis ....................................................................................................................... 32
  - Reliability Centered Maintenance ......................................................................................... 33

Learning, Leadership and Change
- Change Management Support ................................................................................................. 34
- Learning Design and Development ......................................................................................... 35
- Project Management ................................................................................................................ 36
- Rx Journey ................................................................................................................................. 37
- PoweredByRx.com ................................................................................................................... 38

## About Us ................................................................................................................................ 39
Reliability Engineering Certification (REC)

Secure knowledge and credentials from one of the world's largest and most respected engineering colleges.

With the Reliability Engineering Certification (REC), reliability engineers will be well-equipped to reduce risk and increase the value that assets deliver to the triple bottom line.

The REC builds and certifies individual competency in reliability engineering and asset management. Successful candidates will be able to apply reliability engineering to build asset management programs that are consistent with ISO 55000 Asset Management standards.

Participants learn how to:
• Create Asset Management Plans that comply with ISO 55000
• Build and sustain a strategic reliability engineering program
• Prepare control strategies that reduce risk and improve utilization
• Design predictive maintenance strategies and programs
• Establish a root cause analysis program

The REC requires completion of four three-day courses*, and documented application of reliability engineering in the form of a work product. Courses include:
• Reliability Engineering Excellence
• Risk-Based Asset Management
• Predictive Maintenance Strategy
• Root Cause Analysis

You will earn a total of 8.4 CEUs for all four courses.

*At least two courses must be taken at the university granting the certification.

Maintenance Management Certification (MMC)

Build and sustain a world-class Maintenance Program. You will learn practical skills that can be applied on the job right away, demonstrate your commitment to building a solid maintenance program, and increase your value to your organization.

This certification program will enable you to:
• Build and sustain a maintenance program
• Establish appropriate maintenance KPIs and visual management dashboard
• Select the optimum equipment maintenance strategy
• Implement work management strategies that improve asset availability and utilization
• Increase maintenance personnel productivity
• Build a problem-solving culture
• Manage an effective maintenance budget

To earn a Maintenance Management Certification (MMC), candidates must complete four courses and successfully pass the Maintenance Management Certification exam within three years.

Earn 9.5 CEUs.

Required courses:
• Managing Planning and Scheduling
• Maintenance Management Skills

Select two of the following electives:
• Predictive Maintenance Strategy
• Risk-Based Asset Management
• Root Cause Analysis
• Materials Management

*At least two courses must be taken at the university granting the certification.

Who Should Attend
The Maintenance Management Certification is designed for maintenance managers and professionals responsible for building and sustaining a world-class maintenance program.

“ I have the appropriate tools and skill sets to push my company’s maintenance program to become a world-class organization.”
Reliability Engineering Certification (REC)

Secure knowledge and credentials from one of the world’s largest and most respected engineering colleges. With the Reliability Engineering Certification (REC), reliability engineers will be well-equipped to reduce risk and increase the value that assets deliver to the triple bottom line.

The REC builds and certifies individual competency in reliability engineering and asset management. Successful candidates will be able to apply reliability engineering to build asset management programs that are consistent with ISO 55000 Asset Management standards.

Participants learn how to:
• Create Asset Management Plans that comply with ISO 55000
• Build and sustain a strategic reliability engineering program
• Prepare control strategies that reduce risk and improve utilization
• Design predictive maintenance strategies and programs
• Establish a root cause analysis program

The REC requires completion of four three-day courses*, and documented application of reliability engineering in the form of a work product. Courses include:
• Reliability Engineering Excellence
• Risk-Based Asset Management
• Predictive Maintenance Strategy
• Root Cause Analysis

You will earn a total of 8.4 CEUs for all four courses.

*At least two courses must be taken at the university granting the certification.

Reliability Engineering Certification Capstone

This requirement demonstrates reliability engineering competency through documented workplace application.

The work product includes:
1. Criticality ranking
2. FMEA
3. RCA
4. Proposed predictive maintenance
5. Presentation and defense

Who Should Attend

The REC is for people who are responsible for improving asset and capacity reliability, decreasing repetitive failures, building sustainable predictive maintenance programs, and creating a culture of continuous improvement.

REC capstone projects more than pay for the program.

An automobile parts supplier saw a 60% reduction in down time.
A candy manufacturer identified and eliminated a failure, saving the company $325,000 in parts alone over a six-year period.
ISO 55000: Asset Management System

Learn How To
- Describe the clauses of the ISO 55000 standard
- Identify the benefits of the ISO 55000 standard
- Cite six critical concepts for asset management policy and strategy creation
- Develop an asset management policy, strategy and supporting objectives
- Document steps to create the asset management plans and framework

This course is only available as a private course

Learn from practicing reliability professionals on your site at a time convenient for you.

What our Students are Saying:

"We came here as a first exposure to the standard. This course provided that and more. Facilitators were knowledgeable and kept the pace moving and class interesting."

John Batrouny, ATI Metals

"The course is well-designed and fits into a comprehensive strategy to implement structured AM to most any company or industry. The facilitators are knowledgeable and engaging, and have real-world experience to share."

Steven St Clair, Puget Sound Energy

Leadership is the starting line and linchpin of any successful asset management strategy. ISO 55000 states, "Top management should create the vision and values that guide policy, practice and actively promote these values inside and outside the organization" (2.5.3.3). In this two-day course you will practice doing this with a unique template developed by Life Cycle Engineering.

You will see examples of asset management strategies, learn the asset management policy components, and develop a draft policy for your organization. Based on this draft policy, you will identify specific asset management objectives and outline a strategy. Armed with this policy, strategy and objectives document you will leave the workshop prepared to guide the development of the underlying asset management plans.

Who Should Attend

This course is designed for any manager acquiring, managing, operating, maintaining or disposing of physical assets. This should include leaders and middle managers across the organization. It is ideal for joining teams of managers to establish a common language and vision for linking the asset management system to organizational goals.

- Operations Managers
- Maintenance Managers
- Reliability Engineers
- Capital Project Engineers
- Asset Owners
- Asset Managers
- Organizational Development
- Quality Personnel
Maintenance Management Skills

Learn How To

List the roles, goals and motivation of a Maintenance Supervisor

Describe maintenance management critical success factors:
- Using planning and scheduling to drive work execution
- Techniques to improve worker productivity
- Managing meetings effectively

Practice techniques to effectively manage people:
- Methods to handle problems with employees, vendors, coworkers
- Decision making
- Smart delegation
- Supervisory staffing issues: orientation, discipline, supervising friends, and substance abuse issues

Build a management skills action plan:
- Assess your supervisory style to identify strengths and areas for development
- Apply time management techniques
- List ways to control reactions and make good decisions in times of stress
- Outline ways to make the change from technician to supervisor

Outline an effective program to manage your assets
- Best practices for applying preventive maintenance, predictive and condition-based technologies
- Guidelines for assessing your existing PM system and making improvements

What our Students are Saying:

"LCE rejuvenated my enthusiasm as well as provided key fundamentals that I was seeking."

Patrick Banister, Nektar Therapeutics

"This has been another excellent educational experience."

Steven St.Clair, Puget Sound Energy

This course is one of six courses that can be applied to the Maintenance Management Certification program described on page 4.

Who Should Attend

This course is designed for maintenance managers and supervisors. Ideal candidates either supervise maintenance workers or manage maintenance through supervisors. This course is also recommended for people looking to improve their skills, or those being considered for advancement. Supervisors from other related areas such as Operations, Warehouse and Housekeeping can also benefit.
Maintenance Planning and Scheduling

Learn How To
- Outline a proactive work management process
- Calculate work management performance metrics
- Develop a comprehensive “standard” job plan
- Apply work planning best practices:
  - Identifying work and submitting work orders
  - Prioritize work using equipment criticality (RIME)
  - Backlog management
  - Estimating work
  - Effective job plans
  - Job kitting
- Summarize requirements for work management support systems:
  - Equipment data and history
  - Work order system
  - Standard job plans and job libraries
  - Bill of materials
  - Technical library
- Build a schedule using best practices:
  - Master schedule
  - Schedule constraints
  - Schedule balance and leveling
  - Coordination meetings
- Develop key partnerships needed for effective maintenance planning and scheduling
- Differentiate maintenance types and how they impact the planning/scheduling efforts

Who Should Attend
Successful maintenance planning and scheduling programs require the disciplined application of proven processes and interdepartmental partnerships. It is important for departments that are influenced and impacted by the processes to understand the processes. People in the following roles should participate in this training:

- Maintenance Planner/Schedulers
- Production Supervisors
- Storeroom Managers
- Maintenance Managers
- Operation Coordinators
- Maintenance Supervisors
- Plant Engineers

Outline a proactive work management process
Calculate work management performance metrics
Develop a comprehensive “standard” job plan
Apply work planning best practices:
- Identifying work and submitting work orders
- Prioritize work using equipment criticality (RIME)
- Backlog management
- Estimating work
- Effective job plans
- Job kitting
Summarize requirements for work management support systems:
- Equipment data and history
- Work order system
- Standard job plans and job libraries
- Bill of materials
- Technical library
Build a schedule using best practices:
- Master schedule
- Schedule constraints
- Schedule balance and leveling
- Coordination meetings
Develop key partnerships needed for effective maintenance planning and scheduling
Differentiate maintenance types and how they impact the planning/scheduling efforts

What our Students are Saying:

"This class was a great experience…it was extremely informative and the instructor was outstanding and very knowledgeable of the planning function based on real world experiences! It was definitely worthy of my time and effort."

Larry Jeffcoat, Michelin
Managing Planning and Scheduling

In Managing Planning and Scheduling, participants build a work management program based on Reliability Excellence best practices. The course is designed for a Lead Planner or Department Manager to establish a proactive work management program or to transform an existing program into an effective, results-producing department that positively impacts maintenance costs, plant reliability measures and employee morale.

Managing Planning and Scheduling examines topics like designing a work management program strategy, developing standard processes and work, establishing program measures, managing staff development, and planning program improvement. Learners will walk away with a solid foundation for an effective maintenance work management program.

Who Should Attend

People in the following roles should participate in this training:

- Lead and senior planners
- Planning Department Managers
- Maintenance Managers
- Reliability Change Agents
- Reliability Managers
- Continuous Improvement Managers

Learn How To

- Explain the business case for proactive work management
- Build a work management process flow chart and responsibility matrix
- Draft a work management program strategy: objectives, key performance measures, targets, reporting and monitoring methods
- Develop governing principles and standard procedures for CMMS data entry and use
- Outline a management of change process for job plans
- Describe a disciplined approach to managing work for a planned shutdown
  - Scoping and validating work, project management, communication, reviews, lessons learned
- Develop an audit and continuous improvement strategy for the planning program
  - How trends in manufacturing and technology impact planning/scheduling
  - How the planner interacts with failure data and root cause analysis efforts
  - How equipment criticality and risk management influence maintenance strategy
- Build performance management and development strategies for planning personnel

This course is one of six courses that can be applied to the Maintenance Management Certification program described on page 4.
Managing a storeroom is a balancing act. Storeroom managers must have the materials available to keep production flowing while minimizing inventory investment.

In this three-day course, you will learn how to ensure the right parts are in the right place at the right time. When you apply the knowledge and skills learned in this class, quality will increase and costs will decrease. You will be able to manage your storeroom in a way that successfully balances the needs of operations and maintenance while optimizing your inventory and carrying costs.

Who Should Attend

Anyone involved in materials – directly or indirectly – will find value in Materials Management, including:

- Materials Managers
- Maintenance Manager
- Purchasing
- Storeroom Personnel
- Planner/Schedulers
- Operations Managers

Learn How To

- Discuss the materials management challenges that organizations are facing
- Identify the elements of materials management
- Discuss how materials management fits into the overall umbrella of Reliability Excellence
- Discover the characteristics and steps involved in effective materials management processes
- Discuss the basic steps involved in implementing effective inventory control best practices
- Summarize the basic steps involved in implementing effective warehouse management best practices
- Describe how a CMMS can support materials management processes and best practices
- Identify contributors to total cost of materials
- Practice techniques to manage inventory investment
- Define the standard set of basic materials management key performance indicators
- Develop an inventory/investment management action plan

What our Students are Saying:

"What is great about this course is that the content is state-of-the-art and packaged neatly. It would take years to learn this by experience and it is not otherwise documented."

Wayne Groover,
Chaparral Steel

"This was a great course which will help me better develop my work processes in the stockroom."

Bill Csuk,
Wrigley Manufacturing

This course is one of six courses that can be applied to the Maintenance Management Certification program described on page 4.
**Planning forShutdowns, Turnarounds andOutages**

After attending this three-day course, you will save time and money on your next shutdown. Our promise for this program is that you will have a new and deeper understanding of how to effectively manage large maintenance jobs such as power plant outages and refinery refits. This course is 85% concerned with the time before the shutdown begins. The remaining 15% is the execution tactics to keep the project on course. This course includes specific checklists, procedures, strategies and important outside resources that will improve your current shutdown planning and execution. The course also includes examples to demonstrate the major points.

NOTE: While some industries use the phrases outage, shutdown and turnaround interchangeably, other industries ascribe very specific and different meanings to the terms. From the perspective of planning, however, in this course we have decided to use the terms interchangeably.

### Learn How To

- Develop a checklist of everything to consider before the shutdown and when to consider it
- Evaluate the effectiveness of your current shutdown effort
- Measure your shutdown efficiency by benchmarking with world-class shutdown strategies
- Establish good contractor relations to further reliability
- Unearth tools and technologies that can smooth the process and create a backbone for effective plant maintenance and reliability

### Who Should Attend

Successful shutdowns, turnarounds and outages require the disciplined application of proven processes and interdepartmental partnerships. It is important for departments that are influenced and impacted by the processes to understand them. People in the following roles should participate in this training:

- Maintenance Planner/Schedulers
- Production Supervisors
- Storeroom Managers
- Maintenance Managers and Supervisors
- Operation Coordinators
- Plant Engineers
- Outage Coordinators
- Reliability Engineers
- Facilities Managers
- Project Managers
- Asset Management Specialists
- Quality Assurance
- Procurement

### What our Students are Saying:

"I was truly enlightened on the matters of real maintenance and all associated practices that make up the system."

Patrick Banister, Nektar Therapeutics

"This event helped me with knowledge and goal setting for my company in the future."

Petronas Gas Berhad, Malaysia
This course is one of six courses that can be applied to the Maintenance Management Certification program described on page 4.

Who Should Attend

Maintenance Managers, PdM Managers, Maintenance professionals, continuing education students, and any person responsible for justifying or managing duties related to a condition-based monitoring program.

Learn How To

- Explain how applying a combination of maintenance strategies mitigates risk and optimizes your asset maintenance plan
- Define the purpose and benefits of condition-based maintenance
- Describe how predictive maintenance enables proactive maintenance planning and scheduling
- Explain how to use risk mitigation to establish a condition-based maintenance program
- Make a business case to justify a condition-based maintenance program investment
- Summarize benchmarks and trends in the predictive and condition-based maintenance disciplines
- Summarize prevalent condition-based technologies in use today
- Describe the role of Precision Maintenance in a Condition-based Maintenance program
- Report program results: reliability improvements and financial value
- Draft program action plan that incorporates critical success factors in the following areas:
  a. Program objectives
  b. Application: technology, techniques and equipment
  c. Measures
  d. Infrastructure and resources
  e. Organizational support

Condition-based maintenance is a philosophy that uses the equipment’s operating condition to make data-driven decisions and improve quality, productivity and profitability. Unlike industry courses that focus on applying specific predictive technologies like vibration monitoring or oil analysis, this course focuses on establishing, managing and sustaining results from a comprehensive condition-based program.

The course considers predictive maintenance and other techniques as a component of a larger asset maintenance strategy to diagnose, prevent and postpone failures. You will learn the theory and application of multiple PdM technologies. You will review critical success factors of results-producing programs. Through group activities and case studies, you will determine which technologies to use, how to set goals for your program, track progress and practice how to communicate results to different stakeholders. By the end of the session, you will have outlined what a successful condition-based program can look like at your organization.

This course is one of the four courses that lead to the Reliability Engineering Certification program described on page 5.
Reliability Engineering Excellence

Who Should Attend
Ideal for those involved in asset reliability, capacity and predictive maintenance programs. Anyone responsible for decreasing repetitive failures and seeking investments to improve plant reliability, including reliability engineers, reliability technicians and reliability personnel.

Learn How To
- Define how reliability impacts business performance
- Describe the reliability engineer role and responsibilities
- Define the main components of an asset information system
- Use different reliability tools and models to examine reliability
- Explain the components of an asset management plan
- Describe how sustainability principles can be applied to asset management planning
- Assess the efficacy of your organizational support structure for asset management and build a plan to address gaps
- Assess internal asset management capabilities and develop a plan to address gaps
- Explain how to hold external suppliers accountable for asset management capabilities
- Create a business case to support reliability investment options

What our Students are Saying:

“I will utilize the RFD and FMEA tools immediately in my current program.”
Andrew Gillott, Cargill

“The daily discussions and activities helped me think of some new ways to attack issues at my company.”
Reed Watson, Noble Drilling Services Inc.

“One of the best trainings I have completed in my professional development.”
Sam Walker, Nektar Therapeutics

Learn how a Reliability Engineer (RE) drives the value assets can deliver by overseeing equipment life cycle performance from concept through disposal. In Reliability Engineering Excellence, REs learn to build a business case for reliability, design reliability into a system or process before it’s built, identify operating risks and solve problems in all areas of asset management. Life Cycle Institute reliability experts facilitate class activities around system reliability modeling, ISO 55000-based assessment questions and how to use leading and lagging indicators to manage a reliability program. Class participants examine the major components of an asset management plan, justify a capital project and discuss asset data management concerns.

By the end of this course you will be equipped to build and sustain a strategic Reliability Engineering program to achieve your organization’s reliability goals. Special emphasis will be placed on designing for reliability, life cycle asset management, life cycle costing, reliability and statistical analysis, measuring reliability program improvements and building organizational support for reliability.

This course is one of the four courses that lead to the Reliability Engineering Certification program described on page 5.
The Reliability Excellence model is a flexible, scalable framework that has been adopted by dozens of Fortune 500 organizations as their framework for reliability and asset management.

Reliability Excellence for Managers (RxM) is the original reliability program designed to build competency through multiple classroom learning sessions and practical application over a year. Each year the content is updated to include our findings from new research, assessments, and application. In the past decade over 600 people, from nearly 200 organizations, have enrolled in the program.

You will learn how to customize and apply the tools and processes required to develop, implement and sustain world-class, reliability-based performance and a culture of continuous improvement.

Program facilitators are certified reliability professionals with decades of experience implementing reliability. The program is designed and maintained by a team of respected thought leaders and authors in maintenance and reliability, including Keith Mobley, and Tim Kister.
RxM is delivered in four, three-day sessions with a six to eight week interval between sessions. After each session, you are encouraged to apply what you have learned to reinforce learning and raise retention. When you return for the following session, you will share your experiences, thereby gaining a deep understanding and ability to sustain your new learning.

Over the four-part program, you will build a business case for Reliability Excellence. You will learn how leadership and culture impact a change initiative, and how to become a change agent to help keep your organization reliable, agile and competitive. You will become aware of the business processes associated with world-class performance. Finally, you will build a plan to strengthen and stabilize the charge for reliability.

Secure your Certified Maintenance and Reliability Professional (CMRP) credential by taking the exam proctored at the conclusion of the last session. While RxM is not a CMRP prep course, many of the more than 150 participants who have taken an LCE-proctored CMRP exam cite this program as contributing to their success.

Learn How To

Session 1 - Building the Foundation for Rx
(Topics related to SMRP BoK Pillar 1 – Business and Management)

- State the driving factors behind an Rx-based transformational change
- Build a business case for Rx
- Outline the overall philosophies of Reliability Excellence
- Develop Rx functional roles, responsibilities and partnerships within the organization
- Recognize the need for active leadership
- Define governing principles
- Describe how to build an enabling infrastructure, including organizational structure, budget and cost management
- Recognize the correlation between OHS and reliability
- Explain how Rx enables LEAN, Six Sigma, TPM
- Create an Rx A3

And more ...

Session 2 – Leading and Managing Change
(Topics related to SMRP BoK Pillar 4 – Organization and Leadership)

- Differentiate between being effective and efficient
- Differentiate between technical and transformational change
- Assess systems, structures and leadership style
- List five critical success factors for implementing change
- Describe four change roles and their primary activities
- Summarize physiological and psychological effects of change
- Develop an Rx risk management plan
- Develop a Gemba walk job aid

And more ...

Session 3: Best Practice Business Processes and Optimization
(Topics related to SMRP BoK Pillar 2 – Manufacturing Process Reliability and Pillar 3 – Equipment Reliability)

- Discuss the role of standardized processes and procedures.
- Summarize the critical role of work management in success and sustainability
- Discuss methods to lower total cost of ownership and extend useful life of capital assets
- Examine how to eliminate waste and non-value-added activities by implementing a loss elimination process
- Define key requirements of effective materials management
- Discuss how the reliability engineering function manages risks and optimizes performance
- Outline an effective Life Cycle Asset Management program

And more ...

Session 4 – Sustaining Reliability and Continuous Improvement
(Topics related to SMRP BoK Pillar 1 – Business and Management and Pillar 5 – Work Management)

- Develop Rx key performance indicators (KPIs)
- Discuss how a company dashboard and balanced scorecard report Rx progress to leadership
- Use a role and responsibility matrix to increase engagement
- Discuss 4 components of audits and assessments
- Discuss how equipment history and asset process design sustain reliability
- Use tools to support work management
- Draft a master plan to a successful Rx transformation
- Complete a business case for Rx

And more ...
Who Should Attend

This is ideal for people responsible for the design, installation, commissioning, operation and maintenance of capital assets and auxiliary equipment. This includes project engineers, reliability engineers, maintenance managers, operations managers, and engineering technicians.

Learn How To

• Draft components of an asset management plan
• Describe what an asset management organization needs to know to manage risk and improve performance
• Describe the four phases in a risk-based asset management model
• List ways to extend the life of assets and evaluate their effectiveness
• Use a failure mode and effects analysis (FMEA) to analyze risks and map control strategies to failure modes
• Describe how audits, reviews and key performance indicators drive continuous improvement
• Practice applying a standard process for preventive maintenance optimization
• Select the optimal strategy for renewal or disposal based on asset management strategy

What our Students are Saying:

“...My experience at the Life Cycle Institute was wonderful. The content was highly applicable to my job, the facilitator did a fantastic job of providing relevant and interesting examples and the hospitality was great as always.

Michael Atwood, USS-POSOCO

This course is one of the four courses that lead to the Reliability Engineering Certification program described on page 5.

This course is one of six courses that can be applied to the Maintenance Management Certification program described on page 4.

Explore how to improve asset availability and meet reliability goals by applying a risk-based approach to asset maintenance and operations. In the Risk-Based Asset Management (RBAM®) course, you practice how to prioritize reliability efforts on critical equipment and failures that impact your operation. RBAM incorporates reliability-centered maintenance (RCM) principles and continuous improvement practices like PDCA to position your program for decreased downtime, lower maintenance expenditures, and an acceptable total cost of ownership.

During the course, participants classify and analyze assets and failures to rank equipment criticality and draft a risk plan. Next, learners build a failure mode and effects analysis (FMEA) to define control strategies and populate an equipment maintenance plan. Group activities in the class include examining how life cycle cost influences investment and choosing key performance indicators to manage a reliability program. Specific emphasis will be placed on the resources needed to create an asset management plan - a risk, maintenance and asset operations plan – that can manage the entire life cycle of an asset.
Armed with what you learn in this course, you will apply a process for root cause analysis, establish a culture of continuous improvement, and create a proactive environment. Learn to ask the right questions, establish triggers that drive you to the RCA process, and perform cost-benefit analysis.

**Learn How To**

**Investigate the RCA methods**
- Discuss the various RCA philosophies and methodologies
- Discuss the importance of a true RCA process
- Discuss why multiple solutions are important

**Develop your RCA program**
- Develop a systematic way to define and analyze a problem while determining and implementing solutions
- Outline triggers for the RCA effort based on business case thinking
- Identify roles, goals and responsibilities within your organization
- Create a “Straw Man Template” RCA process for your facility

This course is one of the four courses that lead to the Reliability Engineering Certification program described on page 5.

Prepare to implement the RCA process
- Recognize the importance of the change management component in your RCA implementation
- Use the Root Cause of Success (RCS) process to eliminate common implementation issues
- Choose proper corrective actions and follow-up processes for various situations
- Use proper documentation, including incident reporting and the A3 process

Discuss the advantages and disadvantages and know when to apply PdM technologies

Manage and be able to effectively use 8 RCA tools
- Event and Causal Analysis
- Change Analysis
- Fault-Tree
- Design/Application Review
- Sequence-of-Events
- FMEA
- 5-Why
- Cause and Effect

**Who Should Attend**

Anyone interested in acquiring or improving advanced problem-solving skills will benefit from this course. Individuals responsible for continuous improvement, solving maintenance and reliability problems, and preventing future occurrences of equipment and system failures, including technicians, engineers, supervisors and managers.

**What our Students are Saying:**

“Everything was great. Course content was clear and easy to understand. Instructor is very knowledgeable about RCA and related subject matter and willing to assist in any way possible to inform and educate.”

Brad Cary, Sealed Air Corporation

“Life Cycle Institute’s facilitators are truly subject matter experts. I feel confident in taking what I learned to my boss and peers.”

Mickey Kennedy, Special Metals Corporation
This guided study is a comprehensive review of the SMRP Body of Knowledge by an experienced CMRP holder and proctor. Each pillar’s components are explored using interactive discussion, real-world examples and sample questions.

This is a guided review of the SMRP Body of Knowledge (BoK). It is not an active learning-based CMRP preparation class.

SMRPCO does not endorse any preparation course for CMRP certification. SMRPCO does endorse training conducted by SMRP Approved Providers recognized as providing best-in-class reliability and asset management training aligned with SMRP’s BoK. LCE is an SMRP Approved Provider.

Participants who read the following resources have greater success passing the CMRP exam:

• CMRP preparation guide (SMRP website)
• The Asset Management Landscape, 2nd edition (Global Forum on Maintenance and Asset Management – gfmam.org)
• Maintenance and Reliability Best Practices, 2nd edition (Ramesh Gulati)
• Making Common Sense Common Practice, 4th edition: Models for Operational Excellence (Ron Moore)

Learn How To:
Define key elements of a reliability-focused business and management strategy (Pillar 1):
• Create and manage a strategic direction and plan for reliability
• Select, track and report on key performance indicators
• Change management and communication
• Managing environmental, health and safety risks

Outline equipment reliability best practices (Pillar 3):
• Determining equipment reliability expectations and goals
• Evaluate equipment reliability and identify improvement opportunities
• Establish a plan to ensure equipment reliability for new and existing assets
• Cost justify plans for implementation
• Implement reliability plans and periodically review performance

Describe how organization and leadership support maintenance and reliability staffing and development (Pillar 4):
• Determining organizational competency and staffing requirements
• Analyzing organizational capability and developing personnel
• Organizational structure, roles and responsibilities for reliability
• Leading and managing people

Cite work management best practices (Pillar 5):
• How to identify, validate and approve maintenance and reliability work
• Maintenance and reliability work priority, planning and scheduling
• Executing and documenting work
• Analyzing and measuring work performance
• Planning and executing maintenance and reliability projects
• Using information technologies effectively
• Managing resources and materials effectively

Course Information
The course is 3 days of instruction and individual study, with the CMRP exam proctored on the morning of day 4. The CMRP will be awarded by SMRP upon successful completion of the CMRP exam.

CMRP Exam
The CMRP exam is proctored on the morning of day 4. All candidates must register for the exam through SMRP. The exam fee is paid directly to SMRP and is not included in the course fee.

Who Should Attend
Experienced maintenance and reliability professionals who want to attain the CMRP designation. Professionals interested in building their competency in maintenance and reliability disciplines: business and management, leadership, equipment reliability, manufacturing process reliability and work management.
Maintenance Planning and Scheduling online! eMPS transforms our most successful learning program and decades of best-practice benchmarking into a performance-driven, self-paced online solution.

- Create a set of standard processes and tools
- Onboard new planners faster
- Reach geographically dispersed teams
- Validate competency

eMPS is more than self-paced learning. It is an on-the-job resource. You can access over 40 tools and resources via your computer or mobile device, anytime you need them. The open navigation facilitates easy navigation between modules and resources.

eMPS was designed by certified maintenance and reliability professionals and certified learning professionals to create a cutting-edge and relevant learning experience that emphasizes practical application and action.

eMPS Module | What you will learn
---|---
Intro to maintenance planning and scheduling | Business case for proactive work management
| Responsibilities of a maintenance planner/scheduler
| Relationship between failure curves and maintenance strategies
| Key performance indicators and benchmarks

WM process overview | Documenting work process flow steps and accountabilities
| Examine a proactive work management flow
| Gap analysis between current work processes and proactive work flow

Information system and equipment history | Value of equipment history
| How to use history in continuous improvement
| Equipment data to collect and analyze

Work order system and requesting work | Purpose of an effective work order system
| Required work request information
| Use equipment criticality to prioritize work (RIME)

Estimating and measuring work | Different methods to generate consistent estimates
| Job benchmarking, standard estimates and labor libraries
| Using standard work measures to trend efficiency

Work planning | Practice backlog management and prioritize planning efforts
| Create job plans, bill of materials and job kits
| Recommended approach to unplanned work

Work scheduling | Develop and adjust weekly schedule
| Balance manpower

Work execution, closeout and continuous improvement | Use work closeout data to identify improvement opportunities
| Modify work plans and bill of materials based on data

Metrics | Work management program performance metrics

Critical path planning | Applying the critical path method to maintenance projects

Shutdown and outage | Challenges of shutdown execution
| Disciplined approach to scope work for a planned shutdown
| Shutdown planning checklist

Discounted group rates available, and options for an unlimited user license hosted on your own system.
Reliability Centered Maintenance online! eRCM integrates content from our Risk Based Asset Management course with the prevailing Reliability Centered Maintenance standards and decades of best-practice benchmarking into a performance-driven, self-paced online solution.

- Create a set of standard processes and tools
- Onboard new Reliability Engineers faster
- Reach geographically dispersed teams
- Validate competency

Learners build a business case for an RCM program and analyze an asset’s failure risks in a failure mode effects and analysis (FMEA). Learners apply a proven framework to select and justify maintenance strategies. eRCM users explore different RCM implementation approaches, measure progress and create action plans for improvement.

eRCM integrates content from the SAE standard JA1011, NASA program guidance, and IEC’s 60812 it also makes the connection to ISO 55000.

eRCM was designed by certified maintenance and reliability professionals and certified learning professionals to create a cutting-edge and relevant learning experience that emphasizes practical application and action.

<table>
<thead>
<tr>
<th>eRCM Module</th>
<th>What you will learn</th>
</tr>
</thead>
</table>
| Introduction to RCM | RCM process, terminology and tools
| | Using failure and risk analysis to determine maintenance strategies
| Asset hierarchy | Functional hierarchy guidelines
| | Asset data to collect
| Criticality analysis | Calculating asset criticality and ranking assets to manage risk
| Operational context, functions and performance standards | Defining the operating context
| | Functional statements and performance standards
| | Functional block diagramming and component relationships
| Documenting the RCM analysis in an FMEA | Preparing for and building the FMEA: functional failures, failure modes, consequences and effects, risk priority
| Selecting the right maintenance strategy | Selecting maintenance strategies that manage risk and achieve performance
| | Employ failure modeling techniques to select maintenance strategies
| | Justify maintenance strategy selection
| Equipment maintenance plan (EMP) | Group tasks into logical packages for planning
| | Confirm task value and risk-reduction benefits
| | Relationship between the EMP and ISO 55000 requirements
| RCM program approach | Program implementation and management
| | RCM auditing, continuous process, reporting and feedback loop
| Metrics | Define and calculate metrics to trend and monitor program
| | Communicate program progress and seek investments
| PM Optimization | PM optimization process
| RCM business case | Business case for RCM
| Facilitating RCM | Preparing for an RCM study
| | Facilitation techniques to select maintenance strategies

Discounted group rates available, and options for an unlimited user license hosted on your own system.
Life Cycle Institute’s 3A Learning® Process

Learning is Change. Change is Learning.® Today’s competitive advantage goes to those who can learn and adapt faster. High Impact Learning integrates learning, leadership and change management competencies to produce documented, sustainable results.

A hot topic in the learning community is return on investment (ROI). The goal is to provide evidence for changing policies and practices to support investments in people. How do organizations know where to invest their training dollars?

Organizations need to abandon event-based thinking and adapt to performance-based thinking. High Impact Learning does that by encouraging leadership involvement and applying retention strategies that ensure learning is not only an event but a true process that changes behavior and performance. This is achieved by implementing 3A Learning: Align, Assimilate & Apply.

Alignment Phase

Before participating in a learning event, participants should have a thorough understanding of what they are expected to learn, how their behavior is expected to change, the results they are expected to achieve, and how these results contribute to the overall goals of the organization. To help meet these expectations, the use of learning objectives and Learning Impact Maps are crucial.

Well-developed learning objectives are the foundation of a successful learning intervention. These objectives should be measurable and define the action a participant will be able to take post-training.

A Learning Impact Map is a simple tool used to identify if the training can achieve the desired results, prepare participants to learn and change behavior based on the training, and link the desired behavior with organizational performance and business goals.

Assimilation Phase

During the learning event, the focus is on assimilating the learning that resonates best with the participant. An effective learning event will engage participants to apply what they already know in building relevant skills and knowledge that they can focus on and practice during the class. An effective learning event should be participant-centered, include adult learning principles, be led by effective facilitators and incorporate a Learning Impact Map.

Active Learning

What I hear, I forget.
What I see, I remember.
What I do, I understand.
Life Cycle Institute’s 3A Learning® Process

Successful learning events recognize that adults learn differently. They bring a wide range of knowledge, life experiences, interests and competencies to the experience. The following four principles of adult learning should be incorporated into any active learning environment:

1. Prior Knowledge
2. Relevance
3. Active
4. Self-Direction

Application Phase
Applying what one has learned is where 80% of learning takes place. The Application phase involves using the skills and knowledge within the work environment that makes the learning stick, causing a behavior change that produces desired results. During this phase the Learning Impact Maps are used to reflect on the original goals and note any new-found knowledge. Video Apply Phase

Follow-through is an important step in the learning process as it encourages participants to take action, solicit feedback, and continue collaborative learning for up to three months after the learning event.

Results
Training delivers maximum results when a class inspires retention, management is involved, a Learning Impact Map is documented and a follow-through plan is in place. A High Impact Learning program can help you bring these elements together for an educational experience that changes behavior to achieve personal and organizational goals.
Facilitators Make the Difference

Life Cycle Institute class leaders are called facilitators. This acknowledges that in addition to being experienced authorities on their topic, they have a passion for teaching and have developed this passion into a set of learning facilitation skills.

What our students are saying about our facilitators:

"The facilitator kept me engaged and interested at all times."
Allen Jones, Boeing

"The facilitator demonstrated excellent knowledge and understanding of the subject matter."
Tony Geary, Alcoa

"Great instructor. Lots of interaction, not death by PowerPoint."
Steve Gardner, US Army Corps of Engineers

"The instructor’s knowledge obviously came from first-hand experience. It is easier to relate to someone who has been there, done that and knows how plants really operate!"
Chris Gross, North American Stainless

Even though we call them facilitators, they are really both a facilitator and instructor, and can apply either style based on participant needs and the learning objectives.

Life Cycle Institute facilitators complete a rigorous qualification process and are continuously engaged in activities that enhance their effectiveness at facilitating learning.

Some of the competencies demonstrated by Life Cycle Institute facilitators include:

- Learning about the participants and adapting the learning objectives and content to meet their needs
- Engaging everyone in low-risk daily starters and frequent active reviews related to the content
- Using adult learning principles that enhance motivation and improve retention
- Actively involving the participants every eight to 15 minutes
- Using redirected and reverse questions to engage all participants
- Setting up exercises, case studies, games, and simulations by giving clear directions and drawing out reactions and learning points
LCE's core competency is helping clients optimize their industrial assets. Whether these assets are new greenfield or existing brownfield facilities, LCE’s resources, systems, and work processes are all focused on reducing operating costs while improving equipment reliability and plant availability.

The following model illustrates the key elements that impact total cost of ownership and optimum asset performance:

Maximizing the Total Return Over the Asset Life Cycle

Pre-plant design impacts up to 80% of the life cycle cost. Once the design is complete and the equipment ordered, the ability to influence the life cycle cost of a plant or operation is dramatically reduced. Only about 15% of the life cycle cost can be influenced by operating and maintenance best practices.

This figure shows all of the interrelated components of Total Asset Management Strategy and Deployment.

Life Cycle Engineering’s Asset Management Implementation Framework
Our PoweredByRx® approach combines reliability consulting, engineering services and education. Using a “diagnose before prescribing” philosophy we match solutions to our clients’ needs, including holistic transformations based upon our Reliability Excellence Model, targeted reliability and asset management services necessary to resolve specific tactical issues, and change management services vital to the success and sustainability of most initiatives.

### Reliability Excellence® Model

<table>
<thead>
<tr>
<th>SUSTAINABILITY</th>
<th>OPTIMIZATION</th>
<th>PROCESSES</th>
<th>CULTURE</th>
<th>PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Management</td>
<td>Reliability Engineering</td>
<td>Work Management</td>
<td>Governing Principles</td>
<td>Management Commitment</td>
</tr>
<tr>
<td>Audits &amp; Assessments</td>
<td>Management of Change</td>
<td>Work Planning</td>
<td>Goals &amp; Objectives</td>
<td>Functional Partnership</td>
</tr>
<tr>
<td>Equipment History</td>
<td>Information Management</td>
<td>Work Scheduling</td>
<td>Organizational Structure</td>
<td></td>
</tr>
<tr>
<td>Equipment &amp; Process Design</td>
<td>Supervision</td>
<td>Operator Care</td>
<td>Budgeting &amp; Cost Control</td>
<td></td>
</tr>
<tr>
<td>Work Measurement</td>
<td>Organizational Behavior</td>
<td>Asset Care</td>
<td>Occupational Health &amp; Safety</td>
<td></td>
</tr>
<tr>
<td>Management Reporting</td>
<td>Procurement</td>
<td>Loss Elimination</td>
<td>Employee Involvement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Facilities &amp; Equipment</td>
<td>Workforce Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials Management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Our approach to Reliability Excellence creates the transparency to identify risk and develop plans to manage and reduce it. Most important, of course, is safety. Research indicates there is strong correlation between reliability and safety. As a facility becomes more reliable, the number of safety incidents declines. Our approach helps clients reduce risks across the board – risks to health, safety, the environment and production.

We help our clients improve performance by assisting them with holistic transformations or targeted reliability and asset management services to resolve specific tactical issues. The goals and results are different for each client. Improved performance is documented in results like reduced cost, improved capacity, reduced downtime, improved OEE, increased asset utilization, and improved margin.

Because no improvement effort can be successful without the support of the people involved, we help our clients engage employees in the effort to improve reliability and organizational performance. We not only help our clients identify what needs to change to achieve better results, we also help them understand how to change.
Strategic Alignment Workshop

Escalating regulatory pressures, business complexity, global competition, and an increased focus on accountability have led manufacturing enterprises to pursue multiple improvement initiatives. Even though risks are interdependent and controls are shared across the enterprise, these improvement initiatives are often uncoordinated. The result is initiatives that are staffed, planned and managed in silos, significantly increasing the overall cost and business risk.

LCE’s Strategic Alignment Workshop is designed to help manufacturing enterprises align their executive management team, prioritize improvement opportunities, and achieve enterprise-wide step-change performance improvement.

Successful improvement programs require an Executive Leadership Team (ELT) with a shared vision and understanding of what’s necessary to sustain organizational change, achieve optimal performance across the enterprise, and drive reliable top-to-bottom business and work planning, integration and execution. The ELT must set the strategic direction and expectations; provide the resources; and then actively lead the enterprise through the transformational process that will deliver desired results.

The Strategic Alignment Workshop (SAW) is an executive-level working session that aligns leaders relative to the current state of their business, market share and profitability improvement opportunities, and the methodologies to achieve them. In two and a half days of working sessions, LCE will help executives:

• Identify and quantify opportunities: LCE experts perform pre-work before the SAW which includes industry performance benchmarking and an opportunity case that can be expected by improving enterprise performance.
• Develop shared understanding of current state performance: The SAW will use proven SWOT methodology augmented by a proprietary Reliability Excellence Matrix to define the organization’s current-state work culture.
• Understand organizational change best practices: Leading transformational change is complex and unforgiving. The SAW will guide the ELT through the process to develop an effective approach to ensure success.
• Recognize enterprise reengineering best practices: The SAW will outline successful approaches to business process improvements, risk management, financial impact measurement, sustainability, and continuous improvement.

Deliverables:

Strategic plan that includes:
• Business case outlining current state, SWOT, reliability maturity and financial benefits of implementing an enterprise-wide continuous improvement program
• Defined alignment between client business objectives and program mission, vision and governing principles
• Integration points between current initiatives and step-change improvement program
• Program management plan:
  • Enterprise implementation strategy and plan
  • Risk plan
  • Change management strategy
The ISO 55000 series of Asset Management standards, launched in January 2014, establishes a global standard for asset management systems. These new ISO standards enable organizations to achieve their objectives through the effective and efficient management of their assets:

ISO 55000: An overview of the subject of asset management and the standard terms and definitions
ISO 55001: The requirements specification for an integrated, effective management system for asset management.

- This standard describes the four documents of an asset management system:
  - Asset management policy
  - Asset management objectives
  - Asset management strategy
  - Asset management plans
- ISO 55002: Guidance for implementing an asset management system

Life Cycle Consulting offers a full range of services for companies interested in implementing ISO 55000:

- Gap assessments and scoring
- Implementation master plans
- Asset management capability development
- Asset performance framework models
- A note on ISO 55000 certification

The decision to seek formal certification to the ISO 55000 standard should be based upon a compelling business case. The standard's key asset management concepts are foundational to an effective asset management system and can be implemented without necessarily pursuing formal certification. Many companies are deciding to improve how they manage assets in order to achieve the performance gains, while postponing the compliance decision.
Life Cycle Planning For Start-Ups

We combine our 40+ years of experience fixing plants that did not have a total asset management strategy with our team’s experience in hundreds of startups to develop a strategy specifically for new plants and facilities. These strategies are designed to ensure that clients realize the value from their startup and achieve the lowest life cycle cost. The following figure illustrates Total Asset Performance for new plants.

**Integrated Life Cycle Planning for Start-up**

1. Life Cycle Asset Management Implementation Framework
2. Culture, Strategy, Design & Planning
3. Asset Life Cycle Design Activities
4. Operational Preparedness:
   1) Operations & Quality
   2) Maintenance & Reliability
   3) Systems and Infrastructure
   4) HSE and Standards
5. Supply Chain Development

---

Hundreds of FREE resources for your reliability journey

Visit PoweredByRx.com
Life Cycle Excellence offers diagnostic services that are both scalable and customizable. Our clients rely on assessments for benchmarking, establishing a baseline for measuring improvement, or simply to improve the quality of their decision making when prioritizing continuous improvement activities. Assessments commonly precede holistic, transformational initiatives while also serving as an information platform for building a ROI-based business case. They can also be used to determine root cause for specific underperforming areas or processes.

Our diagnostic tools include:

Asset management capabilities assessment - A comprehensive diagnostic tool for understanding the foundation of your asset management system. The tool assesses the effectiveness of more than 80 key processes across nine knowledge domains and integrates the key requirements of the ISO 55000 Asset Management standard.

Reliability Excellence (Rx) assessment - The diagnostic is built off of our proprietary, holistic 29-element Rx model. The assessment scores 29 performance centers linked to Principles, Culture, Processes, Optimization and Sustainability. A calculated score rates the organization on a reactive to proactive scale. We have conducted more than 300 Rx assessments and maintain an extensive experience base for applying this model.

Tactical workstream assessments - Our flexible and scalable workstream assessments can be customized to client-specific needs. Our assessments cover these areas:

- Capital delivery
- Materials management (MRO)
- Work management
- Shutdowns, turnarounds and outages
- Reliability engineering
- CMMS - SAP
Risk-Based Asset Management (RBAM®)

If your asset management strategy is not risk-based, you may be spending money on symptoms of problems instead of the root cause of your losses. For example, one company without a complete asset management strategy in place experienced a limiting factor that impacted production capacity by 25% (to the tune of $30 million), yet had no control plan in place to address the cause, nor the key performance indicators and analytics to even know the problem existed.

A risk-based asset management strategy couples risk management, standard work, and condition-based maintenance to properly apply resources based on process criticality. This ensures that proper controls are put in place and reliability analysis is used to ensure continuous improvement. An effective risk-based management system includes an enterprise asset management or resource solution that properly catalogs asset attribute data, a functional hierarchy, criticality analysis, risk and failure analysis, control plans, reliability analysis and continuous improvement.

Customized standard operating procedures, including mechanical integrity programs and risk-based inspections, are an additional layer of control for your program.

Using our Risk Based Asset Management Implementation Model, Life Cycle Engineering will partner with you to build a risk-based asset management system that will:

- Help you appropriately prioritize how you spend time, money and materials fixing the most critical problems
- Provide the infrastructure for continuous improvement
- Help you meet your corporate business objectives, including regulatory compliance
Manufacturing assets are not always designed to consider all possible failure modes. This results in assets that do not perform the required functions and meet the organization’s performance requirements.

**Calculation of RPN**

<table>
<thead>
<tr>
<th>SUBSYSTEM FUNCTION</th>
<th>FUNCTIONAL FAILURE</th>
<th>COMPONENT</th>
<th>POTENTIAL FAILURE MODE(S)</th>
<th>POTENTIAL EFFECT(S) OF FAILURE</th>
<th>POTENTIAL CAUSE(S) OF FAILURE</th>
<th>CURRENT CONTROLS</th>
<th>CURRENT PROCESS KNOWN FREQUENCY</th>
<th>RISK ASSESSMENT (AS IS)</th>
<th>RECOMMENDED IMPROVEMENTS/ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide 1000 gpm of additive to process</td>
<td>No flow</td>
<td>Motor</td>
<td>No rotation/torque</td>
<td>Shuts down process</td>
<td>Bearing seizure due to lubrication issues</td>
<td>Lube motor bearings</td>
<td>Y2</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

The machine design failure mode and effects analysis (DFMEA) process collects the design documents, the operational parameters, and known asset failure modes based on industry experience, and then analyzes this information to determine the likelihood of failure, the potential consequences of failure, and the planned detectability of the failure. This information is used to generate a Risk Prioritization Number (RPN). Mitigation plans are developed for the items with high RPN numbers to reduce them to an acceptable risk.

**Scope of Services:**

LCE reliability engineering experts will:
- Collect machine design data
- Collect information on planned operations plan
- Develop a functional block diagram
- Identify potential functional failures
- Identify potential failure modes
- Map failure modes to equipment
- Analyze potential failures
- Generate a RPN
- Develop mitigation strategies

**Deliverables:**

Machine Design FMEA workbook
RAM Analysis

Assets are not always designed to consider all possible failure modes. This results in assets that do not perform the required functions and meet the organization's performance requirements. Reliability, Availability and Maintainability (RAM) modeling looks at an asset system's capabilities, preferably in the design phase. RAM modeling will identify potential causes of production losses and can be used to develop mitigation plans in an effort to reduce them to an acceptable risk.

Compressor Functional Block Diagram

Scope of Services:

LCE reliability engineering experts will:

- Develop functional block diagrams
- Gather reliability data, from the equipment manufacturer and or experience with similar equipment in similar service, defined as the ability of a system and its components to perform a required function under stated conditions for a stated period
- Gather operating plan information, defined as the anticipated machine or cell production requirements
- Review the maintainability of the assets, including design-dependent parameters pertaining to ease, accuracy, safety and economy in the performance of maintenance functions
- Complete the RAM analysis
- Develop design strategies to reduce unacceptable risks

Deliverables:

RAM analysis report
Reliability Centered Maintenance

When operations and maintenance tasks are not optimized, your most critical assets may not be receiving the right level of attention. Life Cycle Engineering, Inc. (LCE) can help you apply Reliability-Centered Maintenance strategies so that the right tasks are prescribed for execution at the right time.

LCE will evaluate your Reliability-Centered Maintenance (RCM) program and its ability to preserve the system functionality of your critical assets. LCE experts can apply classical RCM to your critical equipment during the concept and design phase or the operational phase of your equipment’s life cycle.

### Risk Matrix

<table>
<thead>
<tr>
<th>Consequence category</th>
<th>Likelihood of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>People</strong></td>
<td></td>
</tr>
<tr>
<td>Minor / first aid</td>
<td>Improbable</td>
</tr>
<tr>
<td>Lost time injury</td>
<td>Possible (1/1,000 yrs)</td>
</tr>
<tr>
<td>Permanent disability</td>
<td>Improbable (1/100 yrs)</td>
</tr>
<tr>
<td>Single fatality</td>
<td>Many per yr</td>
</tr>
<tr>
<td>Multiple fatality</td>
<td></td>
</tr>
<tr>
<td>Asset value</td>
<td></td>
</tr>
<tr>
<td>&lt;10 units $</td>
<td></td>
</tr>
<tr>
<td>&lt;100 units $</td>
<td></td>
</tr>
<tr>
<td>&lt;1k units $</td>
<td></td>
</tr>
<tr>
<td>&lt;1k units $</td>
<td></td>
</tr>
<tr>
<td>Production loss</td>
<td></td>
</tr>
<tr>
<td>Contained minor</td>
<td></td>
</tr>
<tr>
<td>Uncontained minor</td>
<td></td>
</tr>
<tr>
<td>Significant local</td>
<td></td>
</tr>
<tr>
<td>Major local</td>
<td></td>
</tr>
<tr>
<td>International</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td>Customer</td>
<td></td>
</tr>
<tr>
<td>Local press</td>
<td></td>
</tr>
<tr>
<td>National press</td>
<td></td>
</tr>
<tr>
<td>Reputation</td>
<td></td>
</tr>
<tr>
<td>See page 2 for our Reliability Centered Maintenance Online Course! eRCM integrates content from our Risk Based Asset Management course with the prevailing Reliability Centered Maintenance standards and decades of best-practice benchmarking into a performance-driven, self-paced online solution.</td>
<td></td>
</tr>
</tbody>
</table>

### Scope of Services:

- Identify the optimal tasks and appropriate frequency for your critical assets
- Collect data and perform equipment walk down and field inspection
- Perform and document RCM study

### Deliverables:

- Final RCM report workbook that includes:
  - Functional block diagram of system
  - FMEA
  - Task lists
  - RCM decision diagram used
  - Scales for risk ranking
  - Identified items for further action
  - Record of the steps leading to final determination
We specialize in change management support, staff augmentation and building change management as an organizational competency. Research proves that effective change management has a direct impact on three dimensions of project success. Projects that employ effective change management are:

- **6X** more likely to meet objectives
- **4X** more likely to meet schedule
- **3X** more likely to meet budget

Prosci® 2016 Best Practices in Change Management benchmarking report

We provide resources and expertise to enhance your team’s capabilities in:

- Business process design/redesign
- Software implementations and technology upgrades
- Organization restructuring
- Merger or acquisition
- Expansion or downsizing
- Business model change or new venture
- New marketing campaign
- Job redesign
- Workforce transition

Life Cycle Institute Change Management Services

- Change management strategy
- Change readiness and project risk assessments
- Sponsor and manager coaching
- Integrating change management and project management
- Stakeholder management
- Development of change management plans

Life Cycle Institute offers a multi-dimensional approach

We implement the Prosci methodology

We integrate change management and learning

We develop customized solutions

Our team consists of thought leaders and industry experts

Life Cycle Institute’s team of professionals includes:

- Managing principals
- Change management subject matter experts
- Prosci-certified change management facilitators
- Communications subject matter experts
- Learning subject matter experts who hold a Masters of Education and Certified Professional in Learning and Performance (CPLP®)
- Project Management Professionals (PMP®)
Learning Design and Development

The development of meaningful objectives, relevant content and a practical understanding of how people learn are critical to a successful learning experience. Life Cycle Institute learning subject matter experts apply proven learning principles and expertise to deliver learning solutions that change behavior to produce results.

Our learning subject matter experts provide:

New Course Development

• Live classroom
• Live online
• Computer-based training (CBT)
• Interactive courseware (ICW)

Course Conversion

• Convert existing courses into active, results-producing learning engagements
• Transform classroom-based courses to synchronous or asynchronous online training

Blended Learning

• Create blended products that include classroom and online training for maximum exposure or just-in-time support

Facilitator Development

Learning Needs Analysis and Competency Assessment

Knowledge Capture

We implement our proprietary 3A Learning® process in all learning engagements. This three-phase learning process encompasses the steps required before, during and after learning to achieve results. More information on this approach can be found in the 3A Learning section on page 20.

Why work with Life Cycle Institute’s learning team?

• Our team consists of learning professionals credentialed with Masters of Education, Certified Professional in Learning and Performance (CPLP®), Project Management Professional (PMP)® and certified change management professionals
• We incorporate the elements of our 3A Learning process on all engagements
• SME Partnerships: We have extensive experience working with busy subject matter experts, coaching them to embrace innovative and provocative ways to engage learners
• Focus on objectives: Learning is a process founded on learning objectives that create a clear line of sight on how a learner’s behavior contributes to organizational goals
• Results: Whether you need an online course, classroom-based instruction or a blended learning solution, we will deliver a dynamic solution to meet your business objectives
• Learning leaders: We leverage a proven course development process that comprises the latest science in adult learning and advanced learning strategies to create participant-centered, active learning products
We provide project support to organizations so they can remain focused on strategic vision and leave the tactical execution to us. Our team of experienced project managers and facilitators will work with you to complete project tasks, plan and manage communications, and facilitate meetings.

Our project management professionals provide:

**Project Management**
- Stakeholder management
- Risk management
- Requirements collection
- Develop work breakdown structure
- Plan and schedule project activities
- Project reporting

**Communication Management**
- Communication planning
- Developing communication artifacts

**Group Facilitation**
- Facilitation planning
- Strategy meetings
- Problem-solving sessions
- Planning meetings
- Focus team meetings
- Requirements gathering

**Why work with Life Cycle Institute's project management team?**
- We boast more than 25 years of experience helping clients implement projects
- Our approach to project management is deeply rooted in change management principles, resulting in increased project success
- Project Management Professionals (PMP)® on staff who are experienced in virtual project management
- Communication specialists who can plan and develop effective project communications
Reliability Excellence® is a framework for reliability that begins with the foundation of principles and culture, establishes and optimizes the processes and procedures, and ultimately promotes sustainability to create a culture of continuous improvement.

Organizations implementing Reliability Excellence have seen a significant return on investment and other benefits such as:

- Increased capacity
- Increased product availability
- Reduced cost of goods sold
- Improved OEE
- Reduced maintenance costs and spending

The table to the left shows results seen by our clients in certain industries.
More than 2,000 clients have leveraged the knowledge and experience of LCE’s subject matter experts to improve economic performance of their asset-intensive manufacturing and processing plants, mining operations, energy generation plants, and education and health care facilities. The culmination of 40 years of application, more than 500 years of combined subject matter expert experience, and thousands of successful implementations in government and the private sector uniquely positions LCE as a leader in performance improvement. LCE’s proprietary, holistic, data-driven approach enables clients to achieve leadership positions in their core businesses, leverage their core strengths to grow adjacent opportunities, and operate at superior performance levels that drive industry-leading results.

Life Cycle Engineering (LCE) was founded in 1976 by two civil service engineers working for the government in Washington, DC. They worked directly with the United States Navy to pioneer the application of reliability engineering – and specifically predictive technologies and condition monitoring – to be used in nuclear submarines.

Today, LCE is a privately held company with headquarters in Charleston, South Carolina, providing engineering solutions for private industry, public entities, government organizations and the military, in North America and around the world.

Life Cycle Excellence helps large, asset-intensive companies improve operational performance. Improving productivity of your assets requires understanding where your current systems are underperforming, developing processes and capabilities to close performance gaps, and creating a culture that supports continuous improvement. Our experience helping hundreds of clients ranges from multi-site, organizational transformations to diagnosing and fixing a specific production line problem.

Our team includes subject matter experts in a variety of disciplines from reliability engineering to planning and scheduling to lean /Six Sigma. All of our consultants hold an advanced degree or an accreditation within their profession and are certified Prosci® Change Management Professionals.

Life Cycle Institute is LCE’s human performance practice that integrates learning, change management and project management. The Institute offers 16 courses attended by more than 1200 students from more than 200 companies each year. In addition to individual courses, Life Cycle Institute offers university-backed certification programs in Reliability Engineering and Maintenance Management. Our university partners include Clemson University, The Ohio State University, and University of Kansas.
<table>
<thead>
<tr>
<th>COURSE</th>
<th>WHO SHOULD ATTEND</th>
<th>YOU WILL LEARN HOW TO</th>
<th>DATES &amp; LOCATION</th>
<th>DAYS/CEUS</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Management Skills</td>
<td>Maintenance Managers and Supervisors, as well as Supervisors from Operations, Warehouse or Housekeeping areas</td>
<td>Lead a world-class maintenance department using planning and scheduling best practices to drive work execution, improve productivity, motivate staff, increase output and reduce waste.</td>
<td>Dec 4-6, 2018 (CHS)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Maintenance Planning and Scheduling</td>
<td>Maintenance Planner/Schedulers, Production Supervisors, Storeroom Managers, Maintenance Managers, Operation Coordinators, Maintenance Supervisors</td>
<td>Apply preventive and predictive maintenance practices. Calculate work measurement. Schedule and coordinate work.</td>
<td>Feb 5-7, 2019 (CHS)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Managing Planning and Scheduling</td>
<td>Lead and Senior Planners, Planning Department Managers, Maintenance Managers, Reliability Change Agents, Reliability Managers, Continuous Improvement Managers</td>
<td>Establish a proactive work management program or transform an existing program into an effective, results-producing department that positively impacts maintenance costs, plant reliability measures and morale.</td>
<td>May 7-9, 2019 (KU)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Materials Management</td>
<td>Materials Managers, Storeroom Managers, Planner/Schedulers, Maintenance Managers and Operations Managers</td>
<td>Apply sound storeroom operations principles. Manage inventory to optimize investment. Understand the role of purchasing. Implement effective work control processes.</td>
<td>Mar 4-7, 2019 (CHS)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Planning for Shutdowns, Turnarounds and Outages</td>
<td>Members of the shutdown or outage teams, Planners, Plant Engineers, Maintenance Engineers</td>
<td>Save time and money on your next shutdown by learning how to effectively plan for and manage such large projects. Learn processes and strategies for optimal resource allocation.</td>
<td>Aug 5-8, 2019 (CHS)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Predictive Maintenance Strategy</td>
<td>Plant Engineers and Managers, Maintenance, Industrial and Manufacturing Engineers, Maintenance Supervisors and Managers</td>
<td>Establish, manage and sustain results from a comprehensive condition-based program. Explore the theory, application and program best practices of multiple PdM technologies, including vibration analysis, thermography, oil analysis, ultrasound, motor circuit analysis and other condition-based monitoring techniques.</td>
<td>Nov 6-8, 2018 (KU)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Reliability Engineering Excellence</td>
<td>Reliability Engineers, Maintenance Managers, Reliability Technicians, Plant Managers and Reliability Personnel</td>
<td>Build and sustain a strategic Reliability Engineering program and gain support to achieve your organization’s reliability goals. Build the business case for reliability, design reliability into a process before it’s built, identify operating risks and solve problems in all areas of asset management.</td>
<td>Feb 26-28, 2019 (KU)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Reliability Excellence for Managers</td>
<td>General Managers, Plant Managers, Design Managers, Operations Managers and Maintenance Managers</td>
<td>Build a business case for Reliability Excellence, learn how leadership and culture impact a change initiative and build a plan to strengthen and stabilize the change for reliability. CMRP exam following Session Four.</td>
<td>Session 1 Dates: Mar 19-21, 2019 (CHS)</td>
<td>12 days total</td>
<td>8.4 CEUs</td>
</tr>
<tr>
<td>Risk-Based Asset Management</td>
<td>Project Engineers, Reliability Engineers, Maintenance Managers, Operations Managers, and Engineering Technicians</td>
<td>Learn to create a strategy for implementing a successful asset management program. Discover how to reduce risk and achieve the greatest asset utilization at the lowest total cost of ownership.</td>
<td>Feb 12-14, 2019 (OSU)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
<tr>
<td>Root Cause Analysis</td>
<td>Anyone responsible for problem solving and process improvement</td>
<td>Establish a culture of continuous improvement and create a proactive environment. Manage and be able to effectively use eight RCA tools to eliminate latent roots and stop recurring failures.</td>
<td>Mar 19-21, 2019 (OSU)</td>
<td>3 consecutive days</td>
<td>2.1 CEUs</td>
</tr>
</tbody>
</table>

\[ \text{Register now for our Maintenance Planning and Scheduling eLearning – self-paced & available 24/7} \]