Reliability Engineering Certification (REC)

Work Product Guidelines

LIFE CYCLE INSTITUTE

Reliability Engineering Certification (REC) Work Product

A Reliability Engineer awarded the Reliability Engineering Certification (REC) from the Life Cycle Institute demonstrates competency in Risk-based Asset Management, Root Cause Analysis, Reliability Engineering principles and Predictive Maintenance strategy.

Candidates for the REC must complete four workshops, submit a work product report and present and defend their work product. The required workshops are:

- Risk-Based Asset Management
- Root Cause Analysis
- Reliability Engineering Excellence
- Predictive Maintenance Technologies

Section 1: Certification Deliverables Guidelines

The three main deliverables of the work product include: 1) completion of the work product activities 2) written work product report 3) presentation and defense

1.1 Work Product Activities

Using the templates provided in the ***Form Templates*** section, choose a system in your facility and perform the following.

If your organization has an established methodology or set of templates for these processes, complete your project using **both** approaches. In your report and presentation, defend your preferred approach.

1. Perform a criticality ranking on at least 10 system assets
2. Choose one critical system asset and build a Failure Modes and Effects Analysis (FMEA) for the asset's primary function.
3. Choose one failure mode and complete a root cause analysis (RCA) to determine all of the possible causes
    a. Choose from five RCA Advanced Analysis tools and defend the tool choice
4. From the results of the RCA, propose a predictive maintenance technology approach that could predict or mitigate deterioration. If predictive maintenance is not a recommended solution, explain the rationale.

1.2 Work Product Report Sections

The work product should be submitted in a written report format using the template provided. At a minimum, the report should include the following sections:

1. Description of system chosen for project
2. Criticality Ranking form
3. FMEA form
4. Failure mode choice and RCA trigger
5. RCA tool choice, rationale
6. RCA results
7. Proposed predictive maintenance

1.3 Presentation and Defense of Work Product

After the work product has been submitted we will schedule a one-hour presentation with you during the review week to be conducted via phone and web meeting. Use the provided presentation template to step through your project. We welcome you to invite your manager or

other important stakeholders to the call. Any guests on the call must remain silent and are discouraged from responding to questions and explaining the project on your behalf.

Section 2: Forms, Templates

The following forms and templates should be used to complete your work product:

1. Asset Criticality Tool (Excel spreadsheet)
2. FMEA Tool (Excel spreadsheet)
3. Advanced Root Cause Analysis Techniques – *select an RCA tool from this sheet*
4. Report Template
5. Presentation template

Section 3: Scoring Guide

The work product will be scored by a qualified Reliability Engineer according to five categories:

1. Criticality ranking
2. FMEA
3. RCA
4. Proposed predictive maintenance
5. Presentation and Defense

Each element will be scored with either a one (met) or zero (not met). A total of 15 points is possible for the work product. Candidates must receive at least 13 points to pass successfully, and there must be at least one point in *each* category. For example, if Candidate A receives a total of 13 points, but both points missed are in the Presentation and Defense category, he will be required to perform corrective action on that section before a passing score can be awarded.

If a candidate does not earn a passing score, they will receive direction on the portions of the project to be revised and resubmit for consideration. We will attempt to conduct a preliminary review of submitted work products prior to the scheduled presentation so that corrective action can be made before the interview is conducted.

Section 4: Work Product Review Periods and Due Dates

Review periods are scheduled two times per year, during the week of President's Day and the week of Labor Day. Presentations will take place during the review week via phone and web meeting.

February review period – Week of President's Day each year
Completed Work Products must be received one month prior to the President's Day holiday to be included in this review period.

September review period – Week of Labor Day each year
Completed Work Products must be received one month prior to the Labor Day holiday included in this review period.

A candidate will have until the first review period following his one-year anniversary of completing the coursework to submit his work product. Work products should be submitted to Education@LCE.com by the due dates listed above.

REC Work Product Sample Score Card

#	**Criticality Ranking**	Score
1	Criticality form was used correctly	1
2	A minimum of 10 assets analyzed	1
3	Sufficient ranking granularity provided between assets	1
4	Asset scores are appropriate to the asset type	1
Total		**4**
NOTES		

#	**FMEA**	Score
1	FMEA form completed correctly	1
2	Each failure mode has a frequency, severity and detectability assigned	1
3	Risk Priority Numbers (RPN) are calculated properly and have sufficient granularity	0
4	Recommended actions address one of the RPN number categories	1
Total		**3**
NOTES		

#	**RCA**	Score
1	RCA tool completed correctly	1
2	RCA tool choice was appropriate for failure mode	1
3	Root causes were explained in proper detail, including potential countermeasures	1
Total		**3**
NOTES		

#	**Proposed Predictive Maintenance**	Score
1	PdM technique is described and applied correctly	1
2	PdM technique appropriate to countermeasure identified in RCA	1
Total		**2**
NOTES		

#	**Presentation and Defense**	Score
1	Candidate demonstrated knowledge of project and results	1
2	Candidate adequately answered questions about project	1
Total		**2**
NOTES		

#	**Grand Total:** **Passing score = 13 points**	Score	Total Possible Points
	Criticality Ranking	4	4
	FMEA	3	4
	RCA	3	3
	Proposed Predictive Maintenance	2	2
	Presentation and Defense	2	2
Total		**14**	**15**

***Passing score is 13 points overall and at least one point in each category**

Sample Forms and Templates

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Asset Criticality Analysis Spreadsheet

Asset Number	Level 5 (System)	Level 7 (Asset)	Operational Severity	Safety Severity	Environmental Severity	Single Point Failure	Maintainability	Reliability	Spares Lead Time	Sum of Criteria	Asset Criticality

Failure Modes and Effects Analysis (FMEA)

FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

Plant: _____
System: _____
Subsystem: _____
Analysts: _____

SEV = Severity
OCC = Occurrence
DET = Detection
RPN = Risk Priority Number (SEV x OCC x DET)

Prepared by: _____
Reviewed by: _____
Rev. No.: _____
Date: _____

SUBSYSTEM FUNCTION	FUNCTIONAL FAILURE	COMPONENT	POTENTIAL FAILURE MODE(S)	POTENTIAL EFFECT(S) OF FAILURE	POTENTIAL CAUSE(S) OF FAILURE	CURRENT CONTROLS	CURRENT PROCESS KNOWN FREQUENCY	RISK ASSESSMENT (AS IS)				RECOMMENDED IMPROVEMENTS/ACTIONS	RECOMMENDED IMPROVEMENT PROCESS FREQUENCY	RESPONSIBILITY/DATE	RISK ASSESSMENT (TO BE)			
								SEV	OCC	DET	RPN				SEV	OCC	DET	RPN
											0							0
											0							0
											0							0

Sample Risk Assessment Criteria 1 for FMEA

Severity : Impact failure would have on EHS, Capacity, Cost:
1 = No Impact 2 = 1% - 9% Impact on Capacity or Cost or potential of EHS 3 = 10% - 19% 4 = 20% - 29% 5 = 30% - 39% 6 = 40% - 49% 7 = 50% - 59% 8 = 60% - 69% 9 = 70% = 79% 10 = 80% - 100%

Occurrence : Probability (%) based on known history that the failure will occur. (Assumes worst case senerio):
1 = No possibility or probability 2 = 1% - 19% probability 3 = 20% - 29% probability 4 = 30% - 39% probability 5 = 40% - 49% probability 6 = 50% - 59% probability 7 = 60% - 69% probability 8 = 70% - 79% probability 9 = 80% - 89% probability 10 = 90% - 100% probability

Detection: Using current processes, e.g. PM inspections, etc., what is the probability that failure mode will be detected before it occurs:
1 = 90 - 100% probability of detection (automatic, continuous monitoring/shutdown) 2 = 80% - 89% 3 = 70% - 79% 4 = 60% - 69% 5 = 50% - 59% 6 = 40% - 49% 7 = 30% - 39% 8 = 20% - 29% 9 = 10% - 19% 10 = 1% - 9%

Sample Risk Assessment Criteria 2 for FMEA

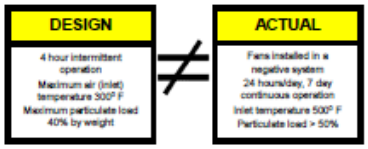
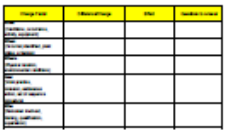
Severity Evaluation Criteria		
Effect	**Criteria: Severity of Effect**	**Rank**
Catastrophic without warning	Very high severity ranking when a potential failure mode affects safe operation, may cause death or injury and/or involves noncompliance with government regulation without warning. Extended Repair outages.	10
Hazardous - with warning	Very high severity ranking when a potential failure mode affects safe operation, may cause death or injury and/or involves noncompliance with government regulation with warning. Extended repair outages.	9
Very High	Item inoperable, with loss of primary function.	8
High	Item operable, but at reduced level of performance. Customer dissatisfied.	7
Moderate	Item operable, but Comfort/ Convenience item(s) inoperable. Customer experiences discomfort.	6
Low	Item operable, but Comfort/ Convenience item(s) operable at reduced level of performance. Customer experiences some dissatisfaction.	5
Very Low	Marginal system degradation.	4
Minor	Annoying. No System degradation.	3
Very Minor	Hardly any effect. Qualified personnel are able to realize a failure has occurred.	2
None	No noticeable effect. Unable to realize a failure has occurred.	1*

Suggested Occurrence Evaluation Criteria		
Failure Rates	**Probability of Failure**	**Rank**
> 1 in 1 month	**Very High:** Failure almost inevitable	10
1 in 2 months		9
1 in 4 months	**High:** Repeated failures	8
1 in 6 months		7
1 in 1 year	**Moderate:** Occasional failures	6
1 in 2 years		5
1 in 3 years		4
1 in 5 years	**Low:** Relatively few failures	3
1 in 8 years		2
≤ 1 in 10 years	**Remote:** Failure is unlikely	1*

Suggested Detection Evaluation Criteria		
Detection	**Criteria**	**Rank**
Absolute Uncertainty	Control will not and/or cannot detect a potential cause/ mechanism and subsequent failure mode; or there is no Control.	10
Very Remote	Very Remote chance the Control will detect a potential cause/mechanism and subsequent failure mode.	9
Remote	Remote chance the Control will detect a potential cause/ mechanism and subsequent failure mode.	8
Very Low	Very Low chance the Control will detect a potential cause/ mechanism and subsequent failure mode.	7
Low	Low chance the Control will detect a potential cause/mechanism and subsequent failure mode.	6
Moderate	Moderate chance the Control will detect a potential cause/mechanism and subsequent failure mode.	5
Moderately High	Moderately High chance the Control will detect a potential cause/mechanism and subsequent failure mode.	4
High	High chance the Control will detect a potential cause/mechanism and subsequent failure mode.	3
Very High	Very High chance the Control will detect a potential cause/mechanism and subsequent failure mode.	2
Almost Certain	Controls will almost certainly detect a potential cause/mechanism and subsequent failure mode.	1*

*__Note:__ *Zero (0) rankings for Severity, Occurrence or Detection are not allowed*

Advanced Root Cause Analysis Techniques

	TECHNIQUE	PURPOSE	APPLICATION	MEMORY JOGGER
1	Design and Application Review	Compares how a system is designed versus how it is applied; specifically in the areas of installation, maintenance, and operating requirements and limitations	Applies to all problems—not just asset related Non-asset problems—evaluate processes and practices	
2	Cause and Effect (Ishikawa or fishbone diagram)	Plots the relationship between various factors that contribute to a specific event	Quality systems, product design, troubleshooting, brainstorming	4M – Man Machine, Method, Materials 
3	Sequence of Events	Displays the sequence of events leading to a failure, event, or incident graphically	Incidents where the time sequence is deemed critical to the evaluation of combined contributing factors	
4	Fault Tree Analysis (FTA)	States undesirable end (top) events and examines casual scenarios in a branched method	Systems wherein undesirable end events can be linked to all major contributing factors - equipment failures, design reviews	
5	Change Analysis	Compares the normal situation with the undesirable situation and determines changes that have occurred	Situations in which a change from normal configuration, operation or activity is likely to contribute or lead to an undesirable condition	What When Where How Who 
6	Failure Mode and Effects Analysis (FMEA)	Identifies likely modes of failure, occurrence frequency and detection mechanism for a given system, in a top-down approach	Product design, troubleshooting, generation of proactive measures for prevention of undesirable event	
7	Event and Causal Factor (ECF) Analysis	Describes, graphically, the time sequence of contributing events and existing conditions associated with an incident	Analysis of accidents and undesirable events Particularly effective for incidents that have primary and secondary events