How to use Failure Modes and Effects Analysis (FMEA) to get the Reliability you Need

Nancy Regan

Best Practices Webinar Series

Meet the Speaker

Nancy Regan

Reliability Centered Maintenance (RCM) Practitioner

- Author of *The RCM Solution*
- President, International RCM Certification Committee
- BS Aerospace Engineering, Embry-Riddle Aeronautical University
- Reliability Vlog on YouTube: RCM Online Training

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POLL QUESTION No. 1

When it comes to Reliability, what is your single biggest challenge or frustration right now? **(Click only one answer)**

- Lack of Management Support
- Poor Reliability Culture
- Lack of Funding
- Too busy in Reactive Mode (aka *running from fire to fire*) to work on proactive strategies

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POLL QUESTION No. 2

Have you ever been directly involved in doing an FMEA?

(Click only one answer)

- Yes
- No

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Why FMEA?

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Why FMEA?

Maintenance and Reliability Basics

- What is Reliability?

  → Get what we need from our machines

- As responsible custodians, we must ensure we take care of our machines properly, so we get what we need from them.

- We manage physical assets at the Failure Mode level.

Failure Mode = *what specifically causes failure*

- We must identify what Failure Modes could stop us from getting what we need from our machines – aka *the Reliability we need* – so we can figure out how to manage them.

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FMEA

Define Reliability

Identify what specifically causes Functional Failure.

Story of what would happen if we did nothing to manage the Failure Mode.

Function	Functional Failure	Failure Mode	Failure Effect
1	A	1	

Identify Consequences

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FMEA is often done poorly.

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FMEA Often Done Poorly

1. Done as a matter of routine
2. By an individual or only part of Reliability team
3. Not carried out properly

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FUNCTIONS

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Failure Modes and Effects Analysis: Hydraulic System

Function	Functional Failure	Failure Mode	Failure Effect
To provide hydraulic fluid to the system.			
		Loss of fluid	Visible oil

To provide redundant flight control hydraulic power (2,500 to 3,200 psi) to operate the actuators anytime the transmissions are operating.

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FAILURE MODES

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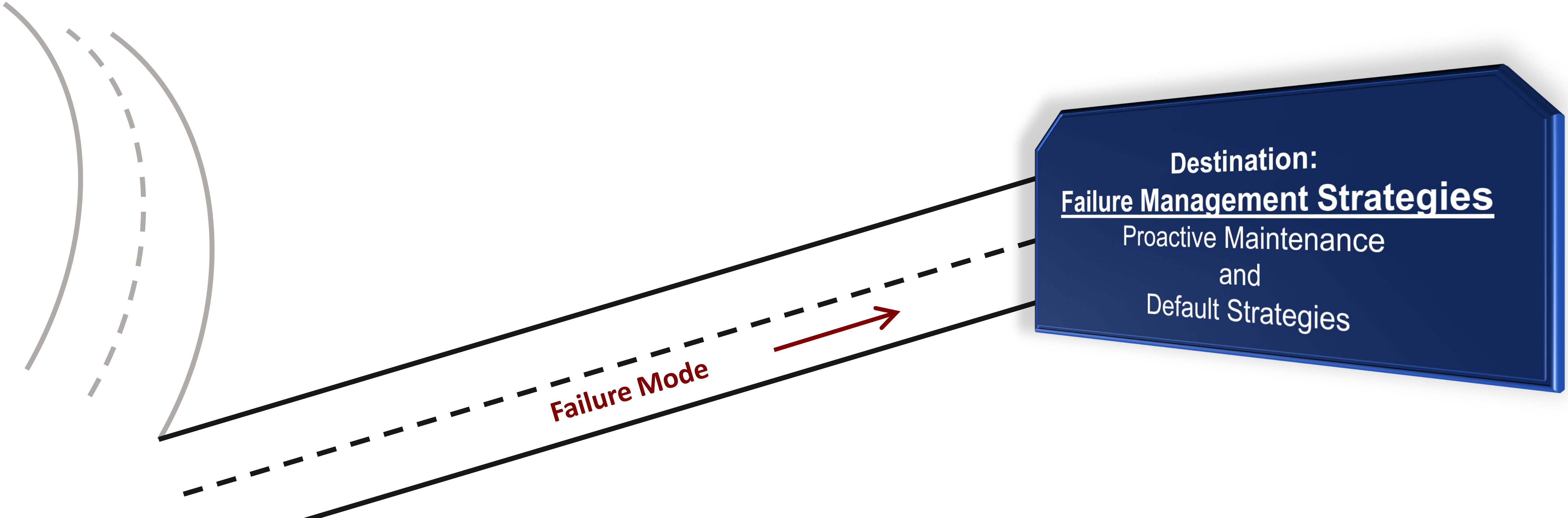
Failure Modes



A properly written Failure Mode puts you on the right road and sends you in the right direction.

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We manage physical assets at the Failure Mode level.

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Failure Modes and Effects Analysis: Hydraulic System

Function	Functional Failure	Failure Mode	Failure Effect
To provide hydraulic fluid to the system.	No flow	Catastrophic pump failure	
		Loss of fluid	
	Low flow	Pump cavitation	
		Clogged suction strainer	
		Bypassing in pump	
	...ressure		
	...pressure	Relief valve set low	

What specifically causes...

Failure Modes must be written at a level so that an appropriate Failure Management Strategy can be developed.

Hydraulic fluid is contaminated with excessive particulates due to normal use.

Hydraulic fluid filter clogs due to normal use.

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FAILURE EFFECTS

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Failure Modes and Effects Analysis: Hydraulic System

Function	Functional Failure	Failure Mode	Failure Effect
To provide hydraulic fluid to the system.	No flow	Catastrophic pum	Loss of all functions. noise at pump, oil analysis, filter examination
			Visible oil
			Hear pump noise, check suction strainer, oil analysis
			Open and inspect
		Bypassing in pump	Check case drain flow, flowmeter
	No pressure	Relief valve stuck open	Audible noise, higher oil temp, pressure test
		Pump failure	Noise at pump, oil analysis, filter examination
		No oil level	Low level indicator
	Low pressure	Relief valve set low	Pressure gauge, check monitor in dash

Failure Effects must be written in enough detail so Failure Consequences can be assessed.

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Well-Written Failure Modes and Effects Analysis: Compressor

Analysis: Compressor

FM		Function		Functional Failure		Failure Mode	Failure Effect
1A1	1	To provide compressed air that is oil free, <95F, at a minimum of 3,500 SCFM, 100 psig output pressure, with a minimum of 5 psig rise to surge to make up this compressor's portion of maintaining 10,500 SCFM and 90 psig header pressure to the plant.	A	Unable to provide compressed air.	1	Main drive shaft (coupling the motor to the compressor) lubrication dissipates	Over time, this causes metal to metal contact which causes abnormal wear on the coupling teeth. Eventually, vibration levels increase. May cause excessive stress on the shaft, motor bearing(s), and the bullgear bearings. Vibration levels increase and are indicated on the system tab of the graphic display. Eventually, vibration levels increase such that the high vibration alarm system (from any one of the stages) produces alarm text on the INFO tab of the graphic display and illuminates the TROUBLE INDICATION light. If the text and the light go unnoticed, eventually, the vibration in one or more of the stages increases such that the high vibration trip system produces alarm text on the INFO tab, shuts down the compressor motor, energizes the prelube pump, and illuminates the PRELUBE PUMP RUNNING light. (The TROUBLE INDICATION light remains illuminated.) The inlet valve closes, and the bypass valve opens unloading the compressor. The graphic display indicates that the compressor is down. Possible internal damage to the motor, shaft, and/or the bullgear bearing. This causes low instrument air to the plant. It takes 2 days to replace the coupling but it could take weeks if the motor, shaft, and/or bullgear are damaged. Production stops for up to 2 days while an alternate means of producing instrument air is put in place.

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A bite out of the middle…?

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Reliability Centered Maintenance (RCM)

Steps 1-4: FMEA
Failure Modes and Effects Analysis

RCM Process

1. Functions
2. Functional Failures
3. Failure Modes
4. Failure Effects
5. Failure Consequences
6. Proactive Maintenance and Intervals
7. Default Strategies

Steps 1-5: FMECA
Failure Modes, Effects, and Criticality Analysis

Step 6:
Includes
Condition Based Maintenance

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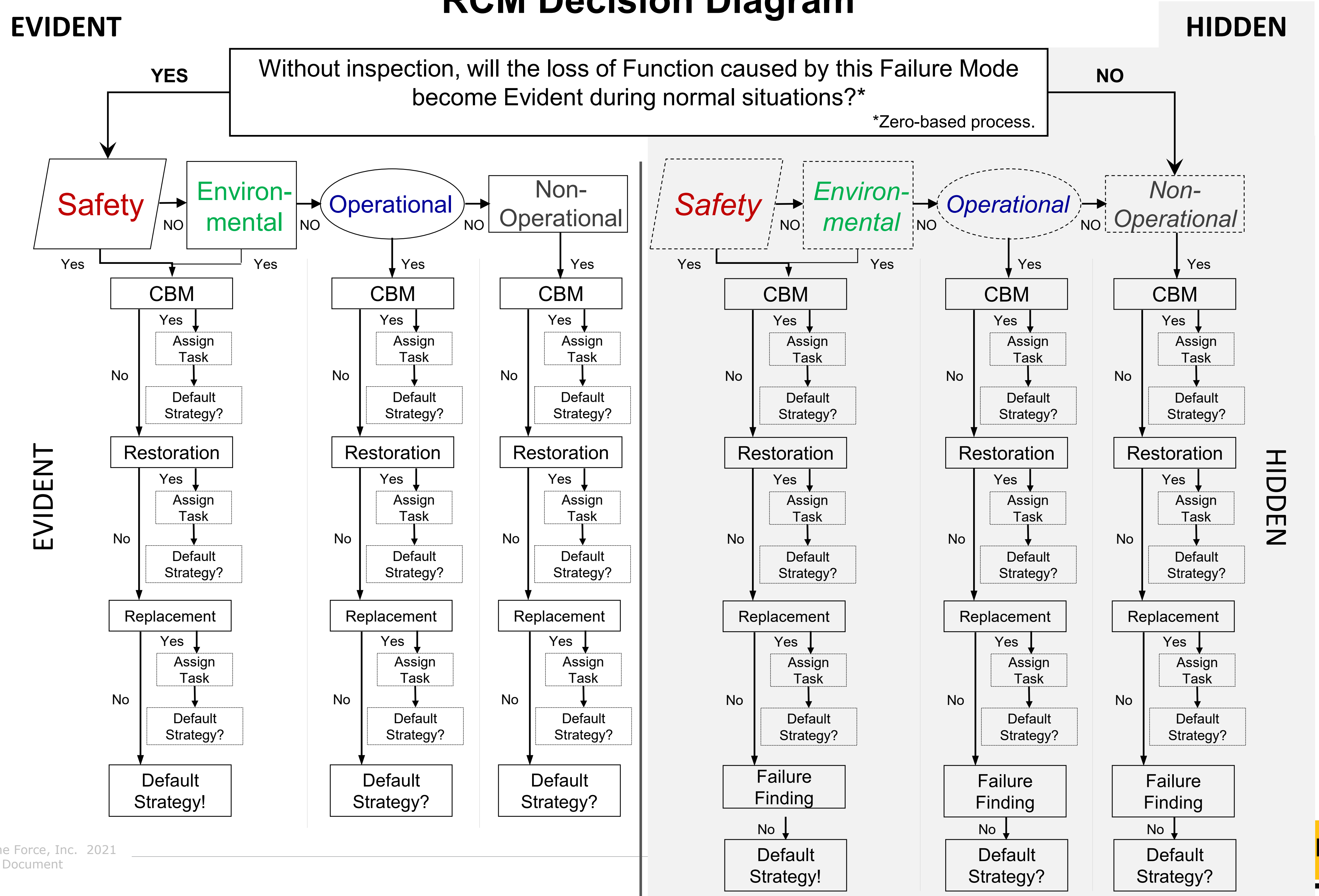
RCM Decision Diagram



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FMEA Done Well

1. Done thoughtfully
2. By entire Reliability team
3. Carried out properly

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Questions

QUESTIONS?

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Next Best Practice Webinar: August 18, 2021:

John Bernet

Using root cause analysis and failure modes to build a total condition maintenance strategy for motor/drive systems

BEST PRACTICE WEBINAR | Wednesday, Aug 18, 11 a.m. ET

In this webinar, John Bernet from Fluke Reliability will discuss best practices for applying root cause analysis and expected failure modes to motor-drive systems.

You will learn the simple steps of total condition maintenance, how different inspection techniques from electrical to thermal can help identify different failure modes, and how vibration analysis in particular can find the most common mechanical faults on rotating machines. We will wrap up with a discussion on the obstacles teams may face when starting a reliability program and learn from those who have succeeded.

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