Example from a Hardware-based FMEA

Machine/Process: Onboard compressed air system

Subject: 1.2.2 Compressor control loop

Description: Pressure-sensing control loop that automatically starts/stops the compressor based on system pressure (starts at 95 psig and stops at 105 psig)

Next higher level: 1.2 Compressor subsystem

Failure Mode	Effects			Causes	Indications	Safeguards	Recommenda-tions/Remarks
	Local	Higher Level	End				
A No start signal when the system pressure is low	Open control circuit	Low pressure and low air flow in the system	Interruption of the systems supported by compressed air	Sensor failure or miscalibration Controller failure or incorrect setting Wiring fault Control circuit relay failure Loss of power for the control circuit	Low pressure indicated on air receiver pressure gauge Compressor not operating (but has power and no other obvious failure)	Rapid detection because of quick interruption of the supported systems	Consider a redundant compressor with separate controls Calibrate sensors annually
B No stop signal when the system pressure is high	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•
	•	•	•	•	•	•	•

Example from a Function-based FMEA

Machine/Process: Onboard compressed air system

Subject: 1. Provide compressed air at 100 psig

Description: Intake air, compress the air to 100 psig, and distribute the air (without loss) to the manufacturing tool stations or machine

Next higher level: Compressed air system

Failure Mode	Effects			Causes	Indications	Safeguards	Recommenda-tions/Remarks
	Local	Higher Level	End				
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
⊟ No/inadequate compressed air on demand	No air flow or pressure	No air flow to manufacturing	Interruption of the systems supported by compressed air	No/inadequate intake air No/inadequate air compression No/inadequate containment of compressed air No/inadequate air distribution flow path	Possibly no air pressure at the gauge on the air receiver or at the gauges for the tool stations (unless the flow path is blocked downstream of a gauge)	Rapid detection of quick interruption of the supported systems	Consider regular monitoring of the pressure differential across the intake air filter Consider checking the rain cap on the air intake annually Consider a redundant compressor
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•

Example of Point Estimate Risk Calculations in an FMEA

Machine/Process: Onboard compressed air system

Subject: 1.2.2 Compressor control loop

Description: Pressure-sensing control loop that automatically starts/stops the compressor based on system pressure (starts at 95 psig and stops at 105 psig)

Next higher level: 1.2.2 Compressor subsystem

Failure Mode	Effects			Causes	Indications	Safeguards	Risk Prioritization			Recommendations/Remarks
	Local	Higher Level	End				Frequency	Cost	Risk	
A No start signal when the system pressure is low	Open control circuit	Low pressure and low air flow in the system	Interruption of the systems supported by compressed air	Sensor failure or miscalibration Controller failure or incorrect setting Wiring fault Control circuit relay failure Loss of power for the control circuit	Low pressure indicated on air receiver pressure gauge Compressor not operating (but has power and no other obvious failure)	Rapid detection because of quick interruption of the supported systems	0.1/y	$500	$50/y	Consider a redundant compressor with separate controls Calibrate sensors annually
B No stop signal when the system pressure is high	•	•	•	•	•	•	•	•	•	•
	•	•	•	•	•	•	•	•	•	•
	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•

Example of Risk Categorizations in an FMEA

Machine/Process: Onboard compressed air system

Subject: 1. Provide compressed air at 100 psig

Description: Intake air, compress the air to 100 psig, and distribute the air (without loss) to the manufacturing tool stations or machine

Next higher level: Compressed air system

Failure Mode	Effects			Causes	Indications	Safeguards	Risk Prioritization			Recommendations/Remarks
	Local	Higher Level	End				Frequency Category	Consequence Category	Risk Index Number	
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
B.No/ inadequate compressed air on demand	No air flow or pressure	No air flow to air-operated valves	Interruption of the systems supported by compressed air	No/inadequate intake air No/inadequate air compression No/inadequate containment of compressed air No/inadequate air distribution flow path	Possibly no air pressure at the gauge on the air receiver or at the gauges for the tool stations (unless the flow path is blocked downstream of a gauge)	Rapid detection of quick interruption of the supported systems	4	2	6	Consider regular monitoring of the pressure differential across the intake air filter Consider checking the rain cap on the air intake annually Consider a redundant compressor
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•

Example of a Higher Level, Hardware-based FMEA

Machine/Process: Onboard compressed air system

Subject: 1.2 Compressor subsystem

Description: Equipment used to compress the intake air to 100 psig (including the compressor and its control loop, the discharge relief valve, and associated piping)

Next higher level: 1. Compression system

Failure Mode	Effects			Causes	Indications	Safeguards	Recommendations/Remarks
	Local	Higher Level	End				
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
⊟ Fails to provide air at 100 psig	No air pressure and the compressor not operating	No air flow/ pressure	Interruption of the systems supported by compressed air	Compressor control loop – no start signal when the system pressure is low Compressor – fails to operate Relief valve – spuriously opens Piping – leak/ rupture	Low pressure indicated on the air receiver pressure gauge	Rapid detection because of quick interruption of the supported systems	Consider a redundant compressor (diesel powered) with separate controls Calibrate sensors annually Replace the relief valve annually
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•

Example of a Lower Level, Function-based FMEA

Machine/Process: Onboard compressed air system

Subject: 1.2 Compress air to 100 psig

Description: Compress intake air to 95 to 105 psig with enough volume to meet production tool/ machine needs

Next higher level: 1. Provide compressed air at 100 psig

Failure Mode	Effects			Causes	Indications	Safeguards	Recommenda-tions/Remarks
	Local	Higher Level	End				
A. Compressor starts prematurely	Unexpected compressor operation	Unexpected air pressure/flow Possible high pressure in the system	Possible injury (especially during maintenance work) Possible system damage from high pressure	Compressor control system sends false signal Manual override of compressor control system	Operating compressor when it is supposed to be stopped	Lockout/tagout of compressor during maintenance Pressure relief valve at the discharge of the compressor for preventing equipment damage	Consider removing the manual override button for the compressor Calibrate pressure sensing switch annually
B. Compressor fails to start on demand	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•