AESQ

HUMAN FACTOR FAILURE MODE & EFFECTS ANALYSIS

Using an FMEA approach to REDUCE HUMAN ERROR

A Rolls-Royce Case Study

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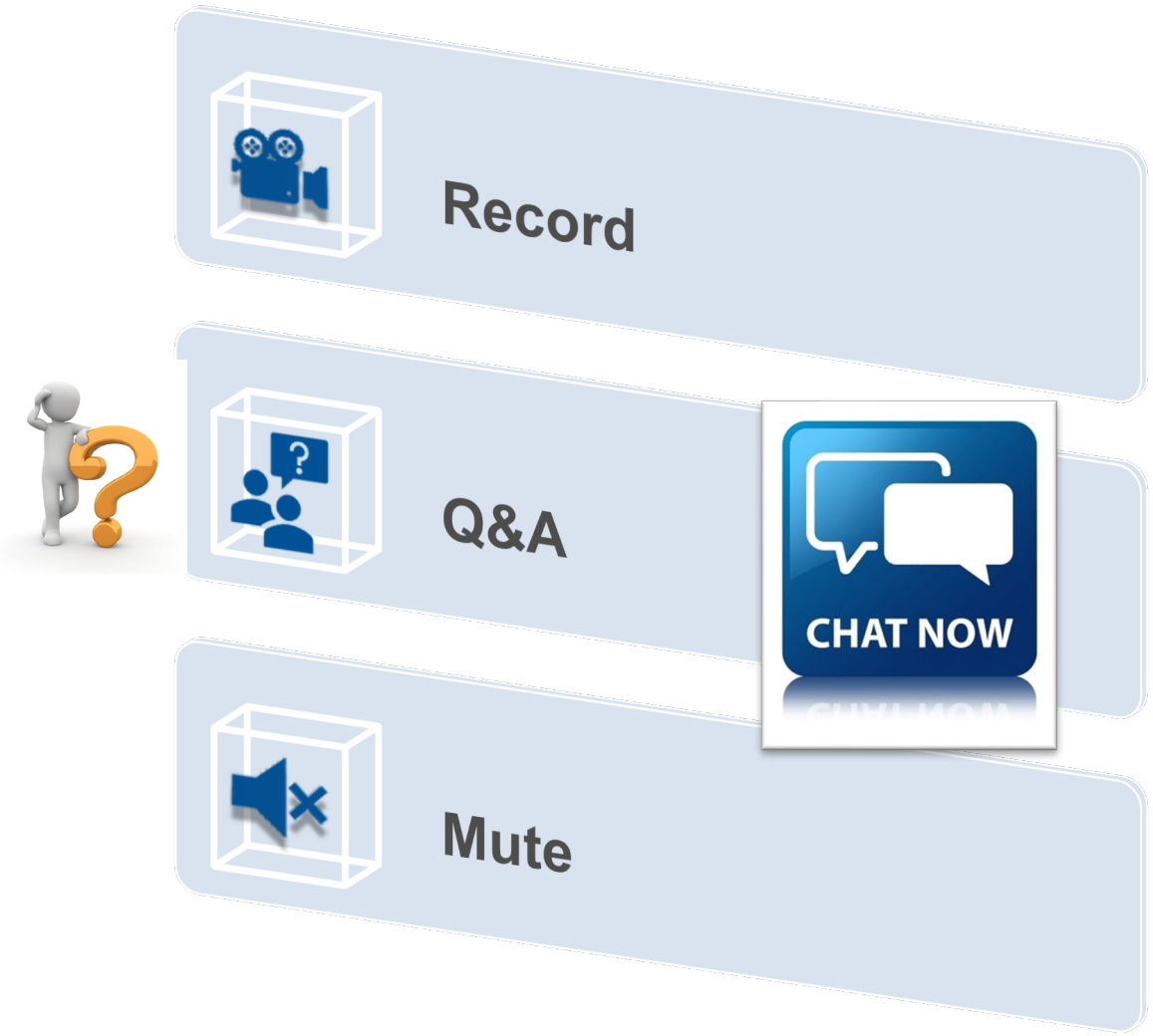
AESQ STRATEGY GROUP
A Program of SAE ITC

Webinar Overview

We are **recording** today's webinar and will distribute the video link following the close of the webinar. It will also be posted on the AESQ website for free viewing.

We will take **questions** during today's webinar using the **Chat** feature.

Please remain on Mute during the presentation to prevent background noise. We will also be muting all lines at the start of the session.



Ian Riggs Introduction

- Worked for Rolls-Royce Aerospace for past 18 years
- Currently the Global Quality & HSE Executive for Civil Aerospace, Assembly & Test Operations
- 16 years experience working for Automotive, including Cosworth High Performance Engines (owned by Audi AG) and Harman International
- Awarded an Engineering Doctorate by Warwick University in 2005
- Founding member of the AESQ in 2013
  - Served two terms as Chairman
  - Led the writing team for AS13100 and AS13003
  - Team leader for RM13004 Interest Group
- Trained over 1500 Rolls-Royce and Supplier Leaders in our Zero Defects Program

Steve Roebuck Introduction

- Worked for Rolls-Royce Aerospace for the past 11 years
- Currently Head of Certification & Quality Assurance Civil Aerospace, Assembly & Test Operations
- Previous Quality Leadership roles in Domestic and Supply Chain Quality at Rolls-Royce
- Previous experience outside of Rolls-Royce working in various Quality Assurance roles across the Aerospace and Pharmaceutical Industry
- Current Human Factors Deployment Lead for Assembly & Test Operations
- First AESQ Webinar after presenting at the AESQ conference in February

AS13100 Webinar Series : Using FMEA to Reduce Human Error

The management of **Human Factors** plays an important part in any organizations' ability to achieve it quality and safety goals.

AS13100 and RM13010 define requirements and guidance to what an effective Human Factors system should include.

In this Webinar we shall share how Rolls-Royce Civil Large Engine Assembly & Test facility has developed a preventative approach to Human Factors related causes by using a **Process Failure Mode & Effects Analysis (PFMEA)** approach

Section 1: The Approach	Section 2: Case Studies	Section 3: Help & Guidance
1. What is meant by Human Factors	4. Case Study 1 : Final Inspection	7. Frequently Asked Questions
2. Failure Mode & Effects Analysis (FMEA) Simple Overview	5. Case Study 2 : Certification Office	8. AESQ Support
3. Using FMEA to reduce the risk of Human Factors – Overview of the approach	6. HF FMEA Summary & Insights	9. Questions & Answers

Registration Overview

506 people registered

representing 273 companies

in 26 Countries

We're in good company....

How to Engage with Us

Rebecca Lemon
Industry Program Manager
SAE

Chris Craig
Senior Operations Quality Manager
Rolls-Royce

Please complete the Poll Questions when asked (they are anonymous).

Use the **Chat Function** to ask a question, at any time, or to make a comment.

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Which Function listed below best describes where you work?

ⓘ Start presenting to display the poll results on this slide.

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What City are you joining from?

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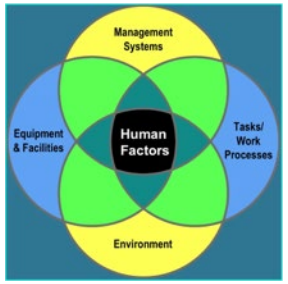
Section 1 : The Human Factors FMEA Approach

1



Overview of Human Factors in AS13100

2

FMEA OVERVIEW

3

Human Factors FMEA Overview

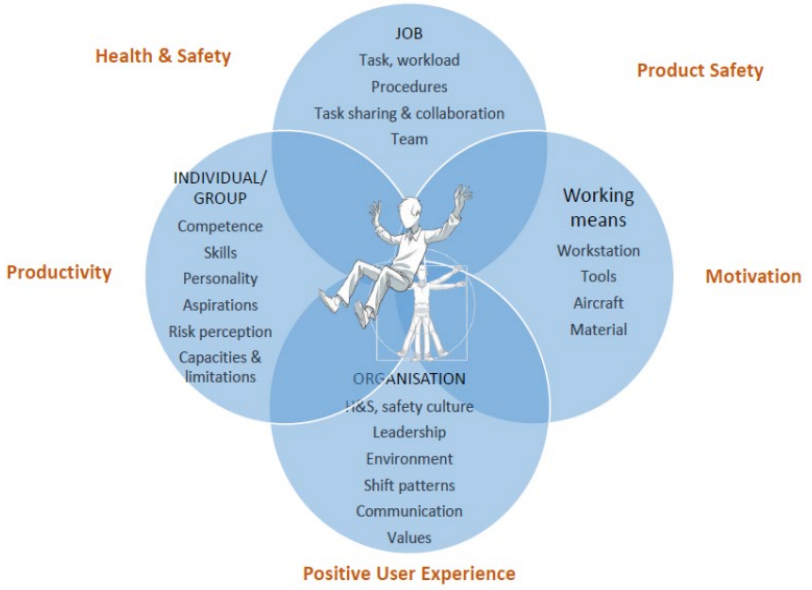
What is/are Human Factors?

Human Factors can influence us at work every day and can negatively impact performance without us knowing it!

Being aware and understanding Human Factors plays an important role in Manufacturing and Assembly Operations

The primary focus of any Human Factors initiative is to improve safety, quality, and efficiency by reducing and managing human errors made by individuals and organizations

There are many disciplines around the study of human factors but today we are going to focus on the Dirty Dozen



Sources of Further Information & Guidance

1. Reference Manual RM13004 and RM13010 are available free of charge from the AESQ website

2. Subject Matter Interest Group to support RM13004 and RM13010 Deployment are established and contactable through AESQ Website

https://aesq.sae-itc.com

AS13100 FMEA Requirements & Guidance

RM13004 is focused on Product Failure Modes and so is not relevant to what we will describe today.

The only relevance to Human Factors FMEA is the template used and the ***'FMEA thinking'*** approach

OP / Step	Requirement	Failure Mode	Potential Effect	Severity	Class.	Potential Cause	Prevention Control	Occurrence	Detection Controls	Detection	RPN

RM13010 describes a wide range of Human Factors topics to support the deployment of AS13100.

For this Human factors FMEA approach we are focusing mainly on the concept of the ***'Dirty Dozen'*** as described in Section 5.1

Aero Engine Assembly Operations

30,000

Components

6,000

Manual Operations

HUMAN FACTORS play a critical part in assuring **PRODUCT QUALITY & SAFETY**

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Does your Company have a Human Factors Program?

ⓘ Start presenting to display the poll results on this slide.

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How many of the Dirty Dozen can you name?

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Human Factors

The Dirty Dozen

1 Lack of Communication

2 Complacency

3 Lack of Knowledge

4 Distraction

5 Lack of Team Work

6 Fatigue

7 Lack of Resources

8 Pressure

9 Lack of Assertiveness

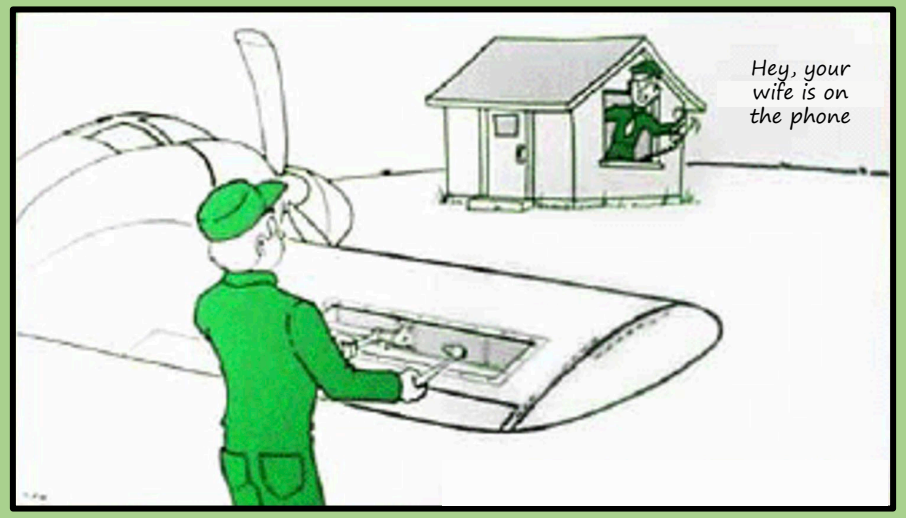
10 Stress

11 Lack of Awareness

12 Norms

The Dirty Dozen

1. Lack of Communication
2. Complacency
3. Lack of Knowledge
4. Distraction
5. Lack of Teamwork
6. Fatigue
7. Lack of Resources
8. Pressure
9. Lack of Assertiveness
10 Stress
11. Lack of awareness
12. Norms



Distraction Safety Nets

1. Always finish the job or unfasten the connection
2. Mark the uncompleted work
3. Lockwire where possible or use Torque seal
4. Double inspect by another or self
5. When you return to the job always go back 3 steps
6. Use a detailed check-sheet.

Posters adapted from
http://www.marss.org/poster.htm#

The Dirty Dozen

1. Lack of Communication
2. Complacency
3. Lack of Knowledge
4. Distraction
5. Lack of Teamwork
6. Fatigue
7. Lack of Resources
8. Pressure
9. Lack of Assertiveness
10 Stress
11. Lack of awareness
12. Norms

Pressure Safety Nets

1. Be sure the pressure isn't self-induced
2. Communicate your concerns
3. Ask for extra help
4. Just say No

Posters adapted from
http://www.marss.org/poster.htm#

The Dirty Dozen

1. Lack of Communication
2. Complacency
3. Lack of Knowledge
4. Distraction
5. Lack of Teamwork
6. Fatigue
7. Lack of Resources
8. Pressure
9. Lack of Assertiveness
10 Stress
11. Lack of awareness
12. Norms

Complacency Safety Nets

1. Train yourself to expect to find a fault
2. Never sign for something that you did not do.

Posters adapted from
http://www.marss.org/poster.htm#

7.3.1 Human Factors Awareness / Training

Training/Awareness
Initial Training
2 yearly refresher training
Toolbox Talks

Improvements/Maturity
HF FMEA
HF Deployment Maturity Assessment

5.2.1.1 Continually improving the maturity of Human Factor deployment

AS13100
Human Factor Requirements

Open Reporting Process
MARS Process – Manage the Action Report System

5.2.1.1 Open Reporting Process

Investigations
Human Factors checklist – considering human factors (Dirty Dozen) during root cause investigations

10.2.1 An approach for recognizing and addressing Human Error causes in investigations.

Just Culture
MEDA investigations
Event Review Group – Line in the sand

4.4.3 An open reporting culture, encouraging the sharing of mistakes without fear of inappropriate retribution.

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Are you familiar with using FMEA?

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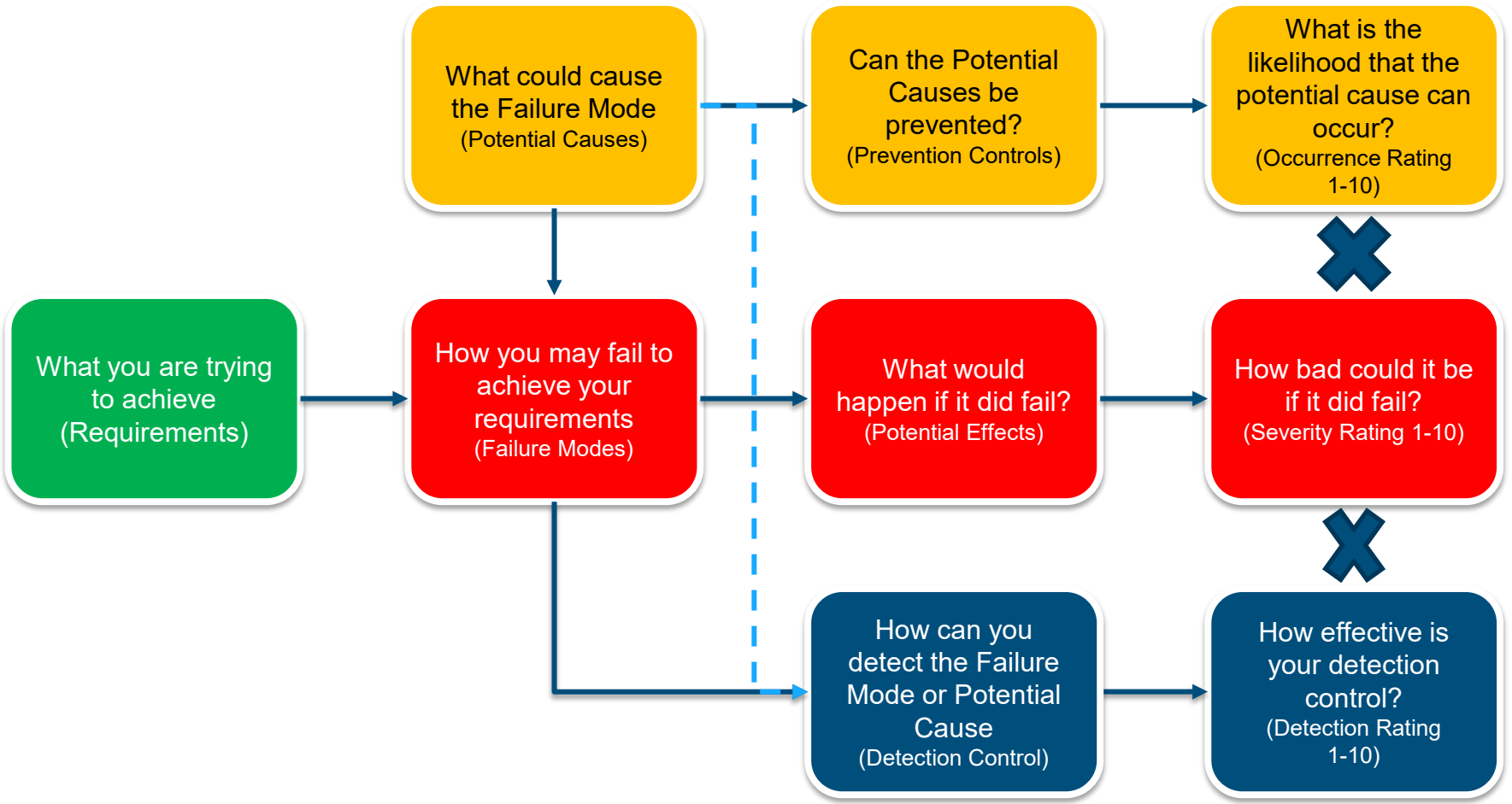
FMEA Simple Overview



Risk Priority Number

FMEA Overview

Step	Requirements	Potential Failure Modes	Potential Effects of Failure	Severity Score	Potential Causes of Failure	Prevention Controls	Occ Score	Detection Controls	Detection Score	RPN	Improvement Actions
OP10 CNC Drilling	Fuel Hole 50mm Diameter +/- 0.1mm	Diameter Too Big	Fuel Leaks leading to a potential explosion in use	9	Drill Oversize	Drill Tool pre-setting check	4	Bore micrometer at OP 50	7	252	
					Spindle alignment error – spindle not running true	Asset Care & machine calibration schedule	3	Operator Weekly Ball bar check (Go / No GO)	8	189	
			Scrap Part	6	Part Loose in Fixture	Air detection system on fixture	1	Bore micrometer at OP 50	7		
					Swarf / Debris on tool	None	4	Bore micrometer at OP 50	7		

Human Factors

Using the FMEA Approach

Requirement	Potential Failure Mode(s)	Potential Cause(s)	Prevention Controls	Detection Controls
No errors due to Human Factors	Complacency			
	Distractions			
	Fatigue			
	Lack of Assertiveness			
	Lack of Awareness			
	Lack of Communication			
	Lack of Knowledge			
	Lack of Resources			
	Lack of Teamwork			
	Pressure			
	Stress			
	Unhealthy Norms			

The Dirty Dozen

(Simplified FMEA template for illustration purposes only. Some columns are missing e.g. the scoring is not included)

Human Factors

Using the FMEA Approach

Requirement	Potential Failure Mode(s)	Potential Cause(s)	Prevention Controls	Detection Controls
No errors due to Human Factors	Complacency			
	Distractions			
	Fatigue			
	Lack of Assertiveness			
	Lack of Awareness			
	Lack of Communication			
	Lack of Knowledge			
	Lack of Resources			
	Lack of Teamwork			
	Pressure			
	Stress			
	Unhealthy Norms			

The Dirty Dozen

What things could cause distractions in the workplace?

(Simplified FMEA template for illustration purposes only. Some columns are missing e.g. the scoring is not included)

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What things could cause distractions in the workplace?

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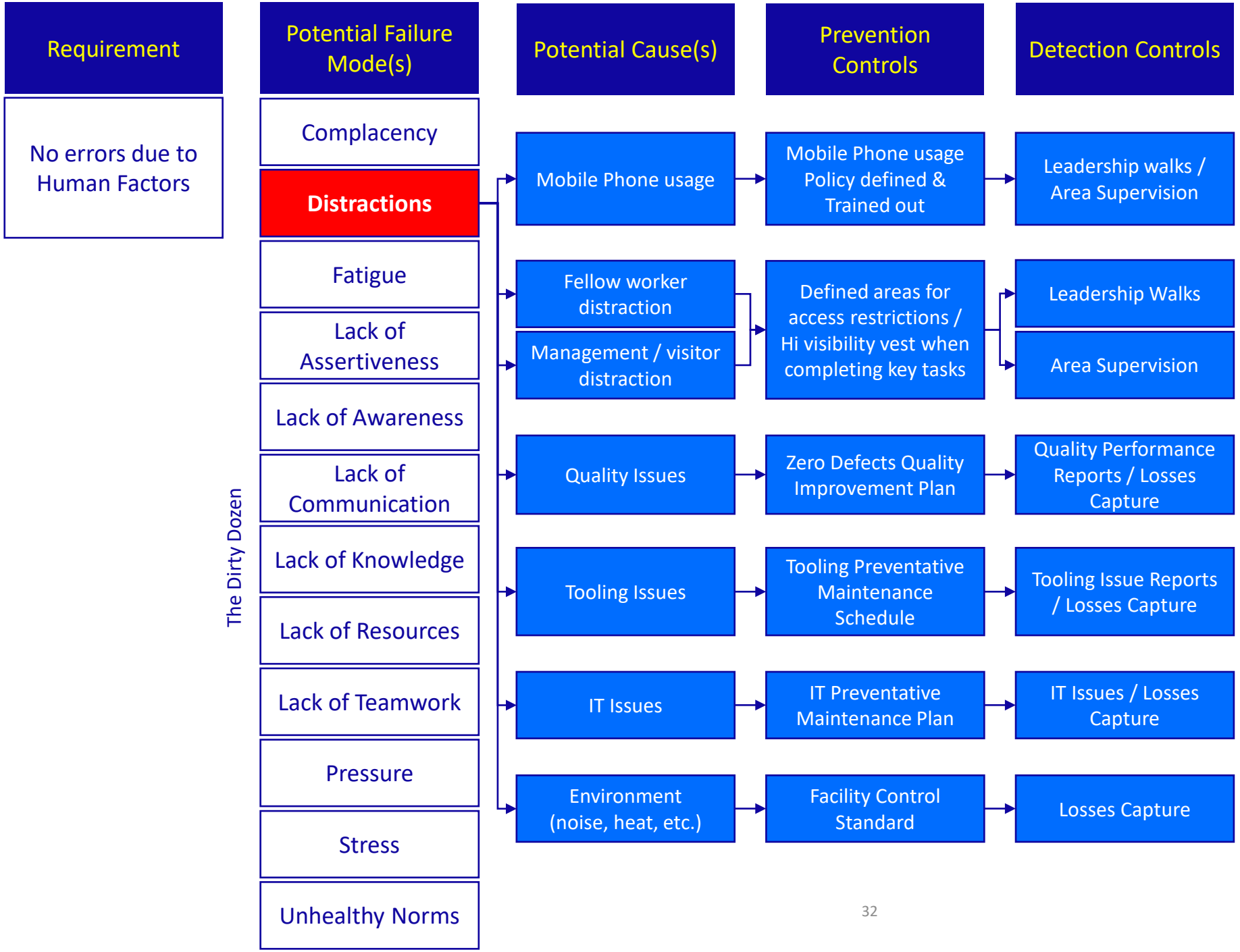
Human Factors

Using the FMEA Approach



(Simplified FMEA template for illustration purposes only. Some columns are missing e.g. the scoring is not included)

Section 2 : The Human Factors FMEA Case Studies

1

Case Study 1
Final Inspection

2

Case Study 2
Certification Office

3

Summary &
Conclusions

Scenario 1 – Final Inspection

Final Inspection includes three main activities;

- Post Test Engine Inspection
- Engine Preparation for Transport
- Final Documentation for Certification

When engines get to Final Inspection they have a specific time window to complete these activities before the transportation is ready to take it off site to be delivered to the customer.

The teams work a 12 hour shift pattern and provide 24 hour cover, seven days per week.

Any delays to this process can cause disruption to the transportation and customer delivery schedule. Delays can be caused by;

- Quality issues found at inspection
- Resource constraints
- Paperwork discrepancies

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Which of the Dirty Dozen apply in this Scenario?

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Scenario 2 – Certification Office

Certification process includes three main activities;

- Ensuring all Assembly and Test operations are complete
- Ensuring all non-conformances are closed out
- Creating CAA Form 1 and Engine Logbook

- When the Certification team receive the final paperwork they have a specific time window to complete these activities before the transportation is ready to take it off site to be delivered to the customer.
- The team works 2 shifts and often cover weekends. Each engine has an owner but sometimes engines have to be passed on to the next shift or weekend shift to complete.
- Delays can be caused by incorrect/missing documentation or open non-conformances.

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Which of the Dirty Dozen apply in this Scenario?

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Human Factors FMEA – Certification Office Extract

Requirement	Failure Mode	Potential Effect	Severity	Class.	Potential Cause(s) of the Failure Mode	Prevention Control(s) for the Potential Causes	Occurrence	Detection Controls of the Failure Mode and/or the Potential Causes	Detection	RPN
No Distraction	Distraction	Delays to despatch of the engine			Paperwork Errors	Gated Process		Individual Observation		
No Pressure	Pressure	Escape to the customer			Delivery Pressure	Team allocation of tasks/daily meeting		Individual Observation		
Good Communication	Lack of Communication	Escape to the customer			Poor handover of engine	Daily engine review		Engine status board		
All Resources	Lack of Resources	Delays to despatch of the engine			Lack of consumables	Consumable champion		Weekly 5S audit		
Full Awareness	Lack of Awareness	Repeat escapes to the customer			Unaware of errors made	Weekly team meeting to feedback errors		None		

Meet the Certification Team....

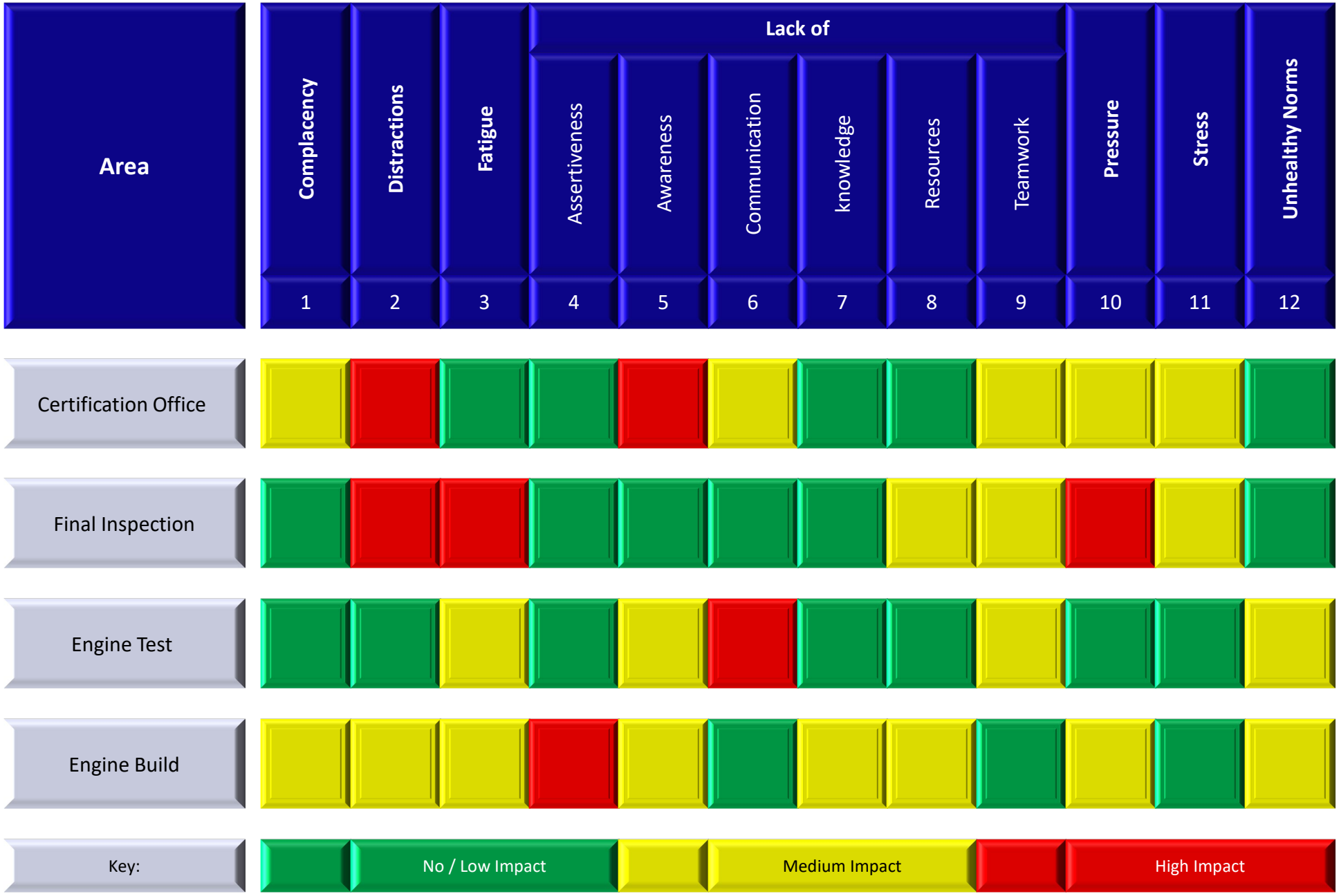
Play Video

Assembly & Test

Human Factors FMEA

Heat Map

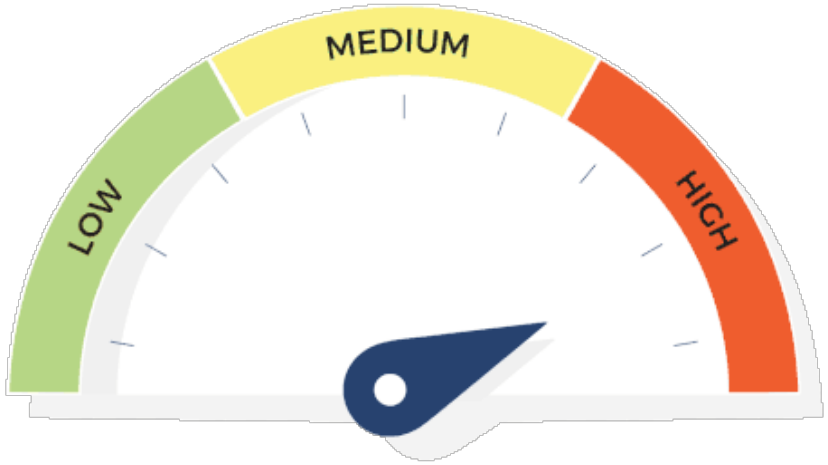
Each area will have its own, unique Human Factor risk profile (and this will change over time)



Key Benefits

- Increased Awareness of Human Factors risks across the teams/organisation
- Increased engagement on Human Factors improvements
- Majority of improvements are low cost but high impact
- Increased levels of MARS (HF) reporting
- Reduction in errors/escapes

Human Factor FMEA : Tips for Success



Human Factors Maturity Score

EFFECTIVE FMEAs WILL
HELP
TRANSFORM YOUR
QUALITY PERFOMANCE!

Tips for Effective Deployment include;

a) Develop FMEA at the team level (Can be done for **Operational** or **Transactional** Processes/Teams)

b) Ensure that the team is **Cross Functional**

c) Use **REFERENCE FMEAs** and adapt them to the local situation

d) Create **Tangible Mitigation Actions** based on Risk

e) Conduct **Regular Reviews** with the team and keep the FMEA updated

f) Keep it **Simple!**

Section 3 : Further Help & Guidance

1

Frequently Asked Questions

2

AESQ Support

3

Q&A

4

Close

Why don’t you add the Human Factors FMEA into the Part Specific Process FMEA as described in RM13004?

RM13004 Process FMEA & Human Factors

OP / Step	Requirement	Failure Mode	Potential Effect	Severity	Class.	Potential Cause(s) of the Failure Mode	Prevention Control(s) for the Potential Causes	Occurrence	Detection Controls of the Failure Mode and/or the Potential Causes	Detection	RPN
	Human Error	~~Fatigue~~				Night Shift					

This is not a Product Failure Mode

Failure Modes in an AS13004 PFMEA describe Product nonconformance

(RM13004, Chapter 4, (f))

RM13004 Process FMEA & Human Factors

OP / Step	Requirement	Failure Mode	Potential Effect	Severity	Class.	Potential Cause(s) of the Failure Mode	Prevention Control(s) for the Potential Causes	Occurrence	Detection Controls of the Failure Mode and/or the Potential Causes	Detection	RPN
	Assemble Part xyz in correct orientation	Part fitted in incorrect orientation				Distraction					

This is not a Cause & Effect Relationship.

If the Potential Causes occurs we should expect the part Failure Mode to occur

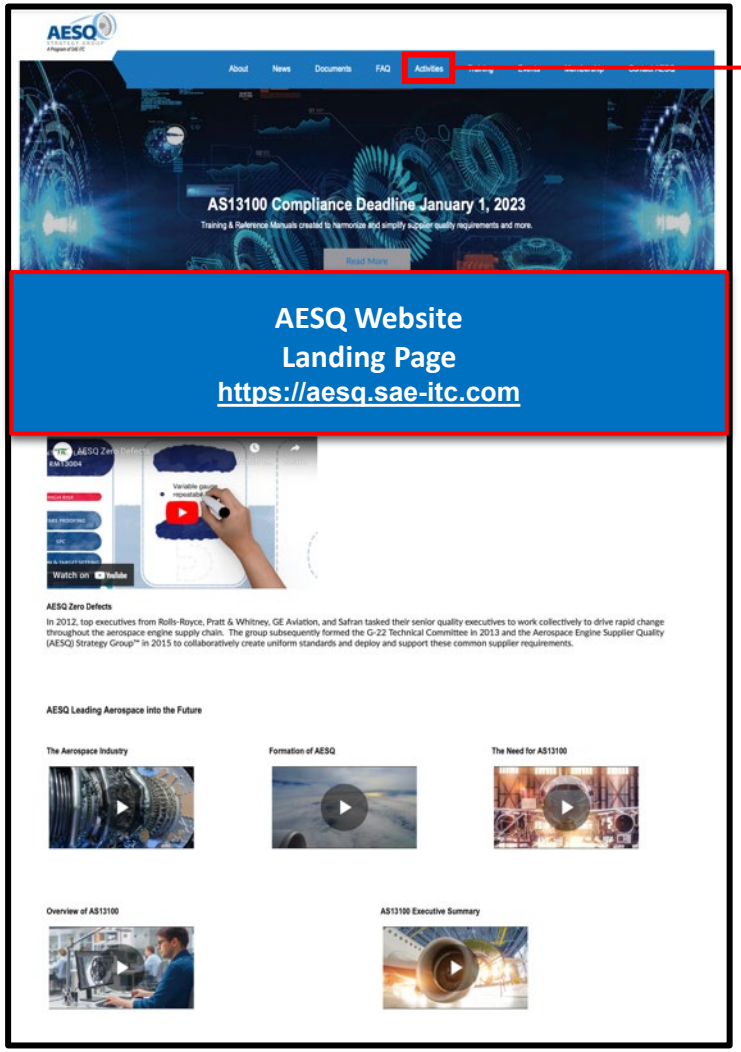
We must avoid simple 'operator error' as a Potential Cause

(RM13004, Chapter 4, (i))

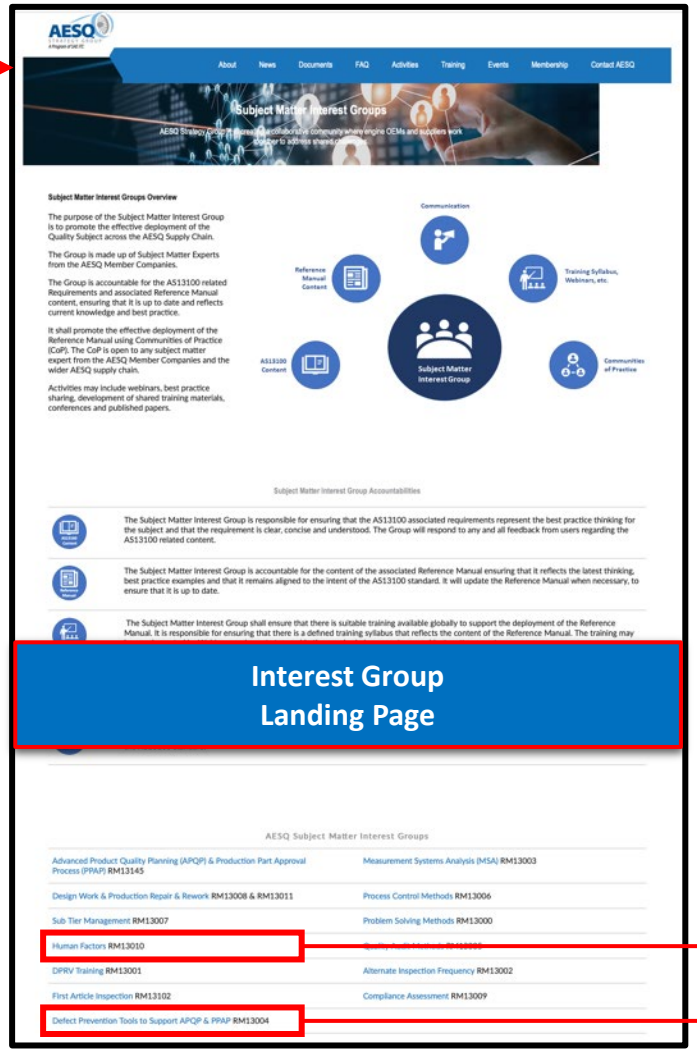
Human Factors are not related to specific part nonconformance.

Instead, they relate to the working environment and can impact any products manufactured in that area.

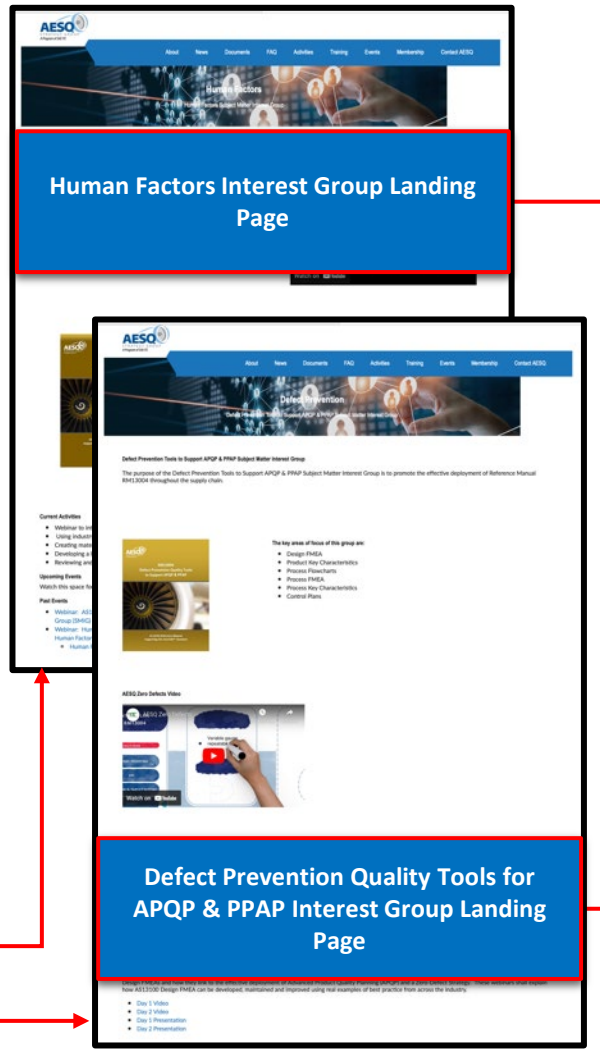
Subject Matter Interest Groups on the AESQ Website



AESQ Website Landing Page
https://aesq.sae-itc.com



Interest Group Landing Page



Human Factors Interest Group Landing Page

Defect Prevention Quality Tools for APQP & PPAP Interest Group Landing Page

Further links to support materials, events, social media pages, etc.

Opportunity to Submit questions

SAE Training

NEW!

SAE C2212 AS13100 and RM 13010: Human Factors for Aviation A 2 Day Course

Who Should Attend: This course is for suppliers and quality practitioners who manage or work with AS13000 requirements in the aerospace engine sector and need background in **Human Factors**.

It supports compliance with SAE's AS13100 requirements related to Human Factors, RM13010.

Both new and experienced quality practitioners should be trained in this powerful defect prevention methodology.

Scan QR Code for more information

Other SAE AS13100 Aligned Courses

C1862 RM13000 8D Problem Solving

C1889 RM13004 FMEA and Control Plans

C2213 RM13145 APQP & PPAP

C1878 RM13003 Measurement Systems Analysis (MSA)

- VILT and In-person in 2023
- Available for CL
- All English

Please use the Chat Function to ask any questions

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Please keep a look out for future AESQ Webinars

Steve


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