AS13100 / RM13004 PROCESS FMEA WEBINAR

Application of RM13004 in a Complex Assembly Environment

Dr Ian Riggs
Quality Executive
Rolls-Royce

Harj Sanghera
Manufacturing Engineer
Rolls-Royce

Steve Roebuck
Head of Certification & Quality Assurance
Rolls-Royce

February 29th 2024
Introductions

Dr Ian Riggs
Global Quality & HSE Executive
Assembly & Test Operations
• Worked for Rolls-Royce Aerospace for
  past 19 years, 16 years experience
  working in the Automotive Industry,
• Founding member of the AESQ in
  2013
• Led the writing teams for AS13100
  and AS13003
• Team leader for AESQ RM13004
  Subject Matter Interest Group

Harj Sanghera
Manufacturing Engineer
Assembly & Test Operations
• Worked for Rolls-Royce Aerospace for
  past 2 years
• Leads the Community of Practice
  (CoP) for RM13004 Process FMEAs in
  Assembly & Test
• BEng Hons Mechanical Engineering
  (Derby University). Awarded the Rolls-
  Royce Sir Denning Pearson Award.
• 10 years engineering experience

Steve Roebuck
Head of Certification & Assurance
Assembly & Test Operations
• Worked for Rolls-Royce Aerospace
  for the past 12 years working in
  manufacturing and supply chain
  quality roles
• Current Human Factors Deployment
  Lead for Assembly & Test Operations
• Previous experience in aerospace
  supply chain (special processes) and
  pharmaceutical industry
A Global Attendance

A Total of 486 People Registered from 207 Organisations in 33 Countries
Getting the most out of the Session

Amanda Myers
Aerospace Standards Committee Manager
SAE

Please note we are recording today’s webinar. This recording will be available for free viewing on the AESQ website subsequent to this event. An email notification will be issued to attendees when the video is available.

We will be muting all lines at the start of the session.

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

Please complete the Poll & Quiz Questions when asked (they are anonymous).
# AS13100 / RM13004 PROCESS FMEA Webinar

## APPLICATION IN A COMPLEX ASSEMBLY ENVIRONMENT

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AS13100 &amp; RM13004 Process FMEA (short) Recap</td>
</tr>
<tr>
<td>2</td>
<td>Process FMEA in an assembly environment – Key Insights</td>
</tr>
<tr>
<td>3</td>
<td><strong>Practical Demonstration</strong></td>
</tr>
<tr>
<td>4</td>
<td>Dealing with Human Error in a Process FMEA</td>
</tr>
<tr>
<td>5</td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>6</td>
<td>Further Information Sources</td>
</tr>
</tbody>
</table>
AS13100 FMEA Requirements & Guidance

AS13100
Available to purchase from
https://www.sae.org/standards/content/as13100

RM13004
Available to Download for FREE at
https://aesq.sae-itc.com/supplemental-material

Recently Revised
AS13100 & RM13004
Process FMEA Requirements
AS13100 Process FMEA Key Requirements (Chapter C)

- Must be Created & Maintained by a CROSS FUNCTIONAL TEAM (20.1)
- PFMEA must be done at the RIGHT TIME in APQP (16.5.10)
- Is PART NUMBER Specific (21.4)
- Include ALL Process Steps (21.4)
- EVERY Design Characteristic included in the PFMEA (21.4.1)
- PFMEA Failure Modes must describe PRODUCT DEFECTS (21.4.1)
- PFMEAs must DRIVE ACTIONS to reduce risk (21.4.3)
- Keep up to date – They are LIVE documents (20.1)
# The Process FMEA Template Overview

<table>
<thead>
<tr>
<th>Section 1</th>
<th>Section 2</th>
<th>Section 3</th>
<th>Section 4</th>
<th>Section 5</th>
<th>Section 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Requirements</td>
<td>Potential Failure Modes</td>
<td>Potential Effects of Failure</td>
<td>Severity Score</td>
<td>Potential Causes of Failure</td>
</tr>
<tr>
<td>Assemble Part A &amp; B together</td>
<td>Parts to be damage free</td>
<td>Parts damaged</td>
<td>Fuel Leaks leading to a failure without warning</td>
<td>8</td>
<td>Parts aggressively married</td>
</tr>
<tr>
<td><strong>What is the process that you are focusing on?</strong> (Process Step)</td>
<td><strong>How could you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
<td><strong>What PRODUCT attributes are you trying to achieve?</strong> (Product Requirements)</td>
<td><strong>Defined by Engineering Drawings &amp; Specifications or Assembly Instructions</strong></td>
<td><strong>PFMEA must include ALL Design Requirements</strong></td>
<td><strong>How would you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
</tr>
<tr>
<td><strong>What PRODUCT attributes are you trying to achieve?</strong> (Product Requirements)</td>
<td><strong>Failure Modes must describe PRODUCT non conformance</strong></td>
<td><strong>Defined by Engineering Drawings &amp; Specifications or Assembly Instructions</strong></td>
<td><strong>PFMEA must include ALL Design Requirements</strong></td>
<td><strong>How could you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
<td><strong>Components are all tied down tightly</strong></td>
</tr>
<tr>
<td><strong>Defined by Engineering Drawings &amp; Specifications or Assembly Instructions</strong></td>
<td><strong>How could the PRODUCT non conformance be prevented?</strong> (Prevention Controls)</td>
<td><strong>How could you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
<td><strong>Components are all tied down tightly</strong></td>
<td><strong>How could you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
<td><strong>Components are all tied down tightly</strong></td>
</tr>
<tr>
<td><strong>PFMEA must include ALL Design Requirements</strong></td>
<td><strong>How could you get the PRODUCT Requirements wrong?</strong> (Potential Failure Modes)</td>
<td><strong>Components are all tied down tightly</strong></td>
<td><strong>Detection Controls</strong></td>
<td><strong>Detection Score</strong></td>
<td><strong>Occ Score</strong></td>
</tr>
<tr>
<td><strong>Product Focused</strong></td>
<td><strong>Process Focused</strong></td>
<td><strong>Risk Mitigation</strong></td>
<td><strong>Product Focused</strong></td>
<td><strong>Process Focused</strong></td>
<td><strong>Risk Mitigation</strong></td>
</tr>
</tbody>
</table>

*see section on using Assembly Instruction later in presentation*
# Process FMEA Information Flow

<table>
<thead>
<tr>
<th>PRODUCT FOCUSED</th>
<th>PROCESS FOCUSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Class.</td>
</tr>
<tr>
<td>Requirement</td>
<td>Potential Cause</td>
</tr>
<tr>
<td>Failure Mode</td>
<td>Prevention Control</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Occurrence</td>
</tr>
<tr>
<td>Severity</td>
<td>Detection Controls</td>
</tr>
<tr>
<td></td>
<td>Detection</td>
</tr>
<tr>
<td></td>
<td>RPN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assemble Part A &amp; B together</th>
<th>Parts to be damage free</th>
<th>Parts Damaged</th>
<th>Fuel leaks</th>
<th>9</th>
<th>Pre Inspection</th>
<th>Parts aggressively married</th>
<th>None</th>
<th>3</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scrap Part</td>
<td></td>
<td>7</td>
<td>Post Inspection</td>
<td>Parts dropped when fitting</td>
<td>Parts individually wrapped for the operator</td>
<td>2</td>
<td>192</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sharp tools used to open packaging</td>
<td>4</td>
<td></td>
<td>None</td>
<td>None</td>
<td>4</td>
<td>256</td>
</tr>
</tbody>
</table>

**RPN Calculation:**
- **Pre Inspection:** RPN = SE * OC * DC
- **Post Inspection:** RPN = SE * OC * DC
Defining the Assembly PFMEA Requirements

Be Careful when using Assembly Instructions
Machining PFMEA Requirements Capture

<table>
<thead>
<tr>
<th>Function</th>
<th>Requirement</th>
<th>Potential Failure Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP10 CNC Drilling</td>
<td>1) Ø 8.0mm +/- 0.15mm</td>
<td>Hole diameter too big</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hole diameter too small</td>
</tr>
<tr>
<td>Drill Fuel Hole</td>
<td>2) Location 8.00mm +/- 0.1mm (x), 10.0mm +/- 0.1mm (y)</td>
<td>Out of location</td>
</tr>
<tr>
<td></td>
<td>3) No burrs or sharp edges</td>
<td>Burrs / sharp edges present</td>
</tr>
</tbody>
</table>

Specification xyz states no burrs / sharp edges on drilled holes are allowed.

Machining PFMEA requirements can be derived directly from the Engineering Drawing and Specifications.

Assembly PFMEAs can be more tricky!
## Assembly Process FMEA Requirements Capture

<table>
<thead>
<tr>
<th>Op No.</th>
<th>Operation Text</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Unpack components from boxes and protective film</td>
<td>Operator</td>
</tr>
<tr>
<td>20</td>
<td>Clean components for risk of FOD</td>
<td>Operator</td>
</tr>
<tr>
<td>30</td>
<td>Inspect components for damage</td>
<td>Inspector</td>
</tr>
<tr>
<td>40</td>
<td>Assemble the inlet &amp; outlet components and align using the bolt holes</td>
<td>Operator</td>
</tr>
<tr>
<td>50</td>
<td>Remove bolts from packaging</td>
<td>Operator</td>
</tr>
<tr>
<td>60</td>
<td>Apply oil to the bolts before fitting</td>
<td>Operator</td>
</tr>
<tr>
<td>70</td>
<td>Fit all 8 bolts and hand tighten</td>
<td>Operator</td>
</tr>
<tr>
<td>80</td>
<td>Torque bolts to 100 lbf.in to achieve the correct clamping force</td>
<td>Operator</td>
</tr>
<tr>
<td>90</td>
<td>Inspect final assembly</td>
<td>Inspector</td>
</tr>
<tr>
<td>100</td>
<td>Signoff and pass the next workstation</td>
<td>Operator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OP / Step</th>
<th>Requirement</th>
<th>Potential Failure Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Unpack components from boxes and protective film</td>
<td>Components not unpacked</td>
</tr>
<tr>
<td>20</td>
<td>Clean components for risk of FOD</td>
<td>Components not cleaned</td>
</tr>
<tr>
<td>30</td>
<td>Inspect components for damage</td>
<td>Damage found</td>
</tr>
<tr>
<td>40</td>
<td>Assemble the inlet &amp; outlet components</td>
<td>Components not assembled</td>
</tr>
<tr>
<td>50</td>
<td>Remove bolts from packaging</td>
<td>Bolts not removed from packaging</td>
</tr>
</tbody>
</table>

Prior to AS13100 It was common practice to take each line from the Assembly Instruction and transfer it to the REQUIREMENTS column in the PFMEA.

Requirements & Failure Modes must describe the **PRODUCT** attributes that need to be achieved

(AS13100 ref 21.4.1)
## Assembly Process FMEQA Requirements Capture

<table>
<thead>
<tr>
<th>Op No.</th>
<th>Operation Text</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Unpack components from boxes and protective film</td>
<td>Operator</td>
</tr>
<tr>
<td>20</td>
<td>Clean components for risk of FOD</td>
<td>Operator</td>
</tr>
<tr>
<td>30</td>
<td>Inspect components for damage</td>
<td>Inspector</td>
</tr>
<tr>
<td>40</td>
<td>Assemble the inlet &amp; outlet components and align using the bolt holes</td>
<td>Operator</td>
</tr>
<tr>
<td>50</td>
<td>Remove bolts from packaging</td>
<td>Operator</td>
</tr>
<tr>
<td>60</td>
<td>Apply oil to the bolts before fitting</td>
<td>Operator</td>
</tr>
<tr>
<td>70</td>
<td>Fit all 8 bolts and hand tighten</td>
<td>Operator</td>
</tr>
<tr>
<td>80</td>
<td>Torque bolts to 100 lbf.in to achieve the correct clamping force</td>
<td>Operator</td>
</tr>
<tr>
<td>90</td>
<td>Inspect final assembly</td>
<td>Inspector</td>
</tr>
<tr>
<td>100</td>
<td>Signoff and pass the next workstation</td>
<td>Operator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OP / Step</th>
<th>Requirement</th>
<th>Potential Failure Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Assemble the inlet &amp; outlet components in the correct alignment</td>
<td>Incorrect alignment</td>
</tr>
<tr>
<td>70</td>
<td>Fit all 8 bolts type xyz into inlet/outlet assembly</td>
<td>Not all bolts fitted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrong bolts fitted</td>
</tr>
<tr>
<td>80</td>
<td>Create even clamping force between inlet and outlet by torquing bolts to 100 lbf.in</td>
<td>Clamping force too high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clamping force too low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clamping force not even</td>
</tr>
</tbody>
</table>

Only the **PRODUCT** focussed instructions are required in the **FMEA REQUIREMENTS** column. This will help to **Reduce the Size** of the Process FMEA and keep it focussed on **Product Conformance**.
## Assembly Process FMEA Requirements Capture

<table>
<thead>
<tr>
<th>Operation Number</th>
<th>Operation Text</th>
<th>Where else in the PFMEA could this information be shown?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Unpack components from boxes and protective film</td>
<td>Potential Cause: Maybe a cause of damage if not done correctly</td>
</tr>
<tr>
<td>20</td>
<td>Clean components for risk of FOD</td>
<td>Potential Cause: Maybe a cause of FOD if not cleaned properly</td>
</tr>
<tr>
<td>30</td>
<td>Inspect components for damages</td>
<td>Detection Control: Should be described in the Detection column against a Damage Failure Mode</td>
</tr>
<tr>
<td>40</td>
<td>Assemble the inlet &amp; outlet components</td>
<td>REQUIREMENTS</td>
</tr>
<tr>
<td>50</td>
<td>Remove bolts from packaging</td>
<td>Potential Cause: Maybe a cause of damage if not done correctly, also potential to select wrong bolts</td>
</tr>
<tr>
<td>60</td>
<td>Apply oil to the bolts before fitting</td>
<td>Potential Cause: May cause stress damage to the bolt if oil is not applied</td>
</tr>
<tr>
<td>70</td>
<td>Fit all 8 bolts</td>
<td>REQUIREMENTS</td>
</tr>
<tr>
<td>80</td>
<td>Torque bolts to 100 lbf.in to achieve the correct clamping force</td>
<td>REQUIREMENTS</td>
</tr>
<tr>
<td>90</td>
<td>Inspect final assembly</td>
<td>Detection Control: Should be described in the Detection column against the appropriate Failure Mode</td>
</tr>
<tr>
<td>100</td>
<td>Signoff and pass the next workstation</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>
Using Standard Assembly Failure Modes

When developing an Assembly Process FMEA there are a number of Standard Failure Modes that can be used to prompt the team.

1. Part not fitted
2. Wrong part fitted
3. Part misaligned
4. Incorrect orientation
5. Damaged part
6. FOD present
7. Incorrect clamping force
8. Uneven clamping force

NOTE: There may be some other Standard Failure Modes that are specific to your assembly process so customise if necessary.

They can also help to validate the accuracy of the Requirements Description.
# Using Standard Assembly Failure Modes to Refine the Requirements Description

<table>
<thead>
<tr>
<th>Function</th>
<th>Requirements</th>
<th>Using Standard Assembly Potential Failure Modes</th>
<th>Potential Effects of Failure</th>
<th>Severity Score</th>
<th>Potential Causes of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assemble Inlet to Outlet</td>
<td>Assemble the Inlet (part # IN1) to the Outlet (part # OU2) using the alignment marking and bolt holes. Ensure that the inlet is in the correct orientation.</td>
<td>Part not fitted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrong part fitted</td>
<td></td>
<td></td>
<td>Part mislabeled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part misaligned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect orientation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Damage to mating faces</td>
<td>Damaged part</td>
<td></td>
<td></td>
<td>Review the Assembly Standard Failure Modes &amp; Update Requirements description if necessary</td>
</tr>
<tr>
<td></td>
<td>No FOD</td>
<td>FOD present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td>Clamping Force too high</td>
<td></td>
<td></td>
<td>No need to include in FMEA if the Standard Failure Mode is not a genuine requirement</td>
</tr>
</tbody>
</table>
Practical Demonstration of
RM13004 PFMEA
in an Assembly Environment
Assemble the Inlet and Outlet components with the inlet facing upwards as shown (orientation). Ensure that there is no damage or FOD present on the mating faces.

Align parts using the white markings and ensure bolt holes are aligned.

Fit 8 bolts (type CDE4506) and hand tighten.

Use torque wrench (#213) to tighten bolts to the specified value in the correct sequence (see instruction xyz) to create an even clamping force between the inlet and outlet components.
Using Standard Failure Modes

1. Part not fitted
2. Wrong part fitted
3. Parts misaligned
4. Incorrect orientation
5. Damaged part
6. FOD
7. Incorrect Clamping Force (Too High/Too Low)
8. Uneven Clamping Force
Using the PFMEA to Identify Improvements

Orientation
Design Error Proofing

Increased diameter thickness & Length

Alignment
Design Error Proofing

Both the inlet and the outlet cannot be misaligned due to a new offset hole position.

Intelligent Torque Wrenches
Error Proof the Process

‘Kitting’ C Class Parts
Risk Reduction/Improvement

Inlet cannot physically be placed in the incorrect orientation due to thickness/length increase.

Error Proofing of Parts must be done in the Design Phase
In APQP PFMEA starts at Design Concept Phase so we can influence the design process

Only the correct parts are available on the line to select and improved protective packaging
## Process FMEA Assembly of INLET and OUTLET

<table>
<thead>
<tr>
<th>Function</th>
<th>Requirement</th>
<th>Failure Mode</th>
<th>Potential Effect</th>
<th>Severity</th>
<th>Potential Cause</th>
<th>Prevention Control</th>
<th>Occurrence</th>
<th>Detection Controls</th>
<th>Detection</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assemble both the inlet &amp; outlet components</td>
<td>Create even clamping force</td>
<td>Insufficient clamping force may lead to excessive vibration in service which</td>
<td>8</td>
<td>Under Torqued</td>
<td>Intelligent Torque Tightening (ITT) Control</td>
<td>2</td>
<td>ITT Confirmation Check –</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between INLET (part number IN2) and OUTLET (part number OU1) by torquing 8 bolts (part number xyz) to 100 lbf.in in the specified sequence (see instruction 123)</td>
<td>force between INLET (part number IN2) and OUTLET (part number OU1) by torquing 8 bolts (part number xyz) to 100 lbf.in in the specified sequence (see instruction 123)</td>
<td></td>
<td></td>
<td>System Used</td>
<td></td>
<td>Automatic Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clamping force too low</td>
<td></td>
<td></td>
<td>Not Torqued</td>
<td>Lineside Part Kitting</td>
<td>6</td>
<td>Operator Check at fitting operation</td>
<td>8</td>
<td>384</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clamping force too high</td>
<td></td>
<td></td>
<td>Undersized (incorrect) bolt used</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **Severity:** Levels range from 1 (low) to 10 (high), indicating the potential impact of the failure mode.
- **Potential Cause:** Details the root cause of the failure mode.
- **Prevention Control:** Measures to prevent the failure mode from occurring.
- **Occurrence:** Levels range from 1 (very low) to 10 (very high), indicating the likelihood of occurrence.
- **Detection Controls:** Actions to detect the failure mode.
- **Detection:** Levels range from 1 (very low) to 10 (very high), indicating the effectiveness of detection.
- **RPN (Risk Priority Number):** Calculated by multiplying the Severity, Occurrence, and Detection scores. Higher RPN values indicate higher priority for risk mitigation.
Managing Human Error in an Assembly PFMEA
Aero Engine Assembly Operations

30,000 Components

6,000 Manual Operations

HUMAN FACTORS play a critical part in assuring PRODUCT QUALITY & SAFETY
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
Why don’t you add the Human Factors FMEA into the Part Specific Process FMEA as described in RM13004?
**RM13004 Process FMEA & Human Factors**

<table>
<thead>
<tr>
<th>OP / Step</th>
<th>Requirement</th>
<th>Failure Mode</th>
<th>Potential Effect</th>
<th>Severity</th>
<th>Class.</th>
<th>Potential Cause(s) of the Failure Mode</th>
<th>Prevention Control(s) for the Potential Causes</th>
<th>Occurrence</th>
<th>Detection Controls of the Failure Mode and/or the Potential Causes</th>
<th>Detection</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avoid Human Error</td>
<td>Fatigue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is not a Product Failure Mode

Failure Modes in an RM13004 PFMEA describe Product nonconformance

(RM13004, Chapter 4, (f))
## RM13004 Process FMEA & Human Factors

### Table: RM13004 Process FMEA

<table>
<thead>
<tr>
<th>OP / Step</th>
<th>Requirement</th>
<th>Failure Mode</th>
<th>Potential Effect</th>
<th>Severity</th>
<th>Potential Cause(s) of the Failure Mode</th>
<th>Prevention Control(s) for the Potential Causes</th>
<th>Occurrence</th>
<th>Detection Controls of the Failure Mode and/or the Potential Causes</th>
<th>Detection</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assemble Part xyz in correct orientation</td>
<td>Part fitted in incorrect orientation</td>
<td>Distraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

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 in Process FMEA Key Insights

- Including Human Factor risks into the Product PFMEA creates too much ‘noise’
- The Human Factor FMEA approach is used to create a high-level analysis of a process environment (area)
- In the Human Factors FMEA the Dirty Dozen are used as the failure modes,
- Each area will have a unique ‘signature’ based upon its environment (which can change over time)
- RR have seen significantly increased Human Factors awareness, issue reporting and improvements where deployed
RM13004 Assembly PFMEA Summary

1. **The Requirements** must describe the physical product outcome you want to achieve.
   - Only use the product related descriptions from the assembly instructions.
   - This will also help to reduce the size of the PFMEA and keep it focussed

2. **Failure Modes** must describe a physical property of the product and are derived from the Requirements description.
   - Use the Standard Failure Mode Checklist (customise if necessary)
   - Use it to refine the Requirements Description if needed

3. **Potential Causes of Failure** should avoid loose descriptions such as “Operator Error”
   - Use the Human Factors PFMEA Approach

4. **Potential Causes of Failure**, develop through engagement with the operators/fitters
   - Observe the actual (or similar*) process
   - Capture their insights into known issues and suggested improvements
   - Provide Feedback on progress (visual management).

*necessary when the process is not yet in place e.g. still in design & development phase*
AESQ – Aerospace Engine Supplier Quality Consortium

Copyright © AESQ Consortium - A Program of SAE ITC. Further use or distribution is not permitted without permission from AESQ Consortium/SAE ITC.

33
Where to Get Further Information on RM13004
RM13004 Sources of Further Information & Guidance

1. **Reference Manual RM13004** is available free of charge from the AESQ website

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

3. **RM13004 LinkedIn Community of Practice** established to answer questions and share best practice (https://www.linkedin.com/groups/9044623/)

Other Reference Manuals and Subject Matter Interest Groups exist for:

- RM13000 Problem Solving
- RM13001 DPRV Training
- RM13002 Inspection Planning
- RM13003 MSA
- RM13005 Quality Audit
- RM13006 Process Control
- RM13007 Sub Tier Management
- RM13008 Design Work
- RM13009 Compliance Assessment
- RM13010 Human Factors
- RM13011 Rework & Repair
- RM13012 First Article Inspection
- RM13145 APQP / PPAP

https://aesq.sae-itc.com
Video recordings and presentation materials of other RM13004 FMEA Webinars are available to download from https://aesq.sae-itc.com/defect-prevention
Check the AESQ Website Future Events page for updates.

LinkedIn RM13004 Community of Practice (CoP)

What other subjects would you like the RM13004 SMIG Group to cover? Contact the LinkedIn CoP to let us know.
AESQ 2024 Webinar Schedule

More will be added throughout the year.

Check the AESQ Website Future Events page for updates.

AESQ Events

Webinar: RM13004 PFMEA for Complex Assemblies
Virtual  February 29, 2024

Webinar: The 3 Cs of SPC - Control, Capability and Centering - and in that order!
Virtual  March 26, 2024

AESQ Supplier Forum Tokyo 2024
In person  April 25, 2024

Webinar: Implementing IX-MR and Target-to-Nominal Charts for small production runs
Virtual  May 14, 2024

AESQ Supplier Forum Trollhattan 2024
In person  June 12 - 13, 2024

Webinar: How to choose which Control Method I need?
Virtual  June 18, 2024

Webinar: Use of Multi-Variate Charts
Virtual  September 17, 2024

Webinar: Dealing with Non-Normal Data
Virtual  October 23, 2024

Webinar: Process Control for Manual Data Collection
Virtual  November 12, 2024

Webinar: How to Assure Successful SPC Implementation
Virtual  December 10, 2024
Thank You for Attending This Webinar – We Hope You Found it Interesting