AS13100 DESIGN FMEA REQUIREMENTS WEBINAR

Rob Farndon
Chief of Mechanical Systems
Rolls-Royce Civil Aerospace

Andrea Neumann
Safety and Certification Engineer, Airworthiness
MTU

June 22\textsuperscript{nd} 2022
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.
# RM13004 DESIGN FMEA Webinars

**June 22nd & 23rd 2022**

AS13100 & RM13004 DESIGN FMEA - Understanding the Requirements

Led by Rob Farndon, these interactive webinars are designed to describe the intent of the AESQ AS13100 requirements for Design FMEAs and how they link to the effective deployment of Advanced Product Quality Planning (APQP) and a Zero Defect Strategy.

These webinars shall explain how AS13100 Design FMEA can be developed, maintained and improved using real examples of best practice from across the industry.

<table>
<thead>
<tr>
<th>SESSION 1</th>
<th>SESSION 2</th>
</tr>
</thead>
</table>
| **AS13100 DFMEA Requirements and Overview**  
(June 22nd 14.00 – 16.00 UK Time) | **Key Care Points when Creating the Design FMEA**  
(June 23rd 14.00 – 16.00 UK Time) |
| Overview of the requirements for Design FMEA in Chapter C of AS13100 and their link to the APQP / PPAP process | A closer look at some of the key steps when creating Design FMEAs to illustrate the intent of the AS13100 requirements, including; |
| Explanation of the intent of each requirement and what success looks like | a) Requirements & Potential Failure Modes |
| Links to further help and guidance | c) Potential Causes |
| | d) Prevention Controls & Occurrence Rating |
| | e) Detection Controls & Detection Rating |
| | f) Calculating the Risk Priority Number (RPN) |
| | g) Prioritizing Improvements |

**Questions & Answers**
Rob Farndon Introduction

- Worked for Rolls-Royce for 33 years.
- Career including Design Practitioner, Manager and Specialist roles in Civil Aerospace.
- Currently Chief of Mechanical Systems Capability.
- Design Process Specialist, and Subject Matter Expert for APQP/PPAP and Defect Prevention toolset including DFMEA.
- Led creation of design processes as part of RR Civil Aerospace APQP/PPAP transformation.
- Lead Design Coach for Civil Large Engines.
- Led authoring team for RM13004 and AS13100 DFMEA content.
- Deputy Team Leader for RM13004 Subject Matter Interest Group.
Andrea Neumann Introduction

• Worked for MTU Aero Engines AG for 2 years
• Career including Type Inspector for Propulsion Systems at German Military Airworthiness Authority
• Currently Safety- and Certification Engineer at Airworthiness Department MTU
• System Safety Assessment Specialist
• Subject Matter Expert for DFMEA
• Led process definition of interfaces between DFMEA and System Safety Process
• Supported definition of Design Failure Mode and Effect Analysis Process at MTU
How to contribute

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

Steven W. Finup
Consulting Engineer
GE Aviation

Stéphan DAUX
APQP Leader & Master
Safran Aircraft Engines
Registration Status  (June 20th)

Over 210 people registered from 20 Countries
We do amazing things…

.. but the consequences of poor quality can be very serious

We have a great responsibility to keep our customers, passengers and our families safe.

Planning for Quality is key.
“QUALITY HAS TO BE CAUSED, NOT CONTROLLED.”

PHILIP B. CROSBY
AS13100 FMEA Requirements & Guidance

Aerospace Engine Supplier Quality Strategy Group

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### AS13100 Chapter C Requirements

<table>
<thead>
<tr>
<th>AS13100 Requirements</th>
<th>Chapter A AS9100 Rev D Supplemental Requirements</th>
<th>Chapter B AS9145 Supplemental Requirements</th>
<th>Chapter C Quality Tools to Support APQP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause Number</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>AS13100 Support Material</td>
<td></td>
<td></td>
<td>RM13145 APQP &amp; PPAP</td>
</tr>
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<td>RM13004</td>
<td>RM13003</td>
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<td>RM13006</td>
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</tr>
</tbody>
</table>

#### AS13100 Chapter C

- **21.1** Design Failure Mode & Effects Analysis (DFMEA)
- **21.2** Product Key Characteristics
- **21.3** Process Flow Diagrams (PFD)
- **21.4** Process Failure Mode & Effects Analysis (PFMEA)
- **21.5** Process Key Characteristics
- **21.6** Production Control Plan
- **21.7** Measurement Systems Analysis (MSA)
- **21.8** Initial Capability Studies
Defect Prevention Key Quality Tools for Zero Defects

See Full Video at https://aesq.sae-itc.com
Quick Chat 1

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

(a) Have you read AS13100?
   I. Yes
   II. No

(b) Have you read RM13004?
   I. Yes
   II. No

(c) How would you judge your knowledge of Design FMEA?
   I. No Knowledge
   II. I know of it but no experience of using it
   III. I have used it a few times
   IV. I consider myself to be an expert
1
DESIGN FMEA REQUIREMENTS IN AS13100
FMEA in AS13100

As a minimum, Design FMEA shall be applied;

(a) New Design
   (21.2.2.5 Case 1)

(b) Changes to existing design
    (21.2.2.5 Case 2)

(c) Use of existing design in a new application, location, or environment.
    (21.2.2.5 Case 2)
AS13100 DFMEA Requirements

Unless otherwise agreed with the customer the DFMEA shall be;

• Completed in line with the process laid out in Chapter 2 of the Reference Manual RM13004, (21.1)

• Assessed using the scoring criteria in RM13004 for Severity, Occurrence and Detection (21.1.3.1)

• RPNs shall be calculated for each Failure Mode – Potential Cause combination (21.1.3.1)

• Prioritized for improvement actions in the following order (21.1.3.3 & 4);
  • High Severity Failure Modes
  • Combination of High Severity and Occurrence scores
  • RPN scores
AS13100 DFMEA FMEA Requirements

- “engineers with expertise in design, analysis/testing, manufacturing, assembly, service, quality, and reliability”
- “stimulate the interchange of ideas between the functions affected and thus promote a team approach”
- “is strongly recommended that manufacturing/assembly engineering participate in the Design FMEA”
Cross Functional Teamwork

59%
Chance of success
Working alone

99.9%
Chance of success
With three subject matter experts working as a team

Terricone & Luca, Successful Teamwork: A Case Study (2002)
Typical Cross Functional Team

Jeff Lee
Engineering Manager
Team Leader

Asmaa Krupa
Service, Quality and Reliability

Sarah Cracknell
Design Responsible

Derek Bell
DFMEA Manager

Daryl Jackman
Specialist

Richard Tandy
Validation

Support also from other functions and specialists as required
AS13100 Design FMEA Requirements

Must be Created & Maintained by a CROSS FUNCTIONAL TEAM
(20.1.2.4)

DFMEA be started during the Planning Phase of APQP
(21.1.2.1)

• “The earlier the Design FMEA is started during the product development process (PDP), the better the chances of optimizing the design in a cost and time effective manner”
# FMEAs as part of an Advanced Product Quality Planning (APQP) System

## Phases of Advanced Product Quality Planning (APQP)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning</td>
<td>Design FMEA</td>
</tr>
<tr>
<td>2 – Product Design and Development</td>
<td></td>
</tr>
<tr>
<td>3 – Process Design and Development</td>
<td>Process FMEA</td>
</tr>
<tr>
<td>4 – Product and Process Validation</td>
<td></td>
</tr>
<tr>
<td>5 – On-going Production, Use and Post-delivery Service</td>
<td></td>
</tr>
</tbody>
</table>

## AESQ Production Part Approval Process (PPAP) Events

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>Design FMEA</td>
</tr>
<tr>
<td>FA</td>
<td>Process FMEA</td>
</tr>
<tr>
<td>PPP</td>
<td>Production Process Run</td>
</tr>
<tr>
<td>PRA</td>
<td>Production Products</td>
</tr>
<tr>
<td>PPR</td>
<td>Production Products</td>
</tr>
<tr>
<td>PA</td>
<td>Prototype/Production Products</td>
</tr>
</tbody>
</table>

## Product Status

- Prototype/test product
- Production trial products
- Production products

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*Diagram showing the integration of FMEA within the APQP system with various phases and events.*
AS13100 Design FMEA Requirements

- Must be Created & Maintained by a **CROSS FUNCTIONAL TEAM**
  (20.1.2.4)

- DFMEA be started during the Planning Phase of APQP
  (21.1.2.1)

- Scope shall encompass the items which the team is responsible for designing
  (21.1.2.5)

- System Architecture and Interfaces & Interaction have to be considered
  (21.1.2.6 & 7)
Design FMEA Scope

What is the scope of DFMEA?
1. For a new design the complete design of the item shall be included to a level of detail which is sufficient to establish risk level for all the Item’s intended functions.
2. For changes to an existing design the DFMEA shall focus on effective scope of change (it is assumed that there is a previously completed Design FMEA available for use. If not a complete Design DFMEA should be conducted).

Why do we need the System Architecture?
- At the beginning the scope has to be defined.
- The role the item plays in the overall design has to be considered.
- This includes design architecture specified by the customer as a constraint.

Why do we need Interfaces and Interactions?
- Interfaces to other components, subsystems or systems has to be discussed.
- Physical and functional interfaces could be important for safety impact.

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Design FMEA is Part of a System

Output of one is input to the other

DFMEA could give information to different further process steps.

DFMEA is an important part of quality closed loop approach.
Every Function, Every Feature & Every Failure Mode

The DFMEA is a process to highlight the key areas of risk of design— that is the output of the DFMEA

If we pre-select the inputs based on what we ‘think’ is high risk then we may miss some important issues

We must sift through all functions and features.

Our products are in service for 30 years or more:

- Designs change
- Deviation exists
- Service experience is generated

→ Information could be documented and assessed in DFMEAs
AS13100 Design FMEA Requirements

- Must be Created & Maintained by a CROSS FUNCTIONAL TEAM (20.1.2.4)
- DFMEA Start during the Planning Phase of APQP (21.1.2.1)
- Scope shall encompass the items which the team is responsible for designing (21.1.2.5)
- System Architecture and Interfaces & Interaction have to be considered (21.1.2.6 & 7)
- RM13004 DFMEA Deployment
- DFMEAs must DRIVE ACTIONS to reduce risk (21.1.2.10)
- Keep up to date – They are LIVE documents (20.1)
Design FMEA Updates

- Changed interfaces or Interactions during design phase
- Design changes during design phase
- Changed application, location, or environment during design phase

Information from similar products

Design FMEA

Analysis and Testing Data

In-Service Data

New/Changed Design DFMEA

In Aerospace products may be in production for 30 years or more
The DFMEA should capture all of the ‘up to date’ knowledge of how to make the part / assembly throughout its life
There should be a continuous drive to lower the associated RPN profile
**FMEA Definition**

Failure Mode and Effects Analysis (FMEA) is a method designed to:

1. **Recognize and evaluate the potential functional failures of an item and the effects and design related causes of those failures.**
2. **Identify actions that eliminate or reduce the chance of the potential failures occurring.**
3. **Document the management of design risk.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Function</th>
<th>Requirement</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>SEV</th>
<th>Potential Causes of Failure</th>
<th>Prevention Controls</th>
<th>OCC</th>
<th>Detection Controls</th>
<th>DET</th>
<th>RPN</th>
<th>Improvement Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Air Bracket</td>
<td>Prevent excessive lateral motion of fuel tube #XYZ</td>
<td>Fuel Tube lateral motion constrained to &lt; x mm</td>
<td>Fuel Tube lateral motion &gt; x mm</td>
<td>Increased high cycle fatigue; Stresses on fuel tube; tube cracking; Fuel leaking leading to fire, explosion, safety hazard</td>
<td>10</td>
<td>Tube locating hole allowable diameter defined as too large</td>
<td>Bracket design; Standard work document XYZ (2) Analysis – tube high cycle fatigue and wear (conducted at nominal)</td>
<td>6</td>
<td>Test – Engine XYX Durability testing with post-test hardware inspections (8)</td>
<td>8</td>
<td>480</td>
<td>Conduct high cycle fatigue and tube wear analysis at RSS Worst-case combination of max. hole ID. Min tube</td>
</tr>
</tbody>
</table>

**FMEA Definition**

Failure Mode and Effects Analysis (FMEA) is a method designed to:

1. Recognize and evaluate the potential functional failures of an item and the effects and design related causes of those failures.
2. Identify actions that eliminate or reduce the chance of the potential failures occurring.
3. Document the management of design risk.
Different Types of FMEA

The primary objective of an FMEA is to improve the product:

a) For Design FMEAs, the objective is to improve the design of the system, subsystem or component.

b) For Process FMEAs, the objective is to improve the design of the manufacturing & assembly process.

c) For FMECA, the objective is to enumerate the risks associated with the operation of the product.
DFMEA FMEA Inputs and Outputs

Typical Inputs:
- Functional Requirements (Boundary Diagrams, Parameter Diagrams, etc.)
- Design Concepts, Design Definition or Model Based Definition
- Manufacturing Data (e.g. Capability, Feasibility)
- Bill of Materials (BOM)
- Service Data and History
- Lessons Learned
- Best Practices
- Prelim. System Safety & Reliability Analysis
- Baseline DFMEA
- Higher Level DFMEA
- Prelim. Design Verification Plan

DFMEA

Typical Outputs:
- Failure Mode Risk Assessment
- Failure Mode Risk Mitigation (& Actions)
- Product CIs & KCs

Design Verification Plan
### The Design FMEA Template

<table>
<thead>
<tr>
<th>Function and Requirement Focus</th>
<th>Design Process Focus</th>
<th>Risk Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Requirement</td>
<td>Prevention Controls</td>
</tr>
<tr>
<td>Fuel Air Bracket</td>
<td>▶️</td>
<td></td>
</tr>
<tr>
<td>Lateral Load</td>
<td>X N mm</td>
<td></td>
</tr>
<tr>
<td>Fuel Tube Lateral Motion</td>
<td>&gt; x mm</td>
<td></td>
</tr>
<tr>
<td>Lateral Static Load</td>
<td>&gt; X N</td>
<td></td>
</tr>
</tbody>
</table>

#### Section 1
- **Item**: What is the item that you are focusing on (Item)?
- **Function**: What function does the item have? (Function)
- **Requirement**: What are you trying to achieve (Product Requirements)?

#### Section 2
- **Potential Failure Mode**: How could you get the Requirements wrong (Failure Modes)?
- **Potential Effect(s) of Failure**: What could happen if it did go wrong (Potential Effects)?
- **SEV**: How bad would it be if it did go wrong (Severity Score)?

#### Section 3
- **Potential Causes of Failure**: What could we get wrong in the design to cause the Failure Mode to occur (Potential Causes)?
- **Prevention Controls**: How could this be prevented (Prevention Controls)?
- **O C C**: How likely is it to be wrong (Occurrence Score)?
- **Detetion Controls**: How will you check if the Cause and/or Failure Mode occur (Detection Controls)?
- **D E T**: How likely are you to detect the Cause or Failure Mode if it was defective (Detection Score)?

#### Section 4
- **DFMEA must include ALL Functions**

#### Section 5
- **Risk Priorit y Numb er (RPN)**

#### Section 6
- **Conduct high cycle fatigue and tube wear analysis at RSS (6)**
- **List of Improvement Actions required to mitigate the key Risks Identified**
- **Engine XYX build process will detect (8)**
## Design FMEA Information Flow

<table>
<thead>
<tr>
<th>Item</th>
<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>Fuel Air Bracket</td>
<td>Prevent excessive lateral motion of fuel tube XYZ</td>
<td>Fuel Tube lateral motion constrained to &lt; x mm</td>
<td>Fuel Tube</td>
<td>fire, explosion safety hazard (10)</td>
<td>10</td>
<td>Tube locating hole allowable diameter defined as too large</td>
<td>Analysis – tube high cycle fatigue and wear (conducted at nominal dimensions only) (6)</td>
<td>6</td>
<td></td>
<td></td>
<td>480</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bracket thermal growth defined as &gt; tube thermal growth</td>
<td>Analysis – Components thermal growth (4)</td>
<td>4</td>
<td></td>
<td></td>
<td>320</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Test – Engine XYX Durability testing with post-test hardware inspections (8)</td>
<td>6</td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>
### Design FMEA Information Flow

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<td>Fuel Tube lateral motion constrained to &lt; x mm</td>
<td>Fuel Tube lateral motion &gt; x mm</td>
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</tr>
<tr>
<td></td>
<td>tube #XYZ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bracket thermal growth defined as &gt; tube thermal growth</td>
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<td>6</td>
<td>320</td>
</tr>
</tbody>
</table>

The description in each column must flow directly from the description in the relevant cell.

If the Requirements column is incorrect then everything to the right will be incorrect.

Precision of language is vital.
### DFMEA FMEA Data Sources

<table>
<thead>
<tr>
<th>Item</th>
<th>Function</th>
<th>Requirement</th>
<th>Potential Failure Modes</th>
<th>Potential Effects of Failure</th>
<th>Severity Score</th>
<th>Potential Causes of Failure</th>
<th>Prevention Controls</th>
<th>Occ Score</th>
<th>Detection Controls</th>
<th>Detection Score</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Service Data**
- Lessons Learned
- Baseline DFMEA
- Prelim. System Safety & Reliability Analysis

**Architectures/Design**
- Drawings, Assembly Instructions & Engineering Specifications

**Functional Requirements**
- Standard Work
- Service Data
- Experience from other projects

**Validation & Verification Plan**
**Design FMEA Ranking Criteria**

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Severity Category (Product)</th>
<th>Criteria: Severity of Effect on Product – DFMEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Safety and/or Regulatory Compliance</td>
<td>Potentially hazardous failure without warning. Failure potentially affects safe operation of the product or causes regulatory non-compliance.</td>
</tr>
<tr>
<td>9</td>
<td>Primary Function</td>
<td>Potentially hazardous failure with warning. Failure potentially affects safe operation of the product, causes regulatory non-compliance or results in a significant reduction in safety margins.</td>
</tr>
<tr>
<td>8</td>
<td>Secondary Function</td>
<td>Product is not operational, safety not compromised. Failure causes major customer dissatisfaction and severe disruptions.</td>
</tr>
<tr>
<td>7</td>
<td>Secondary Function</td>
<td>Operability severely affected; primary function/systems may be degraded. Failure causes high degree of customer dissatisfaction or severe disruptions.</td>
</tr>
<tr>
<td>6</td>
<td>Secondary Function</td>
<td>Operability significantly degraded; secondary systems may be inoperable. Failure causes significant customer dissatisfaction or severe disruptions.</td>
</tr>
<tr>
<td>5</td>
<td>Secondary Function</td>
<td>Moderate effect on operability; secondary systems may be degraded. Product secondary systems do not conform to operational requirements. Failure causes customer dissatisfaction, often resulting in operational disruption.</td>
</tr>
<tr>
<td>4</td>
<td>Anomalous</td>
<td>Moderate effect on operability; non-compliance to functional requirement, although all systems operational. Failure causes minor customer dissatisfaction not noticed by most customers, often requiring action at next overhaul.</td>
</tr>
<tr>
<td>3</td>
<td>Awareness</td>
<td>Slight effect on operability. Non-compliance to functional requirement. Failure causes minor customer dissatisfaction noticed by many customers, often requiring action at next overhaul.</td>
</tr>
<tr>
<td>2</td>
<td>No Effect</td>
<td>No discernible effect on product operation.</td>
</tr>
</tbody>
</table>

**Criteria: Likelihood of Detection (DFMEA)**

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Likelihood of Design Freeze</th>
<th>Criteria: Occurrence of Cause (DFMEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Irrelevante</td>
<td>No go/no go practices which base design are available for this technology, viz., design or test methods.</td>
</tr>
<tr>
<td>9</td>
<td>High Likelihood</td>
<td>High severity of customer dissatisfaction or operational failure.</td>
</tr>
<tr>
<td>8</td>
<td>Medium High Likelihood</td>
<td>Medium severity of customer dissatisfaction or operational failure.</td>
</tr>
<tr>
<td>7</td>
<td>Medium Likelihood</td>
<td>Medium severity of customer dissatisfaction or operational failure.</td>
</tr>
<tr>
<td>6</td>
<td>Low Likelihood</td>
<td>Low severity of customer dissatisfaction or operational failure.</td>
</tr>
<tr>
<td>5</td>
<td>Very Low Likelihood</td>
<td>Very low severity of customer dissatisfaction or operational failure.</td>
</tr>
<tr>
<td>4</td>
<td>Irrelevant</td>
<td>No go/no go practices which base design are available for this technology, viz., design or test methods.</td>
</tr>
<tr>
<td>3</td>
<td>Irrelevant</td>
<td>No go/no go practices which base design are available for this technology, viz., design or test methods.</td>
</tr>
<tr>
<td>2</td>
<td>Irrelevant</td>
<td>No go/no go practices which base design are available for this technology, viz., design or test methods.</td>
</tr>
<tr>
<td>1</td>
<td>Irrelevant</td>
<td>No go/no go practices which base design are available for this technology, viz., design or test methods.</td>
</tr>
</tbody>
</table>

1) The Ranking Criteria for Severity, Occurrence and Detection defined in RM13004 should be used.

2) Alternative Ranking Criteria may be used only if approved by the customer.
FMEA Risk Priority Number Scoring

Severity x Occurrence x Detection = RPN

4 x 5 x 5 = 100
# FMEA Risk Priority Number Scoring

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Potential Effects</th>
<th>Severity</th>
<th>Potential Causes</th>
<th>Prevention Controls</th>
<th>Occurrence</th>
<th>Detection Controls</th>
<th>Detection</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td></td>
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<td>8</td>
<td></td>
<td>5</td>
<td>128</td>
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<tr>
<td></td>
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<td>8</td>
<td></td>
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<td></td>
<td></td>
<td>2</td>
<td>72</td>
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<tr>
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<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

- **The Highest Severity Score** corresponding to the failure effects.
- **Each cause gets separate line in DFMEA**.
- **The Lowest Occurrence Score** corresponding to the best prevention control.
- **The Lowest Detection Score** corresponding to the best detection.
- An RPN Score For every Potential Cause & Failure Mode Combination.
FMEA Action Prioritization

RPN PARETO

PRIORITY FOR IMPROVEMENT

1. High Severity Scores
2. Combination of Severity x Occurrence Scores
3. High RPN Scores

DO NOT USE THRESHOLDS!!!

Threshold = 100
Notes on Risk Mitigation

Severity Scores
Can only be reduced through Product Redesign e.g. removing the need for a function or providing a ‘fail safe’ solution.

Occurrence Scores
Can be reduced through generating more experience with analysis and/or testing during the design phase

Detection Scores
Can be reduced through enhanced and/or earlier testing
### DFMEA FMEA Improvement Actions

<table>
<thead>
<tr>
<th>Hole Diameter Too Big</th>
<th>IMPROVEMENT ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev</td>
<td>Potential Cause</td>
</tr>
<tr>
<td>10</td>
<td>Tube locating hole allowable diameter defined as too large</td>
</tr>
</tbody>
</table>

#### IMPROVED ACTIONS

<table>
<thead>
<tr>
<th>Recommended Actions</th>
<th>Responsibility</th>
<th>Target Date</th>
<th>Action Taken</th>
<th>Sev</th>
<th>Occ</th>
<th>Det</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct high cycle fatigue and tube wear analysis at RSS Worst-case combination of max. hole ID. Min tube OD configuration</td>
<td>Daryl Jackman</td>
<td>July 7th</td>
<td>Introduced June 25th</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>160</td>
</tr>
<tr>
<td>Conduct accelerated stress test to determine limits of max. hole ID. Min tube OD configuration</td>
<td>Sarah Cracknell</td>
<td>June 1st</td>
<td>Introduced May 29th</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>240</td>
</tr>
</tbody>
</table>

**Improved Occurrence Score from 6 to 2 by gain more experience with design**

**Improved Detection Score from 8 to 4 by changing verification schedule**
How long will it take? What is the benefit?

<table>
<thead>
<tr>
<th>Number of DFMEAs completed by the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st}</td>
</tr>
<tr>
<td>Engineering Man Hours</td>
</tr>
</tbody>
</table>

![Logarithmic Cost of Defect Escapes](chart.png)
Quick Chat 2

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

(a) How does your organization currently comply to AS13100 and RM13004

I. Not at all, we do not do Design FMEAs
II. It is very different to how we currently do it
III. We comply with more than 75% of the requirements but there is more we need to do
IV. This is how we conduct Design FMEAs

Steven W. Finup
Consulting Engineer
GE Aviation

Stéphan DAUX
APQP Leader & Master
Safran Aircraft Engines
3 DESIGN FMEA SUMMARY & FURTHER INFORMATION
Design FMEA Efficiency : Success Factors

Tips for Efficient Deployment include:

a) Do the right preparation

b) Work with a **CROSS-FUNCTIONAL** Team

c) Teams that are prepared to **GET ON** and try it, avoid procrastination

d) Have the right **MIND-SET**

e) Right choice of **SOFTWARE** to manage data

**EFFECTIVE DFMEAs WILL TRANSFORM YOUR DESIGN PERFORMANCE!**
Sources of Further Information & Guidance

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

2. Global FMEA training is available to support this approach through the SAE.

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

https://aesq.sae-itic.com
Subject Matter Interest Groups on the AESQ Website

AESQ Website Landing Page

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.
Submit questions
## RM13004 DESIGN FMEA Webinars

**June 22nd & 23rd 2022**

### AS13100 & RM13004 DESIGN FMEA - Understanding the Requirements

Led by Rob Farndon, these interactive webinars are designed to describe the intent of the AESQ AS13100 requirements for Design FMEAs and how they link to the effective deployment of Advanced Product Quality Planning (APQP) and a Zero Defect Strategy.

These webinars shall explain how AS13100 Design FMEA can be developed, maintained and improved using real examples of best practice from across the industry.

<table>
<thead>
<tr>
<th>SESSION 1</th>
<th>SESSION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AS13100 DFMEA Requirements and Overview</strong> (June 22nd 14.00 – 16.00 UK Time)</td>
<td><strong>Key Care Points when Creating the Design FMEA</strong> (June 23rd 14.00 – 16.00 UK Time)</td>
</tr>
<tr>
<td>Overview of the requirements for Design FMEA in Chapter C of AS13100 and their link to the APQP / PPAP process</td>
<td>A closer look at some of the key steps when creating Design FMEAs to illustrate the intent of the AS13100 requirements, including;</td>
</tr>
<tr>
<td>Explanation of the intent of each requirement and what success looks like</td>
<td>a) Requirements &amp; Potential Failure Modes</td>
</tr>
<tr>
<td>Links to further help and guidance</td>
<td>c) Potential Causes</td>
</tr>
<tr>
<td>Questions &amp; Answers</td>
<td>d) Prevention Controls &amp; Occurrence Rating</td>
</tr>
<tr>
<td></td>
<td>e) Detection Controls &amp; Detection Rating</td>
</tr>
<tr>
<td></td>
<td>f) Calculating the Risk Priority Number (RPN)</td>
</tr>
<tr>
<td></td>
<td>g) Prioritizing Improvements</td>
</tr>
<tr>
<td></td>
<td>Questions &amp; Answers</td>
</tr>
</tbody>
</table>
Thank You For Attending!

Please join again tomorrow