LOGISTICS

EARL CAPOZZI
PRATT & WHITNEY
Logistics
Code of Conduct

• No Commercialism

• No discussion of cost, pricing plans, pricing policies, product usage surveys, marketing plans or any related topics

• Presentations must focus on technical issues (not on marketing aspects of products) and relate to or support the development or maintenance of G-22 Committee work

• Be aware of and follow ITAR & EAR rules and regulations governing export control

• Discussions should be open and follow the agenda or other legitimate direction agreed upon by consensus of the committee - avoid unauthorized or ‘private’ meetings
Code of Conduct

• Respect basic meeting etiquette:
  – Only one person speaking at any given time
  – Attack the issue, not the person
  – Be on time...returning from breaks/lunch
  – Respect all ideas & comments
  – No silent skepticism, be candid
  – Do not dominate discussions
  – Stay focused on the meeting & agenda

• Strive for high-quality standards to benefit all stakeholders – users, customers, suppliers and the industry as a whole

• Strive for an open atmosphere that promotes a free-flowing interchange of standards technical information
# Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Item</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:15</td>
<td>Welcome to Pratt &amp; Whitney and AESQ</td>
<td>Jill Albertelli, Pratt &amp; Whitney</td>
</tr>
<tr>
<td>08:40</td>
<td>Introduction to the Supplier Forum</td>
<td>Martin Schaeffner, MTU</td>
</tr>
<tr>
<td>09:10</td>
<td>Supplier Survey Results</td>
<td>Olivier Castets, Safran</td>
</tr>
<tr>
<td>09:25</td>
<td>Intro to Published Standards</td>
<td>Barrie Hicklin, Honeywell</td>
</tr>
<tr>
<td>09:35</td>
<td>Overview of the AESQ Standards</td>
<td>Olivier Castets, Safran &amp; Helen Djäknegren, GKN</td>
</tr>
<tr>
<td><strong>09:10</strong></td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>09:30</td>
<td>AS13004 PFMEA &amp; Control Plans</td>
<td>Ian Riggs, Rolls-Royce &amp; Nick Streppa, GKN</td>
</tr>
<tr>
<td>10:10</td>
<td>AS13003 Measurement System Analysis</td>
<td>Martin Schaeffner, MTU &amp; Christopher Vest, Parker</td>
</tr>
<tr>
<td>11:00</td>
<td>AS13006 Process Control methods</td>
<td>Pete Teti, P&amp;W, Eric Schneider &amp; Jason Bronson, Birken</td>
</tr>
<tr>
<td>11:30</td>
<td>AS13002 Inspection Frequency</td>
<td>Larry Bennett, GE &amp; Austin Shears, PCC</td>
</tr>
<tr>
<td><strong>12:00</strong></td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>Voice of the Customer</td>
<td>Richard Gallagher, Boeing</td>
</tr>
<tr>
<td>13:40</td>
<td>Group Picture</td>
<td></td>
</tr>
<tr>
<td>13:55</td>
<td>AS13000 Problem Solving using 8D</td>
<td>Olivier Castets, Safran &amp; Mateusz Zyla, Collins</td>
</tr>
<tr>
<td>14:25</td>
<td>Standards Feedback Summary</td>
<td>Barrie Hicklin, Honeywell</td>
</tr>
<tr>
<td>14:35</td>
<td>Future Initiatives introduction</td>
<td>Lisa Claveloux, Pratt &amp; Whitney &amp; Ian Riggs, Rolls-Royce</td>
</tr>
<tr>
<td><strong>14:50</strong></td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>15:10</td>
<td>AS13005 Quality Audit Requirements</td>
<td>Helen Djäknegren, GKN</td>
</tr>
<tr>
<td>15:25</td>
<td>AS13007 Supplier Management</td>
<td>Barbara Negroe, GE</td>
</tr>
<tr>
<td>15:40</td>
<td>Human Factors</td>
<td>Ludovic Chevet, Airbus &amp; Catherine Catarina-Graca, Safran</td>
</tr>
<tr>
<td>16:10</td>
<td>Reflections of the Day &amp; Q&amp;A</td>
<td>Barrie Hicklin, Honeywell</td>
</tr>
<tr>
<td>16:25</td>
<td>Closing remarks</td>
<td>Dan Eigenbrode, P&amp;W &amp; Martin Schaeffner, MTU</td>
</tr>
</tbody>
</table>

AESQ – Aerospace Engine Supplier Quality Strategy Group
This document slide does not contain ITAR or EAR technical data. The content of this presentation slide is proprietary and confidential information of the AESQ. It is not permitted to be distributed to any third party without the written consent of the AESQ.
WELCOME FROM
PRATT & WHITNEY

JILL M. ALBERTELLI
VICE PRESIDENT, QUALITY
PRATT & WHITNEY
INTRODUCTION TO THE AESQ

MARTIN SCHAEFFNER,
MTU AERO ENGINES AG
Commercial Aviation – A Growth Market

In 2036

4.5% / yr Increase in Passenger Traffic =

2 X active aircraft worldwide

7,100 billion passenger km in 2016
17,000 billion passenger km in 2036

23,000 active aircraft in 2016
45,000 active aircraft in 2036

Quelle: Ascend, IATA, MTU
Aviation Safety

The Quality of our products and services are extremely important. Quality and continuous improvement are an absolute must!

Statistically two aircraft would crash every week unless reliability is further improved.

Increase in flight movements: 4-5% p.a.
Real life examples: the Jetblue case

Incident at Long Beach on Sep 18th 2014, engine fire
By Simon Hradecky, created Thursday, Sep 18th 2014
http://avherald.com/h?article=47a83a2d&opt=0

A Jetblue performing flight from Long Beach, CA to Austin, TX with 142 passengers and 5 crew, was climbing out of Long Beach's runway 30 when the crew reported a fire indication for the right hand engine stopped the climb at 9000 feet and returned for a safe landing...

Passengers reported the right hand engine emitted a loud bang, smoke entered the cabin afterwards. The passenger oxygen masks were manually released by the cabin crew.

On Jan 21st 2016 the NTSB released their final report: The probable cause of the engine failure and subsequent undercowl engine fire was due to the fatigue fracture of a high pressure turbine stage 2 disk blade retaining lug that released two blades which impacted the low pressure turbine case causing a fuel line to fracture spraying fuel on the hot engine cases where it ignited.

During a machining operation of the disk lug, a tool mark was introduced that set up the area for fatigue cracks to initiate.
Manufacturing Quality Escapes in Turbine Engines

--> An FAA proposal for further investigation and action – January 2018

• The trend of manufacturing quality escape safety board issues that resulted in at least one operational event has been increasing.

• The percentage of total turbofan ADs associated with manufacturing quality escapes has been cyclic since 2004, but 2016 (37%) was the highest percentage in the prior four years, and second only to 2011 (44%).

• The top drivers in turbofan manufacturing quality escape ADs were related to issues with surface finish, incorrect dimensions, and forging (all with 8), followed by incorrect assembly (7).

• Life limited parts (32) made up the vast majority of the turbofan manufacturing quality escape ADs, more than three times the next closest part type.
AESQ Vision

To establish and maintain a **common set of Quality Requirements** that enable the Global Aero Engine Supply Chain to be truly competitive through **lean, capable processes** and a **culture of Continuous Improvement**.
AESQ Vision

In detail

• Create common standards within the engine manufacturers (OEM’s) in regard to quality

• Deploy together the written standards throughout our supply chain

• Establish capable quality processes and a culture of continuous improvement

Main targets

• To improve quality within the supply chain

• Improve on time delivery and minimize costs through a reliable quality performance

• Gain efficiency by standardized processes
AESQ Key Quality Elements

→ also aligned to AS9145 APQP & PPAP

→ Video
AESQ Will Drive Progress

AS13000, AS13001, AS13002, AS13003, AS13004 have all been flowed down by all AESQ members and are part of your Purchase Order.

AS13006 is accepted by all members and will be flowed down shortly. More to come!
SUPPLIER SURVEY RESULTS

OLIVIER CASTETS
SAFRAN
Are you Aware of the Published Standards?

Yes

No

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

We still have some work to do
Are you aware of the published standards?

Are you Aware of the Published Standards?

- **2017-APR**: 63% Yes, 37% No
- **2017-OCT**: 75% Yes, 25% No
- **2018-APR**: 71% Yes, 29% No
- **2018-OCT**: 72% Yes, 28% No
- **2019-APR**: 13% Yes, 87% No
Which Standards Have You Heard Of?

- AS13000: 70.00%
- AS13001: 60.00%
- AS13002: 50.00%
- AS13003: 50.00%
- AS13004: 60.00%
- AS13005: 30.00%
- AS13006: 40.00%
- AS13007: 20.00%
- AS13100: 10.00%
- AS9145: 40.00%
- AS9146: 70.00%
- AS9117: 0.00%
- No, not applicable: 0.00%
Which standards are you familiar with?

Which Standards are you Familiar with Below?

- AS13000
- AS13001
- AS13002
- AS13003
- AS13004
- AS13005
- AS13006
- AS13007
- AS13100
- AS9145
- AS9146
- AS9117
- No, NA


This document slide does not contain ITAR or EAR technical data. The content of this presentation slide is proprietary and confidential information of the AESQ. It is not permitted to be distributed to any third party without the written consent of the AESQ.
Which Standards are in YOUR Contracts?
Have any of the standards been contractually flowed to you by a customer?

![Bar chart showing percentage of standards flowed by customer over time](chart.png)

- **AS13000**: 80% in 2017-Apr, 70% in 2017-Oct, 60% in 2018-Apr, 50% in 2018-Oct, 40% in 2019-Apr
- **AS13001**: 90% in 2017-Apr, 80% in 2017-Oct, 70% in 2018-Apr, 60% in 2018-Oct, 50% in 2019-Apr
- **AS13002**: 70% in 2017-Apr, 60% in 2017-Oct, 50% in 2018-Apr, 40% in 2018-Oct, 30% in 2019-Apr
- **AS13003**: 60% in 2017-Apr, 50% in 2017-Oct, 40% in 2018-Apr, 30% in 2018-Oct, 20% in 2019-Apr
- **AS13004**: 50% in 2017-Apr, 40% in 2017-Oct, 30% in 2018-Apr, 20% in 2018-Oct, 10% in 2019-Apr
- **AS13006**: 40% in 2017-Apr, 30% in 2017-Oct, 20% in 2018-Apr, 10% in 2018-Oct, 0% in 2019-Apr
- **AS9145**: 30% in 2017-Apr, 20% in 2017-Oct, 10% in 2018-Apr, 0% in 2018-Oct, 0% in 2019-Apr
- **AS9117**: 20% in 2017-Apr, 10% in 2017-Oct, 0% in 2018-Apr, 0% in 2018-Oct, 0% in 2019-Apr
- **AS9146**: 10% in 2017-Apr, 0% in 2017-Oct, 0% in 2018-Apr, 0% in 2018-Oct, 0% in 2019-Apr
- **No, NA**: 0% in 2017-Apr, 0% in 2017-Oct, 0% in 2018-Apr, 0% in 2018-Oct, 0% in 2019-Apr
Have you flowed or are you planning to flow any of these standards to your suppliers?
INTRODUCTION TO PUBLISHED STANDARDS

BARRIE HICKLIN
HONEYWELL
# Introduction to Published Standards

| AS13004 PFMEA & Control Plans | Ian Riggs, Rolls-Royce  
                               | Nick Streppa, GKN          |
|-------------------------------|-------------------------|
| AS13003 Measurement System Analysis | Martin Schaeffner, MTU  
                                        | Christopher Vest, Parker Hannifin |
| AS13006 Process Control Methods | Pete Teti, Pratt & Whitney  
                                         | Eric Schneider, Birken       |
|                               |                          | Jason Bronson, Birken        |
| AS13002 Inspection Frequency  | Larry Bennett, GE  
                              | Austin Shears, PCC           |
| AS13000 Problem Solving Using 8D | Olivier Castets, Safran  
                                        | Mateusz Zyla, Collins Aerospace |
AESQ STANDARDS
OVERVIEW

OLIVIER CASTETS
SAFRAN

HELEN DJÄKNEGREN
GKN
AESQ Website: aesq.sae-itc.com
AESQ Standards – Global Deployment

**Vision** - To establish and maintain a common set of Quality Requirements that enable the Global Aerospace Engine Supply Chain to be truly competitive through lean, capable processes and a culture of Continuous Improvement

### AESQ Standards - Global Deployment Status

<table>
<thead>
<tr>
<th>AESQ Member</th>
<th>Accepted</th>
<th>Accepted</th>
<th>Accepted</th>
<th>Accepted</th>
<th>Accepted</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arconic (P&amp;P)</td>
<td>May-15</td>
<td>Feb-16</td>
<td>May-17</td>
<td>Mar-16</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
<tr>
<td>GE</td>
<td>May-14</td>
<td>Oct-14</td>
<td>Jan-15</td>
<td>Jan-16</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
<tr>
<td>Honeywell</td>
<td>Jan-16</td>
<td>Mar-15</td>
<td>Oct-15</td>
<td>Jan-16</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
<tr>
<td>MTU</td>
<td>Aug-15</td>
<td>Jan-16</td>
<td>4Q16</td>
<td>Jan-16</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
<tr>
<td>PCC Structurals</td>
<td>Mar-15</td>
<td>Jan-15</td>
<td>May-15</td>
<td>Jun-16</td>
<td>3Q 18</td>
<td>Sep-18</td>
</tr>
<tr>
<td>Rolls-Royce</td>
<td>Dec-14</td>
<td>Oct-15</td>
<td>Jan-15</td>
<td>Jan-15</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
<tr>
<td>Safran</td>
<td>Jan-15</td>
<td>Jan-15</td>
<td>Jan-15</td>
<td>Jan-15</td>
<td>Aug-17</td>
<td>Sep-18</td>
</tr>
</tbody>
</table>
AS13001 Delegated Product Release Verification Training

**Original State**
- 3 days
- GE Aviation
- Pratt & Whitney
- SAFRAN
- Rolls-Royce

**Future State**
- 3 days
- GE Aviation
- Pratt & Whitney
- SAFRAN
- Rolls-Royce
- Total 12 days

**AESQ Principles**
- ✔ Standardise
- ✔ Simplify
- ✔ Adopts Existing Industry Standards
- ✔ Prescriptive, Auditable
- ✔ Common Language
- ✔ Supported by 3rd Party Training & Consultancy

**Expected Benefits**
- ✔ One Common Training Requirement
- ✔ Industry-wide DPRV database through SAE
- ✔ Delivered globally by SAE
- ✔ Refresher training every 3 years

**Rev A aligns with AS9117 - DPRV**
AS13004 PFMEA & CONTROL PLANS

NICK STREPPA
GKN

DR IAN RIGGS
ROLLS-ROYCE
AS13004 Process FMEA & Control Plans

Original State

- Varying standards and approaches

Future State

In Scope: Risk Mitigation requirements with execution guidance & recommended timing, supporting AS9145

Out of Scope: DFMEA requirements,

AESQ Principles

- ✔ Standardise
- ✔ Simplify
- ✔ Adopts Existing Industry Standards
- ✔ Prescriptive, Auditable
- ✔ Common Language
- ✔ Supported by 3rd Party Training & Consultancy

Expected Benefits

- Standardised process
- Increased pace of adoption
- Improved compliance to a better standard
- Reduced quality risks
- Ultimately improved quality & delivery
1. Required for *EVERY* part number*
2. *ALL* Process Steps (those that transform the product)
3. *EACH* design feature / characteristic must be included
4. PFMEA Failure Modes that describe how the *PRODUCT* can fail to meet *DESIGN INTENT*
5. Created by a *CROSS FUNCTIONAL TEAM*
6. Kept as a ‘*LIVE*’ document

*Typical deployment for NPI, Major Changes and to address Quality Issues*
Trent 7000 Front Fan Case APQP / PPAP using AS13004

Nick Streppa
GKN Newington
Leader in advanced machining of Ti, Al and Nickel based metallic components

- Over 50 years of experience
- 121,000 sq. ft. of manufacturing space
- 130 highly skilled work force
- Concurrent engineering capability

**Key Product Base**
- Semi finished LPT cases
- Intermediate and Compressor cases
- Large metallic fan cases

**Machine capability up to 144” OD:**
- Multi-axis high speed milling
- Turning
- Robotic deburring
- CMM Inspection
- Assembly

**Quality Certification** ISO9001:2015, AS9100D, ISO14001, and OHSAS18001
Problem Statement

Onboarding of Rolls Royce Trent 7000 Front Fan case manufacture at GKN Newington

- New product introduction & all challenges that come with NPI
  - New unique part geometry
  - No allowance for poor quality due to cost of raw material
  - Tough material

- PPAP level A required for rate and quality

- Implementation of Zero Defect philosophy
Process Flow & PFMEA

Key PFMEA highlights:

• Review of DFMEA with Rolls-Royce design engineering onsite at GKN Newington input into PFMEA

• PFMEA was product specific and created by a cross-functional team with extensive experience of the processes

Elements of Process Flow:

• Simple Process
• Processing equipment selected is appropriate and capable for manufacture of component
• Manufacturability assessment shared with Rolls-Royce design engineering.
Control Plans

PFMEA Feeds into the control plan

Key to eliminating and preventing defects is controlling the sources of variation – control plan is the tool for this!

Sources of Variation:

- Material Properties
- Fixtures
- Part Setup
- Tooling
- Unique part geometry
- Human Factors such as ergonomics and competency
Benefits

> Zero non-conformances on FAI part
> Zero non-conformances on (5) subsequent PPAP parts
> PPAP level A was achieved
> Made a difficult part predictable, reproducible and at the intended rate
> Satisfied Customer
Lessons Learned

• Adequate time and resources need to be devoted to PFMEA as well as experienced team of people.

• PFMEA is conducted prior to manufacturing parts – not as an afterthought.

• PFD, PFMEA, Control plans are all a means of defect prevention

• Project management, teamwork and communication
HOW TO USE REFERENCE PFMEAS WITH AS13004

What they are

&

How to use them
## What is a Reference PFMEA?

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirement</th>
<th>Potential Failure Modes</th>
<th>Potential Effects</th>
<th>Potential Causes</th>
<th>Prevention Controls</th>
<th>Detection Controls</th>
<th>Prevention</th>
<th>Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP10</td>
<td>CNC Drilling</td>
<td>Drill <strong>FUEL</strong> Hole</td>
<td>Fuel leak leading to explosion</td>
<td>Oversize tool</td>
<td>Tool presetting</td>
<td>Bore mic at OP 50</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50mm Diameter +/- 1.0 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>OP20</td>
<td>CNC Drilling</td>
<td>Drill <strong>AIR</strong> Hole</td>
<td>Slight increase in noise level</td>
<td>Oversize tool</td>
<td>Tool presetting</td>
<td>Bore mic at OP 50</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50mm Diameter +/- 3.0 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

**Blue Boxes show the (partial) content of a Reference PFMEA for Hole Drilling where the Failure Mode is ‘Hole Too Big’**
Creating a Part Specific PFMEA using Reference FMEAs

A ‘shell PFMEA is created for each operation and every Characteristic required to produce a specific part number using the Process Flow Diagrams, Characteristics Matrix and Drawing / Specifications.

This operation is now completed using a dedicated software tool by Rolls-Royce Bangalore. The process takes only a few hours.
Completing the Part Number Specific PFMEA

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirements</th>
<th>Potential Failure Modes</th>
<th>Potential Effects</th>
<th>SEV</th>
<th>Potential Causes</th>
<th>Prevention Controls</th>
<th>OCC</th>
<th>Detection Controls</th>
<th>DET</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP10 CNC Drilling</td>
<td>Drill Fuel Hole 50mm Diameter +/- 1.0 mm</td>
<td>Hole too Big</td>
<td>Fuel leak leading to explosion</td>
<td>9</td>
<td>Oversize tool</td>
<td>Tool pre-setting</td>
<td>4</td>
<td>Bore mic at OP 50</td>
<td>7</td>
<td>2 5 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scrap part</td>
<td>6</td>
<td>Spindle alignment error</td>
<td>Asset Care &amp; Calibration</td>
<td>3</td>
<td>Weekly ball bar check</td>
<td>8</td>
<td>2 1 6</td>
</tr>
<tr>
<td>OP10 CNC Drilling</td>
<td>Drill Air Hole 20mm Diameter +/- 3.0 mm</td>
<td>Hole too Big</td>
<td>Slight increase in noise level</td>
<td>3</td>
<td>Oversize tool</td>
<td>Tool pre-setting</td>
<td>2</td>
<td>Bore mic at OP 50</td>
<td>7</td>
<td>5 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Concession</td>
<td>4</td>
<td>Spindle alignment error</td>
<td>Asset Care &amp; Calibration</td>
<td>1</td>
<td>Weekly ball bar check</td>
<td>8</td>
<td>3 2</td>
</tr>
</tbody>
</table>

The team may need to add in additional Failure Modes, Potential Causes and/or Control information based on their knowledge of the specific part numbers. Some information in the Reference PFMEA may not be relevant so can be deleted.
Let’s have a go!
1. Pick 10 Characteristics, at Random, from the ‘Process Pot’

2. Put them on the PFMEA Template under ‘Requirements’

3. Start Clock

4. Retrieve the Reference PFMEAs for each Characteristic from the Store and stick them in the Template

5. When complete STOP the Clock.

Volunteers Please!

How long did it take to do 10 Characteristics?

How long would it take to do 100 Characteristics?

How long for 1,000?

How long would a Computer take?
How long does it take?

Create Reference PFMEAs
30 man hours per REF PFMEA

Create Shell PFMEA
30 man hours per Shell PFMEA (manual)
<5 hours using Software

Complete 1<sup>st</sup> - 3<sup>rd</sup> Part Specific PFMEAs
400 man hours per PFMEA

Complete future Part Specific PFMEAs
100 man hours per PFMEA

Estimates are for a medium complexity part (1000 Characteristics)

Reference PFMEAS once created will be used for all future PFMEAs and only updated when necessary. This is a ‘one off’ activity.

Initial Part Specific PFMEAs will take longer as the cross functional team discuss issues for the first time e.g. what would happen if….? Initial PFMEAs should be treated as a learning exercise.

Shell FMEAs can be created using software in hours. Quest and Tata Consultancy Services have this capability.
SOURCES OF FURTHER INFORMATION & GUIDANCE

- Process PFMEA Practitioner Guide on how to deploy AS13004 (including the creation and use of Reference FMEAs) is available free of charge AESQ website and from the Rolls-Royce Supplier Portal
- Available in English, German and Chinese
- Rolls-Royce has made many Reference PFMEAs available to external businesses to promote the deployment of AS13004 via its Supplier Portal
- We recommend that suppliers invest in a suitable FMEA software tool to manage the level of data created efficiently
- Global PFMEA training is available to support this approach through SAE, Smallpeice Enterprises and Industry Forum
1. Rolls-Royce suppliers reporting **STEP CHANGE** in performance due to AS13004 introduction – Many achieving Zero Defects at launch

2. Key Success Factors include;
   a) Use **CROSS FUNCTIONAL WORKING** (including Design input)
   b) Use of **REFERENCE PFMEAs**
   c) Right choice of **SOFTWARE** to manage data
   d) Focus on **PREVENTIVE CONTROLS** such as error proofing, SPC, etc. – PFMEAs must drive action.
   e) Teams that are prepared to **GET ON** and try it, avoid procrastination
   f) Always **AVOID SHORTCUTS**
It *really* is that easy.....

It *really* is that effective.....
AS13003 MEASUREMENT SYSTEM ANALYSIS

CHRISTOPHER VEST
PARKER HANNIFIN

MARTIN SCHAEFFNER
MTU AERO ENGINES AG
AS13003 Measurement System Analysis

Original State

Future State

AESQ Principles
- Standardise ✔
- Simplify
- Adopts Existing Industry Standards ✔
- Prescriptive, Auditable ✔
- Common Language ✔
- Supported by 3rd Party Training & Consultancy

Expected Benefits
- Improved knowledge of Measurement Capability
- Clarification of minimum acceptance standards
- Mandates replaces guidance
- Adopts Automotive Industry Action Group ‘Blue Book’ on MSA
- Improved Quality Performance

<table>
<thead>
<tr>
<th>Method</th>
<th>Feature Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>Critical</td>
</tr>
<tr>
<td>-10% of total tolerance</td>
<td>Major</td>
</tr>
<tr>
<td>-5% of total tolerance</td>
<td>Minor</td>
</tr>
<tr>
<td>Accuracy ratio</td>
<td>Requirements &gt; 10.1</td>
</tr>
<tr>
<td>Accuracy Error / Bias</td>
<td>Requirements &gt; 4.1</td>
</tr>
<tr>
<td>Repeatability</td>
<td>&lt;10% of total tolerance</td>
</tr>
<tr>
<td>-20% of total tolerance</td>
<td>&lt;20% of total tolerance</td>
</tr>
<tr>
<td>-50% of total tolerance</td>
<td>Only required on operator dependent interpretation</td>
</tr>
<tr>
<td>Gauge RSR</td>
<td>&lt;10% of total tolerance</td>
</tr>
<tr>
<td>-20% of total tolerance</td>
<td>&lt;20% of total tolerance</td>
</tr>
<tr>
<td>-50% of total tolerance</td>
<td>Only required on operator dependent interpretation</td>
</tr>
<tr>
<td>Computer-driven measurement systems correlation</td>
<td>&lt;10% of total tolerance</td>
</tr>
<tr>
<td>-20% of total tolerance</td>
<td>&lt;20% of total tolerance</td>
</tr>
<tr>
<td>-50% of total tolerance</td>
<td>Only required on operator dependent interpretation</td>
</tr>
<tr>
<td>Linearity</td>
<td>&lt;1% of total tolerance</td>
</tr>
<tr>
<td>- Only required on operator dependent interpretation</td>
<td></td>
</tr>
<tr>
<td>Attribute Study: pass/fail</td>
<td>Kappa ≥ 0.8</td>
</tr>
<tr>
<td>- Only required on operator dependent interpretation</td>
<td></td>
</tr>
<tr>
<td>Attribute study: ordinal</td>
<td>ICC ≥ 0.75</td>
</tr>
<tr>
<td>- Only required on operator dependent interpretation</td>
<td></td>
</tr>
</tbody>
</table>
Problem Statement:

How do we ensure proper inspection methods are utilized relative to accuracy and adequacy?
Parker Aerospace Approach:

EVERY FEATURE, EVERY PART

- Each feature is unique in its physical characteristics
- Read across from other parts adds risk
- Defined deliverable in Design & Development planning
- Apply to both variable and attribute
- Required each time change is made
Parker Aerospace Approach:

EVERY FEATURE, EVERY PART

- Requires measurement instructions
- Utilize standard criteria for acceptance
- Defined action plans where criteria not met
- Narrowing of control limits
- Selection of new measurement system
Benefits:

- Reduced rejections downstream
  - Accept/Reject agreement over 99%
- Allowed for validation of new automated inspection devices
- Reduced customer rejections
  - Protected customer from gauge with 28% R&R
- Confidence with operators and data for SPC
- Reduced human factors
AESQ – Aerospace Engine Supplier Quality Strategy Group

This document slide does not contain ITAR or EAR technical data. The content of this presentation slide is proprietary and confidential information of the AESQ. It is not permitted to be distributed to any third party without the written consent of the AESQ.

AS13003 – Measurement System Analysis

Lessons Learnt:

- MSA must be evaluated prior to understanding Cpk
- Computer controlled measurement systems not always adequate
- Evaluation of vision systems critical
- Visual inspection highly dependent on operator

Case Study:

Gage R&R (ANOVA) for Measurement 2

Components of Variation

Measurement 2 by Parts

Measurement 2 by Operators

Parts * Operators Interaction

Gage R&R (ANOVA) for Measurement 2

Mack R&R

Xbar Chart by Operators

Parts Chart by Operators

Operators Chart

Fixed Limit Control Chart

UCL

LCL

CL

Parts

Sample

Data

Components of Variation

R Chart by Operators

Xbar Chart by Operators

Parts Chart by Operators

Operators Chart

Fixed Limit Control Chart

UCL

LCL

CL

Parts

Sample

Data
Summary

• The goal is to make sure that every measurement system (gage + outside influences) used is suitable for the intended task → representing “real” part quality! The AS13003 method summarizes different tools and delivers a standardized approach.

• By using the MSA method you get a reliable and understandable statement if you can rely on your results or not → don’t touch your production processes before you are sure about your measurement

• An MSA helps to eliminate influences coming from different measurement strategies

• A CMM measurement is not always reliable – accuracy and inspector variance matters

• A comparison to an independent reference measurement gives a valuable insight into the production line measurement;
AS13006 PROCESS CONTROL METHODS

Peter E Teti
Pratt & Whitney

Eric Schneider
Birken Mfg. Co.

Jason Bronson
Birken Mfg. Co.
### AS13006 PROCESS CONTROL METHODS

#### Original State

- **Varying standards & approaches**
- PC requirements not clearly defined/understood
- Inconsistent application/flowdown to sub-tiers
- Lack of commitment/belief in benefits
- Belief low volume environments not applicable

#### AESQ Principles

- Standardise  ✔
- Simplify  ✔
- Adopts Existing Industry Standards  ✔
- Prescriptive, Auditable  ✔
- Common Language  ✔
- Supported by 3rd Party Training & Consultancy  ✔

#### AESQ Principles

- Common standard & approach
- Aligned with AS13002, 13003, 13004, AS9103, AS9145 & AIAG “Blue Books”

### Future State

- **In scope:** Process Control for all characteristics
- **Out of scope:** Foundational requirements

### Expected Benefits

- **Improved variation control & reduction techniques,** broad-based belief in benefits
- **Common prescriptive standard fully aligned with AESQ, AS9103 & AIAG Blue Book Stds**
- **Focus on accurate data analysis and proactive problem resolution**
- **Improved Quality Performance, reduced risk**
Birken Manufacturing specializes in the manufacturing of Complex Aerospace Jet Engine Components and provides CNC machining, Tig Welding, Inspection, NDT, Concurrent Engineering, and Assembly and Testing Services. We supply aerospace engine OEM’s worldwide.
Using the tools of PFMEA and Process Control Methods, work to improve Birken’s quality performance by eliminating high Milling scrap costs and Part Marking escapes to our Customers occurring over last several years.

**Problem Identification**

**SCARP DRIVERS ($K)**

- Milling: $345
- Sub-tier: $180
- Assembly: $40

**Business Impact**

- Marking: 16
- Packaging: 2
- Paint: 1

**ESCAPE DRIVERS**

**Customer Impact**

**Approach**

Using the tools of PFMEA and Process Control Methods, work to improve Birken’s quality performance by eliminating high Milling scrap costs and Part Marking escapes to our Customers occurring over last several years.

**Problem Resolution**

**AS13004**

**PFMEA and Control Plans**

- Process Flow Diagram (PFD)
- Process Failure Modes Effects Analysis (PFMEA)
- Process Control Plan (PCP)

**AS13006**

**Process Control Methods**

This document does not contain any export regulated technical data.
This document does not contain any export regulated technical data.
AS13006 — PROCESS CONTROL METHODS

- Points of Emphasis used to Generate Operator Awareness
- Created a Standardized Process for Milling Set-Ups
- Implemented for ALL Milling Operations
- Lead to the implementation of similar Checklists for Turning Operations

**CHECKLIST MANIFESTO**
By Atul Gawande
Before – During – After Flight, Before – During – After Surgery, Before – During – After Set Up, Then—During Production

- Incorporates Serial № Entry Verification
- Incorporates Duplicated Entry Check
- Incorporates Illegitimate Serial № Check

This document does not contain any export regulated technical data.
This document does not contain any export regulated technical data.
BENEFITS

MILLING
- PFMEA helped identify process failure modes at each step
- PFMEA helped identify effective process control methods to better detect and prevent failure mode causes
- Visual Checklist has helped Birken reduce its Milling Scrap Rate by more than 60% since its inception

MARKING
- Implementing error/mistake proofing into the Serial Nº Database system greatly reduces the chance of human error
- PFMEA identified the following key failure mode cause:
  - Software provided opportunity for operator to modify the number of digits. This number directly controls the length of the Serial Nº.
  - Knowing the marking software’s control limitations, a Serial Nº Database system has been developed to error-proof the human factor in controlling the Serial Nº input into the part marking program(s).
  - Since its implementation, current results show no additional nonconformances related to content.

KEY LESSONS LEARNT
- Importance of a Cross-Functional Team
- A robust PFMEA along with the right Process Control Method(s) can deliver positive results
- “Golden Nuggets” of true data can help a problem look worse before it gets better

This document does not contain any export regulated technical data.
RELATIONSHIPS TO OTHER INDUSTRY STANDARDS

AS13006 designed to align and work closely with other industry standards

Related Standards
AS13000: Problem Solving Requirements (8D)
AS13002: Developing & Qualifying Alternative Inspection Frequency Plans
AS13003: Measurement Systems Analysis Requirements
AS9103: Variation Management of Key Characteristics
AS9145: Advanced Product Quality Planning & Production Part Approval Process

AS13006 drives the use of process control methods and stresses the importance of solid foundational activities.
SUPPORTING MATERIAL

Guidance Document
Practical information to support the implementation of process control
• Benefits of process control
• Overcoming resistance
• Details on PC methods
• Various control charts applications
• Calculating process capability
• Managing non-normal data
• Case studies based on aerospace applications
• Associated formulas
• Maturity review

Training Syllabus
• Partial syllabus shown
• Refer to Appendix C for the full training syllabus
• Can aid in developing company training plan

Case Studies
Based on aero engine component applications

Assessment Checklist
• Used to evaluate the process control health of the company
• Supplier to build into their internal audit program
• Used annually as a minimum
• Conducted by someone proficient in process control

GO TO AESQ WEBSITE - aesq.saeitic.org
AS13002 INSPECTION FREQUENCY

AUSTIN SHEARS
PCC

LARRY BENNETT
GE
AS13002 Inspection Frequency

Original State

100% Inspection
REDUCED Sample
Error Proof AQL

Future State

Common Method for Inspection Planning
Guidance on commodity specific planning

AESQ Principles
- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy

Expected Benefits
- Reduced need for Customer training & support
- Improved access to training & consultancy
- Removal of complexity of reporting
- Improved problem solving skills
PCC France Overview

PCC France specializes in air and vacuum investment cast components for aerospace, defense, automotive, and commercial applications.

**Materials:**
- Titanium, Steel, Nickel, and Cobalt-Based Alloys.

**Capabilities:**
- Titanium Investment Castings:
  - Diameter: 47" (120 cm)
  - Length: +50" (+127 cm)
  - Pour Weight: 840 lbs.
- Stainless Steel Investment Castings:
  - Diameter: 47" (119 cm)
  - Length: 50" (127 cm)
  - Pour Weight: 1,100 lbs. Vac, 1,650 lbs. Air
Problem Statement

• Each Aero-Engine company had their own inspection methodology for reduced inspection.

• A single standard for reduced inspection frequencies is more efficient.
Standard Approach

In-Process Inspection Approach:

- Define current process characteristics (customers/parts/tooling)
- Determine current process applicability to AS13002 (run rate/process type/etc.)
  - Utilize 13003(MSA) toolset
- Review historical data and NC’s for areas of opportunity
- Develop and implement sampling plan per AS13002 requirements
- Utilize AS13003 MSA

Metal In-Process Inspection

Characteristics formed by hard-tool or soluble core

Sampling monitoring following § 7.4 Requirements for Complex Structural Castings of AS13002

<table>
<thead>
<tr>
<th>Production Rate</th>
<th>Sampling Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (&gt; 200)</td>
<td>1 part by Quarter</td>
</tr>
<tr>
<td>Medium (&gt; 50)</td>
<td>1 part a Semester</td>
</tr>
<tr>
<td>Low (&lt; 50)</td>
<td>1 part a year</td>
</tr>
</tbody>
</table>

Characteristics formed by ceramic core

Are we confident on the core printed area?
- No Sampling

Characteristics subject to manual dressing

Characteristics generated via an controlled machine tool

Sampling monitoring following §7.1.8 Reduced Inspection of variable
- Every part is inspected
- 1 characteristic by group

Sampling monitoring following §7.2 Software / Numerical Control of AS13002
- First and last part of each batch
- 1 characteristic by group

Sampling monitoring following §7.2,3 Reduced Inspection of variable
- Every part is inspected
- 1 characteristic by group
Final Inspection Approach:

- Define current process characteristics (customers/parts/tooling)
- Determine current process applicability to AS13002 (run rate/process type/etc.)
- Utilize 13003(MSA) toolset
- Define current Cpk from process control data
- Develop sampling plan package
- Propose sampling plan to customer

Metal Final Inspection

For KC, sampling plan defines following:
Note §7.1.2

<table>
<thead>
<tr>
<th>Type</th>
<th>Risk</th>
<th>Cpk &lt; 1</th>
<th>1 ≤ Cpk &lt; 1.33</th>
<th>1.33 ≤ Cpk &lt; 1.66</th>
<th>1.66 ≤ Cpk &lt; 2</th>
<th>Cpk ≥ 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Low (MTR)</td>
<td>1 : 1</td>
<td>1 : 20</td>
<td>1 : 100</td>
<td>1 : 100</td>
<td>1 : 100</td>
</tr>
<tr>
<td>Minor</td>
<td>Medium (MCTI)</td>
<td>1 : 1</td>
<td>1 : 10</td>
<td>1 : 50</td>
<td>1 : 50</td>
<td>1 : 100</td>
</tr>
<tr>
<td>Major</td>
<td>High (KC)</td>
<td>1 : 1</td>
<td>1 : 20</td>
<td>1 : 100</td>
<td>1 : 100</td>
<td>1 : 100</td>
</tr>
<tr>
<td>Major</td>
<td>Extreme (KC)</td>
<td>1 : 1</td>
<td>1 : 20</td>
<td>1 : 100</td>
<td>1 : 100</td>
<td>1 : 100</td>
</tr>
</tbody>
</table>
Benefits

PCC France:
• Reduced internal cost of over-inspection
• Defined sampling rates based on production run rates
• Reduced ambiguity of inspection requirements
• Consistent measurement sampling strategy by criticality of characteristics across product families

Customers:
• Consistent reporting
• Improved lead times
• Simplified requirement flow down to suppliers
Lessons Learned

• Companies outside AESQ are successfully implementing AS13002

• Both customer and supplier need to understand actual critical characteristics

• Not all characteristics need to be inspected using CMM
  – Go/No Go gauges and Poka-Yoke should be included in inspection planning discussions

• Sampling can provide increased throughput with no impact on product quality

• Sampling and gauging strategies can be utilized across part families
  – Review opportunities to adopt AS13002 sampling with legacy product

• Suppliers are in a partnership with customers and both need to work together
Benefits:

- Provides a standardized format for reduced inspection submission
  - Easier review for supplier quality engineer
- Clear requirements for ongoing monitoring

Lessons Learned:

- Internal training is critical to effective implementation
  - Supplier quality engineers need to understand both the spec requirements as well as statistics
- Need to understand control type for each characteristic
  - Optimize impact of the spec by utilizing the correct control type
- Process stability is a precursor to process capability
  - Process needs to be stable and capable
In Summary

- AS13002 provides the industry with a common standard and framework for reduced inspection

- Reduced inspection enables improvement in many business metrics such as cost, lead time and delivery

- We are in this together ... AS13002 provides many benefits to both suppliers and customers
Boeing Propulsion Systems

Voice of Customer

2019 AESQ Supplier Forum
Richard Gallagher

- Propulsion Systems Quality
  - Engine Company Support/Quality Investigations
  - 33 Years with Boeing
  - 10 Years USAF
Boeing Propulsion Systems
Where it all began… for me!

Bradley International Airport 1971
Propulsion Systems Division
M&Q Core Quality
Renton
Everett
**Everett Site:** Engine, Strut, and APU Build up 747, 767, & 777

- Built in 1966 to manufacture the new 747
- 98.3 Acres
- 2.2 Miles around the main factory
- 472,000,000 cubic feet
- 747, 767, 767 Tanker, 777, and 787 all produced here
- First 747 named “The City Of Everett” flew in Feb. 1969

---

**Renton Site:** Engine Build up for 737 Program

- Built in 1941 to build the experimental XPB-1 Sea Ranger
- 1 Sea Ranger was built before the order was canceled and Renton began manufacturing B-29 Bombers for WWII.
- Boeing built 1,119 B-29’s over a 2.5 year period
- Currently Renton produces the 737 Next Generation, the 737 based P-8 submarine hunter, and the new 737 Max
Boeing South Carolina

787 Fuselage, Final Assembly, and Delivery

- Produces 787 Dreamliner's
- 1800 solar panels (10 acres) installed on the roof
- Produces 20% of the plant’s power to include powering the giant autoclaves that bake the composite fuselage
- Achieved zero waste to landfill status in 2011
- New Propulsion South Carolina facility produces 737 max inlets, and will produce the 777X Nacelle.

737 Max Inlet & 777X Nacelle Production
We are the Boeing Company
What happens to the engine at Boeing?
The PSD family
What is quality?

What is Quality?

- More than zero defect parts…
- It’s constant improvement of design, processes, people, and services…
- It’s understanding who your customers are, what they need, and meeting or exceeding those expectations…
Boeing’s Expectations...

- **Zero Defect** Engines
- **Compliant**
- **On Time!**

- Accept NO Defects
- Create NO Defects
- Pass on NO Defects

THESE ARE OUR EXPECTATIONS AS YOUR CUSTOMER
The Supply Chain

ANY TIME A LINK IS BROKEN IT AFFECTS THE CUSTOMER
Impact of poor quality: Late deliveries

• Fines
• Canceled orders
• Missed revenue flights
• Impacted flight schedules
• Poor reputation
• Angry customers
Everett Delivery Process Flow

Factory Roll Out

- Paint & Weigh
- Fuel
- Functional Test, Engine Run, & Airworthiness Inspection

Boeing Pre-flight & B-1 Flight

Intermediate Inspection

Customer Walk/Inspection

Customer Preflight & C-1 Flight

Delivery Preparation

FAA Certificate of Airworthiness “Ticket” & Delivery
Impact of poor quality: People
Quality Is Personal

THIS COULD BE YOU OR YOUR LOVED ONE LOOKING OUT THIS WINDOW
Let’s Recap!

What is Quality?

More than zero defect parts.…
It’s constant improvement of design, processes, people, and services.
It’s understanding who your customers are, what they need, and meeting or exceeding those expectations.

Poor Quality Can Result In?

Fines…
Canceled orders…
Missed revenue flights…
Impacted flight schedules…
Poor reputation…
Angry customers…
All we ask...

YOUR CUSTOMER’S EXPECTATIONS...

ON TIME...

COMPLIANT...

DEFECT FREE PRODUCTS...
AS13000 PROBLEM SOLVING USING 8D

MATEUSZ ZYLA
COLLINS AEROSPACE

OLIVIER CASTETS
SAFRAN
AS13000 Problem Solving

Original State

**Rolls-Royce**  **GE**  **Pratt & Whitney**  **SAFRAN**

- 7-Step
- Apollo
- DIVE/Red-X®
- 8D

Future State

**GLOBAL 8D**

- 8D

AESQ Principles

- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy

Expected Benefits

- Reduced need for Customer training & support
- Improved access to training & consultancy
- Removal of complexity of reporting
- Improved problem solving skills
Collins Aerospace, a unit of United Technologies Corp. (NYSE: UTX), is a leader in technologically advanced and intelligent solutions for the global aerospace and defense industry.

Created in 2018 by bringing together UTC Aerospace Systems and Rockwell Collins, Collins Aerospace has the capabilities, comprehensive portfolio and expertise to solve customers’ toughest challenges and to meet the demands of a rapidly evolving global market.
PROBLEM STATEMENT

PROBLEM STATEMENT:

• ~70% reject rate due to casting voids/porosity
• Discovered after machining (MPI)

BACKGROUND:

• Collins buys castings and machines them
• Castings are FPI’ed and X-Rayed
• Machine shop performs MPI after machining
• All 3 inspection techniques (FPI, X-Ray, and MPI) need to be approved by Collins
• Casting process is “Frozen”
• No major process changes were noted
STANDARD APPROACH

DEFINE AND CONTAIN

• D0 – Implement Immediate Containment and Prepare for 8D
  • Stop manufacturing castings
  • Requested casting supplier to review process history
  • Confirm that the post machining technique detecting the issue is correct
  • Identified all affected stakeholders

• D1 – Form the Team
  • Cross-functional team
  • Set up regular cadence 8D meetings
  • Select a Champion and Team Leader

• D2 – Define the Problem
  • Discovery Point: Post machining MPI
  • Manifestation: increased rejection rate at MPI and visual evidence of porosity
  • Impact: 70% of all castings are rejected at MPI (historical rejection rate was <5%)
  • Focus: casting process and why excessive porosity is observed on castings

• D3 – Develop Containment Action
  • Quarantine all castings in WIP
  • Define Lot Date Codes of affected population
  • Increased x-ray sampling to 100% inspection requirement
INVESTIGATE AND CORRECT

• **D4 – Identify and Verify Root Causes**
  - **Root Cause investigation tools:** Fishbone Diagram / 3x5 Why / Process Review / Test Lots
  - **Generation Point:** Vent shape change during casting process.
  - **Detection:** X-ray technique was updated and the acceptance criteria was changed in error
  - **Systemic:** Casting supplier Frozen Process procedures were not adequate

• **D5 – Identify Corrective Action**
  - **Generation Point:** Vent shape change based on testing
  - **Detection:** X-ray technique update to correct acceptance criteria
  - **Systemic:** Identified internal procedures needing updates
  - **Read-across:** Review of all other Collins parts

• **D6 – Implement and Validate Corrective Action**
  - **Generation point:** Updated work instructions and confirmed change via test lot
  - Updated the PFMEA to include the vent change as a significant component

• **D7 – Define and Plan preventive Action**
  - **Systemic fixes:** Supplier and Collins collaborated on defining process change approval requirements
  - **Monitor effectiveness via supplier and machine shop follow ups**
  - **Proposed hog-out option for design engineering review**

• **D8 – Recognize the Team & Close the Investigation**
BENEFITS

PREVENTS REOCCURRENCE

READ-ACROSS

COMPLETE PACKAGE

STANDARD METHODICAL APPROACH

CORRECTIVE ACTION VALIDATION
LESSONS LEARNT

DON'T JUMP TO CONCLUSIONS

POOR ROOT CAUSES YIELD POOR CORRECTIVE ACTIONS

ROOT CAUSE – MAKE SURE TO ADDRESS ALL THREE!

REVIEW ALL PROCESS CHANGES

BIG TEAMS CAN GET HARD TO MANAGE

ACQUIRE VALUE ADD TEAM MEMBERS
Before AS13000 / 8D?

Every body was doing 8D in different flavor...

Sometimes in a very poor way

• Solving the wrong problem
• Just doing 5 whys (and then what?)
• Jumping to solutions (because the root causes are known for a long time...)
  – Forgetting why the containment (control plan) did not work
• Forgetting to read across
• Forgetting to close the loop back to the FMEA

Difficult to find a effective training
Benefits of the AS13000/8D

Standardization of a well known and effective method
Not « Yet Another Problem Solving Method! »
• Easy change management if your organization was already doing some sort of 8D
Called, accepted and prescribed by every customer
Standardization of the vocabulary around 8D (escape point, generation point...) 
Standardization of the template

Provide a training syllabus
To choose wisely your training provider
STANDARDS FEEDBACK

BARRIE HICKLIN
HONEYWELL
## Standards Feedbacks

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>What was the software?</td>
<td>AS13004</td>
</tr>
<tr>
<td>Do you believe all primes are in alignment with what they are looking for in a PFMEA?</td>
<td>AS13004</td>
</tr>
<tr>
<td>How regularly do you expect suppliers to revisit the PFMEA produced prior to production? I understand it is a &quot;live&quot; document, but does the standard communicate specific requirements around revisiting and making updates based on new findings?</td>
<td>AS13004</td>
</tr>
<tr>
<td>Are you aware of the pending change to the AIAG FMEA reference manual?</td>
<td>AS13004</td>
</tr>
<tr>
<td>Will a guide book be created for MSA</td>
<td>AS13003</td>
</tr>
<tr>
<td>How often should MSA be performed?</td>
<td>AS13003</td>
</tr>
<tr>
<td>Can I reduce Inspection frequency without a msa?</td>
<td>AS13003</td>
</tr>
<tr>
<td>Will the PowerPoint presentations be available to all attendees?</td>
<td>AS13003</td>
</tr>
<tr>
<td>does AESQ provide additional guidance on establishing Process - KPI beyond AS 9103</td>
<td>AS13006</td>
</tr>
<tr>
<td>What software are you using?</td>
<td>AS13006</td>
</tr>
<tr>
<td>Does process control start with measurement?</td>
<td>AS13006</td>
</tr>
<tr>
<td>Can you submit based on processes vs specific part numbers</td>
<td>AS13002</td>
</tr>
<tr>
<td>if AESQ 13XXX standards are good enough for engines, then why not apply to the rest of the systems</td>
<td>AS13002</td>
</tr>
<tr>
<td>Unfortunately we had issues with product that has been on a reduced inspection plan that has failed. What percentage of confidence is acceptable?</td>
<td>AS13002</td>
</tr>
</tbody>
</table>
FUTURE INITIATIVES

Lisa Claveloux
Pratt & Whitney

Dr Ian Riggs
Rolls-Royce

Helen Djäknegren
GKN

Barbara Negroe
GE Aviation

Catherine Catarina-Graca
Safran
Product Life Cycle & Document Interaction

AS9145 (APQP/PPAP) & AESQ Standards

AS9145 (PDP)  Kick Off  End of Concept (PDR)  Design Release (CDR)  Initial Prod. Approval  Production Launch

1. Planning

AS9145 APQP Phases

2. Product Design & Development

AS9145 Key PPAP Events

3. Process Design & Development

AS9145 PPAP Element Timing

4. Product & Process Validation

AS9102 FAIR Production Process Run  PPAP Approval

5. Ongoing Production, use and Post Delivery Service

AESQ 2nd Level Documents

AS13004 – PFMEA & Control Plans
AS13003 – Measurement Systems Analysis
AS13006 – Process Control Methods
AS13002 – Inspection Frequency

AESQ Systems Documents

AS13000 – Problem Solving Requirements for Suppliers - 8D
AS13001 – Delegated Product Release Verification Training Requirements
In-process Initiatives

- AS13100 Supplemental Quality Requirements
- APQP/PPAP/FAI
- Design Supplier Requirements
- Audit
- Supplier (sub-tier) Management
- Human Factors
AS13100 Management Standard

Original State

AS9100 / 9110 / 9120

Customer Requirements

Future State

AS9100 / 9110 / 9120

AS13100

Free Issue Acceptable Means of Compliance (Guidance)

AESQ Principles

- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy

Expected Benefits

- AESQ Single Standard of Requirements
- Further harmonises the current AESQ Company unique requirements
- Aligned to AS9100, AS9110 & AS9120
- Existing Standards to be integrated into AS13100 or made available as free issue Acceptable Means of Compliance
APQP, PPAP & FAI Common Approach

Original State

- AS9102 = FAI
- AS9102
- AS9145
- Company Specific Requirements

Future State

- AS9102 = FAI
- AS9145
- Company Specific Requirements
- Common Set of Additional Requirements

Expected Benefits

- Builds on Industry Standards
- Provides a Common interpretation of APQP / PPAP / FAI Requirements across industry
- Creates a Common Language
- Removes duplication and redundancy between companies

AESQ Principles

- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy
AESQ Design Supplier Requirements

Original State

- Multiple Documents to Manage
- Duplication
- Different Deliverables
- Different Ways of Working

Future State

1. Common understanding and language.
2. Aligns to AS13100 and other industry standards
3. Provides acceptable means of compliance for AS9100 and other regulatory requirements
4. Simple, prescriptive and surveillance requirements
5. Free issue guidance material that can be used by supply chain
6. Promotes pro-active Zero Defects principals within the design activity.

AESQ Principles

- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy

Expected Benefits

- AESQ Design Supplier Requirements
  - AESQ Principles
  - AESQ Expected Benefits

Design requirements to be included in AS13100. Guidance material to be free issue from AESQ website.
Quality Audit Requirements (former AS13005)

Original State
Internal and supplier audit requirements in many documents

Future State
Every Customer audit every supplier

Risk based supplier audit

Internal audits to many requirements

Aerospace Standard AS13005
- Audit types & checklists
  - System
  - Production process
  - Product
  - Special process
- Auditor qualification, KPI’s
- Audit outcome

Expected Benefits
- Lean & effective internal audit process provides confidence in state of compliance throughout Aero-Engine supply chain
- Improved rigor of audit approach
- Reduced and/or eliminated unnecessary and/or duplicate audits => Cost reduction / resources liberated by customer and supplier.
- Reduced supplier audits for performing suppliers (low risk) that demonstrate compliance to internal audit requirements
- Recognizes existing 3rd party certification

AESQ Principles
✓ Standardise
✓ Simplify
✓ Adopts Existing Industry Standards
✓ Prescriptive, Auditable
✓ Common Language
✓ Supported by 3rd Party Training & Consultancy
Supplier Management (former AS13007)

- Lots of sub-tier surprises?
- Is the variation and risk understood?
- Is the risk owned?
- How is it managed?
- How will it be improved?
Supplier Management (former AS13007)

### Original State

- **Industry Standard for Supplier/Tier Management**

### Varied Customer-Specific Requirements

- Tier X Flow down ???

### AESQ Principles

- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- Common Language
- Supported by 3rd Party Training & Consultancy

### Future State

- Single AESQ Standard
- Fewer Customer-Specific Requirements

### Expected Benefits

- Simplify language for organizations to manage suppliers
- Ability to use the standard throughout all tiers of the supply chain
- Standard will simplify and reduce the number of methods the suppliers must use to meet Customer requirements (i.e. simplify/make common the “how to”)
## Human Factors

### Original State

- **Maintenance Organisations (Part 145)**
- **Human Factors Approach**

### Future State

- **Human Factors Awareness**
- **Clarity on Human Factors in Part 21 areas**
- **Free Issue Guidance & Training Material**
- **Human Factors Reporting Process as an Acceptable Means of Compliance**
- **Human Factors Investigation Process as an Acceptable Means of Compliance**

### AESQ Principles

<table>
<thead>
<tr>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardise</td>
<td>Simplify</td>
<td>Adopts Existing Industry Standards</td>
<td>Prescriptive, Auditable</td>
<td>Common Language</td>
</tr>
</tbody>
</table>

### Expected Benefits

- **Common understanding and language of Human Factors across supply chain**
- **Aligns to AS13100 and other industry standards**
- **Free issue guidance and training material that can be used by supply chain**

---

AESQ – Aerospace Engine Supplier Quality Strategy Group

This document slide does not contain ITAR or EAR technical data. The content of this presentation slide is proprietary and confidential information of the AESQ. It is not permitted to be distributed to any third party without the written consent of the AESQ.
HUMAN FACTORS

LUDOVIC CHEVET
AIRBUS
An Airbus takes off or lands every 1.4 seconds

End December 2018

19,340 Orders
11,763 Deliveries
7,577 Backlog
The Market

Source: Airbus GMF 2018

Air traffic doubles every 15 years
The Market

Source: Airbus GMF 2018

World fleet will double in the next 20 years

Level of exposure will increase

- 10,450
- 10,600
- 10,850
- 26,540
- 37,390

Beginning 2018

New Deliveries

Source: Airbus GMF 2018
Supply Chain risks are today one of the greatest concern for aviation stakeholders.

Source: Allianz Risk Barometer 2014

Note: Respondents could select more than one risk.
Supply Chain Risks… Business Interruption

Any link in the chain can stop propagation of NC to the end customer

Illustration by courtesy of ScandiAvia
Human Errors are the origin of most supply chain issues

Minimizing human errors in the supply chain is key toward product safety, quality and delivery
Aviation safety will continue to evolve, always putting safety of passengers first.
What is Human Factor?

Human Factor is a science studying how errors occur.
What is Human Factor?
The Dirty Dozen

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

Dirty Dozen are primary causes of human error
Error is gold

Trust based SMS helps human errors identification

Just and fair culture
Human Factor in Aviation Value Stream

Human Factor approach shall be reinforced in production organisations

Several projects within Airbus
The AESQ project is matching Airbus strategy and taking an active role in it.

**AESQ Principles**
- Standardise
- Simplify
- Adopts Existing Industry Standards
- Common Language
- Supported by 3rd Party Training & Consultancy

**Expected Benefits**
1. Common understanding and language of Human Factors across supply chain
2. Aligns to AS13100 and other industry standards
4. Free issue guidance and training material that can be used by supply chain

**Human Factors Approach**
- Human Factors in AS13100
- Human Factors in Part 21 areas
- Free Issue Guidance & Training Material
- Human Factors Reporting Process as an Acceptable Means of Compliance
- Human Factors Investigation Process as an Acceptable Means of Compliance

** AESQ Strategy Group**
A Program of SAE ITC
We are in growth industry
We put safety of passengers first

End to End human factor approach is key for collective success

AESQ and Airbus will support the supply chain

Game
CLOSING REMARKS

DAN EIGENBRODE
PRATT & WHITNEY
AESQ Vision

To establish and maintain a common set of Quality Requirements that enable the Global Aero Engine Supply Chain to be truly competitive through lean, capable processes and a culture of Continuous Improvement.
AESQ Vision

In detail

• Create common standards within the engine manufacturers (OEM’s) in regard to quality
• Deploy together the written standards throughout our supply chain
• Establish capable quality processes and a culture of continuous improvement

Main targets

• To improve quality within the supply chain
• Improve on time delivery and minimize costs through a reliable quality performance
• Gain efficiency by standardized processes
AESQ Will Drive Progress

Spread the Word

Provide feedback on the AESQ website
Thank You for Attending

Please Return Home Safely