How to Effectively Deploy Defect Prevention Methods in the Aero Engine Supply Chain

October 9th 2019, Toulouse

An AESQ Supplier Forum Event
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Toulouse Supplier Forum Delegate Pack

Delegate Pack Contents

1) Agenda
2) Using PolLEV and Wifi Details
3) Presentation Material
4) Case Studies
5) Speaker Biographies
6) AS13xxx Standard Training Provider Information
7) AESQ Website Details
8) Airbus A380 Tour Details
The AESQ Steering Group Members

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Executive Sourcing Quality Leader  
GE Aviation

Lisa Claveloux  
Director Supplier Quality  
Pratt & Whitney

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Director, Quality Systems & Regulatory Compliance  
Honeywell

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Senior VP Corporate Quality  
MTU Aero Engines

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VP Quality  
PCC Structural

Osa Omoruyi  
Director of Quality  
Arconic

AESQ – Aerospace Engine Supplier Quality Strategy Group

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Voice of the Customer

Olivier Balmat
VP Industrial Quality

Safran Aircraft Engines
AESQ SUPPLIER FORUM IN TOULOUSE

SAFRAN INTRODUCTION

October 8th, 2019
SAFRAN: TECHNOLOGY THAT BENEFITS OUR DAILY LIVES

1 SINGLE-AISLE COMMERCIAL JET TAKES OFF every 2 SECONDS, powered by our engines**

MORE THAN 62,000 LANDINGS a day using our equipment

80+ SUCCESSFUL ARIANE 5 LAUNCHES in a row***

3,000 MILITARY AIRCRAFT fitted with our inertial navigation systems

1 OUT OF EVERY 3 HELICOPTER TURBINE ENGINES sold worldwide

OVER 40,000 POWER TRANSMISSIONS totalling over 1 billion flight-hours

MORE THAN 21,500 NACELLE COMPONENTS in service

MORE THAN 100 KM OF ELECTRICAL WIRING on an Boeing 787 Dreamliner

1 MILLION SEATS in service in airline fleets worldwide

**in partnership with GE, through CFM International
***in partnership with Airbus, through ArianeGroup
A COMPREHENSIVE RANGE OF AIRCRAFT PROPULSION SYSTEMS AND EQUIPMENT

Cockpit
- Control systems
- Panel & displays
- Seats

Avionics sensors
- Aircraft condition monitoring systems

Lavatories, water & waste

Cabin interiors
- Seats
- IFEC – In-flight entertainment & connectivity

Power & data wiring

Oxygen systems

Flight actuators

Auxiliary Power Unit (APU)

Exit slide

Anti icing & de-icing

Inerting & fuel systems

Galleys & equipment

Exterior lighting

Nacelles & components

Power transmission systems

Engines
- Engine control systems (FADEC)
- Power distribution and generation

Landing gears
- Braking & landing control systems
- Wheels and carbon brakes

Cabin interiors

Seats

IFEC – In-flight entertainment & connectivity

Engines
- Engine control systems (FADEC)
- Power distribution and generation
PROPULSION: THE BROADEST POWER RANGE

(1) Rolls-Royce Turbomeca Ltd, a 50/50 joint company between Safran Helicopter Engines and Rolls Royce

(2) PowerJet is a 50/50 joint company between Safran Aircraft Engines and UEC Saturn (Russia)

(3) CFM International is a 50/50 joint company between Safran Aircraft Engines and GE (USA)

(4) By Europrop International (EPI), a consortium of Safran Aircraft Engines, Rolls-Royce, ITP and MTU Aero Engines

(5) In collaboration with GE (USA)

(6) Through the Engine Alliance (Safran Aircraft Engines 15%, Safran Aero Boosters 7.5%)

(7) In collaboration with GE (Safran Aircraft Engines 23.7%)

(8) Through Europropulsion, a 50/50 joint company between Safran and Avio (Italy)
CFM® – A French-American alliance

Safran Aircraft Engines & GE, successful partners for over 40 years

50/50 joint company
All activities are equally split: design, development, production, sales and support.

No. 1 engine supplier worldwide for mainline commercial jets (over 100 seats)

More than 570 customers worldwide

Partnership extended to 2040
LEAP® – Combining the best technologies from Safran Aircraft Engines and GE

A320neo

737 MAX

C919

LEAP-1A
Entry into service in August 2016

LEAP-1B
Entry into service in May 2017

LEAP-1C
Entry into service 2018

More than 17,000 orders and commitments as of July 2018

-15% lower fuel consumption*

-15% reduction in CO₂ emissions*

* Compared with previous-generation engines
How can we manage the LEAP ramp up and ensure safety at the same time?

By fully endorsing the APQP process and the corresponding AESQ standards through 3 projects

<table>
<thead>
<tr>
<th>SPI</th>
<th>SPOC</th>
<th>SPRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>To manage the APQP and its tollgates</td>
<td>To ensure the right level of requirements over the control plan</td>
<td>To ensure the capability of the production processes</td>
</tr>
<tr>
<td>To ensure maturity at each steps of the development</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supported by
- AS9145 for APQP
- AS13004 for PFMEA
- AS13003 for MSA

Supported by
- AS13002 to qualify alternate inspection frequency plan

Supported by
- AS13006 for Process Control
AESQ Overview

Barbara Negroe
Executive Sourcing Quality Leader
GE Aviation
Vice Chair - AESQ

Lisa Claveloux
Director Supplier Quality
Pratt & Whitney
Commercial Aviation – A Growth Market

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.
Aero Engine Supplier Quality (AESQ)
Aero Industry Requirements Flowdown 2012

Regulator Requirements

Customer Requirements

Industry Requirements

NADCAP

AS Standards
(AS9100, AS9145, AS9103, etc.)

AEROL Engine Manufacturers

Rolls-Royce
SABRe

GE
S-1000

P&W
ASQR-01

Safran
SAFe

Aero Engine Supply Chain
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 with a focus on Defect Prevention 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
Aero Industry Requirements Flowdown 2019

Regulator Requirements → Customer Requirements → Industry Requirements

- NADCAP
- AS Standards (AS9100, AS9145, AS9103, etc.)

AERO Engine Manufacturers

- AESQ AS13xxx Standards
- Rolls-Royce SABRe
- GE S-1000
- P&W ASQR-01
- Safran SAFe

Aero Engine Supply Chain

AESQ – Aerospace Engine Supplier Quality Strategy Group

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Product Life Cycle & Document Interaction

AS9145 (APQP/PPAP) & AESQ Standards

1. Planning
   - AS9145 (PDP)
     - Kick Off
     - End of Concept (PDR)

2. Product Design & Development
   - AS9145 APQP Phases
     - Design
     - Records & DRA
     - Process Flow Diagram
     - PFMEA
     - Control Plan
     - Packaging, Preservation & Labelling
     - MSA
     - ICS
     - FAI

3. Process Design & Development

4. Product & Process Validation
   - AS9102 FAIR
   - Production Process Run

5. Ongoing Production, use and Post Delivery Service
   - PPAP Approval

AESQ 2nd Level Documents

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

AESQ Systems Documents

AS13004 – PFMEA & Control Plans
AS13003 – Measurement Systems Analysis
AS13002 – Inspection Frequency Plans
AS13006 – Process Control Methods
Aero Industry Requirements Flowdown Vision

Regulator Requirements

Customer Requirements

Industry Requirements

NADCAP

AS Standards
(A9100, AS9145, AS9103, etc.)

AERO Engine Manufacturers

AESQ Quality Management Requirements
(Supplemental to AS9100)

Aero Engine Supply Chain
AESQ Website

Access AESQ Website to;

• Provide feedback on current and developing standards

• Share best practice deployment stories

• Get clarification of Standard deployment & interpretation

https://aesq.sae-itc.com
AESQ Will Drive Progress

AS13000, AS13001, AS13002, AS13003, AS13004 and AS13006 have all been flowed down by all AESQ members and are part of your Purchase Order.
Deployment Case Studies

AS13xxx Series Standards

Barrie Hicklin
Director Quality Systems & Regulatory Compliance
Honeywell
Defect Prevention Key Quality Tools for Zero Defects

1. Design Risk Analysis e.g. Design FMEA
   - Identify & Understand
   - Potential Design Risks
   - & Mitigate
   Design meets customer requirements and can make defect two parts

2. Process Failure Mode & Effects Analysis to AS13004
   - Identify & Understand
   - Process Design
   - & Mitigate
   Process can make defect too parts

3. Control Plan to AS13004
   - Identifying & Mitigating
   - Risk
   - Process Capability
   - CPAK
   Process must be on target with minimum variation

4. Inspection Capability to AS13004
   - Variable repeatability reproducibility
   - Attribute Agreement Analysis to AS13003
   - Initial Process Capability to AS13006
   - Process & maintains the process
   - Inspection

5. Process Control to AS13006
   - Inspections & Waits to
   - Maintain
   - Audit

6. Defect Prevention & Management
   - AESQ Quality Standards & Guidance
   - RAISING THE STANDARD FOR QUALITY
Supplier Case Studies

**Case Study 1**
- AS13004 PFMEA & Control Plan
- Standard Highlights: Dr Ian Riggs
- FACC Case Study
- Q&A

**Case Study 2**
- AS13003 Measurement Systems Analysis (MSA)
- Standard Highlights: Martin Schäffner
- Mechachrome Case Study
- Q&A

**Case Study 3**
- AS13002 & AS13006 Process Control
- Standard Highlights: Peter Teti
- PW Kalisz Case Study
- Q&A

**Case Study 4**
- AS13000 Problem Solving using 8D
- Standard Highlights: Olivier Castets
- Meggitt Case Study
- Q&A

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Case Study
AS13004 Process Failure Mode & Effects Analysis (PFMEA) & Control Plans

Dr Ian Riggs
Global Quality Executive
Rolls-Royce Civil Aerospace
AS13004 Process FMEA & Control Plan Overview

1. Process Flow Diagram

- OP10 CNC Drilling: Drill Fast Hole 50mm Diameter +/- 1.0 mm, Hole too Big
  - Potential Cause: Fuel leak leading to explosion
  - Prevention Controls: Bore mic at OP 50

- OP20 CNC Drilling: Drill Air Hole 150mm Diameter +/- 3.0 mm, Hole too Big
  - Potential Cause: Slight increase in noise level
  - Prevention Controls: Bore mic at OP 50

2. Process FMEA

3. Production Control Plan

Keep Updating
## AS13004 Process FMEA & Control Plans: Maturity Checklist

<table>
<thead>
<tr>
<th>Ref #</th>
<th>Category</th>
<th>Clause Ref.</th>
<th>Question</th>
<th>Complies</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.1</td>
<td>4.1.1</td>
<td>Have the tools and methods defined within this standard been deployed using a cross functional team?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4.1</td>
<td>4.1.2</td>
<td>Has the design organization completed a Design Risk Analysis (DFMEA) that identifies risks associated with safe and proper operation of the product?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4.2</td>
<td>4.2.1</td>
<td>Has AS13004 been applied to all New Product Introduction programmes?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4.2</td>
<td>4.2.2</td>
<td>Has AS13004 been applied to products and/or services currently used in production following manufacturing process changes, transfer to a new location or being addressed for improvement?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.2</td>
<td>4.2.3</td>
<td>Once invoked, is AS13004 being applied throughout the lifecycle of a product, process risk being reviewed on a continual basis and mitigation actions being taken and actioned on a frequent basis?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4.2</td>
<td>4.2.4</td>
<td>Has AS13004 been flowed to all suppliers that manufacture and/or supply products and services?</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

**AS13004 Assessment Checklist**

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What is a PFMEA?

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OP10</strong></td>
<td>Drill FUEL Hole</td>
</tr>
<tr>
<td><strong>OP20</strong></td>
<td>CNC Drilling</td>
</tr>
</tbody>
</table>

**What are you trying to create?**

Defined by Engineering Drawings & Specifications

**How could you get the Requirements wrong?**

How bad would it be if was not to specification?

**Potential Failure Modes**

- Fuel leak leading to explosion
- Oversize hole
- Fuel leak
- Spindle alignment error

**Potential Effects**

- Hole too big
- Fuel leak leading to explosion
- Oversize tool
- Tool pre-setting

**Prevention Controls**

- Spindle alignment
- Calibration

**Detection Controls**

- Bore mic

**What would need to fail in the process to cause the Failure Mode?**

- Oversize tool
- Tool pre-setting

**How could this be prevented?**

- Spindle alignment
- Calibration

**How likely is it to happen?**

- Concession

**How likely are you to detect the Cause or Failure Mode?**

- Spindle alignment
- Calibration

**Risk Profile (RPN) = Severity x Occurrence x Detection**

<table>
<thead>
<tr>
<th>S</th>
<th>E</th>
<th>V</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>6</td>
<td>3</td>
<td>252</td>
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<tr>
<td>6</td>
<td>4</td>
<td>2</td>
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<td>4</td>
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<td>2</td>
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</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>28</td>
</tr>
</tbody>
</table>

Product Focussed

Process Focussed

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Process FMEA & Control Plans : Critical Success Factors

- Must be created & Maintained by a CROSS FUNCTIONAL TEAM
- Required for EVERY part number*
- Include ALL Process Steps
- EVERY Design Characteristic included in the PFMEA**

- PFMEA must be done at the RIGHT TIME
- PFMEA Failure Modes must describe PRODUCT DEFECTS
- PFMEAs must DRIVE ACTIONS to reduce risk
- Keep up to date – They are LIVE documents

*Typical deployment for NPI, Key Changes (Design or Process), Source Changes as well as Major Quality Issues Corrective Actions

**Rolls-Royce Requirement
Process FMEA Case Study

Juergen Klinglhuber
Director, Quality
FACC Aerostructures

Andre Haertelt
VP Operations Manufacturing Quality
FACC Aerostructures
AS 13004 (PFMEA & CONTROL PLAN)
BENEFITS OF DEPLOYING PREVENTION TOOLS
AS PART OF APQP AND ZERO DEFECTS

AGENDA

1) WHO WE ARE
2) WHERE WE ARE NOW
3) HOW WE GOT THERE
4) WHERE WE WANT TO GO
5) HOW WE CHANGED
6) WHAT WE LEARNED
WHO WE ARE
FACC OVERVIEW – FIGURES & FOOTPRINT

100% Aerospace composite lightweight

2 Engineering centers in Austria

5 Plants

20% YoY average growth EUR 780 Mio. revenue in 2018/19

3,500 Employees worldwide

[Map of FACC locations worldwide]
WHERE WE ARE
THE EFFECT OF BIQ – THE HARD FACTS
WHERE WE WERE
PFMEA TO AS13004 AS AN ENABLER – THE SOFT FACTS

PFMEA
ONE-OFF CHARACTER
FOR THE RECORDS
DONE IN ISOLATION (QUALITY)

Control Plan
FOR CUSTOMER SATISFACTION
RATHER INSPECTION PLANS
NOT ALIVE
NOT DERIVED FROM PFMEA

Late after FAIR
WHERE WE WANT TO BE
PFMEA TO AS13004 AS AN ENABLER – THE SOFT FACTS

PFMEA AS A “SCHOOL OF THOUGHT”
- CROSS FUNCTIONAL COLLABORATION – COMMON GOALS
- FROM ONE-OFF TICK BOX EXERCISE TO CULTURALLY EMBEDDED PLM ELEMENT
- EARLY ENGAGEMENT WITH EFFECT ON DRAWING BY-OFF PROCESS

PFMEA AS A TOOL
- INCREASED PRODUCT UNDERSTANDING (DESIGN SEVERITY SCORING)
- BUILDING BLOCKS FOR FORMAL RECORDING AND DEVELOPMENT OF PORTFOLIO COMMODITY KNOWLEDGE
- STANDARD ALLOWING MORE EFFICIENT APPLICATION WITH EVERY TURN
HOW WE GOT THERE
THE CHALLENGING STARTING POINT

AS13004 FOR EVERYTHING AND NOW
HOW WE GOT THERE
DEPLOYMENT OF AS13004 @ FACC
WHERE WE WANT TO GO
FULL PORTFOLIO COVERAGE – “INFECTION”

LIGHTHOUSE PROJECT TO GAIN EXPERIENCE
KNOWLEDGE TRANSFER
COMMODITY COMMONALITIES (PART FAMILIES)
DOMINO/SNOWBALL EFFECT

FIRST DEFINED PART OF RR

FLEET & LEGACY
NPI RR
FLEET & LEGACY
NPI RR
FLEET & LEGACY
NPI RR
FLEET & LEGACY
HOW WE CHANGED
AS13004 – THE QUALITY OF PFMEA

OLD VS. NEW FACC PFMEA → MORE DETAILED FUNCTIONAL NET
HOW WE CHANGED
AS13004 EMBEDDED IN THE ORGANISATION

EXT & INT COLLABORATION

PRODUCT UNDERSTANDING

ELIMINATION OF PFMEA AMBIGUITY
(FEATURE VS PROCESS)

CROSS-PEOPLE AND CROSS-PROCESS INTERACTION

MGMT UNDERSTANDING OF BENEFITS
(UPFRONT INVESTMENT VS CoNQ)

MORE FOCUS ON ZERO DEFECTS MINDSET SPREAD THROUGHOUT THE COMPANY
WHAT WE LEARNED
STRONGER TOGETHER

> COLLABORATION IS KEY
> GOOD MODERATION DRIVES RESULTS
> COMMODITY DRIVES SCOPE (FEATURE & PROCESS)
> AS13004 BY MS EXCEL BEARS RISKS AND MEANS MANUAL EFFORT

> NEW DEPARTMENT WITH DEDICATED AND SKILLED FMEA HOST FOR FMEA SESSIONS
> GROWING DATABASE (REFERENCE FMEA FOR COMMON PROCESSES, FEATURE BASED FOR PRODUCT SPECIFIC ASPECTS → BUILDING BLOCKS / LEGO® SYSTEM FMEA)
> UNIFYING SOFTWARE SOLUTION COVERING FULL CIRCLE FMEA–CP–SPC IN EVALUATION
# WHAT WE LEARNED

**OBSERVATIONS ON AS13004**

<table>
<thead>
<tr>
<th>Feature Focus</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS13004 Ideal for “One Stop Shops” – Make2Print/OEM/Sub-Tier Coordination Efforts</td>
<td>-</td>
</tr>
<tr>
<td>Feature Focus – Risk of omitting commodity related process aspects</td>
<td>-</td>
</tr>
<tr>
<td>Defined standard creates clarity, supports RFT and reduces effort</td>
<td>+</td>
</tr>
<tr>
<td>Helps to identify critical manufacturing features and drives process control via control plan – supports on time production readiness</td>
<td>+</td>
</tr>
<tr>
<td>Acts as tool knowledge mgmt and sheds light on similar product and processes</td>
<td>+</td>
</tr>
</tbody>
</table>
WHAT WE LEARNED

RECOMMENDATIONS

SHARE RESPONSIBILITIES (NOT QUALITY ONLY)

GO STEP BY STEP AND ADHERE TO STRUCTURES

DEFINE LIGHTHOUSE PARTS

GRADUALLY INCREASE SCOPE

SUCCESS

PLAN IN ADVANCE

PPAP

CHANGE MGMT

EARLY COORDINATION WITH DESIGN OWNER
THANK YOU
AS13004 Success Stories

RR XWB Stub Shaft
Deployed AS13004 PFMEA on all Characteristics
Cross-functional teamwork
Zero Defects at Product Launch
APQP / PPAP Delivered in 50% of the time scheduled

Sam Suzhou make Engine Mounts for XWB.
16 Part Specific FMEAs in 3 months
Introduction of error proofing and prevention controls.
Defect Free since September 2017

Trent 7000 Fan Case Delivered Defect Free at PPAP after applying ZD Toolkit.
Parts now delivered Defect Free Manufactured by GKN, Newington.
PPAP completed in 6 months instead of the usual 18 months.

Hanwha is a Structures & Transmissions supplier.
Feature based PFMEA using Reference PFMEAs
Cross-functional team (design, manufacturing & Hanwha)
This led to DPU reduction:
Trent XWB A-Frame: to 0.00.
Trent 7000 A-Frame DPU improved to 0.0.
Using REFERENCE PFMEAs to improve Effectiveness & Efficiency
<table>
<thead>
<tr>
<th>Process</th>
<th>Requirements</th>
<th>Potential Failure Modes</th>
<th>Potential Effects</th>
<th>S</th>
<th>E</th>
<th>V</th>
<th>Potential Causes</th>
<th>Prevention Controls</th>
<th>O</th>
<th>C</th>
<th>C</th>
<th>Detection Controls</th>
<th>D</th>
<th>E</th>
<th>T</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC Drilling</td>
<td>Drill <strong>FUEL</strong> Hole</td>
<td>Hole too Big / Too Small</td>
<td>Fuel leak leading to explosion</td>
<td>9</td>
<td></td>
<td></td>
<td>Oversize tool</td>
<td>Tool pre-setting</td>
<td>4</td>
<td></td>
<td></td>
<td>Bore mic at OP 50</td>
<td>7</td>
<td></td>
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<td>252</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Scrap part</td>
<td>6</td>
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<td></td>
<td>Spindle alignment error</td>
<td>Asset Care &amp; Calibration</td>
<td>3</td>
<td></td>
<td></td>
<td>Weekly ball bar check</td>
<td>8</td>
<td></td>
<td></td>
<td>189</td>
</tr>
<tr>
<td>CNC Drilling</td>
<td>Drill <strong>FUEL</strong> Hole</td>
<td>Out of Position</td>
<td>Stress on Fuel pipe leading to cracks</td>
<td>9</td>
<td></td>
<td></td>
<td>Incorrect manual offset</td>
<td>None</td>
<td>2</td>
<td></td>
<td></td>
<td>CMM at OP 120</td>
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<td></td>
<td>126</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Concession</td>
<td>4</td>
<td></td>
<td></td>
<td>Machine calibration out of limit</td>
<td>Asset Care &amp; Calibration</td>
<td>1</td>
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<td>Weekly ball bar check</td>
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<td></td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>CNC Drilling</td>
<td>Drill <strong>FUEL</strong> Hole</td>
<td>Hole too Deep / too Shallow</td>
<td>Fuel leak leading to explosion</td>
<td>9</td>
<td></td>
<td></td>
<td>Incorrect offset used</td>
<td>None</td>
<td>2</td>
<td></td>
<td></td>
<td>CMM at OP 120</td>
<td>7</td>
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<td></td>
<td></td>
<td></td>
<td>Concession</td>
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<td>Asset Care &amp; Calibration</td>
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<td></td>
<td>Weekly ball bar check</td>
<td>8</td>
<td></td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>
Creating a Part Specific PFMEA using Reference FMEAs

Reference PFMEA Database

- CNC Drilling
- CNC Milling
- CNC Grinding
- E Beam Welding
- TIG Welding
- Casting
- Part Marking
- Cleaning
- Chemical Etch

Part Specific Design and Process Documentation

'SHELL' Part Number PFMEA

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirements</th>
<th>Potential Failure Modes</th>
<th>Potential Effects</th>
<th>Potential Causes</th>
<th>Prevention Controls</th>
<th>Occurrence</th>
<th>Detection Controls</th>
<th>D</th>
<th>E</th>
<th>N</th>
<th>Preventive Action</th>
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<tbody>
<tr>
<td>OP10</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CNC Drilling</td>
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<tr>
<td>OP20</td>
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<tr>
<td>CNC Milling</td>
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<td>OP30</td>
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<tr>
<td>CNC Grinding</td>
<td></td>
<td></td>
<td></td>
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## 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>Potential Causes</th>
<th>Prevention Controls</th>
<th>O C C</th>
<th>Detection Controls</th>
<th>D E T</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 9</td>
<td>Oversize tool</td>
<td>Tool presetting 4</td>
<td>Bore mic at OP 50</td>
<td>7</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scrap part 6</td>
<td>Spindle alignment error</td>
<td>Asset Care &amp; Calibration 3</td>
<td>Weekly ball bar check</td>
<td>8</td>
<td>189</td>
<td></td>
</tr>
<tr>
<td>OP20 CNC Drilling</td>
<td>Drill AIR Hole 50mm Diameter +/- 3.0 mm</td>
<td>Hole too Big</td>
<td>Slight increase in noise level 3</td>
<td>Oversize tool</td>
<td>Tool presetting 2</td>
<td>Bore mic at OP 50</td>
<td>7</td>
<td>56</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Concession 4</td>
<td>Spindle alignment error</td>
<td>Asset Care &amp; Calibration 1</td>
<td>Weekly ball bar check</td>
<td>8</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

**Additions & Subtractions by Teams as required**

---

**Aerospace Engine Supplier Quality Strategy Group**

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Using the ‘Bridge Tool’ to create the SHELL PFMEA

Real Time Demo

Developed by Rolls-Royce
Bangalore

Equivalent Processes available from Quest Engineering Consultancy and Tata Consultancy Services (TCS)
How long does it take?

- Create Reference PFMEAs: 30 man hours per REF PFMEA
- Create Shell PFMEA: 30 man hours per Shell PFMEA (manual method): <2 Hours using Bridge Tool
- Complete 1st - 3rd Part Specific PFMEAs: 400 man hours per PFMEA
- Complete future Part Specific PFMEAs: <100 man hours per PFMEA
1. Deploying AS13004 Practitioner Guide available free of charge on the RR Supplier Portal and the AESQ website

2. Available in English, German and Chinese

3. Selection of Rolls-Royce Reference PFMEAs available to external businesses via its Supplier Portal (open to all)

4. Invest in;
   - Dedicated FMEA IT software
   - Global PFMEA training is available to support this approach through SAE, Smallpeice Enterprises and Industry Forum
1. Select the Cross Functional Team

2. Upskill the Team using AS13004 Approved Training

3. Create a Coaching network to develop the Team’s capabilities

4. Develop your Reference PFMEA Database

5. Use IT Solution to create ‘Shell’ PFMEA

6. Complete the PFMEA with the Cross Functional Team

7. Identify and implement improvement actions from the PFMEA
Effective Process FMEAs will TRANSFORM YOUR QUALITY PERFORMANCE!
Case Study
AS13003 Measurement Systems Analysis

Martin Schaeffner
Senior VP Corporate Quality
MTU Aero Engine

Anthony Hartwig
Customer Quality Manager
Mechachrome
Why is MSA so Important?

1. We are reliant upon Measurement & Inspection to ensure non-conforming products are detected

2. Data from Measurement and Inspection is required to identify changes to process stability

3. All Measurement Systems have error – we must ensure that this is as small as possible and within agreed thresholds

4. MSA allows us to measure the Capability of our Measurement and Inspection processes

5. It helps identify sources of variation so that mitigating / improvement actions can be taken to improve capability

6. Many of the required MSA Tests for Gauges is part of the Calibration Process
What Types of MSA are there?

- Accuracy*
- Resolution**
- Repeatability
- Reproducibility
- Linearity*
- Stability
- Attribute Agreement Analysis

* Usually done as part of Gauge calibration  ** Gauge Selection Criteria
AS13003 Measurement System Analysis Overview

Section 7
Measurement System Requirements
The When & the What Acceptance Criteria

Section 8
Elements to Consider when conducting an MSA
MSA Design
Sample selection and size
Analysis of results, etc.

Section 9
MSA Audit Checklist

Section 10
MSA Case Studies
Gauge R&R
Gauge R&R for CMM
Attributes
Accuracy Ratio etc.
AS13003 Measurement Systems Analysis Overview

Figure 2: Defines what type of MSA needs to be done

Table 1: Defines when MSA needs to be done

<table>
<thead>
<tr>
<th>Event</th>
<th>Event Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New inspection device or method introduction.</td>
<td>Perform MSA</td>
</tr>
<tr>
<td>2</td>
<td>New/Chang Production Process.</td>
<td>Evaluate current or Perform MSA</td>
</tr>
<tr>
<td>3</td>
<td>Any significant change to the current inspection device or method, e.g., equipment, operator, environment, location, sequence, calibration standard, inspection fixture, CMII software or hardware change.</td>
<td>Evaluate current or Perform MSA</td>
</tr>
<tr>
<td>4</td>
<td>Following a product change, the product related to be is expected to be done from the Measurement System (non-conforming material left the facility).</td>
<td>Evaluate current or Perform MSA</td>
</tr>
<tr>
<td>5</td>
<td>Change in how an inspection device or method is used, or its application. For example: 1. When changing from simple geometry to complex. 2. When changing from similar tolerance product characteristics. 3. Moving from visual inspection of edge create with dimensional requirements to visual inspection of cosmetic appearance requirements.</td>
<td>Perform MSA</td>
</tr>
<tr>
<td>6</td>
<td>Product requirements are changed to be more restrictive or tightened.</td>
<td>Redo from base data or Perform MSA</td>
</tr>
<tr>
<td>7</td>
<td>As part of a First Article Inspection (FAI), following a topic in use of more than 24 months.</td>
<td>Evaluate current MSA</td>
</tr>
<tr>
<td>8</td>
<td>Existing inspection device or method is being used to accept product and has not previously been evaluated per this standard as directed by the purchaser.</td>
<td>Perform MSA when required</td>
</tr>
<tr>
<td>9</td>
<td>Product audit non-conformance or product investigation when suspected to be from the measurement system.</td>
<td>Evaluate current or Perform MSA</td>
</tr>
<tr>
<td>10</td>
<td>To verify a measurement system is adequate before SPC.</td>
<td>Perform MSA</td>
</tr>
</tbody>
</table>

Table 2: Defines the acceptance thresholds for each type of MSA

<table>
<thead>
<tr>
<th>Method</th>
<th>Feature Category</th>
<th>Critical</th>
<th>Major</th>
<th>Minor</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤10% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Based on total tolerance.</td>
</tr>
<tr>
<td>Accuracy ratio**</td>
<td>Requirement = 10:1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Values up to 4:1 may be acceptable when approved by the purchaser</td>
</tr>
<tr>
<td>Accuracy Error / Bias</td>
<td>≤10% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Purchase requirements may override this.</td>
</tr>
<tr>
<td>Repeatability</td>
<td>≤10% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Purchase requirements may override this.</td>
</tr>
<tr>
<td>Gauge R&amp;R</td>
<td>≤10% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Purchase requirements may override this.</td>
</tr>
<tr>
<td>Computer driven measurement systems correlation</td>
<td>≤10% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Purchase requirements may override this.</td>
</tr>
<tr>
<td>Linearity**</td>
<td>≤1% of total tolerance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Only required on operator dependent interpretation.</td>
</tr>
<tr>
<td>Attribute study: pass/fail</td>
<td>Kappa &gt; 0.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Only required on operator dependent interpretation.</td>
</tr>
<tr>
<td>Attribute study: ordinal</td>
<td>ICC &gt; 0.75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Only required on operator dependent interpretation.</td>
</tr>
</tbody>
</table>

*A: When required by the customer
** For equipment that requires programming e.g. CMII
*** Unless additional methods are required by the customer.
AS13003
MSA
implementation

Measurement System Analysis deployment
Anthony Hartwig Customer Quality Manager
Mecachrome FRANCE
MECACHROME COMPANY OVERVIEW

- 3000 employees worldwide
- Locations France / Canada / Portugal / Tunisia Morocco / Potential Development in USA
- 400 Millions Euros in 2018
- Aerostructure / Aeroengine / Energy Space & defence / Automotive Sport Automotive
- 1000+ suppliers & sub-contractors
- Since 1937: Knowledge and innovation of our teams at the service of our customers for profitable growth
A multisectoral know-how – Our Customers

AEROSTRUCTURE

56% OF REVENUE 2017

AEROMOTOR

20% OF REVENUE 2017

AUTOMOTIVE

19% OF REVENUE 2017

ENERGY, SPACE & DEFENCE

5% OF REVENUE 2017
Before MSA:

- Measurements systems choice and use based on historical industrial best practices.
- Pillar was the regular calibration.
- Data reliability linked to employees skills.
- Reoccurring discussions on data’s reliability.
• Mecachrome has decided to go on MSA implementation

• Inspection, Quality, Master Black Belt, Engineering, all operational people including customers were involved on the MSA implementation
  – Several months for the basis of our internal process.
  – Ongoing discussion with our customers
  – Key activities: agreement with customers & internal minds change process.
    i.e.: Agreements for CMM on numbers of repetitions: mini 3 dynamics + 2 statics
Developing pragmatical approach on “classical devices”. We have more than 10000 of classical devices (just for Aubigny plant).

Not realistic to do R&R studies on each use. National standards applied to create choices matrix.

For adapted classical devices we apply R&R Study and sometimes this gave some surprises i.e. Results above 113%, so complete design was reviewed.
What Results did we get?

- MSA allowed us to identify issues which weren’t seen by “basic calibration” → variability root causes. i.e:
  - broken pin on tooling
  - design not efficient
- CMM is not capable to measure small diameters
- Last but not least: we can trust on our measurements when Gauge R&R is acceptable
Insights

• What did we learn about the MSA deployment
  – Perform continuously
  – Face skilled people reaction, “why changing what we do since decades” ?
  – Lead with a multi functional team
  – Adapt internal communication. “It is a useful tool not another thing to satisfy customers”
  – Share openly with customers
AS13003 Measurement Systems Analysis

Success Factors

• The goal is to make sure that every measurement system (gage + outside influences) used is **Fit for Purpose**

• 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;
Nous saluons le retour
(Welcome Back)

How to Effectively Deploy Defect Prevention Methods in the Aero Engine Supply Chain
Case Study

AS13006 Process Control Methods

Pete Teti
Product & Process Validation Fellow
Pratt & Whitney

Nauset Light Beach, Cape Cod, Eastham, MA (2017)
- Processes must be controlled to maintain stability and capability
- Using statistical concepts, processes can be managed to prevent defects
- Statistical Process Control is required for Key Characteristics but should also be considered for
  - Characteristics with marginal or poor capability
  - Visual inspection operations
- SPC allows variation to be identified, controlled and reduced.
- The best form of Process Control is Error Proofing
- There are a range of Process Control methods available to suit all process types
Process Control Methods Guidance Materials

- Practical information to support the implementation of Process Control:
  - Benefits of process control
  - Overcoming resistance
  - Details on Process Control methods
  - Various control charts applications
  - Calculating process capability
  - Managing non-normal data
  - Associated formulas
- Case studies based on aerospace applications
- Assessment Checklist provides a method to measure the maturity of Process Control application within the business
- Defined Training Syllabus to help identify suitable courses to support deployment
AS13006 Case Study

Boguslaw Bac
Quality Director
Pratt & Whitney Kalisz

Agnieszka Kryściak
Manager, Part & Process Approval
Pratt & Whitney Kalisz
Check this box if presentation contains “no technical data” OR summarize the export classifications of all slides in this presentation as instructed below:

Instructions: Box 1 and one (1) of boxes 2-5 must always be completed

<table>
<thead>
<tr>
<th>Classification:</th>
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<tbody>
<tr>
<td>1. Canadian ECL(s):</td>
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<td>2. ECCN(s) (EAR):</td>
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<td>3. P-ECCN(s):</td>
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<tr>
<td>4. USML (ITAR):</td>
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<tr>
<td>5. P-USML:</td>
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PRATT & WHITNEY IN POLAND

P&W Kalisz

P&W Tubes

P&W Aero Power

P&W Rzeszów

PW 1000

PW 800

APS 5000

Airbus A320 NEO

Gulfstream 500

Boeing 787
# PRATT & WHITNEY KALISZ

<table>
<thead>
<tr>
<th>Produces</th>
<th>1550 P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Land</td>
<td>150 000 sqm</td>
</tr>
<tr>
<td>Buildings (production &amp; offices)</td>
<td>40 000 sqm</td>
</tr>
<tr>
<td>Sales</td>
<td>185 M USD</td>
</tr>
<tr>
<td>Employment</td>
<td>1608</td>
</tr>
</tbody>
</table>

### Customers:
- Pratt & Whitney East Hartford
- Pratt & Whitney Canada
- Pratt & Whitney Rzeszów
- Collins Aerospace

### Production Items:
- **Bevel Gears**
- **Stators**
- **Main Shaft**
- **Carrier**
- **Input Coupling**
- **Carrier FDGS**
- **BH#4 NEO**
- **SMP**

### Plants:
- **Plant 1**
- **Plant 2**
- **Plant 3**
- **Plant 4**
PRATT & WHITNEY KALISZ NGPF ENGINE CONTENT

- Input Coupling
  - Plant 3

- Fan Shaft
  - Plant 3

- Front hub
  - Plant 2

- Torque Frame
  - Plant 3

- Carrier
  - Plant 3

- Journal Pin
  - Plant 1

- ADT & Wind mill gears
  - Plant 1

- Small Machining Parts
  - + Bearing housing
  - Plant 4

- TIE Shaft
  - Plant 3

- Cupling nuts
  - Plant 2

FDGS components

EXPORT CLASSIFICATION: NO TECHNICAL DATA
INTRODUCING NEW PRODUCT

Spring Bearing PW 1000 engine for A320 NEO

Challenges during product implementation:

- Assuming quick implementation
- Low cost = zero defects
- Thin-walled part and no experience in machining titanium parts
- PPAP full approval expectation

Implementation of AS 13006 with associated AS 13004:

- Proactive process control
- Identification of Key Characteristics
- Selection of appropriate process control tools
- Based on Foundational Activities (making process control achievable)
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OUTSIDE DIAMETER CONTROL EXAMPLE

PROCESS FLOW

PFMEA

CONTROL PLAN

OUTSIDE DIAMETER CONTROL

TURNING OPERATION

SHOT PEENING OPERATION

OUTSIDE DIAMETER DEFORMATION

HIGH RPN

KEY CHARACTERISTIC

OUTSIDE DIAMETER DEFORMATION EXAMPLE
OutsSide Diameter Control Example

AS 13006 Scope

Product Capability

Process Control Methods

Supporting Foundational Activities

SAE International AS 13006 (2018, September) Figure 1 – Process control overview
PRATT & WHITNEY KALISZ

OUTSIDE DIAMETER CONTROL EXAMPLE

- Dedicated training program for engaged parties
- Standard method along with utilization of continuous improvement tools
- TPM sessions scheduled
- Environmental factors identified and controlled
- Gauge control system in place (calibration and MSA)

SUPPORTING FOUNDATIONAL ACTIVITIES

Maintenance
Training
Environment
Standard methods
Capable Measurement
SUPPORTING FOUNDATIONAL ACTIVITIES

PRODUCT CAPABILITY

PROCESS CONTROL METHODS

AS 13006 scope

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OUTSIDE DIAMETER CONTROL EXAMPLE

SAE International AS 13006 (2018, September) Figure 1 – Process control overview
automatic offset adjustment based on tool measurement results saved on a chip

tool life time management - tool blocking after defined wear

automatic inspection of tool condition after machining

machine probing - automatic correction of tool paths based on in-process measurements

Process Control Method

Mistake Proofing

Life usage controls

SHOT PEENING

process parameters indicated by CNC program

embedded parameters control with automatic switch off

robotic arm ensuring positioning repeatability

media verification system scheduled and maintained
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OUTSIDE DIAMETER CONTROL EXAMPLE

TURNING OPERATION

SHOT PEENING

MAIN RULE

Implement data collection from production runs at the production source

CP = 1.85
CPK=1.50

CP = 1.82
CPK=0.11
SHOT PEENING:
- Fixture modification
- Process parameters change

TURNING I
- ØCD

TURNING II
- ØBP

PRODUCT CAPABILITY
- CP = 2.53
- CPK = 2.20

Capability is understood and drives improvements
Customer Benefits

• Fulfillment of project assumptions
• Customer satisfaction
• On time delivery
• PPAP full approval

Internal Benefits

Zero Nonconformance
Proactive process monitoring
Quick identification of possible source of nonconformance
FPY first pass yield

Lesson Learnt

• Implementation of process control as close as possible to production source
• Employee engagement on every step of Process Control Activities
• Results prove effectiveness of the method
1. Strive for Error-Proofing wherever possible

2. Apply SPC where it is required because of the process capability not just because it is a KC

3. Quick feedback from the process to determine if the process has changed – Process Control not Process Analysis!

4. Select the right calculation to determine Process Capability

5. Don’t forget to apply to attribute data too!

6. Ensure you have people in the organisation that are qualified in Statistical Techniques
Defect Prevention  Key Quality Tools for Zero Defects

Advanced Quality Planning & Process Control

We must focus on defect prevention. Inspection is never 100% effective.

INSPECTION CAPABILITY to AS13003
- Variable gauge repeatability & reproducibility
- Attribute agreement analysis to AS13003

MANUFACTURING CONTROLS
- Process capability
- Process must be on target with minimum variation
- Initial process capability to AS13006
- Inspection & target setting
- Audit

PROCESS CONTROL to AS13006
- Define from process & inspection
- Maintain

3D PROBLEM SOLVING

AS13000

RAISING THE STANDARD FOR QUALITY

AESQ QUALITY STANDARDS & GUIDANCE

Aerospace Engineering Supplier Quality Strategy Group

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Case Study
AS13000 Problem Solving Requirements for Suppliers (8D)

Olivier Castets
Quality Manager Components & Accessories
Safran Aircraft Engines

Brett Withington
Quality Director
Meggitt
Every body was doing Problem Solving 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
• Overview of the structure problem solving process
• Explanation of the requirements of each of the 8 Steps
• Prescriptive Template to drive standardization and learning from best practice
• 8D Check List for each step to use during problem investigation
• Standard Training Syllabus & Methods Training
• AS13000 also available in French.
Company overview – Organisation structure
Customer-focused organisation aligned to end markets

Airframe Systems
- Braking Systems
- Fire & Safety
- Power & Motion
- Avionics & Airframe Sensing
- Polymer Seals
- Fuel Systems & Composites

Engine Systems
- Flow Control
- Thermal Systems
- Engine Composites
- Engine Sensors

Energy & Equipment
- Defense Systems
- Training Systems
- Heatric
- Energy Sensors & Controls

Services & Support
- Americas
- UK & Europe
- Asia Pacific
Company overview – Our global footprint

11,000 staff worldwide

**UK**
Employees: 2,674
Sites: 9

**Rest of Europe**
Employees: 1,241
Sites: 7
Denmark, France and Switzerland

**USA**
Employees: 6,211
Sites: 23

**Rest of World**
Employees: 1,100
Sites: 6
China, Mexico, Singapore and Vietnam
Company overview – Technology
Pioneering research in differentiated technology

- Braking Systems
- Fire Protection
- Thermal Systems
- Engine Composites
- Flow Control
- Sensing & Monitoring
- Fuel Containment
- Defence Systems
- Electrical Power
- Avionics
- Training Systems
- Digital Manufacturing
Overview of problem solving activities

AS13000 – 8D problem solving

Meggitt is split into 4 customer focussed divisions supporting Airframes, Energy & Equipment, Engines, Services & Support

Divisional approaches are different based on the industry and customer approach, leading to a multi-faceted approach to problem solving

As each site has a different product / customer family, then there is a significant difference in

- The format used to report RCCA
- The depth of problem solving techniques
- The capability of the sites to effectively problem solve

This gives the central quality function difficulty in training the sites in a consistent manner
Deployment of AS13000

1. Acceptance of the standard, as a Whole Meggitt Standard
   - AS13000 was introduced by the Engines sites to the Central Quality function
   - Group Quality reviewed the standard to determine the applicability for ALL Meggitt sites

2. Systemise the Standard
   - Meggitt has been developing a “Global QMS (Quality Management System)” to standardise the use of quality tools across all divisions & sites
   - Meggitt procedure MQA-10 Control of Nonconforming outputs embedded the AS13000 standard directly into the Meggitt central procedure
   - The Meggitt 8D template MFT-4 is the AS13000 8D template

**MEGGITT PROCEDURE**

Control of Nonconforming Outputs

Company Confidential

<table>
<thead>
<tr>
<th>Document:</th>
<th>Version:</th>
<th>Function:</th>
<th>Process Owner:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQA-10 Control of Nonconforming Outputs</td>
<td>2</td>
<td>Quality Assurance</td>
<td>Group Quality Director</td>
</tr>
</tbody>
</table>

**10.0 REFERENCED DOCUMENTS**

- MQPS-12 Meggitt Product Performance Issues Escalation Procedure
- MQA-20 Documented Information Procedure
- MQA-24 Internal Audit Procedure
- Meggitt Quality Clinic and COPA training materials
- AS13000 Problem Solving Requirements for Suppliers
- AS13004 PP/MEA & Control Plan
- MQA-1 - Abbreviations and Definitions dictionary
- MFT-4 8D Template
- MFT-40 Meggitt Group Quality Alert knowledge sharing
Deployment of AS13000

3. Whole Business deployment
   - The control of NC outputs procedure resides on the Q-Pulse database, making the process accessible to ‘ALL’ staff
   - The system requires Quality leaders to accept the process for adoption into all sites
   - ALL sites are required to adopt the Global QMS within their businesses
   - Divisional leadership supports the sites in the deployment of the tool

4. Governance
   - Central quality complete internal audits of all sites against the Global QMS to ensure compliance
Results

Current situation

The deployment of the AS13000 standard is still fairly early in its deployment across Meggitt in its entirety.

Our Engines Division have taken a lead in this and are working to develop the tools to help with the wider Meggitt deployment.

The Division is responding more fully to the customer expectation of utilising the AS13xxx series of standards.

Lessons Learned

The Meggitt procedure for the Control of Nonconforming outputs has the 8D process defined, but during the construction of the process, the use of AS13004 (PFMEA) has been utilised to further strengthen the full process approach to problem solving.
### AS13000 - Example

#### D. Identify and verify Root Causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>Cause Description</th>
<th>Verifying Test</th>
<th>Result of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contamination</td>
<td>Yes/No</td>
<td>Tested</td>
</tr>
<tr>
<td>2</td>
<td>Damage</td>
<td>Yes/No</td>
<td>Tested</td>
</tr>
</tbody>
</table>

#### 4. Define Corrective Action

**Corrective Action**
- Implement corrective measures to prevent recurrence.
- Monitor the effectiveness of corrective actions.
- Report改正 prevention measures to relevant stakeholders.

#### 5. Implement Corrective Action

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Implement A</td>
<td>01/01/2020</td>
<td>01/30/2020</td>
</tr>
<tr>
<td>2</td>
<td>Implement B</td>
<td>02/01/2020</td>
<td>02/28/2020</td>
</tr>
</tbody>
</table>

---

**Notes:**
- Meggitt proprietary and confidential. No unauthorised copying or disclosure.
The adoption of the AS13000 8D is a major shift across the whole of Meggitt, with 11,000 employees this will take time, effort, and consistent messaging to implement a whole corporation change.

Some employees are sceptical, especially those that are not within sites that have the standard flown down by customers, they sometimes do not see the need or benefit.

Leadership is imperative for a global distribution and use of the tool, the leaders are setting the expectation, and then supporting the up skilling of the sites.

Making a change is difficult, but a tool that adds benefit to the business is worth investing the time and energy in deploying.
Benefits of the AS13000 8D Approach

Standardization of a well known and effective method
Not just ‘Another Problem Solving Method!’
Easy change management if your organization was already doing some sort of Root Cause Investigation
Called, accepted and prescribed by every customer
Standardization of the vocabulary around 8D (escape point, generation point…)
Standardization of the template
Problem Solving is a Team Sport!

Provide a training syllabus
Choose your training provider wisely
SAE Offer Training in AS13000 Globally
AESQ Supplier Forum
Human Factors

Catherine CATARINA-GRACA
Senior Supplier Quality Manager
Safran Aircraft Engines

Ludovic CHEVET
Lead Supply Chain & Quality Manager
Airbus
An **Airbus** takes off or lands **every 1.4 seconds**

<table>
<thead>
<tr>
<th>Orders</th>
<th>Deliveries</th>
<th>Backlog</th>
</tr>
</thead>
<tbody>
<tr>
<td>19,340</td>
<td>11,763</td>
<td>7,577</td>
</tr>
</tbody>
</table>

End December 2018
The Market

Source: Airbus GMF 2018

Air traffic doubles every 15 years

World fleet will double in the next 20 years

Airbus GMF 2018: 4.4% growth p.a.
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
Minimizing human errors in the supply chain is key toward product safety, quality and delivery.
Latent Errors

Latent Errors are the origin of most supply chain issues.
Aviation safety will continue to evolve, always putting safety of passengers first by a global understanding of humans’ behaviour and impact on work performance.
What is Human Factor?

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

Human error is not a root cause
The Dirty Dozen are primary causes of human error.
Just Culture

In your work, an error, something forgotten or bad workmanship can cause the death of one or more people. A person who makes an error must report it. An error is a repairable and pardonnable mistake, but hiding it is a crime.
Several projects within Airbus

Human Factor approach shall be reinforced in production organisations

Human Factor in Aviation Value Stream

Objects:
- Aircraft Design
- Manufacturing Supply Chain
- Maintenance
- Flight Test
- Airline Ops
- Supply Chain
- Operations

Activities:
- Human Factors
Airbus is taking active role in AESQ project which is matching Airbus strategy.

**AESQ Principles**
- Standardise
- Simplify
- Adopts Existing Industry Standards
- Prescriptive, Auditable
- 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
Take Away

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
Thank you
Let’s Talk Deployment…

Erika Grimm
Supplier Quality
GE Aviation

Helen Djäknegren
Director Global Supplier Quality & Development
GKN Aerospace
AESQ journey for proactive quality

AESQ driving unified approach to defect prevention
Elements of Effective Change Management

Mindset
- Awareness
- Strategy & Vision

People
- Commitment

Culture
Leadership
- Accountability
- QMS

Execution
- Organizational Capability
- Training

Tools
- Implementation

AESQ – Aerospace Engine Supplier Quality Strategy Group
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AESQ Deployment Tools

There are several tools currently available to suppliers to assist in your defect prevention journey … find them on our website (https://aesq.sae-itc.com/)

**Mindset:**

- **AESQ Zero Defect Video** – help your organization understand defect prevention and how the AESQ standards support that culture

- **Industry Impact Page** – see real examples of how AESQ and supplier deployment is having an impact on the industry

**Execution:**

- **Standard Guidance and Support Material** – find guidance material and templates for issued AESQ standards

- **Training Resources** – see a list of providers that offer training for each AESQ standard
CLOSING REMARKS

Ian Riggs  
Global Quality Executive  
Rolls-Royce Civil Aerospace

Barbara Negroe  
Executive Sourcing Quality Leader  
GE Aviation
A380 Final Assembly Line Tour Logistics

<table>
<thead>
<tr>
<th>Time</th>
<th>Group 1 Description</th>
<th>Time</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30</td>
<td>Coach pick up at <strong>Radisson Blu Hotel</strong> Toulouse Airport</td>
<td>10:00</td>
<td></td>
</tr>
<tr>
<td>08:45</td>
<td>Coach Arrives at Museum Aeroscopia (you may store luggage at Museum)</td>
<td>10:15</td>
<td></td>
</tr>
<tr>
<td>09:00</td>
<td>Tour start A380 FAL Professional Tour by Manatour</td>
<td>10:30</td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td>Tour Ends</td>
<td>11:30</td>
<td></td>
</tr>
<tr>
<td>10:15</td>
<td>Coach takes Group back to the Radisson Blu Hotel</td>
<td>11:45</td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td>Arrive at Hotel</td>
<td>12:00</td>
<td></td>
</tr>
</tbody>
</table>
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Reflections on the Day
Thank You for Attending

Please Return Home Safely