AESQ STRATEGY GROUP™
A Program of SAE ITC

WELCOME TO THE
AESQ SUPPLIER FORUM

HOSTED BY
PRATT & WHITNEY

10 April 2019
Hartford, Connecticut, USA

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

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

WELCOME FROM

PRATT & WHITNEY

JILL M. ALBERTELLI

VICE PRESIDENT, QUALITY
PRATT & WHITNEY

GO BEYOND

AESQ SUPPLIER FORUM – PRATT & WHITNEY KICKOFF

JILL M. ALBERTELLI
VICE PRESIDENT, QUALITY

APRIL 10, 2019

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

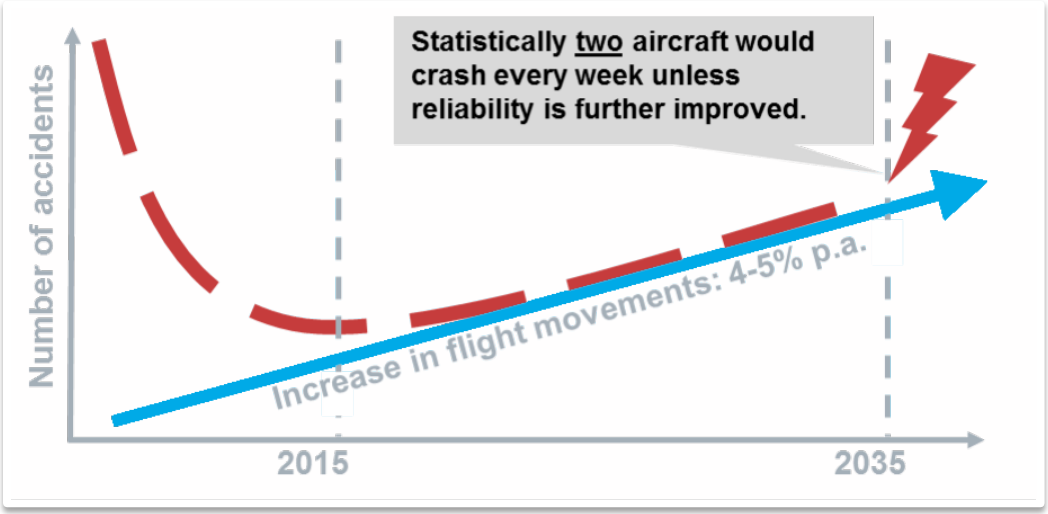
23,000 active aircraft in 2016

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!



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

Scenes on board (Photo: Jared West):

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.

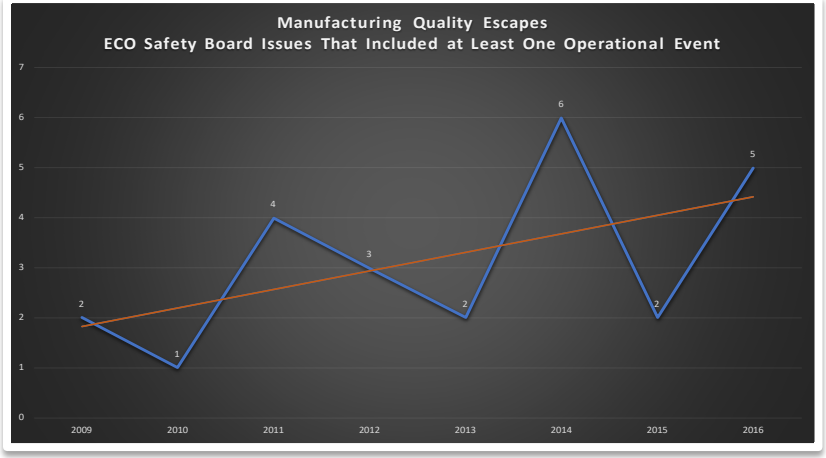
On Jan 21st 2016 the NTSB released their final report: The probable cause of the engine failure and subsequent undercowl engine fire was due to the fatigue fracture of a high pressure turbine stage 2 disk blade retaining lug that released two blades which impacted the low pressure turbine case causing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

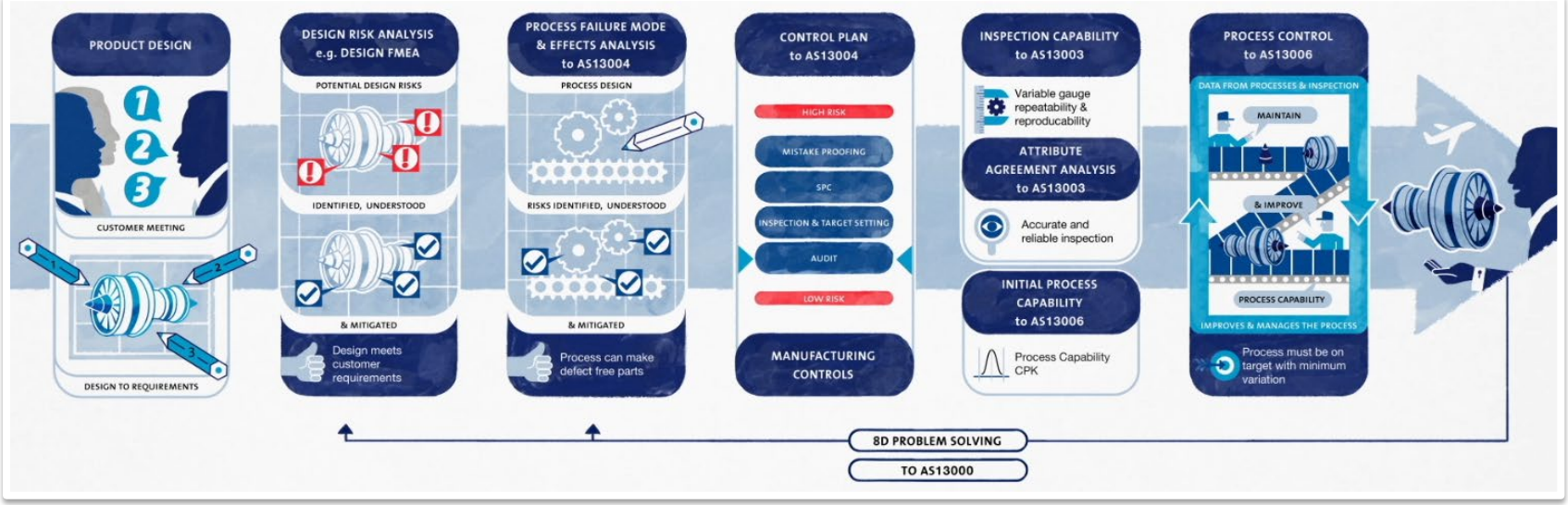
- Create common standards within the engine manufacturers (OEM's) in regard to quality
- Deploy together the written standards throughout our supply chain
- Establish capable quality processes and a culture of continuous improvement

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

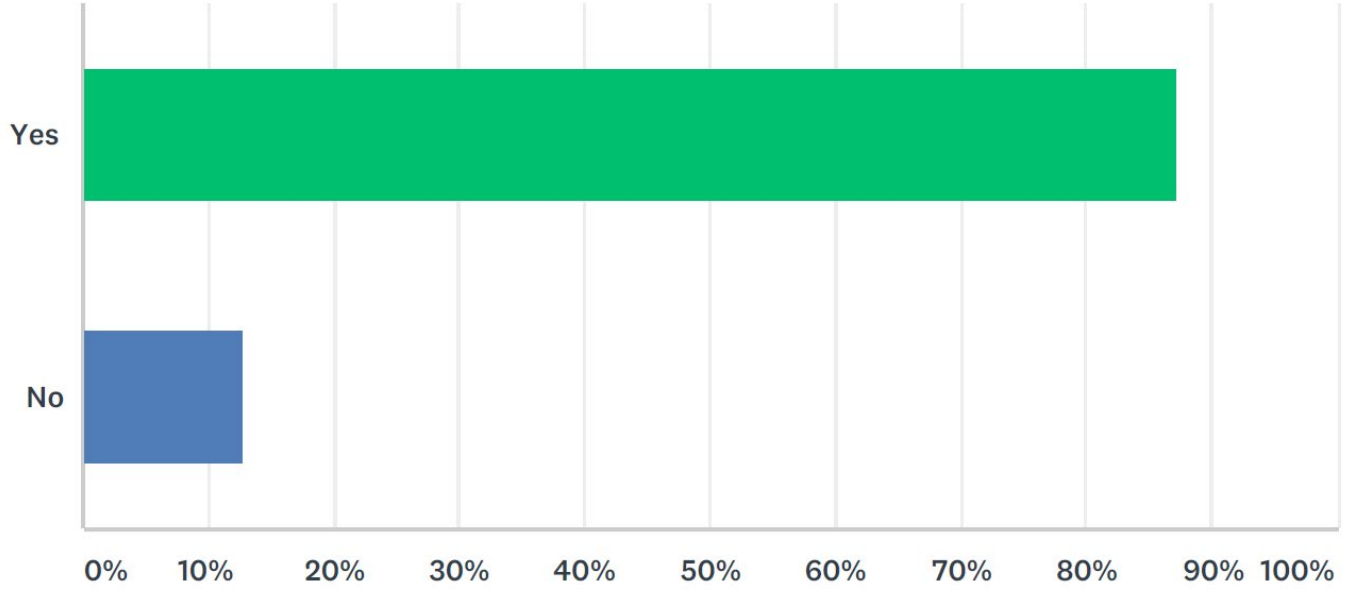
AS13000, AS13001, AS13002, AS13003, AS13004 have all been flowed down by all AESQ members and are part of **your** Purchase Order.

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

SUPPLIER SURVEY RESULTS

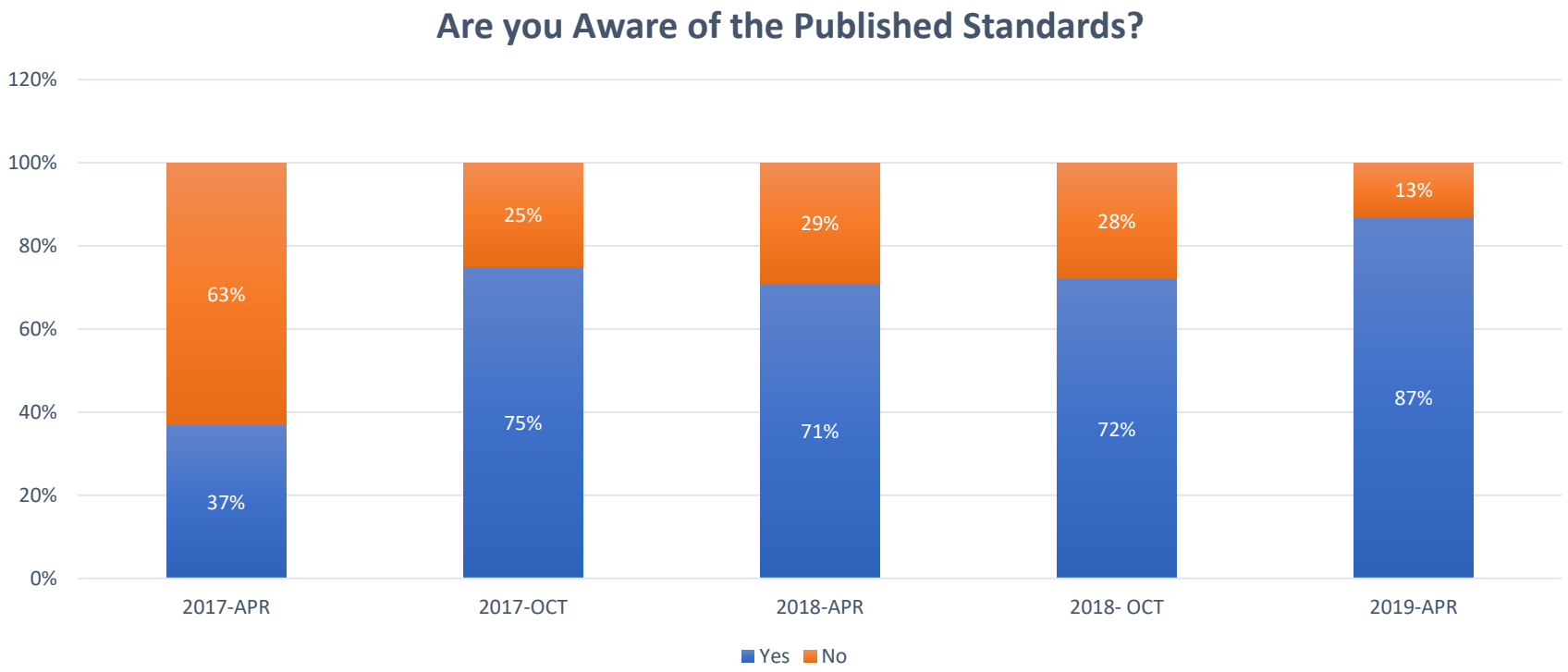
OLIVIER CASTETS
SAFRAN

Are you Aware of the Published Standards?

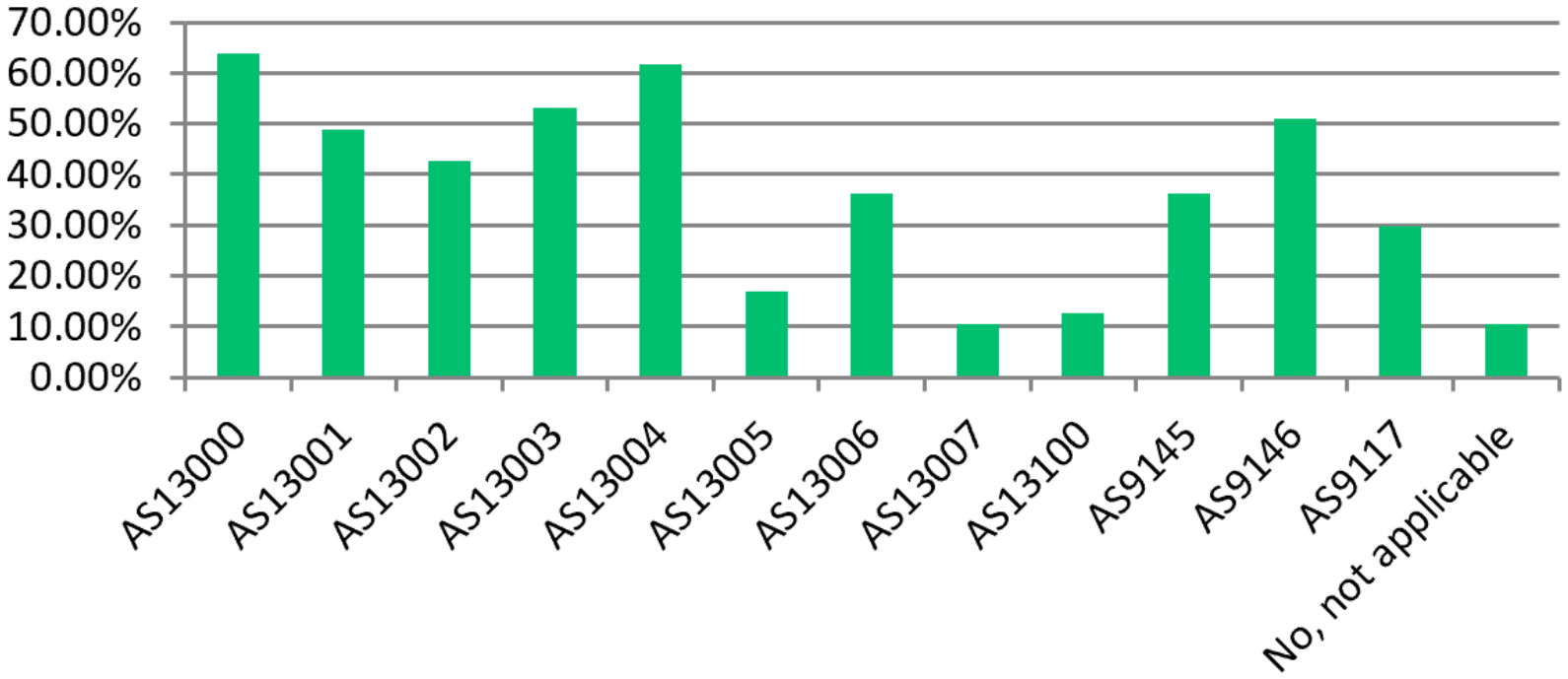


We still have some work to do

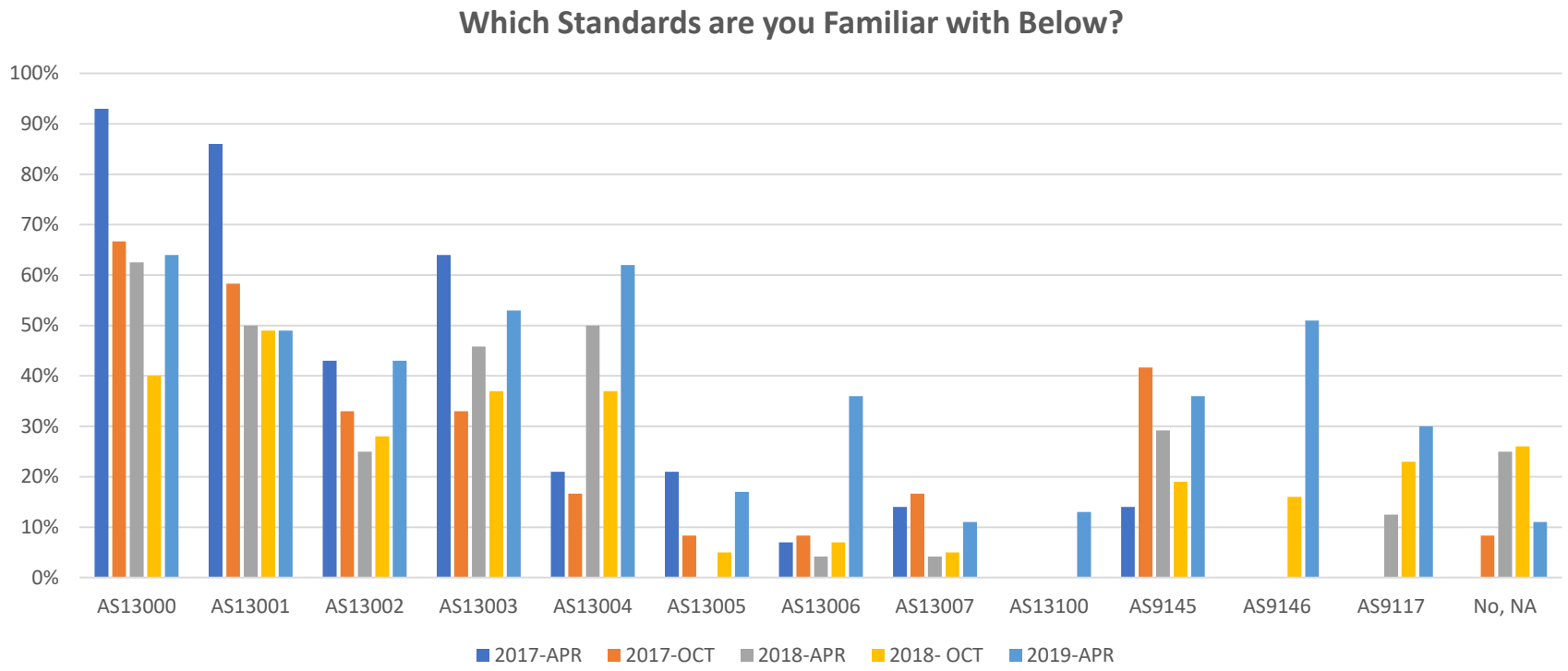
Are you aware of the published standards?



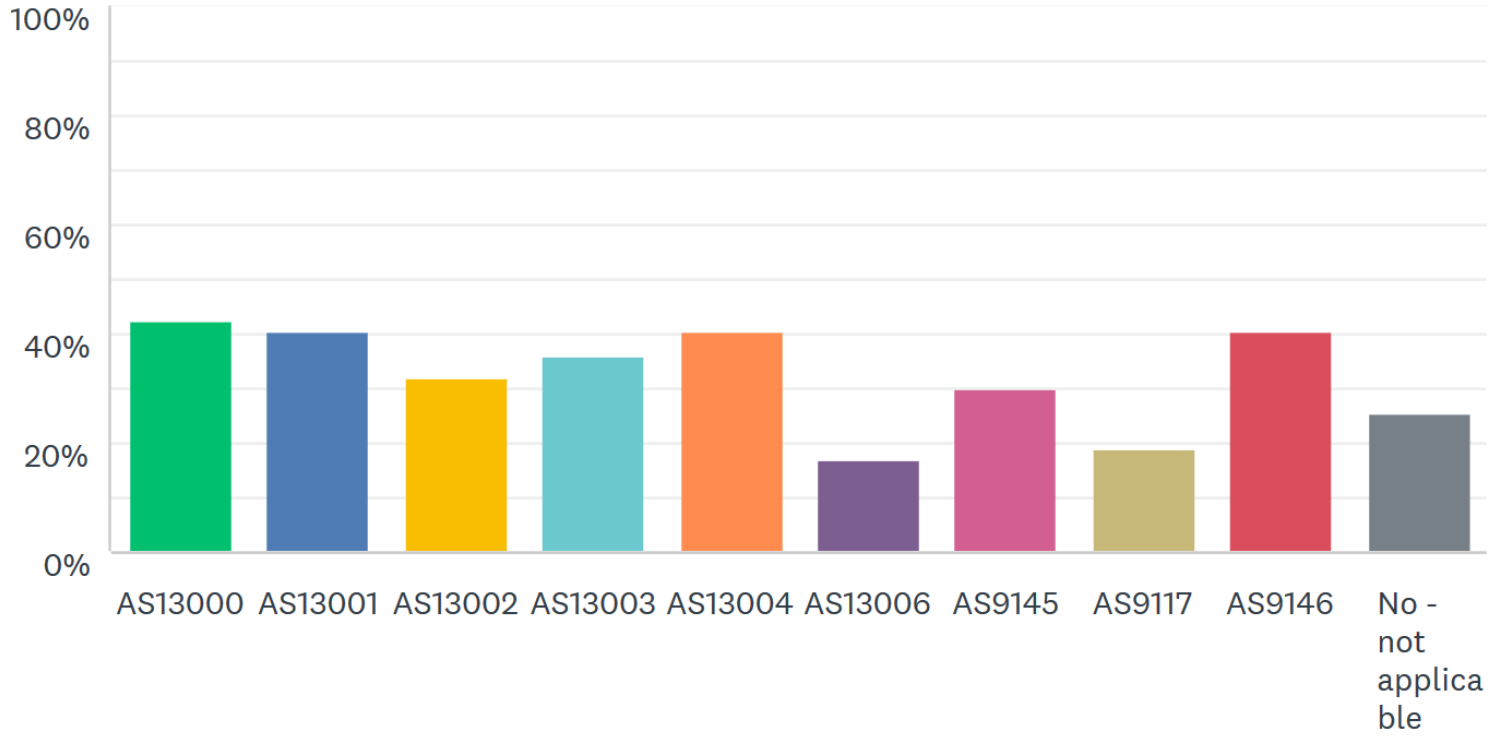
Which Standards Have You Heard Of?



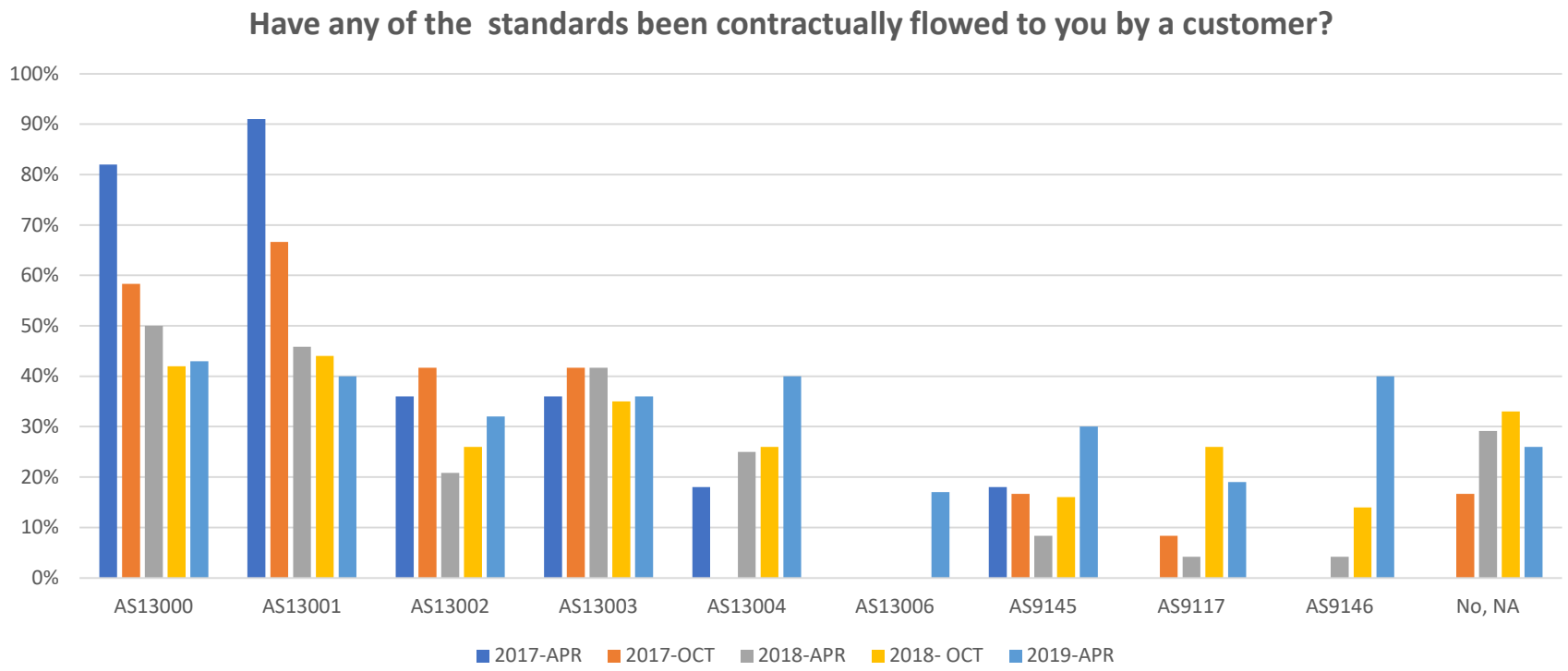
Which standards are you familiar with?



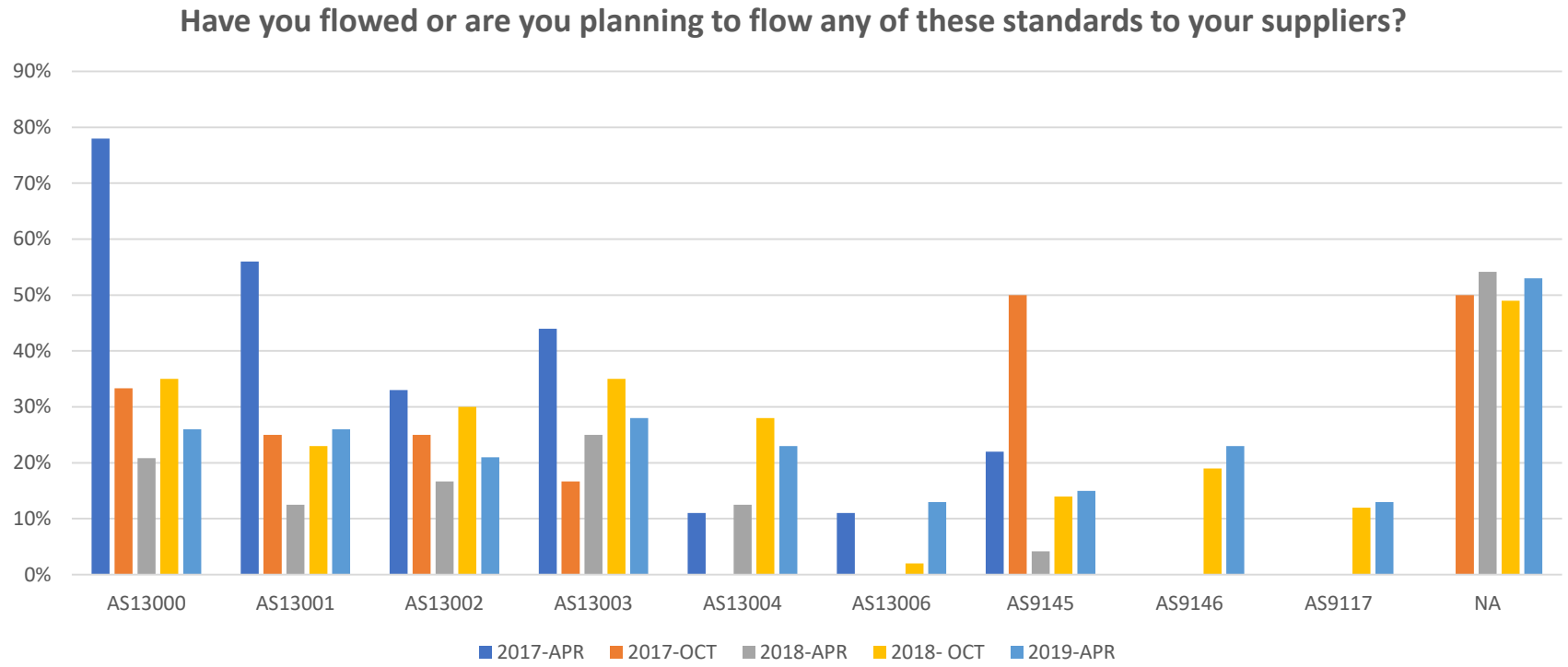
Which Standards are in YOUR Contracts?



Have any of the standards been contractually flowed to you by a customer?



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

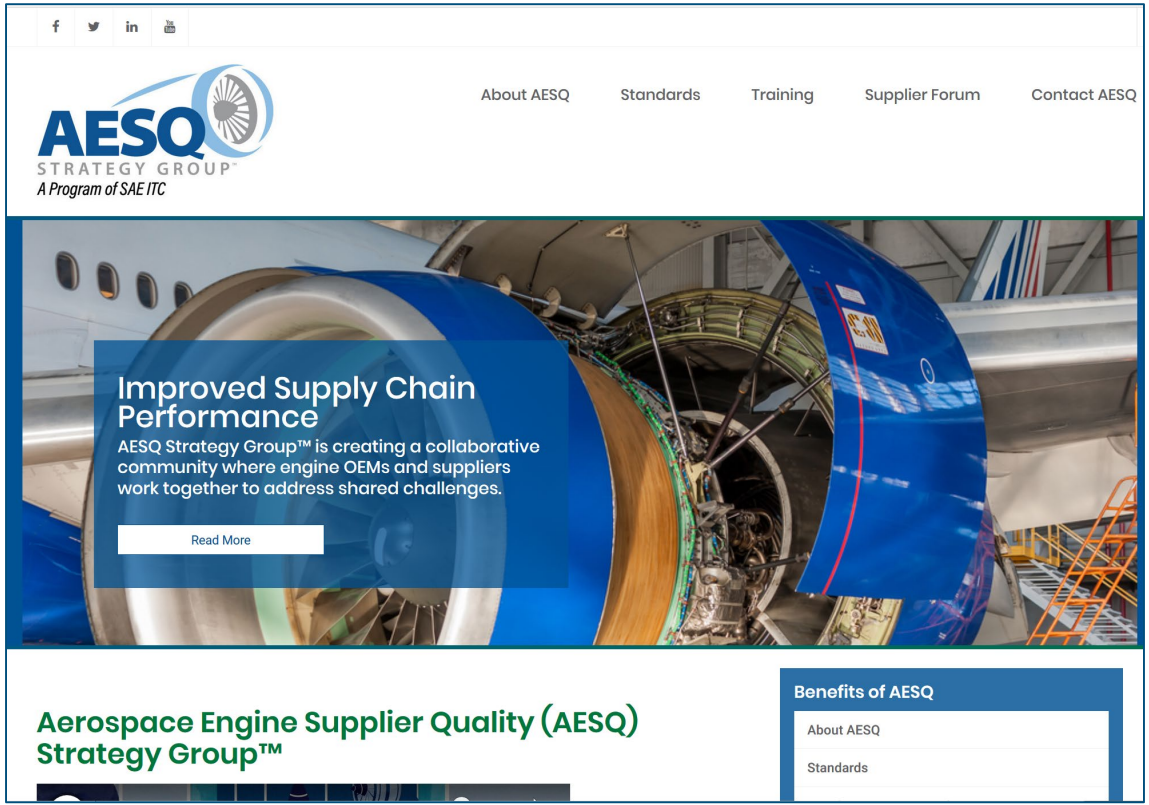
AS13004 PFMEA & Control Plans	Ian Riggs, Rolls-Royce Nick Streppa, GKN
AS13003 Measurement System Analysis	Martin Schaeffner, MTU Christopher Vest, Parker Hannifin
AS13006 Process Control Methods	Pete Teti, Pratt & Whitney Eric Schneider, Birken Jason Bronson, Birken
AS13002 Inspection Frequency	Larry 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

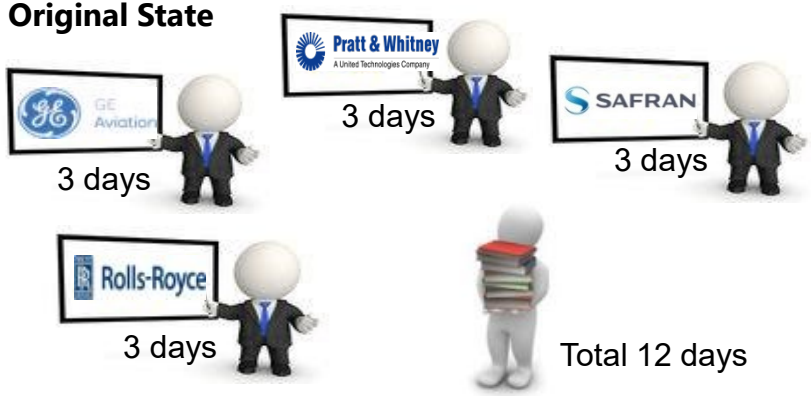
AESQ Standards - Global Deployment Status

	AS13000 Problem Solving Requirements for Suppliers	AS13001 DPRV	AS13002 Developing and Qualifying Alternate Inspection Frequency Plans	AS13003 Measurement Systems Analysis Requirements for	AS13004 Process Failure Mode and Effects Analysis (PFMEA) and Control Plans	AS13006 Process Control Methods
AESQ Member	**Accepted**	**Accepted**	**Accepted**	**Accepted**	**Accepted**	**Accepted**
Arconic (P&P)	May-15	Feb-16	May-17	Mar-16	Aug-17	Sep-18
GE	May-14	Oct-14	Jan-15	Jan-16	Aug-17	Sep-18
GKN	Jun-14	Mar-15	Apr-15	Mar-15	Aug-17	Sep-18
Honeywell	Jan-16	Mar-15	Oct-15	Jan-16	Aug-17	Sep-18
MTU	Aug-15	Jan-16	4Q16	Jan-16	Aug-17	Sep-18
PCC Structurals	Mar-15	Jan-15	May-15	Jun-16	3Q 18	Sep-18
Pratt & Whitney	Jan-15	Mar-15	Apr-15	Mar-15	Aug-17	Sep-18
Rolls-Royce	Dec-14	Oct-15	Jan-15	Jan-15	Aug-17	Sep-18
Safran	Jan-15	Jan-15	Jan-15	Jan-15	Aug-17	Sep-18

AS13001 Delegated Product Release Verification Training

AESQ STRATEGY GROUP
A Program of SAE ITC

Original State



Future State

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

AESQ Principles

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

Expected Benefits

- Reduced costs for customers & suppliers
- Reduced training time for DPRV personnel
- Training provided in region of DPRV personnel
- Customer training limited to on-site

* *Rev A aligns with AS9117 - DPRV*

SAE INTERNATIONAL

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

AS13004 Process FMEA & Control Plan – HIGHLIGHTS

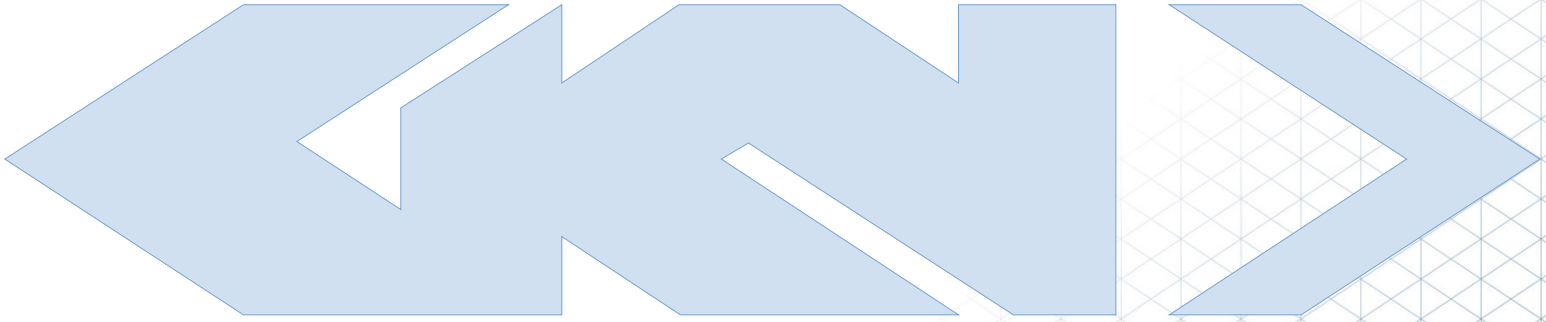
1. Required for ***EVERY*** part number*
2. ***ALL*** Process Steps (those that transform the product)
3. ***EACH*** design feature / characteristic must be included
4. PFMEA Failure Modes that describe how the ***PRODUCT*** can fail to meet ***DESIGN INTENT***
5. Created by a ***CROSS FUNCTIONAL TEAM***
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

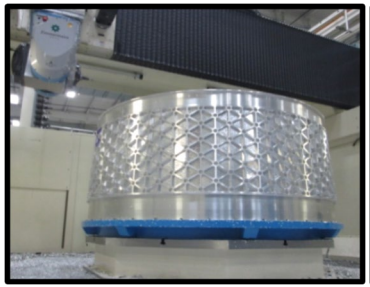
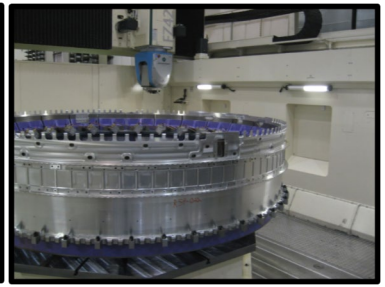
GKN Newington



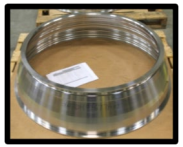
Newington, Connecticut - USA

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


Large Fan Cases

Semi finished LPT Cases

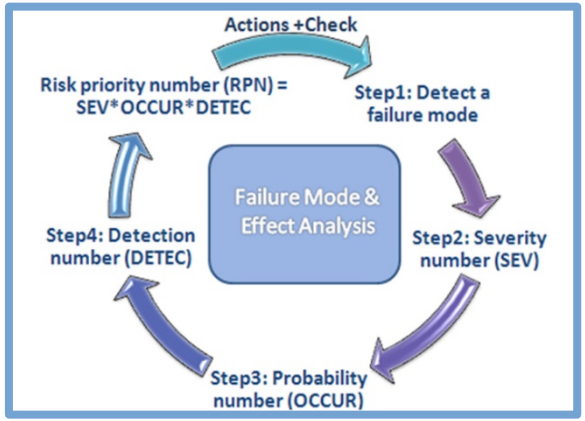
Intermediate Cases

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

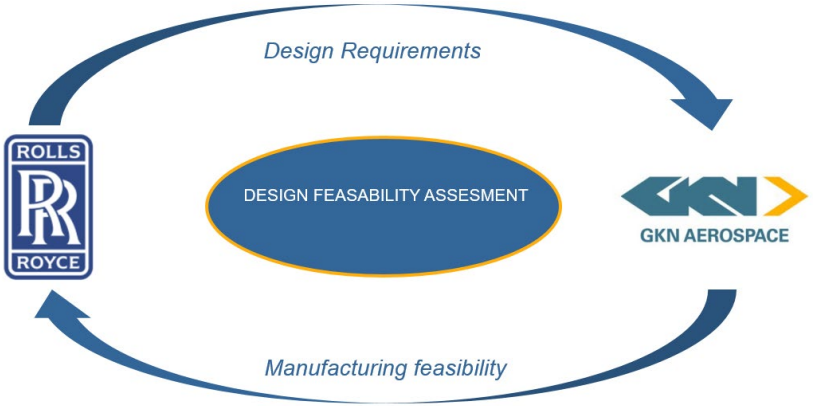


Elements of Process Flow:

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

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



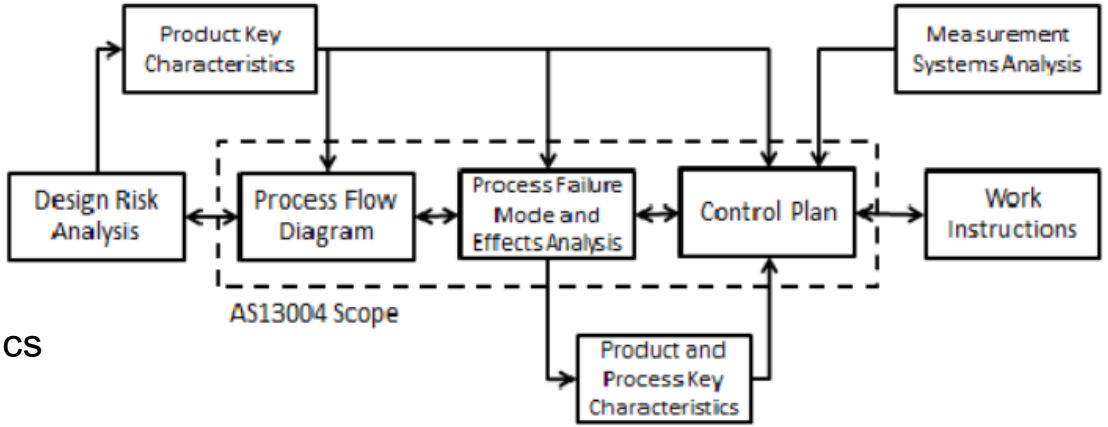
Control Plans

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

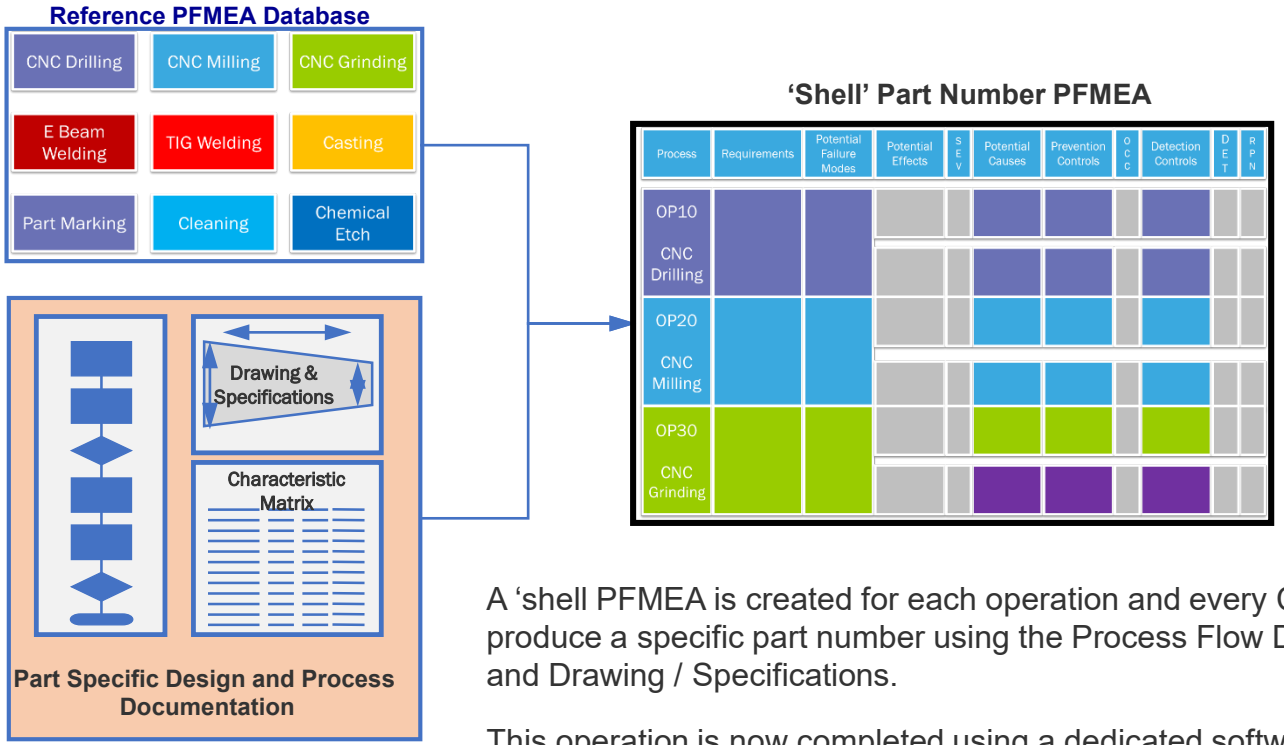
What they are
&
How to use them

What is a Reference PFMEA?

Process	Requirements	Potential Failure Modes	Potential Effects	SEV	Potential Causes	Prevention Controls	OCC	Detection Controls	DET	RPN
OP10 CNC Drilling	Drill **FUEL** Hole 50mm Diameter +/- 1.0 mm	Hole too Big	Fuel leak leading to explosion	9	Oversize tool	Tool pre-setting	4	Bore mic at OP 50	7	252
			Scrap part	6	Spindle alignment error	Asset Care & Calibration	3	Weekly ball bar check	8	216
OP20 CNC Drilling	Drill **AIR** Hole 50mm Diameter +/- 3.0 mm	Hole too Big	Slight increase in noise level	3	Oversize tool	Tool pre-setting	2	Bore mic at OP 50	7	56
			Concession	4	Spindle alignment error	Asset Care & Calibration	1	Weekly ball bar check	8	32

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

Process	Requirements	Potential Failure Modes	Potential Effects	SEV	Potential Causes	Prevention Controls	OCC	Detection Controls	DET	RPN
OP10 CNC Drilling	Drill Fuel Hole 50mm Diameter +/- 1.0 mm	Hole too Big	Fuel leak leading to explosion	9	Oversize tool	Tool pre-setting	4	Bore mic at OP 50	7	252
			Scrap part	6	Spindle alignment error	Asset Care & Calibration	3	Weekly ball bar check	8	216
OP10 CNC Drilling	Drill Air Hole 20mm Diameter +/- 3.0 mm	Hole too Big	Slight increase in noise level	3	Oversize tool	Tool pre-setting	2	Bore mic at OP 50	7	56
			Concession	4	Spindle alignment error	Asset Care & Calibration	1	Weekly ball bar check	8	32

Additions and subtractions

Additions and subtractions

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!

How long did it take to do 10 Characteristics?

How long would it take to do 100 Characteristics?

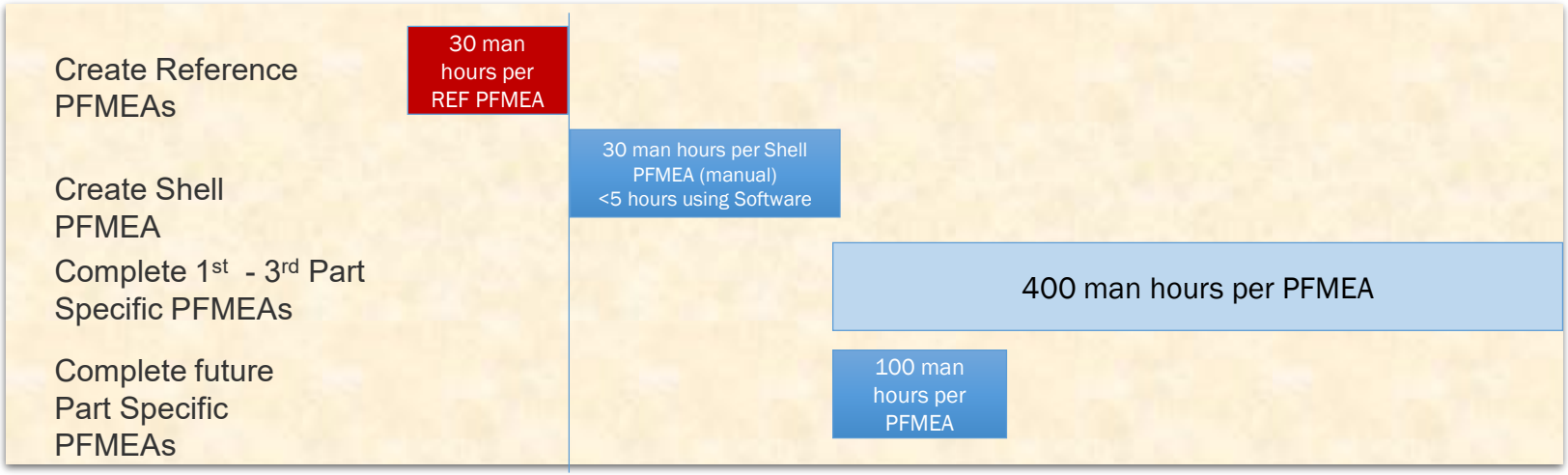
How long for 1,000?

How long would a Computer take?

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 does it take?



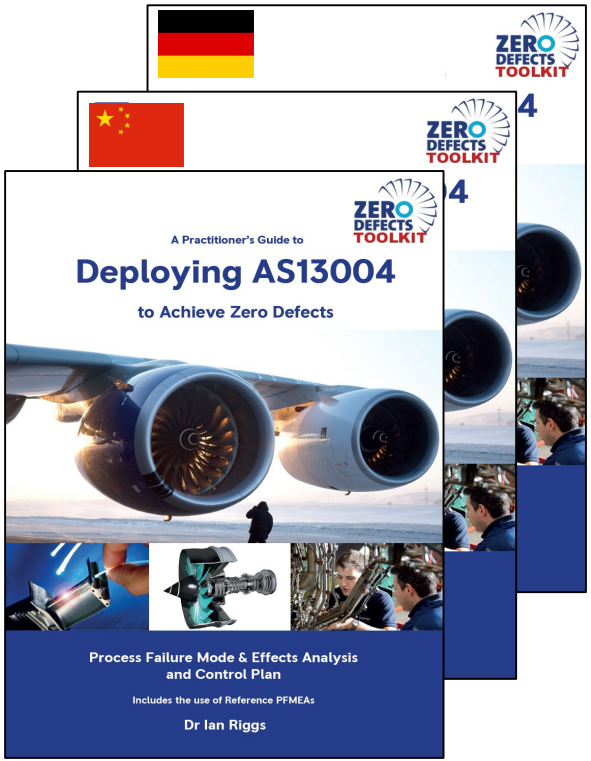
Estimates are for a medium complexity part (1000 Characteristics)

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

AS13004 Process FMEA & Control Plan – SUCCESSES

AS13004 TRANSFORMING QUALITY PERFOMANCE!

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

Method	Feature Category			
	Critical	Major	Minor	
Resolution	≤10% of total tolerance ***			
Accuracy ratio**	Requirement = 10:1		Requirement 4:1	
Accuracy Error / Bias	≤10% of total tolerance			
Repeatability	≤10% of total tolerance	≤20% of total tolerance	≤30% of total tolerance*	Purchaser requirements may override this
Gauge R&R	≤10% of total tolerance	≤20% of total tolerance	≤30% of total tolerance*	Purchaser requirements may override this
Computer driven measurement systems correlation	≤10% of total Tolerance		≤20% of total Tolerance	Purchaser requirements may override this
Linearity**	≤1% of total tolerance		-	
Attribute Study: pass/fail	Kappa ≥ 0.8		-	Only required on operator dependent interpretation
Attribute study: ordinal	ICC ≥ 0.75		-	Only required on operator dependent interpretation

AESQ Principles

- [x] Standardise
- [ ] Simplify
- [x] Adopts Existing Industry Standards
- [x] Prescriptive, Auditable
- [x] Common Language
- [x] 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

AESQ STRATEGY GROUP™
A Program of SAE ITC

PARKER HANNIFIN – AEROSPACE
GAS TURBINE FUEL SYSTEMS TECHNOLOGY

Chris Vest
Director of Quality
Mentor, OH

AS13003

Problem Statement:

How do we ensure proper inspection methods are utilized relative to accuracy and adequacy?

AS13003 – Measurement System Analysis

Parker Aerospace Approach:

EVERY FEATURE, EVERY PART

- Each feature is unique in it's 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

AS13003 – Measurement System Analysis

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

AS13003 – Measurement System Analysis

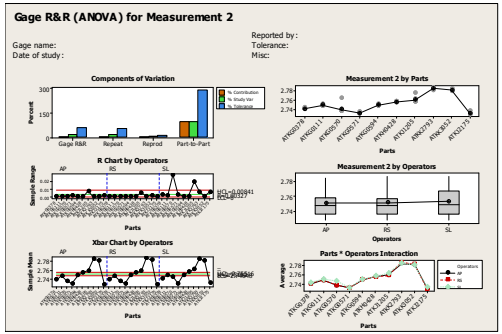
Benefits:

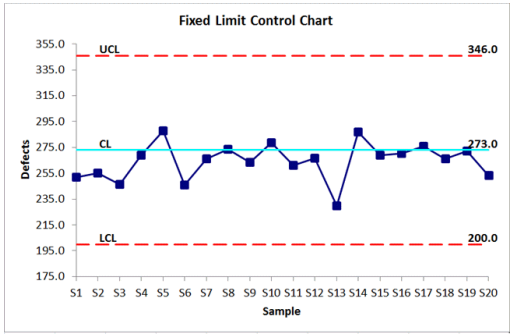
- Reduced rejections downstream
    - Accept/Reject agreement over 99%
- Allowed for validation of new automated inspection devices
- Reduced customer rejections
    - Protected customer from gauge with 28% R&R
- Confidence with operators and data for SPC
- Reduced human factors

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:





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

Future State

Common standard & approach Aligned with AS13002, 13003, 13004, AS9103, AS9145 & AIAG "Blue Books"

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

AESQ Principles

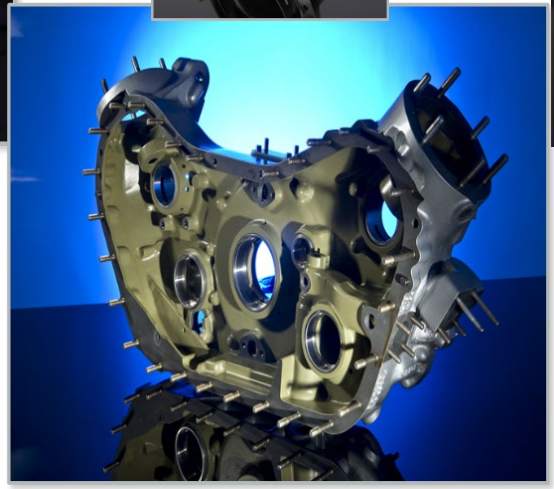
- ☑ Standardise
- ☑ Simplify
- ☑ Adopts Existing Industry Standards
- ☑ Prescriptive, Auditable
- ☑ Common Language
- ☑ Supported by 3rd Party Training & Consultancy

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

COMPANY OVERVIEW

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.



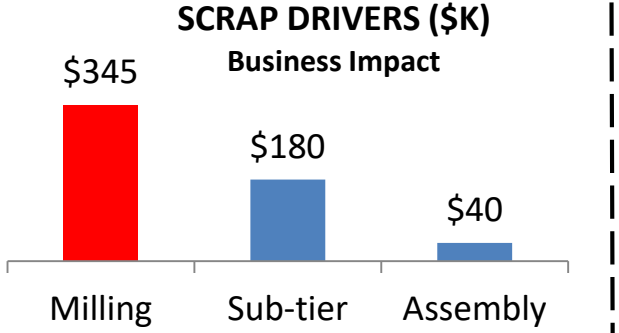
PROBLEM STATEMENT

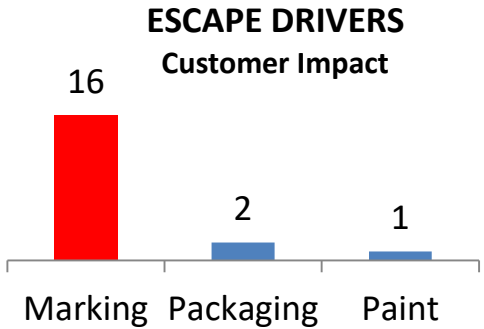
*Using the tools of PFMEA and Process Control Methods, work to improve Birken's quality performance by eliminating high **M**illing scrap costs and Part **M**arking escapes to our Customers occurring over last several years*

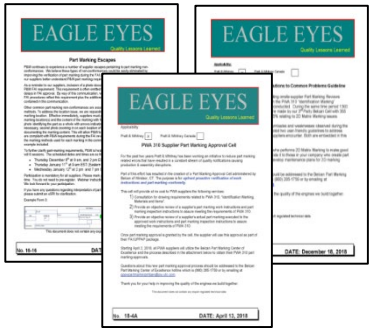
Milling & Marking
We're the M & M Team!!

Approach

Problem Identification



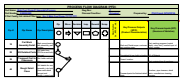




Problem Resolution

AS13004
PFMEA and Control Plans

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

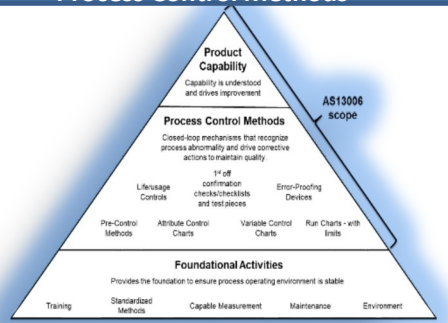


What does the process do?

What could go wrong?
Could we prevent or detect?

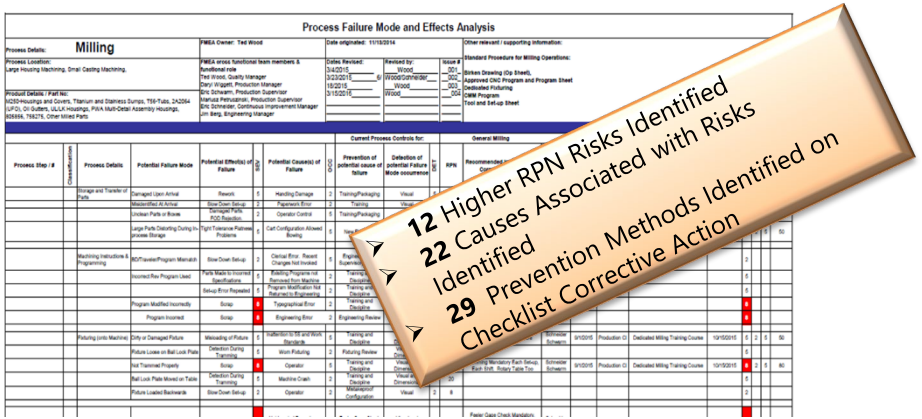
What am I supposed to do?
How am I supposed to do it?
Where am I supposed to record it?

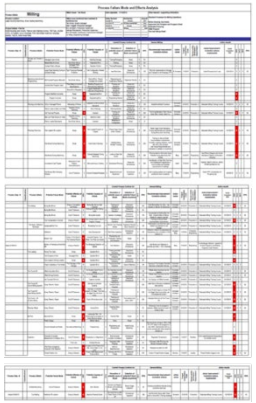
AS13006
Process Control Methods



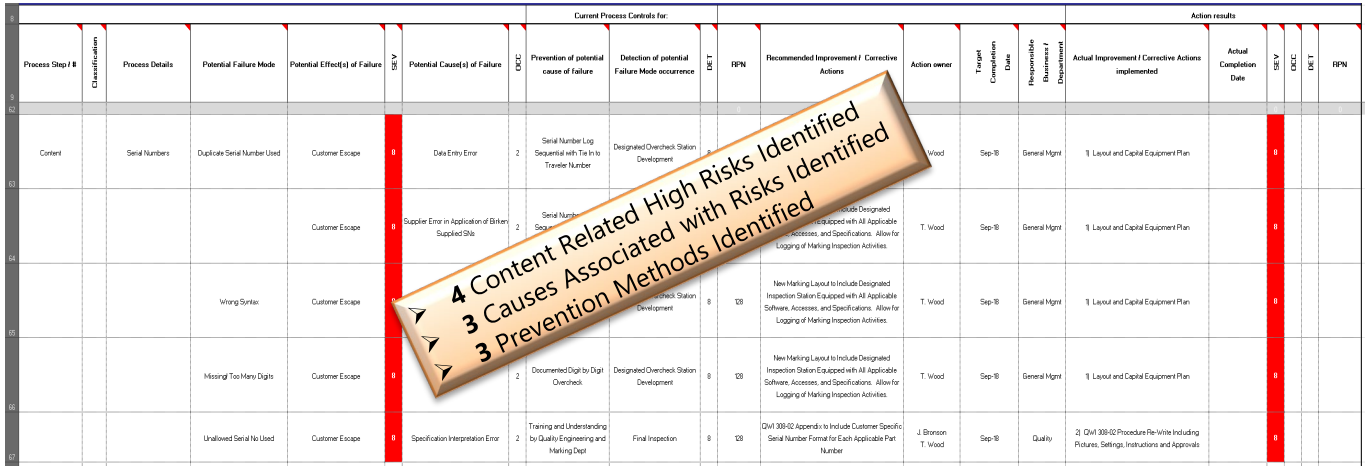
AS13004 — PFMEA AND CONTROL PLANS

MILLING



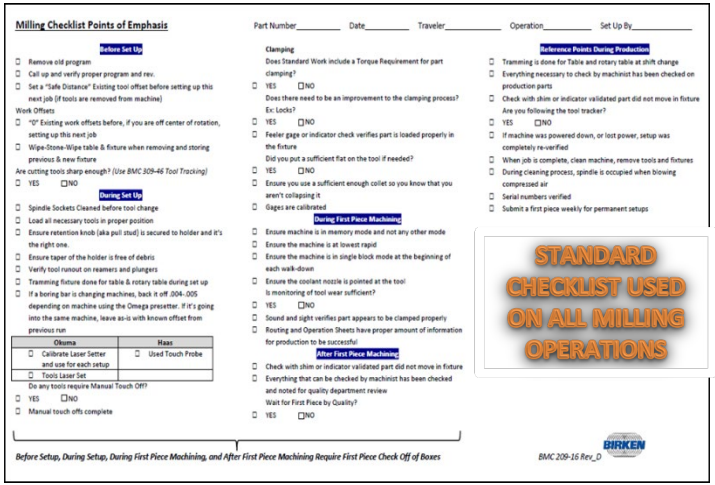


PART MARKING



AS13006 — PROCESS CONTROL METHODS

MILLING



Milling Checklist Points of Emphasis

Part Number_____ Date_____ Traveler_____ Operation_____ Set Up By_____

Before Set Up

- ☐ Remove old program
- ☐ Call up and verify proper program and rev.
- ☐ Set a "Safe Distance" Existing tool offset before setting up this next job (if tools are removed from machine)

Work Offsets

- ☐ "0" Existing work offsets before, if you are off center of rotation, setting up this next job
- ☐ Wipe-Stone-Wipe table & fixture when removing and storing previous & new fixture

Are cutting tools sharp enough? *(Use BMC 309-46 Tool Tracking)*

☐ YES ☐NO

During Set Up

- ☐ Spindle Sockets Cleaned before tool change
- ☐ Load all necessary tools in proper position
- ☐ Ensure retention knob (aka pull stud) is secured to holder and it's the right one.
- ☐ Ensure taper of the holder is free of debris
- ☐ Verify tool runout on reamers and plungers
- ☐ Tramming fixture done for table & rotary table during set up
- ☐ If a boring bar is changing machines, back it off .004-.005 depending on machine using the Omega presetter. If it's going into the same machine, leave as-is with known offset from previous run

Okuma	Haas
☐ Calibrate Laser Setter and use for each setup	☐ Used Touch Probe
☐ Tools Laser Set	

Do any tools require Manual Touch Off?

☐ YES ☐NO

- ☐ Manual touch offs complete

Clamping

Does Standard Work include a Torque Requirement for part clamping?

☐ YES ☐NO

Does there need to be an improvement to the clamping process? Ex: Locks?

☐ YES ☐NO

- ☐ Feeler gage or indicator check verifies part is loaded properly in the fixture

Did you put a sufficient flat on the tool if needed?

☐ YES ☐NO

- ☐ Ensure you use a sufficient enough collet so you know that you aren't collapsing it
- ☐ Gages are calibrated

During First Piece Machining

- ☐ Ensure machine is in memory mode and not any other mode
- ☐ Ensure the machine is at lowest rapid
- ☐ Ensure the machine is in single block mode at the beginning of each walk-down
- ☐ Ensure the coolant nozzle is pointed at the tool

Is monitoring of tool wear sufficient?

☐ YES ☐NO

- ☐ Sound and sight verifies part appears to be clamped properly
- ☐ Routing and Operation Sheets have proper amount of information for production to be successful

After First Piece Machining

- ☐ Check with shim or indicator validated part did not move in fixture
- ☐ Everything that can be checked by machinist has been checked and noted for quality department review

Wait for First Piece by Quality?

☐ YES ☐NO

Reference Points During Production

- ☐ Tramming is done for Table and rotary table at shift change
- ☐ Everything necessary to check by machinist has been checked on production parts
- ☐ Check with shim or indicator validated part did not move in fixture

Are you following the tool tracker?

☐ YES ☐NO

- ☐ If machine was powered down, or lost power, setup was completely re-verified
- ☐ When job is complete, clean machine, remove tools and fixtures
- ☐ During cleaning process, spindle is occupied when blowing compressed air
- ☐ Serial numbers verified
- ☐ Submit a first piece weekly for permanent setups

Before Setup, During Setup, During First Piece Machining, and After First Piece Machining Require First Piece Check Off of Boxes

BMC 209-16 Rev_D

STANDARD CHECKLIST USED ON ALL MILLING OPERATIONS

- ➢ 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 Reference

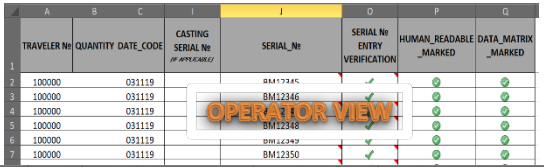
PART MARKING

ERROR PROOFING

SERIAL NUMBER LOG - P/N

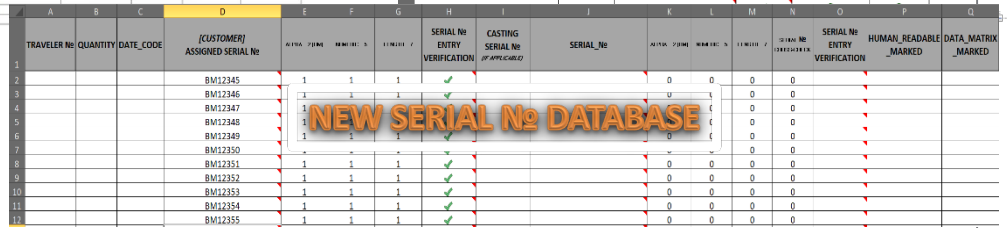
SERIAL NUMBER	TRAV#	DATE	QTY

ORIGINAL



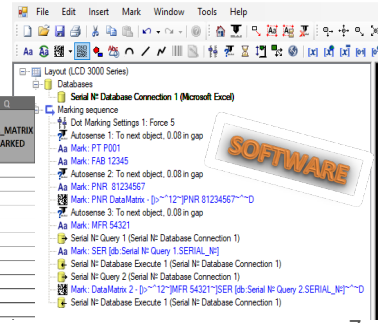
TRAVELER №	QUANTITY	DATE_CODE	CASTING SERIAL № (IF APPLICABLE)	SERIAL_№	SERIAL № ENTRY VERIFICATION	HUMAN_READABLE _MARKED	DATA_MATRIX _MARKED
100000		031119		BM12345	✓	✓	✓
100000		031119		BM12346	✓	✓	✓
100000		031119		BM12348	✓	✓	✓
100000		031119		BM12349	✓	✓	✓
100000		031119		BM12350	✓	✓	✓

OPERATOR VIEW



TRAVELER №	QUANTITY	DATE_CODE	[CUSTOMER] ASSIGNED SERIAL №	SERIAL № ENTRY VERIFICATION	CASTING SERIAL № (IF APPLICABLE)	SERIAL_№	SERIAL № ENTRY VERIFICATION	HUMAN_READABLE _MARKED	DATA_MATRIX _MARKED
			BM12345	✓					
			BM12346	✓					
			BM12347	✓					
			BM12348	✓					
			BM12349	✓					
			BM12350	✓					
			BM12351	✓					
			BM12352	✓					
			BM12353	✓					
			BM12354	✓					
			BM12355	✓					

NEW SERIAL № DATABASE



File Edit Insert Mark Window Tools Help

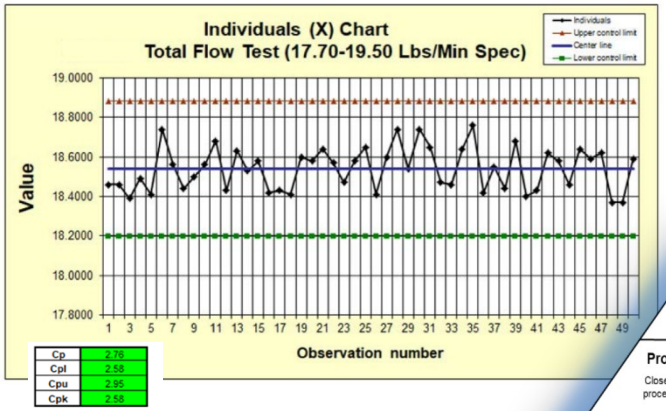
Layout (LCD 3000 Series)
Databases
Serial № Database Connection 1 (Microsoft Excel)
Marking sequence
Dot Marking Settings 1: Force 5
Autosense 1: To next object, 0.08 in gap
Mark: PT P001
Mark: FAB 12345
Autosense 2: To next object, 0.08 in gap
Mark: PNR 81234567
Mark: PNR DataMatrix - [\]>^^12^]PNR 81234567^^~D
Autosense 3: To next object, 0.08 in gap
Mark: MFR 54321
Serial № Query 1 (Serial № Database Connection 1)
Mark: SER [db: Serial № Query 1.SERIAL_№]
Serial № Database Execute 1 (Serial № Database Connection 1)
Serial № Query 2 (Serial № Database Connection 1)
Mark: DataMatrix 2 - [\]>^^12^]MFR 54321^]SER [db: Serial № Query 2.SERIAL_№]^^~D
Serial № Database Execute 1 (Serial № Database Connection 1)

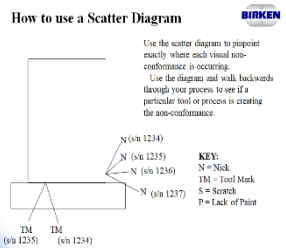
SOFTWARE

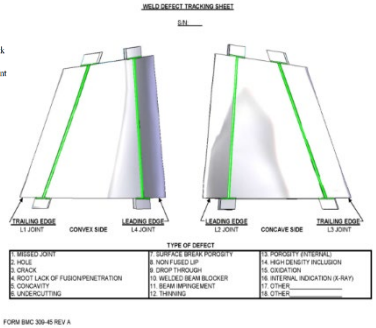
- ➢ Incorporates Serial № Entry Verification
- ➢ Incorporates Duplicated Entry Check
- ➢ Incorporates Illegitimate Serial № Check

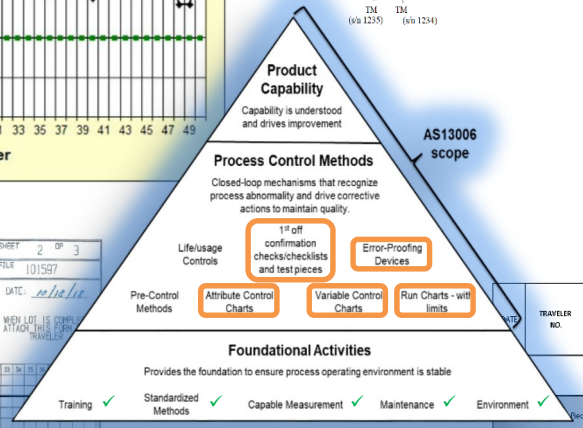
AS13006 — PROCESS CONTROL METHODS

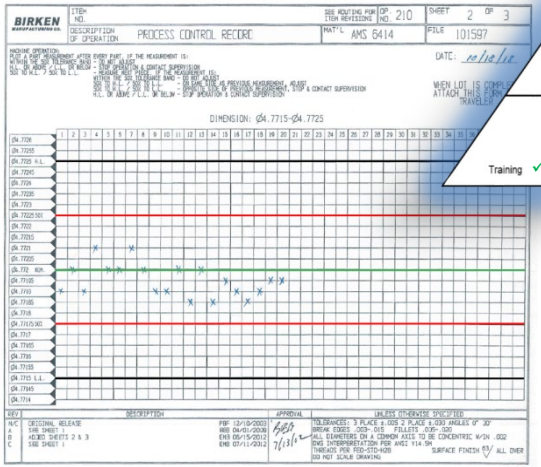
PROCESS CONTROL METHODS WE EMPLOY









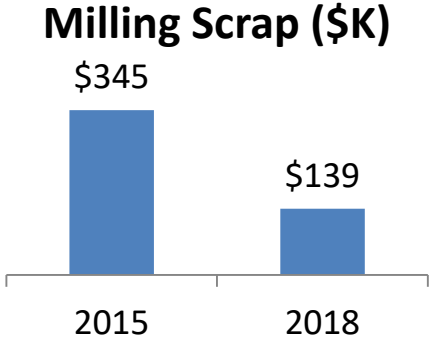


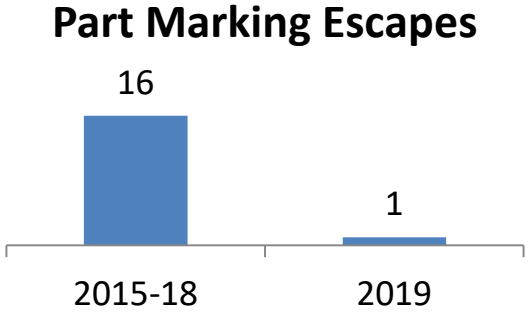
1ST PIECE MARKING VERIFICATION LOG

TRAVELER NO.	OP#	PART NO.	ACTUAL HUMAN READABLE PART MARKING (TO BE FILLED IN HERE BY THE INSPECTOR DIGIT BY DIGIT)	ACTUAL 2D CONTENT PART MARKING (TO BE FILLED IN HERE BY THE INSPECTOR DIGIT BY DIGIT)	IN-PROCESS INSPECTOR STAMP FOR VERIFICATION
First Piece Confirmation					
Last Piece Confirmation					
First Piece Confirmation					
Last Piece Confirmation					

BMC210-08 REV. C

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*

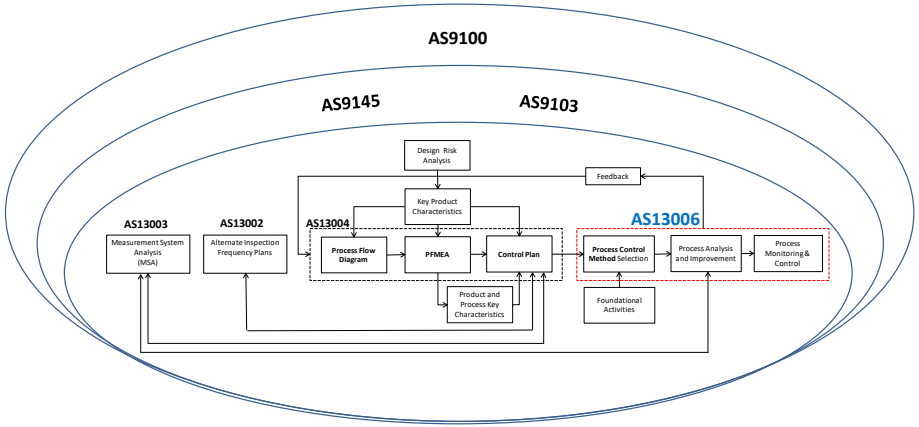
MARKING

- Implementing error/mistake proofing into the Serial № 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 №.
  - Knowing the marking software's control limitations, a Serial № Database system has been developed to error-proof the human factor in controlling the Serial № 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

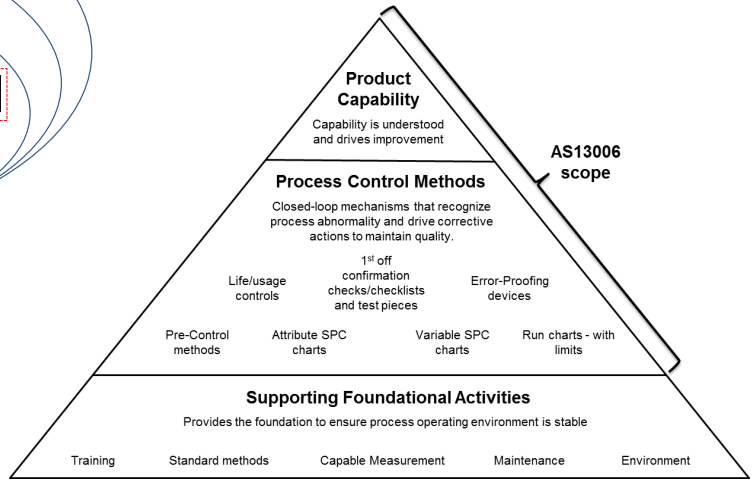
RELATIONSHIPS TO OTHER INDUSTRY STANDARDS



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



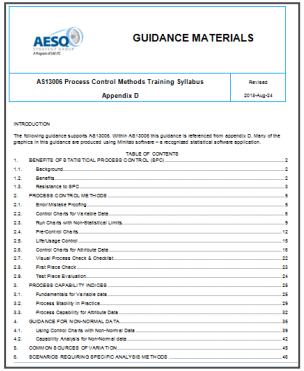
AS13006 drives the use of process control methods and stresses the importance of solid foundational activities.

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



GUIDANCE MATERIALS

AS13006 Process Control Methods Training Syllabus — Revised 2018-Aug-24

Appendix D

INTRODUCTION

The following guidance supports AS13006. Within AS13006 this guidance is referenced from appendix D. Many of the graphics in this guidance are produced using Minitab software – a recognized statistical software application.

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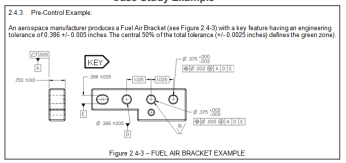
Case Studies

Case Study Example



2.4.3. Pre-Control Example:

An aerospace manufacturer produces a Fuel Air Bracket (see Figure 2.4-3) with a key feature having an engineering tolerance of 0.386 +/- 0.005 inches. The central 50% of the total tolerance (+/- 0.0025 inches) defines the green zone).

KEY

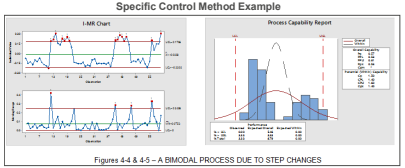
Figure 2.4-3 – FUEL AIR BRACKET EXAMPLE

Guidance Table Example

Table 2.6-1 – ATTRIBUTE CONTROL CHARTS

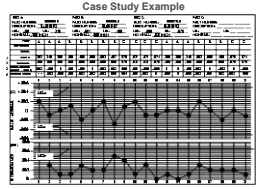
Scenario	When to use	Control type (which chart)	Example
A process that observes discrete values, such as pass/fail, go/no-go, present/absent, or conforming/ non-conforming. For example a circuit card could consist of a number of solder joints that either conform or do not conform to a set standard	Appropriate: When it is important to control the number or % of defects over a given time period, lot to lot, or unit to unit such as measuring improvement over time, when go/no-go gauges are employed or when visual inspections are used. Not Appropriate: Cannot be used for establishing process control or process capability in the same way as variables data	**P-chart** Plot the percent defective – classifying product as good or bad with changing or constant subgroup size **NP-chart** Plot the number defective – classifying parts as good or bad with constant subgroup size	Plot the monthly percent defective rate of a critical supplier; plot the On Time Delivery performance of a critical supplier A machining cell produces fuel control valves in standard lot sizes of 50. Final Inspection performs a 100% inspection of the product and plots the number of valves that are determined to be nonconforming.

Specific Control Method Example



Figures 4-4 & 4-5 – A BIMODAL PROCESS DUE TO STEP CHANGES

Case Study Example



Control of multiple part numbers on one chart

Based on aero engine component applications

Training Syllabus

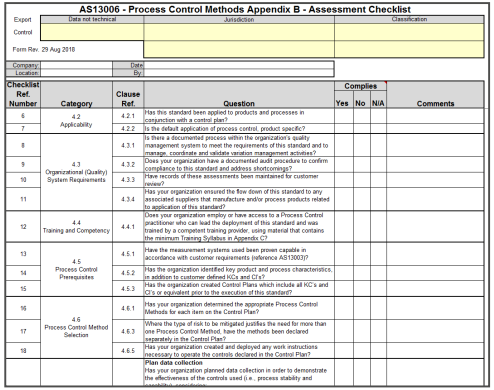
- Partial syllabus shown
- Refer to Appendix C for the full training syllabus
- Can aid in developing company training plan

Table 1 – Training Syllabus

THEME	OUTCOMES	MINIMUM CONTENT
The importance of Process Control	Appreciation of customers' needs and the benefits to the organization, industry and society Learning Objective: Learner will be able to describe the importance of process control including how it benefits company, industry, and society.	• Examples and discussion on process control failures • Reputational impact • Effect on the Aerospace industry • Benefits of achieving design nominal (Taguchi's Loss Function) • Understanding and importance of a closed loop control system • Effectiveness of in process control over end-of-line inspection
Process Control in Context of Quality Planning	Understanding of the linkages between the quality planning activities Learning Objective: Learner will be able to explain the purpose of Control Plans, what they contain, and their use in developing work instructions. Learning Objective: Learner will be able to describe how Control Plans link to Process FMEA.	• Linkage between PFMEA, Control Plans, and work instructions • Purpose and content of a Control Plan

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



AS13006 - Process Control Methods Appendix B - Assessment Checklist

Export Control — Data not technical — Jurisdiction — Classification

Form Rev. 29 Aug 2018

Company: Location: Date: By:

Checklist Ref. Number	Category	Clause Ref.	Question	Complies Yes	No	N/A	Comments
6	4.2 Applicability	4.2.1	Has this standard been applied to products and processes in conjunction with a control plan?				
7		4.2.2	Is the default application of process control, product specific?				
8	4.3 Organizational (Quality) System Requirements	4.3.1	Is there a documented process within the organization's quality management system to meet the requirements of this standard and to manage, coordinate and validate variation management activities?				
9		4.3.2	Does your organization have a documented audit procedure to confirm compliance to this standard and address shortcomings?				
10		4.3.3	Have records of these assessments been maintained for customer review?				
11		4.3.4	Has your organization ensured the flow down of this standard to any associated suppliers that manufacture and/or process products related to application of this standard?				
12	4.4 Training and Competency	4.4.1	Does your organization employ or have access to a Process Control practitioner who can lead the deployment of this standard and was trained by a competent training provider, using material that contains the minimum Training Syllabus in Appendix C?				
13	4.5 Process Control Prerequisites	4.5.1	Have the measurement systems used been proven capable in accordance with customer requirements (reference AS13003)?				
14		4.5.2	Has the organization identified key product and process characteristics, in addition to customer defined KCs and CTs?				
15		4.5.3	Has the organization created Control Plans which include all KC's and CI's or equivalent prior to the execution of this standard?				
16	4.6 Process Control Method Selection	4.6.1	Has your organization determined the appropriate Process Control Methods for each item on the Control Plan?				
17		4.6.3	Where the type of risk to be mitigated justifies the need for more than one Process Control Method, have the methods been declared separately in the Control Plan?				
18		4.6.5	Has your organization created and deployed any work instructions necessary to operate the controls declared in the Control Plan?				
			Plan data collection Has your organization planned data collection in order to demonstrate the effectiveness of the controls used (i.e., process stability and				

GO TO AESQ WEBSITE - aesq.saeitc.org

AS13002 INSPECTION FREQUENCY

AUSTIN SHEARS
PCC

LARRY BENNETT
GE

AS13002 Inspection Frequency

Original State

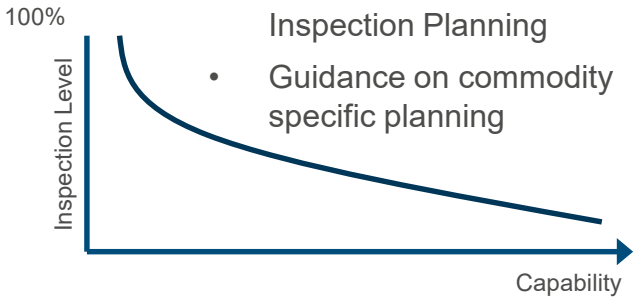
100% Inspection

REDUCED Sample

Error Proof AQL

Future State

- Common Method for Inspection Planning
- Guidance on commodity specific planning



AESQ Principles

- [x] Standardise
- [x] Simplify
- [ ] Adopts Existing Industry Standards
- [x] Prescriptive, Auditable
- [x] 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

8D

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 c)
  - 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

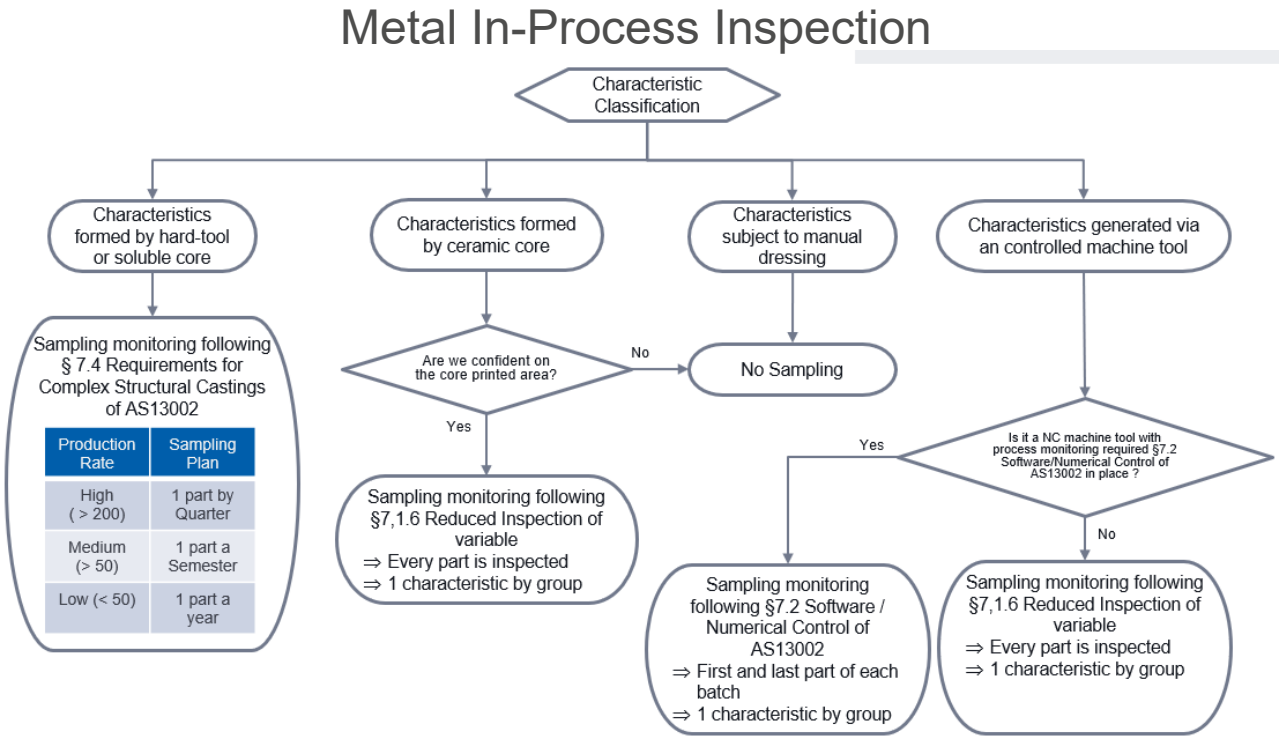
- **Each Aero-Engine company had their own inspection methodology for reduced inspection.**

- **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

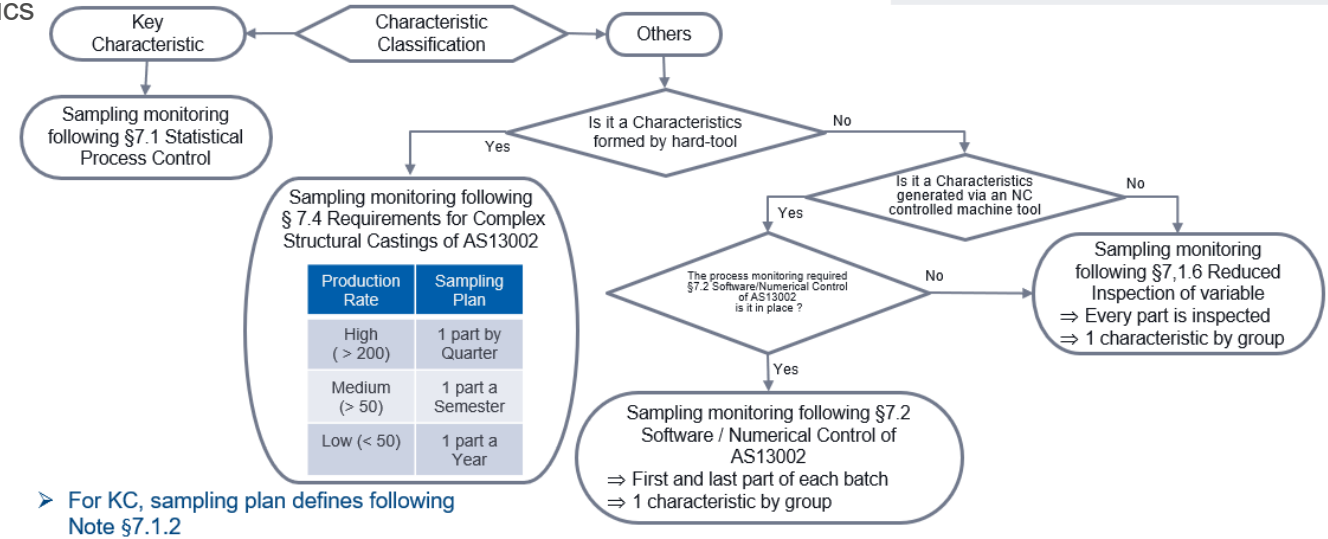


Standard Approach

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

Type	Risk	Cpk < 1	1 ≤ Cpk < 1.33	1.33 ≤ Cpk < 1.66	1.66 ≤ Cpk < 2	Cpk ≥ 2
Minor	Low (MTR)	1 : 1	1 : 20	1 : 100	1 : 100	1 : 100
Minor	Medium (MCTI)	1 : 1	1 : 10	1 : 50	1 : 50	1 : 100
Major	High (KC)	1 : 1	1 : 5	1 : 20	1 : 20	1 : 100
Major	Extreme (KC)	1 : 1	1 : 2	1 : 10	1 : 10	1 : 100

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**

AS13002 Implementation at GE

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**

VOICE OF THE CUSTOMER

RICHARD GALLAGHER

SUPPLIER QUALITY LEADER

BOEING

Boeing Propulsion Systems

Voice of Customer

2019 AESQ Supplier Forum

D906QXXXX

Boeing Propulsion Systems

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!

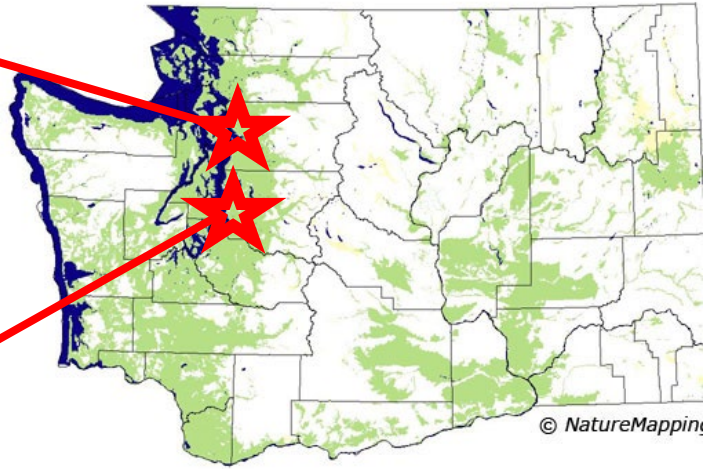

CANADA
Bellin
Cape
MOUNTAINS
Seattle
Renton
Cape
Elizabeth
Cape
Shoalwater
Mt. Rainier
Glacier Peak
Ellensburg
Mattawa
Columbia River
Pullman
IDAHO
WAHL
SLOPE
AKIMA
ALLEY
RED
Richla
WALLA
LEY
HORSE HEAV
COLUMBIA GORGE
Columbia River
Vancouver
WASHIN
WINES & WINERIES

Boeing Puget Sound

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

- 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.

We are the Boeing Company

Propulsion Systems Division | M&Q Core Quality

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…

BOEING

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

✓Accept NO Defects
✓Create NO Defects
✓Pass on NO Defects

Nonconformance Reduction

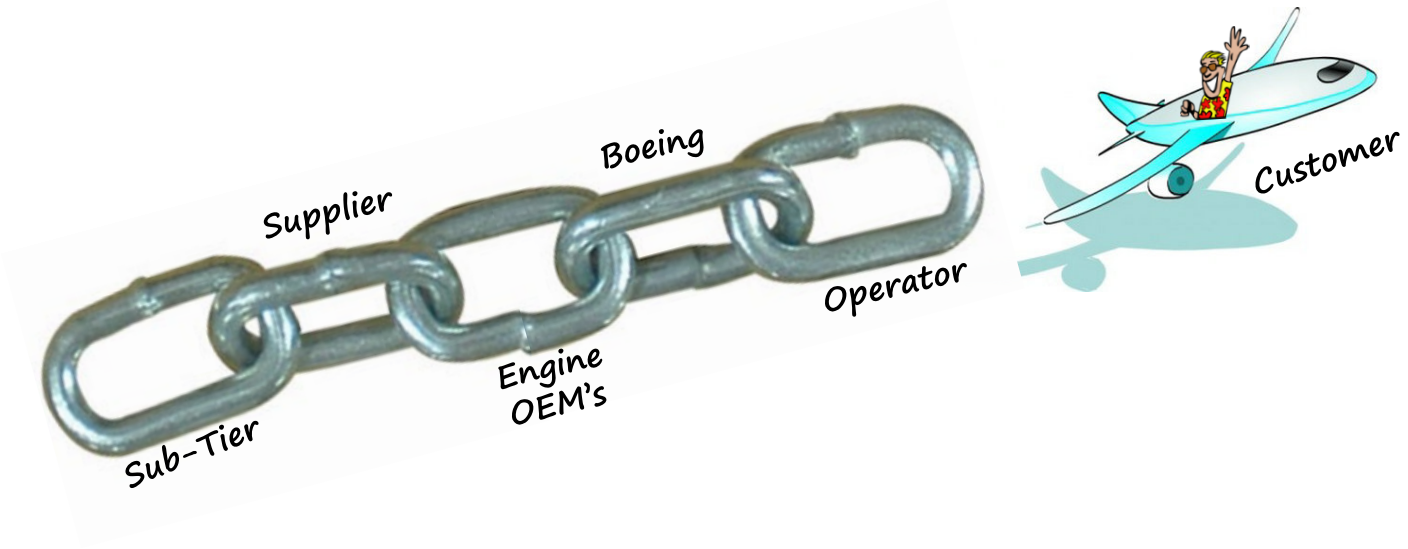
Continuous improvement

ZERO NOE's!

Partnering For Success

THESE ARE OUR EXPECTATIONS AS YOUR CUSTOMER

The Supply Chain

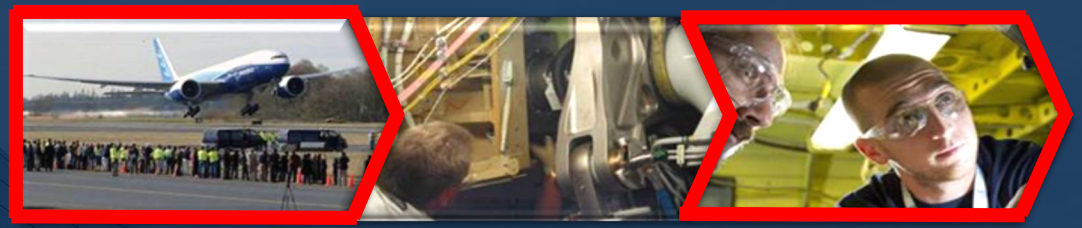


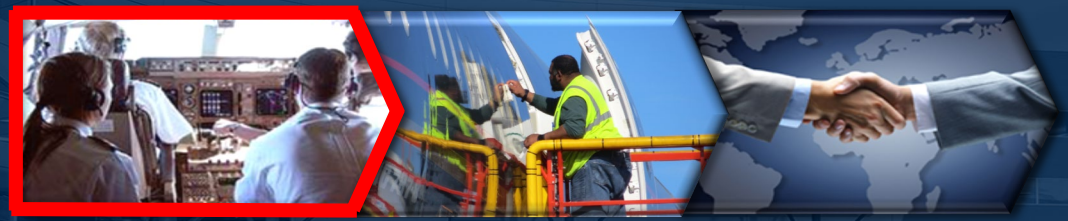
ANY TIME A LINK IS BROKEN IT AFFECTS THE CUSTOMER

Impact of poor quality: Late deliveries

- Fines
- Canceled orders
- Missed revenue flights
- Impacted flight schedules
- Poor reputation
- Angry customers

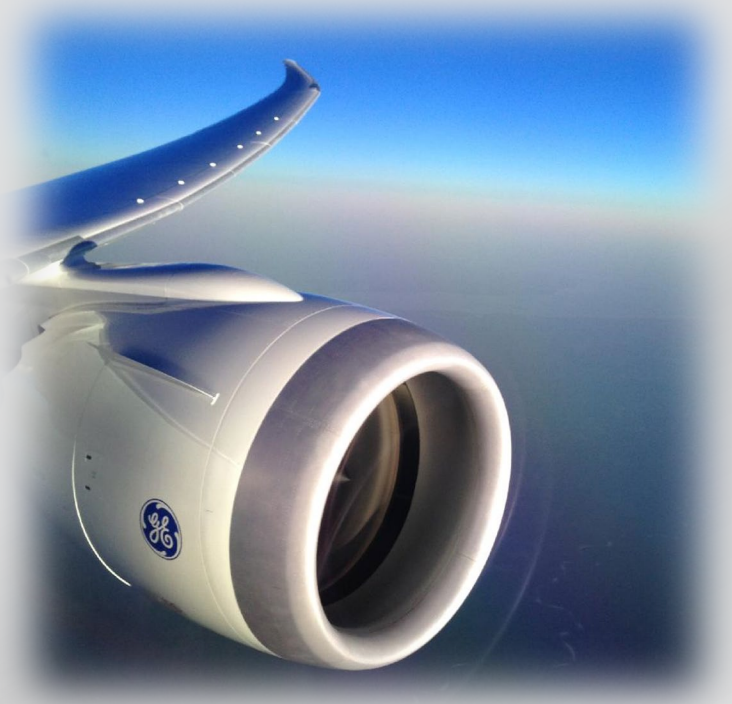
Everett Delivery Process Flow





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...


BOEING

AS13000 PROBLEM SOLVING USING 8D

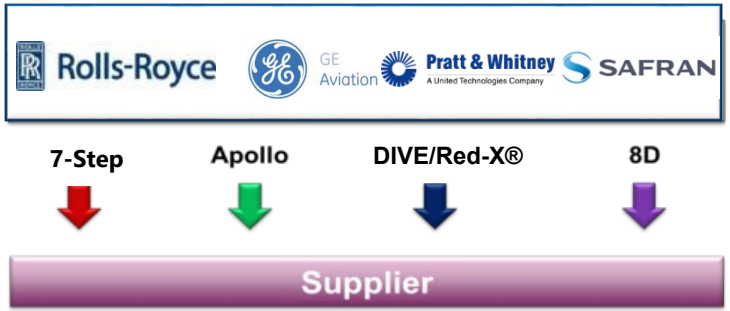
MATEUSZ ZYLA
COLLINS AEROSPACE

OLIVIER CASTETS
SAFRAN

AS13000 Problem Solving

AESQ STRATEGY GROUP
A Program of SAE ITC

Original State



Future State

AESQ Principles

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

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- Reduced need for Customer training & support
- Improved access to training & consultancy
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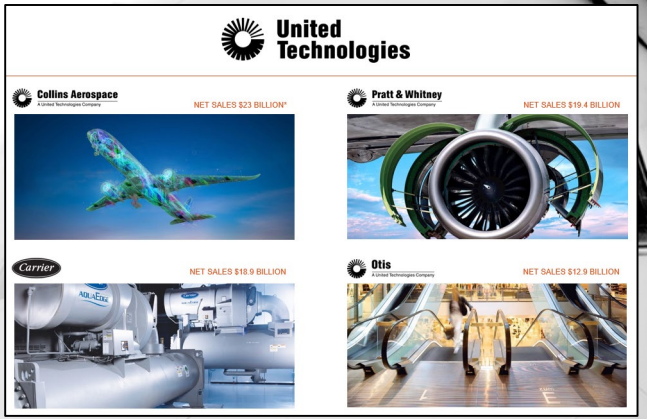
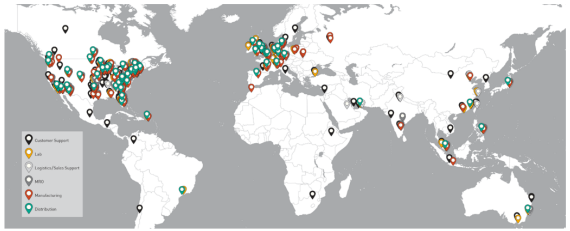
ABOUT COLLINS AEROSPACE

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.



GLOBAL LOCATIONS, LOCAL SUPPORT



NEARLY 300 SITES WORLDWIDE

Where you need us, when you need us – everywhere, every day

STRATEGIC BUSINESS UNITS

AEROSTRUCTURES
Based in Chula Vista, California

- Nacelle systems
- Flight control surfaces
- Naval composites
- Other material and structural components

AVIONICS
Based in Cedar Rapids, Iowa

- Avionics systems
- Cabin management systems
- Information management systems and services
- Aircraft sensors
- Fire protection

INTERIORS
Based in Winston-Salem, North Carolina

- Aircraft seating
- Interior systems
- Evacuation systems
- Life rafts
- Lighting
- Veneers
- Potable water systems
- De-icing products

STRATEGIC BUSINESS UNITS

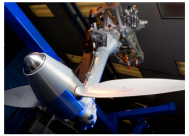
MECHANICAL SYSTEMS
Based in Charlotte, North Carolina

- Landing systems
- Actuation
- Propellers
- Flight controls
- Pilot controls
- Hoist and winch systems
- Cargo systems

MISSION SYSTEMS
Based in Cedar Rapids, Iowa

- Communication, navigation and guidance
- Missile actuation
- Simulation and training
- Strategic command and control
- Unmanned aircraft systems
- Electronic warfare
- Ejection seats
- Intelligence, surveillance and reconnaissance
- Space solutions

POWER & CONTROLS
Based in Windsor Locks, Connecticut



- Electric systems
- Engine controls
- Air management
- Airframe controls

Collins Aerospace

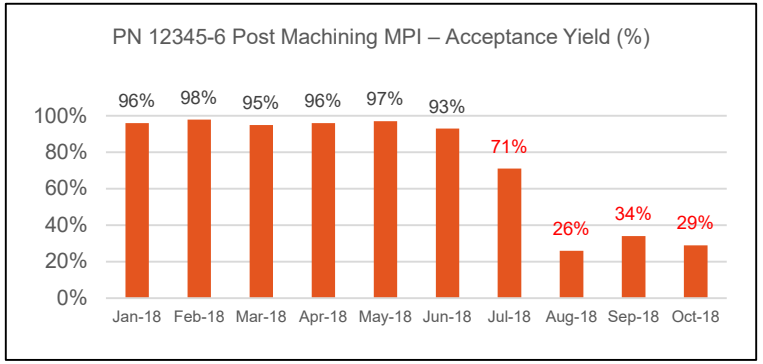
PROBLEM STATEMENT

PROBLEM STATEMENT:

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

BACKGROUND:

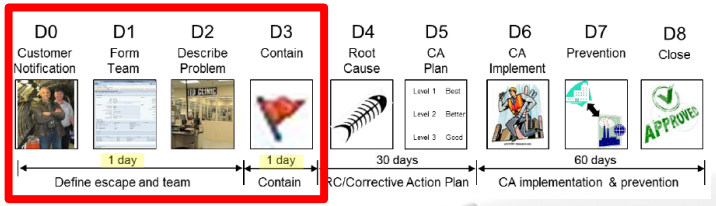
- Collins buys castings and machines them
- Castings are FPI'ed and X-Rayed
- Machine shop performs MPI after machining
- All 3 inspection techniques (FPI, X-Ray, and MPI) need to be approved by Collins
- Casting process is "Frozen"
- No major process changes were noted



Collins Aerospace

STANDARD APPROACH

DEFINE AND CONTAIN

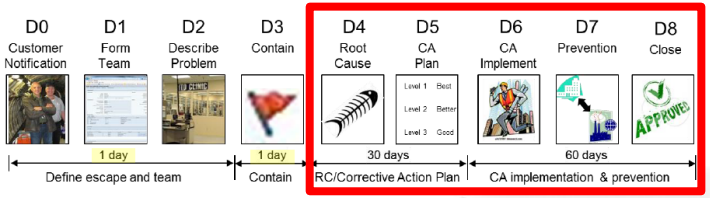


- D0 – Implement Immediate Containment and Prepare for 8D
  - Stop manufacturing castings
  - Requested casting supplier to review process history
  - Confirm that the post machining technique detecting the issue is correct
  - Identified all affected stakeholders
- D1 – Form the Team
  - Cross-functional 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

Collins Aerospace

STANDARD APPROACH

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

Collins Aerospace

BENEFITS

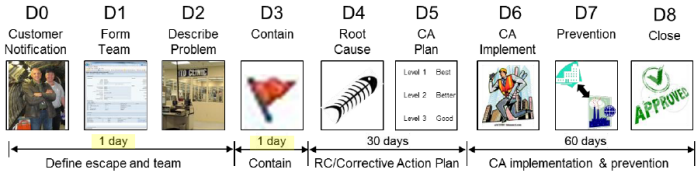
PREVENTS REOCCURRENCE

READ-ACROSS

COMPLETE PACKAGE

STANDARD METHODICAL APPROACH

CORRECTIVE ACTION VALIDATION



Collins Aerospace

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

Collins Aerospace

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

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

FUTURE INITIATIVES

Lisa Claveloux
Pratt & Whitney

Dr Ian Riggs
Rolls-Royce

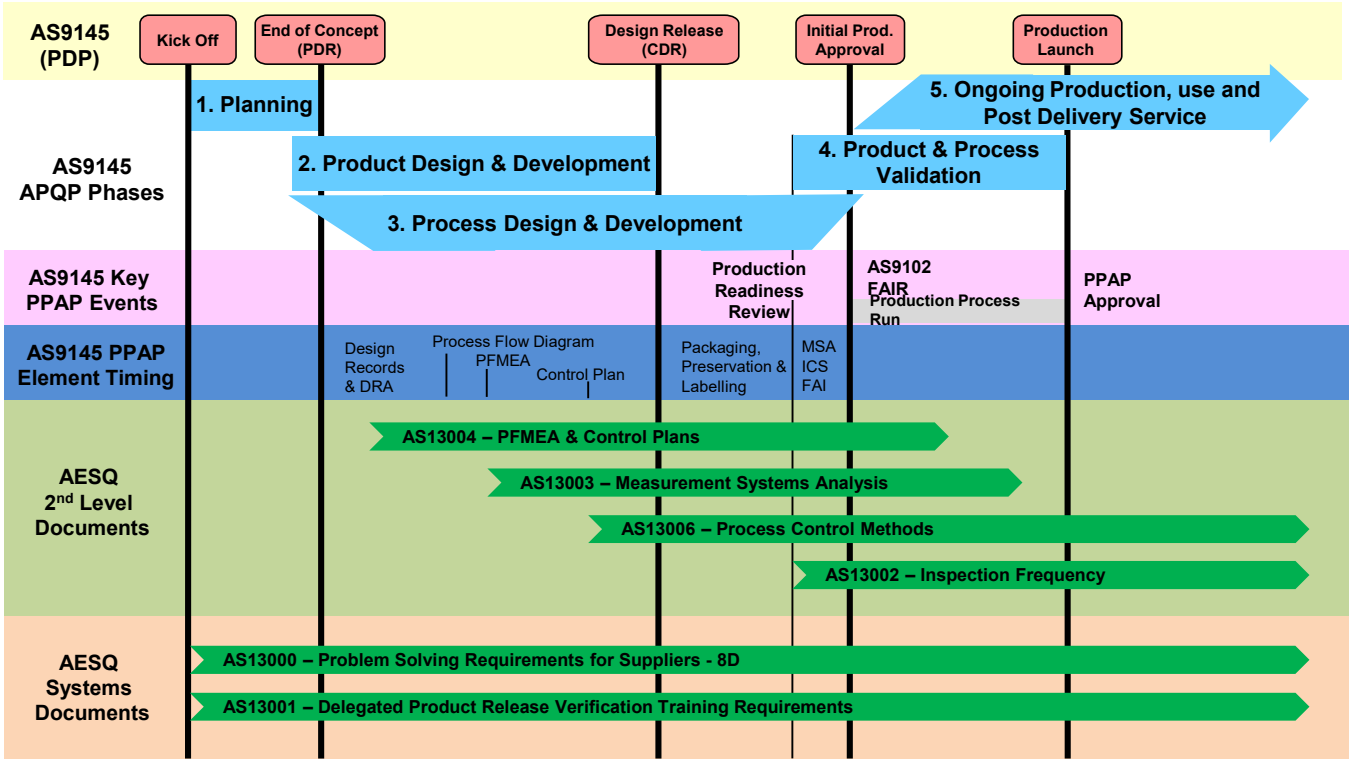
Helen Djäknegren
GKN

Barbara Negroe
GE Aviation

Catherine Catarina-Graca
Safran

Product Life Cycle & Document Interaction

AS9145 (APQP/PPAP) & AESQ Standards

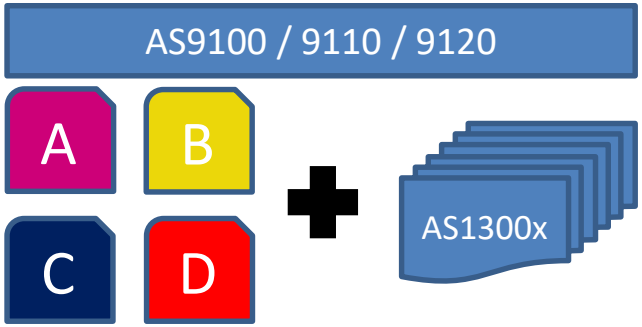


In-process Initiatives

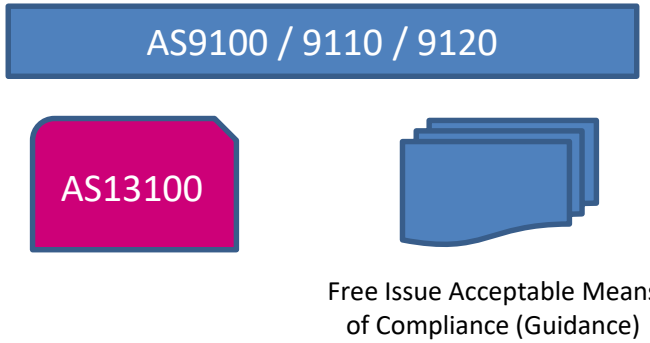
- AS13100 Supplemental Quality Requirements
- APQP/PPAP/FAI
- Design Supplier Requirements
- Audit
- Supplier (sub-tier) Management
- Human Factors

AS13100 Management Standard

Original State



Future State



AESQ Principles

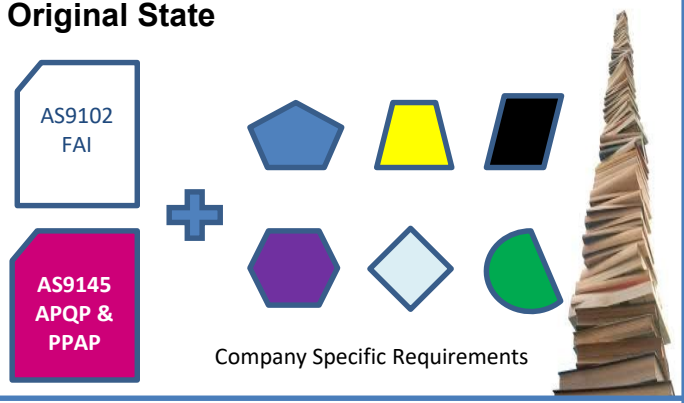
- ☑ Standardise
- ☑ Simplify
- ☑ Adopts Existing Industry Standards
- ☑ Prescriptive, Auditable
- ☑ Common Language
- ☑ Supported by 3rd Party Training & Consultancy

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

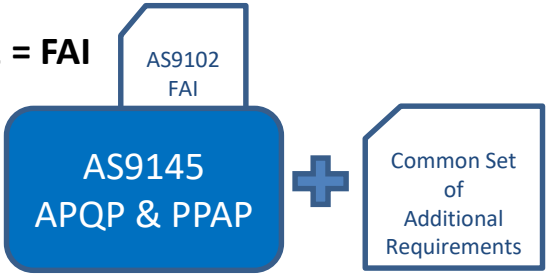
APQP, PPAP & FAI Common Approach

Original State



Future State

AS9102 = FAI



AESQ Principles

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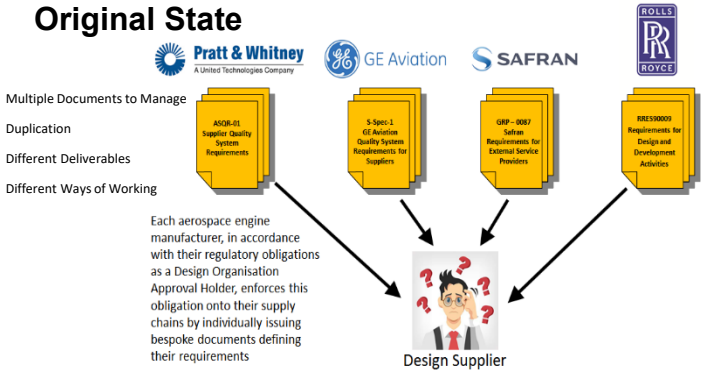
- ☑ Adopts Existing Industry Standards
- ☑ Prescriptive, Auditable
- ☑ Common Language
- ☑ Supported by 3rd Party Training & Consultancy

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 Design Supplier Requirements

Original State



Future State

Design requirements to be included in AS13100.
Guidance material to be free issue from AESQ website

AESQ Principles

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

Expected Benefits

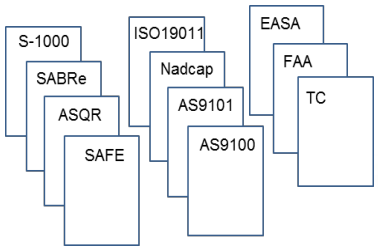
1. Common understanding and language.
2. Aligns to AS13100 and other industry standards
3. Provides acceptable means of compliance for AS9100 and other regulatory requirements
4. Simple, prescriptive and surveillance requirements
5. Free issue guidance material that can be used by supply chain
6. Promotes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

Quality Audit Requirements (former AS13005)

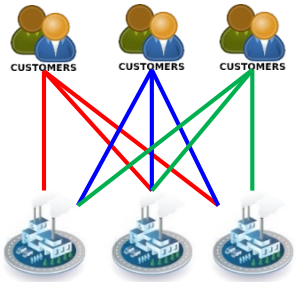
AESQ STRATEGY GROUP
A Program of SAE ITC

Original State

Internal and supplier audit requirements in many documents



Every Customer audit every supplier



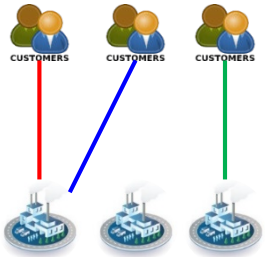
Internal audits to many requirements

Future State

Aerospace Standard AS13005

- Audit types & checklists
  - System
  - Production process
  - Product
  - Special process
- Auditor qualification, KPI´s
- Audit outcome

Risk based supplier audit



One internal audit requirement

AESQ Principles

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

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

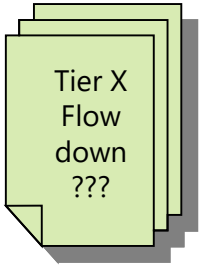
Supplier Management (former AS13007)

Supplier Management (former AS13007)

AESQ STRATEGY GROUP
A Program of SAE ITC

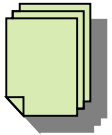
Original State

Varied Customer-Specific Requirements



Future State

Fewer Customer-Specific Requirements



AESQ Principles

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

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

Original Equipment Organisations (Part 21)

Future State

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

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

Expected Benefits

- Common understanding and language of Human Factors across supply chain
- Aligns to AS13100 and other industry standards
- Provides Acceptable Means of Compliance for AS9100, AS13100 and future Regulation (Human Factors element of Safety Management System)
- Free issue guidance and training material that can be used by supply chain

HUMAN FACTORS

LUDOVIC CHEVET
AIRBUS

An **Airbus** takes off or lands **every 1.4 seconds**

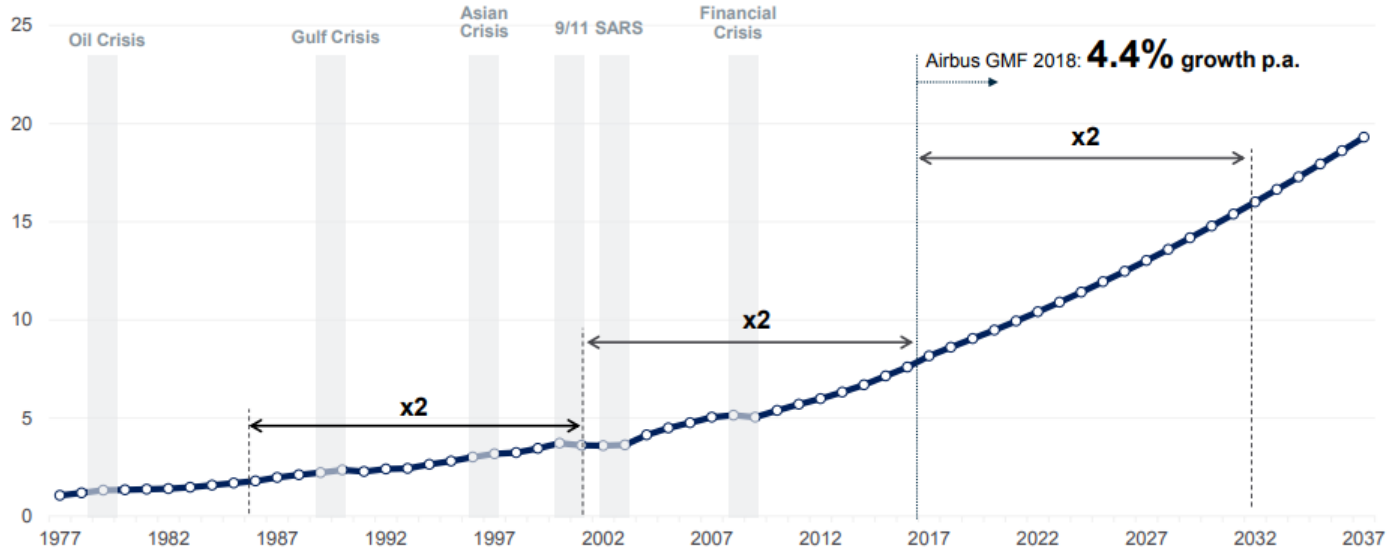
19 340	11 763	7 577
Orders	Deliveries	Backlog

End December 2018

AIRBUS

The Market

Source: Airbus GMF 2018

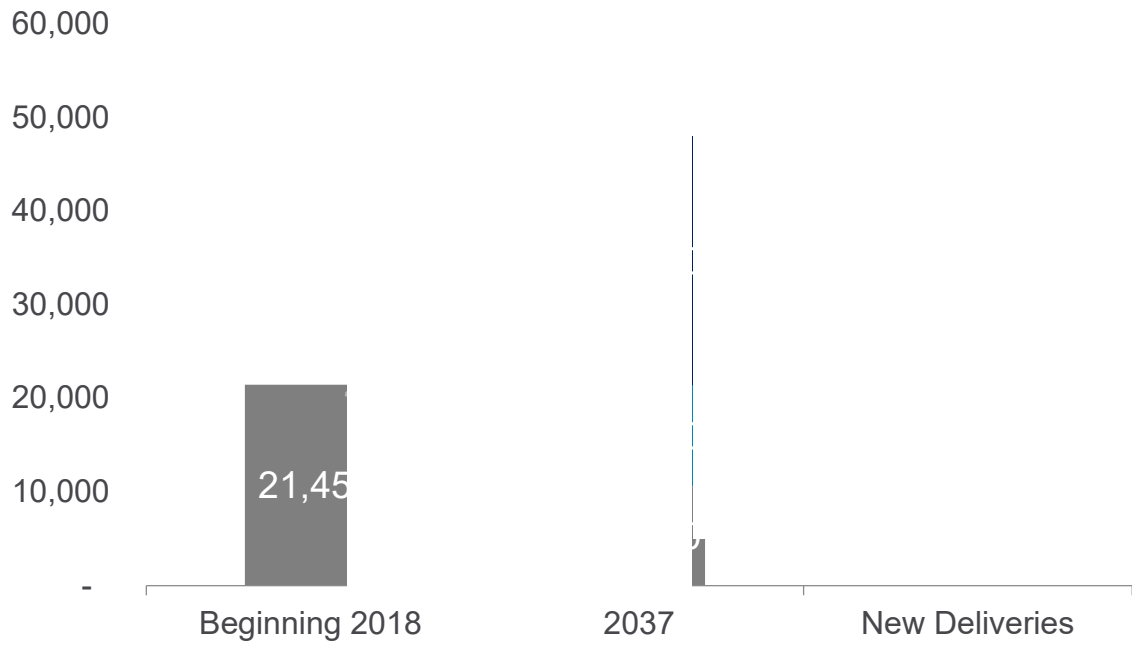


Air traffic doubles every 15 years

AIRBUS

The Market

Source: Airbus GMF 2018

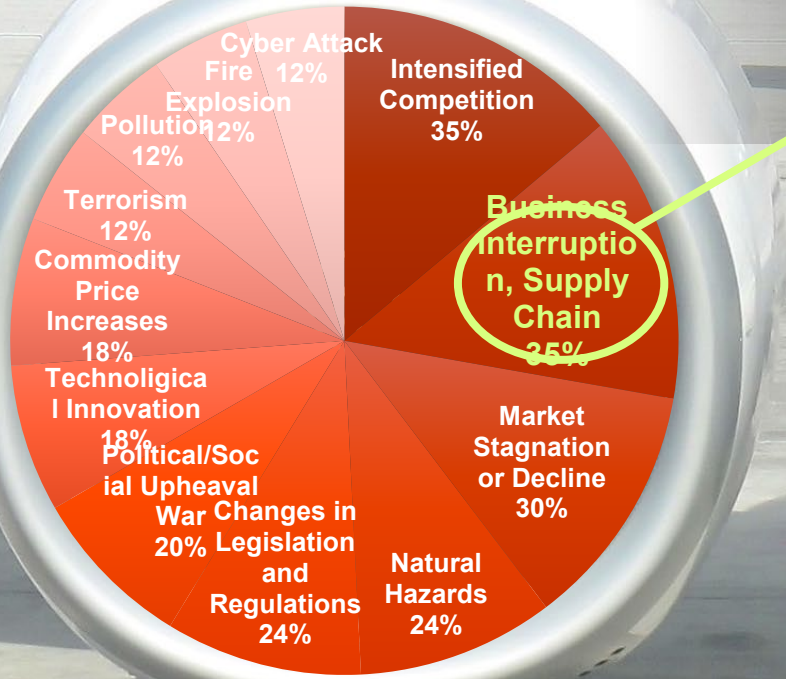


World fleet will double in the next 20 years

Level of exposure will increase

AIRBUS

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

AIRBUS

Supply Chain Risks… Business Interruption

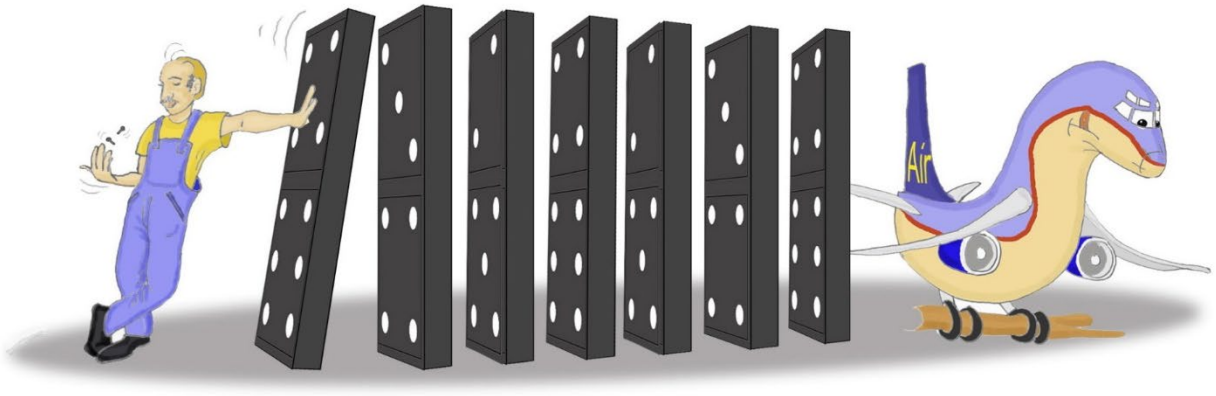


Illustration by courtesy of ScandiAvia

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

AIRBUS

Human Errors

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

AIRBUS

Aviation safety will continue to evolve, always putting safety of passengers first

Aviation safety will continue to evolve, always putting safety of passengers first

Aviation safety will continue to evolve, always putting safety of passengers first

AIRBUS

What is Human Factor ?

Human Factor is a science studying how errors occur

AIRBUS

What is Human Factor ?

Human error is not a root cause

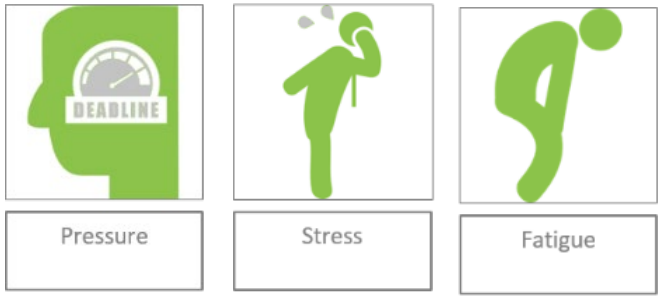
AIRBUS

The Dirty Dozen

Dirty Dozen are primary causes of human error

AIRBUS

Error is gold

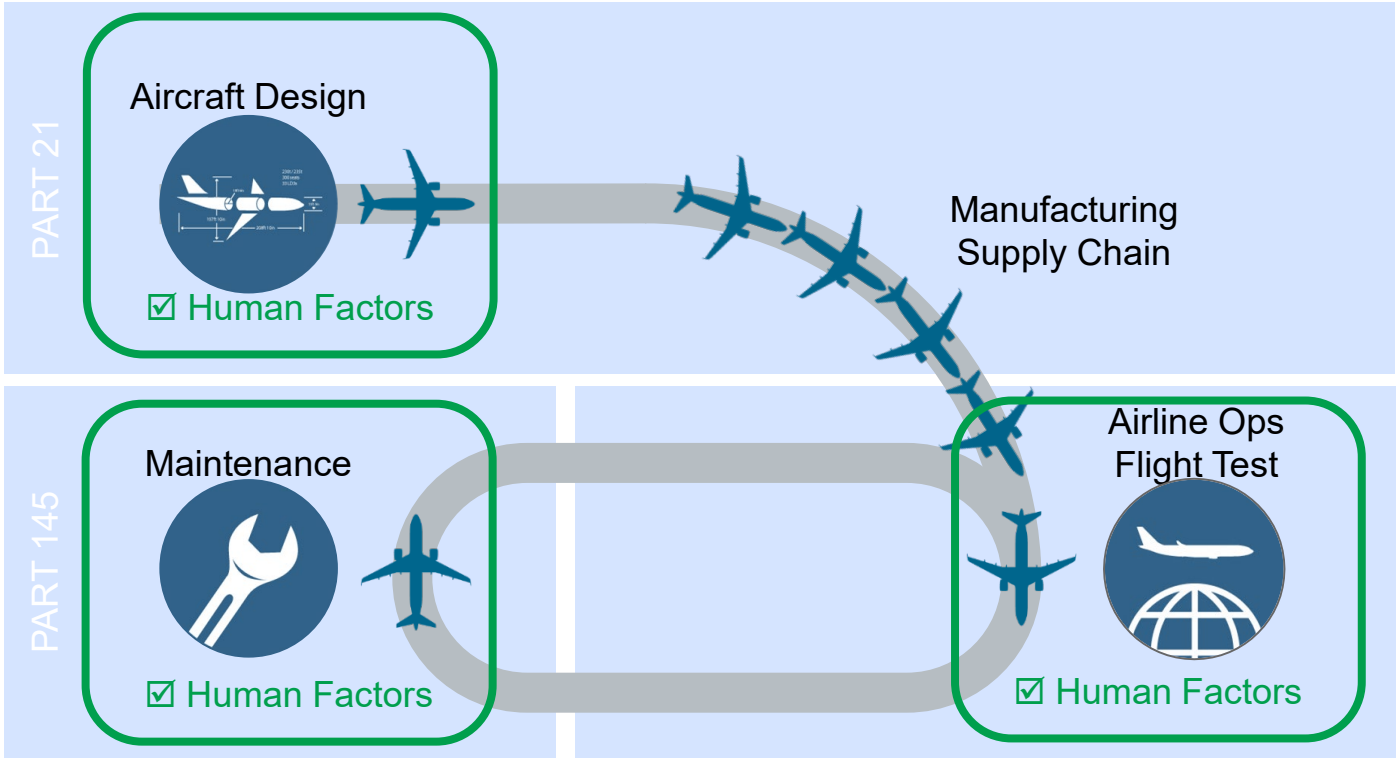


Trust based SMS helps human errors identification

Just and fair culture

AIRBUS

Human Factor in Aviation Value Stream



Human Factor approach shall be reinforced in production organisations

Several projects within Airbus

AIRBUS

AESQ STRATEGY GROUP and Human Factors

A Program of SAE ITC

Original State

Maintenance Organisations (Part 145)

Human Factors Approach ✓

Original Equipment Organisations (Part 21)

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4. Free issue guidance and training material that can be used by supply chain

AESQ project is matching Airbus strategy

Airbus is taking active role in it

AIRBUS

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

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