SABRe Briefs & Guidance



First / Last Article Inspection Report (FAIR / LAIR) Supplier Briefing Pack

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Introduction to First Article Inspection (FAI)

Importance of FAI to Rolls-Royce

- It provides evidence that in defining the production method, all engineering, design and specification requirements are correctly understood, accounted for, verified and recorded.
- It provides a baseline against which to compare future parts to determine if anything has changed.
- It forms part of the certification of a product and satisfies International Standard requirements.

FAI process Regulations and Procedures

ABROSPACE ARKS RV. C STANDARD Version and arks Version and arks Version 2014 and Version 2014 and Compared Articles		SABRE Rolls-Royce Supplier Management System Requirements
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IAUG AS9102		SABRE Edition 2 (B 4.4)



Introduction to First Article Inspection (FAI)

When the FAI is not Right First Time the impact on:

Rolls-Royce as Customer....

- Delays sentencing of the FAIR's.
- Delays the shipping of the components.
- Causes build line stoppage and disruption to engine test schedules:
 - Premium / overtime labour to make up for lost time
- Hazard to engine delivery dates:
 - Aircraft delivery delay charges : \$20K per engine per day.
 - Charter aircraft for engine transport : \$100-150K per flight.
- Requires additional resource to re-assess the FAIR.

Airframe Manufacture or Airline as Customer....

- Aircraft On Ground (AOG).
- Reputation.
- Litigation.





What Happens when the FAI Process Fails

Incorrect application of FAI failed to detect an undersize chamfer resulting in virtually no bearing race life in service

PART DESCRIPTION: No. 2 Bearing Housing FWxxxxx QTY IMPACTED: All parts delivered from the supplier WHERE NON CONFORMANCE DISCOVERED: RRD Build line WHEN NON CONFORMANCE DISCOVERED: 08.09.2009 WHO DISCOVERED NON CONFORMANCE: Fitter

PROBLEM DESCRIPTION:

Gap identified between flanges of No. 2 Bearing Housing FWxxxxx and RDS Roller Bearing FJxxxxx as result of non-conforming chamfer on No. 2 Bearing Housing. Resulted in distorted bearing race with no assessable life.

DWG requirement: Actual measured: 1,5 +/- 0,10mm x 45° 0,57mm x 45° (worst case)









General Arrangement - Section through RDS support

Introduction to First Article Inspection (FAI)

Common Issues

- Forms not completed properly.
- Supporting documents not included.
- Incorrect material used; incomplete material certification; lack of detail on the traceability of the material.
- Materials or special process sources not approved.
- Functional testing not identified or report not included.
- Document defining the sequence of operations and evidence of completion not included.
- Inspection results data integrity.
- CMM results not traceable to design characteristics.
- Attribute data recorded when characteristic is expressed by numerical limits.
- Engineering requirements not understood.
- Engineering characteristics not accounted for.
- CMM results not traceable to design characteristics.
- Attribute data recorded when characteristic is expressed by numerical limits.
- FAI training and process not defined or effective.
- Flow-down and oversight of FAI is inconsistent and ineffective.



The Rolls-Royce First Article Inspection Process

There are four steps in the Roll-Royce Management System process to verify a production method:



• This procedure verifies the Production Method and is separate from verifying the Design and verifying the Produced Product.

Note: The use of 'Engineering Definition' within this document refers to the product drawing number stated in the Rolls-Royce Purchase Contract.





Application of FAI to Rolls-Royce designed product:

- Product identified for 'development use only'
 - FAI is <u>not</u> mandatory on product identified for 'development use only', part numbers prefixed with 'D'. [e.g. DKH]
- Standard Parts
 - FAI is <u>not</u> mandatory on R-R Standard part numbers prefixed with the following letters, unless the drawing identifies a R-R specification or the manufacturer applies a R-R specification:
 - $\bullet \quad \mathsf{ESC} \ : \ \mathsf{ESW} \ : \ \mathsf{FBS} \ : \ \mathsf{K} \ : \ \mathsf{KB} \ : \ \mathsf{KC} \ : \ \mathsf{KJ} \ : \ \mathsf{KL} \ : \ \mathsf{KM} \ : \ \mathsf{KU} \ : \ \mathsf{U} \ : \ \mathsf{UBS} \ : \ \mathsf{UK}$
- Transportation covers
 - FAI is <u>not</u> mandatory on product designed specifically for the purpose of protection during transportation, unless the drawing identifies a R-R specification or the manufacturer applies a R-R specification.
 [e.g. Engine intake covers; Fabric covers in 'Aerolac' Red with 'For Transportation Only', or similar wording, in white lettering].
- Change of production source or method of a detail within an assembly
 - FAI is <u>not</u> mandatory on a higher level part number within a Cascade Diagram, to validate a change in the production source or method of a lower level part number.
 - When product equivalency is not demonstrated on the lower level part number consideration should be given to performing FAI on the higher level part number.
- Finished product or materials free issued by Rolls-Royce
 - FAIR is <u>not</u> required, a copy of the R-R Release Note to be included in the report.





Full First Article Inspection report:

- New Product Introduction change in the design affecting form, fit, or function of the part.
- Product Introduction change of source of complete manufacture for a part.
- An approved 'Complete' FAI report is not available.
- At the request of Rolls-Royce or its customers.

Partial First Article Inspection report:

- An FAI report approved as 'Not Complete' and the non-conformance corrective action has been implemented.
- A change in manufacturing source(s), manufacturing processes, inspection method(s), location, tooling, or materials with the potential of affecting form, fit, or function.
- A change in numerical control program or translation to another media.
- A natural or man-made occurrence which may adversely affect the manufacturing process.





Full or Partial FAI report:

- A lapse in production of two years will require FAI (Full or Partial) on characteristics that may be impacted by the period of inactivity.
- The lapse is from the completion of last production operation to the actual restart of production.
- An assessment to be conducted encompassing the production method, equipment, personnel.

Last Article Inspection report (LAIR)

- A Last Article Inspection is required when a production source is to change. A LAIR is the same as a FAIR, but conducted on a product prior to the end of production in the existing source.
- The requirement for a LAIR may be waived by the Source Change Control Authority (SABRe Edition 2 Section A4.2 Control of work transfer) when a First Article Inspection report satisfies both of the following:
 - Is less than two years old.
 - Is fully representative of the current method of manufacture.





Application of results from previous First Article Inspection report

- For new product, FAI requirements may be satisfied by reading across results from a previously approved FAI performed on identical characteristics of similar (benchmark) product produced by identical production methods .
- When results are read across, the FAI report for the new product is required to identify the product number and approved FAI report reference of the benchmark product and also a rationale for the read across.
- All characteristics of the Engineering definition or associated production method that are not identical to the benchmark product are subject to independent FAI.
- An example of this may be:
 - A new assembly where only one detail part within the assembly is changed and there is no impact on the assembly process or functional test parameters.



Step 2 - Plan The First Article Inspection



Planning shall consider all tasks required to carry out a First Article Inspection:

- All Design characteristics defined by the Engineering Definition and required for product realisation (including those defined in 'notes', controlling specification or a Digital Product Definition) shall be accounted for and recorded.
- Dimensional characteristics not accessible at the end of the production process and independently inspected at the last point in the process the characteristic is accessible.
 - When these characteristics could be affected by subsequent production operations, agree with the Design Authority whether re-verification at the end of the production process is required and the method of verification. It is not acceptable to assume 'outcome of the process' and no verification is required.
- Resource required to conduct the First Article Inspection and compiling of report.
- Documentation and evidence required in the report.
- Actions to prevent product being released prior to the approval of the FAI report.



Step 2 - Plan The First Article Inspection



Planning shall consider all tasks required to carry out a First Article Inspection:

- Independent inspection of dimensional characteristics at the end of the production process, using:
 - A capable measurement system.
 - Personnel different from those who inspected the product characteristic during the production process (see Note 1).
 - Verification equipment that is not the equipment used by the production process, except for automated equipment. Where automated equipment is used, the program and programmer shall not be the same as those used in the production process (see Notes 1 and 2).

Note 1:

When the production measurement system has been independently verified by a previous approved First Article Inspection report, the production measurement system may be used to conduct the First Article Inspection. Note 2:

When inspection tooling designed specifically for the product (Designed Tooling) is used in production and no viable alternative can be used to conduct the FAI independent inspection, use of the Designed Tooling is acceptable providing the gauge is calibrated and certified prior to use for the FAI.

When the production process includes final inspection, this is not recognized by Rolls-Royce as independent inspection



Step 2 - Plan The First Article Inspection



Planning - Create a Cascade diagram and use it to identify:

- The Bill of Material.
- The sub-assembly and part numbers where FAI reports are to be carried out.
- Where characteristics are not measurable in the final product.





Step 3 - Execute First Article Inspection



Execute First Article Inspection in accordance with the plan

- FAI shall be conducted against the Engineering Definition.
 - Finished characteristics verified against a manufacturing definition or condition of supply shall be re-verified to the Engineering Definition.
- Inspection of dimensional characteristics performed on a single product. Where this is not physically possible, the results from more than one product may be used if they have been produced and verified using the same:
 - Engineering Definition.
 - Bill of material.
 - Production method (including supply chain).

The FAI report shall be annotated to signify the use of multiple products and provide traceability of the products used to obtain inspection result for each characteristic.



Step 3 - Execute First Article Inspection





Step 3 - Execute First Article Inspection



Structure of an First Article Inspection report - Content sheet

- Rolls-Royce First / Last Article Inspection Report Approval Form.
- Content Sheet (Specific to the content of the actual FAIR).
- Rolls-Royce First / Last Article Inspection Report Content Review Form.
- Product Definition.
- Purchase Document .
- Fixed Process Approval form / Source Demonstrated Repair Approval (when applicable).
- Production process control documentation.
- AS / EN / SJAC 9102 Form 1.
 - Cascade Diagram.
 - R-R FAIR Approval forms for any associated FAIRs which are already approved.
 - Release Documentation for Standard Catalogue items and Commercial-Off-The-Shelf items.
- AS / EN / SJAC 9102 Form 2.

Supporting documentation [e.g. Material certs; Special process data cards and product specific validation reports; Functional test techniques and test result report; Evidence of design acceptance of non-conformance].

• AS / EN / SJAC 9102 Form 3.

Supporting documentation [e.g. Marked-up Engineering definition; FAI Inspection Plan; Printouts of measured results from automated measurement equipment; Evidence of design acceptance of non-conformance; Evidence of Design authority approval of measuring equipment which is not capable].





Review and approval of First Article Inspection Report:

- Review of the verification evidence and sentencing of the First Article Inspection Report shall be by authorised personnel.
- Product shall not be released prior to the approval of the FAI Report.
- The report will be reviewed and approved by a Materials and Special Process Authority when the FAI report includes materials, special processing or functional testing.
- The report will be reviewed and approved by the Design Authority when the following applies:
 - There is no evidence of an agreement with the Design Engineer on the use of measurement equipment with an unacceptable capability.
 - There is no evidence of an agreement with the Design Engineer that dimensional characteristics independently verified during production (not accessible at the end), with potential to be affected by subsequent production operations, do not require re-verification at the end of production.
- The report will be dispositioned and approved by the Manufacturing Engineer Authority for the product.





Sentencing the First Article Inspection Report

Complete

• First Article Inspection is complete when all characteristics have been accounted for and verified against a single product without non-conformance to the Engineering Definition.

Not complete

• First Article Inspection is not complete when all characteristics have been accounted for, verified and non-conformance has been identified and sentenced.

Reject

• First Article Inspection (including Fixed Process Approval where applicable) is unsatisfactory or has not been completed in accordance with this procedure.





Sentencing the First Article Inspection Report

- The Report signatories are signing to 'Approve' or 'Reject' the FAI / LAI Report.
- The 'Disposition of the Report', 'Complete' / 'Not Complete', is based on conformance of characteristics to the Engineering definition and NOT on non-compliance to the mandatory requirements that apply to a FAI / LAI Report.
- Non-compliance to SABRe B 4.4 requires a Quality Plan approved by the Rolls-Royce Management System Process Owner. The QP must containing a statement instructing the FAI Report to be 'Not complete'.
- Cascading up of a 'Not Complete' approval in an assembly:
 - It is not a requirement to automatically cascade up a 'Not Complete' status from a lower level part number to a higher level part number. Each FAIR, at each level within the cascade diagram should be sentenced on its own merits as to whether it is 'Complete' or 'Not Complete'.
 - For example if the higher level part number has no non-conformance associated with it, then it should be sentenced 'Complete'.





Materials and Special Process Authority

The Materials and Special Process Engineer or equivalent is responsible to confirm that:

- The declared material(s) meets specification and is permitted by the Engineering definition or is a suitably authorised alternative.
- The declared special processes are permitted by the Engineering definition and have been conducted in accordance with the requirements of controlling specification.
- When part specific data card or work instruction is required, in accordance with RRP 50000, this is available and appropriately authorised.
- Functional tests, controlled by the laboratory function, have been performed and comply with the Engineering definition and/or controlling specification.
- Sources used for material(s), special processes and functional testing hold the required level of approval.





Design Engineer

The Design Engineer is signing to confirm that:

- When the measurement capability is below the target specified by MSX 001, the limitation(s) of the measurement system can verify that the engineering definition (and design intent) has been achieved.
- When a characteristic is not accessible at the end of the production process and may be affected by subsequent production operations, the characteristic was independently verified at the last point in the process it was accessible and the method of verification at the end of the production process is acceptable to demonstrate that the engineering definition (and design intent) has been achieved.





Manufacturing Engineer Authority

The Manufacturing Engineer Authority is responsible for confirming that:

- The Engineering Definition is adequate to allow for the definition of a suitable production, repair and overhaul or maintenance method.
- The production or repair and overhaul method is suitable to meet the Engineering Definition.
- Functional tests, controlled by the Manufacturing Engineering function, have been performed and comply with the Engineering definition and/or controlling specification.
- The declared dimensional results, functional test results, and standards comply with the Engineering Definition or the non-conformance has been fully accepted and suitable preventative actions have been identified.

