First Article Inspection Training
AS9102, rev C

AS9102, rev C - Aerospace First Article Inspection Requirement

Invoked by AS9100D: (Quality Management Systems – Requirements for Aviation, Space, and Defense organizations)

8.5.1.3 Production Process Verification

The organization shall use a representative item from the first production run of a new part or assembly to verify that the production processes, production documentation, and tooling are able to produce parts and assemblies that meet requirements. This activity shall be repeated when changes occur that invalidate the original results (e.g., engineering changes, production process changes, tooling changes).

NOTE: This activity can be referred to as First Article Inspection (FAI).

FIRST ARTICLE INSPECTION (FAI)

(Also referred to as Production Process Verification)

- *A planned, complete, independent, and documented inspection and verification process to ensure that prescribed production methods have produced an item conforming to engineering drawings, Digital Product Definition (DPD), planning, purchase order, engineering specifications, and/or other applicable design documents.*

- *It applies to organizations that are responsible for producing the design characteristics of a product. They shall flow down the requirements to suppliers or processors who produce design characteristics.*

Why is an FAI required?

To validate that product realization processes are capable of producing parts and assemblies that meet engineering and design requirements. A well planned FAI will:

- *Shows manufacturing processes are capable of producing conforming product and manufacturing process capability.*

- *Shows suppliers and manufacturers understand the process requirements.*

- *Provides assurance and reduces risk that product conforms to requirements at the start of production and provides a vehicle for continued assurance as process or requirements change.*

What is an FAI intended to do?

- *Help ensure safety of flight.*
- *Improve quality, delivery, and customer satisfaction.*
- *Reduce costs and production delays associated with product non-conformance.*
- *Identify production processes that are not capable.*
- *Used to initiate and/or validate corrective actions.*
- *Reduce costs and production delays associated with non-conforming products.*

Some “rules” for use

Applies to:

- *Assemblies, sub assemblies, and detail parts including castings and forgings, and modifications to part standards.*

Unless contractually required this does not apply to:

- *Development or prototype parts that are not considered part of the first production run.*

- *Unique or single part run production orders not intended for ongoing production (i.e., out of production spares)*

- *Standard catalogue items, or deliverable software (see definitions).*
  - ❑ *Standards (nuts, bolts, screws, washers.....).*
  - ❑ *Common electrical or electronic parts.*

What is included on a First Article Inspection Report (FAIR)

- *Verification of all design characteristics*
- *Material and Special Process Certifications*
- *Manufacturing Process Verification*
- *Non-conformance resolution*
- *FAIRs for major subassemblies*

Some key definitions

Attribute data:

Only an appraised vs a measured characteristic to determine whether or not it conforms (go/no-go, accept/reject, pass/fail, etc).

Standard of the shelf items:

Items intended by design to be purchased and used as is without modification.

Design Characteristics:

Dimensional, visual, functional, mechanical, and material features or properties that describe or constitute the design of an article as specified by drawing or DPD requirements.

Designed Tooling:

Product specific tooling specifically made to validate characteristics of a specific item or family of parts (i.e., a check fixture).

Digital Product Definition (DPD):

Requirements of digital data files that disclose, either directly or by reference, the physical or functional requirements, including data files that disclose the design or acceptance criteria of a product.

First Article Inspection Report (FAIR):

The forms and package of documentation for a part number, subassembly, or assembly that record FAI results.

First Production Run:

The initial group of one or more parts that are the result of a planned process designed to be used for future production of the same parts.

Partial (Delta) FAI:

Addresses differences between current configuration and prior approved configuration. Typically applies when only a few characteristics change. When used list previous part number, revision level, and reason for the partial in Form 1, Block 14.

Qualified tooling:

Universal calibrated monitoring and measuring equipment used to validate product characteristics. Identified and traceable to calibration records. Not part or item specific (caliper, thread gages, scales, etc).

Special Processes:

Any process or provision where the resulting output CANNOT be verified by subsequent monitoring or measuring. Deficiencies are only apparent after the product is in use or the service has been delivered.

Variable Data:

Quantitative measurements. Expresses as a measurement with tolerances. Can be verified using qualified tooling and expressed as a number.

FAI Requirements

Part Requirements

- *Perform FAI on new product representative from the first production run. First production delivery parts require an FAI.*
- *For assemblies, the assembly level FAI is performed on those characteristics specified on the assembly level drawing or DPD.*
- *When changes occur that invalidate the original results, a new FAI (or partial FAI must be performed).*

Planning Requirements

- *Unless otherwise specified, FAI requirements are to be in accordance with AS9102.*
    - *Considerations for planning FAI with customers*

Digital Product Definition

Requirements

When requirements are in a DPD format and traditional 2D drawing information is not available for all applicable design requirements, DPD design characteristics required for product verification shall be extracted, verified, and included in the FAIR.

Organization shall

- *Have a process to extract DPD information applicable to DPD design characteristics.*
- *Extract the DPD information required for product realization.*
- *Ensure all production, inspection, and operations requiring verification have been completed as planned and meet the DPD design characteristics.*

Digital Product Definition

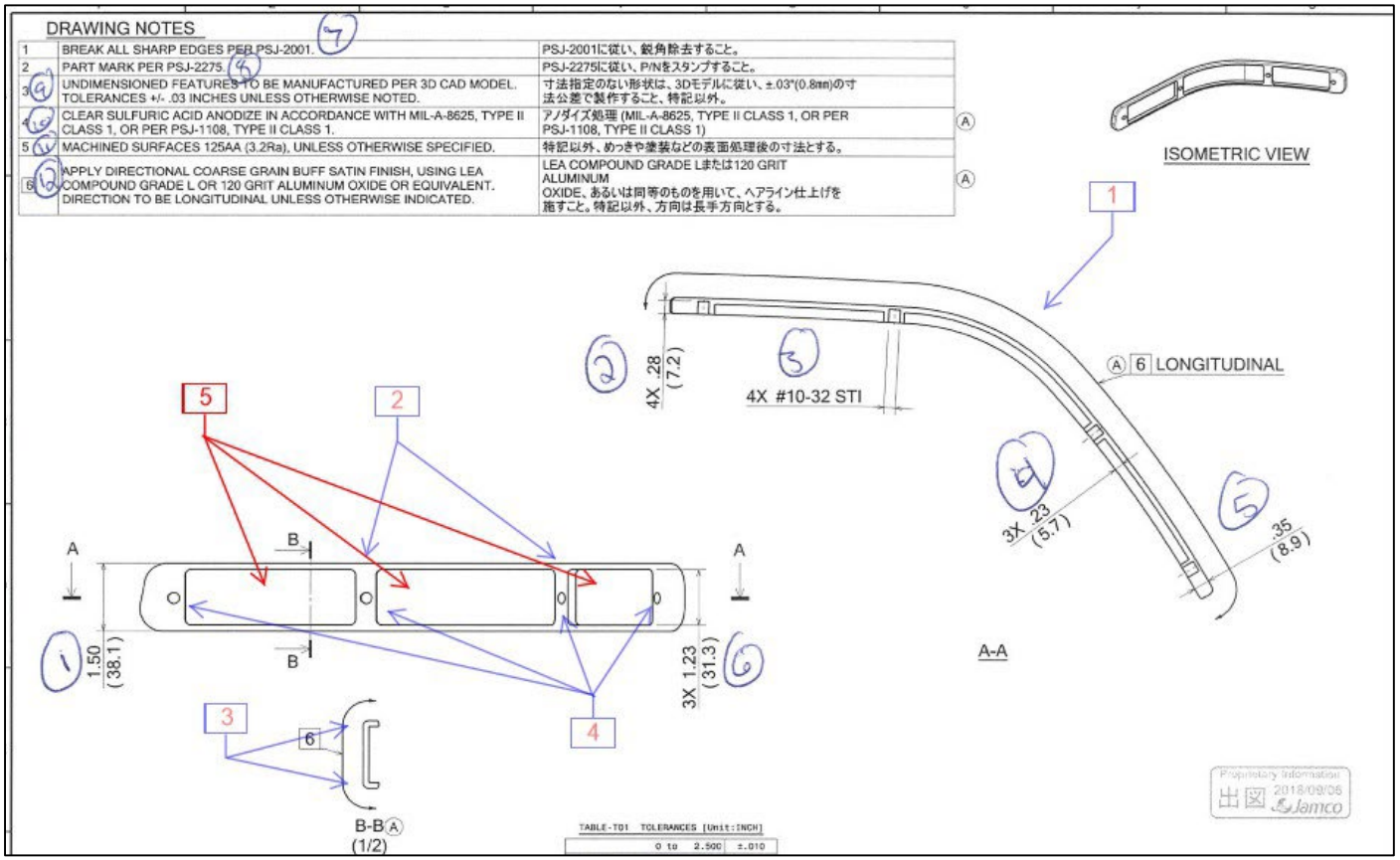
The following slide demonstrates what DPD is asking. The drawing shows a number of dimensions along with drawing notes. The dimensions and notes are "bubbled" and included on FAI Form 3 for this part as follows:

A. Bubbles 1-6 captured variable data shown on the 2D drawing picture sheet. Those bubbles are:
    1. Width (1.50")
    2. Hole depth, x4 (0.28")
    3. Hole thread size, 4x (10-32 STI)
    4. Depth of cutout, 3x (0.23")
    5. Thickness (0.35")
    6. Width of cutout, 3x (1.23")
B. Bubbles 7 – 12 acknowledged drawing notes.

Features identified in the boxes are features made per the model that are not part of the 2D picture sheet. This feature data from the model needs extracted to show what the "required" measurement is for Form 3, Field 8 so it can be measured and recorded in Field 9. Those boxes ask:

A. Box 1 – What is the angle of this bend? What is the radius of the bend?
B. Box 2 – What is the width of the ribs (length defined by cutout dimension)? What are hole locations in relationship to the ribs and the part? What is the spacing of the holes from what reference point?
C. What is the angle and radius of the corners?
D. What are hole locations in relationship to the ribs and the part? What is the spacing of the holes from what reference point?
E. There are three cutouts described with the width defined (1.23"). What is the length of each cutout and from what reference point?

Digital Product Definition



These are five examples of the type things needing extracted and reported. There may be more. DPD extraction from models for FAI is increasingly important as more and more parts are being made with less and less features and dimension available on the picture sheet or 2D drawing.

FAI Non-Conformance Handling

You can create or receive an FAI with a non-conformance!

Process to perform or evaluate:

- *Record the non-conformance on Form 3.*

- *Record the document non-conformance reference number on Form 3, block 11 (NCR, DS tag or DMR number).*

- *Check Form 1 Box 19 (Non-conformance) of the FAIR and sign the report.*
- *Quarantine parts (MRB).*

- *Corrective actions need implemented and a partial FAI performed for the affected characteristics on the next production run after implementation of corrective actions.*
  - *If the partial does not clear the non-conformance then the FAI is still not complete and the requirement for correction is still in effect.*
  - *A full FAI may be done in lieu of a partial FAI.*
  - *Quarantined parts may be reworked to the FAI verified corrective actions.*

Evaluation

- Review documentation for the manufacturing process.
- Make sure all supporting documentation is present and review for completeness.
- Verify raw material and special process certifications.
- Verify customer approved processes are utilized (Form 2, Block 9). Information should match paperwork received.
- Review any non-conformance documentation.
- Verify required designed tooling is used and recorded on Form 3, Block 10).
- Verify every design characteristic requirement is accounted for, uniquely identified, and has results traceable to each unique identifier.
- Verify design characteristics that are the output of the manufacturing process are measured, inspected, tested, or verified to determine conformance, including DPD characteristics.
- Verify part marking is correct, legible, and correctly located per specifications.

When should an FAI be performed?

(Can be Full or Partial)

When any of the following occur:

- *A change in design characteristics that affects form fit or function.*
- *A change in manufacturing sources, processes, location of manufacture, tooling, or materials that can potentially affect form, fit, or function.*
- *A change in (Computer) Numerical Controlled [(C)NC] program or translation to another media that can potentially affect form, fit, or function.*
- *A natural or man-made event that may adversely affect the manufacturing process.*
- *Implementation of a corrective action based on a non-conformance.*
- *A lapse in production for two years shall be updated for any characteristic that may be impacted by the inactivity.*

FAI Forms

FAIR is in three parts

- *FORM 1 – Part Number Accountability*
  - *Listing of parts, components, and subassemblies used to make the item listed in Block 1.*
- *Form 2 – Product Accountability*
  - *Materials, special processes, and functional testing used to make the item listed in Block 1.*
- *Form 3 – Characteristic Accountability (see next slide)*
- *Balloon Drawing*
  - *Used in conjunction with Form 3 to* verify every design characteristic requirement is accounted for, uniquely identified, and has results traceable to each unique identifier.

Characteristic Accountability

1. Verify every unique design characteristic during the FAI and record the associated results. Every characteristic shall have it's own unique characteristic number.

2. Reference characteristics may be omitted.

3. More than one line may be used for any characteristic if needed.

4. Characteristics not measurable in the final product shall be verified during the manufacturing process as long as they are not affected by subsequent operations or by destructive means.
    a. Detail level characteristics may be referenced on the assembly level FAIR.

Form “rules”

1. Any format form can be used, however they shall contain all “Required” and “Conditionally Required” information and have the same field reference numbers.

2. Forms have changed in AS9102 Revision C, so use forms that comply.

3. All forms shall be completed either electronically or in permanent ink.

4. All forms shall be in English (Unless specified otherwise by contract).

5. Continuation sheets and adding additional rows on a Form are acceptable.

Forms

1. “Mandatory” – no choice.

2. “Shall” – required if information is available.

3. “May” – indicates choice.

4. For completing blocks on the FAI Forms

    a. (R) – Required. Mandatory information to be on the FAIR.
    b. (CR) – Conditionally Required. Shall be completed when the information is available.
    c. (O) – Optional. Provided for convenience. May be left blank.

Recording Results

1. Record results in the primary measurement units on the drawing or DPD unless otherwise specified by the customer.

2. Use variable data when the design characteristic is expressed in numerical terms. Attribute data may be used in lieu of variable data when:
   a. No inspection technique resulting in variable data can be done.
   b. Designed or qualified tooling is consistently used as a check fixture. When used, record the range for acceptance.

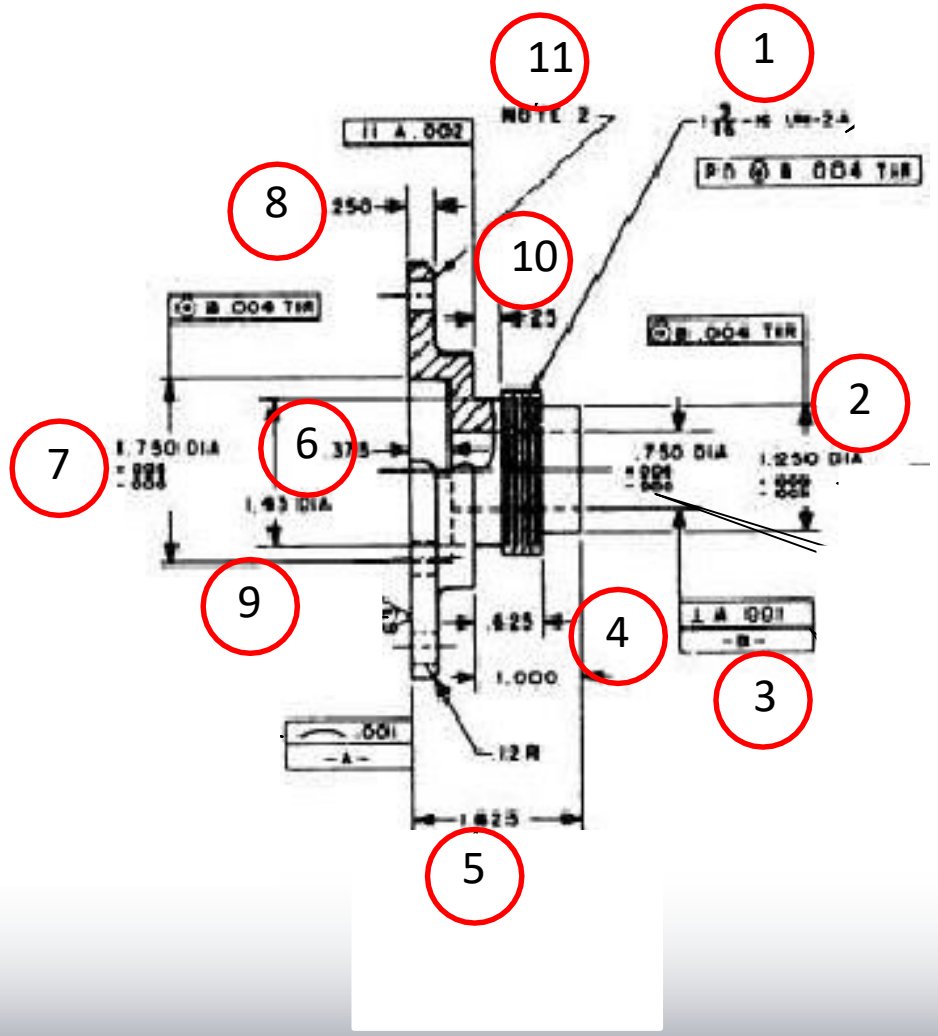
3. Attribute data shall be used when design characteristic does not specify numerical limits (i.e., drawing notes like “deburr” or part mark). Signify results as “Verified” or “Acceptable”.

BALLOONED DRAWING

A ballooned drawing is a required element of a FAIR package to support Field 5 of Form 3.

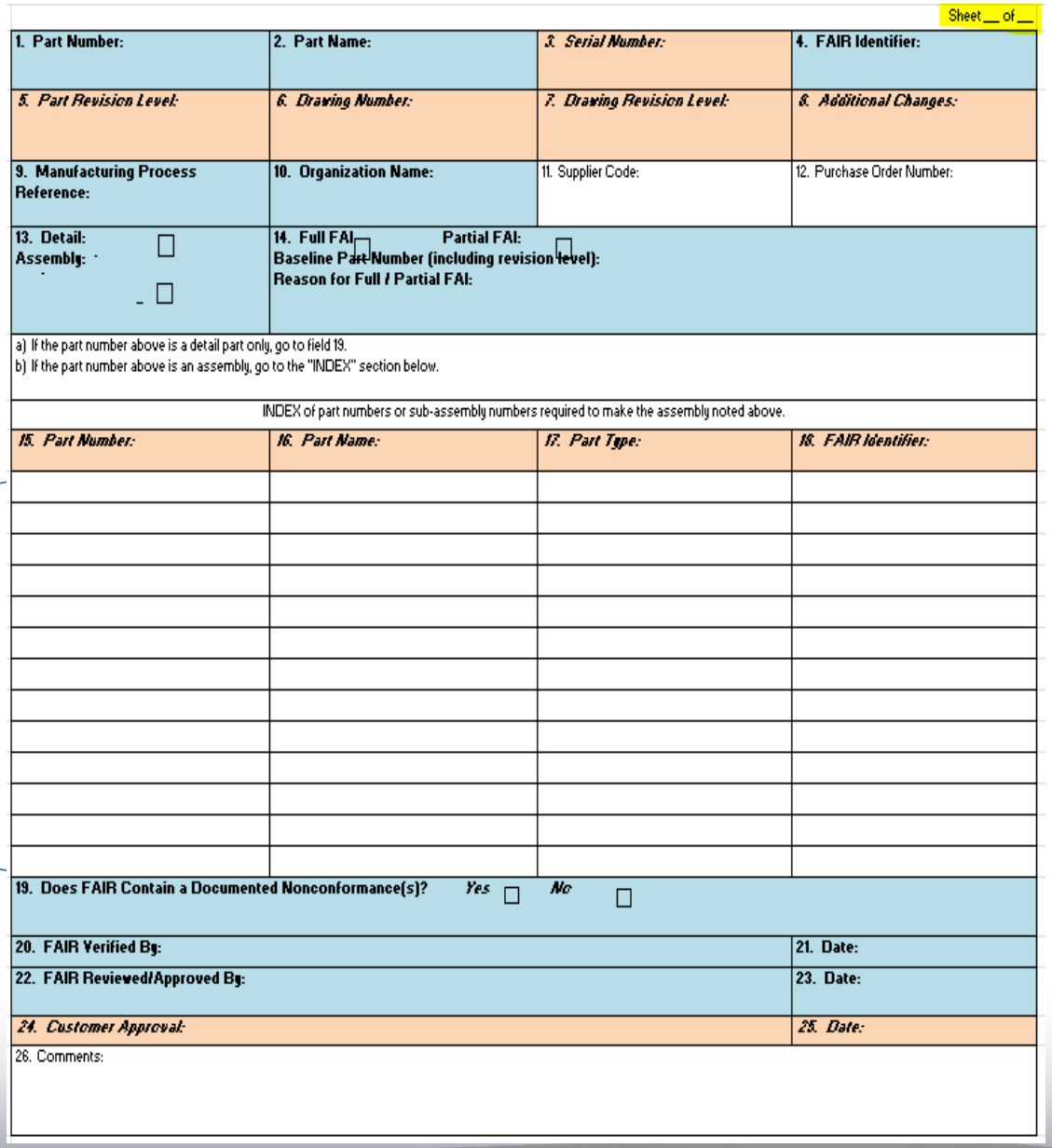
- Identify 100% of characteristics:
- Balloon and number all dimensions
- Balloon and number all applicable drawing note/flagnote callouts
  - Material and hardness callouts, finish callouts, part mark callout, etc.
  - Don’t forget any requirements identified in the drawing itself (not in notes/flagnotes)

BALLOONED DRAWING



Form 1

- Fields highlighted in **BLUE** are required fields and completing them accurately is mandatory.
- Fields highlighted in **ORANGE** are
- Conditionally required fields. They are to be completed when the information is available. If no information is available then enter "N/A".
- Fields that are WHITE are optional and can be left blank.
- Highlights:
    1. Block/column 15 is where all components used to make the part number shown in block 1 are to be listed. These would be the items typically on the Bill of Materials.
        1. **REMEMBER:** Some of these items may also require FAIR of their own.



Sheet __ of __

1. Part Number:	2. Part Name:	3. Serial Number:	4. FAIR Identifier:
5. Part Revision Level:	6. Drawing Number:	7. Drawing Revision Level:	8. Additional Changes:
9. Manufacturing Process Reference:	10. Organization Name:	11. Supplier Code:	12. Purchase Order Number:
13. Detail: ☐ Assembly: ☐	14. Full FAI ☐ Partial FAI: ☐ Baseline Part Number (including revision level): Reason for Full / Partial FAI:		

a) If the part number above is a detail part only, go to field 19.
b) If the part number above is an assembly, go to the "INDEX" section below.

INDEX of part numbers or sub-assembly numbers required to make the assembly noted above.

15. Part Number:	16. Part Name:	17. Part Type:	18. FAIR Identifier:

19. Does FAIR Contain a Documented Nonconformance(s)? Yes ☐ No ☐	
20. FAIR Verified By:	21. Date:
22. FAIR Reviewed/Approved By:	23. Date:
24. Customer Approval:	25. Date:
26. Comments:	

Instructions for Form 1

BLOCK NO.	STATUS	INSTRUCTION
1	Required	Enter the complete part number for the part
2	Required	Enter the name of the part
3	Conditionally Required	Enter the serial number of the part (if serial number controlled)
4	Required	Enter the reference number which identifies the FAIR.
5	Conditionally Required	Enter the part revision level of the FAI part. NOTE: This may be different than the drawing revision level.
6	Conditionally Required	Enter the complete drawing number of the FAI part
7	Conditionally Required	Enter the drawing revision level. NOTE: This may be different than the part revision level.
8	Conditionally Required	Provide reference numbers of any changes incorporated in the product but not reflected in the drawing/part revision level. Example: Engineering change orders, manufacturing changes, deviations, or exclusion from drawing requirements, etc.
9	Required	Enter the manufacturing order number. Additional information such as PO number, batch number, date code or line number may be included as needed to provide traceability to the specific manufacturing lot.
10	Required	The name of the organization preparing the FAIR. (For internal FAIR this is "Jamco-America".)
11	Optional	The supplier code of the organization which prepared the FAIR
12	Optional	The PO Number for parts made by approved suppliers
13	Required	Check detail or assembly FAI as appropriate
14	Required	Check full or partial FAI as appropriate
15	Conditionally Required	The part number(s) and items from the BOM included in the assembly identified in Block 1
16	Conditionally Required	The name of the part installed in the assembly
17	Conditionally Required	Enter whether the part is a detail part, sub-assembly, software, or Industry Standard
18	Conditionally Required	The FAIR number for the item identified in block 16
19	Required	Check yes/no for Nonconformances on top level assembly
20	Required	Printed name and signature of the person preparing the FAIR. Indicate by checking the appropriate box if the FAIR is complete or not complete.
21	Required	Date block 20 was completed by the person preparing the report
22	Required	Printed name and signature of the person from the preparing organization who reviewed/approved the FAIR
23	Required	Date block 22 was signed
24	Required for externally generated FAIR	Printed name and signature of JA reviewer accepting the external FAIR as correct
25	Required for externally generated FAIR	Date block 24 was signed
26	Optional	Add comments

Form 2

- Fields highlighted in **BLUE** are required fields and completing them accurately is mandatory.
- Fields highlighted in **ORANGE** are
- Conditionally required fields. They are to be completed when the information is available. If no information is available then enter "N/A".
- Fields that are WHITE are optional and can be left blank.
- Highlights:
  - If there is a material of process listed in Block/column 6 then all block entries across that line entry need to be completed.
  - If there is a material listed make sure the Certificate of Conformance number is listed.
  - Include the name and address of any vendor supplying material or performing any process for you is shown in Block/column 8 in Block/column 9.

Sheet __ of __

1. Part Number:	2. Part Name:		3. Serial Number:		4. FAIR Identifier:
5. Material or Process Name:	6. Specification Number:	7. Code:	8. Supplier:	9. Customer Approval Verification:	10. Certificate of Conformance Number:
11. Functional Test Procedure Number:			12. Acceptance Report Number:		
13. Comments					

Instructions for Form 2

BLOCK NO.	STATUS	INSTRUCTION
1	Required	Enter the complete part number for the part
2	Required	Enter the name of the part
3	Conditionally Required	Enter the serial number of the part (if serial number controlled)
4	Required	Enter the reference number which identifies the FAIR.
5	Conditionally Required	Enter the name of the material or special process
6	Conditionally Required	Enter the following: •Material specifications and form for all materials incorporated into the FAI (braze filler, welds, etc.). •Special process specifications •Any Industry Standard items which were modified
7	Optional	Enter any required code from the customer for material or process listing
8	Conditionally Required	Enter the name, address, and code of the supplier performing the special process listed
9	Conditionally Required	Indicate if the special supplier processes are approved by the customer: Enter yes if approved, no if not approved, or N/A if not required.
10	Conditionally Required	Enter the C of C number for the special process completion, raw material test report, modified Industry Standard item compliance number, or traceability number
11	Conditionally Required	Enter the Functional Test Procedure/Acceptance Test Procedure number, if applicable
12	Conditionally Required	Enter the functional test/acceptance test certification number indicating compliance to requirements
13	Optional	Any additional comments

Form 3

- Fields highlighted in **BLUE** are required fields and completing them accurately is mandatory.
- Fields highlighted in **ORANGE** are

Conditionally required fields. They are to be completed when the information is available. If no information is available, then enter "N/A".

- Fields that are WHITE are optional and can be left blank.

Sheet __ of __

1. Part Number:				2. Part Name:			3. Serial Number:	4. FAIR Identifier:
Characteristic Accountability				Inspection / Test Results				
5. Char. No.:	6. Reference Location:	7. Characteristic Designator:	8. Requirement:	9. Results:	10. Designed / Qualified Tooling:	11. Nonconformance Number:	12. Additional Data / Comments:	

Instructions for Form 3

BLOCK NO.	STATUS	INSTRUCTION
1	Required	Enter the complete part number for the part
2	Required	Enter the name of the part
3	Conditionally Required	Enter the serial number of the part (if serial number controlled)
4	Required	Enter the reference number which identifies the FAIR.
5	Required	Enter the unique assigned balloon number
6	Conditionally Required	Identify the drawing location (zone, drawing sheet, etc.)
7	Conditionally Required	Record the characteristic type (Key characteristic, flight safety, etc.)
8	Required	Enter the specified requirement for the characteristic. Include nominal and tolerance, drawing note, specification requirement.
9	Required	Enter measurements obtained for the design characteristic in the same measurement unit described on the drawing (inches, mm, etc.). •For multiple characteristics list each as an individual value or list it once with min and max measured values. If a characteristic is found non-conforming, then list that characteristic separately with its measured value. •When qualified tooling is used as a go/no go gage record the results as pass/fail. • When automated inspection equipment produces measurement results, those results may be referenced on Form 3 identified as pass/fail and attached only when: – The characteristic numbers are clearly linked in the attached report [e.g., characteristic identification on Coordinate Measurement System (CMS) report is the same as on this form]. – The results in the attached reports are clearly traceable to the characteristic numbers. – The results are directly comparable to the design characteristic. * A CMS report only depicting deviation from nominal in multiple axes is not acceptable; the report shall reflect an actual geometric value. •If a design requirement requires verification testing, record the actual results on the form. If a lab report or certificate is required record its reference number. •For characteristics with visual verification requirements rated against standard photographs, list the photo number of the closest comparison •For processes which require verification per design characteristics include a statement of conformance and list number, indicator and write “Accept” •For characteristics verified by attribute inspection include a statement of conformance. “Accept”
10	Conditionally Required	Record tool identification or NC program number if tooling or program is used as the inspection media for attribute acceptance. When qualified tooling is used for attribute acceptance, record the gauge value or range (e.g., minimum/maximum value), as applicable.
11	Conditionally Required	Enter the DMR number/s for characteristics found non-conforming
12	Optional	Enter any additional data or qualifying comments needed

Some Final FAI Comments

- The block at the top of each Form that says “Sheet ____of ___” is for that Form only.
  - Example: If each Form is only one page then all three Forms will say “Sheet 1 of 1”.
- As you can add pages to each Form as needed to include all needed information then Forms would be numbered accordingly.
  - Example: If Form 2 needed two pages Form 2 would be numbered “Sheet 1 of 2” and “Sheet 2 of 2”. Forms 1 and 3 would both stay “Sheet 1 of 1”.
- A complete FAI package may consist of several First Article Inspection Reports.
  - If the FAIR is a top level assembly, anything listed on Form 1 that is a sub-assembly, component, or modified commercial item should have their own FAIR attached to and as part of that top level FAIR.
- A First Article Inspection Report does not have to have all three Forms.
  - If the FAIR is for a process only, such as plating, and has no characteristics to capture then Form 3 is not needed.
  - If the FAI has no materials and special processes not already accounted for then Form 2 is not needed.
  - The same applies for Partial FAI’s. Only the Forms needed to capture the reason or characteristics driving the Partial requirement are needed.
- An FAI can fail and have a non-conformance as indicated on Form 3 instructions. It is still a completed FAI with a failed feature. The FAI can be corrected by rework or on the next production run and a partial FAI done for the feature that failed that indicates correction of the defective condition.