

FIRST ARTICLE INSPECTION 101: COMPREHENSIVE USER GUIDE

A first article inspection tells the story of the manufacturing processes that a part goes through before receiving approval from the governing design body. Sometimes a first article inspection is performed internally, but often the first article inspection is performed by the third-party manufacturer or a third-party inspection company and later reviewed by the governing design body.

A first article inspection (FAI) is the process of validating and verifying a manufacturing process or a change to a manufacturing process to ensure that it conforms with the specifications outlined by the technical requirements, as defined by the governing design body or the customer requirements.

In this article, we outline the importance of first article inspections, as well as guide you through the things that you will need to successfully perform a first article inspection.

What is a First Article Inspection? (FAI)

A first article inspection is as simple as it sounds. It is the inspection of the initial completed part to approve the procedures and capabilities of production. The process of completing an FAI often includes the validation of the materials used, special processes, assembled components, part marking/part identification, and dimensional requirements.

- **Materials used** - each part is manufactured using specific materials that have the composition to perform the needed task. Sometimes cheaper materials will be used for mass production of medical devices or automotive components. For critical components, materials are often tested for cracks, fractures, inclusions, hardness, conductivity, and more.
- **Special Processes** - Special processes are anything that is done to change the external properties of a part, such as paint, chemical films, soft and hard anodize coating or nickel plating.
- **Assembled components** - Assembled components are all the parts that are fastened, sealed, riveted, bolted, or inserted into the main part. It is possible for an FAI to feature multiple parts assembled to each other, as well as many different types of assembled components. Common assembled components for aerospace and defense parts are helicoils, threaded inserts, nut plates, and brackets.
- **Part marking/part identification** - Part marking is a crucial step to ensure the traceability of a product. Popular part marking methods include etching, engraving, ink stamping, tagging and raised/depressed molded.
- **Dimensional Requirements** - Dimensional requirements are typically determined by the governing design agency and are used to ensure the fit and function of a component. Dimensional requirements include lengths, diameters, true positions, profiles, perpendicularity, as well as other geometric dimensional callouts.

When a first article is called for, this typically means that the governing body requires the vendor to utilize an AS9102 form to fulfill their inspection.

Why Do I Need a First Article Inspection?



A first article inspection is often prescribed by the governing design body to validate the materials and processes used by the manufacturer to produce the part. A first article inspection is intended to catch any discrepancies, as well as manufacturing process issues or inefficiencies that could lead to an increase in cost when the part goes to full-scale production.

Not all parts from every industry require an official first article inspection on an AS9102 form, but it is almost universally used for all produced parts in the aerospace and defense industry.

How to Perform a First Article Inspection.

Performing a first article inspection usually involves collecting the required documents and transposing the required information into the First Article Inspection Report or AS9102 form.

1. Collect required documents.
2. Confirm that the product was manufactured according to the manufacturer's requirements.
3. Transpose material information, special process information, and dimensional inspection data to the First Article Inspection Report or AS9102 form.

What documents are needed for a first article inspection?

- **Material Certificate** - A certificate from the material producer (mill) that contains information about the composition of the material, as well as the heat lot information. Mill material certificates should contain a lot number, batch number, and heat lot number. (You will need material certifications for all components used for the main assembly).
- **Raw Material Test Results** - After the material is produced, it is tested to ensure that it meets the material requirements for the specified material composition. The raw material test results must be traceable to the material certificate by the lot number, batch number, or heat lot number.
- **Material testing reports** - A report shall be submitted for each destructive and non-destructive test required or performed on the material. These tests often include sheer testing, penetrant testing and eddy current testing.
- **Dimensional Inspection Report** - A dimensional inspection report covers all required dimensions for the FAI or the Delta FAI. The dimensional inspection report is typically accompanied by a balloon drawing that numbers the dimensions required on the FAI.

- **Special Process Certificates** - A report shall be submitted for all special processes performed on the part. If the special process requires the use of paint/coating or other materials that have expiration dates, the expiration date should be included on the certificate as well.

All certificates should be traceable back to the original material certificate!

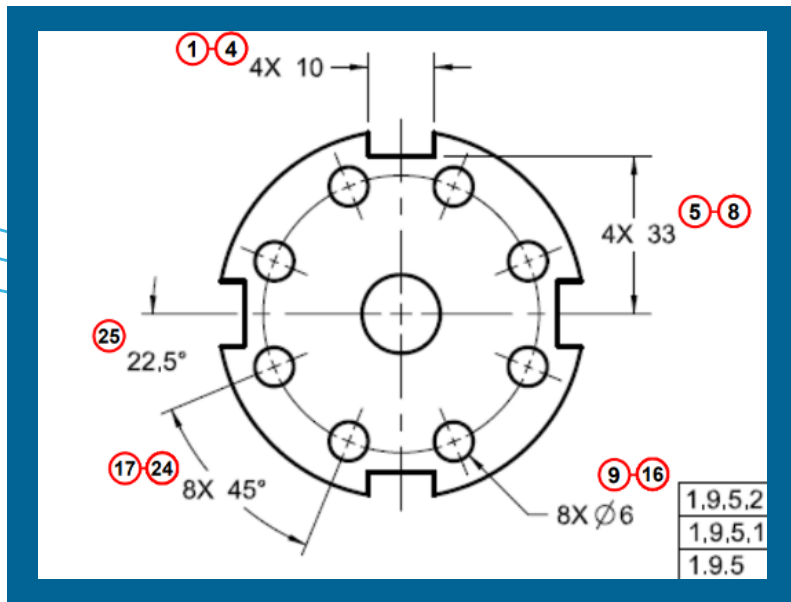
- **Other Requested Documents** - Often the governing design body will also request additional certifications with their first article, such as oven logs, non-destructive testing (NDT) technique approval, and NDT personnel credentials.

Who Performs the First Article Inspection?

The first article inspection is typically performed by a quality technician that is trained in the intricate details of the AS9102 standard. You do not have to be certified to fill out first article inspection forms, but you will need a basic knowledge of the manufacturing processes, blueprint reading, inspection criteria, and special processes.

In a manufacturing environment, the person completing the first article inspection also often presents that information to a source inspector or a receiving inspector. Complete and accurate information is crucial for first articles, especially when your supplier scorecard can sometimes include affected defects and corrections.

What is a Balloon Drawing?



A balloon drawing is created by adding a numbering scheme “balloons” to each dimension on a blueprint that will define the order of the inspection report. Typically, a first article inspection report will come with a balloon drawing to assist in identifying inspection and engineering on manufacturing defects, as well as dimensions where further analysis is needed of tolerances.

What is an AS9102 Form?

The AS9102 form is an aerospace first article requirement that lays out a template for collecting and reporting important information about the materials, special processes, and dimensional requirements. The AS9102 form outlines the standard fields for first article inspection, and it is common for customers to add fields for their own specific requirements.

FORM 1: Part Number Accountability

Form 1 contains 24 standard fields for part number accountability, including important information about the organization, as well as all part numbers involved.

REQUIRED INFORMATION

1. Part Number
2. Part Name
9. Manufacturing Process Reference (router number / manufacturing plan number)
10. Organization Name
13. Detail Part or Assembly FAI
14. Full Part or Partial FAI
19. Signature
20. Date (for field 19)

CONDITIONALLY REQUIRED INFORMATION

3. Serial Number
4. FAIR Number
5. Part Revision Level
6. Drawing Number
7. Drawing Revision Level
8. Additional Changes
15. Part Number (Only required for assemblies)
16. Part Name (Only required for assemblies)
17. Part Serial Number (Only required for assemblies)
- 18 FAIR Number (Only required for assemblies)

OPTIONAL INFORMATION

11. Supplier Code
12. Customer P.O. Number
21. Reviewed By
22. Date (For field 21)
23. Customer Approval
24. Date (For field 23)



FORM 2: Product Accountability

Form 2 contains 15 standard fields for product accountability, including information for materials, special processes, and functional testing requirements.

REQUIRED INFORMATION

1. Part Number
2. Part Name
14. Signature
15. Date (for field 14)

CONDITIONALLY REQUIRED INFORMATION

3. Serial Number
4. FAIR Number
5. Material or Process Name
6. Specification Number
8. Supplier
9. Customer Approval Verification
10. Certificate of Conformance Number
11. Functional Test Procedure Number
12. Acceptance Report Number

OPTIONAL INFORMATION

7. Code (customer process or material code)
13. Comments

FORM 3: Characteristic Accountability

Form 3 contains 14 standard fields for characteristic accountability, including dimensional verification and blueprint requirement verifications.

REQUIRED INFORMATION

1. Part Number
2. Part Name
5. Characteristic Number
8. Requirement
9. Results
12. Signature
13. Date (for field 12)

CONDITIONALLY REQUIRED INFORMATION

3. Serial Number
4. FAIR Number
6. Reference Location (Blueprint Zone or Note)
7. Characteristic Designator (Critical, Key, Flight Safety)
10. Designed / Qualified Tooling
11. Nonconformance Number

OPTIONAL INFORMATION

14. Additional Data / Comments

What Happens if a Part Fails a First Article Inspection?

Depending on organizational and governing standard(s) requirements, nonconforming first article inspected parts are segregated and dispositioned by the organization or the customer. Depending on the customer, you may get a concession for the nonconformance, or you may have to reproduce the product using a more capable method.

What is the Alternative to a First Article Inspection?

Most quality management systems require part verification and documentation for proving manufacturing process capability, but not all governing standards explicitly require a first article inspection. The first article inspection requirement is only applied universally to aerospace parts.

AS9100 D (Aerospace and Defense) includes specific requirements for validation of the first product requirements.

AS9100 D - 8.5.1.3 p2

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).

ISO 9001:2015 (General Manufacturing) does not have a first part requirement but does require documented evidence of conformance to customer requirements.

ISO 9001:2015 8.5.1.a

Controlled conditions shall include, as applicable:

a) the availability of documented information that defines:

- 1) the characteristics of the products to be produced, the services to be provided, or the activities to be performed;*
- 2) the results to be achieved;*

ISO 13485 (Medical) does not have a first part inspection requirement and also does not explicitly require documentation of inspection results, but it does have requirements for planning and implementing demonstrations of conformity. An inspection report is recommended to provide objective evidence of compliance to the specification.

ISO 13485 8.1.a

The organization shall plan and implement the monitoring, measurement, analysis and improvement processes needed to:

- a) demonstrate conformity of product;*

ISO 17025 (Testing and Calibration Labs) does not have a requirement for first part inspection because ISO 17025 does not have any governance for manufacturing processes. ISO 17025 does require retention of technical records involving customer requirements.

ISO 17025 7.8.1.2

The results shall be provided accurately, clearly, unambiguously and objectively, usually in a report (e.g. a test report or a calibration certificate or report of sampling), and shall include all the information agreed with the customer and necessary for the interpretation of the results and all information required by the method used. All issued reports shall be retained as technical records.

Industrial Inspection and Analysis Labs Services is accredited to ISO 17025.

If a first article inspection is not required, typically, any inspection report or collected data that can objectively prove compliance to customer and regulatory requirements is acceptable, such as dimensional inspection reports, CMM data reports, and production inspection logs.

Conclusion

First article inspection is a fantastic tool for documenting the materials, special processes, and dimensional requirements outlined by the customer. It is always up to the organization to determine which tool they will use based on customer requirements or the efficacy of the tool.

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Inspections from IIA.



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