Interchangeability and Replacement Inspection of Aircraft Components

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Abstract. Although the aircraft components swap and substitution have described in HB/Z99.7-1987, but for aircraft design, manufacturing and quality control personnel, as the swap and replacement and inspection of aircraft components lack sufficient experience, and the aircraft development stage is resulted, not to swap with the aircraft design and relevant technical requirements to replace the inspection work. Moreover, the manufacturing process lacks sufficient preparation for the manufacture of tooling and inspection methods, this reason lead to a number of exchange problems during the exchange and replacement inspection, and affecting to the subsequent production. In this article, the swap and replacement inspection technologies are discussed in detail from perspective of the manufacturing process, and on the basis of HB/Z99.7-1987. Then, the swap and replace the problems is analyzed, summarized.

1. Introduction

Aircraft components interchangeable and replacement check is to verify whether the product has a swap and replacement. From the manufacturer's perspective, this is requested that the production line can be stably manufactured to meet the requirements of the exchange and replacement products. It creates favorable conditions for the use, maintenance and rapid airworthiness of aircraft, is conducive to the organization of specialized production and can effectively reflect the stability of product quality [1]. At present, the standard of HB/Z99.7-1987 and replace in the provided aircraft components swap, but due to aircraft design and quality control staff lack in the process of aircraft manufacturing and inspection exchange experience, resulting in the aircraft manufacturing process, the lack of exchange and replacement check technical requirements, the manufacturing process caused by the lack of adequate preparation for manufacturing industry equipment and detection means, and then make the swap and replace the inspection work cannot be carried out, the impact of the development cycle of aircraft [2-3]. In this paper, from the angle of the manufacturing process, on the basis of HB/Z99.7-1987, this paper elaborates on the aircraft components and replace the swap inspection technology of workflow, and for exchange and emerge to replace the inspection process issues detailed analysis, the author gives the thinking and experience in aircraft components are interchangeable and replacement.

2. The workflow of Exchange replacement inspection

The workflow of Exchange replacement inspection are mainly includes the determination of exchange and replacement items, the technical requirements for exchange and replacement, the technical review of exchange and replacement parts, the process tolerance allocation, and the process preparation of exchange and replacement parts. The workflow of Exchange replacement inspection is shown in Fig.1.

The workflow of aircraft component exchange and replacement inspection is analysis detailed as follows.

(1) Exchange and replacement project determination. The exchange and replacement items are jointly determined by the product design, user representatives and manufacturers. In the early days of
the aircraft development, exchange and replacement items need to be identified so that the manufacturer can prepare for the process and avoid late changes to the production line. At the same time, each interchange and replacement inspection item corresponds to a product drawing number.

Figure 1. The workflow of Exchange replacement inspection.

(2) Requirements for technical requirements for interchange and replacement. After the exchange check item has been determined, the product design shall incorporate the interchangeability and replacement inspection sites and technical requirements into the technical conditions for the acceptance of the drawings or components. Product design personnel to determine the technical requirements should pay attention to check the product state provisions, such as sports attitude.

(3) Technical review of exchange and replacement drawings. Technical review of the drawings and technical conditions of the exchange and replacement items are by the manufacturer and the technicians. That includes tolerance allocation and design compensation between exchange and replacement parts and reference parts.

(4) Process tolerance allocation. The manufacturing department shall be responsible for the allocation of the tolerance of the three stages and the subordinate components of the reference parts, interchangeable parts, and opposite parts, so as to ensure the interchangeability and substitution of the products.

(5) Process preparation for exchange and replacement parts. In the process of exchanging and replacing parts, it is necessary to give full consideration to the guarantee methods and testing methods of the reference parts, interchangeable parts and technical requirements. For the parts of interchange and replacement, the intersection point, function and so on, control method must be set up and corresponding test method should be provided.

(6) Prepare exchange and replacement inspection plan. The military aircraft shall begin the exchange and replacement inspection at the stage of small batch production after the design is finalized, but the exchange and replacement shall not be required. The process department shall, in accordance with this principle, prepare an exchange and replacement inspection plan in accordance with the exchange principle and the actual production situation. The exchange and replacement inspection plan shall include inspection of each exchange item, implementation of the vehicle, and regular inspection of the sorties and so on.
(7) Technical requirements for the preparation of interchange and replacement inspection. The interchange and replacement inspection technical requirements shall be worked out by the manufacturer, the competent department, the competent process department in accordance with the exchange and replacement catalogues, the design drawings / technical requirements, the exchange and replacement requirements and relevant documents. The technical requirements for interchangeability and replacement inspection shall be specified in terms of reference parts, interchangeable parts, inspection methods, interchangeability and replacement checks, points of intersection, inspection of pin bars, specifications, etc.

(8) Exchange and replacement pre inspection. The manufacturer shall inspect the finished product before checking and adjust the product to its best condition, and then submit it to the exchange and replacement inspectors for inspection.

(9) Interchange and replacement inspection. The exchange and replacement inspectors inspect benchmark parts, exchanges and replacements, and combinations according to product drawings / technical conditions, interchangeability and replacement inspection technical conditions.

(10) Fill out the exchange and replacement inspection report. The inspection results are filled out by the exchange and replacement inspectors in the exchange and replacement inspection reports.

(11) Check the nonconforming items for exchange and replacement. Inspect the unqualified items by the manufacturer according to the nonconforming procedure, and make improvement measures.

(12) Certificate of exchange and replacement inspection certificate issued. When the inspection of exchange and replacement is qualified, the certificate of exchange and replacement inspection certificate issued by the manufacturer's technology department shall be issued.

(13) Periodic inspection. Perform periodical inspection in accordance with the exchange and replacement inspection plan.

3. Analysis and solution of exchange and replacement inspection

Verification of the Finite Element Model. In traditional manufacturing, manufacturing data is mainly transmitted by tooling, long transmission path, low product accuracy and poor stability. Inspection of interchangeability and replacement is necessary. But in the aspect of digital manufacturing, swap and spare parts, standard physics, function and structure requirements are very clear, when the swap and replace parts, reference parts can meet the design requirements, check and replace swap seems to verify the design, most of the parts have no need for inspection.

In fact, with the development of exchange and replacement inspection, the author finds that there is a gap between the actual manufacturing process and the imagination, and the understanding of digital manufacturing is not comprehensive enough in the process of production. There are two main problems. (1) Manufacturing process control is defective. For example, the configuration of the replacement parts and the reference parts is not accurate; the assembly stress is not controlled. (2) The digital detection method of the product is not enough; it cannot effectively reflect the parallel situation after the product is out of the shelf, such as the intersection point of the enclosed area, the coaxiality, the shape of the product and so on. The above problems are the product exchange has great influence and substitutability, so at this stage the swap and replacement inspection is necessary, but with the means of detection, improve the manufacturing process control, can gradually reduce the swap and replace inspection items.

The interchange and replacement inspection method. (1) Determination of specifications for pin bars for intersection inspection. Check the pins on the coaxial frame of the intersection and check the diameter of the pin bar. The manufacturing accuracy of the tool and the manufacturing accuracy of the pin rod shall be considered. The check pins are checked on the coaxial rack, as shown in formula (1).

\[ d = D - U + L + \min T \]  

(1)
In which, D is the coaxial requirement of inspection object; L makes the coaxiality accuracy for the tooling; minT is the lower limit of the accuracy grade of the check pin. The spoiler intersection for example, assuming the intersection hole nominal size for 8mm, the design requirements of spoiler two intersections coaxial for 0.3mm, tooling manufacturing precision of 1/3, which is 0.1mm manufacturing precision inspection for F7 pin, check the diameter of the pin should be carried out according to the minimum standard coaxial inspection. The pin diameter is 7.83 f7.

(2) Interchange and replacement inspection method. In HB/Z99.7-87, 5 inspection methods are defined, namely, 1:1, 1:2, 2:1, 2:2, 2:4 (except for two confidential inspection). In which, When the standard process equipment and assembly process are well equipped and the components or components are stable in quality, 1:1 interchange and replacement inspection methods are recommended. In the above 5 inspection methods, the 1:1 exchange check is the lowest cost inspection method because of no need to change, and it is also the inspection method expected by the manufacturing department. Other inspection methods apply only to fully interchangeable items and require at least two machine reference parts or interchangeable parts. Suppose that the benchmark of the first machines is A, the interchangeability is a, the second machine benchmark is B, and the interchangeable parts are B, the inspection items are shown in tab 1.

<table>
<thead>
<tr>
<th>NO.</th>
<th>Inspection method</th>
<th>Check item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1: 1</td>
<td>A, a, B, b, A+a, B+b</td>
</tr>
<tr>
<td>2</td>
<td>1: 2</td>
<td>A, a, b, A+a, A+b</td>
</tr>
<tr>
<td>3</td>
<td>2: 1</td>
<td>A, B, a, A+a, B+a</td>
</tr>
<tr>
<td>4</td>
<td>2: 2</td>
<td>A, a, B, b, A+a, A+b, B+b</td>
</tr>
</tbody>
</table>

When the product quality is stable under the condition, A, a, B, B are the production line of random products, equivalent to 1:2 and 2:1 examination results, if you do not consider the production arrangement, selection of the 1:2 inspection method to obtain the benchmark quality more stable, can change a more stable quality, select the 2:1 check method. From the exchange check item, 1:1 check more than 1:2 and 2:1 inspection items, but the lack of "change" process, cannot visually display products can be interchangeable". In other words, A+a qualified, B+b qualified, does not mean that A+b can also be qualified. But A B, the equivalent in the production line of two pieces of arbitrary choice datum and a, B is equivalent to the production line arbitrarily chosen two pieces interchangeable parts, A+a B+b qualified, qualified, the quality and stability of the production line, A+b and B+a also need to be qualified.

4. Summary

In view of the interchangeability and replacement inspection in the aircraft manufacturing stage, the workflow of aircraft interchange and replacement inspection is analyzed, and the importance of exchange and replacement inspection in aircraft manufacturing is illustrated. of the manufacturing process and replace the common problem are Analyzed, and the corresponding solutions for the plane scene, provides a feasible method to replace the swap and check the problem, to further improve the exchange and Inspection Standard Specification for replacement aircraft based on reference..

References


