Date Issued October 17, 1995

Strut Cover - Jesse Alteration # JIS0086

A. Effectivity

Engine Model(s)

Engines affected by this document and its implementation are:
Pratt and Whitney PW4000 models

PW4050	PW4060
PW4052	PW4060A
PW4056	PW4060C
PW4460	PW4462

Part Nomenclature

Fairing - Service Replacement Part

OEM Part Number(s) to be Replaced

51G831-01 left hand detail	51G832-01 right hand detail

B. Subject

Alteration Title

Alternative Aluminum Strut Cover.

Alteration Number and Date

Alteration Number JIS0086
Issue Date: 09/21/95

Detail Part Number and Nomenclature

JR00074	Strut Cover - left hand
JR00070	Strut Cover - right hand

C. Reason

Problem

The OEM Kevlar Strut Cover performs its intended function during service. However the part experiences distress during operation and during disassembly at overhaul. Part distress during service is a result of erosion of the bonded stainless steel mesh surface which results in mesh fiber tearing and surface roughening. This leads to a loss of performance. In addition, during overhaul and part removal, and occasionally during operation the part experiences edge delamination of the Kevlar plies.

Cause

Erosion occurs from various size ingested particles which pass over and scrape the strut cover surface at very low angles of incidence.

Delamination damage around the periphery of the part occurs when the part, which is riveted and silicone bonded in place, is forcefully removed from the intermediate case strut. Delamination can also occur if part edges, which are not adequately sealed with silicone rubber, are exposed to the gas path.

Background

Jesse Industries was approached by an Airline to provide an alternate material, lower cost, improved durability strut cover to replace the OEM Kevlar composite cover. Erosion and edge delamination of composite parts are common problems in the aerospace industry. Many parts, such as the Pratt and Whitney composite fan exit guide vane and the splitter fairing, have incorporated metal leading edge treatment to prevent erosion and leading edge delamination of fiber plies. The change to an aluminum strut cover will significantly reduce the erosion problem and eliminate the delamination problems. An additional benefit will be a smoother aero surface over longer operational periods.

D. Description of Alteration

Replacement Aluminum Strut Cover

1. Process Summary

The subject alteration involves the replacement of a Kevlar part with an aluminum part. The form, fit and function of the aluminum part will be identical to the composite part. Replacement information can be found in PW4000 Series Engine Manual (PN 50A822); Compressor Intermediate Case Assembly 72-34-01, Repairs 22 and 34.

2. New Components

See Jesse drawing: JR00070
JR00074

3. Special Materials

No special materials will be used. The aluminum alloy 6061 (AMS 4027) selected for the strut cover is the same alloy that has experienced millions of successful service hours as JT9D fan exit guide vanes in the same operational engine environment.

E. Substantiation

FAR 33.4

Instructions for continued airworthiness. Installation of the aluminum covers will be identical to that of the current composite parts and can be done to instructions in the OEM Engine Manual. In service inspection criteria and repair instructions (Reference 1) will be provided to users of the new covers.

FAR 33.15 Materials

6061 aluminum alloy strut covers (AMS 4027) will be anodized to AMS 2470, which is the same treatment used in preparing the JT9D fan exit guide vanes for service operation. Rivets used in the installation of the strut cover will be identical to current bill of material.

FAR 33.19 Durability

Metal parts in gas turbine engines have demonstrated improved erosion durability and no delamination when compared to composite parts. The aluminum alloy selected has a proven durability record after millions of service hours as JT9D fan exit guide vanes.

The aluminum strut cover (Figure 1) was designed by Chromalloy Connecticut for Jesse Industries to provide equivalent or higher deflection stiffness when compared to the OEM Kevlar composite part without significant weight increase (Table 1).

TABLE I

	Composite Part	Aluminum Part	Weight Increase
Part Weight	171 gms	183 gms	12 gms
Set Weight	6.026 lbs	6.449 lbs	0.423 lbs

The machined cavities on the non gas path side provide weight reduction while maintaining stiffness. The aluminum part is at least 25% stiffer than the composite part. Details of the development and substantiation test effort and data are presented in Reference 2.

Although a stiffness improvement alone does not indicate that the part will be vibration/flutter free, other factors in the design and attachment indicate that vibration/flutter are not a concern. These factors are:

- Part is assembled on a layer of silicone rubber and has an edge seal of rubber as well. The rubber provides excellent vibration damping to the part.
- The unsupported axial and radial span length of the strut cover is relatively short.
- Part is fastened all around its periphery by rivets.
- Part is constructed with ribs on the back surface which are also effective in preventing panel vibratory modes from operating.

Damage from large foreign objects is not any more a concern for the aluminum part than for the composite part. The strut cover is protected behind the metal leading edge of the strut. In addition, anything which does get by and impacts the strut cover will do so at a very shallow angle which will minimize damage.

FAR 36 Acoustic Considerations

The OEM designed strut covers used on early PW4000 engines consisted of a perforated composite laminate structure with a fine mesh bonded metallic screen as an outer covering. However, whatever sound absorbing qualities these parts had was eliminated by SB PW4ENG 72-490 which introduced non-perforated replacement strut covers. The metallic covers proposed will be similar acoustically to these most recent OEM parts and therefore the engine noise signature will be unchanged.

Service History Monitoring

United Airlines is proposing to perform a CSU (Controlled Service Use) test. Periodic visual inspections for cracks will be made during this test.

F. References

1. In service inspection criteria and repair instructions
2. Mechanical test report of strut cover panels

Date Issued 10/17/95

Reference 1

A. Aluminum Strut Cover In Service Inspection Criteria

1. Inspect aluminum strut cover; refer to Figure 1 (attached).
   a. Inspect for cracks or tears in the aluminum strut cover.
      1. Cracks are not acceptable and are not repairable.
      2. Tears not to exceed 0.005 inch (0.127 mm) depth in area A and 0.010 inch (0.254 mm) depth in area B of the part are repairable per Par B. below.
   b. Inspect for scattered pitting and corrosion.
      Defects not to exceed 0.005 inch (0.127mm) in area A of part and 0.010 inch (0.254 mm) in area B of part are repairable per Par B.
   c. Inspect strut cover wall thickness in the pockets whenever cover is removed from strut.
      Wall thickness in the pocket cannot be less than .020 inch (0.508 mm).
   d. Small localized round bottom dents which cover less than 5% of the part area and are not deeper than 0.010 inch are acceptable.
   e. Inspect silicone rubber sealant around the strut cover.
      Replace with either RTV157 or RTV159 when gap is evident between case strut and strut cover.

B. Aluminum Strut Cover Repair Procedures

1. For tears or corrosion pitting
   Use orbital sander or grit blast with progressively finer grit to remove defects from part. Minimum thickness after blending is .020 inch in area A and .050 inch in area B.
   Restore surface to finish smoothness of the original part.
2. Small localized round bottom dents which cover less than 5% of the part area and are not deeper than 0.010 inch do not require repair.
3. Anodize the entire part per AMS 2470 or locally anodize with Irridite or Alodine where anodize finish is missing and parent metal is showing.

C. Aluminum Strut Cover Installation Procedure

1. Part numbers JR00074 and JR00070 are installed identically to the OEM part as defined in PW4000 Series Engine Manual (PN 50A822); Compressor Intermediate Case Assembly; Repairs 22 and 34
   Task 72-34-01-300-022-003,
   Task 72-34-01-300-034.
   To ensure complete coverage sealant should be applied directly to Rib C (Fig. 1) before installation.
2. Fairings may be installed as singular pieces of either part number or as a complete engine set (16 pieces).

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Mechanical Test of PW4000 Composite and Aluminum Strut Covers

A. Development Testing

A.1. Test Approach

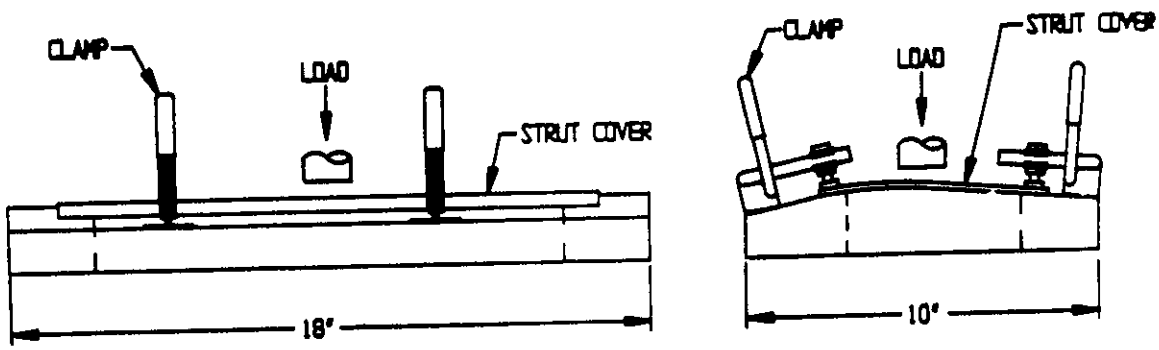
The development program was conducted to determine how to provide equivalent or increased stiffness for the aluminum replacement part as compared to the OEM Kevlar composite strut cover panel without increasing part weight and without changing critical assembly dimensions.

Several batches of 6061 aluminum panels were fabricated with variations in machined wall thickness cavities; part weight and stiffness were compared. To determine part stiffness a 10" by 18.5" test fixture, which approximated the part curvature, was used to support the entire periphery of the strut cover in a manner similar to the support in the engine case strut.

Laboratory mechanical deflection tests was performed on perforated (acoustic) and non perforated solid OEM Kevlar strut covers. Similar deflection tests were performed on solid aluminum parts.

After assembly into the test fixture (figure 1) the part was clamped at four locations and deflected up to 0.20 inch in an Instron test machine. Load readings were recorded at 0.05 inch increments of deflection on a strip chart. A flat ended, 1.25 inch diameter rod, located at the center of the panel, and attached to the Instron machine was used to slowly deflect the convex shaped air flow surface of the panel. During engine operation the convex surface experiences only slightly higher air pressure than the concave surface.

Figure 1

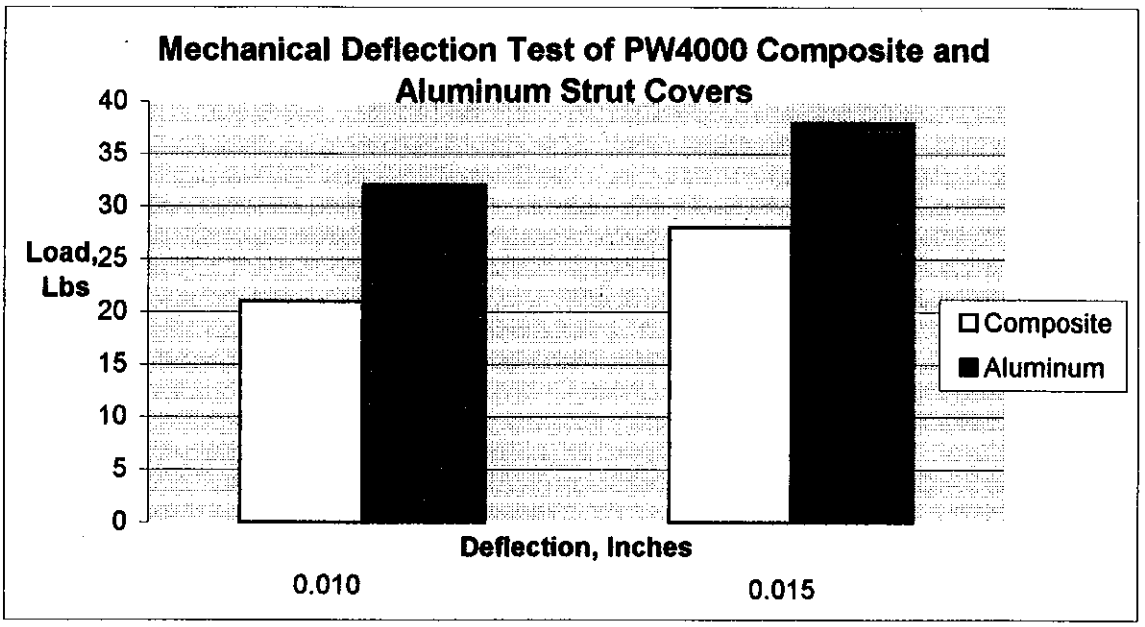


A.2. Development Data

Deflection and weight data were collected for several weight ranges of aluminum panels which were fabricated to evaluate small dimensional variations in the size and depth of the pockets on the back surface of the parts. In addition, deflection tests were performed on acoustic and non acoustic composite panels.

Typical deflection data, shown below, indicated that the aluminum parts were at least 25% stiffer than the composite parts (figure 2)

Figure 2

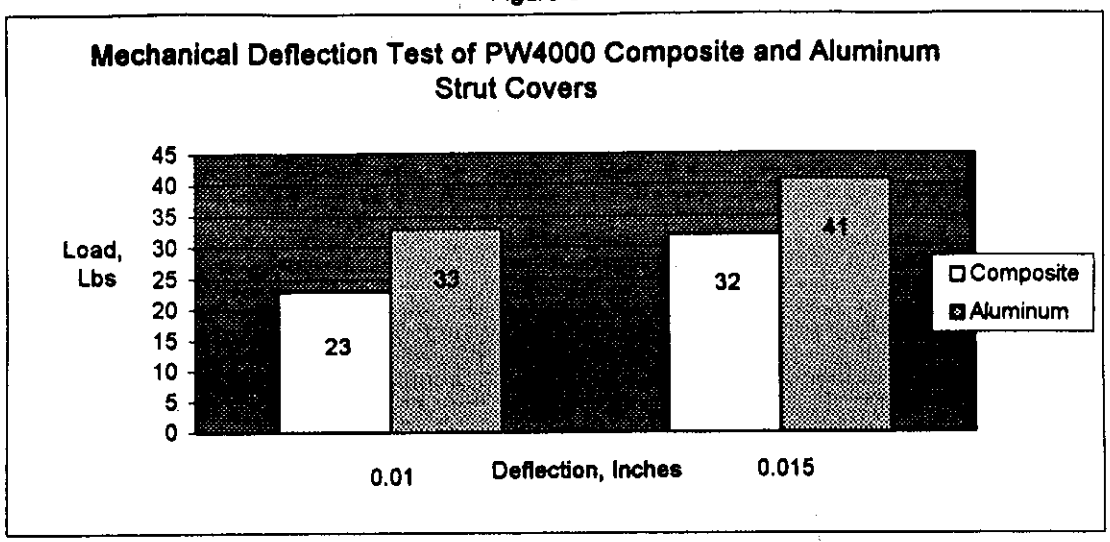


B. Substantiation Tests

After completion of the development effort, a batch of aluminum panels (PN's JR00074, JR00070) were fabricated to the final design and conformity checked per the blueprint. FAA form 8130-9 is attached to verify that critical part dimensions and weight were met.

In addition, deflection tests were performed (figure 3) and witnessed by the FAA DER. The deflection data continued to show that the aluminum parts are stiffer than the composite parts.

Figure 3


Mechanical Deflection Test of PW4000 Composite and Aluminum Strut Covers
Load, Lbs
45
40
35
30
25
20
15
10
5
0
23
33
32
41
Composite
Aluminum
0.01
Deflection, Inches
0.015