1.0 Purpose

This engineering report provides the inspection results for spoiler actuator, P/N 1524800-19, removed from Cessna C650, S/N 7063 which experienced unexpected roll during flight.

2.0 Introduction and Summary

The inspection was performed per Nabtesco Inspection Plan # EO12297, Rev. B. The inspection took place at Nabtesco Gifu Plant from August 6 to August 8, 2012, under witness by JTSB (Japan Transport Safety Board) and Cessna, except dimensional inspection of gear and shafts those were performed at Miyako Seiki, gear manufacturer.

During the inspection, all inspection items determined by Fault Tree Analysis (FTA) in EO12297, as possible causes of the events reported in NTSB (National Transport Safety Board) aircraft level investigation or Cessna actuator level investigation, were carefully checked. There were no obvious evidence observed and possible causes listed in the FTA have been all cleared. Therefore, from the results of the inspection, it was difficult to determine that the actuator was involved in the events reported during aircraft or actuator level investigations.

3.0 Reference Documents

1. NTSB Report # ERA12FA127 (Aircraft Level Investigation)
2. Cessna Report # HY-GEN-606, Rev. N/C “Roll Spoiler PCU Investigation 650-7063”, dated 5/17/2012 (Actuator Level Investigation)
3. Nabtesco Inspection Plan # EO12297, Rev. B, dated 8/8/2012*
4. Fault Tree Analysis with Assessment

* During briefing of the inspection plan on 8/6/2012, errors were confirmed on inspection plan EO12297, Rev. A. Draft of EO12297, Rev. B with corrections was sent to NTSB and the corrections were approved on 8/6/2012 by email (Refer to Appendix 3 of this report). The inspection was performed based on the NTSB approval, and EO12297, Rev. B was formally issued on 8/8/2012 after completion of the inspection for record purpose.

4.0 Applicable Unit

Item: Servo Actuator Assembly, Spoiler Hydraulic
P/N: 1524800-19 (Cessna P/N 9914155-19)
S/N: 2641
MFG Date: 2.20.1995

5.0 Inspection

5.1 Receiving Inspection

Receiving inspection was performed before starting detail part inspections per the inspection plan # EO12297, Rev. B. And the following were confirmed during the inspection.

1. No evidence of slip marks on Cover (P/N 1524822), Screws (P/N NAS1102-04-5P), Headend Assy. (P/N 1524803-3), and Screws (P/N NAS 1351-3-6P)
2. Ball (P/N MS9461-04) and Lockwire (P/N 20995C32) were not included in the package

Detail results of the inspection are shown in Appendix 1 of this document.

5.2 Detail Parts Inspection

5.2.1 Visual Inspection

Part visual inspection was performed per Section 3.1 of # EO12297, Rev. B. In addition to the items listed in EO12297, Piston, P/N 1524802-3, was also inspected to check wear against housing bore diameter.

There were no anomalies observed except the findings in Table 1.

Detail results of the inspections are shown in Section 1.0 in Appendix 2 of this document.

Table 1: Findings during Visual Inspection

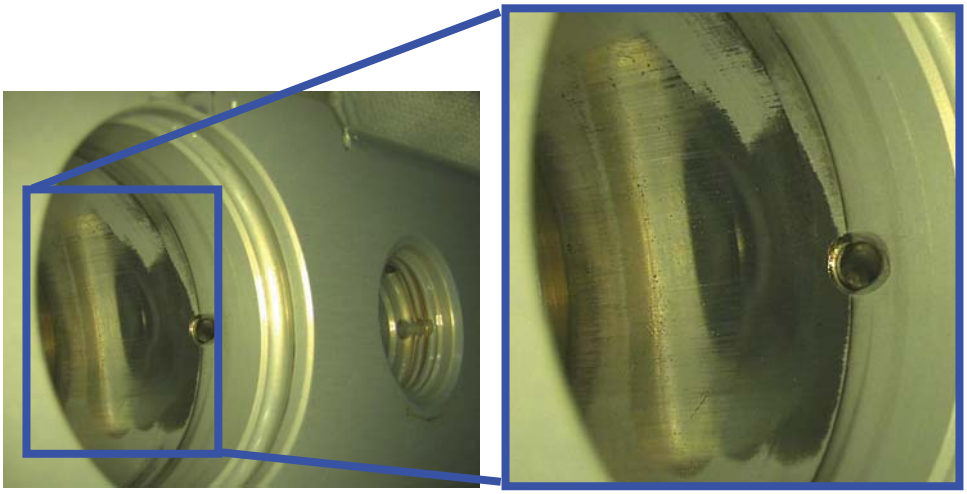
#	Findings	Descriptions
1	Wear mark and linear scratch on inner bore, housing, P/N 1524801-7	➢ Wear mark was observed on inner bore of housing. ➢ Minor linear scratches were also observed on inner bore of housing. (Refer to Page 2 of Appendix 2 for details)  Wear Mark, Housing Inner Bore

Table 1: Findings during Visual Inspection

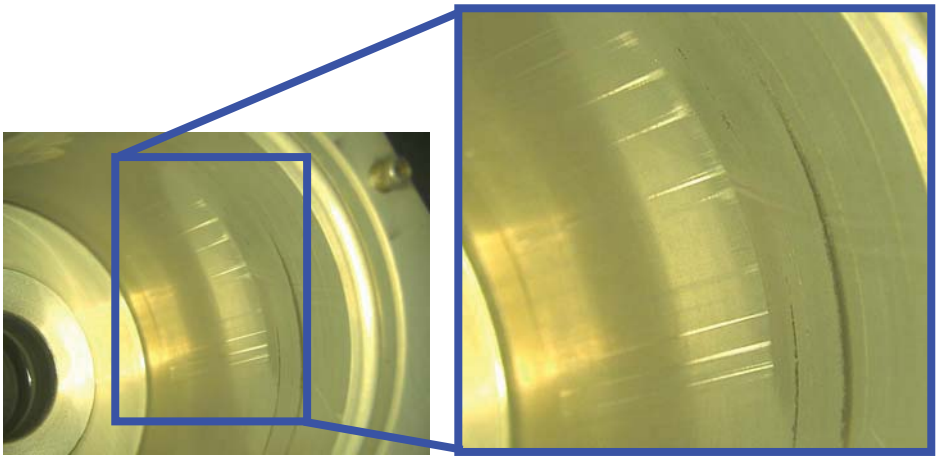
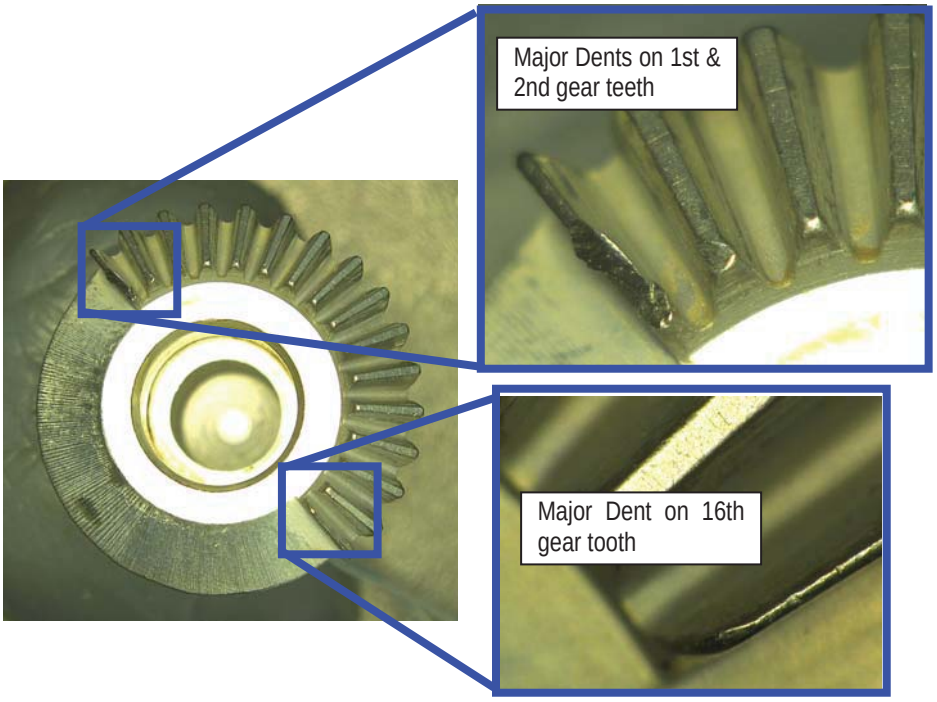
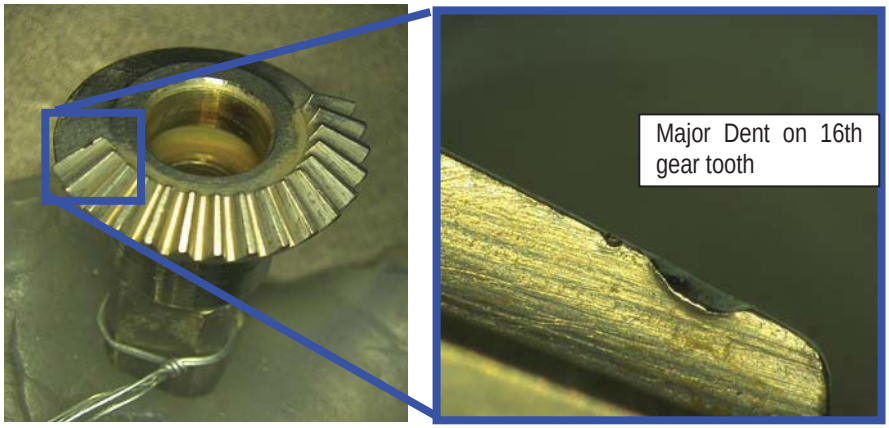
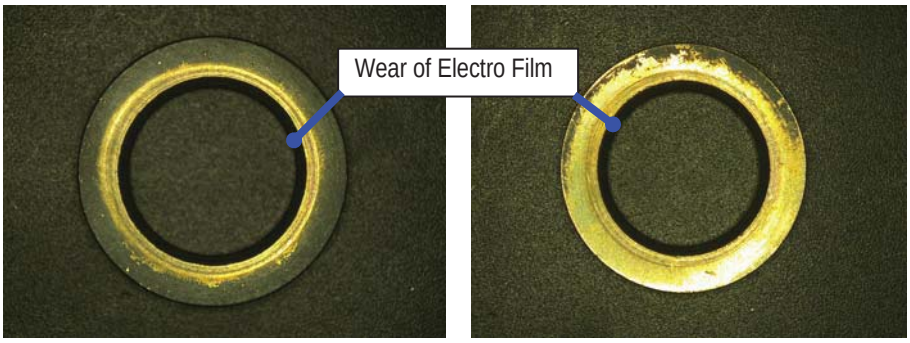
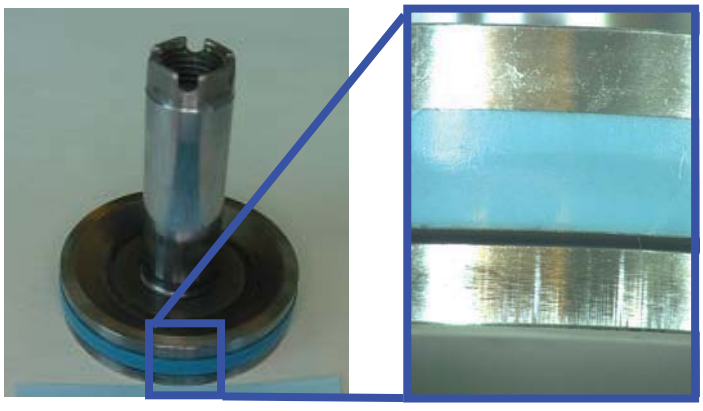
#	Findings	Descriptions
	Wear mark and linear scratch on inner bore, housing, P/N 1524801-7 (continued)	 Linear Scratches, Housing Inner Bore
2	Dents on gears (shaft), P/N 1524823	➢ Major dents on 1st, 2nd and 16th gear teeth and a minor dent on 15th gear tooth were observed on the Manifold side shaft. ➢ Major dents on 16th gear tooth and minor dent on 12th gear tooth were observed on the cover side shaft. (Refer to Page 5 thru Page 8 of Appendix 2 for details with magnified photos)  Dents on Gears, Manifold Side Shaft

Table 1: Findings during Visual Inspection

#	Findings	Descriptions
	Dents on gears (shaft), P/N 1524823 (continued)	 Dents on Gears, Cover Side Shaft
3	Wear of electro film, bearing, P/N 1524828	➢ Electro film on flange were worn out for both bearings, cover and manifold side. (Refer to Page 10 of Appendix 2 for details with visual inspection results)  Electro Film Wear, Cover Side Bearing Electro Film Wear, Manifold Side Bearing
4	Linear scratch on piston head, piston, P/N 1524802-3	➢ Minor linear scratch was observed on piston head, piston head side. (Refer to Page 12 Appendix 2 for details)  Piston Head Linear Scratch

5.2.2 Dimensional Inspection

Part dimensional inspection was performed per Section 3.2 of # EO12297, Rev. B except items in Table 2. In addition to the items in EO12297, load of Spring, P/N 1524821, was also checked to its drawing requirements.

Table 2: Items not Measured during Dimensional Inspection

#	Item	Reasons
1	Packing groove diameter, housing, P/N 1524801-7	Inner diameter of packing groove could not be measured because packing was installed. (Refer to Page 14 of Appendix 2 for detail)
2	Packing groove diameter, cover, P/N 1524822	Inner diameter of packing groove could not be measured because packing was installed. (Refer to Page 16 of Appendix 2 for detail)
3	Gear dimensions, shaft, P/N 1524823	Gear dimensions could not be measured except number of gears because the master gear used for production of the subject gears were no longer available at Miyako Seiki, gear manufacturer. (Refer to Page 17 & 18 of Appendix 2 for detail)
4	Outer diameter, arm-drive, P/N 1524825	Outer diameter of arm-drive could not be measured because gear was assembled. (Refer to Page 19 of Appendix 2 for detail)

There were no deviations from the drawing requirements observed except the findings in Table 3.
Detail results of the inspection are shown in Section 2.0 in Appendix 2 of this document.

Table 3: Findings during Dimensional Inspection

#	Findings	Descriptions
1	Out of drawing requirement, flange thickness, bearing, P/N 1524828	➢ Flange thickness of bearing were not within the drawing requirement. (Refer to Page 21 of Appendix 2 for details with dimensional measurement results)
2	Out of drawing requirement, free play, summing gear assembly, P/N 1524855	➢ Free play of summing gear assembly was not within the drawing requirement. (Refer to Page 23 of Appendix 2 for details with dimensional measurement results)

5.3 Assessment on Findings

Except the findings described in Section 5.2, no anomalies or deviations from the drawing requirements were observed with the inspection items determined by FTA of the inspection plan # EO12297, Rev. B.

The findings in Section 5.2 are also not considered as a possible cause of the events reported because of the reasons in Table 4.

Table 4: Assessment of Findings

#	Findings	Nabtesco's Assessment
1	Wear mark and linear scratch on inner bore, housing, P/N 1524801-7 (Item #1 of Table 1)	Wear mark is considered due to side load on the piston during field operation. However, amount of wear is minor and bore diameter was still within the drawing requirement. It is hard to consider that the wear mark resulted in the events observed during the aircraft or actuator level investigations. Linear scratches are considered due to contamination sticking between housing inner bore and piston head. However, scratch was very minor and hard to consider that the scratch or contamination itself resulted in the events.
2	Dents on gears (shaft), P/N 1524823 (Item #2 of Table 1)	Major dents observed were on teeth not being used in operation. Small dents on other teeth were minor and, according to Miyako Seiki, gear manufacturer, no effects on gear operation can be considered. Therefore, it is hard to consider that the dents observed gear teeth resulted in the events observed during the aircraft or actuator level investigations.
3	Wear of electro film (Item #3 of Table 1) & Out of drawing requirement, flange thickness, bearing, P/N 1524828 (Item #1 of Table 2)	Out of bearing flange thickness from the drawing requirement is due to wear of electro film. And wear of electro film is considered as common wear often observed on the units returned after 17 years field operation. Amount of wear was minor and, even with electro film worn out, it is designed to provide appropriate bearing function with base material of aluminum nickel bronze. Therefore, it is hard to consider that the out of bearing flange thickness resulted in the events observed during the aircraft or actuator level investigations.
4	Linear scratch on piston head, piston, P/N 1524802-3 (Item #4 of Table 1)	Linear scratches are considered due to contamination sticking between housing inner bore and piston head, and side load against housing bore diameter. However, scratch was very minor and it is hard to consider that the out of bearing flange thickness resulted in the events observed during the aircraft or actuator level investigations.

Table 4: Assessment of Findings

#	Findings	Nabtesco's Assessment
5	Out of drawing requirement, free play, summing gear assembly, P/N 1524855 (Item #2 of Table 2)	Out of the drawing requirement is considered due to wear of retainer after 17 years field operation. The drawing requirement is for the new production, and amount of wear observed with the subject retainer were considered minor and don't affect on the actuator performance from our more than 30 years field experience. Therefore, it is hard to consider that the out of free play resulted in the events observed during the aircraft or actuator level investigations.

The FTA updated with the results of inspection included is shown in Appendix 4 of this document.

6.0 Conclusion

During the inspection, all inspection items determined by Fault Tree Analysis (FTA) in EO12297, as possible causes of the events reported in NTSB (National Transport Safety Board) aircraft level investigation or Cessna actuator level investigation, were carefully checked. There were several findings including anomalies in visual inspection and deviations from the drawing requirements in dimensional inspection. However, those findings were minor and it is hard to consider that any of those findings resulted in the events observed during aircraft or actuator level investigation.

There were no obvious evidence observed and possible causes listed in the FTA have been all cleared. Therefore, from the results of the inspection, it was difficult to determine that the actuator was involved in the events reported during aircraft or actuator level investigations.