NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

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MATERIALS LABORATORY ERRATA / ADDENDUM REPORT Report No. 00-148

A. ACCIDENT

Place : Nantucket, Massachusetts
Date : October 31, 1999
Vehicle : Boeing 767-366ER
NTSB No. : ~~DCA0M-A006~~ DCA00MA006 GP
Investigator : Scott Warren, AS-40

B. COMPONENTS EXAMINED

The following longitudinal control system components that were arbitrarily numbered during disassembly at Boeing:

1. PCA #3 – Servo Slide and Servo Sleeve, S/N 759; Bias Spring; Spring Guide; Servo Cap
2. PCA #4 -- Servo Slide and Servo Sleeve, S/N 1967
3. MH #1 -- Servo Slide and Servo Sleeve, S/N 1960
4. MH #3 – Portions of Separated Servo Slide and Servo Sleeve
5. Bellcrank # 1 (4 pieces)
6. Bellcrank #2 (4 Pieces)
7. Bellcrank #3 (3 pieces)
8. Bellcrank #4 (3 pieces)
9. Bellcrank #5 (2 pieces)
10. Input Push-Pull Rods for Bellcranks ##. 3, 4, and 5.

C. DETAILS OF THE EXAMINATION

This errata / addendum report has information that replaces several paragraphs in Materials Laboratory Report No. 00-071 on the components listed above and includes additional information on examination of rivets. The report only addresses the rivets in the bellcranks listed as components 5 through 9 in section B above.

The following party representatives participated in the generation of this report.

Hani Salaheldin, Egypt Air;
Michael Marx, Consultant for the Egyptian Government.

1. The following text replaces the text in the last two paragraphs on page 8 and the top of page 9 of Materials Laboratory Report No. 00-071. Also note that a new figure (29A) has been added and is attached to this report.

The rivets in the No. 3, No. 4, and No. 5 bellcranks all separated in the area between the yellow and green arms. The direction of shear in all rivets in the No. 3 and No. 4 bellcranks was as if the bellcrank arms were moving to a lower relative angle. The direction of shear of the rivets in the No. 5 bellcrank was as if the bellcrank arms were moving to a higher relative angle. The fractured rivets from the green arms of the No. 3 and No. 5 bellcranks were examined with a scanning electron microscope. This examination showed that all undamaged portions of the fractures contained elongated dimples, typical of ductile shear overstress.

Examination of the exposed rivet heads on the exterior of the yellow arms of the No. 3, No. 4, and No. 5 bellcranks showed that there was a gap between the underside of the head and the arm. The typical gap was measured on the yellow arm from the No. 3 bellcrank as about 0.01 inch. The presence of the bearings in the green arms of these bellcranks prevented a direct examination of the tail end of the rivets for similar gaps.

Examination of the separated surfaces of the rivet from the No. 3, No. 4, and No. 5 bellcranks showed that the separations were on a slightly slanted plane. Approximately one half of the fracture faces on the rivets from the yellow arms were heavily smeared, with the smearing marks generally perpendicular to the shearing direction. The other half of these fractures were less damaged and were generally slightly recessed below the bearing surface of the arm.

Examination of the rivet fracture faces on the green arms from the No. 3, No. 4, and No. 5 bellcranks showed only smearing damage in the circumferential direction, consistent with damage created during shearing of the rivets.

Detailed visual and SEM examinations were conducted of the rivet fracture areas on the green arm from the No. 5 bellcrank (see figure 27). A side view of this arm is shown in figure 28. Unlabeled arrowheads in this view denote the two bearing surfaces on the bellcrank, bracket “r” indicates the recessed area, and arrow “rv” indicates one of the sheared rivets. The fracture in rivet “rv” propagated on a slightly slant plane and terminated flush with the bottom of the recess. An SEM view of the fracture face on this rivet is show in figure 29 with arrow “o” indicating the origin of fracture. The SEM examination also revealed a circumferential crack and mark in this rivet. Arrow “c” in figure 29 indicates the crack, which was slightly below the fracture. What appeared to be an origin of this crack was obscured by the smeared over final portion of the fracture face on the rivet.

The shank of the other rivet from the No. 5 bellcrank's green arm (opposite from rivet "rv") contained a step at a similar location, flush with the bottom of the recess. Figure 29A shows an SEM view of this rivet fracture, with the step indicated by the arrow. The direction of the deformation associated with this step was as if the rivet was subjected to a shear load opposite to the direction of the shear load associated with the rivet fracture. None of the rivets from the No. 3 and No. 4 bellcranks contained evidence of similar damage. The circumferential damage (crack, mark or step) on the rivets from the No. 5 bellcrank appeared to follow the contour of the corner between the recessed portion of the bearing surface and the rivet hole.[1]

2. The caption in figure 29 should cite figure 28 instead of figure 26. The correct caption is listed below:

Figure 29. SEM view of the fracture surface on the rivet indicated by arrow "rv" in figure 28. Arrow "o" indicates the origin of fracture, the unlabeled arrow indices the direction of the fracture, and arrow "c" indicates the circumferential crack. (19X).

3. On page 8, paragraph 2, line 4 of Report 00-071, the depth of the circumferential recess in the outboard (green) arm should read 0.015 inches, rather than 0.15 inches. The correct sentence is listed below.

The shaft in the outboard arm contains a 0.015-inch deep circumferential recess between bearing surfaces that contact the inboard arm.

4. The following new information is added.

The separated rivets in the No. 1 through No. 5 bellcranks were arbitrarily labeled "A" and "B". (Rivet piece "A" in the green arms corresponded to rivet piece "A" in the yellow arms.) Examinations were conducted of the centerline holes through the rivet pieces. These examinations were hindered by shear deformation at the fractured faces.

Examination of the rivet pieces in the green arm from the No. 1[2] bellcrank with the aid of a binocular microscope revealed deformation of the centerline hole in the area corresponding to the rivet tails, consistent with compression deformation that occurred during bucking of the rivet. The reaming operation, specified by a manufacturer, appeared to be performed in all rivets with the

[1] The edge of this corner was slightly irregular, apparently as a result of a deburring or smoothing operation during original manufacturing.

[2] Green arm in bellcrank No. 1 was the only arm that did not containe the internal bearing and had tail ends of the rivets exposed).

reaming drill penetrating all the way through tail ends in all rivets except for rivet "B" in the green arm of the No. 3 bellcrank. This rivet had a step adjacent to the end of the tail where the reaming was incomplete.

The drilled surface of the centerline holes of rivets from the No. 3 bellcrank appeared rougher than in other rivets. A metallic burr or chip was found in the tail portions of the "A" and "B" rivets from bellcrank No. 5 and in the "A" rivet from the No. 3 bellcrank.

Jean Bernstein
Senior Metallurgist

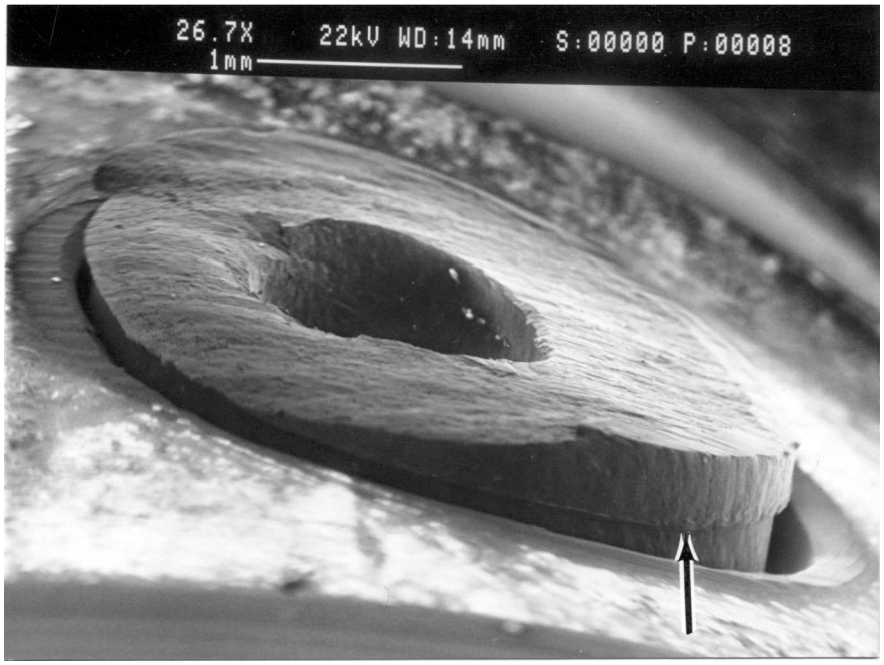

Figure 29A. SEM view of the fracture in the rivet located opposite to the rivet denoted by arrow "rv" in figure 28. The arrow indicates the step. (26.7X).