

NATIONAL TRANSPORTATION SAFETY BOARD

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



January 4, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-002

A. ACCIDENT INFORMATION

Place : Miami, Florida
Date : September 19, 2016
Vehicle : Airbus A320-232, P4-AAA
NTSB No. : ENG16IA037
Investigator : Pocholo Cruz, AS-40

B. COMPONENTS EXAMINED

1. Left (inboard) side of number 2 engine fan cowl;
2. Multiple pieces of right (outboard) side of number 2 engine fan cowl.

C. DETAILS OF THE EXAMINATION

An Aruba Airlines Airbus A320-232, registration P4-AAA performing flight AG-820 from Miami, FL (USA) to Oranjestad, Aruba (Aruba), departed Miami's runway 08R when the right hand (No. 2) engine outboard fan cowl separated from the right hand engine. The airplane returned to Miami without incident. There were no reported injuries. The airplane sustained damage to the engine, engine pylon, right main landing gear, right main landing gear door and right fuselage.

NTSB staff traveled to Miami on October 13 and 14, 2016 to examine the inboard (left side) and outboard (right side) halves of the No. 2 engine fan cowl and interview maintenance personnel. A materials group was formed at the MiamiTech maintenance facility. The group consisted of the following individuals:

Donald Kramer – Materials Engineer, NTSB
Gunnar Kemnitz – Flight Safety Investigator, Pratt & Whitney

The findings from the examination are reported below.

1. Left side of No. 2 engine fan cowl

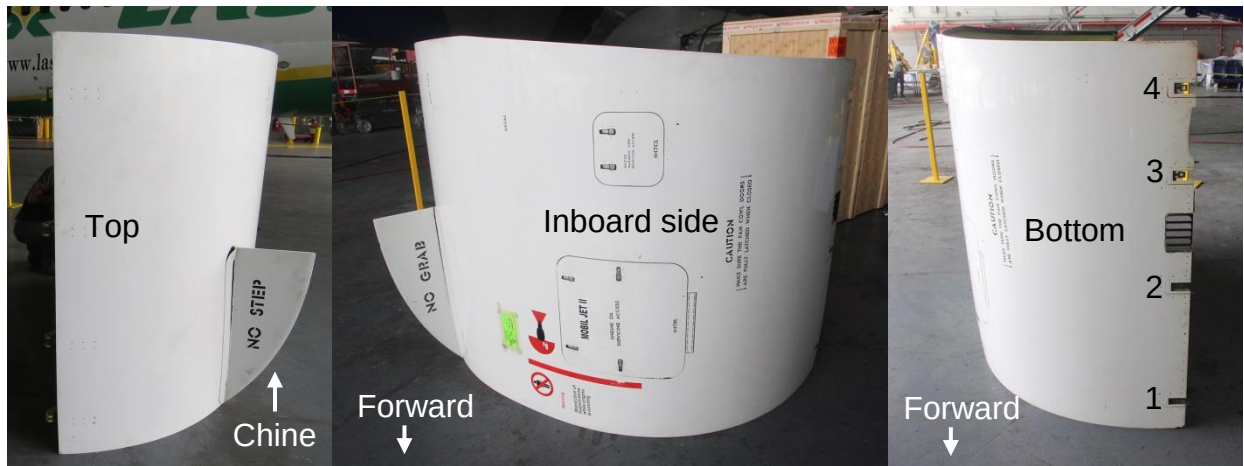


Figure 1: Views of left side of No. 2 engine fan cowl from the top to the bottom.

Views of the left side of the fan cowl are shown in figure 1 starting at the top of the cowl and proceeding to the bottom. Visual examination revealed cracks in the outer skin at the aft root end of a chine attached to the cowl approximately one-third of the way from the top. For convenience, the latches and keepers were numbered 1 through 4 starting at the forward end of the cowl. The keepers were examined for indications of wear or deformation but no apparent indication of either were found, as shown in figure 2. All of the keepers exhibited some play when moved by hand. There were alignment pins on the left side of the cowl that mated with guide holes on the right side. All of the pins were present and there were no apparent signs of damage.

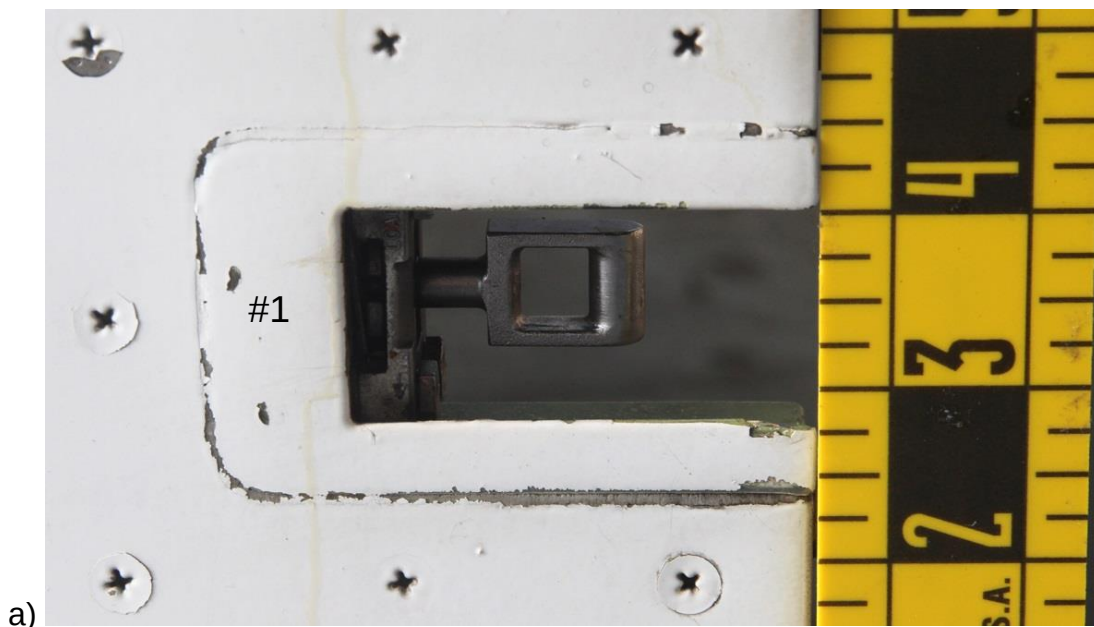


Figure 2: Images of keepers on left side of fan cowl: a) keeper for latch #1;

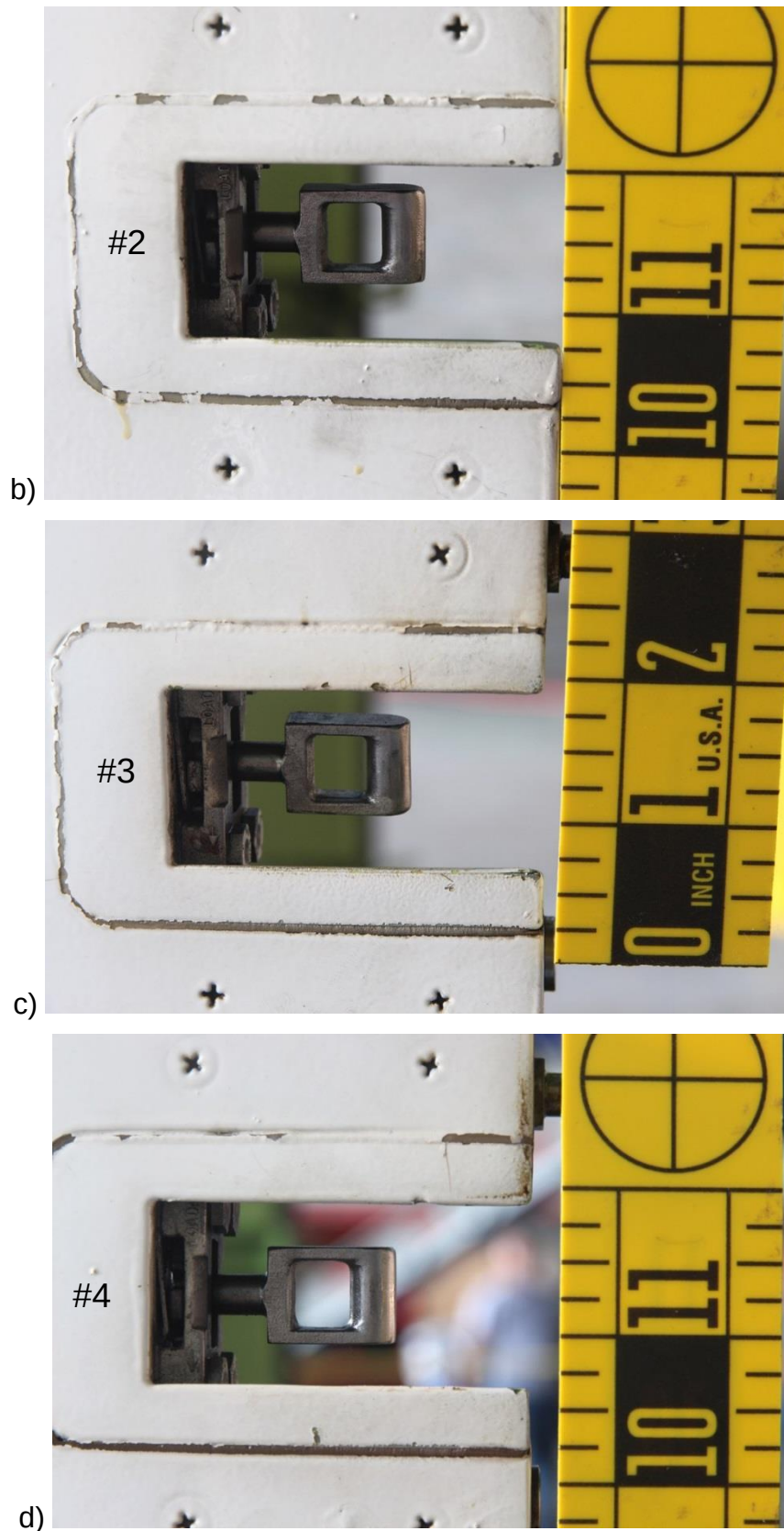


Figure 2 (cont.): b) – d) keepers for latches #2 through #4, respectively.

2. Right side of No. 2 engine fan cowl

The cowl was a composite construction consisting of an aluminum honeycomb core and carbon fiber composite skins adhesively bonded to the inner and outer faces of the core. The right side of the No. 2 engine fan cowl was fractured into multiple pieces. The fracture and delamination patterns were used to reconstruct the cowl where possible. Outer and inner views of the reconstructed cowl are shown in figures 3 and 4, respectively.

2.a. *Operation of latch mechanism*

The operation of the latch/catch mechanism is illustrated in figure 5 using a series of images that was taken using a latch on the left (No. 1) engine fan cowl. The latch handle is spring-loaded so that the handle naturally moves to the open position. As the operator moves the handle to the closed position, the latch rotates up until it contacts a plate that limits further rotation of the latch. Continuing to move the handle toward the closed position causes the latch to retract, engaging the keeper on the opposite half of the cowl. The handle has two catches that engage with two posts, one on either side of the latch. When the catches are engaged with the posts, the handle is locked. Opening the latch requires releasing the catch, which is achieved by pressing a release lever in the center of the handle (see figure 3).

2.b. *Examination of No. 2 engine fan cowl latches*

Images of the right fan cowl latches are shown in figures 6a through 6d for latches 1 through 4, respectively. The handle for latch #1 (Figure 6a) was deformed. The catches were not engaged with the posts but were flattened against the underside of the handle. The posts and the slots in the catches did not exhibit any contact or deformation marks indicative of forced disengagement of the catches due to an external load. The links for latch #1 were deformed as shown in the right photo of figure 6a.

Images of latch #2 are shown in figure 6b. The plate that limits latch travel was fractured and the handle was missing. The base of the latch and the links in the latch mechanism were deformed as shown in the right photo of figure 6b.

Images of latches #3 and #4 are shown in figures 6c and 6d, respectively. In their as-examined condition, the catches were engaged with the posts on latches #3 and #4. The lower portion of the #4 latch handle was deformed in the forward direction by approximately 1/8". There were no apparent indications of deformation to the #3 latch handle or to the links in the latch mechanism for either latch, as shown in the right photos of figures 6c and 6d.



Figure 3: Outer view of the reconstructed right side fan cowl.



Figure 4: Inner view of the reconstructed right side fan cowl.

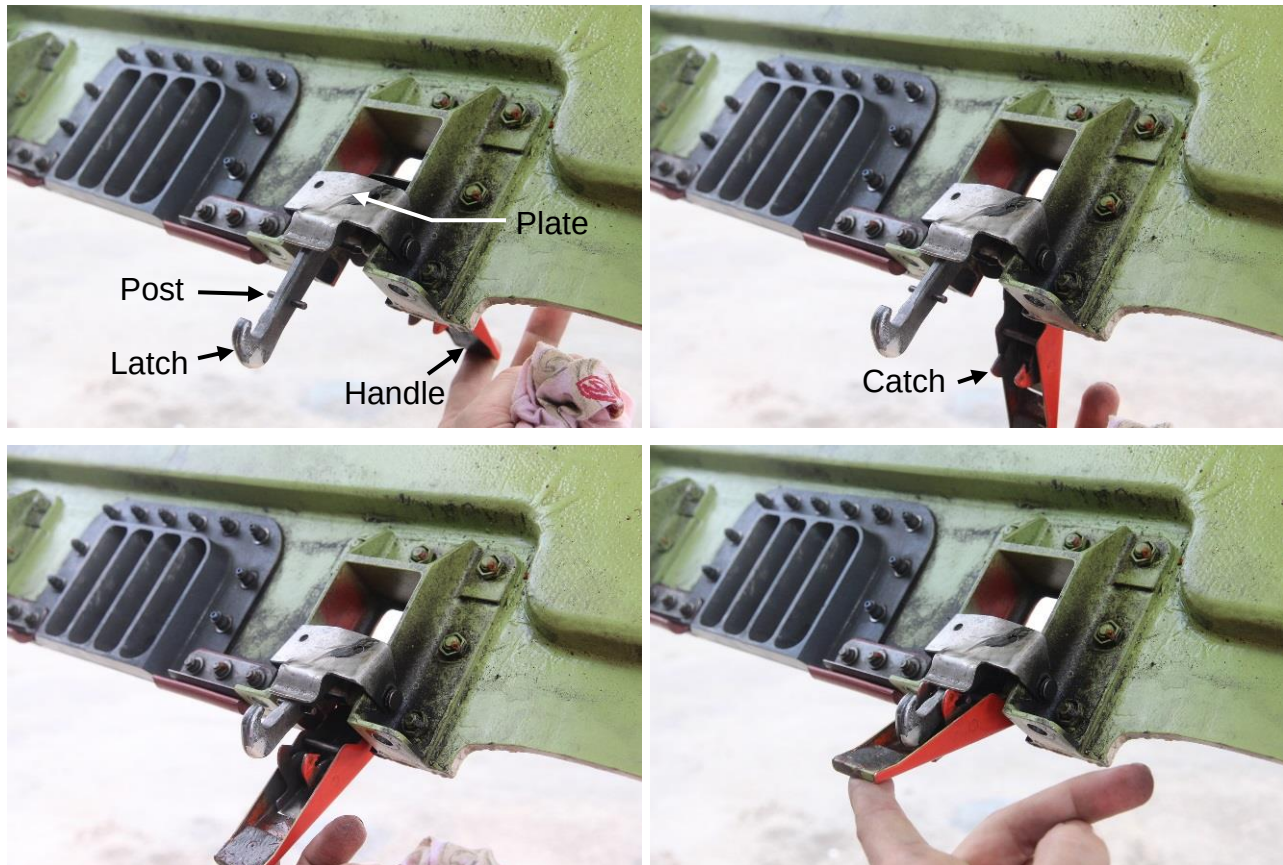


Figure 5: Series of photos illustrating the operation of the latch mechanism on the No. 1 engine fan cowl.



Figure 6: Photos of the fan cowl handles/latches and link mechanisms. Latches are numbered 1 through 4 starting at the forward end of the cowl; a) latch #1; b) latch #2;

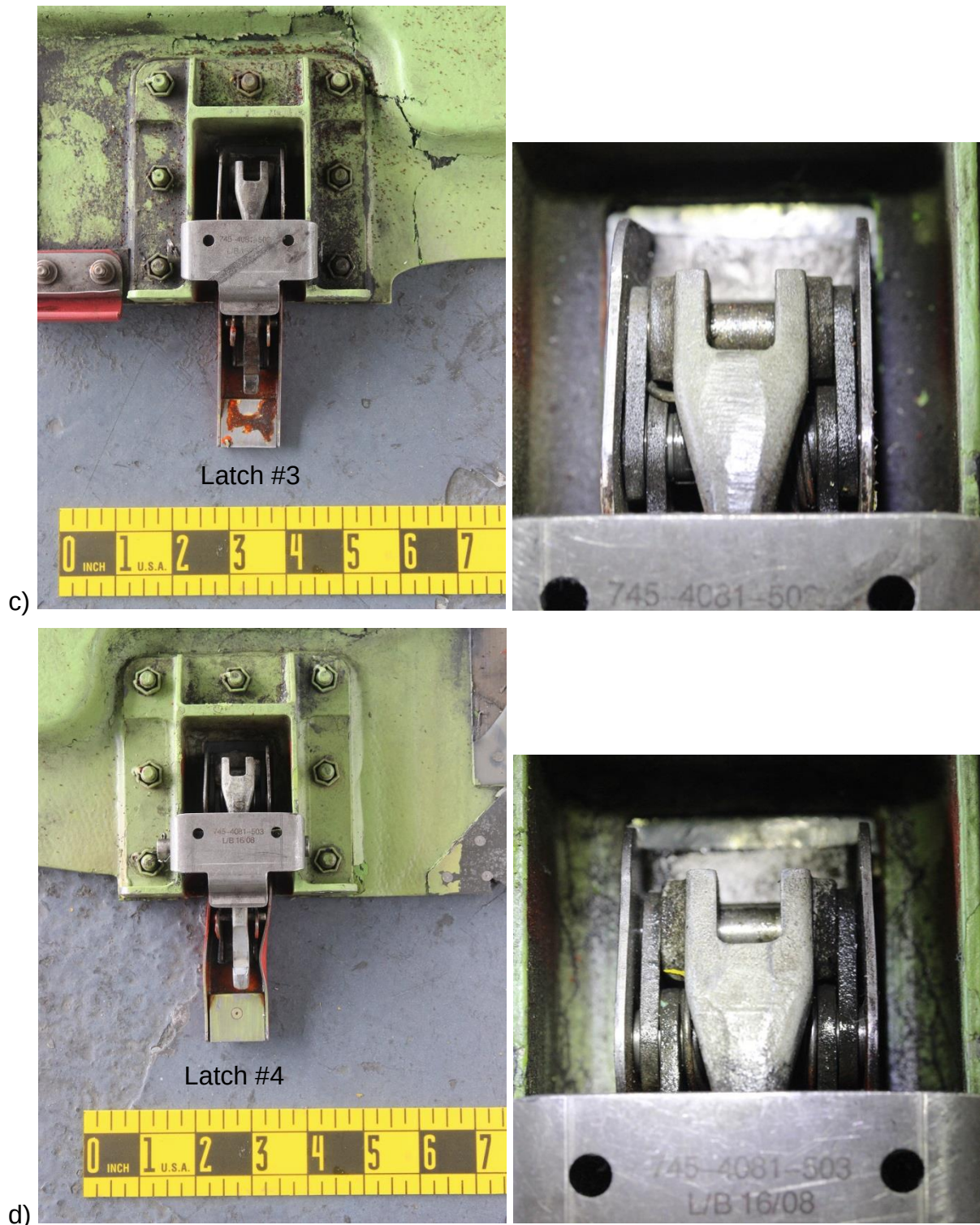


Figure 6 (cont.): latch #3 and d) latch #4.

2.c. Examination of cowl fractures and delaminations

A plastic grill between latches 2 and 3 was fractured along the edge of its mounting flange as shown in figures 4, 5 (example of intact grill), and 7. The flange was also fractured near the forward end of the grill through two adjacent bolt holes. The cowl was fractured along the forward and the top edges of the number 2 latch fitting (adjacent to the grill cutout). The fracture along the top edge of the fitting extended to the forward edge of the grill cutout, separating the number 2 latch fitting from the rest of the cowl. The core, inner skin and outer skin were fractured in the circumferential/radial plane over an approximately 16-inch length, labelled “a” in figure 4, from the forward edge of the grill cutout to a rectangular patch on the outer skin. The core was delaminated from the outer skin in certain locations on either side of the fracture as shown in figure 7.

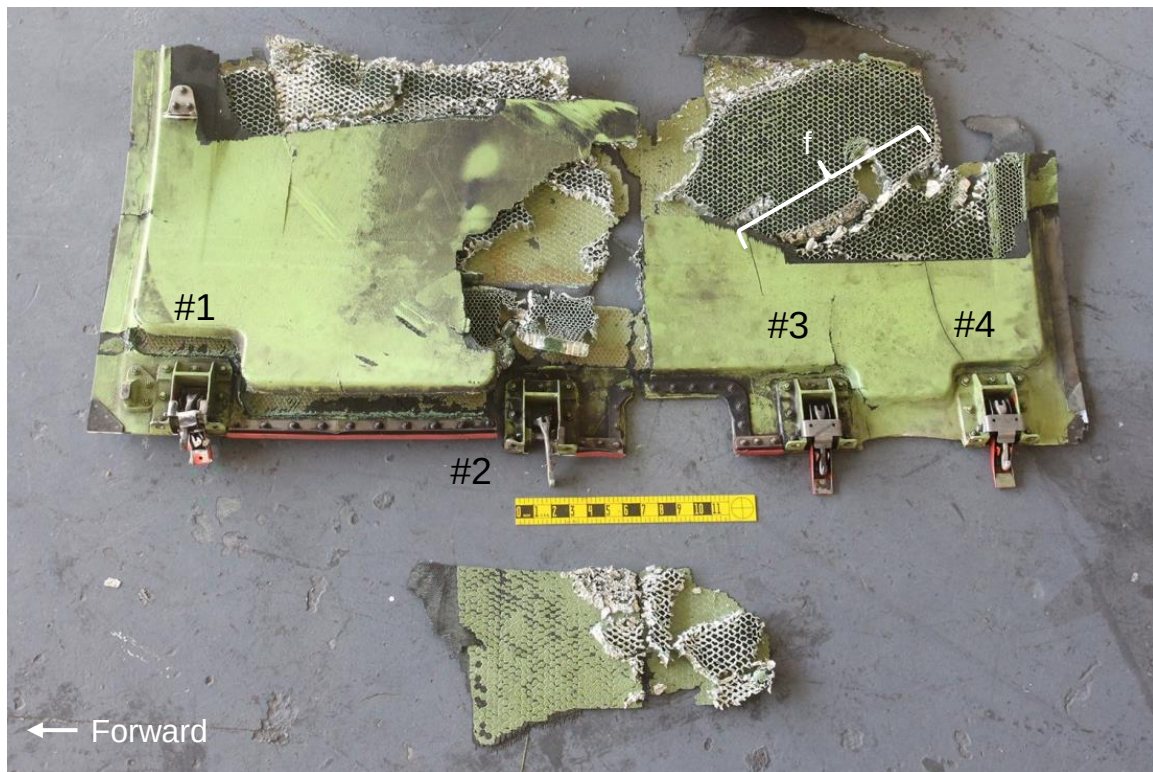


Figure 7: Inner view of lower portion of the fan cowl with inner skin pieces set aside.

The inner skin and core were fractured along the axial direction below two cutouts in the cowl, as shown in figure 4, near the upper end of the 16-inch circumferential/radial fracture. Along the aft portion of the fracture, labelled “b”, the outer skin was delaminated from the core or missing. As seen in the outer view of the cowl in figure 3, the outermost white ply of the outer skin had delaminated from the underlying carbon fiber plies in two locations toward the aft end of the cowl, labelled “d” and “e”. The outermost ply had torn in a chevron or partial chevron pattern consistent with the delaminations proceeding in the aft to forward direction.

The inner skin was disbonded from the core along the lower portion of the cowl as shown in figures 7 and 8. Along the aft portion there was a longitudinal fracture through the outer skin and core in the delaminated region, labelled “f” in figure 7. Along the forward

portion, the delamination extended from the previously noted axial fracture, labelled “c”, toward the bottom of the cowl crossing a bond line between different core density materials as seen in figures 8 and 9.

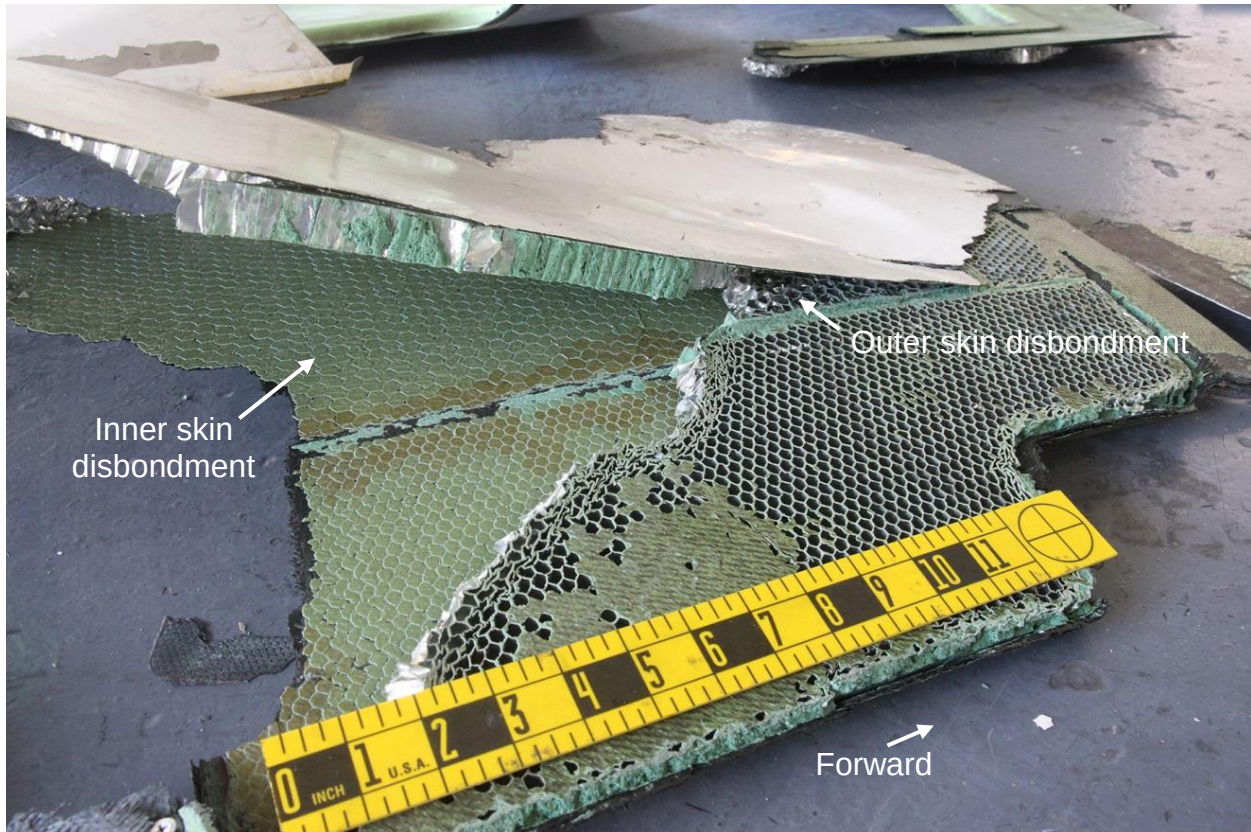


Figure 8: Image of the lower forward portion of the fan cowl showing the delamination of the inner skin from the core and the separation of the lower portion of the outer skin with doubler from the core.

The forward lower portion of the outer skin had disbonded from the core and a piece of the skin had separated from the rest of the outer skin along with the number 1 latch, as shown in figures 8 and 9. The skin tore along the edge of a doubler that ran along the lower edge of the cowl. Near the forward edge of the cowl, the tear intersected another doubler that ran along the forward edge of the cowl after which the tear proceeded at an approximately 45° angle to the edges of the cowl.



Figure 9: Forward lower portion of outer skin with number 1 latch still attached. The inner skin was disbonded from the core at the upper aft corner of the piece. The outer skin was disbonded from the core over the remainder of the piece. The skin separated along the edge of a doubler along the lower edge of the cowl.

At the top of the cowl, the outer skin had disbonded from the core from the forward edge to the aft edge as shown in figure 10. At the forward edge, the disbonded region extended from the top edge down to approximately 24 inch from the top. At the aft edge, the disbonded region extended from the top edge down to approximately 30 inch from the top. In between, the edge of the disbonded region followed an irregular profile.

There was a series of longitudinal fractures through the inner skin and core that coincided with the lowermost row of attachment bolts that attached the hinge fittings to the cowl, indicated as "f" in figure 10 and also shown in figures 11a and b.

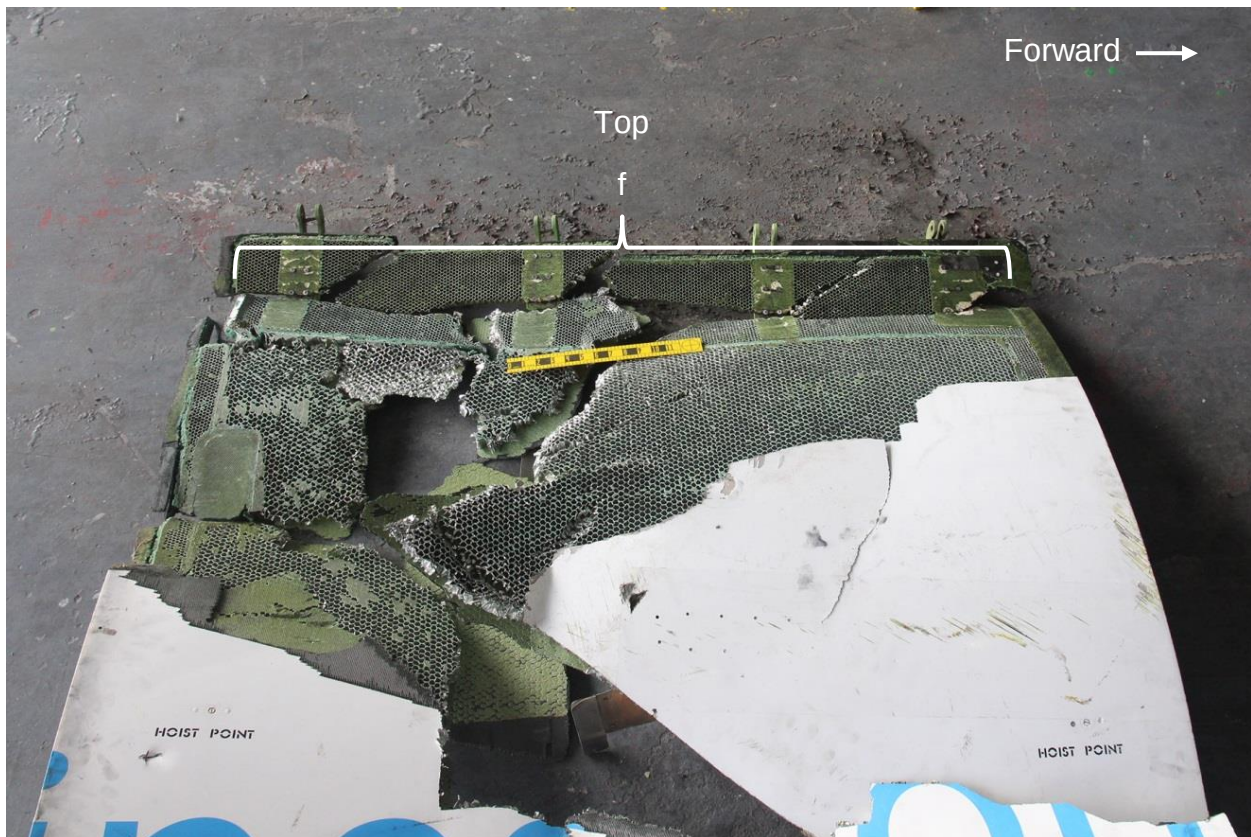


Figure 10: Outer side of the top of the cowl showing delamination of the outer skin and a series of longitudinal fractures at the root of the hinge fittings.

Three of four hinges (toward the aft end of the cowl) were equipped with a metal rod that was designed to contact a stop when the cowl was opened, thereby limiting its travel. The rods were fractured and/or deformed as shown in figures 11a and b. The first hinge from the forward end of the cowl was not equipped with a travel limiting rod. The second hinge was equipped with a rod whose center section was missing. Examination of the hinge indicated that the rod had been sheared at its forward and aft ends. The rods on the third and fourth hinges were deformed and had been sheared at the forward end but were still attached at the aft end. The rod on the third hinge was deformed approximated 0.5 inch center to center and the rod on the fourth hinge was deformed approximately 0.25 inch center to center.

Donald Kramer, Ph.D.
Sr. Materials Engineer

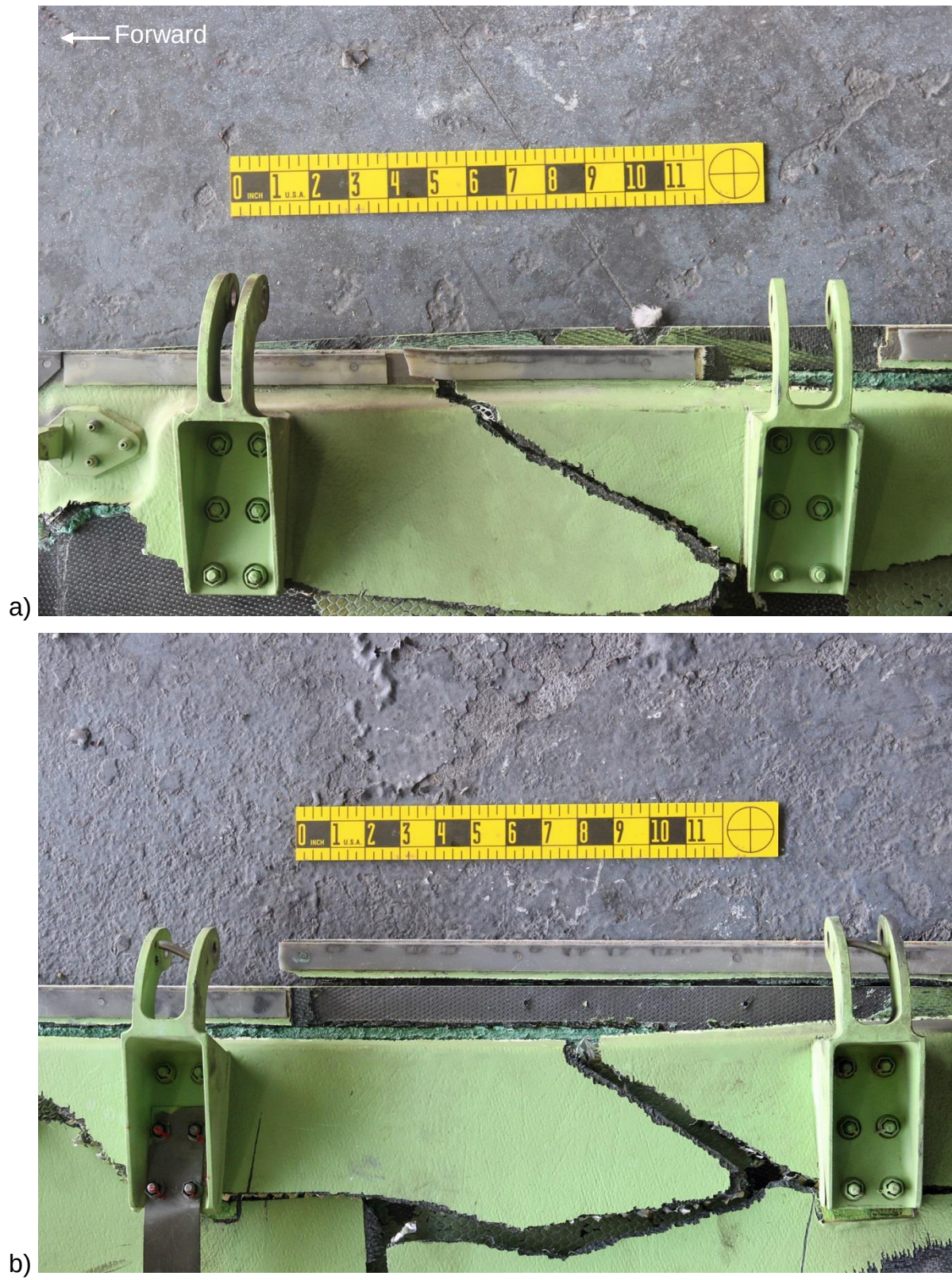


Figure 11: Images of the hinge fittings at the top of the right fan cowl: a) two fittings at forward end of cowl and b) two fittings at aft end of cowl.