NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

April 7, 2011

MATERIALS LABORATORY FACTUAL REPORT Report No. 10-101

A. ACCIDENT

Place : Borrego Springs, California
Date : April 8, 2010
Vehicle : Snow Rocket F1 (N28VS)
NTSB No. : WPR10LA195
Investigator : Joshua Cawthra

B. COMPONENTS EXAMINED

1. Forward control stick piece
2. Aft control stick piece
3. Partial control column assembly
4. Portion of elevator control servo assembly
5. Piece of 18 inch long aluminum control rod

C. DETAILS OF THE EXAMINATION

The purpose of this report is to document the fracture mode for each failed linkage component. The as-received components are shown in Figure 1.

Figure 2 shows the partial control column assembly and the forward and aft control stick pieces. All fractures associated with these components were inspected using a 5X to 50X stereo zoom microscope. As indicated in Figure 2, each fracture occurred due to overstress. The forward control stick has a manually-drilled 0.22 inch diameter hole drilled in the forward side of the tube wall about 0.42 inch above the top of the stick socket. The overstress facture initiated at the edges of this hole. The aft control stick has a 0.15 inch diameter hole drilled in the forward and aft sides of the tube wall (clearance holes to accommodate a mounting bolt) about 0.40 inch below the top of the stick socket. The overstress facture in the aft stick initiated at the edges of the forward hole.

The linkage fractures associated with the elevator control servo assembly are shown in Figure 4. All fractures associated with the elevator control servo assembly were inspected using a 5X to 50X stereo zoom microscope. In all instances, the fractures are due to bending overstress.

A control linkage that measured approximately 18 inches long and 0.5 inch in diameter had threaded ends as shown in Figure 4. Both threaded ends fractured due to bending overstress as indicated by inspection with a 5X to 50X stereo zoom microscope.\

As indicated in Figure 5, the forward control stick fractured in overstress due to cantilever bending just above the control column fitting. Near the top of the forward control stick, six 4-40 NC threaded holes are located in the tube (see Figures 5 and 6). As indicated in Figure 6, the threads are stripped in holes labeled 1, 4, and 6. Hole 4 has a second untapped hole overlapping it. The top of the forward control stick is saw-cut and hand filed as indicated in Figures 5, 6 and 7.

The NTSB preliminary report reveals that a witness indicated that the pilot's forward control stick broke during flight. According to a representative from Team Rocket LP, the control sticks are fabricated from aluminum alloy 6061 tempered to the T6 condition. The specified nominal tube dimensions are 0.875 inch outside diameter and 0.049 inch wall thickness. The compositional, dimensional, conductivity, and hardness attributes of the forward and aft control sticks are listed in Table 1.

Table 1 Attributes of the Forward and Aft Control Sticks.

Attribute	Method or test specification	Aft control stick	Forward control stick
Metal alloy composition identification	x-ray fluorescence	Consistent with aluminum alloy 6061	Consistent with aluminum alloy 6061
Conductivity (% IACS at 68°F based on equal volume)	ASTM E1004	40	41.6
Hardness (HRB, uncorrected for concave geometry)	ASTM E18	42.8 40.4 41.9 39.8 40.0 Average 41.0	42.9 42.6 42.0 43.1 43.0 Average 42.7
Hardness (HRE, uncorrected for concave geometry)	ASTM E18	87.1 87.4 84.1 Average 86.2	89.2 89.5 88.1 Average 88.9
Hardness (HR15T, uncorrected for concave geometry)	ASTM E18	79.0 79.0 79.0 Average 79.0	79.5 80.0 79.5 Average 79.7
Hardness (HBS, uncorrected for concave geometry)	ASTM E140 conversion	80.3	83

Nominal outside diameter (inch)	Micrometer	0.768	Not measureable
Nominal inside diameter (inch)	Micrometer	0.876	Not measureable
Wall thickness (inch)	Micrometer	0.050	0.051

As indicated in Table 1, the aluminum alloy composition and tube wall thickness are with specification for the control sticks. The hardness and conductivity measurements for both control sticks are consistent with aluminum alloy 6061 in a T4 or a lower strength T6 condition.

Michael K. Budinski
Chief, Materials Laboratory Division

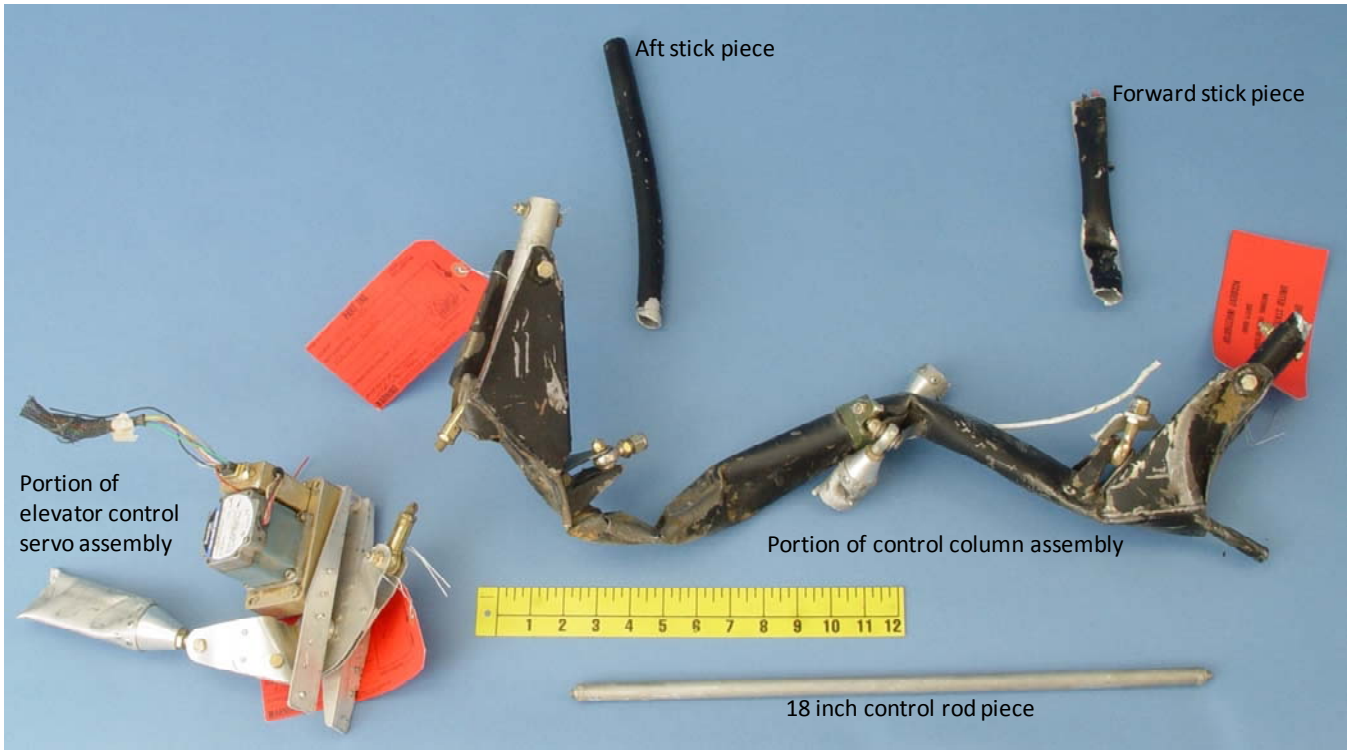

Figure 1 The as-received accident components.

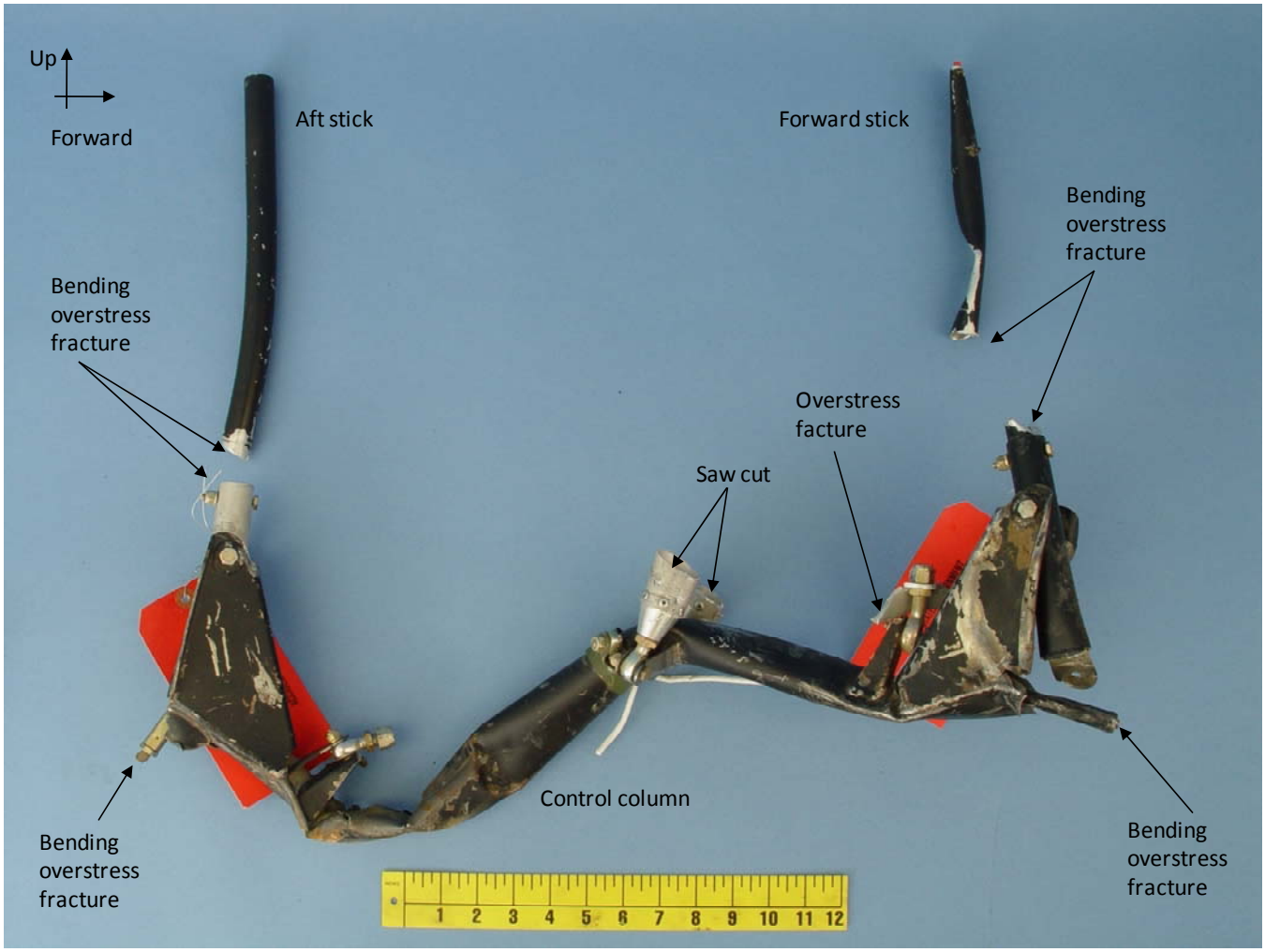

Figure 2 Partial control column assembly with the control stick pieces placed near their pre fracture locations. The mode of fracture for each broken piece is identified in the figure.

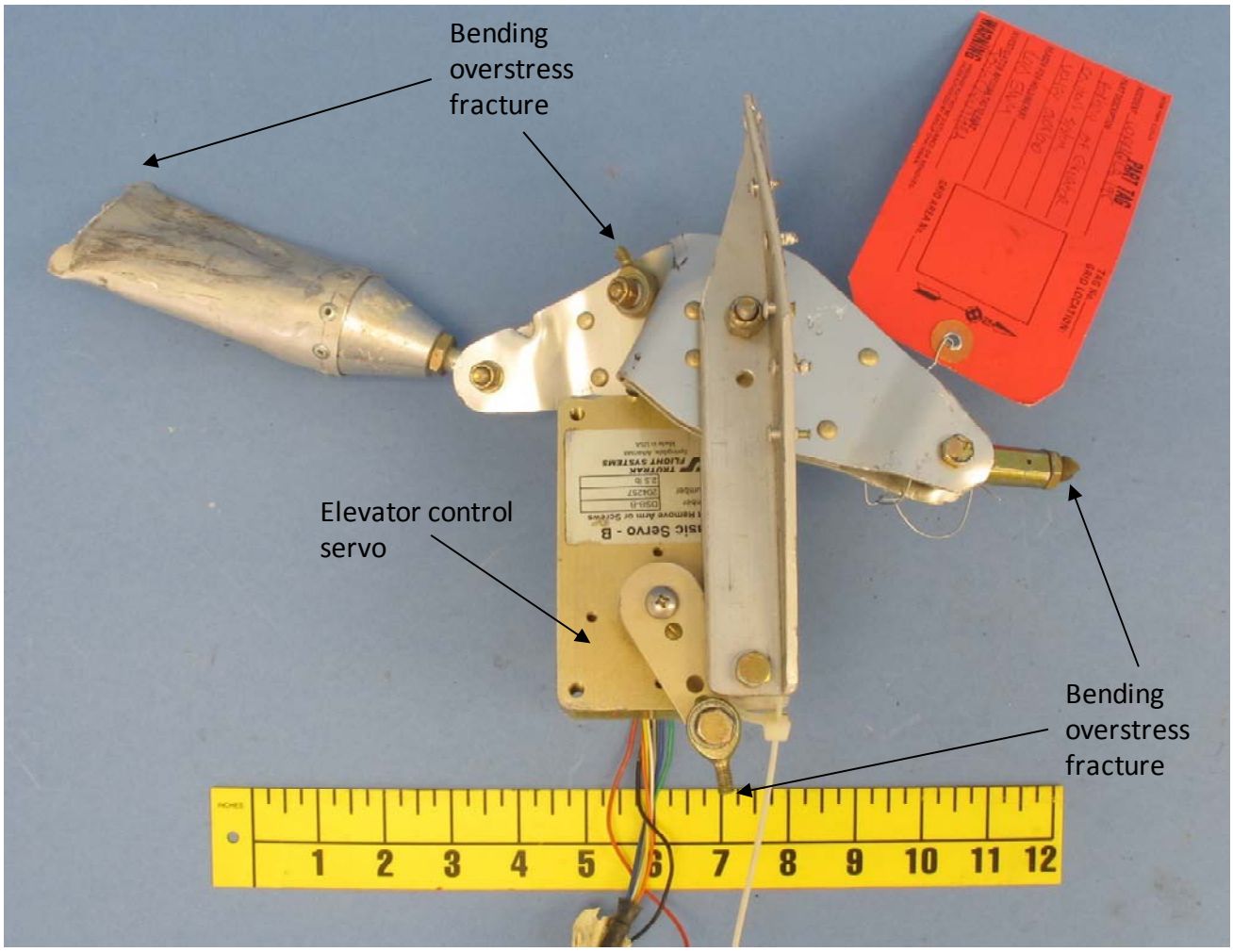

Figure 3 Portion of elevator control servo assembly showing each linkage fracture.

Figure 4 Eighteen-inch long control rod piece showing bending overstress fractures in the threads at each end.

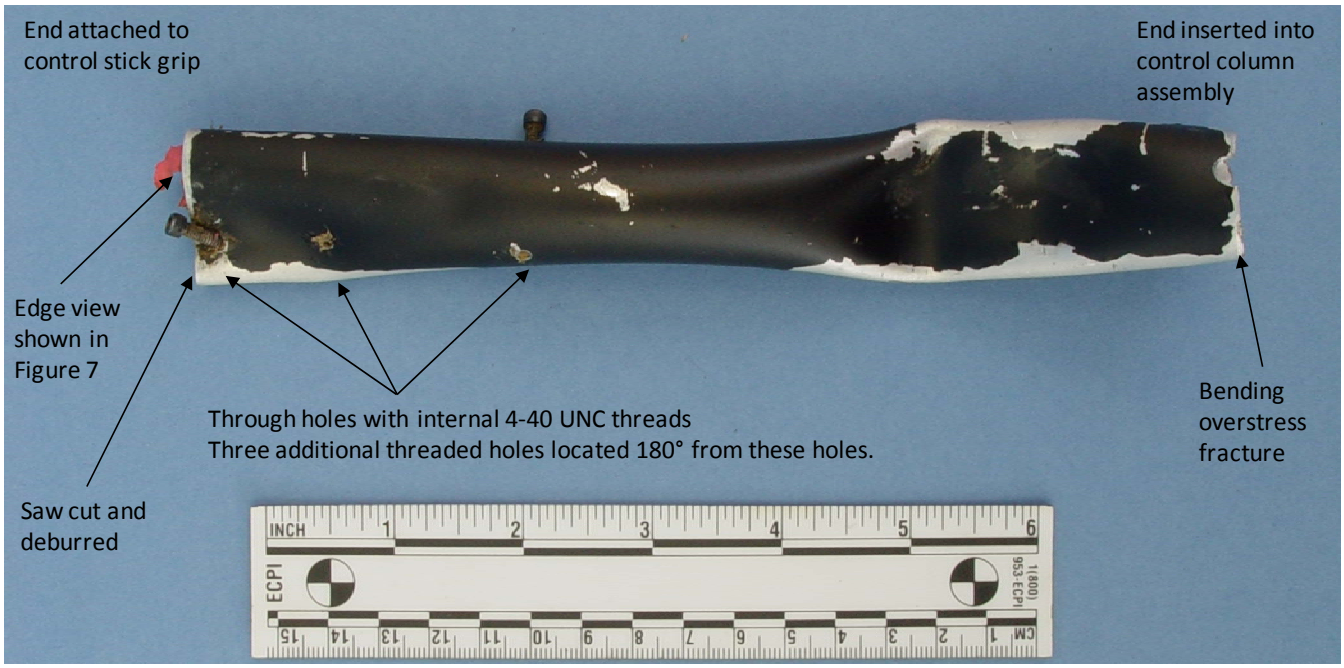

Figure 5 Image of the forward control stick with significant features identified. The forward direction of the control stick is facing out of the page.

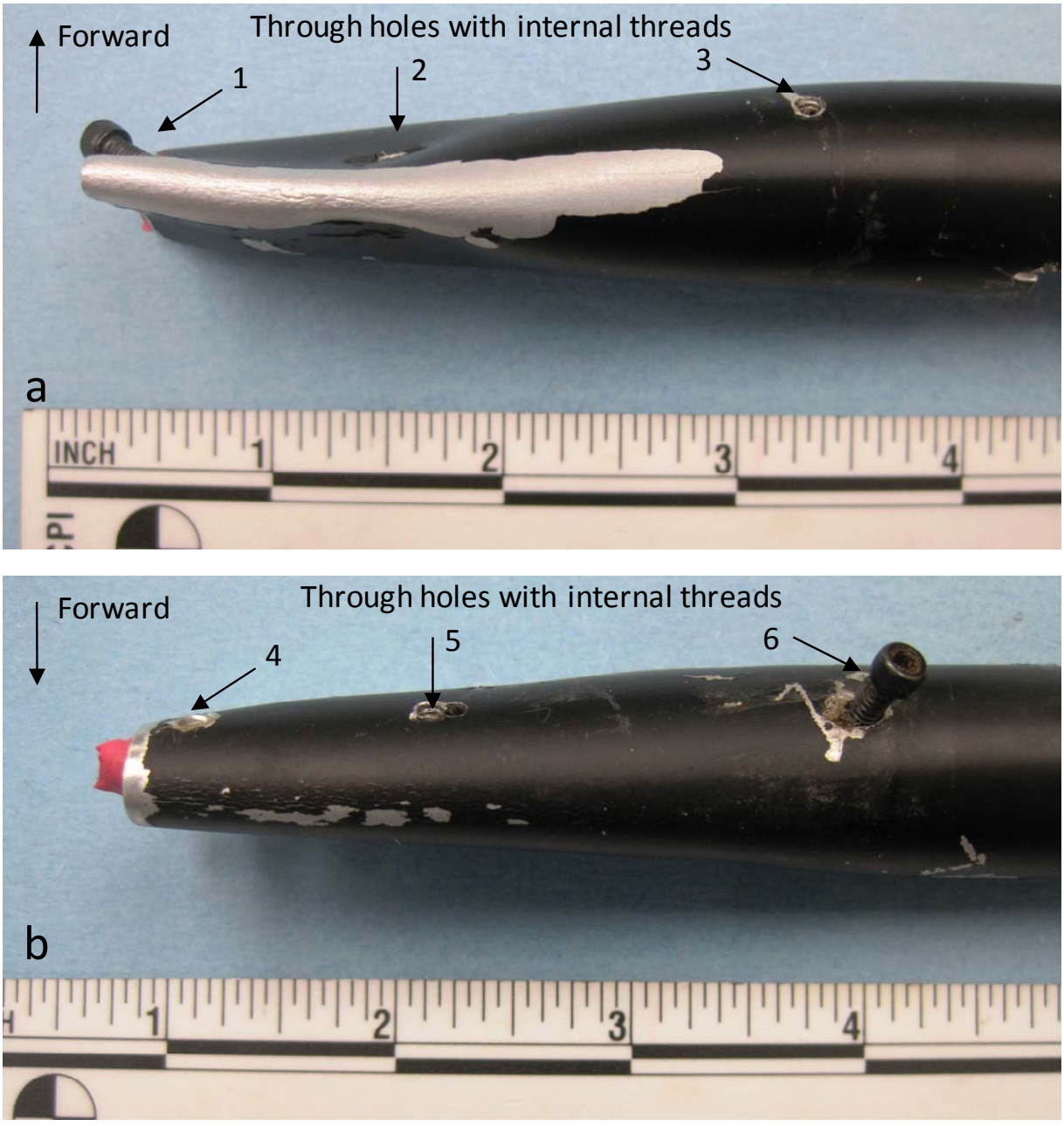

Figure 6 Upper end of the forward control stick showing the location of threaded holes.

Figure 7 Edge view of the top of the forward control stick piece.