NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

SURVIVAL FACTORS SPECIALIST'S FACTUAL REPORT

February 18, 2019

I. ACCIDENT

Aircraft	:	Airbus EC130 T2 [N11VQ]
Operator	:	Blue Hawaiian Helicopters
Location	:	Kauai, HI
Date	:	January 17, 2016
Time	:	1435 Hawaii standard time (HST)[1]
NTSB #	:	WPR16FA055

II. SURVIVAL FACTORS SPECIALIST

Specialist	:	Jason T. Fedok National Transportation Safety Board Washington, DC

III. SUMMARY

On January 17, 2016, about 1430 Hawaii standard time (HST), an Airbus EC130 T2, N11VQ, landed hard on a beach 2 miles west of Hanalei on the Hawaiian island of Kauai after a reported loss of engine power. The commercial pilot and all 6 passengers were seriously injured. The helicopter sustained substantial damage to the tailboom and airframe. The helicopter was registered to Nevada Helicopter Leasing LLC, operated by Blue Hawaiian Helicopters under the provisions of 14 Code of Federal Regulations, Part 135, and was conducting an air tour flight at the time of the accident. Visual meteorological conditions prevailed for the flight, and a company visual flight plan had been filed. The local flight originated in Lihue at 1406.

IV. DETAILS OF THE INVESTIGATION

1.0 Helicopter Information

The accident helicopter was configured to seat a pilot and six passengers, each seated in an individual seat (see figure 1). The helicopter seats are identified in this report as follows: the pilot seat was front left and seats 1 and 2 were front center and front right respectively. Seats 4, 5, 6, and 7 were the rear seats numbered right to left sequentially.

[1] All times reported in local time.

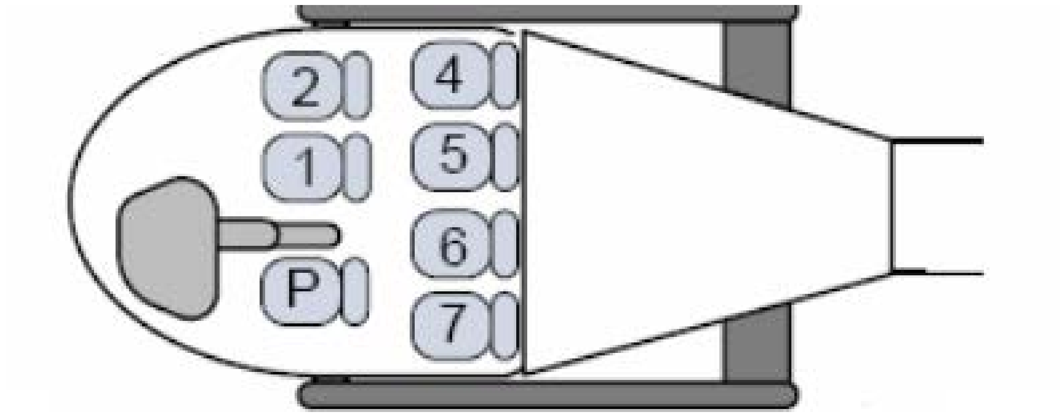

Figure 1. Accident helicopter's internal configuration.[2]

2.0 Seat Information

The seats were manufactured by Zodiac Seats France[3] (Zodiac), part numbers 19820-02-00 (referred to as T198) and 28410-0400 (referred to as T284). Part and serial numbers for each seat position in the accident helicopter are shown in table 1. Both part number seats were similar in design and appearance (see figures 2 and 3).

Seat Position	Part Number	Serial Number
Pilot	19820-02-00	14T3178
1	19820-02-00	14T2054
2	19820-02-00	14T3658
4	28410-04-00	13T0458
5	28410-04-00	14T3354
6	28410-04-00	14T1926
7	28410-04-00	14T3353

Table 1. Part and serial numbers for each seat position.

[2] Seat #3 was not installed in the accident helicopter.
[3] The seats were originally designed and certified by Sicma Aero Seat, prior to the company's acquisition by Zodiac Seats France.

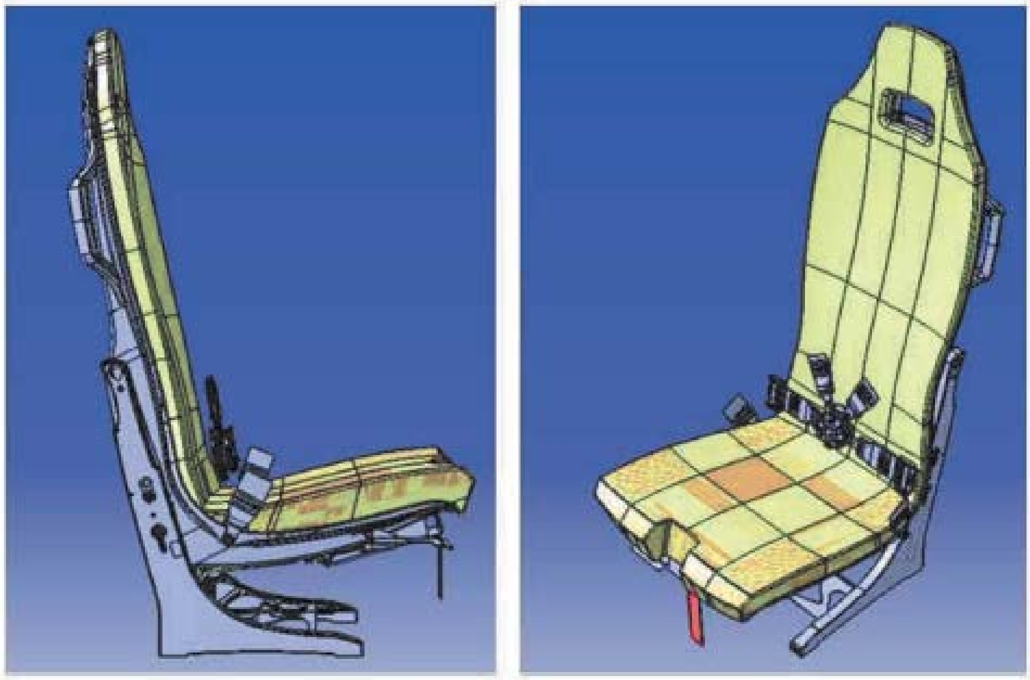

Figure 2. Zodiac seat T198.

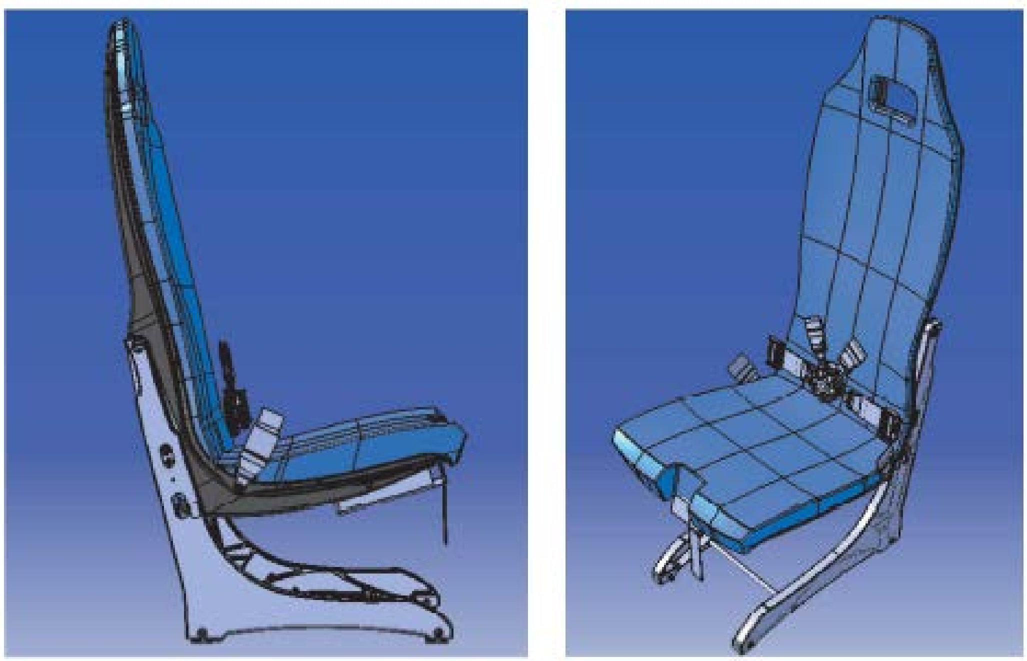

Figure 3. Zodiac seat T284.

Both part number seats were designed and certified to the standards contained in EASA ETSO C127a. Seat T198 received EASA approval on May 21, 2012 while seat T284 received approval on August 16, 2012. The EC 130 T2 certification basis was 14 CFR 27 amendment 27-1 through 27-32 effective June 11, 1996. Section 27.785 described the requirements for helicopter seats per amendment 27-25.

Section 27.785 stated, in part, that:

(f) Each seat and its supporting structure must be designed for an occupant weight of at least 170 pounds, considering the maximum load factors, inertial forces, and reactions between the occupant, seat, and safety belt or harness corresponding with the applicable flight and ground-load conditions, including the emergency landing conditions of Sec. 27.561(b). In addition--
(1) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in Sec. 27.397; and
(2) The inertial forces prescribed in Sec. 27.561(b) must be multiplied by a factor of 1.33 in determining the strength of the attachment of--
(i) Each seat to the structure; and
(ii) Each safety belt or harness to the seat or structure.

and

(i) Each seating device system includes the device such as the seat, the cushions, the occupant restraint system, and attachment devices.
(j) Each seating device system may use design features such as crushing or separation of certain parts of the seats to reduce occupant loads for the emergency landing dynamic conditions of Sec. 27.562; otherwise, the system must remain intact and must not interfere with rapid evacuation of the rotorcraft.

Section 27.561(b) specified the emergency landing condition per amendment 27-32.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when--
(1) Proper use is made of seats, belts, and other safety design provisions;
(2) The wheels are retracted (where applicable); and
(3) Each occupant and each item of mass inside the cabin that could injure an occupant is restrained when subjected to the following ultimate inertial load factors relative to the surrounding structure:
(i) Upward--4g.
(ii) Forward--16g.
(iii) Sideward--8g.
(iv) Downward--20g, after the intended displacement of the seat device.
[(v) Rearward--1.5g.]

Section 27.562 specified the occupant protection during emergency landing dynamic conditions per amendment 27-25.

(a) The rotorcraft, although it may be damaged in an emergency crash landing, must be designed to reasonably protect each occupant when--
(1) The occupant properly uses the seats, safety belts, and shoulder harnesses provided in the design; and
(2) The occupant is exposed to the loads resulting from the conditions prescribed in this section.

(b) Each seat type design or other seating device approved for crew or passenger occupancy during takeoff and landing must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat in accordance with the following criteria. The tests must be conducted with an occupant, simulated by a 170-pound anthropomorphic test dummy (ATD), as defined by 49 CFR 572, Subpart B, or its equivalent, sitting in the normal upright position.
(1) A change in downward velocity of not less than 30 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is canted upward 60° with respect to the impact velocity vector, and the rotorcraft's lateral axis is perpendicular to a vertical plane containing the impact velocity vector and the rotorcraft's longitudinal axis. Peak floor deceleration must occur in not more than 0.031 seconds after impact and must reach a minimum of 30g's.
(2) A change in forward velocity of not less than 42 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is yawed 10° either right or left of the impact velocity vector (whichever would cause the greatest load on the shoulder harness), the rotorcraft's lateral axis is contained in a horizontal plane containing the impact velocity vector, and the rotorcraft's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. Peak floor deceleration must occur in not more than 0.071 seconds after impact and must reach a minimum of 18.4g's.

Both T198 and T284 seats consisted of a composite bucket affixed to a structural frame composing both the seat legs and seatback supports. The seatback supports contained energy absorbing features in order to meet the requirements referred to in 14 CFR sections 27.785, 27.561, and 27.562. Corrugated absorption devices and fuses[4] were built into either side of seatback supports (total of two in each seat) to absorb energy in event of high vertical loading (see figures 4 and 5). The composite seat bucket was affixed to the seat frame on a set of tracks via two “bucket fixings” and plastic bushings (rollers). When subjected to high vertical loads, these features allowed the bucket to move downwards while the absorption devices deformed (i.e. stretched) and absorbed vertical energy (see figure 6). The undeformed dimension of the absorption devices was 10.7cm.

[4] Fuses were metal links that fractured once a specified amount vertical force was experienced allowing the seat to stroke downward.

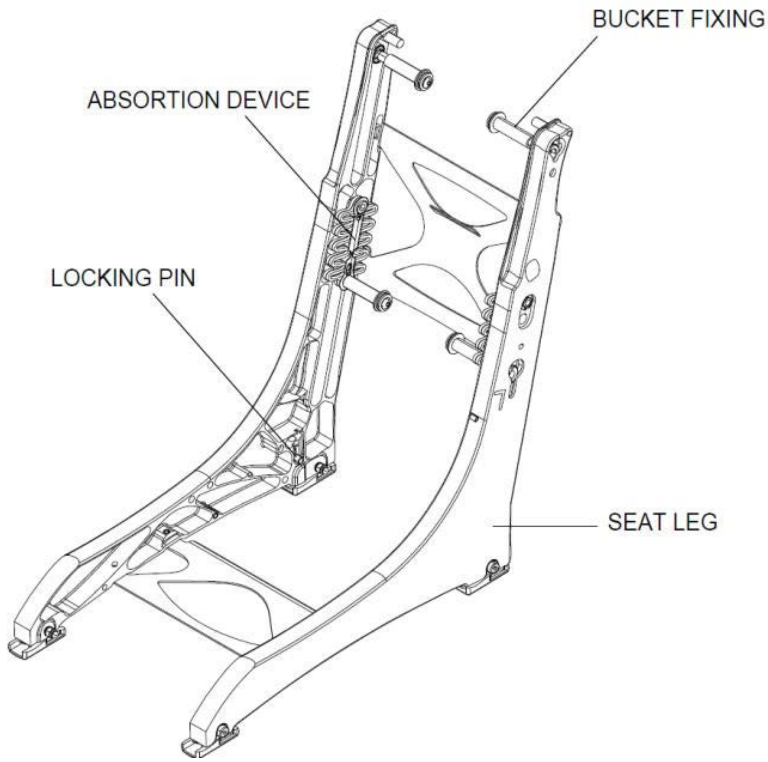

Figure 4. Structural elements of the seat legs and seatback supports.

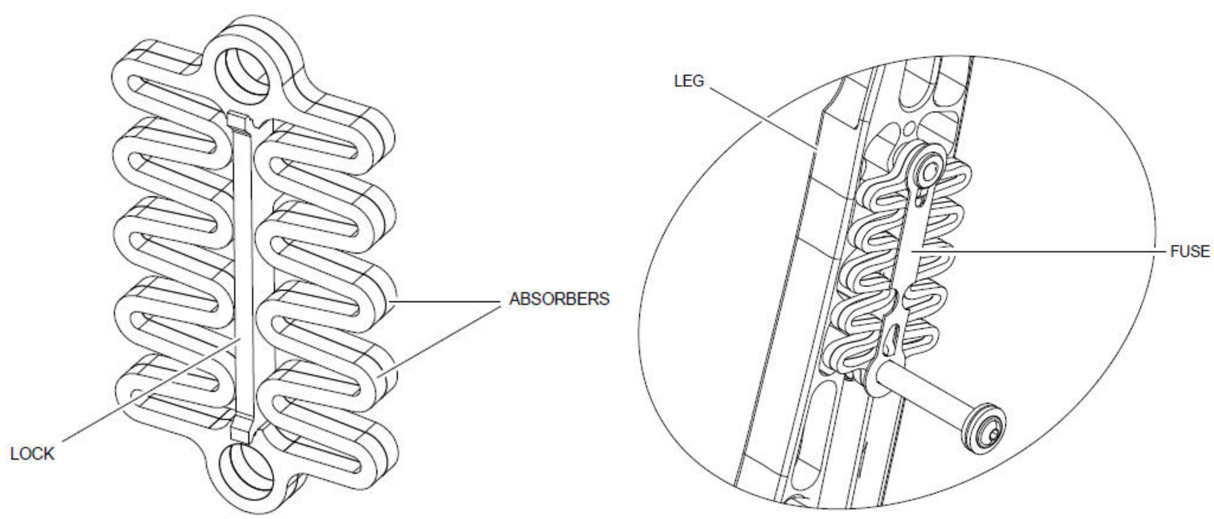

Figure 5. Close-up views of the corrugated vertical energy absorber and fuse.

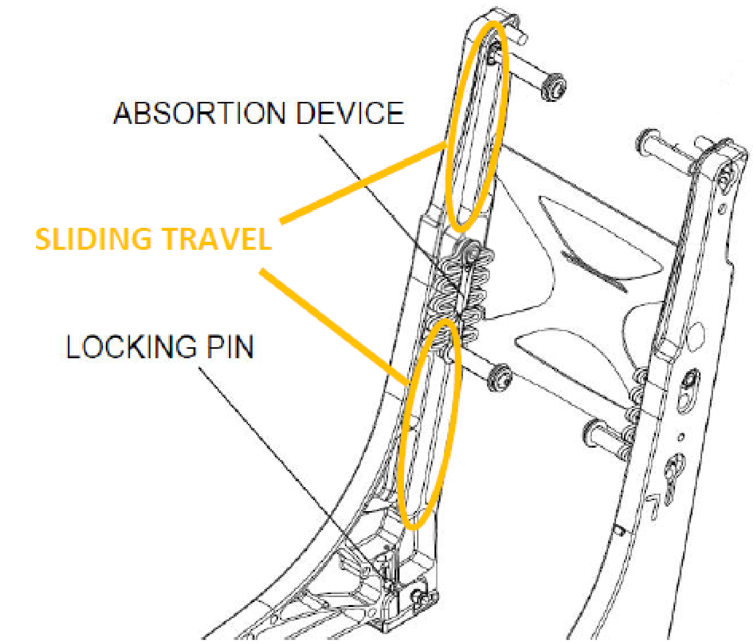

Figure 6. Areas of sliding travel during vertical energy absorption.

Zodiac provided the NTSB (through BEA) with redacted documents concerning the seats' certification. The documents showed that the seats passed the three major tests required by the applicable Part 27 regulations previously discussed. Specifically, the seats passed a 30g downward dynamic test with a 50th percentile (170 lb.) anthropomorphic test dummy (ATD) and the seat pitched up at 60 degrees. During this test a "permanent deformation of the absorbing device in the downward direction was observed in accordance with design." The redacted documents provided by Zodiac did not contain any measurements to indicate the extent to which the absorption devices had deformed. A 18.4g forward dynamic test was passed with a 50th percentile (170 lb.) ATD and the seat yawed at 10 degrees clockwise. During this test a "permanent deformation of the upper bucket [seat] axis, [in] the forward direction… in accordance with design" was observed. The redacted documents provided by Zodiac did not contain any measurements to indicate the extent to which the seats deformed. Finally, the seats also passed a 13.3g downward static test with a 50th percentile (170 lb.) ATD in order to verify that the absorption devices did not deform under such a static load.

2.0 On-scene Documentation

On May 11, 2016, the NTSB Investigator-in-Charge (IIC), along with technical representatives from Blue Hawaiian Helicopters, Air Methods Corporation, Airbus Helicopter and Zodiac Aerospace, examined the helicopter wreckage at the Lihue hangar.

The seats were documented in situ and then removed from the helicopter for additional examination. All seats were correctly installed according to Airbus and Zodiac technical representatives. Two major types of deformation were observed: downward deformation affecting the length of the absorption devices and forward deformation of the upper seat axis (see figure 7).

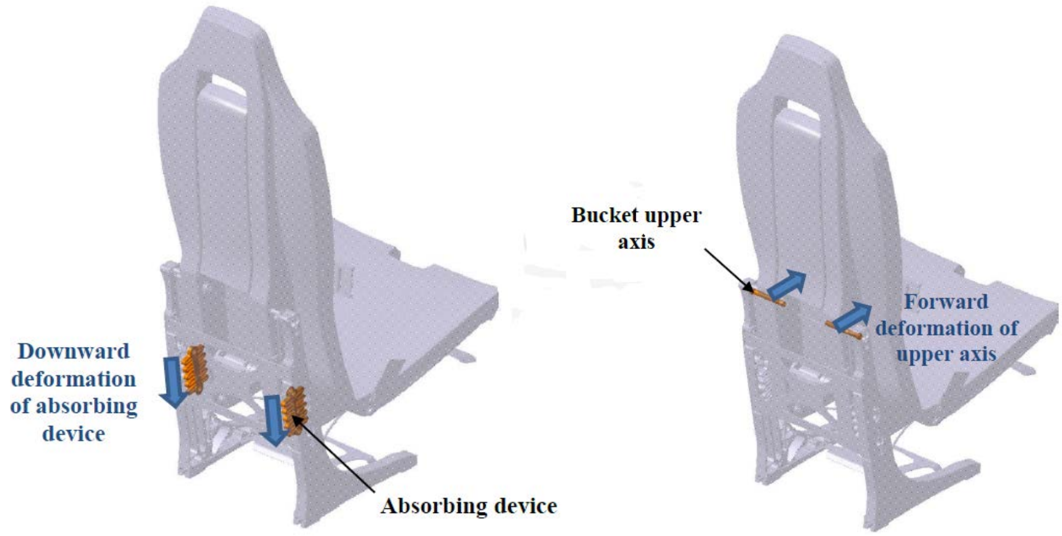

Figure 7. Two types of deformation observed during the accident.

Pilot Seat

There was no damage noted to the seat itself with the exception of the left side of the rear plastic cover which was partially detached. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001441) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 45.0cm on the left lapbelt side and 43.0cm on the right lapbelt side.

The seat showed evidence of downward stroking during impact and that the bucket contacted the underseat sheet metal, causing permanent deformation to the sheet metal. Both absorbers and fuses were fractured. The broken absorbers each measured 26.0cm, which equated to at least 15.3cm of downward seat stroke. Wear and plastic shavings were noted on all four plastic bushings. It was also noted that there was "significant deformation of upper bucket [in the] forward direction."

Seat #1

There was no damage noted to the seat itself. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001289) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 27.3cm on the left lapbelt side and 26.0cm on the right lapbelt side.

The seat showed no evidence of downward stroking during impact. Neither absorber was deformed or fractured and each measured about 10.7cm. The left fuse was fractured but the right fuse was not. There was no wear or plastic shavings noted on any of the plastic bushings. It was also noted that there was "major deformation of [the] upper [seat] axis in [the] forward direction."

Seat #2

There was no damage noted to the seat itself with the exception some minor cracking of the rear plastic cover. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001687) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 40.0cm on the left lapbelt side and 28.0cm on the right lapbelt side.

The seat showed evidence of downward stroking during impact.[5] Both fuses were fractured and both absorbers were deformed but not fractured. The left-side absorber measured 14.43cm, which equated to approximately 3.73cm of downward seat stroke. The right-side absorber measured 13.96cm, which equated to approximately 3.26cm of downward seat stroke. Wear and plastic shavings were noted on the four plastic bushings. It was also noted that there was "bending of seat upper axis [in the] forward direction... a little more displacement on the left side"

Seat #4

There was no damage noted to the seat itself. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 000404) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 36.0cm on the left lapbelt side and 29.5cm on the right lapbelt side.

The seat showed evidence of downward stroking during impact but there was no damage to the underseat sheet metal. Both fuses were fractured and both absorbers were deformed but not fractured. The left-side absorber measured 14.54cm, which equated to approximately 3.84cm of downward seat stroke. The right-side absorber measured 14.44cm, which equated to approximately 3.74cm of downward seat stroke. Wear and plastic shavings were noted on the four plastic bushings. It was also noted that there was "small bending of [the] seat upper axis [in the] forward direction."

Seat #5

There was no damage noted to the seat itself. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001620) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 37.0cm on the left lapbelt side and 30.7cm on the right lapbelt side.

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[5] Some deformation was noted to the underseat sheet metal; however there was no evidence of contact between the seat and the sheet metal.

The seat showed evidence of downward stroking during impact but there was no damage to the underseat sheet metal. Both fuses were fractured and both absorbers were deformed but not fractured. The left-side absorber measured 17.19cm, which equated to approximately 6.49cm of downward seat stroke. The right-side absorber measured 17.26cm, which equated to approximately 6.56cm of downward seat stroke. Wear and plastic shavings were noted on the four plastic bushings. It was also noted that there was "small bending of [the] seat upper axis [in the] forward direction."

Seat #6

There was no damage noted to the seat itself. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001161) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 21.5cm on the left lapbelt side and 23.0cm on the right lapbelt side.

The seat showed evidence of downward stroking during impact but there was no damage to the underseat sheet metal. Both fuses were fractured and both absorbers were deformed but not fractured. The left-side absorber measured 17.93cm, which equated to approximately 7.23cm of downward seat stroke. The right-side absorber measured 17.54cm, which equated to approximately 6.84cm of downward seat stroke. Wear and plastic shavings were noted on the four plastic bushings. It was also noted that there was "bending of [the] seat upper axis [in the] forward direction."

Seat #7

There was no damage noted to the seat itself. The seatpan and seatback foam had been removed prior to documentation but were noted not to have been original equipment supplied with the seat. The seat foam and upholstery had manufacturing labels from Aero Comfort Company. The Airbus-manufactured 4-point rotary restraint system (P/N 35814010-18-070, S/N 001628) was difficult to operate (due to sand) but was undamaged and functional. It was adjusted to a length of 19.5cm on the left lapbelt side and 21.7cm on the right lapbelt side.

The seat showed no evidence of downward stroking during impact. Neither absorber was deformed or fractured and each measured about 10.7cm. Neither fuse was fractured or deformed. There was no wear or plastic shavings noted on any of the plastic bushings. It was also noted that there was "significant bending of [the] upper seat axis [in the] forward direction."

Table 2 summarizes the occupants' seat position, weight, and postaccident measurements of seat stroke.

Seat	Occupant Weight[6]	Left Side Stroke	Right Side Stroke	Left Fuse	Right Fuse	Upper Axis Displacement
Pilot	185 lbs.	15.3 cm	15.3 cm	Broken	Broken	0.63 cm
1	143 lbs.	0 cm	0 cm	Broken	Not Broken	0.83 cm
2	180 lbs.	3.73 cm	3.26 cm	Broken	Broken	0.23 cm
4	154 lbs.	3.84 cm	3.74 cm	Broken	Broken	0.05 cm
5	223 lbs.	6.49 cm	6.56 cm	Broken	Broken	0.055 cm
6	263 lbs.	7.23 cm	6.84 cm	Broken	Broken	0.08 cm
7	188 lbs.	0 cm	0 cm	Not Broken	Not Broken	0.40 cm

Table 2. Summary of occupant seat position, weight, and seat stroke.

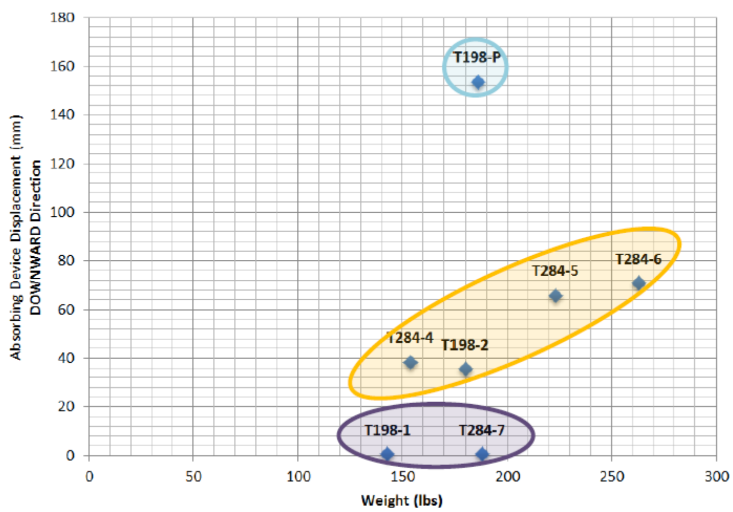

Figure 8. Safran Seats France plot of occupant weight vs. absorption device displacement.

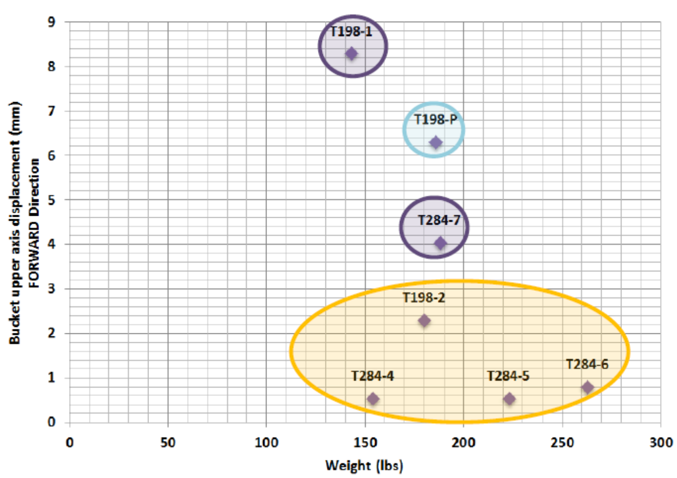

Figure 9. Safran Seats France plot of occupant weight vs. upper seat axis displacement.

[6] Occupant weights were recorded on the flight's weight and balance form.

3.0 Impact Simulation

Airbus provided the NTSB with the results of an in-depth simulation of the helicopter's impact with the sand. According to the simulation the helicopter likely experienced two impacts. The helicopter initially struck the sand with a vertical velocity of 40 feet/second (12.2 meters/second) with a 10.2 degree right roll and 3.6 degree nose-up attitude (see figure 10).

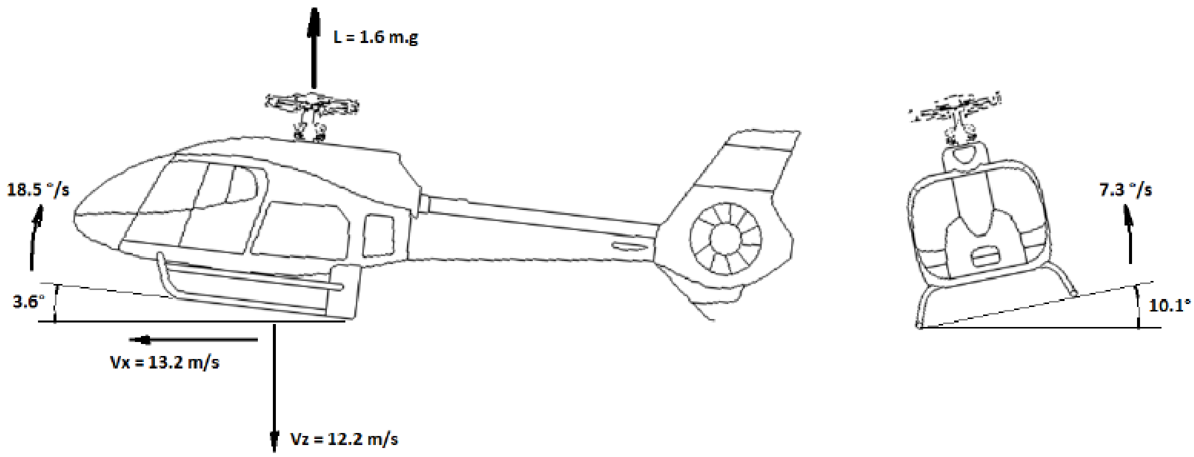

Figure 10. Initial impact conditions based on GPS data and Appareo 1000 data. (Courtesy: Airbus)

Analysis of on-scene photographs indicated that the right skid deformed and dug into the sand approximately 50 cm. The simulation indicated that the helicopter then likely rebounded and bounced approximately 21.3 feet (6.5 meters) at a 16-degree angle. Load factors at the center of gravity for the initial impact were determined to be 9g horizontal, 4g lateral, and 24g vertical. The load factors of the second impact (after the bounce) were determined to be 7g horizontal, 1g lateral, and 19g vertical.

Based on this simulation, Airbus also produced plots of the occupants' acceleration in the different seating positions of the helicopter (see figure 11).

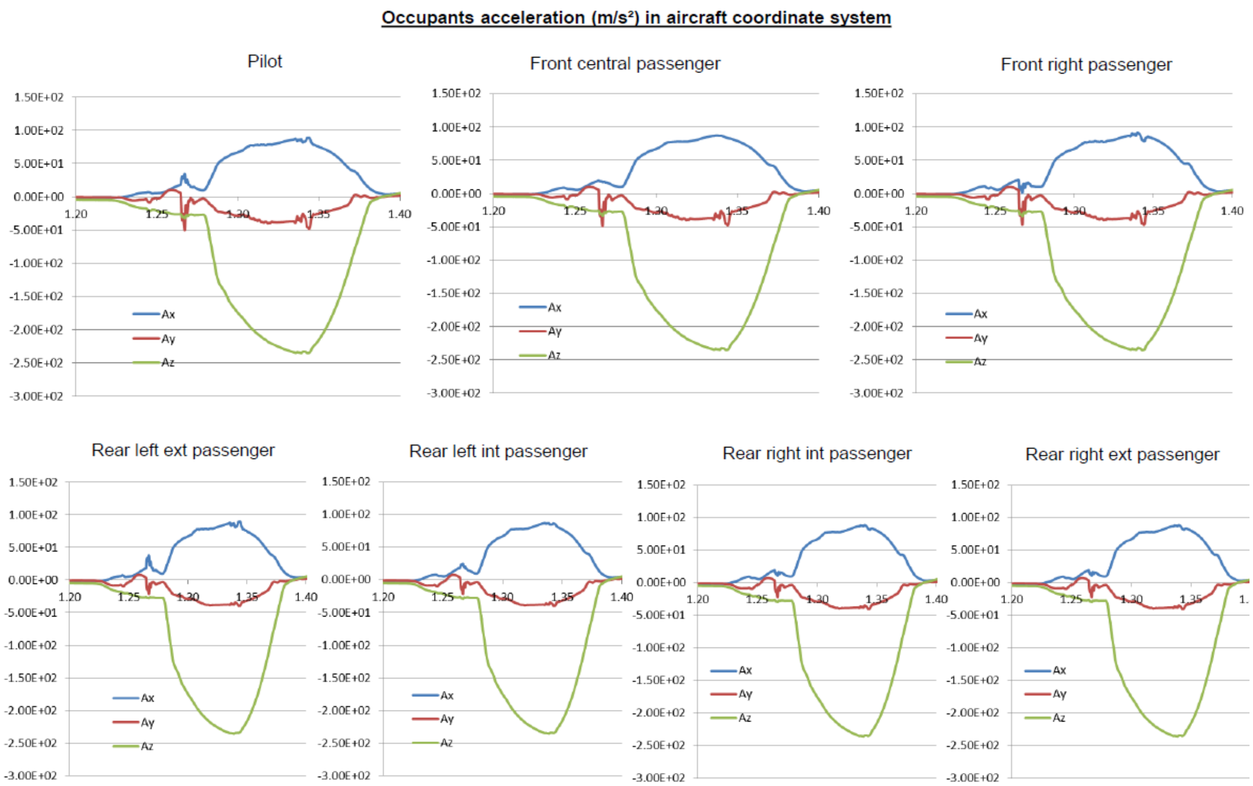

Figure 11. Calculated occupant accelerations during impact (Courtesy: Airbus)

4.0 Injury Information

Six of the seven helicopter occupants in this accident were diagnosed with thoracolumbar compression fractures on the day of the accident. With the exception of the occupant of seat 1 (who became paraplegic), the occupants remained neurologically intact. The occupants in seats 2 and 7 had fractures at multiple vertebral levels. The occupants in seats 1 and 2 both had sternal fractures. Seat 1's occupant was limited to a buckle fracture while seat 2's occupant's fracture was significantly displaced. For more detailed injury information, see the NTSB Injury Group Factual Report.

Jason T. Fedok
Survival Factors Investigator