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

March 5, 2015

# Vehicle Recovery Group Factual Report

DCA-15-MA-019

## A. ACCIDENT

| | |
|---|---|
| Operator: | Scaled Composites, LLC |
| Location: | near Koehn Dry Lake, CA |
| Date: | October 31, 2014 |
| Time: | 1007 Pacific Daylight Time |
| Vehicle: | Scaled Composites SpaceShipTwo reusable suborbital rocket, N339SS |

## B. VEHICLE RECOVERY GROUP

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## C. SUMMARY

On October 31, 2014, about 1007 Pacific daylight time,[1] a Scaled Composites SpaceShipTwo (SS2) reusable suborbital rocket, N339SS, experienced an in-flight anomaly during a rocket-powered flight test, resulting in loss of control of the vehicle. SS2 broke up into multiple pieces and impacted terrain over a 5-mile area near Koehn Dry Lake, California. One test pilot (the copilot) was fatally injured, and the other test pilot was seriously injured. SS2 had launched from the WhiteKnightTwo (WK2) carrier aircraft, N348MS, about 12 seconds before the loss of control. SS2 was destroyed, and WK2 made an uneventful landing. Scaled Composites was operating SS2 under an experimental permit issued by the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation under the provisions of 14 *Code of Federal Regulations* (CFR) Part 437.

The vehicle recovery group convened on November 1-6, 2014, in Mojave, CA, to examine and document the vehicle wreckage and oversee the recovery of the wreckage to a secure location. Following the on scene work, the group continued to monitor additional recovery efforts.

## D. DETAILS OF THE INVESTIGATION

### 1.0 Wreckage Distribution

The main wreckage sites were contained within an area of approximately 5 miles by 0.5 miles. The main wreckage sites contained 10 major individual impact sites which were, in general, loosely bounded by Redrock Randsburg road to the north, and a set of railroad tracks to the south. The wreckage site numbers were originally assigned by the Kern County Sheriff's Office, while the sub-site numbers were assigned as the investigation progressed to cover the major wreckage items found during the on-scene phase of the investigation. An Evidence Response Team (ERT) from the Federal Bureau of Investigation (FBI) conducted a total station survey of the main impact sites. The positions of these sites as determined by this survey are listed in table 1.

[1] Unless otherwise indicated, all times in this report are Pacific daylight time based on a 24-hour clock.

Table 1
Wreckage site coordinates as provided by the FBI

| Site number | Coordinates (deg min sec) | General Description |
|---|---|---|
| 1 | 35°20'31.63"N<br>117°55'8.45"W | Right boom |
| 2 | 35°19'34.34"N<br>117°56'42.85"W | Main oxidizer tank and wings |
| 3 | 35°20'31.84"N<br>117°55'29.93"W | Left boom |
| 3a | 35°20'37.91"N<br>117°55'29.14"W | Torque tube |
| 4 | 35°18'15.10"N<br>117°58'31.31"W | Cockpit and nose section |
| 4a | 35°18'18.76"N<br>117°58'35.82"W | Forward pressure tank |
| 4b | 35°18'35.21"N<br>117°58'00.00"W | Left feather actuator |
| 5 | 35°17'33.59"N<br>117°59'16.01"W | Rocket Engine |
| 6 | 35°21'20.15"N<br>117°55'12.47"W | Pilot's Parachute |
| 8 | 35°20'05.02"N<br>117°56'14.05"W | Pilot's Seat |

Note: Site 7 was the wreckage site command post and contained no wreckage.

In addition to the main wreckage sites, several pieces of lighter-weight wreckage were found in the area between the main wreckage sites and the Ridgecrest, CA area. These pieces were picked up by either the Kern County Sheriff's office or representatives from Scaled Composites and were delivered to the wreckage storage hangar. The positions of many of these additional pieces were determined using either handheld GPS data or coordinates determined by referring to a map and the locator's best estimate of where the piece was found. These positions are listed in appendix A. The inclusion of these wreckage pieces increased the total length of the wreckage distribution to approximately 33 miles. In many cases, the precise location of the impact point for a piece of wreckage could not be determined.

The positions of all of the recovered wreckage (when the impact positions were available) are shown in figure 1. In addition to this figure, two additional wreckage maps were developed showing the points in the southwest (SW) area of the total wreckage distribution and the points in the northeast (NE) area of the total wreckage field. These maps are shown in figures 2 and 3. In these figures, the wreckage locations where FBI ERT survey data was used are shown in blue, while the remainder of the wreckage

locations are shown in red (the numbers adjacent to the red symbols in figures 2 and 3 correspond to an item number in Appendix A).

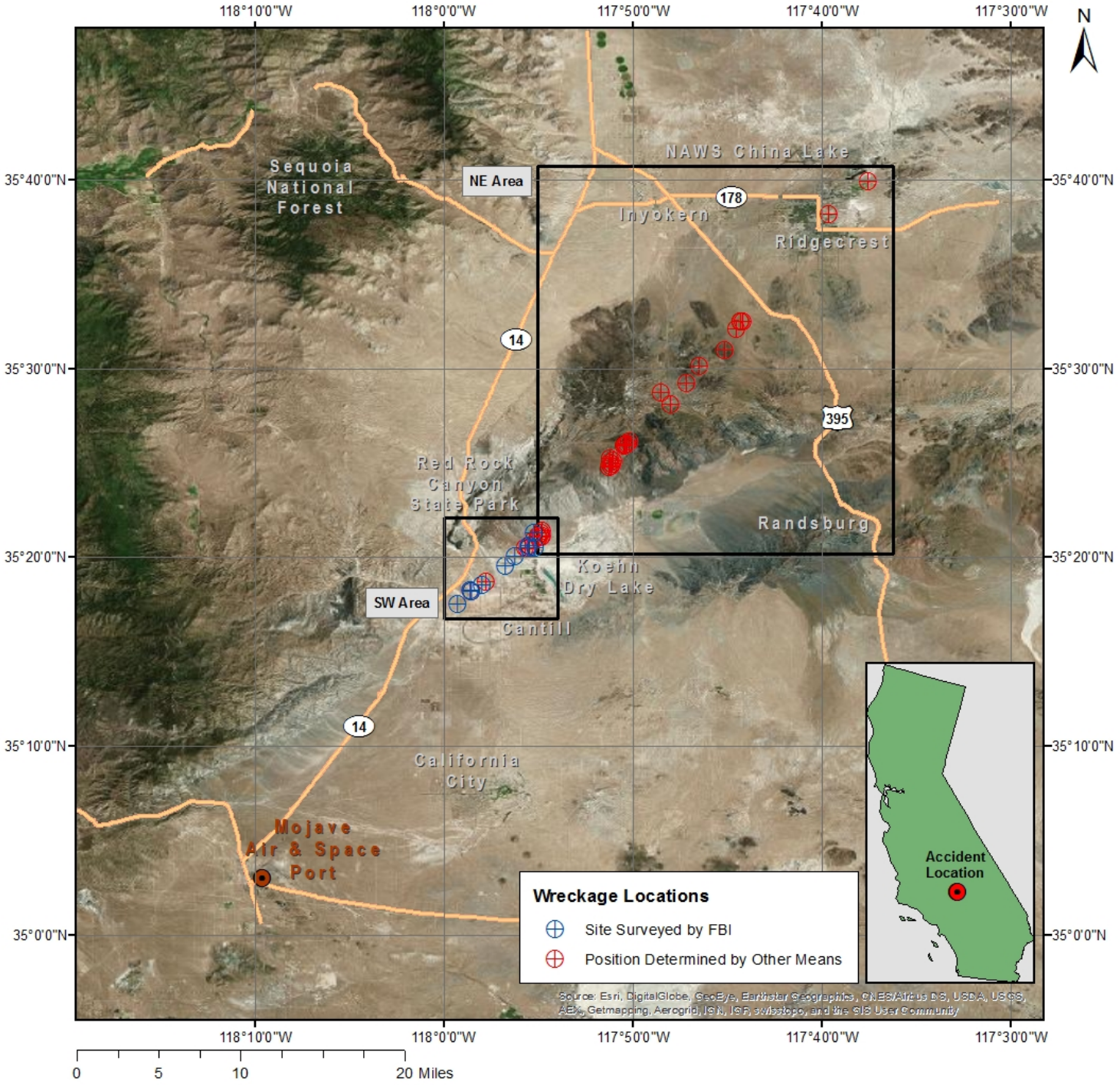



Figure 1
Overall map of the wreckage locations

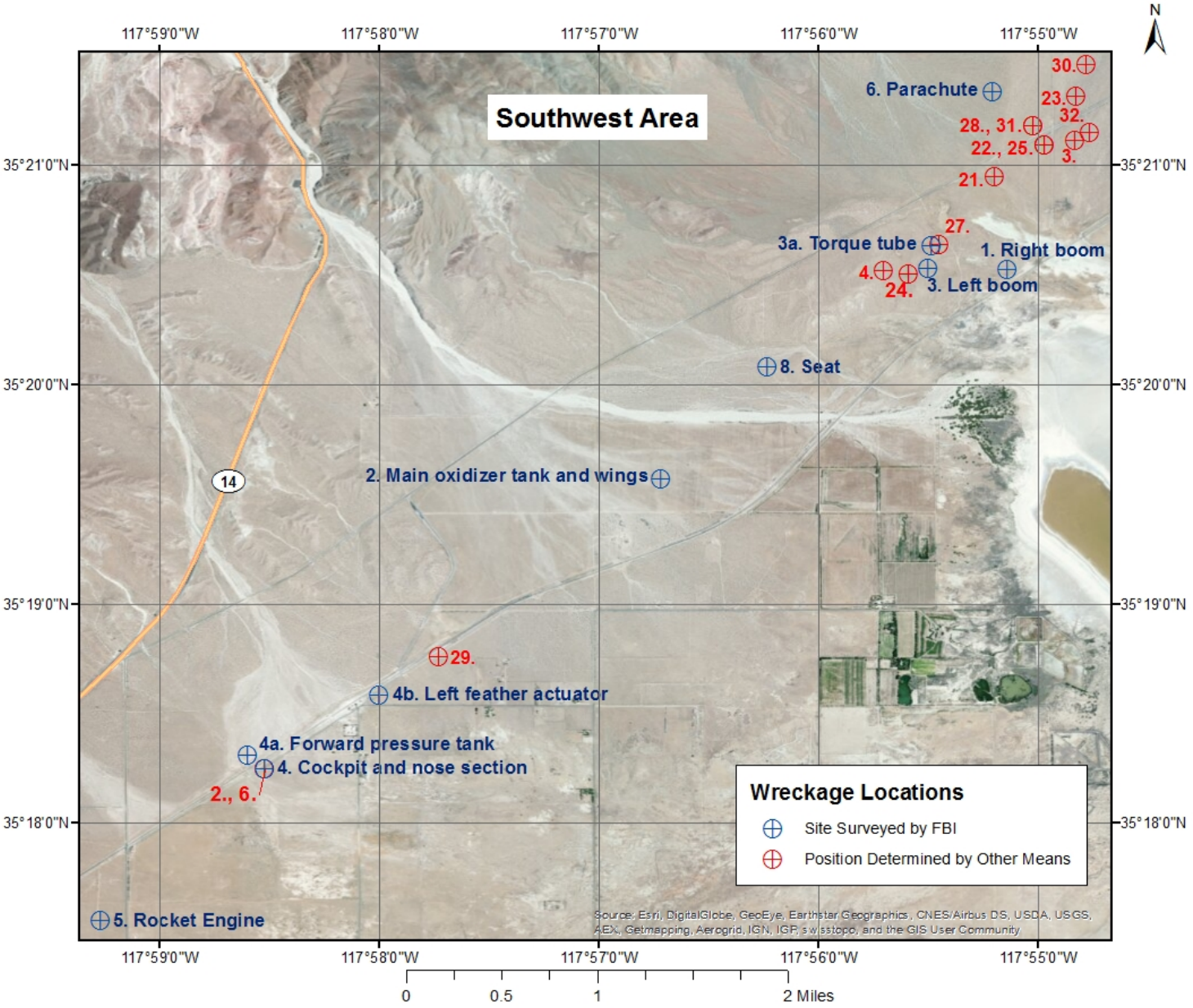



Figure 2
Wreckage locations from the southwest portion of the wreckage field

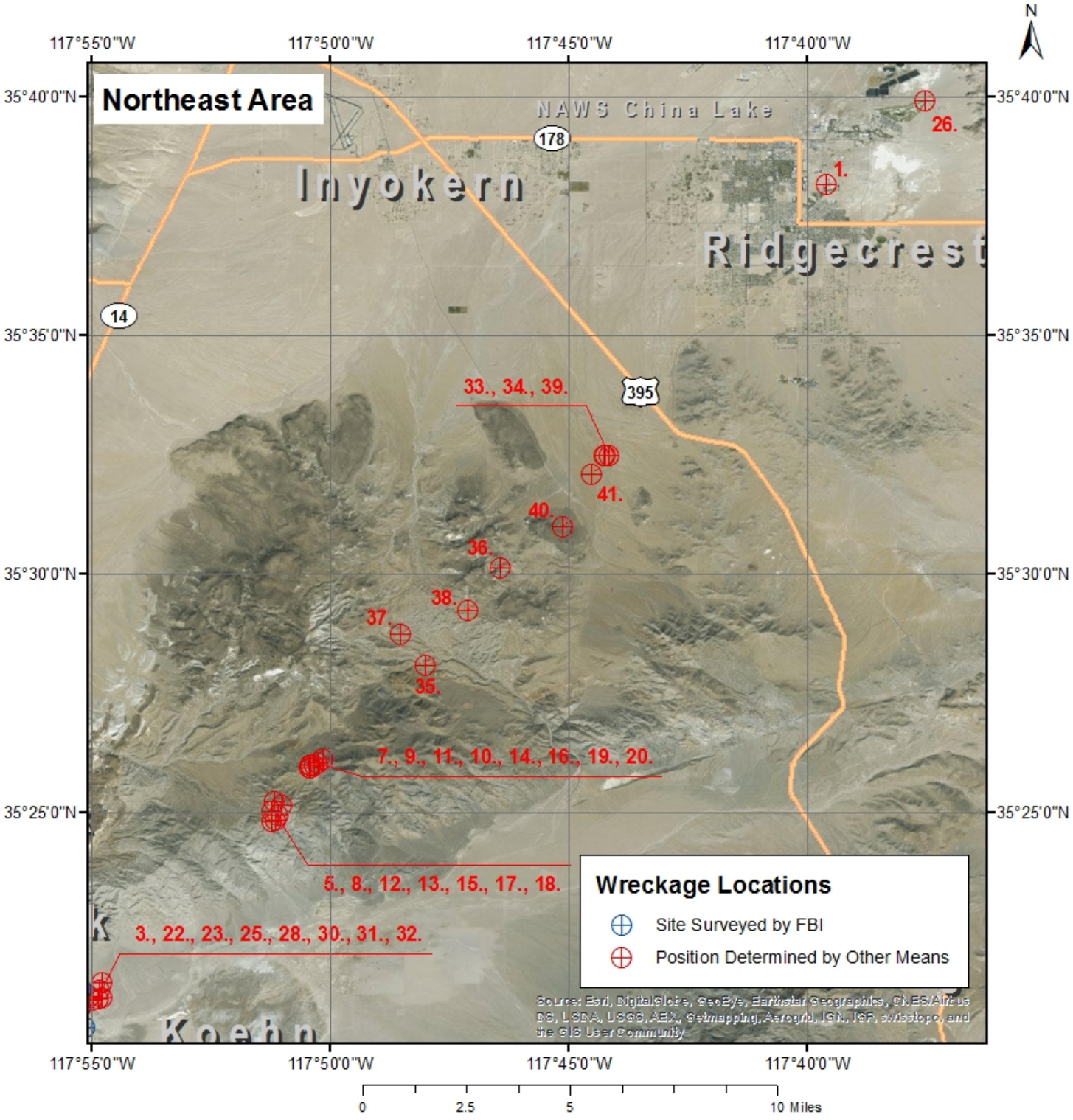



Figure 3
Wreckage locations from the northeast portion of the wreckage field

## 1.1 Wreckage Description

The main wreckage sites were examined and documented as follows:

### 1.1.1 Site 1 – Right Boom

The main portion of the right boom was found fractured into two pieces at the horizontal stabilizer actuator attach rib and lying on its inboard side (see figure 4).

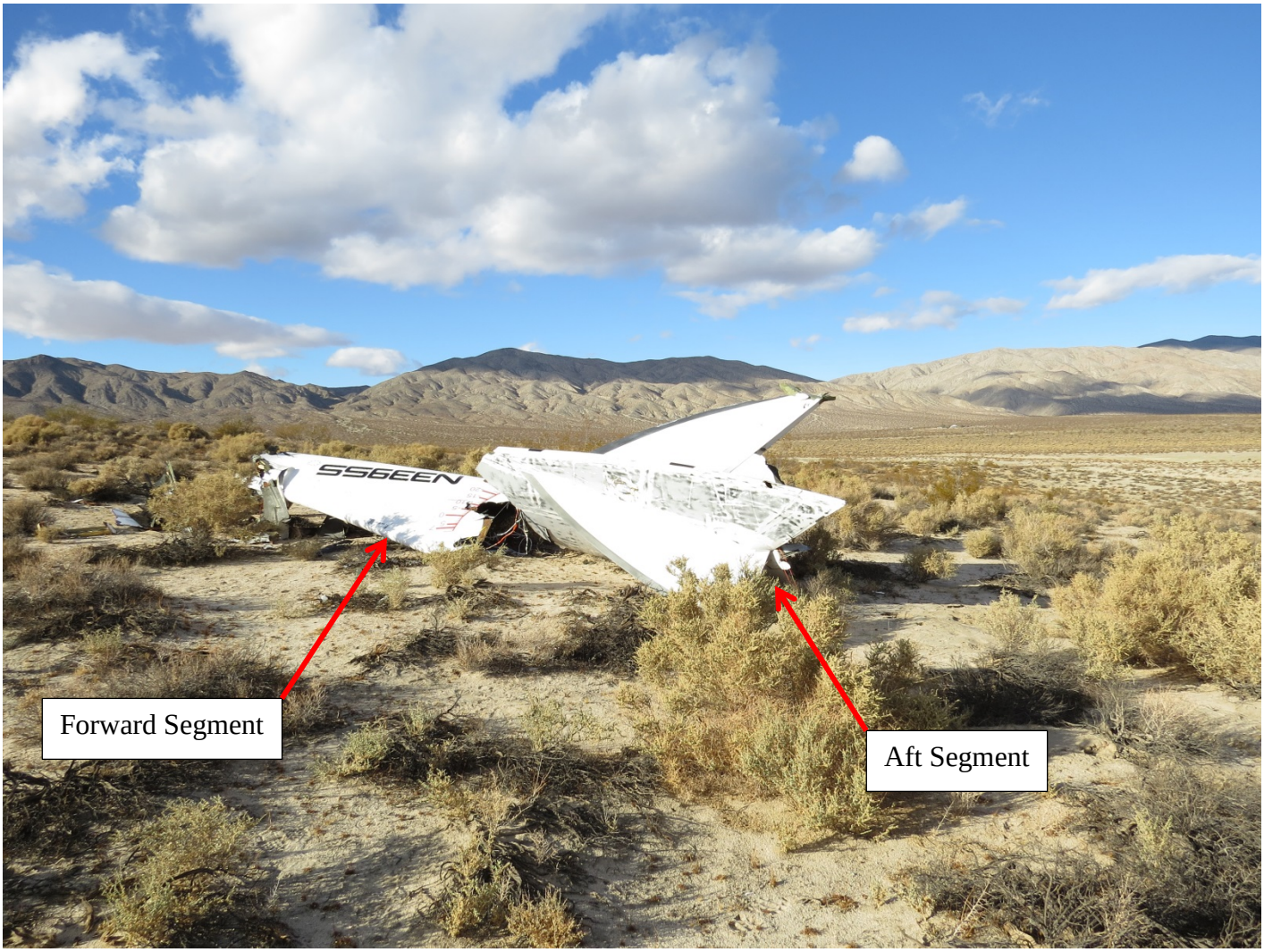



Figure 4
Right boom – Overall view

The tusk area was buried in the ground and separated from the rest of the boom. After the tusk was recovered from the ground, the lock pin was observed to be unbroken and no deformation could be observed.

The outboard feather hinge on the feather flap side was intact. The wing side hinge was separated from the wing and still attached to the feather flap hinge.

The stub rib from the torque tube assembly was present and attached to the boom. The trailing and mid spars along with the aft torque tube connections to the boom were intact. The trailing edge spar was present on the ground (see figures 5 and 6).

Rudder ribs and the upper rudder hinge were found in the tusk hole area.

(b) (4)

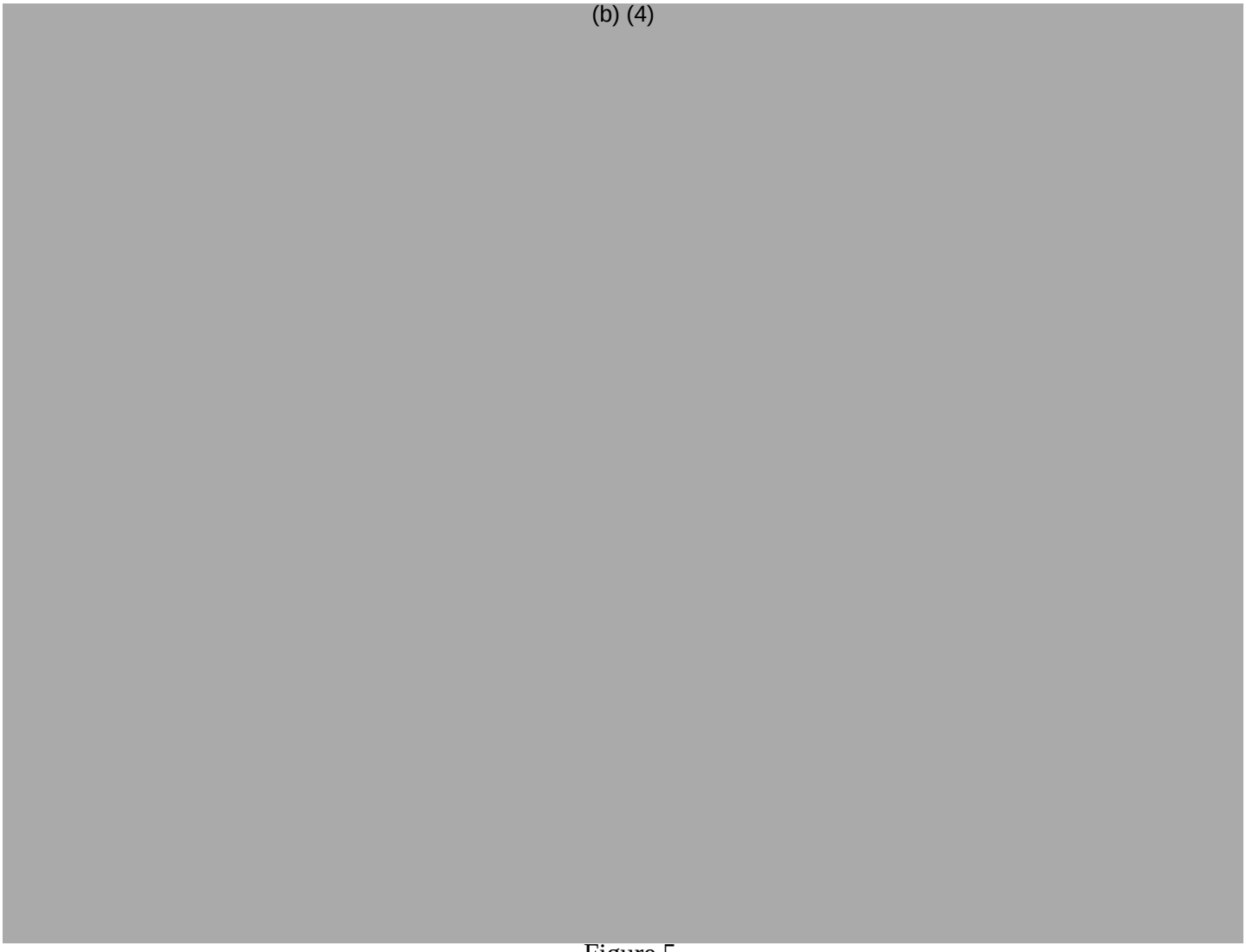


Figure 5
Right boom – view from forward end


Figure 6
Right boom – forward segment

A witness mark was observed on the horizontal stabilizer position scale consistent with a horizontal stabilizer position between -6 and -9 deg (see figure 7).

Figure 7
Right boom – view showing split between forward and aft segment

The mega-strake was attached to the boom and intact.

The Kapton reflective tape was missing from the inboard surface of the boom. That surface was noted to have a sticky residue remaining (see figure 8).

The midsection of the rudder was present. The balance weight horn was present, but the weight was not.

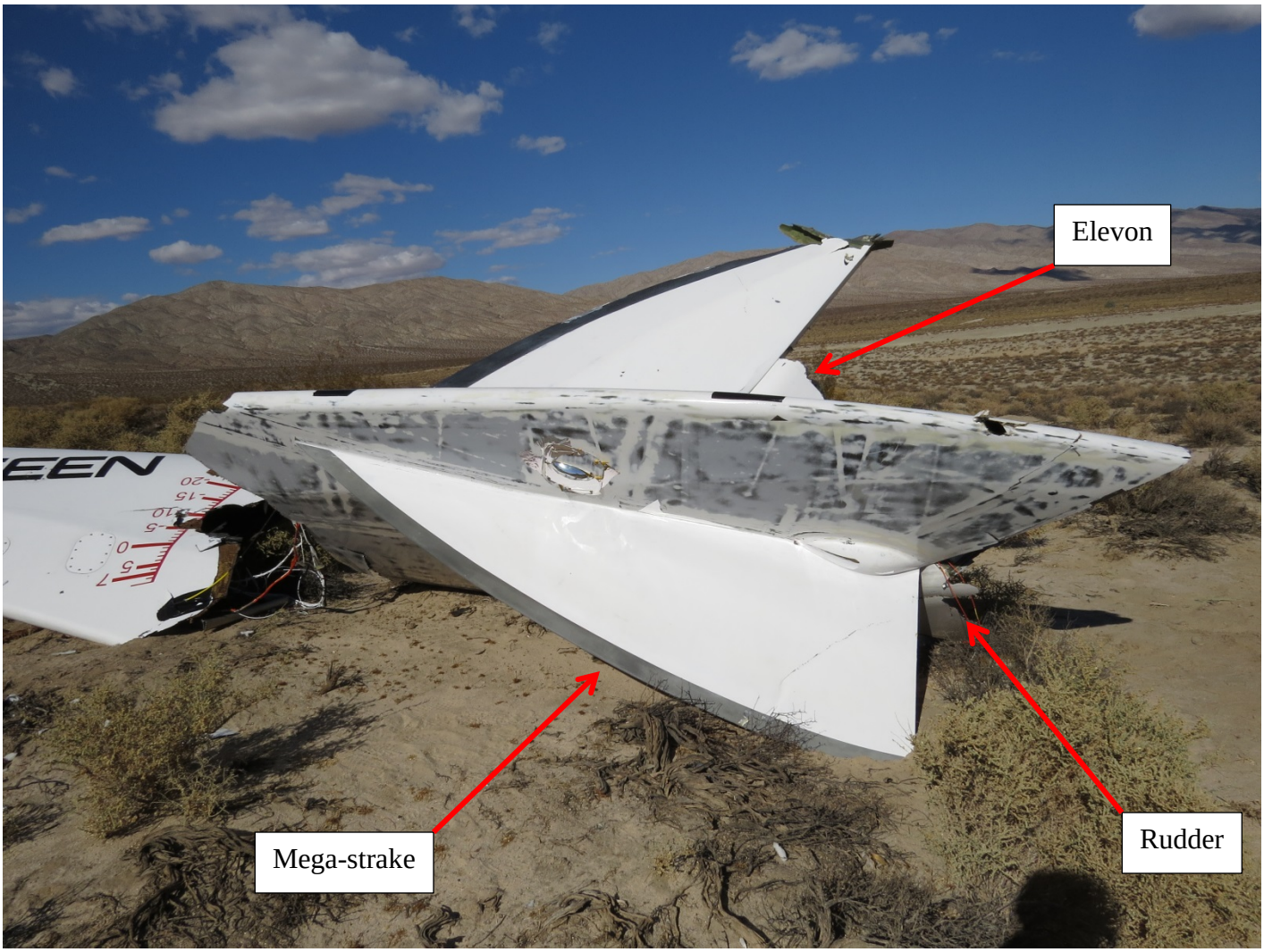



Figure 8
Right boom – aft segment showing mega-strake and remaining elevon and rudder surface sections

The push rod that actuates the elevon horn was broken at the rivets at the horn to pushrod interface.

The mid and lower rudder hinges were present.

The elevon control torque tube control horn and associated structure were intact.

The inboard portion of the elevon was present on the boom (see figure 9). The length of the trailing edge of this piece of elevon control surface was measured to be 36 inches. The length of the leading edge of the same piece was measured to be 38 ¼ inches.

Figure 9
Right boom – aft end showing elevon section remaining

The elevon mid hinge was present, and the outboard hinge was broken off.

The outboard portion of the elevon was found approximately 500 yards away from the right boom. The balance weight was not attached, but the weight was later found at a different location. The leading edge measured 38 ½ inches and the trailing edge measured 33 inches.

The horizontal stabilizer accelerometers were present.

A portion of the upper feather flap skin was noted in the area on the ground around the horizontal stabilizer.

The horizontal stabilizer actuator was noted to be secure in its mounting.

### 1.1.2 Site 3 – Left Boom

The main portion of the left boom was found in one piece and laying on its inboard side resting in front on the forward torque tube which was broken at an approximate 45 deg angle (see figure 10).

Figure 10
Left boom – overall view

The tusk area was buried in the ground and separated from the rest of the boom with 12 inches of structure remaining above ground. After the tusk was recovered from the ground, the lock pin was observed to be unbroken and no deformation

could be observed. The lock pin retaining flange was missing on the outboard side. The tusk was noted to be oriented in the ground at an angle of approximately 90 deg away from the orientation of the boom on the ground. The bottom of the tusk section was measured to be 44 inches. The lower skin dimension from the leading edge to rib SS2-10D422 was measured to be 35 inches.

The outboard feather hinge on the feather flap side was intact. The wing side hinge was separated from the wing and still attached to the feather flap hinge.

The lower portion of the rudder was present and was measured to be 57 inches from the bottom to the top fracture surface of the rudder. The lower rudder hinge was noted to be fractured. The mid rudder hinge was intact, but it was separated from the boom structure. The rudder pushrod was present but bent. The rudder lockout damper was intact. The rudder balance weight was absent from site 3, but was later found at a different location.

The inboard portion of the elevon was present on the boom (see figure 11).

The middle elevon section was found approximately 20 yards away from the boom. This section measured 38 ½ inches on the leading edge and 47 ½ inches on the trailing edge. Accelerometer wires were found on this section of elevon, but the accelerometers were missing.

The elevon mid and outboard hinges were present on the horizontal stabilizer.

The outboard elevon section, including the balance weight, was found approximately 30 yards away from the left boom. The trailing edge dimension of this section was 10 ¾ inches, and the measurement from the counterbalance to the hinge was 9 3/8 inches.

(b) (4)

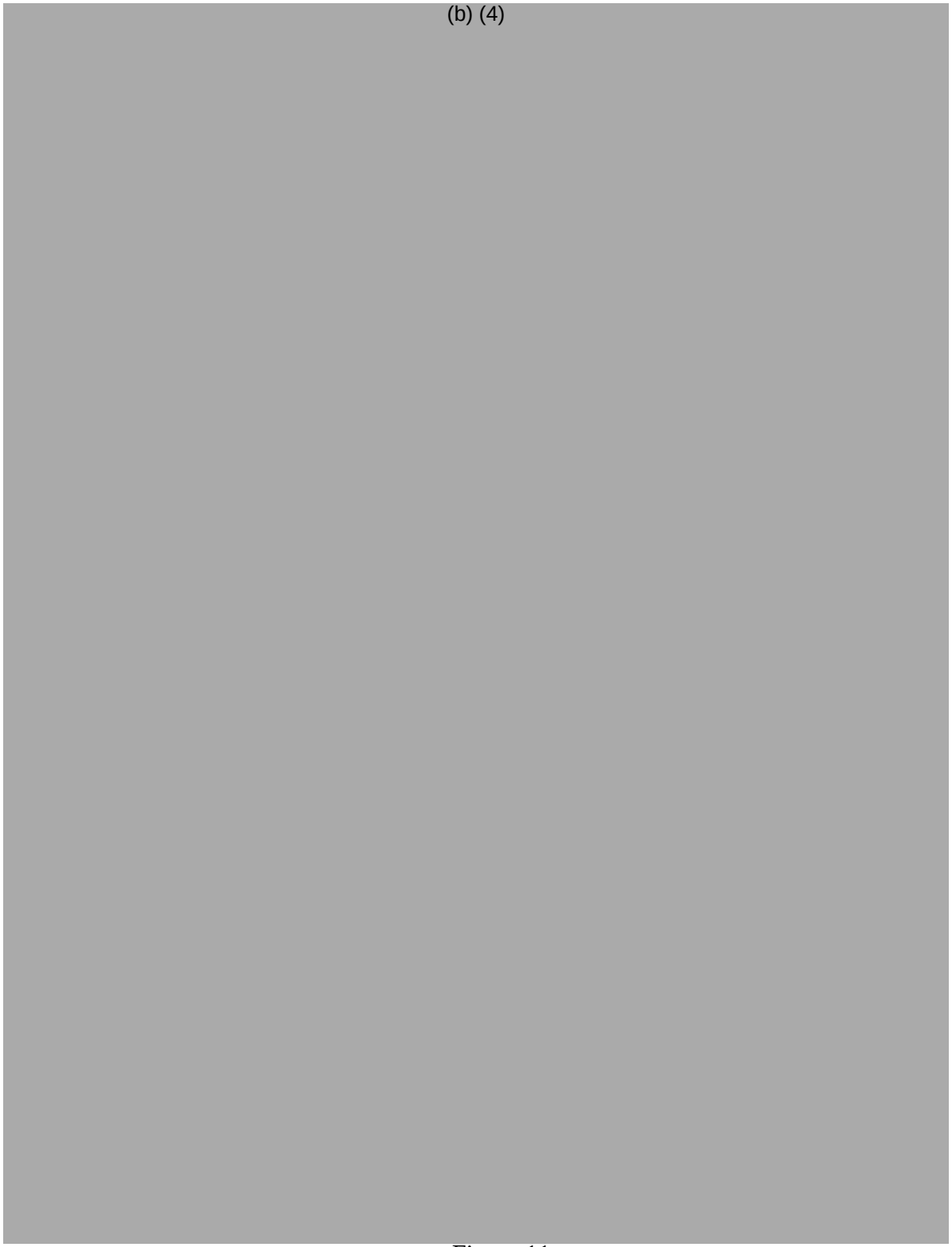


Figure 11
Left boom – view from aft end showing elevon and rudder sections remaining

The stub rib from the torque tube assembly was present and attached to the boom and measured 34 ½ inches (see figure 12).

The interconnect cable for the rudder was present.

(b) (4)

Figure 12
Left boom – view from forward end

The indicator mark on the horizontal stabilizer was aligned with markings on the horizontal stabilizer position scale consistent with a horizontal stabilizer position of -8 ½ deg (see figure 13).


Figure 13
Left boom – horizontal stabilizer reading of -8.5 deg

The mega-strake was missing from the boom.

The Kapton reflective tape was missing from the inboard surface of the boom. That surface was noted to have a sticky residue remaining.

### 1.1.3 Site 3a – Torque Tube Assembly

The torque tube assembly was found approximately 600 feet away from the left boom. The measurement from the center of the left actuator horn to the center of the right actuator horn was 60 inches. The measurement of two ground scar holes next to the torque tube assembly was 122 inches, center to center (see figure 14).

(b) (4)

Figure 14
Torque tube – overall view

The right outboard side of the aft torque tube was broken and on the ground adjacent to the left side of the torque tube assembly.

The left and right actuator horns were present and damaged at the pin locations of the actuator and torque tube assembly connection point. No actuator mounting hardware was present at the attachment points.

Both inboard feather hinges on the torque tube assembly were intact with intact pivot hardware. The mating fuselage hinges were present but separated from their mounting flanges.

A portion of the lower feather flap skin was present close to the torque tube.

The Bobcat 5 camera mount (with no camera attached) from the outboard looking passenger compartment camera (at the left hand, mid, side passenger window) was found approximately 75 yards from the torque tube.

### 1.1.4 Site 2 – Main fuselage

The main fuselage section was found resting inverted with the main oxidizer tank (MOT) displaced from its normal position. The main oxidizer valve was displaced but still attached to the MOT. The MOT was ruptured on the mid-forward face of the tank, and the portion of the MOT that was resting on the ground displayed damage consistent with crush damage (see figures 15-19).

(Photo: Kern County Sheriff's Office)

Figure 15
Main fuselage – aerial view

(Photo: Kern County Sheriff's Office)

Figure 16
Main fuselage – aerial view – close up

Figure 17
Main fuselage – overall view


Figure 18
Main fuselage – view of right side

Figure 19
Main fuselage – view of left side

All four wing side feather hinge mounting flanges were intact, but the hinges were located in sites 1 and 3.

The aft spar was intact and almost completely broken away from the rest of the structure at the gear wells.

The left and right feather lock hooks were noted to be in the in-transit positions. The rod end for the right feather lock actuator was noted to be broken. The actuator for the left feather lock hook could not be observed. The feather lock interconnect cable was present and attached to the left and right feather locks.

The left and right elevon pushrods were attached to the left and right wingtip bellcranks.

The left and right landing gear assemblies were found in the retracted positions. The struts and tires of both landing gear were found to still be pressurized, and they were all depressurized prior to recovering and transporting the wreckage.

The rocket motor controller (RMC), slave data acquisition system (DAS) boxes, and data acquisition unit (DAU) 5 and 6 boxes were identified.

The batteries in the left and right side wells were present, and the circuit breakers were extended. One battery was noted to have a lit LED indicating that it still had some remaining charge.

A section of lower cabin skin was present and fractured at the junction with the cabin door.

All 4 leading edge compressed air tanks were found. The two left tanks were found in the wing, and the two right tanks were found outside of the wing. All 4 compressed air tanks were found to be unpressurized.

The left and right (b) (4) bottles were present. The plumbing was found to be detached on both bottles and the bottles were unpressurized.

The forward spar was broken at butt line (BL) 0.

A feather lock actuation valve was found approximately 150 yards away from the main fuselage section.

The DAS battery was found approximately 100 yards away from the main fuselage section and appeared to have damage consistent with a fire.

### 1.1.5 Site 4 – Cockpit section

An impact crater that was approximately 9 feet in diameter and 3 feet deep was noted at the side of Cantil Road running through site 4.

The forward pressure tank was found approximately 530 feet away from the impact crater (see figures 20-24).


(Photo: FBI)

Figure 20
Cockpit section – aerial view of impact crater and forward pressure tank


(Photo: FBI)

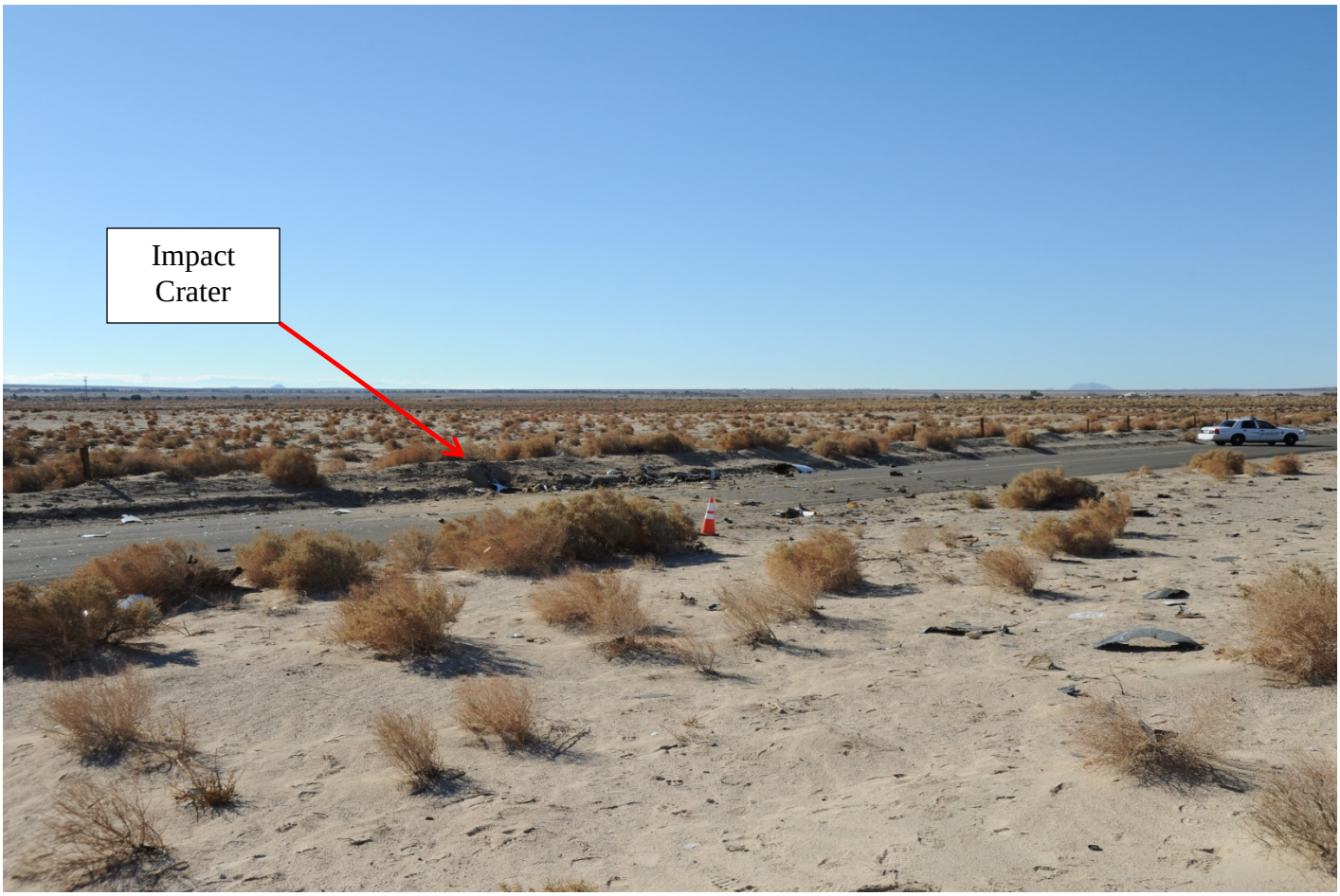
Figure 21
Cockpit section – impact crater and debris

(Photo: FBI)

Figure 22
Cockpit section – impact crater - close up


(Photo: FBI)

Figure 23
Cockpit section – impact crater and debris field




(Photo: FBI)

Figure 24
Cockpit section – impact crater and debris field

The copilot's seat and parachute were found adjacent to the impact crater. The drogue chute was out of the casing, and the parachute came out of its casing during recovery of the copilot's remains. The parachute lines were all stowed except for those extended due to recovery work. The head rest was separated from the seat, and the seat was broken at the hip area. The static line was attached to the harness and seat, but the static line was severed 49 inches from the seat bracket end. The nature of the severing could not be determined. The parachute D-ring was found in the stowed position.

Portions of the left and right hand sides of the cabin surrounding the crew station were found.

The left feather lock handle was found in the locked position with the gate block present and in place to keep the lever from moving unless lateral movement was applied.

The right feather lock handle was found separated from the center console.

The multi-function displays (MFD's) were found damaged with multiple components scattered throughout site 4.

The following items were identified (in damaged condition) throughout site 4 (note – this is a representative listing of the type of items present at site 4. Not all items present at site 4 were identified):

Forward pressure tank (see figure 25);
Crew station wiring;
Right stick section with pitch load cell;
Forward pressure tank fragments;
Two (of two) crew oxygen bottles;
DAU #1;
Co-pilot's helmet in 2 pieces with lining material present;
Right circuit breaker panel from the right hand outboard wall with circuit breaker fragments present;
Left circuit breaker panel from the left hand outboard wall with circuit breaker fragments present;
Fire extinguisher bottle;
Copilot's electronic kneeboard;
Nose gear extend actuator;
Complete nose gear assembly with skid was found in three pieces;
Right hand forward and side crew station windows;
Left hand forward and side crew station windows;
Upper crew station window;
Two (of two) oxygen regulators;
Stainless steel nose cone fragments;
Two (of two) feather actuation valves;
Two (of two) feather system vent valves;
Two (of two) feather lock actuation pulleys and associated hardware;
Two (of two) feather actuation handles and associated control pushrods;
Two (of two) control sticks.


Figure 25
Cockpit section – forward pressure tank

The left feather actuator was found approximately 0.6 miles from the impact crater in site 4 (see figure 26). No deformation was noted on either attachment end of the actuator. The forward rod end was intact, but the attachment pin was missing. The aft spherical bearing was missing. There was a crack in the outer wall of the actuator at a location consistent with the position of the piston head. The length of exposed chrome was measured to be 3 7/8 inches.

Figure 26
Left feather actuator

### 1.1.6 Site 5 – Rocket motor (see figures 27 and 28)

(Photo: FBI)

Figure 27
Rocket motor – overall view

(Photo: FBI)

Figure 28
Rocket motor – overall view

The rocket motor impact site was documented by the propulsion group.

### 1.1.7 Site 6 – Pilot's parachute (see figures 29-30)

Figure 29
Pilot's parachute

Figure 30
Pilot's parachute

The pilot's parachute along with the pilot's helmet and other flight gear was recovered from site 6. Further documentation of this gear was conducted by the survival factors group.

### 1.1.8 Site 8 – Pilot's seat

The pilot's seat was recovered from site 8 (see figures 31-33). The seat was fractured at the hip point. The harness was intact. The static line was attached to the seat. The seat rail release mechanism was damaged. Further documentation of the seat and other survival gear was conducted by the survival factors group.

(Photo: Kern County Sheriff's Office)

Figure 31
Pilot's seat – left side

(Photo: Kern County Sheriff's Office)

Figure 32
Pilot's seat – right side

(Photo: Kern County Sheriff's Office)

Figure 33
Pilot's seat – aerial view

### 1.1.9 Wreckage recovery

All of the wreckage found in the 10 main wreckage sites (as well as that collected from other areas such as Ridgecrest and China Lake) was recovered to a hangar at Mojave Air and Space Port (see figures 34-36). Teams from Scaled Composites conducted the recovery after each main wreckage site was documented. In some cases, cutting or other disassembly of the wreckage was required to facilitate the recovery work. The unloading of each load of wreckage was overseen by an NTSB representative. The hangar was secured, and limited access procedures were established.

Figure 34
Wreckage recovery from site 2

(Photo: FBI)

Figure 35
Left boom recovery from site 3


Figure 36
Wreckage stored in hangar

Scott Warren
Team Leader, Aircraft Systems Investigators

Appendix A
Locations of additional recovered wreckage

Table 1
Locations of additional recovered wreckage

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 1 | Cabin Section | Above wing, aft of door, side unknown | N35°38'10.06" | W117°39'36.48" | Located around Burroughs High School |
| 2 | Nose Ballast | Nose Ballast recovered with backhoe from the impact crater point. | N35°18'15.10" | W117°58'31.31" | Found in Site 4 impact crater |
| 3 | Left aft feather attach lug | Lug where left feather actuator attaches to fuselage at the aft end. One lug is missing from bracket (outside), other is bent. Section of longeron attached. Hardware is missing. | N35°21'6.87" | W117°54'49.88" | |
| 4 | (b) (4) valve | (b) (4) valve believed to be from some of the rocket system components mounted to the bulkhead just aft of the $N_2O$ tank | N35°20'31.16" | W117°55'41.92" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 5 | Left lower wing body fairing | Portion of wing body fairing attached to the aft fuselage. Fills gap between the left feather flap and the left hand side of the fuselage. | N35°25'9.85" | W117°50'59.85" | |
| 6 | Nose Bowl - Misc Nose Hardware | This was all of the nose pieces that were retrieved from the impact crater (site 4) below the nose ballast. Main segment is the nosecone with the flush air data system flattened into it. Other reaction control system (RCS) valves and components from the nose area were also recovered. | N35°18'15.10" | W117°58'31.31" | Found in Site 4 impact crater |
| 7 | #1 lower floor section at cabin door | Floor section directly inside main cabin door | N35°25'3.21" | W117°50'25.20" | |
| 8 | Gusset between longeron and fuselage skin | | N35°25'3.21" | W117°51'12.17" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 9 | Left longeron | | N35°26'0.40" | W117°50'23.23" | |
| 10 | Left lower feather flap skin | | N35°26'8.17" | W117°50'8.55" | |
| 11 | Lower right rudder section | | N35°26'0.40" | W117°50'23.23" | |
| 12 | Mid bulkhead to upper fuselage skin gusset | Side unknown | N35°24'51.87" | W117°51'7.51" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 13 | Mid row upper cabin windows | Row of windows directly above the emergency door | N35°24'57.69" | W117°51'4.30" | |
| 14 | Speedbrake hinge | Hinge position unknown | N35°26'2.24" | W117°50'15.01" | |
| 15 | Random skin section | Unknown location on vehicle | N35°24'49.34" | W117°51'13.22" | |
| 16 | Right upper nose section | | N35°26'0.40" | W117°50'23.23" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 17 | Right or left cabin section above wing 1 | This mates to a section from the previous group of parts found (#1 above) | N35°25'14.46" | W117°51'9.74" | |
| 18 | Right or left cabin section above wing 2 | This mates to a section from the previous group of parts found (#1 above) | N35°25'14.46" | W117°51'9.74" | |
| 19 | Spoilflap closeout rib - possibly left | Side unknown | N35°25'57.53" | W117°50'24.33" | |
| 20 | Spoilflap closeout rib - possibly right | Side unknown | N35°26'0.15" | W117°50'18.78" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 21 | Avionics box | Navaero box - mounts in cabin on right gib floor | N35°20'56.72" | W117°55'11.83" | |
| 22 | Speed brake actuator assembly | Mounts to aft fuselage floor aft of torque tube | N35°21'05.54" | W117°54'58.00" | Found in close proximity to item #25 |
| 23 | Downcomer RCS line | Ran down right side of cabin to nose for RCS | N35°21'18.91" | W117°54'49.55" | |
| 24 | Horizontal stabilizer controller box | Mounted under gib floor in cabin - unknown if #1 or #2. | N35°20'30.34" | W117°55'35.11" | Has misc structure attached to it |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 25 | Right elevon mass balance | | N35°21'05.54" | W117°54'58.00" | |
| 26 | Carbon fragment | | N35°39'54.52" | W117°37'32.28" | Recovered on #3 green of NAWS China Lake golf course |
| 27 | Bobcat camera mount | From mid left window | N35°20'38.20" | W117°55'27.0" | Found near torque tube, site 3a |
| 28 | Upper portion of aft bulkhead | With horizontal support attached | N35°21'10.90" | W117°55'01.27" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 29 | Pin and 1 (of 2) spools from one of the feather actuation horns | This piece has carbon tow still intact where it was torn from the structure | N35°18'45.63" | W117°57'43.69" | |
| 30 | One web from an aft feather actuator attach lug | This mates with / was torn off of item #3 above | N35°21'27.49" | W117°54'46.63" | |
| 31 | Pin and 2 (of 2) spools from one of the feather actuation horns | | N35°21'10.90" | W117°55'01.27" | |
| 32 | Cabin Emergency Plug door handle | | N35°21'09.03" | W117°54'45.74" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 33 | Tailcone closeout piece #2 | | N35°32'29.22" | W 117°44'14.28" | |
| 34 | Tailcone piece | | N35°32'30.18" | W117°44'9.60" | |
| 35 | Feather flap upper skin piece | | N35°28'6.12" | W117°48'0.0" | |
| 36 | LH Upper feather flap skin piece (with gap seal) | | N35°30'8.58" | W117°46'26.16" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 37 | Boom Left upper skin piece with rudder balance blister | | N35°28'44.64" | W117°48'30.30" | |
| 38 | Upper Feather flap Skin piece | | N35°29'14.64" | W117°47'6.42" | |
| 39 | Cabin Skin piece outer mold line from around a window | | N35°32'28.98" | W117°44'15.12" | |
| 40 | Right aft fuselage at feather actuator mount | | N35°31'0.0" | W117°45'7.08" | |

| Item number | Component | Additional Description (if applicable) | Latitude | Longitude | NOTES |
|---|---|---|---|---|---|
| 41 | Fuselage skin piece | | N35°32'5.58" | W117°44'30.60" | |
| 42 | Right Feather Actuator with aft lug | | unknown | unknown | Found by witness who stated that it was dumped in the location from which it was recovered after being found somewhere else. Actual location of impact is unknown. |
| 43 | Left rudder mass balance weight | Mounted to rudder horn assembly | unknown | unknown | |