NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

October 6, 2011

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID: DCA11MA075

A. ACCIDENT:

Location:	Point Mugu, California
Date:	May 18, 2011
Aircraft:	Boeing 707-321B, N707AR, operated by Omega Refueling Services, Inc.

B. POWERPLANTS GROUP:

Group Chairman:	Carol Horgan National Transportation Safety Board Washington, DC
Member:	Frank Motter Federal Aviation Administration Van Nuys, CA
Member:	Hongyang Bao Pratt & Whitney East Hartford, CT

C. SUMMARY

On May 18, 2011, at 5:27 pm Pacific Daylight Time (PDT), a modified Boeing 707, registration N707AR, operated by Omega Aerial Refueling Services as flight 70, crashed on takeoff from runway 21 at the Point Mugu Naval Air Station, California (KNTD). The airplane impacted beyond the departure end of the runway and was destroyed by post-impact fire. The three flight crewmembers received minor injuries.

Witnesses reported that they observed a fireball on the left side of the airplane and "something shiny" go up and over the left wing just after the airplane lifted off. The flight crew

reported that, during takeoff, at about 20 feet above ground level, the No. 2 (left inboard) engine throttle lever slammed back to the idle position. The airplane stopped climbing and began to drift to the left and descend. The captain lowered the pitch slightly and leveled the wings, and the airplane touched down, and then veered off the left side of the runway surface. The crew reported that there were a couple of impacts and then a final violent impact before the airplane came to rest in a wetland marsh.

The witness reports were confirmed by a video of the takeoff, which was recovered on May 22, 2011. See Attachment 1.

A Powerplants Group was formed at NBVC, Point Mugu, CA on May 19, 2011. The group documented the engine wreckage May 19 through May 22, 2011.

D. INVESTIGATION

1.0 Engine information

The airplane was equipped with 4 Pratt & Whitney JT3D-3B turbofan engines. The JT3D-3B is a dual spool, low-bypass, axial flow turbofan engine with a 15-stage compressor, a 4-stage turbine, and 8 cannular combustion chambers. It has a takeoff static thrust rating of 18,000 pounds.

1.2 Engine data

position	*model*	*serial number*	*time since new (hours)*	*cycles since new*	*time since last service visit (hours)*	*cycles since last service visit*
1	JT3D-3B	645181	57,932	17,790	1,026	284
2	JT3D-3B	668448	48,119	14,576	1,138	373
3	JT3D-3B	668147	51,182	20,462	5,474	1,522
4	JT3D-3B	668804	19,399	8,943	1,176	332

Table 1. Engine data

2.0 Documentation of engine wreckage

A 4,120-foot debris field began about 7,500 feet from the approach end of runway 21, near taxiway A2. Main landing gear (MLG) tire marks indicated that the airplane contacted the runway about 900 feet into the debris field and that the airplane departed the runway on a 218 degree heading near taxiway A1, continued across the grass infield and taxiway A, and came to rest in a saltwater marsh to the left of the runway overrun. See Figure 1.

This report divides the 4,120-foot debris field into 4 areas, beginning to end. See Table 2.

Area	*Area begins*	*Area ends*	*Distance into debris field*
A	Start of debris field	First MLG runway marks	0 feet – 902 feet
B	Airplane on ground	Runway departure point	902 feet – 1,315 feet
C	Airplane departs runway	Taxiway A	1,315 feet – 3,178 feet
D	Taxiway A	End of debris field	3,178 feet – 4,120 feet

Table 2. Debris field areas

Figure 1. Energy path of N707AR. The debris field before the main landing gear tire marks (Area A) is shown in green. *Photograph courtesy of NBVC.*

2.1 Area A

Objects found in the first 902 feet of the debris field consisted of No. 2 (left inboard) pylon structural material, an engine core cowl, engine fan cowl material, and the No. 1 (left outboard) engine inlet cowl. The first piece of wreckage was a fragment of the No. 2 pylon torque bulkhead. The second piece, found about 44 feet into the debris field, was a piece of the No. 2 pylon overwing fitting.

The first ground scar was found next to several fan cowl fragments near the left shoulder of the runway, about 170 feet into the debris field. The scar was diagonally orientated toward the left infield, and the No. 1 engine inlet cowl was located directly in line with the ground scar, about 450 feet away. See Figure 2. The inlet cowl was identified as the No. 1 cowl because it was the only inlet cowl in the wreckage that did not have a pylon turbocompressor housing attached, and the B707 No. 1 pylon lacks this structure.

There were two rubbed areas with tar-like deposits on the leading edge of the inlet cowl, consistent with the transfer of asphalt from the runway surface. The side of the inlet cowl showed a large depression between 1 and 6 o'clock.[1] Soot deposits were present in this depression, but not on the rest of the inlet cowl. There were no terrain features or objects on the ground that could have produced the depression. A main shaft dome extension was found floating in a pool of standing water about 50 feet beyond the inlet cowl.

Figure 2. Runway impact scar and No. 1 engine inlet cowl

The next ground scar was a set of gouges located about 330 feet further into the debris field, on the left side of the runway. See Figure 3. There were rivet heads, white paint, aluminum, and soot embedded in the gouges. The corresponding damage found on the No. 2

[1] Clock references are approximate circumferential locations in a clockwise direction, viewed from the rear of the engine looking forward.

engine (see paragraph 2.2.1), and the fact that the final resting position of the No. 2 engine and pylon was in line with the direction of the scar, identified it as the place where the No. 2 engine and pylon first struck the ground. The orientation of the scars indicated that the No. 2 engine and pylon were transverse to the runway when they struck the ground, consistent with having separated from the airplane in flight. See Figure 4.

The first main landing gear tire marks were found on the runway about 663 feet beyond the scars.

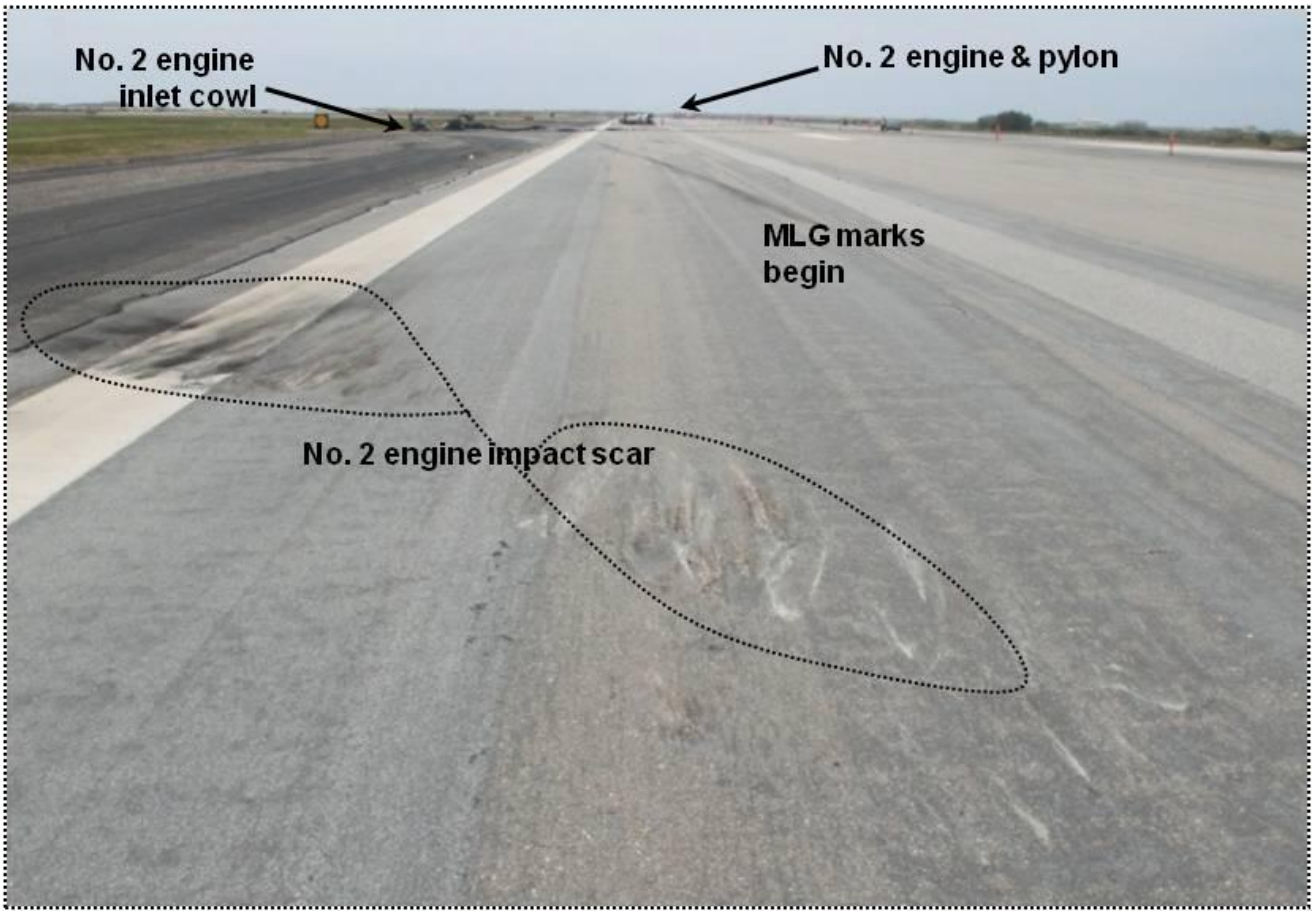

Figure 3. No. 2 engine & pylon runway impact scar

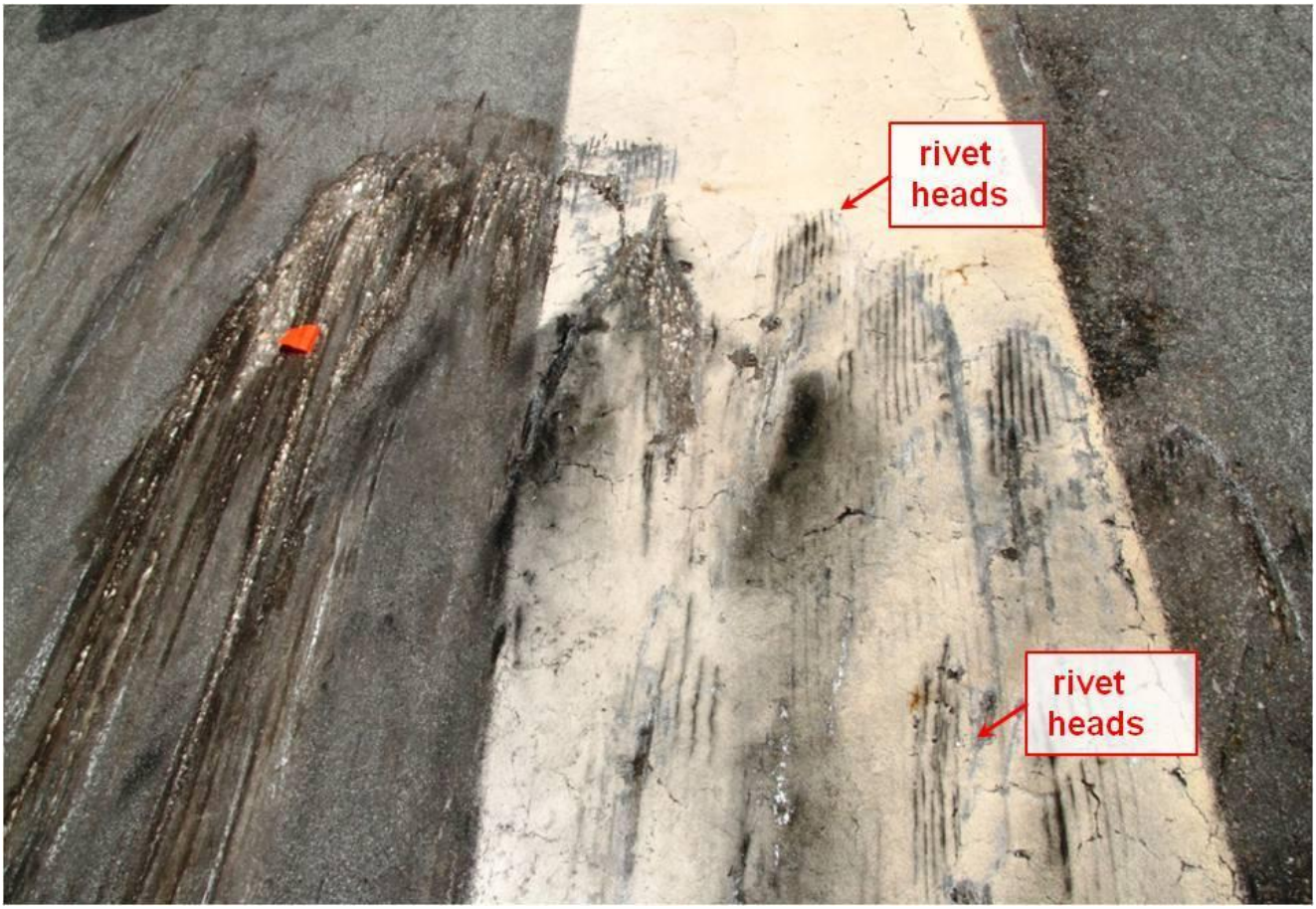

Figure 4. Detail of No. 2 engine & pylon runway impact scar

2.2 Area B

The No. 2 engine inlet cowl was found on the left shoulder of the runway at the arresting gear mechanism. The No. 2 engine and pylon were located about 700 feet beyond the double set of ground scars. See Figure 5. Some small fragments of turbine gas path components and cascade material were found on the runway between the engine ground contact scars and the No. 2 engine and pylon. The inlet cowl was not severely deformed. The turbocompressor cowling structure was still attached. See Figure 5.

Figure 5. No. 2 engine & pylon, and No. 2 engine inlet cowl *Photograph courtesy of NBVC*

2.2.1 No. 2 engine

The No. 2 engine was located on the left side of the runway, 1,163 feet into the debris field. With the exception of the inlet cowl, most of its cowling was intact. The engine-to-pylon attachments appeared intact. The turbocompressor unit was attached.

Figure 6. No. 2 engine inlet cowl

Both thrust reverser sleeves were partially deployed. The thrust reverser sleeves and core cowls were severely damaged, consistent with the engine scraping the ground while perpendicular to the runway. The material, paint, and rivets lost to scraping was consistent with the material found embedded in the runway gouges. See Figure 7.

Inspections of the holed areas in the cowling determined that the holes were located over projections of engine externals that had penetrated the cowling when the engine struck the runway

and scraped along its surface. The annular casing was intact and the engine showed no signs of fire damage or uncontainment. See Figure 8.

Figure 7. No. 2 engine and pylon *Photograph courtesy of NBVC*

Figure 8. No. 2 engine cowl damage from contact with runway

The No. 2 engine inlet case was deformed inward on the inboard side. See Figure 9.

Figure 9. View into No. 2 engine inlet *Photograph courtesy of NBVC*

The trailing edges of the inlet guide vanes (IGVs) were torn and deformed in the direction of compressor rotation. All of the compressor first stage (C1) blade tip leading edges were missing material and/or curled opposite the direction of rotation, consistent with abnormal contact with the IGV trailing edges by the compressor rotor and with the blade path during rotation. See Figure 10.

Figure 10. No. 2 engine inlet guide vane trailing edge and C1 airfoil leading edge damage

The exhaust nozzle was deformed inward, partially obstructing the view of the low pressure turbine (LPT). Several airfoil fragments were observed lying inside the exhaust case. The tips of observable 4th stage LPT airfoils were deformed opposite the direction of rotation. See Figure 11.

2.2.2 No. 2 pylon

The No. 2 pylon had separated from the airplane at the wing attachment fittings. The inboard mid-spar fitting showed flat fracture surfaces with arcing termini. See Figure 12.

The pylon pieces found at the start of the debris field were matched to No. 2 pylon fractures. See Figure 13.

Figure 11. No. 2 engine, view through exhaust

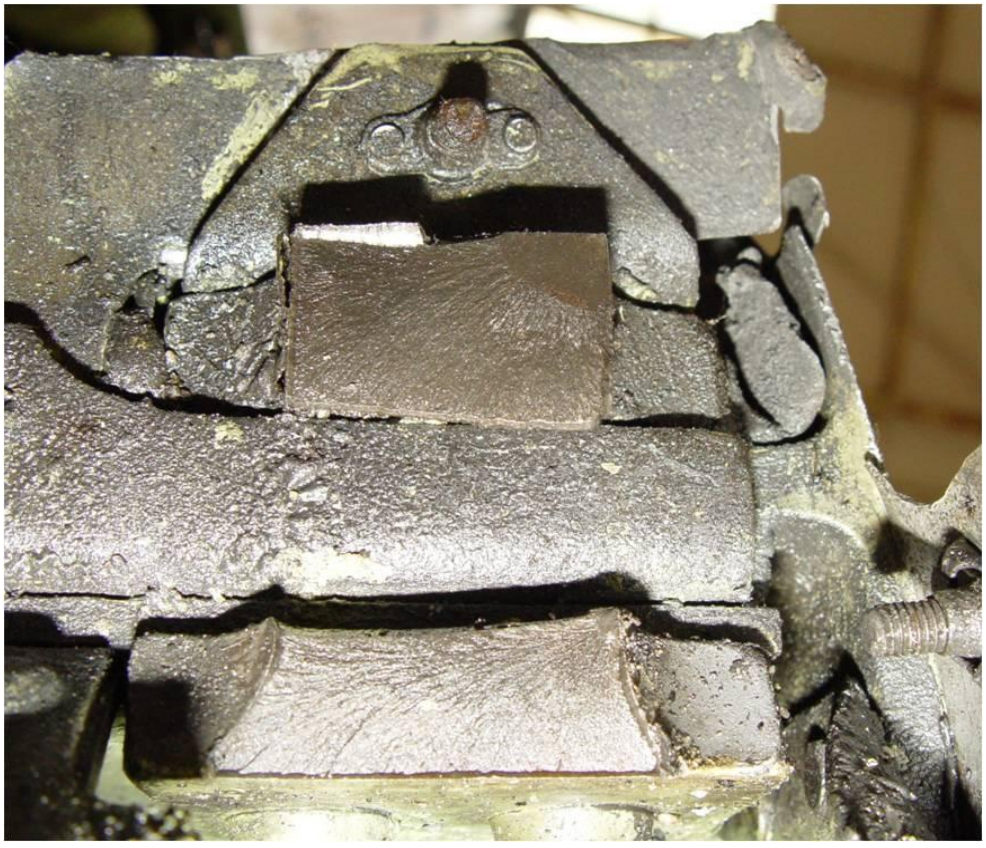

Figure 12. Fracture faces of the No. 2 pylon mid-spar fitting

(a) (b)

Figure 13. No. 2 pylon showing the first 2 pieces of wreckage found along the airplane's energy path: (a) torque bulkhead fragment and (b) overwing fitting fragment

The airplane departed the asphalt surface near taxiway A1, which was 9,500 feet from the departure end of the runway. See Figure 14.

Figure 14. Runway departure *Photograph courtesy of NBVC.*

2.3 Area C

About 2,046 feet into the debris field, a furrow appeared amid the MLG scars, and engine components began to appear again, including engine fan blades, thrust reverser components, core cowl and exhaust fragments, and a pylon drag link. These components showed no evidence of pre-impact damage. The No. 1 pylon was found along the furrow, about 2,876 feet into the debris field. See Figure 15. The No. 1 engine was found about 145 feet beyond the pylon, near taxiway A.

Figure 15. No. 1 pylon, showing separation at wing, and lack of turbocompressor feature. *Photograph courtesy of NBVC.*

No turbocompressor unit was found with the engine. The engine data plate identified the engine as serial number P645181, which was confirmed against the operator maintenance records as the engine installed in the airplane's No. 1 position.

2.3.1 No. 1 engine

All of the cowlings were missing. There was no evidence of uncontainment or undercowl fire. The main gearbox was fractured, and gearbox fragments, the air starter, the constant speed drive and generator, and the fuel control unit were found strewn around the engine. See Figure 16. Soil and grass were embedded in openings, and the engine externals were crushed and fractured, consistent with the displacement of soil and grass along the furrow. See Figure 17.

Figure 16. No. 1 engine, right side

Figure 17. No. 1 engine, left side

One IGV was broken at 12 o'clock. The IGV trailing edges were missing material and were curled and deformed in the direction of compressor rotation, consistent with abnormal contact of the IGVs by the low pressure compressor rotor during operation. Most of the C1 and C2 fan blade airfoils were fractured adjacent to their platforms, consistent with powered rotation during impact. See Figure 18.

Figure 18. No. 1 engine inlet, showing fractured fan blades

The engine tail cone was severely crushed and several exhaust gas temperature probes were bent. The LPT was intact. See Figure 19.

Figure 19. No. 1 engine exhaust with LPT intact

2.4 Area D

The ground scars and debris showed that the airplane then crossed taxiway A and entered marshy terrain. The main wreckage was partially submerged and partially consumed by fire. It consisted of the fuselage, the right wing with the No. 3 (right inboard) engine attached, and an inboard section of the left wing. Scattered debris aft of the main wreckage included remnants of the burned outboard left wing, the right main landing gear truck, the No. 4 (right outboard) engine, and the No. 4 engine inlet. See Figure 20.

Figure 20. Overview of Area D. *Photograph courtesy of NBVC*

2.4.1 No. 4 engine

The No. 4 engine was found 3,845 feet into the debris field, 275 feet from the main wreckage. The engine was attached to the pylon. The cowlings, except for the inlet cowl, appeared intact. No evidence of uncontainment or engine fire was noted. The low pressure compressor rotor (C1 and C2) had liberated. The engine was partially submerged. See Figure 21.

Figure 21. No. 4 engine

The No. 4 engine's separated first and second compressor rotor stages (C1 and C2) were found about 50 feet away. See Figure 22. An approximate 70° arc of both the C1 and C2 blade airfoils was fractured adjacent to the platform. The visible intact C2 blades were bent opposite to the direction of rotation.

Figure 22. No. 4 engine C1 and C2 rotor stages

The turbine nozzle was severely crushed and did not permit inspection through the exhaust. The No. 4 engine inlet cowl was found about 152 feet to the right of the engine. It had landed in marshy grass and showed little distortion/impact damage. The turbocompressor inlet housing was attached. See Figure 23.

Figure 23. No. 4 engine inlet cowl with turbocompressor inlet

2.4.2 No. 3 engine

The No. 3 engine was found with the airplane fuselage at the main wreckage site, 4120 feet from the beginning of the debris field. It was partially attached to the airplane's right wing. See Figure 24.

Figure 24. No. 3 engine partially attached *Photograph courtesy of NBVC*

Access to the No. 3 engine was limited on site. The visible engine cowlings, including a view into the engine inlet, showed no signs of uncontainment or undercowl fire. See Figure 25.

Figure 25. No. 3 engine. *Photograph courtesy of NBVC*

4.0 Wreckage distribution data

Relative location of engine components in the debris field is provided in Table 3. Table 4 provides engine component distribution across the 4 debris field areas.

Approximate distance into debris field (feet)	Approximate distance from main wreckage (feet)	location
-93	4,213	taxiway A2 (3500 feet from runway 21 departure end)
0	4,120	No. 2 pylon torque bulkhead fragment
44	4,076	No. 2 pylon overwing fitting fragment
120	4,000	No. 1 core cowl
193	3,927	No. 1 inlet cowl ground scar; fan cowl fragments
490	3,702	No. 1 inlet cowl
500	3,620	No. 2 engine ground impact marks
902	3,218	First MLG marks
946	3,174	runway arresting cable (8500 feet from runway 21 departure end)
950	3,170	No. 2 inlet cowl (207 feet to left of runway centerline)
1,163	2,957	No. 2 engine & pylon
1,315	2,805	runway departure near A1
1,659	2,461	taxiway A1 (1500 feet from runway 21 departure end)
2,521	1,599	No. 1 engine ground impact scars
2,876	1,244	No. 1 pylon
3,018	1,102	No. 1 engine
3,092	1,028	entry on taxiway A
3,845	275	No. 4 engine & pylon
4,057	63	No. 4 inlet cowl
4,120	0	Main wreckage / No. 3 engine

Table 3. Relative locations of engine components in the debris field

Distance into debris field	*evidence*
0 feet – 902 feet	No. 2 pylon material, No. 1 fan cowl, No.1 inlet cowl
902 feet – 1315 feet	initial MLG tire marks, No. 2 inlet cowl, No. 2 engine & pylon
1315 feet – 3092 feet	No. 1 pylon, No. 1 engine, No.1 engine components
3092 feet – 4120 feet	No. 4 engine & pylon, No.4 inlet cowl, fuselage with intact No.3 engine

Table 4. Distribution of engine wreckage

E. ATTACHMENTS

Attachment 1. Windows Media Audio/Video file, VIDEO 707-FTMugu-StableZoom

Carol M Horgan
Powerplants Group Chairman