

Assessment of Saigon C-5A SN 68-218 Crash Site

April 4, 1975

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1. Objectives

1.1. Description of Crash Events

The objective of this report is to provide a description of the events of the crash of the U.S. Air Force C-5A, SN 68-218 near Saigon, South Vietnam on April 4, 1975, from initial contact on the east side of the Saigon River to final resting place of the four major aircraft components, flight deck, troop compartment, empennage and wing, and associated parts visible on aerial and ground photographs.

1.2. Assessment of Report of Dr. Stanley Morain

An additional objective is to assess and critique the report by Dr. Stanley Morain on the interpretation of the crash site prepared for this investigation. Particular attention will be given to the alleged occurrence of fire and fuel spill at the site, the period when the troop compartment was allegedly airborne and the alleged abrupt stopping of the troop compartment against an embankment-like structure and the associated evidence for these occurrences.

## 2. Methodology

### 2.1. Data Used

The data used for this assessment includes aerial and ground photographs and movie films taken after the accident and collateral charts, diagrams, maps and reports. These data were used to reconstruct the various major events of the touchdown and subsequent destruction of the aircraft.

### 2.2. Crash Events Analyzed

Available aerial and ground photographs, maps, reference documents and consultation with experts with knowledge of the local terrain and vegetation types have been used to describe the before - and - after conditions, separating naturally occurring anomalies from those caused by the crash of the C-5A. As far as possible, the cause or sources of the visible ground scars and vegetation changes -- both naturally occurring and crash induced -- have been identified and documented with photographic examples.

### 2.3. Morain's Report Verification

The interpretation, measurement and analyses

contained in the report and testimony by Dr. Stanley Morain were tested in an attempt to verify his findings. Where any analysis revealed differing conclusions these were explained and documented.

3. Findings of Interpretation - Physical Description of Data

3.1. Normal Aircraft Configuration

Charts and photographs contained in defendant's Exhibit Nos. D 1216, D 1217, D 1307, D-9 and D 1320 were used for all measurements and descriptions of aircraft components. Collateral information contained in documents prepared by Mr. John Edwards of Lockheed Aircraft Corporation were used for conditions and measurements specific to this C-5A and the crash investigation.

3.2. Local Terrain and Vegetation

Local terrain and vegetation conditions are typical of wet land rice culture in many parts of Southeast Asia. This area is characterized by relatively flat river terrace terrain prepared for rice growing by draining the land, constructing levees 1/2 meter (20") or so in height, transplanting of rice

plants grown in nearby nurseries and reflooding during the growing season. The total growing period from planting to harvest is generally 4-5 months in duration. Rice at the time of the crash had been freshly planted in many of the fields around the aircraft parts. In the case of the troop compartment there was no evidence that planting for the season had yet taken place in the field where that structure came to rest. The area was however flooded as evidenced by standing water nearly completely surrounding the troop compartment.

Associated with the rice lands are naturally occurring patches of trees, shrubs and grasses occupying sites either too wet because of low lying terrain, too dry because of slight elevation in terrain or devoted to other land uses -- farm storage, municipal facilities, woodlots, roads, trails, rivers, etc. Generally the terrain is very flat typical of river delta lands covered by alluvial soils of mixed clay, silt, sand and gravel zones (See Figures 1 & 2).

The C-5A crash while ultimately destructive of the aircraft allowed survival of many passengers and crew because of three factors -- the flat terrain allowing relatively uniform deceleration (expending of energy of the moving

aircraft) evenly over a distance of nearly a half mile, slick soil surfaces due to rice paddy conditions (flooded, muddy soils of low compaction) providing a lubricated surface for easy sliding and soft, muddy soil to facilitate a retarding of the aircraft as parts of the belly structure dug into the soft surface and were torn away. This tearing caused a cumulative slowing of the aircraft from an initial touchdown speed of 270 knots to a resting point of the troop and flight crew compartments nearly a half mile from initial ground contact.

Several soil structures and drainage features are visible on the photographs such as river levees and the Saigon River that could potentially have altered greatly the course of the crash had the aircraft contacted them in a different fashion, but the skill of the flight crew, and in my opinion the grace of God saved many lives in this accident.

Much of the crash area was devoted to rice culture at the time of the crash and growing rice is visible in fields near the river through which the aircraft parts slid, as it was at the beginning of the rice growing season. Much of the area through which the empennage, troop compartment and flight deck slid had already been planted to rice as seen in the evenly

spaced rows of rice plants (grass-like leaves) in the foreground of Figure 3. The area where the wing and the two right engines came to rest and burned is occupied by natural grasses, shrubs and a Vietnamese cemetery and as such was for the most part drier soil area. It also was slightly higher -- perhaps a quarter of a meter (10") or so -- than the rice paddys to the east where the other parts of the aircraft came to rest (See Figure 4.).

Evidence for the flatness of the terrain of perhaps an overall rise in elevation from the fields nearest the river to the touchdown point on the east side of the Saigon River of a meter (3') or less over about a half mile horizontal distance, and a lesser rise of perhaps a tenth of a meter (4") on the west side over a similar distance can be seen by the views in Figure 5 taken on the ground on the east bank and Figure 6 taken from the ground on the west bank. Also, the presence of standing water in slight depressions on the west bank verifies the flatness of the terrain.

The east bank of the river where the aircraft first touched down did not have current rice culture as seen in Figure 5 and as such was not flooded. The soil at the point of

touchdown was thus somewhat more firm than that in the rice paddy on the west bank allowing the aircraft to "skip" on initial touchdown where tire marks are visible. (See Figure 7) The levees (around the rice paddys) were a significant obstacle to the rolling of the landing gear tires and were effective in removing both rear main gear assemblies and one forward gear assembly as the aircraft passed over them. Had these levee structures not been present exactly where they were, the landing gear assemblies may not have failed at that point as the ground appears to be relatively firm and the aircraft did roll some distance before contacting the levees.

As noted the terrain on the east side of the Saigon River is relatively flat and the aircraft touched the upper portion of two levees spaced about 69 meters (225') apart without contacting the ground between them. Thus, the aircraft was flying nearly level at this point -- neither descending or climbing -- which further verifies the flatness of the terrain.

There is a row of palm trees along a permanent levee slightly right or north of the aircraft flight path where one or more trees were contacted by the right wing and sheered off as seen in Figure 8.

### 3.3. Post Crash Site Ground Conditions

#### 3.3.1. East side of Saigon River

The touchdown point of the aircraft on the east side of the Saigon River shows evidence of the aircraft being in a nearly level aircraft attitude and in a slight descent. The sequence of touchdown marks suggests the following possible events.

First levee contact - The first levee contacted by the aircraft appears to be about 1/2 meter (20") in height and was hit by several of the tires in the landing gear, or other structural members, taking out about half of the levee height or .25 meters (10"). There was no apparent aircraft parts torn off at that point. See Figure 9.

Second levee contact - The second levee which lies approximately 225' from the first appears to have been contacted by tires on all three landing gear (left and right main gear tires and nose gear tires) or by other structural members. It may be assumed that the contact was by both front and rear main gear tires but that cannot be verified from the photographs available and it is possible that not all

wheels touched the levee because of the uneven top of the levee and the uncertainty of the attitude and condition of the belly of the aircraft at this point. It is apparent that the sink rate (descent) of the aircraft at this point was minimal because the soil torn out of the second levee was perhaps .4 meters (about 15") or about 5" deeper than the dent in the first levee. If the aircraft forward velocity was 310 mph, that equates to 455 feet per second (fps). Assuming the horizontal distance between levees 1 and 2 to be approximately 225 feet the rate of descent was 5" in 1/2 second or 50' per minute. See Figure 7.

Rice paddy contact - The next contact point was past levee number 2 by about 50' on the level ground in the rice paddy, perhaps another 5" below the past point of contact on the levee. At 455 fps the aircraft traveled 50' in .11 seconds while descending 5", or 227' per minute rate of descent. These figures are of course only estimates but probably bracket the true rate of descent.

At the third point of contact on the east side of the Saigon River, i.e., in the rice paddy it appears possible that the nose gear with four tires across first

contacted the ground as evidenced by the slight rolling marks of 3 or 4 tires between the main gear tire marks. These marks could have been made by other structural members hanging below the aircraft.

The next marks in sequence of touchdown were made by the left main landing gear followed by the right main landing gear. These measurements were obtained by using D 1216 tread width of 35' 11" (431") which was measured to be 60 mm on Figure 7. The overall rolling tire marks run for about 50 to 70 feet in a forward direction.

Third levee contact - The fourth contact point on the East side of the Saigon River was at the levee on the west side of that rice paddy. At that point it appears that the nose had raised to a point where the nose gear and any other structures hanging in the center area cleared that levee and did not touch ground again until the west side of the River. The left and right main gear tires contacted the third levee in the line of contact points and in my opinion at that point both left gears (forward and rear) and the right rear gear separated from the aircraft. What was probably the right main gear assembly came to rest near the base and south about

10' of the tenth palm tree in the row of trees to the north of the flight track (See Figure 10).

The two outer (rear) tires and wheels in the rear members of the six wheels of the right rear main gear were torn loose and landed at other locations. Several tires were visible such as one to the northeast of tree #1 about 50'; one to the west of tree #1 about 143', slightly right of the aircraft flight track, and yet another nearly under the flight track. (See Figure 11). Fifteen tires were accounted for definitely and possibly two others as seen in Figure 12.

The two left main gear assemblies broke into several pieces and came to rest in widely scattered locations beneath the flight track of the aircraft on the east side of the Saigon River.

A plotting of the visible locations of tires and gear components from the three main landing gears that came to rest on the East side of the Saigon River are shown in Figure 11 through 17.

As the aircraft progressed forward the broken strut or struts from the left main gear assemblies

contacted the ground leaving a scar of about 144' with the western-most segment 76' long. See Figure 18. Measurement of this scar is difficult because no vertical photography has become available and the oblique photos are not optimum for this view.

Over the remaining distance from the last scar of the broken landing gear strut while still attached to the aircraft to the east bank of the River a number of ground indentations and remnant parts are visible indicating that the initial contact of the aircraft damaged the structure and parts began to fall away hitting the ground and remaining on that side. This included one of the landing gear doors as seen in Figure 11. There is a row of palm trees running along an east-west levee just north of the final flight track of the aircraft. See Figures 13 & 17. It appears that the first tree in the row (the easternmost tree) was sheared off 16' above ground and perhaps the second tree although measurements indicate that it is about 113 feet off the centerline of the flight track and thus may not have been impacted. The estimated distances of the trees and their heights were measured from several photos using an aircraft tire given as 4.02' in diameter for calculation. An average of readings

taken on several photos was made as shown in table #1. The aircraft wing span is shown to be 222.75 in D 1216 and thus the measurement of trees off centerline can be compared with the distance from the flight track centerline to the wing tip (111.37') to determine whether a tree was within or outside of the area covered by the wing.

As it appears that the first tree was broken off at 16' above the levee top or 17' 8" above the paddy floor (assuming the levee was 20" high), the wing was about 3' higher than its normal ground clearance (about 14.5' parked on the ramp) which indicates the low flying altitude at that point.

In my opinion the "blow-down" effect of the air from the low flying aircraft left a visible path along the ground where dust would have been blown away, grass would have been bent over and general appearance of the ground would have changed to reveal the flight path over the ground. The flight height from that point to touchdown on the west side of the Saigon River was probably not over 50-70' above ground thus providing a relatively low rate of descent on impact on the west side of the River.

Other than the general changes in vegetation and soil surface caused by the blow-down there were numerous ground scars caused by tumbling landing gear parts, tires and pieces of metal such as gear doors and belly covering visible on the east side of the River. (See Figure 11)

### 3.3.2. West side of Saigon River

The aircraft apparently hit the levee on the west bank of the Saigon River and tore out soil nearly to the level of the rice paddy of about 4'. This scar is visible in Figure 19 and 20 and this indicates a slightly nose high attitude at touchdown. From that point westward the belly of the aircraft was in contact with the ground which as noted was very flat, soft and wet which served to dampen any bouncing motion, prevent the sparking of metal which might have caused a fire and lubricated the path of the aircraft. As the aircraft moved forward it was slowed in its progress by parts that dug into the moist, soft soil and were torn loose. (See Figure 21)

Because of the weight of the aircraft (nearly 450,000 lbs.) and the velocity (270 knots at touchdown) the deceleration was, in my opinion, relatively uniform and gradual as no major obstructions were impacted by the airframe --

particularly the troop compartment and the flight deck. The nose remained slightly elevated as evidenced by no depressions in the track centerline.

The forward travel of the troop compartment was in nearly a level, straight line from the point of touchdown on the east and then the west side of the River to its stopping point (See Figures 17 & 21). Because of the soft, wet soil along the path on the west side any heavy object impacting the ground left a very visible scar as seen in numerous Figures, such as 21: Therefore, if the troop compartment had been airborne along this path and come down with any significant vertical force a huge scar or indentation would surely have been visible. As it was the path along which both the troop compartment and the flight deck traveled is devoid of any abrupt indentations and instead a steady trace of the sides of the fuselage are readily visible throughout the sliding path of these components.

The initial impact on the west side was relatively mild as the rate of descent was gradual. The scars in the soil are relatively uniform in depth and width. (See Figure 21.) These scars appear to extend continuously from the

initial contact point near the River's edge to the final stopping place, with no major changes in the width or line of travel. As seen in Figure 17 the troop compartment came to rest in nearly perfect alignment from the initial touchdown orientation.

The standing water seen in the tracks in Figure 21 and 22 outlines the location of the fuselage sides as the aircraft slid forward as well as ground indentations from components that bounced along the surface. Following these indentations leads the observer to a final resting place of various aircraft parts such as engines, landing gear and other structures. (See Figure 23, and later 29 and 33)

As the aircraft progressed forward the underside of the fuselage wore away lowering the aircraft compartments, wings, empennage, etc., to the ground. At about 1050' from the touchdown point sufficient structure had torn away, particularly toward the aft end of the aircraft as it was still sliding slightly nose high, to weaken the fuselage structure to the point where a major separation of aircraft sections began to occur.

In Figure 22 it is possible to see several indications of a change in aircraft configuration. It appears that the aircraft fuselage ground away to the point where the engines finally came in contact with the muddy, soft soil surface (at about 733' from the river) which effectively slowed the whole structure sufficiently to permit the flight deck to move forward away from the wing. The pieces of fuselage side and belly were left along the slide path in the mud as the aircraft moved along as seen in Figures 22 and 23. As the flight deck separated from the aircraft at the leading edge of the wing and began a gentle arc to the left (south), further deterioration of structural integrity allowed the wing, which still had flying speed to drag both left and right engines on the soil surface causing both left engines to separate from the engine pylons. The tracks for these two left engines can be seen in Figure 23, as the engines diverged in their travel to their final stopping place -- the outboard (No. 1) engine coming to rest to the left of the flight deck track and the inboard (No. 2) engine stopping to the right and slightly behind the troop compartment.

At this point the wing became lighter in weight as the two left engines were gone, the main part of the aircraft no longer

was firmly attached and the wing lifted free of the fuselage taking part of the center section holding the two wings together and with the two right engines still attached flew forward for approximately another 1739 feet and impacted ahead of the place where the troop compartment came to rest. At this point essentially all of the fuel was still in the wing as there is no evidence of fuel spillage, as reported by the eye witnesses, before the wing structure resting place.

In my opinion, had fuel spilled out, there would have been a possibility of fire at that point (as there was in the wing area). Any vegetation damaged or staining caused by fuel spillage would have taken a number of days to become visible and then only in areas where heavy concentration of fuel would have polluted the soil. The green vegetation around the crash site was neither burned by fire nor crushed by the structures; the brown vegetation around the troop compartment, flight deck and in various other locations appears to be a natural occurrence during the growth cycle of these plants caused by flooding of the plants, and is not related to fire or chemical damage from fuel spillage. In my opinion all of the brown areas in the vicinity of the troop compartment and flight deck were brown before the crash as a result of natural

growth retardation from flooding. Standing water can be seen around the flight deck and nearly completely around the troop compartment. Using Figures 24-26, which are two stereo pairs, one can see standing water and the relative height of vegetation and terrain in the vicinity of the troop compartment and flight deck.

As the wing separated from the aircraft the troop compartment, which was located immediately aft of the wing continued its forward slide as it was much lighter at this point, having lost the weight of the wing with its load of fuel (See Figure 22). It thus began skimming along the surface leaving even less tracks in the soft mud than before but still in contact with the soil.

The cargo floor was still beneath the troop compartment but soon separated (See Figure 27) as the fuselage sides continued to wear away finally leaving only the sliding troop compartment which by now had "out riggers" formed by the fuselage side walls which had been holding the cargo floor in place only moments before. These outriggers served to float the troop compartment across several levees and clumps of vegetation permitting a slow final deceleration.

It is possible to trace the continuous slide of both the troop compartment and flight deck back to the point of separation from the wing by drawing a line from traces seen on Figure 27 and other photos from the two structures back to the point where the two lines intersect.

The total distance from the River bank to the forward edge of the troop compartment was measured to be about 2161' using Figure 28, scaling from the known length of the troop compartment of 75.67'. This distance corresponds closely with measurements made from other photos of the same line.

Two points indicating that the aircraft slid forward in a slightly nose high attitude are one, the presence of the nose gear coming to rest near the troop compartment, and the relatively intact condition of the gear and tires seen in Figure 29, and also the fact that the nose of the flight deck with the bulkhead supporting the RADOME is seen at the front of the flight deck, Figures 30-32. Had the aircraft been nose low or even level the RADOME would have ruptured and torn away sooner and the nose gear would have been ground up under the aircraft and been deposited at some

earlier point. Figure 29 also reveals the stopping place of one of the left jet engines, slightly to the right rear of the troop compartment. The other left side jet engine came to rest to the left of the flight deck ground path as seen in Figure 33.

The close up ground views of the troop compartment as well as the low altitude photos taken out of the movie film reveal standing water all around the troop compartment and also reveal that the front overhang of the floor is not in contact with the ground indicating that the compartment had not yet reached the stand of vegetation located ahead of the stopping point some 10' or so. This can be seen in Figures 24 a & b where one can look under the overhanging floor and see standing grass which shows clearance of a foot or more of open space beneath this point. The troop compartment did not stop abruptly against an abutment but came to rest on flat ground -- standing water shows that to be the case (See Figure 34.) This situation is particularly evident when photographs are viewed stereoscopically (in 3D) which is the method this witness used on Figures 24 a & b for the troop compartment and 25, 26 and 30 and 31 for the flight deck.

Figures 35-36 also shows vegetation with

fully formed and undamaged leaves with no evidence of fire.

Had there been a fire around the troop compartment this brown vegetation would have burned vigorously.

A similar situation exists around the flight deck where standing water is visible on all sides of this structure and also much undamaged (unburned) vegetation can be seen as there was no fire or fuel spillage near this structure. (See Figures 25, 26, 30 and 31).

The wing structure burned furiously as evidenced by fire, smoke and burned vegetation which appears black and without recognizable leaves and foliage. Photos of the wing area were compared with photos taken of vegetation around the troop compartment to show the absence of fire in the troop compartment and flight deck areas. (See Figures 37 and 38 and compare with Figures 35 and 36.)

The two right engines are visible in the wing area accounting for all four engines. The wing landed upside down facing back from where it came and was heavily damaged by fire from the jet fuel that was in the wings when they impacted well ahead of the troop compartment. The wind

blew the fire and flames away from the troop compartment as seen in Figure 23.

The empennage broke loose from the aircraft about the same time the wings separated from the flight deck and troop compartment coming to rest slightly to the North of the slide track of the troop compartment. See Figure 27. No fire was present in the empennage area.

4. Comparison of these findings with  
those of Dr. Stanley Morain

There are several measurements made by Dr. Morain that were erroneous because he used incorrect dimensions for aircraft components for calibration -- namely tire dimension and length of troop compartment. The tire diameter is actually 4.02' instead of the 3.75' used by Dr. Morain. The troop compartment and part of the fuselage still attached, is actually 75.67' instead of the 65' he used. These errors would influence all calculations in which the incorrect dimensions were used to estimate ground distances.

Dr. Morain indicated the possibility of fire around the troop compartment which was not confirmed by photo evidence, which would have showed burned vegetation or burned paint on

the aircraft had fire been present in that location. In my opinion there was no fire at any point along the slide path or final stopping place for the troop compartment, flight deck or empennage. The only fire that existed was at the wing structure. There was also no significant fuel spillage except at the wing. This is confirmed by eye witnesses and by the absence of evidence of fuel burning except in the wing area.

The troop compartment did not become airborne at any time after initial touchdown on the west side of the River but instead was in continuous sliding contact with the ground as evidenced by the continuous skid marks -- even though some were rather faint where the structure became "light" but was still moving in a "planing" fashion over the moist soil of the rice paddy.

The photographs presented in this report verify all of my opinions regarding these points.

TABLE #1

Distance of Trees Off Center Line - in Feet

<u>Observation</u>	Tree Number			
	1	2	3	4
1	99	119	124	131
2	89.3	109.5	113.7	119.6
3	91.4	114.6	119.9	128.2
4	96	115.2	118	128
5	<u>88</u>	<u>105.6</u>	<u>114</u>	<u>120.1</u>
Average Distance	92.7	112.8	117.9	125.4

Tree Heights - in Feet

	Tree Number			
	1	2	3	4
Height	16	27	31	31

Aircraft wing span 222.75'  
 From centerline to end of wing = 111.37'