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DEPARTMENT OF THE AIR FORCE
16AF ADVON
APO NEW YORK 09283

REPLY TO
ATTN OF: C

13 FEB 1966

SUBJECT: Search Operations, Palomares, Spain

TO: SAC (Gen John D. Ryan)
USAF (Maj Gen Woodrow P. Swancutt)

1. The attached study was prepared by the Systems Analysis Team which functioned at the accident site from 30 Jan 66 to 8 Feb 66. The team was composed of representatives from Sandia Corporation; SEC, Wright-Patterson AFB; and DAD, Eglin AFB. This team was assisted by USAF, AEC, and Los Alamos Scientific Laboratory personnel at the site plus 21 organizations that furnished computer computations and theoretical studies.

2. The postulated solution number 1, page 17, and the conclusions on page 25 and 26 are the primary basis for the present ground search. The probable point of impact for the secondary is a circle of 5000 ft. radius, whose center lies at 37 degrees 14.65'N latitude and 1 degree 49.9'W longitude. For ground search activity, the area has been enlarged to a square configuration measuring 10,000 ft. on each side using the probable impact position above as the center.

3. I propose to cover this area at least three times with searchers separated at arms length. Successive searches will be made perpendicular to the previous sweep. The search team varies between 150 - 200 personnel. PAC 1S monitors accompany the searchers. String is used to guide the searchers and prevent gaps in the area to be covered. The searchers are instructed to mark with flags any crater, hole, or suspicious depression for further investigation. The investigation is made by a team composed of USAF, AEC, Los Alamos Scientific Laboratory, and Sandia Corporation people using choppers to follow up the line of ground searchers.

4. Copies of this letter and the report have been forwarded for information to the addressees shown on pages 33 and 34.

DELMAR E. WILSON, Maj Gen, USAF
Commander

1 Atch
Staff Study of Search Operations

#135
Pg 37

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[redacted] ANALYSIS OF BALLISTICS OF FOUR MK 28 FI WEAPONS RELEASED AS A RESULT OF THE COLLISION OF A B-52 AND KC-135 NEAR VERA, SPAIN, ON 17 JANUARY 1966

7 FEBRUARY 1966

STAFF STUDY
BY
SYSTEMS ANALYSIS TEAM
OF
SEARCH OPERATIONS

PREPARED FOR
MAJOR GENERAL DELMAR E. WILSON
COMMANDER, 16TH AIR FORCE

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BASIC PROBLEM

The basic problem was to define the impact area for No. 4 weapon and/or No. 4 weapon parts. In order to establish with some degree of accuracy the probable trajectory for No. 4 weapon and the resulting impact position, the following points must be established:

I. The probable point in space where weapons 1, 2, and 3 left the B-52 aircraft.

II. The probable point in space where weapon No. 4 left the B-52 aircraft.

III. The significant events which could have affected the trajectory of weapon No. 4 both before and after it left the B-52 aircraft.

RELATED FACTORS

I. The B-52 and the weapons all experienced deceleration as a result of the break-up of the aircraft. The amount and kind of decelerations the B-52/weapons experienced during break-up significantly affects the resulting trajectories of all weapons.

II. The MK28FI weapon employs a series of chutes. Determination of which chutes (if any) retarded the weapon's fall, the condition of the chutes and when they deploy, is critical to the prediction of the resulting trajectory.

III. An HE explosion sometime prior to the weapon's impact would have a significant effect on the weapon's trajectory. An explosion coupled with possible variation in chute deployment could result in a wide variation (miles) in impact location of weapon parts.

IV. The tail cover assembly from Weapon 4 was located and appeared to have failed in a manner signifying that pressure from within the case could have forced it from the weapon afterbody.

V. Testimony of Fernando Simo Orts, Ship Master of the fishing vessel MANDELLA ORTS SIMS, observed a very large chute with an object approximating the size of a weapon descending and sinking in the sea.

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~~ATOMIC ENERGY ACT - 1954~~

VI. No. 3 engine from the KC-135 and the horizontal stabilizer of the B-52 showed evidence of contamination.

VII. The weapon rack from the B-52 bomb bay and the 1 weapon were not contaminated.

VIII. The best available information places the B-52 flight conditions immediately prior to collision at:

Altitude - 30,500 ft.

KTAS - 405

Knots Ground Speed - 365

True Course - 256 Deg

True Heading - 262 Deg

Wind al Altitude - 305/60

And in a 300 ft/min Glide

IX. The impact Location of items of interest are:

ITEM	LATITUDE (N)	LONGITUDE (W)
Weapon No. 1	37° 14' 25"	1° 46' 47"
Weapon No. 2	37° 14' 37"	1° 48' 47"
Weapon No. 3	37° 14' 52"	1° 47' 33"
Weapon No. 4 Tail Plate	37° 15' 14"	1° 46' 43"
KC-135 Engine No. 3	37° 14' 58"	1° 48' 25"
B-52 Tail Section	37° 15' 00"	1° 46' 53"

X. Analysis by LASL indicated that the secondary is virtually indestructible.

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~~ATOMIC ENERGY ACT 1954~~

DISCUSSION

The following information is provided to document the details of the information obtained or generated in support of this study.

I. Description of Collision and Weapon Release Conditions

A. After some portion of the KC-135 collided with the upper fuselage of the B-52, a rupture of one longeron occurred just aft of the B-52 wing trailing edge. These longerons are loaded in tension and are impact sensitive. The fuselage design is such that loss of a primary load carrying member will cause almost immediate spread of the failure to all other members. As a consequence, a few seconds after the initial longeron failure, the fore and aft fuselage sections separated.

B. The B-52 forward fuselage has a normal download on it in level flight. The horizontal stabilizer also has a download which balances the rotational moments. When the longeron fails, the compensating tail loads are removed and the forward fuselage pitches down. The B-52 crew members testified that the aircraft pitched nose down and left wing down. This initial motion was not violent since the crew testimony also places the g effects in the cockpit at about zero g.

C. During this motion there is a deceleration along the flight path of the wing and remaining forward fuselage

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section. The crew members indicated that they were thrown forward, but not violently, and this deceleration during the initial pitch-down is therefore estimated to be about 1/2 g. After several second this motion developed ultimate loads on the left wing. The left wing then snapped off, imparting a violent rolling and pitching condition to the remaining fuselage and right wing section. One crew member who survived was literally thrown across the cabin area and pinned down by the high g forces which resulted from the wing failure. The effect of the left wing separating from the fuselage during this rolling-pitching condition would be a rapid change in the roll and pitch rate which probably failed the vertical beam of the bomb rack support.

D. Weapon number 1 was found with a major piece of the bomb rack still attached. The recovered bomb bay and rack pieces indicated a high g loading occurred, which caused the relatively massive weapons to separate at about the same time. The fuselage side panels of the bomb bay show no evidence of damage by the weapons, and the bomb bay doors offer no hindrance to the separation of the weapons. As a consequence, it is concluded that all four weapons were released at approximately 4-5 seconds after the initial longeron failure. The weapons would not receive any drastic alteration of their lateral velocity (essentially zero) and since they separate rather than move with the

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violent motion of the fuselage, they have only a minor change in vertical velocity. However the 1/2 g deceleration along the flight path is significant, and the B-52 fuselage (and weapons) probably decelerated to a velocity of 200 to 400 ft/sec less than the B-52 velocity prior to collision. In addition, the B-52 fuselage lost an undetermined amount of altitude prior to weapon separation.

II. Release Point Location

A. Based on the previous analysis, the weapon release conditions were postulated. The next step was to locate the release point in space. The violent release conditions and the marginal stability of this weapon in free fall makes it almost a certainty that the weapons began to tumble. The tumbling, or the violence of the breakaway from the bomb bay, sheared the tail-cover thru the designed shear point at the 8 each 1/4 inch retaining bolts of weapon number 1 and 3 in the same manner as the normal tail-cover release, since the tail cover is designed to fail in the bolt holes. Weapon numbers 2 and 4, however, did not fail in this manner. Therefore, we are reasonably certain that number 2 was tumbling while numbers 1 and 3 were beginning to deploy chutes in the first few seconds after release.

B. To establish a release point, the three known weapon impact points, along with the available wind data, the

previously deduced initial B-52 and weapon velocity, and the observed weapon impact configurations were used to calculate trajectories. The trajectories were then placed on the known impact position to establish the calculated release point.. Weapon 1 was observed to fall with a chute, and was found with the 16 ft ribbon chute intact, so these conditions were used for its trajectory calculation. Weapon 2 had an HE explosion on impact, and all of the weapon including the ring forging and the tail plate was found in very close proximity to the impact point. Its trajectory was therefore calculated assuming a tumbling free fall unit. Weapon No. 3 also had an HE explosion on impact, indicating a relatively high impact velocity, but the accompanying tail cover plate, the 4 ft chute, and 16 ft chute-bag were not found. In addition, the 16 ft ribbon chute was damaged at the time the weapon was found, and the location of debris indicated a deployed 16 ft chute. The trajectory of weapon 3 was therefore presumed to be influenced by an inflated but damaged, 16 ft ribbon chute, and a drag area of less than 50% of thenominal chute drag area was arbitrarily assigned, based on the ballisticians judgment and experience. As a result of these calculations, three hypothetical release points were obtained. These three points were plotted on the ground grid map, and a probable release point was determined from their locations. This probable release point is within a

[redacted]

5000 ft diameter circle the center of which is located at latitude 37°15.5'N and longitude 1°47.9'W. The collision point is estimated to be approximately one half to one nautical mile farther toward the ocean. This places the collision point and release point over land. This verifies the crew statements as well as the testimony of several ground observers. Several additional verification checks were made. The Boeing representative had calculations made for a KC-135 engine trajectory, a B-52 engine trajectory, and an ejection seat trajectory. These Boeing calculations substantiated the release point calculations.

III. Analysis of Tail Cover Plate Failure

Having established with reasonable accuracy, how and where weapon no. 4 separated from the aircraft then the next step is to look at the evidence concerning the weapon no. 4 tail plate cover failure.

A. The most solid evidence is the recovered no. 4 weapon tail-cover plate and forged ring assembly. The part number of this assembly has been matched with the factory record of assembly of no. 4 weapon. Further verification is provided, by the presence of the forged rings with weapons 1, 2, and 3.

B. It was noted that the rivets attaching the ring forging to the weapon outer skin were sheared uniformly around the circumference of the ring. There are at least four theories as to how the tail plate assembly separated in this manner:

[redacted]

1. Detonation of the HE would provide a uniform pressure transmitted through the weapon parts and parachute packs to the tail plate. A description of the parts of the weapon is contained in Appendix A.

2. A lateral force applied to the weapon after body in the bomb bay during collision and fuselage breakup was sufficient to buckle both the outer weapon case and the inner parachute can, which would result in progressive rivet failure circumferentially. Subsequently, combined aft and radial blows on the ring forging and tail plate assembly (which was evidenced by the battered areas) or forces due to weapon tumbling completed the rivet failure.

3. An aft force applied uniformly to the four fins in a direction parallel to the weapon longitudinal center-line could push the ring forging from the weapon.

4. A tumbling weapon having much higher rotational velocity than 1, 2, and 3, causing the forged ring to be separated from the skin before the cover plate fails at the eight attachment points.

IV. Pertinent Testimony of Observers

Consideration must be given to the testimony of observers as it relates to this weapon. Several crew members reported seeing a white chute, but it is difficult to correlate

their statements since weapon 1 was descending by a 16 ft white ribbon chute (and had shed a 4 ft chute with the 16 ft chute-bag) and weapon 3 was similarly descending, although its chute was damaged, in addition four orange and white personnel chutes were deployed. Thus 8 chutes are known to have been in the air although the inflated condition of the 4 ft chutes (with 16 ft chute-bag) after separation from weapons 1 and 3 is unknown. One observation was, however, quite definitive and informative, but like all eye witness observations, it leaves much to be desired. The testimony and comments on it follow.

A. Francisco Simo Orts, ships master of the fishing boat. MANUELLA ORTS SIMO stated in his written statement that he saw the collision, called the coast guard cutter, and observed six chutes, four orange and white, one white and one darker. He then stated that a "half body" landed in the water near his boat 25 meters away and sank immediately. He stated that 3-4 minutes later, a "whole body" landed in the water 80 meters from his boat. This is the extent of his initial written statement.

B. Captain Joe Ramirez provided a verbal statement of the follow-on interviews in which Senor Orts indicated that the first chute was on the shore side of the ship and was the "dark" chute. He described what he meant by the phrase "half body,"

as looking like a head above a larger approximately square object, and from the combination was hanging what they described as entrals. There was no doubt in the minds of he and his crew that it was a man who had been cut in half. Senor Orts and his crew then described the other chute as being the white one, and much bigger. In addition they stated that the "whole body" appeared to be the right size for a man, but a stout man. They also stated that the "whole man" oscillated at about 30 degrees from the vertical. (They did not state an angle, but rather indicated the kind of oscillation they saw. This was about a four second period of oscillation). Orts also stated that the big white chute stayed on the surface for about 30 seconds and then sank quickly.

C. Captain Ramirez then described the trip aboard a USN minesweeper with Senor Orts. Apparently he was able to take them immediately to the position of his boat, using triangulation with shore landmarks. At his indicated position, the minesweeper received 2 Sonar signals, and repeated the location procedure and Sonar signals to verify the ability of Orts to specify his location.

D. On Tuesday evening, February 2, Captain Ramirez arranged a follow-on interview between Senor Orts and the Systems Analysis Team. In this interrogation, he repeated his previous statements quite accurately and answered several

new inquiries. He stated that he had seen the white chute for 6-8 minutes, that it passed directly overhead and then landed on the water. When given a choice between pictures of a chute (which we concluded was the most likely chute configuration) with or without ribbons Senor Orts immediately said no, no, no, then grabbed the pen and redrew our sketch of the solid chute to show that it had a diameter at the skirt that was much smaller than at its maximum diameter. Later he was asked to compare the size of the white chute with the other chutes he saw and he said it was much, much bigger than the orange and white (28 ft personnel) chutes.

E. Since the testimony of Senor Orts is an extremely significant factor in this staff study, it is important that some background be included which gives some insight to the quality of his testimony. Senor Francisco Simo Orts is the "Ships Master" (captain) of the fishing boat MANUELLA ORTS SIMO which fishes with large nets off the bottom of the coastal waters in the vicinity of the accident. He is not only the owner of his boat, which is the largest in the port, but also owns the DORITA which his brother sails as ships master. As a consequence he is a major businessman in the port city of Aquilla, particularly since his ships are the largest in the harbour. It is notable that the

winds on 17 Jan 66 were of such intensity at the surface that only four fishing boats were able (or willing) to operate. Two of the four were the boats owned by Senor Orts. His entire livelyhood depends on an intimate knowledge of the waters in this area and his ability to sail them, therefore his testimony, supported by his crew members, seems valid.

F. As a result of this meeting the deployment of the 64 ft chute had to be considered as the most likely possibility. His description of the chute, its oscillation, its size, and denial of the ribbon construction makes it seem quite likely that the number 4 weapon deployed its 64 ft chute and that the weapon case at least was in the water off the coast at the point indicated by Senor Orts. His sketch of the "half man" was so detailed that, when shown to anyone who had ever seen one, it appeared to be a sketch drawn with the knowledge that it was a chute and chute-bag. The "head" is the straps connecting the 4 ft pilot chute to the bag, the "torso" is the bag and the "entrals" are closing flaps and dangling tie lines. The only part of his descriptions which is inadequate for reasonable speculation is the shape of what is presumably the weapon 4 case. If they had been able to define the shape of the case as either longer or shorter than their phrase of a "stout whole body," a more definitive assumption would have been

possible. However, at the follow-on interview, Senor Orts drew a picture which is equally vague, being a little too long for only a chute section of the weapon case and a little too short for the entire weapon.

V. Weapon 4 Impact Predictions

A. As a result of the previous analysis the probable release point and release conditions were established with reasonable accuracy. Thus trajectory calculations for weapon 4 can be initiated if subsequent events affecting the weapon's trajectory can be inferred from available evidence.

B. Impact predictions for weapon case with chute.

The evidence appears to be overwhelming that Senor Orts and his crew did observe a 64 ft chute with weapon 4 or a portion thereof impacting in the sea about 5 miles off shore, therefore, trajectories were backtracked from this impact position. Initial trajectory calculations indicated that if the 64 ft chute were deployed shortly after weapon separation, the weapon would impact at sea well beyond the 5 mile sighting. Therefore, the 64 ft chute must have been deployed sometime after the weapon separated from the B-52. The winds were strong. The accident occurred at 1022 Zulu and wind data were available from Metro stations at Gibraltar and Palma at 0000 Zulu and 1200 Zulu. From these

wind readings 16th Air Force meteorologists estimated a probable wind structure for the vicinity and time of the crash. These predicted wind data are as follows:

Altitude, Ft	Direction, Deg.	Velocity, Knots
30,000	305	60
25,000	300	55
20,000	290	50
15,000	290	45
10,000	280	30
5,000*	270	25
Sea Level*	270	20

* - These winds were estimated from fisherman's testimony.

An average wind of 68 ft/sec from 300° was used for most of the trajectory calculations. The trajectories of systems supported by large chutes (such as the 64 ft chute) are almost entirely controlled by the wind. Note that the sink or vertical velocity of the complete weapon (weight 2248 lbs) with the 64 ft chute at sea level is only 30 ft/sec whereas the horizontal wind velocity on the sea surface is about the same. The possible impact area for the location of no. 4 is within a triangle with the apex on land and the weapon release point (37°15.45'N and 1°47.9'W) with azmuth lines extending in directions of 110 and 130° from the apex and with the base of the triangle about 18.6 miles from the release point to base of triangle. This extreme and unlikely distance of 16 nautical miles assumes the 64 ft chute opens shortly after release following an HE explosion where the secondary was

separated from the unit, reducing the weight of the weapon portion attached to the chute to about 500 pounds.

C. Impact predictions for secondary.

The assumption of an H.E. explosion occurring, implies probable separation of the secondary from the remaining weapon case with chute. As the secondary is very dense, its separate trajectory should not be significantly affected by winds. Some wind drift would be achieved by the secondary (and weapon) during their fall as a complete bomb, prior to the H.E. detonating. A maximum forward travel can be established for the secondary, by assuming the secondary separated from the rest of the weapon shortly after release, following an H.E. explosion. While this assumption is inconsistent with probable chute deployment times, it can be used to predict a limit as to how far the secondary would be expected to travel beyond the probable point of weapon separation from the aircraft. The maximum forward travel for these conditions was calculated to be 23500 ft along course of aircraft. The most probable impact position of the secondary assuming H.E. detonation at an altitude as low as 15000 ft was calculated to be a circle of 5000 ft radius whose center lies at 37°14.65'N and 1°49.9'W.

[redacted]

POSTULATED SOLUTIONS

The following are considered the most probable solutions:

I. Solution I. Weapon separated from the aircraft debris slightly before or along with weapons 1, 2, and 3 and tumbled to an altitude of 10,000 to 20,000 ft at which time it collided with aircraft debris which was in the vicinity of the KC-135 No. 3 engine resulting in an HE explosion. The HE explosion blew off the tail cover plate assembly and deployed successively the 16 ft and 64 ft chutes. The dense secondary [redacted] separated from the weapon and free fell, impacting on land West of the main debris. The best estimate of an impact area for the secondary, based on this solution is within a circle having a radius of 5000 ft about a center point located at 37 degrees 14.65 minutes N longitude and 1 degree 49.9 minutes W latitude. The estimated dimensions of a secondary crater are 3 to 8 feet in diameter, with a possible penetration to a depth of 5 to 20 ft, depending upon the type of soil and the orientation (nose-on or flat) at impact. The weapon case remnants (weight about 500 lbs) descended out to a sea impact supported by the 64 ft chute, to the approximate area of Senor Orts sighting of a large chute.

A. Arguments For:

1. Senor Orts and his crew observed for 6 to 8 minutes, a large chute descending with a stout man attached.

[redacted]

[redacted]

A[redacted]

F[redacted]

The sink velocity of the 64 ft chute with unit remnants would be approximately 15 to 20 ft/sec.

2. Senor Orts indicated that the chute was white and larger than the crew personnel chutes he observed. Personnel chutes are 28 ft in diameter and are orange and white in color.

3. Senor Orts sketch of the chute resembled a 64 ft solid canopy and not 16 ft ribbon chute as his sketch showed the maximum inflated diameter as being above the skirt section. In addition, the chute passed over the fisherman's boat and he indicated that the chute was a solid canopy.

4. Senor Orts and his crew indicated that the chute was oscillating approximately ± 30 degrees. Solid canopy chutes oscillate about that much whereas ribbon chutes are more stable, and exhibit oscillations usually less than ± 10 degrees.

5. In the estimate of Senor Orts the chute stayed on the surface of the water for 30 seconds. A solid canopy chute might trap some air at impact and keep the system buoyant for a short period.

6. The position of the coverplate assembly relative to the location of other debris and the estimated release point of weapons 1, 2, and 3 indicates a different phenomena occurring on #4 than on weapons 1, 2, and 3.

7. The uniform shearing of the rivets which hold the forged ring of the tail cover assembly to the weapon skin

indicated an abnormal failure. The tail cover plate is designed to separate from the ring forging and weapon by failing eight counterbored holes using a mild detonating fuze. The weapon 2 tail cover plate failed in the manner designed.

8. The KC-135 No. 3 engine with pylon attached was highly contaminated.

9. The B-52 horizontal stabilizer upper surface had four scratches which were made by a contaminated object.

10. The forward bomb bay was recovered essentially intact. The bomb bay, the vertical support pedestal of the recovered rack and weapon 1 were not contaminated.

B. Arguments Against:

1. It should be noted that the 64 ft chute was not deployed from weapons 1, 2, and 3. Therefore, some different anomaly must be presumed for weapon #4 to explain deployment of its 64 ft chute.

2. The probability of weapon 4 colliding with debris becomes more remote the farther the weapon falls.

3. It is difficult to explain how the B-52 tail section became contaminated in the air due to the separation distance at ground impact between the KC-135 #3 engine and the B-52 tail section.

4. The ground area where the secondary would have impacted has been searched for surface objects.

II. SOLUTION 2. Weapon 4 separated from the aircraft debris slightly before or along with weapons 1, 2, and 3 and tumbled to an altitude of 15,000 to 25,000 ft at which time it collided with aircraft debris which was in the vicinity of the KC-135 No.3 engine. The collision resulted in an HE explosion which blew off the tail cover assembly and successively deployed the 16 ft and 64 ft chutes. The secondary lodged in the weapon case and this configuration [redacted] drifted out to sea supported by the 64 ft chute to the approximate area of the sighting by Senor Orts and his crew of a large chute.

A. Arguments For:

1. Same as A1 for Solution 1, i.e., "Senor Orts and his crew observed for 6 to 8 minutes, a large chute descending with a stout man attached. The sink velocity of the 64 ft chute with unit remnants would be approximately 15 to 20 ft/sec."

2. Same as A2 for Solution 1, i.e., "Senor Orts indicated that the chute was white and larger than the crew personnel chutes he observed. Personnel chutes are 28 ft in diameter and are orange and white in color."

3. Same as A3 for Solution 1, i.e., "Senor Orts sketch of the chute resembled a 64 ft solid canopy and not 16 ft ribbon chute as his sketch showed the maximum inflated diameter as being above the skirt section. In addition, the chute passed over the fisherman's boat and he indicated that the chute was a solid canopy."

[redacted]

4. Same as A4 for Solution 1, which is, "Senor Orts and his crew indicated that the chute was oscillating approximately ± 30 degrees. Solid canopy chutes oscillate about that much whereas ribbon chutes are more stable, and exhibit oscillations usually less than ± 10 degrees."

5. Same as A5 for Solution 1, i.e., "In the estimate of Senor Orts the chute stayed on the surface of the water for 30 seconds. A solid canopy chute might trap some air at impact and keep the system buoyant for a short period."

6. Same as A6 for Solution 1, i.e, "The position of the coverplate assembly relative to the location of other debris and the estimated release point of weapons 1, 2, and 3 indicates a different phenomena occurring on #4 than on weapons 1, 2, and 3."

7. Same as A7 for Solution 1, i.e, "The uniform shearing of the rivets which held the forged ring of the tail cover assembly to the weapon skin indicated an abnormal failure. The tail cover plate is designed to separate from the ring forging and weapon by failing eight counterbored holes using a mild detonating fuze. The weapon 2 tail cover plate failed in the manner designed."

8. Same as A8 for Solution 1, i.e., "The KC-135 No. 3 engine with pylon attached was highly contaminated."

[redacted]

[redacted]

9. Same as A9 for Solution 1, i.e., "The B-52 horizontal stabilizer upper surface had four scratches which were made by a contaminated object."

10. Same as A10 for Solution 1, i.e., "The forward bomb bay was recovered essentially intact. The bomb bay, the vertical support pedestal of the recovered rack and weapon 1 were not contaminated."

11. A possible cause of the cover plate assembly separation is the direct impact and reaction of the secondary with the contents of the chute section at the time of the HE explosion. Since the possibility of the secondary remaining wedged into the case for any period of time results in a completely different trajectory, this possibility, however remote, must be considered.

B. Arguments Against:

1. Same as B1 for Solution 1, i.e., "It should be noted that the 64 ft chute was not deployed from weapons 1, 2, and 3. Therefore, some different anomaly must be presumed for weapon #4 to explain deployment of its 64 ft chute."

2. Same as B2 for Solution 1, i.e., "The probability of weapon 4 colliding with debris becomes more remote the farther the weapon falls."

3. Same as A3 for Solution 1 and 2, i.e., "It is difficult to explain how the B-52 tail section became contaminated in the air due to the separation distance at ground impact between

the KC-135 #3 engine and the B-52 tail section."

4. It is difficult to explain how the secondary becomes wedged into the case after the HE explosion.

III. Solution 3. The aft section of the No. 4 unit was damaged in the bomb bay during aircraft structural breakup by collision with weapon 1 and other debris. This damage weakened the tail plate assembly attachment which subsequently failed due to tumbling or collision with other debris. The parachutes deployed successively around 25,000 ft. altitude. The intact weapon (weight approximately 2100 lbs) drifted out to sea with the 64 ft chute and impacted in the area of Señor Orts' sighting.

A. Arguments For:

1. Same as A1 for Solution 1 and 2, i.e., "Señor Orts and his crew observed for 6 to 8 minutes, a large chute descending with a stout man attached. The sink velocity of the 64 ft. chute with unit remnants would be approximately 15 to 20 ft/sec."

2. Same as A2 for Solution 1 and 2, i.e., "Señor Orts indicated that the chute was white and larger than the crew personnel chutes he observed. Personnel chutes are 28 ft. in diameter and are orange and white in color."

3. Same as A3 for Solution 1 and 2, i.e., "Señor Orts' sketch of the chute resembled a 64 ft. solid canopy and not 16 ft. ribbon chute as his sketch showed the maximum inflated diameter as being above the skirt section. In addition, the chute passed over the fisherman's boat and he indicated that the chute was a solid canopy."

[redacted]

4. Same as A4 for Solution 1 and 2, i.e., "Señor Orts and his crew indicated that the chute was oscillating approximately ± 30 degrees. Solid canopy chutes oscillate about that much whereas ribbon chutes are more stable, and exhibit oscillations usually less than ± 10 degrees.

5. Same as A5 for Solution 1 and 2, i.e., "In the estimate of Señor Orts the chute stayed on the surface of the water for 30 seconds. A solid canopy chute might trap some air at impact and keep the system buoyant for a short period."

6. The description of the weapon case by the crew of Señor Orts' boat cannot be conclusively interpreted as being either a full length case or a case shortened by an HE explosion.

7. The rack positions of weapons 1 and 4 in the bomb bay were upper left and lower left, respectively. This fact, coupled with the fact that three of four fins from weapon #1 were missing, leads to the possibility that weapon #1 struck weapon #4 during release.

B. Arguments Against:

1. It is difficult to explain how the B-52 tail section became contaminated in the air due to the separation distance at ground impact between the KC-135 #3 engine and the B-52 tail section.

[redacted]

2. Same as Item 6 in Arguments for:, i.e., "The position of the coverplate assembly relative to the location of other debris and the estimated release point of weapons 1, 2 and 3 indicates a different phenomena occurring on #4 than on weapons 1, 2, and 3."

[redacted]

[redacted]

CONCLUSIONS

It is the conclusion of the systems analysis team that:

I. All four MK 28 FI weapons separated from the aircraft at approximately the same time and a few seconds after the initial breakup of the aircraft.

II. The MK 28 weapons separated from the B-52 by falling thru the bomb bay door area.

III. The probable point of weapon separation from the B-52 is within a 5000 ft diameter circle the center of which is located at latitude 37°15.5'N and longitude 1°47.9W.

IV. The velocity of the weapons at separation was 200-400 feet per second less than the velocity of the aircraft immediately prior to the collision.

V. The vertical velocity imparted to the weapons due to the manner of aircraft breakup was small.

VI. H.E. detonation in weapon no. 4 probably occurred sometime after it separated from the aircraft and prior to its surface impact, probably due to inflight collision with another object. Debris from the H.E. detonation resulted in contamination of the no. 3 KC-135 engine and the B-52 tail section.

VII. The 64 ft parachute was deployed on weapon no. 4 and impacted on the sea with the weapon case or parts thereof.

VIII. While it is probable that the secondary would not remain within the weapon case after an H.E. detonation this possibility cannot be eliminated.

IX. The best estimate of the position of the secondary is a circle of 5000 ft radius, whose center lies at 37°14.65'N latitude and 1°49.9'W longitude.

X. The best estimate of the case position at impact is the position estimated by Mr. Francisco S. Orts.

[redacted]

RECOMMENDATIONS

It is recommended that:

I. The Navy search be concentrated in the area indicated by the visual sighting of Senor Orta.

II. Careful investigation of the weapon case or remnants found in the sea should be made before it is raised. In addition, any weapon parts should be raised in a litter or fine net [redacted] If photographic evidence clearly indicates that the secondary is not with the weapon case, the above precautions are not necessary.

III. A ground search of a 10,000 ft diameter circle centered at 37°14.65'N and 1°49.4'W longitude for the secondary should be made. The search should be conducted anticipating a shallow depression of 3 to 8 ft in diameter with the secondary 5 to 20 ft below the surface.

IV. The systems analysis team of Messrs. Bachman, Bennett, Campbell, and Maydew should be returned to Torrejon AB, Spain, and thence to their respective home duty stations, and that they continue to serve in an analytical and advisory capacity from there. The recommended mode of operations would be for "Search Operations" to send an action message containing description of any new information deemed significant by Search Operations and/or the Sandia Representative at the site. This information should be addressed to Sandia Corp,

[redacted]

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SEG, and DAD at the addresses noted on the signature page of this document. Discussions, calculations and/or other actions necessary to interpret and analyze the significance of the information would be conducted and immediate reply made regarding the significance of the information and its effect on search operations.

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APPENDIX A

I. Description of Parachute System:

A. The chute systems consist of a 30 inch diameter stabilization chute, a 64 ft diameter solid canopy chute, a 16.5 ft diameter ribbon chute, and a 4 ft diameter guide surface chute. The 30 inch chute is packed on the front end of the 64 ft chute pack. The 4 ft guide surface chute is packed on the forward side of the tail plate. The B-52 pilot has two chute options, either the sequenced 4 ft - 16.5 ft - 64 ft option of the 30 inch stabilization chute. The 30 inch chute is used to help stabilize the weapon and to keep the mach number below 0.8 during the near free fall trajectory.

B. The normal operation of the 4 - 16.5 - 64 ft system is as follows. After the unit separates from the aircraft, a timer-actuated mild detonating fuze ejects the tail plate from the weapon thereby deploying the 4 ft extraction chute. The 4 ft chute pulls the 16 ft chute bag out of the weapon and pulls the bag off the 16 ft chute. Note that the 4 ft guide surface chute supporting the 16 ft chute bag then floats off separately from the weapon. The 16 ft ribbon chute inflates and decelerates the weapon for 3 seconds at which time a timer-actuated mild detonating fuze enables the release of the 16 ft chute shroud line attachments. The 16 ft chute then pulls the 64 ft chute pack out of the weapon and pulls the bag off the chute. The 64 ft chute opens and decelerates the weapon for the balance of the trajectory while the 16 ft chute supporting the 64 ft chute

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bag goes floating off separately. This mode results in 3 chutes in the sky.

C. The normal operation of the 30 inch stabilization chute system is as follows: After the unit separates from the aircraft, a set of timer-actuated mild detonating fuzes blow the tail plate off and release the 16 and 64 ft chute shroud line attachment plates. The 4 ft chute pulls out the 16 ft chute which pulls out the 64 ft chute which deploys the 30 inch stabilization chute. Recall that the 30 inch chute is packed on the front of the 64 ft chute bag. Note that the 4 ft chute attached to the 16 ft chute bag, the 16ft chute attached to the 64 ft chute bag and the 64 ft chute canopy then floats off separately from the weapon. The 30 inch chute then stabilizes the weapon during the balance of the trajectory. This mode results in four chutes in the sky.

D. Spurious electrical signals or damage to unit No. 4 during the accident or during the trajectory could result in parachute and/or deployment system damage. Hence, a very large number of parachute drag area combinations are possible for unit #4. An exact prediction of which of these many possible drag area combinations occurred is not possible.

II. <u>Description of Weapon Tail Assembly</u>:

The shape component of tail assembly of the MK28FI Bomb consists essentially of two concentric cylinders. The inner cylinder houses the parachutes and the outer cylinder forms

the skin of the tail assembly. The two cylinders are tied at the aft end to a forged ring with a single rivet pattern. The estimated longitudinal failure load for rivet shear (which occurred on No. 4) is 88,000 lbs. The ring also provides a mounting surface for the aft feet of the four fins and the cover plate. The aft feet of the fins are bolted to the ring directly, (the bolts do not go thru the outer skin) with two bolts per fin foot. The cover plate is bolted to the ring at eight places. Counterbored holes in the cover plate retain the plate until an MDF system on the forward surface of the plate is fired. At this time, the counterbored holes fail, at a load of approximately 22 thousand pounds. The forward feet of the four fins are riveted to an intermediate ring assembly, the concentric cylinders (after body case and parachute container) are terminated at the forward end at another ring assembly. A bulkhead, to which the parachute shroud lines are attached, thru other plates, is bolted to this forward ring assembly. The 30 inch parachute shroud line attachment plate is cantilevered aft to the bulkhead. The 64 ft parachute shroud line attachment plate (spider) is attached to the aft surface of the bulkhead with explosive bolts (MDF). The 16 ft parachute shroud line attachment plate (spider) is attached to the 64 ft release spider with explosive bolts. During normal operation of the chute, the timer-activated MDF on the 16 ft spider fires (3.5 seconds after the tail plate leaves) which releases the 16 ft chute shroud lines

allowing the 16 ft chute to deploy the 64 ft chute. During normal operation of the free-fall option (30 inch chute deployed) a timer-activated MDF fires which separates the 64 ft chute spider (plate) from the bulkhead thereby allowing the 16 ft and 64 ft chutes to separate from the weapon.

Submitted by the Systems Analysis Team

Camp Wilson, Sixteenth Air Force, Spain 7 February 1966

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STAFF STUDY

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