CARRIER SUITABILITY DEMONSTRATION

SP-1564

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SUMMARY

The carrier suitability of the U2-R was demonstrated aboard the USS America in November of 1969. Two landings, a lightweight and a heavyweight takeoff were accomplished by [redacted] STAT

Immediately following the two demonstration landings, four operational pilots from the 1130th ATTG each made four landings in the same aircraft. Only two arresting cables were used and all arrestments but one were on the #1 cable. Two go arounds for missed cables due to hook bounce were experienced. The hook bounce resulted from the liquid spring in the hook down mechanism losing its charge. There were no wave offs given by the LSO or elected by the pilot.

Minor aircraft damage caused by hook bounce and repeated arresting cable whip were experienced. The damage was experienced on landing only so it would not compromise an operational mission.

The U2-R was taken below to the hangar deck to demonstrate that it could be done for servicing and transporting.

It is concluded that the U2-R meets the model spec. (SP-1125) and can be operated aboard a "Kittyhawk" class carrier.

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REFERENCES

1. SP-1528, "Carrier Suitability Test on Land", 1 Oct. 1969, STAT

INTRODUCTION

A program with the U2-R was conducted aboard the aircraft carrier America (CVA 66) on 21, 22 and 23 November 1969. Purpose of the program was to demonstrate the carrier suitability of the U2-R and to check out and qualify four operational pilots.

The program was given the unclassified name Blue Gull V. The 1130th ATTG from Edwards Air Force Base provided maintenance, operations and logistics support. Lockheed ADP was responsible for the suitability demonstration and the 1130th was responsible for the operational pilot checkouts.

This report will deal primarily with the suitability demonstration and will refer to the checkout program only where it is pertinent to the aircraft operation.

The 1130th ATTG under the command of [redacted] had a well organized staff both aboard the carrier and at the shore station. Their excellent support functions made it possible to accomplish the program safely and expeditiously. STAT

The America was under the command of Capt. R. E. Rumble, USN. His keen interest in the program and his desire to operate the ship as required to optimize conditions for the U2-R, contributed greatly to the success of the program.

STAT

STAT The demonstration landings and takeoff were made by [redacted]

DESCRIPTION OF TESTS

PILOT TRAINING

Prior to going aboard ship with the U2-R, all pilots were given carrier qualification training at Pensacola and were qualified in the T2 aboard the USS Wasp. None of the pilots involved in Blue Gull V had taken the U2-G aboard a carrier. The LSO assigned to the 1130th ATTG worked with the pilots at Edwards Air Force Base, North Base on a series of U2-R Mirror Landing Practice flights. Each pilot had six MLP flights within two weeks of the actual carrier landings.

CONFIGURATION

Two U2-R aircraft were prepared for the program. Serial number 055 was designated primary and 054 was the backup. Arresting hook kit RX-107 was installed on each aircraft. The kit consists of a hook assembly, hook cover assembly, tail gear door deflectors and a tail wheel delector.

Main landing gear strut RL5-9 was installed in both aircraft. This strut had been proven by tests to have better energy absorbing characteristics and is scheduled as a change to all U2-R's by Service Bulletin #275.

Cameras were installed on 055 for the initial arrestments. External pods were installed to photograph the main landing gear, the hook and tail gear, and the carrier deck.

All unnecessary electronic systems were removed from the aircraft and it was ballasted for a zero fuel weight of 18,935 pounds.

The span between the connectors on the arresting cable is 107 feet and the U2-R wing span is 103.5 feet. This requires the aircraft being close to deck centerline to avoid damage if a tip hits the deck ahead of the cable.

CONFIGURATION (Cont.)

To preclude the possibility of damaging the wing tip a spring steel deflector (RG297) was designed and installed. This temporary installation was made as a precautionary safety item for the test program. Time did not permit designing and fabricating a "no drag" device for this purpose after the need was recognized.

DEPLOYMENT

The equipment required aboard ship was air lifted to Norfolk Naval Air Station and placed aboard prior to the sailing date. A major item included prior to sailing was a fuel truck serviced with certified spec. compliance JP-5 fuel. Although the JP-5 fuel on board ship should have been satisfactory, it appeared advisable to have separate fuel because the America was just coming out of a ten months lay up in the ship yard.

The personnel and shore based equipment were airlifted to Wallops Sta., Virginia on 19 November 1969. The two U2-R's were ferried to Wallops Sta. on 20 November 1969.

Personnel were ferried out to the America via C-1A's from Wallops Sta. early on 21 November 1969. The equipment already on board was placed in position, lines for positioning the U2-R on the deck and elevator were laid out and painted and the U2-R started making low approaches in early afternoon.

LANDING DEMONSTRATION

The aircraft arrived over the ship with sufficient fuel to make low passes and establish a pattern technique. The weather was not ideal for a first landing test. The sea was causing some deck pitching but it was not noticeable to the pilot. There was moderate turbulence and varying winds. The captain was trying to hold 25 knots relative wind down the angle deck. With the ship held on a constant heading and speed the wind was varying between 19 and 33 knots and 30 degrees right and left of the angle deck centerline.

The pattern was flown at 70 knots plus 1 knot for each 100 gallons of fuel on board. The turbulence was severe at times. It was causing a plus and minus 10 knots fluctuation in airspeed but aircraft controllability was satisfactory. One very noticeable difference in flying the pattern on the ship from the MLP's was the burble behind the ship. The aircraft will lose altitude and speed as it approaches the fantail then regain it as the fantail is passed. The tendency for the pilot is to add power as the aircraft starts to sink. The aircraft has already started to rise before the power responds so the power must be reduced immediately. On the go arounds the up draft from the intersection of the angle deck and the straight deck caused a sudden wing drop but it was easily controllable.

After several low passes the fuel load was down to where touch and goes could be started. No problems were encountered during the touch and goes so #1 and #2 arresting cables were strung for the first landing. During all flying an 1130th ATTG navigator on board the America monitored ship position and continuously updated "Bingo Fuel" (minimum fuel necessary for safe return to an airport) and heading for the pilot.

The landing approach required a 5 to 10 degree left drift correction. After the LSO gave the cut it was necessary to make a correction to the right to line up with the angle deck centerline. This caused the landing to be made with right wing down. The wing tip deflector hit first, followed by the tail

LANDING DEMONSTRATION (Cont.)

gear and main gear. The touchdown was smooth with no bounce or left wing drop. The #1 cable was hooked and the aircraft stopped. The pilot reported a mild deceleration. Runout was 163 feet. Fuel load at landing was 416 gallons. Wind across the deck was varying considerably but was recorded at 26 knots at the moment of arrestment.

After the landing the hook was latched up and the pilot taxied forward over the arresting cable. The cable was retracted and the pilot shut the engine down. He remained in the cockpit while the aircraft was towed back into position for takeoff. Starting point was just forward of the #4 cable station. The aircraft was not refueled between flights. After engine start the sump tank level remained at the 48 - 50 gallons (outboard tank) transfer level. This gave assurance that the tanks containing fuel were feeding the sump.

The takeoff was made on the straight deck. Pogos were not used so the aircraft was balanced by a man at the right wing tip. Lateral control was effective as soon as the aircraft started rolling. Takeoff distance was 150 - 200 feet. Fuel load was 400 gallons.

The second landing was much better than the first one. Although the same conditions were encountered on final approach, the wings were held level at landing and through the runout. On both landings the aircraft was steered with the rudder pedals during runout. Wind speed at arrestment was 30 knots on the second landing.

After the second landing it was agreed that the U2-R was carrier qualified and was ready for the operational pilot checkout program to start the following day, Saturday 22 November 1969.

The pilot checkout program went quite satisfactorily. The first day the sea was smooth and the air conditions were much smoother in the morning than the

LANDING DEMONSTRATION (Cont.)

day of the first landings. Two pilots made four landings each and one pilot made two landings before operations were ceased in the late afternoon due to a tail gear door failure. The aircraft was flown back to Wallops Sta. for an overnight gear door replacement job.

On Sunday 23 November 1969 the weather was not as calm as it had been on Saturday but the wind was steadier than it had been on either Friday or Saturday. The final six landings were made to complete the pilot qualification program.

During the three days of landings and takeoffs on the carrier there were sufficient variables in weather, wind across the deck and pilot technique to establish a fairly broad operating envelope. There were no wave offs given by the LSO or elected by the pilot.

Figures 1 through 3 show high speed camera sequences of some landings.

RUNOUT

The arresting gear was set for 20,000 pounds based on the tests at Lakehurst (ref. SP 1528). From these tests it was predicted that the maximum runout would be 230 feet for the U2-R at normal landing weight and 25 knots relative wind. With this runout from the #3 cable the left wing tip would end up 6 feet from the deck edge on a centerline engagement and over the deck edge from the #4 cable. It was decided that for the test and qualification program only the #1 and #2 cables would be used. The arresting gear setting was left at 20,000 pounds for the entire program. The table on page 6 shows data from all arrested landings.

Runout distance shows some inconsistancy for like conditions but all are less than predicted. From these numbers it appears that 160 feet to 225 feet is

ARRESTED LANDINGS 055

SS AMERICA 21, 22 & 23 November 1969

PILOT	LANDING NUMBER	FUEL GAL.	WIND KTS	AIRCRAFT RUNOUT FT	REMARKS
STAT	1	416	26	163	Hit rt. tip first, no bounce
	2	364	30	162	Good, one bounce, no nose dip
	1	400	21	183	Good rotation, smooth
	2	535	17	204	Good
	3		20	191	Good
	4	429	19	176	Good
	1	360	19	183	Slight bounce, mild nose dip
	2	530	25	217	Caught #2 wire with power on, one bounce, more dip
	3	476	24	194	Good
	4	380	24	171	Good
	1	380	24	190	Bounced, dipped badly, nose 10" from deck
	2	546	25	190	No photos
	3	314	33	163	Slight bounce
	4	516	36	168	Perfect
	1	368	29	195	Caught cable in air, bad dip
	2	470	31	179	Caught cable in air, mild dip
	3	370	33	161	Caught cable in air, bad dip
	4	288	33	161	Bounced at hook up, mild dip

RUNOUT (Cont.)

the range to expect for the U2-R. In one case where the pilot missed the #1 cable due to hook bounce, he advanced the throttle to go around and caught #2 cable. The power response was so rapid the aircraft had started to fly again as it caught the cable. This caused the main gear to slam down and the aircraft pitched around the main gear. The nose dipped below horizontal but still had adequate deck clearance. This "power on" arrestment gave the longest deck runout of 217 feet. All engagements were within two feet of centerline. There were two go arounds caused by missed cables. Otherwise all engagements were with the #1 cable. It is believed that all cable misses were caused by a hook snubber malfunction. This is discussed in detail under Aircraft Damage in this report.

During the landings, the pilots learned that the aircraft can be steered easily during runout. The ease of steering and the short runouts measured indicate that all four cables can be used if desired. Figure 4 shows runout on all "Kittyhawk" class carriers. The wing tip position varies slightly due to deck angle differences.

GO AROUND

In both go around cases the throttle was advanced after the pilot was sure he had missed the cables. The throttle was advanced from cut position (idle) but the engine had not fully unwound to idle. Power response was excellent and the aircraft lifted off with plenty of deck to spare.

HEAVYWEIGHT TAKEOFF

The heavyweight takeoff was demonstrated at the completion of the pilot qualification program. Fuel load for the takeoff was 2,088 gallons. It was distributed by filling the sump tank, both outboards and 750 gallons in each inboard.

HEAVYWEIGHT TAKEOFF (Cont.)

Extreme care was used to balance the fuel load laterally and maintain wings level while waiting for takeoff. In spite of these precautions the left wing was heavier on takeoff. This was a minor problem on all takeoffs aboard ship. It is believed that ship heel in turning and or wind off of the island tend to cause this problem. Whenever the aircraft has partially filled tanks this can be expected to some degree.

A full power takeoff on the straight deck was made with 30 knots wind across the deck. Starting point was just ahead of the #4 cable location and takeoff point was even with the end of the slant deck. The takeoff distance was 430 feet. The right pogo fell clear within 100 feet of roll and slid for approximately 100 feet. The left pogo remained in longer because of the wing heaviness and fell clear in about 200 feet and slid another 150 feet.

The aircraft lifted off abruptly and climbed out steeply. Even if the deck had been pitching, the aircraft would not have touched the deck after the initial lift off.

MOVING AIRCRAFT TO AND FROM HANGAR DECK

At the completion of the first days flying, the aircraft was placed on the #2 elevator and taken below to the hangar deck. The size of the U2-R made precise positioning of the aircraft on the elevator important.

Prior to deployment, measurements of the USS America elevator and bulkhead openings were taken and handling drawings revised. Plywood bulkheads to simulate the opening to the hangar deck were cut out and sent to Edwards North Base. An elevator was laid out on the ramp, bulkheads positioned, and several practice runs were made with the U2-R.

MOVING AIRCRAFT TO AND FROM HANGAR DECK (Cont.)

Figures 5 and 6 show how the aircraft is handled. The main and tailgear are rotated 90 degrees and the aircraft is pushed sideways onto the elevator. The lines on the deck and elevator position the aircraft so that it clears the bulkhead opening by approximately 2 feet at the nose and 1 foot at the tail. Manual movement is easiest in these close quarters.

With the landing gear 4 feet 6 inches from the outboard edge of the elevator, one entire wing panel is out over the water. To preclude any sudden movement of the aircraft the ship must be slowed down or heading changed to cancel out the wind across the deck. This was done and the operation conducted in relatively calm air. Another important consideration is fuel balance. To assure the lateral CG favoring the deck side the inboard wing was kept low by 250 pounds of shot placed near the tip. This caused the fuel to run to the low side and eventually the tip was so low that the wing could not be lifted by the crew.

The aircraft was pushed onto the elevator by manpower quite easily. Except for the heavy wing the aircraft came off of the elevator and through the bulkheads onto the hangar deck easily. Once onto the hangar deck the gear was turned sufficiently to guide the aircraft around to where an adequately wide passageway or "fire lane" existed in the hangar deck. This whole operation took 55 minutes.

In returning the aircraft to the flight deck the procedure was reversed. Prior to moving, fuel was transferred to level the wings. The shot bags were placed on the inboard wing but the wing was held level by manpower. Once on the elevator, a wing tip stand was placed under the wing and the wing secured to the elevator by a chain at the pogo. This held the wings level enough to prevent fuel running toward the outboard wing. After the elevator reached the flight deck it was determined that the inboard wing was the heaviest prior to releasing the tie down chain.

MOVING AIRCRAFT TO AND FROM HANGAR DECK (Cont.)

The fuel movement problem going down was a good lesson to everyone. It showed how unmanageable the aircraft would be if the fuel moved outboard while going on or off of the elevator. It is conceivable that the aircraft could roll overboard and no one could stop it.

The return to flight status on the flight deck was uneventful and required approximately the same time as going down. It appears that this movement could be reduced to 30 minutes each way as a routine operation.

AIRCRAFT DAMAGE

As predicted from earlier arrestment tests, there was some minor damage to the aircraft. Cable whip damaged the aft gear doors and door actuator rods. Hook bounce damaged the underside of the fuselage. The plastic hook fairings were also damaged.

Aft gear door deflectors are part of the RX 107 kit. Purpose of the deflector is to keep the cable away from the door during engagement whip of the cable. Although the deflector takes most of the blow, the cable still hits the door slightly. The load taken by the deflector is transmitted through the door to the actuator rod. Failures start with rod and bracket bending, then door cracking and finally rod failure. Figure 7.

The failures were progressive and did not create a problem after just one arrestment. This type failure should not compromise an operational mission. A study of the high speed films of the landings shows no tendency for the taut cables to come up high enough to hit or catch on the aircraft. All damage is done by the cable after the hook picks it up.

AIRCRAFT DAMAGE (Cont.)

It appears that the deflectors afford some protection to the doors and should be installed for operational flights. However, if the deflectors and tail gear doors were removed for training programs, there should be sufficient clearance for cable whip and no damage should result.

Damage to the underside of the fuselage was minor but did require a repair after the program was completed. The damage is caused by the hook hitting the structure either at initial arrestment or when the hook bounces up from the deck. Figure 8. High speed photos show one case where the hook hit the deck and bounced up against the fuselage and apparently missed hooking the #1 cable. Figure 9. The hook bouncing did not start until after seven arrestments. The liquid spring hook damper was found to have lost its charge when checked at the completion of the program. The lack of damping was not noticeable to the men manually cocking the hook on the deck. It is assumed that the damper lost its charge sometime prior to the eighth arrestment.

The damper had been serviced prior to the runway tests at Lakehurst in September 1969. During the Lakehurst tests it was subjected to ten taxi arrestments and two landing arrestments. Engaging speeds in the Lakehurst tests were much higher than those on the carrier. Prior to deployment to Wallops Sta. the damper was checked and found to be satisfactory and did not require reservicing. Pictures taken of the hook on the first landings show it staying "glued" to the deck from initial contact until it picked up the cable. The damper is under investigation and appropriate corrective action will be taken.

The plastic fairings around the hook and the plastic cone aft of the hook were damaged the first day. They were removed and not replaced. The damage is caused by cable whip also. This damage to cheap replaceable parts occurs at landing and therefore will not compromise an operational mission. Figure 10.

AIRCRAFT DAMAGE (Cont.)

The wing tip deflector was bent some on the first landing. It is estimated that a tip load of 700 - 800 pounds caused the bending. The wing is designed for a tip load in excess of 1,000 pounds. No damage to the wing tip attachment could be detected. The wing tip deflectors touched the deck ahead of the cable several times during the program. It appears desireable to revise the tip skid leading edge shape so that it will slide up over the cable connector or pulley.

CONCLUSIONS AND RECOMMENDATIONS

1. The U2-R can be safely operated from an aircraft carrier. Because of the larger elevator and opening at the hangar deck, only the "Kitty-hawk" class (CVA 63 and above) should be considered.

2. Wind across the deck between 20 knots and 35 knots for landing is satisfactory. Arresting gear setting should be 20,000 pounds. At normal landing weight, runout will be between 160 feet and 225 feet depending on relative wind velocity.

3. All four arrestment cables can be used by the U2-R. If the pilot lands off centerline he can steer to the safe side during runout.

4. Takeoff performance on either angle deck or straight deck is satisfactory. Pogos should be used for heavy takeoffs. To preclude Fresnel Lense damage by a pogo, heavy takeoffs should be made on the straight deck.

5. For future training operations the aft gear doors and hook fairings should be removed. This will allow sufficient clearance for cable whip without damaging the aircraft or fairings.

6. When fueling aboard a carrier for a heavyweight takeoff, obtaining fuel balance is more difficult than on land. The wings should be secured to the deck in a level position. If possible, the ship should be ballasted level and held on a straight course between the fueling period and the takeoff.

7. The RX 107 kit should include a device for the tip skid to slide up over protuberances on the deck.

8. Extreme caution must be exercised in maintaining lateral balance of the aircraft while on the elevator.

PILOTS REPORT

Date: 21 November 1969 A/C Serial: 055 Pilot: [redacted] STAT

Test: Carrier Landing Demonstration

Weather: Scattered clouds with gusty winds. Ten miles visibility under the clouds with moderate turbulance. Wind varying 19 - 33 knots 30° left and right of carrier slant deck centerline.

Report: I took off from Wallops airport and headed directly for the ship at 5,000 feet. The ship was spotted fifteen miles out and the pattern was entered at 400 feet to the right of the ship on the ships heading. I flew three minutes beyond the ship and made a left turn onto the down wind using 20° bank angle. Several low passes were made in order to finalize the pattern and burn out some of the 1,200 gallons of fuel on board. The turbulence was extremely bad, however, lateral control was no problem in the pattern. The burble effect from the rear of the ship was quite noticeable. During the final stages of the approach the aircraft loses airspeed and sinks, then the power must be added and just as the power takes effect the airspeed is increasing and the altitude is increasing as the approach end of the deck is crossed. On go around at the crotch, where the angle deck meets the straight deck, there is a tremendous up draft along with a rapid left wing drop which is easily controlled. On the first arrestment I was holding from 5 to 10° drift correction down the final approach and the airspeed was fluctuating ± 10 knots during the most turbulent periods. The usual burble effect was encountered and after the LSO gave the cut I had to make a correction to the right to line up with the centerline of the angle deck. The touch down was made right wing first then tail wheel then main gear. The touch down was smooth with a very mild deceleration on the run out. Steering corrections were made

Report: (Cont.)

throughout the roll out to maintain just slightly right of center line. After the cut, power was left at idle throughout the runout. On the No. 2 landing the same 5 - 10° left drift correction was held on final, the same burble effect was encountered, and after the cut on this landing a slight right turn was made to line up with the angle deck center line. The touch down was two point and the wings remained level throughout the runout. The right rudder was used to steer the aircraft to the right during the runout.

FIGURE INDEX

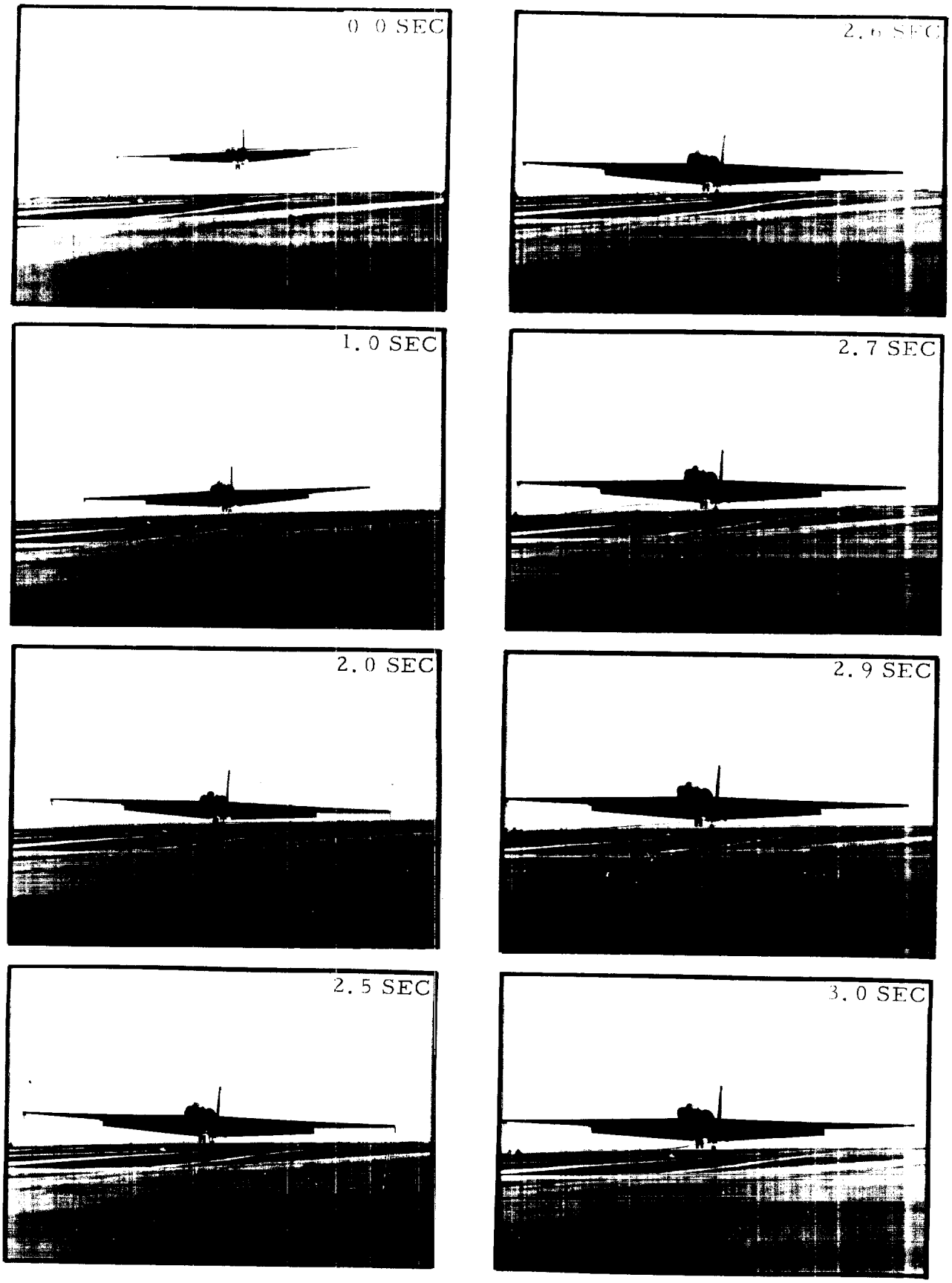


FIG. 1 SECOND LANDING

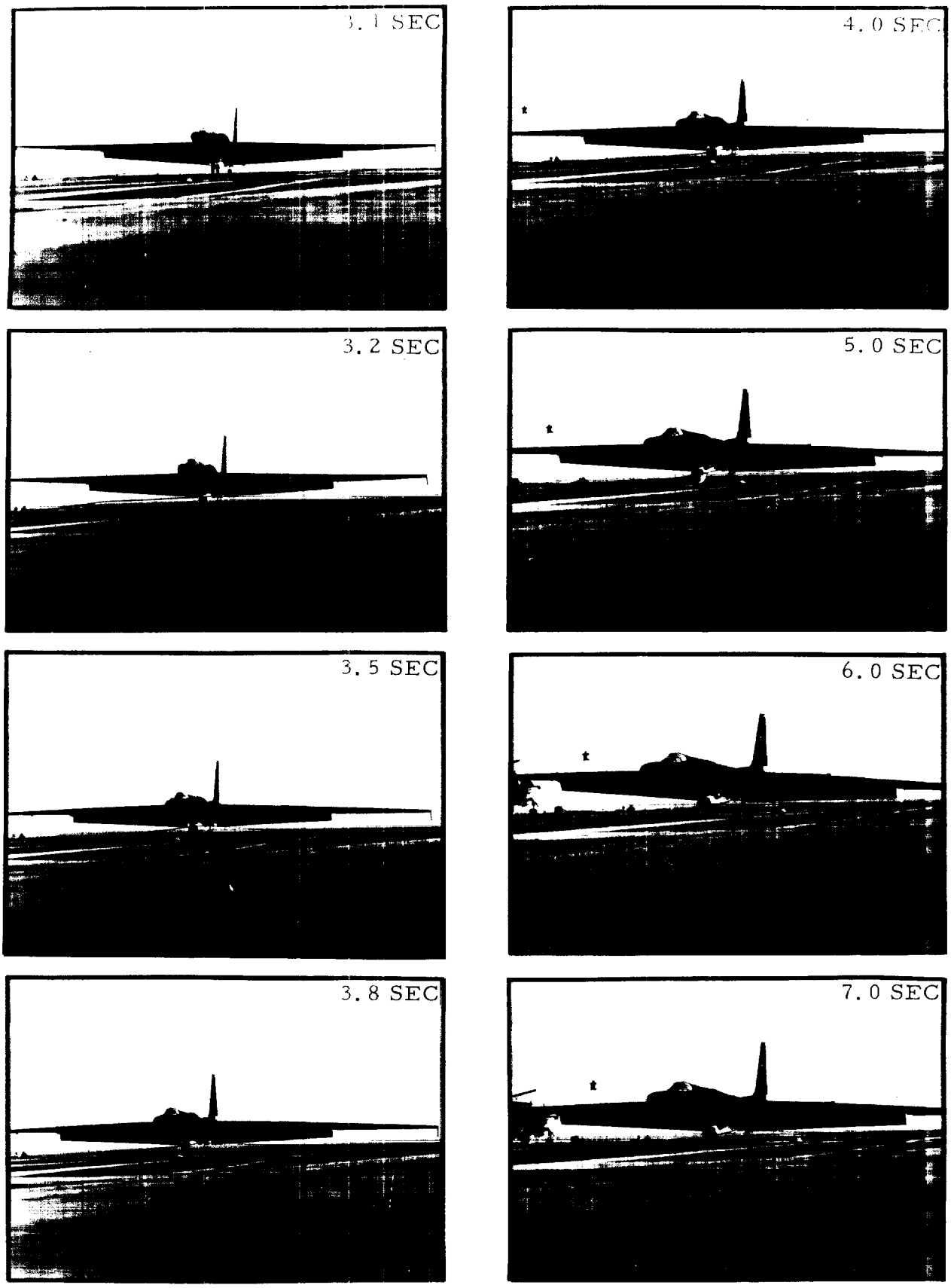


FIG. 2 SECOND LANDING CONTINUED

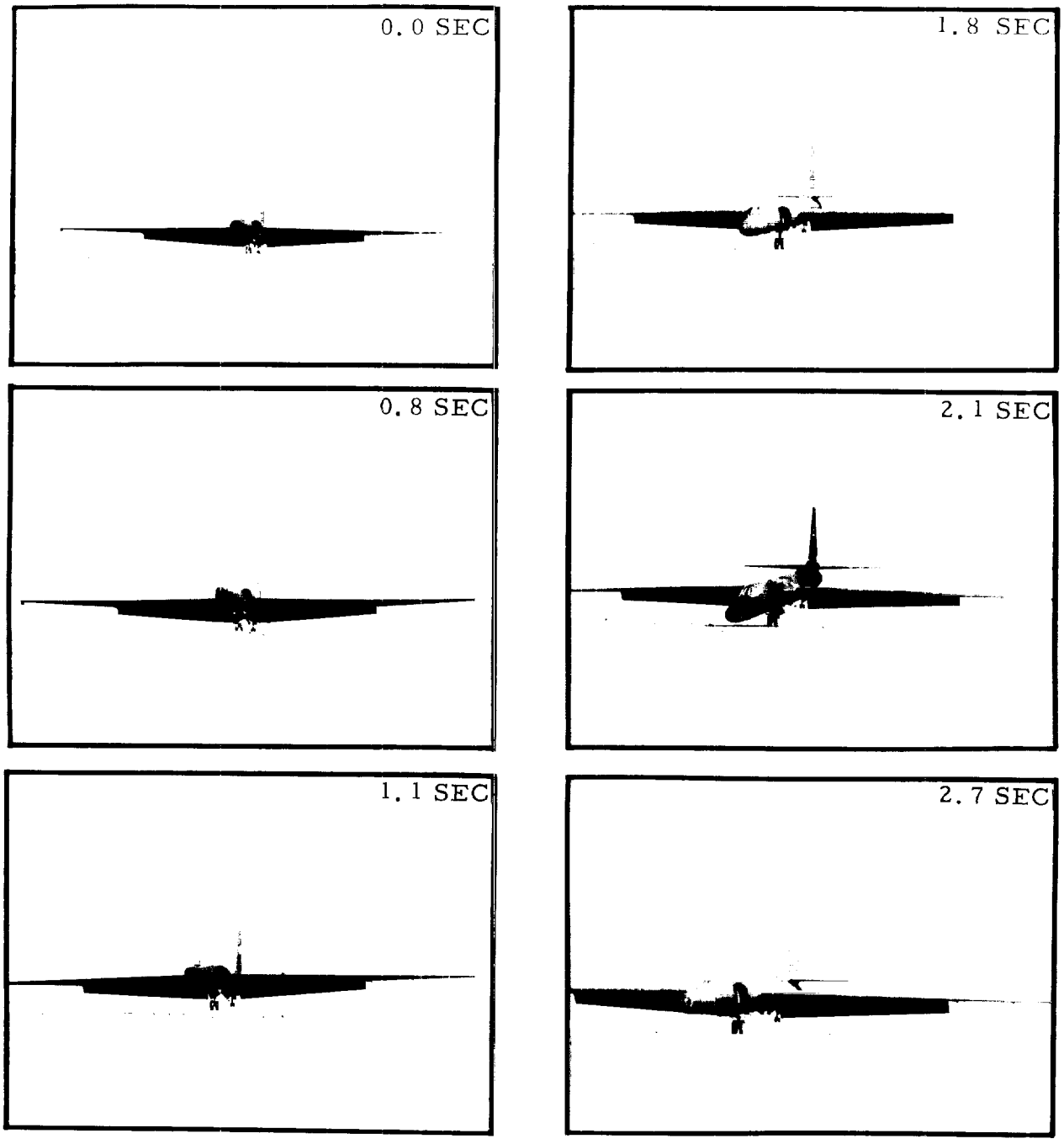
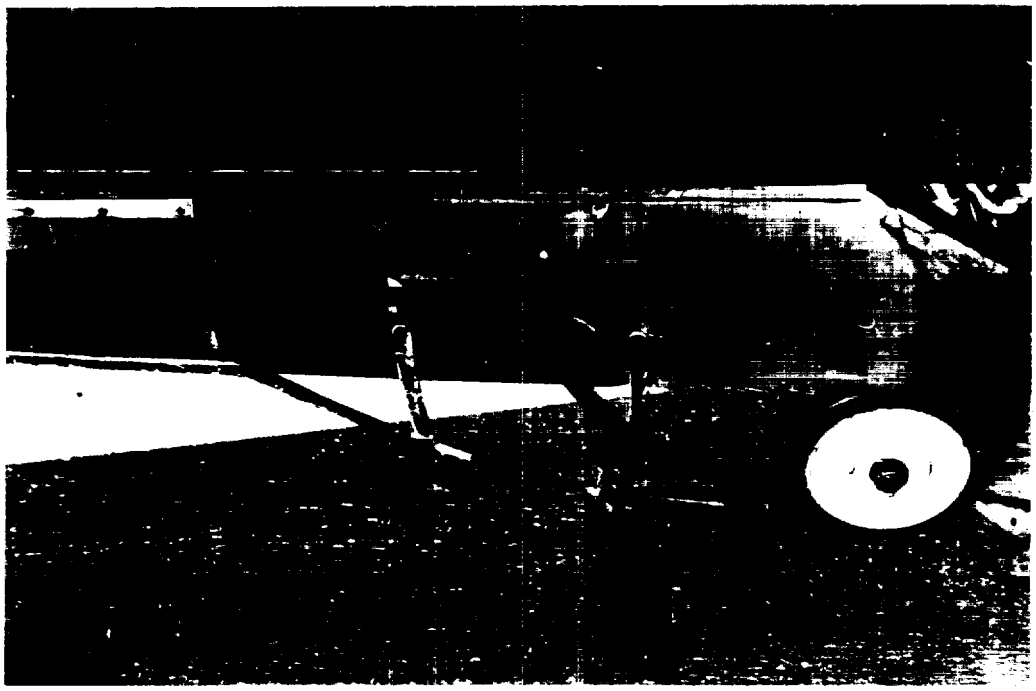


FIG. 3 LOW NOSE DIP CAUSED BY CABLE HOOKUP ON BOUNCE



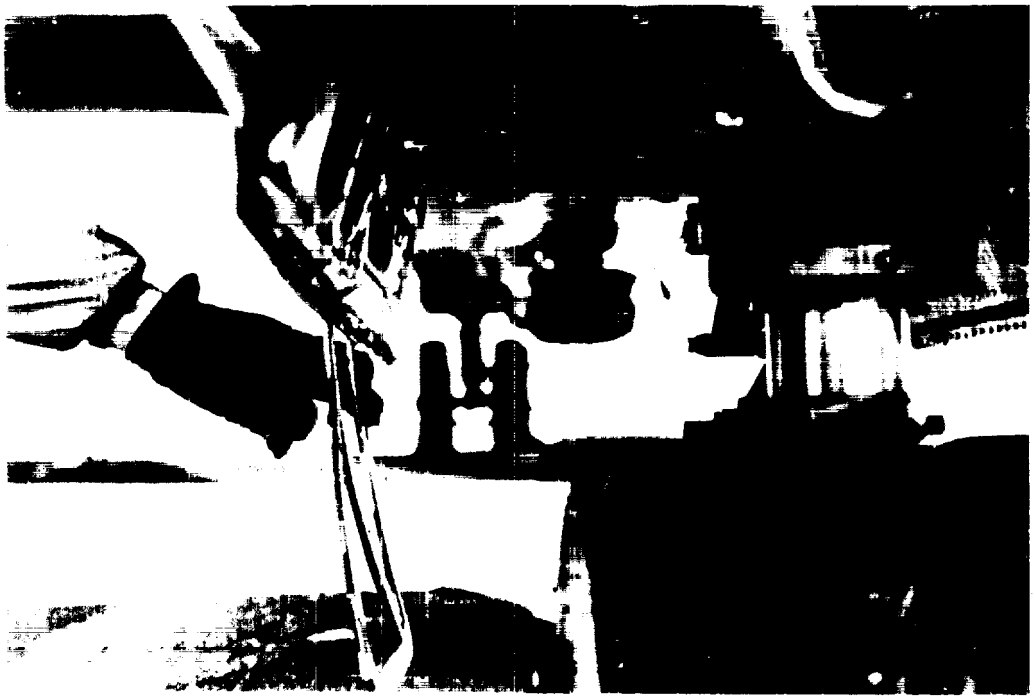
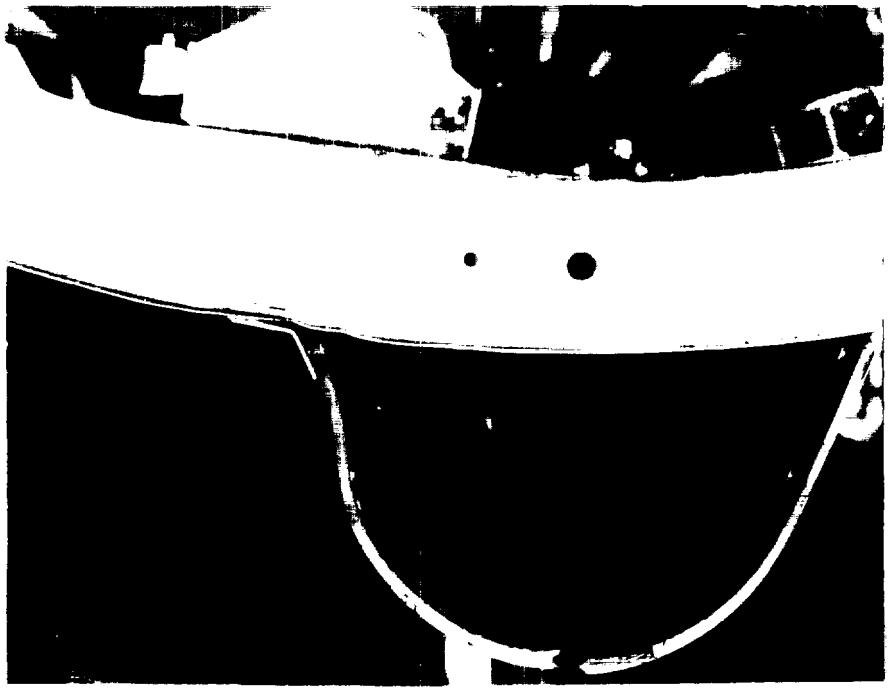


FIG. 7 DAMAGED L.H. TAILGEAR DOOR



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CRACKED STA 608 BULKHEAD RING

7374-10

DENTED SKIN AND RING STA 608

FIG. 8 FUSELAGE DAMAGE

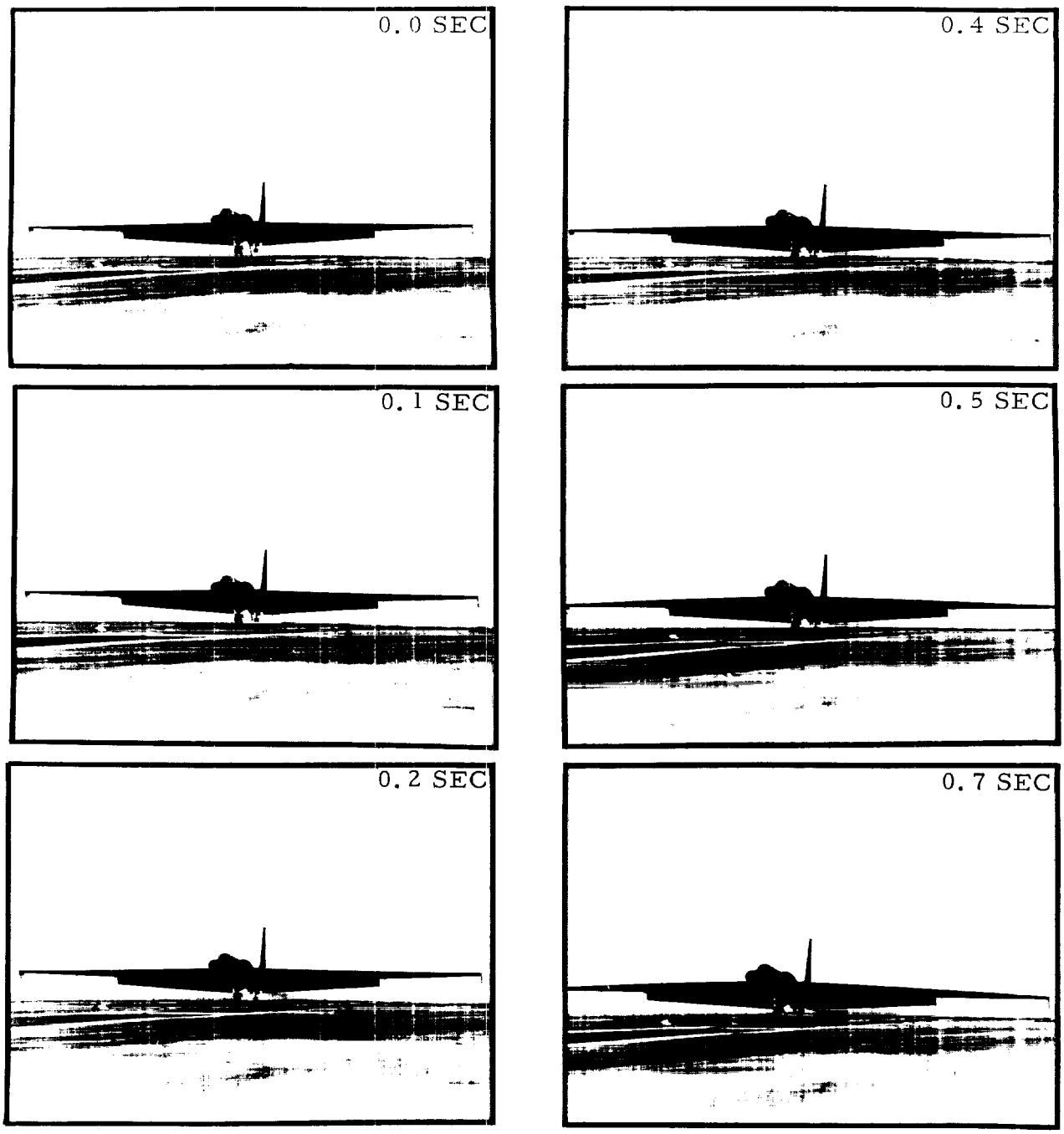
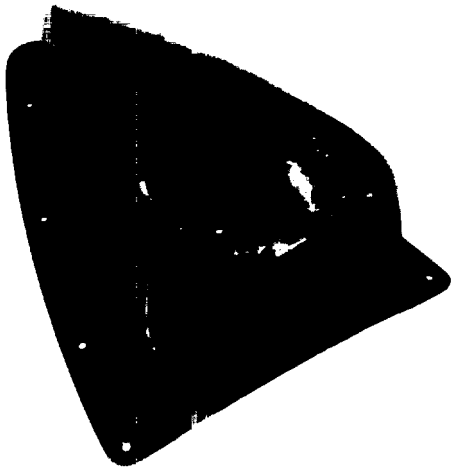


FIG. 9 HOOK BOUNCE CAUSED BY DEFLATED HOOK SNUBBER



7374-6

DAMAGED HOOK AFT FAIRING CAUSED BY CABLE WHIP

7374-4

DAMAGED HOOK FAIRINGS CAUSED BY HOOK MOVEMENT

FIG. 10 FAIRING DAMAGE